Regulation Impact Statement: for Decision

Phasing Out Greenhouse-Intensive Water Heaters in Australian Homes

Prepared for the

National Framework for Energy Efficiency

by

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with National Institute of Economic and Industry Research

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The RIS was prepared by George Wilkenfeld & Associates (GWA), who also managed the research for the impact assessment on behalf of DCCEE. The scenario modelling of the water heater market was carried out by the National Institute of Economic and Industry Research (NIEIR). The RIS draws on a range of studies commissioned by DEWHA, including energy price projections prepared by Syneca Consulting, simulations of thermal performance by Thermal Design, and consumer research on water heater purchase behaviour by Winton Sustainable Research Strategies.

The expert advisory group for the project comprised Peter Dempster (Syneca Consulting), Lloyd Harrington (Energy Efficient Strategies), Alan Pears (Sustainable Solutions), Hugh Saddler (Pitt&Sherry) and George Wilkenfeld (GWA).

Executive Summary

Background
This Decision Regulatory Impact Statement (RIS) has been prepared to communicate the potential costs and benefits arising from the proposed phase-out of greenhouse gas intensive hot water heaters from existing Australian houses (Class 1 dwellings: defined in the Building Code of Australia as detached, row, terrace or town houses, but not including apartments).

Policy and Consultation
The Council of Australian Governments (COAG) under the National Framework for Energy Efficiency in December 2008, and again under the National Strategy on Energy Efficiency in July 2009, agreed to investigate the phase out of greenhouse-intensive water heaters in Australian homes, to assist householders save money on energy bills and contribute to reducing Australia's greenhouse gas emissions. National agreement was subject to further investigation on the costs and benefits of implementing a two stage phase-out for existing homes.

If agreed, the phase-out will apply in all states and territories except Tasmania. Tasmania has declined to participate in the program, citing the low greenhouse intensity of its public electricity supply due to a high proportion of hydro-electric power generation.

The water heater industry has been aware of the proposals since 2007, and made extensive submissions on the Consultation RIS published in January 2010.

The problem
The present pattern of water heater choice results in significantly higher economic costs to the community and higher greenhouse gas emissions than if consumers selected the options with the lowest lifetime costs.

Water heater replacements generally occur in a crisis situation as stress purchases, where systems suffer a catastrophic failure. Replacement decisions are usually rushed with inadequate research. Buyers often select the cheapest capital cost option even if they know it to have higher lifetime costs. The most common replacement is 'like for like'.

Domestic Water Heating Background and Market
Around half of Australia's 8 million homes have greenhouse-intensive electric water heaters, which produce up to three times the greenhouse gases of low emission alternatives. As Australian electricity generation is primarily coal based, electric water heaters will remain the most greenhouse-intensive type for decades, despite changes in generation fuel mix expected under the Renewable Energy Target (RET) and proposed carbon pricing measures.

Water heating is the second largest energy user in households, accounting for nearly 23% of household energy used in 2008, 22% of household greenhouse gas emissions and over 5% of total stationary energy sector emissions. Electricity accounted for about half of water heating energy but 80% of water heating emissions. Natural gas supplies most of the balance with some use of LPG and direct solar.

Greenhouse gas-intensity
The aim of the proposed measure is the phase-out of 'greenhouse-intensive water heaters'. An emissions intensity exceeding 100 g CO_2-e/MJ of energy delivered is proposed as the

regulatory definition of ‘greenhouse-intensive’.[1] This metric was adopted, for new houses, in the 2010 revision of the Building Code of Australia (BCA), along with a simple method of calculation.

Modelled impacts
The most effective and efficient way to phase out electric water heaters is to regulate against their installation, except in restricted circumstances. The options examined in this RIS are:

- A ‘Business as Usual’ **(S1 BAU)** model of actual market behaviour, based on observed tendencies to replace ‘like’ with ‘like’, resist high capital purchases and under-value investment in more efficient water heaters;
- exclusion of electric water heaters from the entire replacement market after 2010 (the **S2 Rapid** scenario); and
- Exclusion of electric water heaters from the replacement market in some areas after 2010 and in all areas after 2012 (the **S3 Extended** scenario).

The cost-benefit analysis in this RIS takes into account the value of Renewable Electricity Certificates (RECs) created by solar and heat pump water heaters, as these are legislated until 2030. It does not incorporate the value of any Commonwealth or State rebates, as these can change at any time.

Water heater purchasers will respond to the withdrawal of electric water heaters from the market by either:

- preferring solar and heat pump water heaters, with high capital costs but also high energy cost savings (**Model A, B** – these are differentiated by energy prices); or
- preferring natural gas and LPG water heaters, with lower capital costs but also lower energy savings (**Model C**).

Either of these responses would reduce the water heating emissions of a household by 50% to 60%, compared with replacing an electric water heater.

The main findings from modelling these scenarios are summarised in Table E1. Rapid phase-out (S2) has slightly higher impacts in terms of greenhouse gas reductions, which is the main objective of the proposal, followed closely by Extended phase-out (S3) (Figure E1).

In the Extended Phase Out, emissions from household water heating in 2020 would be 4.2 Mt lower than otherwise. This is equivalent to 1.4% of the total emissions from stationary energy combustion in 2008, the latest published National Greenhouse Gas Inventory.

The water heaters that would substitute for the electric types excluded from the market could either cost about the same to purchase and install (e.g. LPG), cost slightly more (natural gas, heat pump) or significantly more (solar). They could cost less to run (solar, heat pump), about the same (natural gas and, if a household has low hot water use, LPG) or significantly more (LPG).

The average capital cost increases shown in Table E1 will be offset by lower energy costs under most scenarios, except that in some scenarios the savings take longer to exceed costs. The phase out would be about equally cost-effective for all household income groups, with slightly greater net benefit for the lowest incomes (less than $40k/yr) and the highest (more than $100k/yr). However, the initial capital cost will be a more significant issue for lower income groups.

[1] Greenhouse-intensity for the purposes of this RIS depends on the greenhouse- intensity of the type of energy used and the quantity of energy a water heater consumes to deliver a given quantity of hot water. It excludes the emissions associated with the manufacture or transportation of water heaters.

Table E1 Assessment of options against main criteria

Criterion	Year or Period (a)	S2 (Rapid Phaseout) - Changes from S1 (BAU) Scenario			S3 (Extended Phaseout) – Changes from S1 (BAU) Scenario		
		Model B	Model C	Interpolated	Model B	Model C	Interpolated
Cumulative greenhouse reduction compared with S1 BAU	2011-20 T	34.5 Mt	19.4 Mt	30.5 Mt	31.3 Mt	18.0 Mt	28.0 Mt
	2011-20 C	60.6 Mt	34.5 Mt	54.3 Mt	56.3 Mt	36.4 Mt	51.1 Mt
	2011-30 T	80.9 Mt	50.8 Mt	65.6 Mt	77.2 Mt	49.1 Mt	62.5 Mt
	2011-30 C	102.1 Mt	63.0 Mt	82.0 Mt	98.3 Mt	64.6 Mt	78.7 Mt
% emissions reduction compared with S1 BAU	2011-20 T	29%	17%	26%	26%	16%	24%
	2011-20 C	36%	21%	32%	33%	22%	30%
	2011-30 T	37%	25%	31%	35%	24%	30%
	2011-30 C	39%	26%	33%	37%	27%	31%
Emission reduction achieved in 2020	2020	5.2 Mt	3.4 Mt	4.3 Mt	4.9 Mt	3.4 Mt	4.2 Mt
NPV Net benefit (cost) (b)	2011-20 T	$M 714	($M 151)	NA (e)	$M 657	($M 188)	NA (e)
	2011-20 C	$M 2,452	$M 281	NA (e)	$M 2,252	$M 215	NA (e)
	2011-30 T	$M 3,586	$M 1,009	NA (e)	$M 3,405	$M 965	NA (e)
	2011-30 C	$M 4,621	$M 1,365	NA (e)	$M 4,408	$M 1,325	NA (e)
Benefit/cost ratios (b)	2011-20 T	1.3	0.7	NA (e)	1.4	0.6	NA (e)
	2011-20 C	2.2	1.5	NA (e)	2.3	1.4	NA (e)
	2011-30 T	2.3	2.9	NA (e)	2.4	3.1	NA (e)
	2011-30 C	2.6	3.6	NA (e)	2.8	3.9	NA (e)
Implied $/tonne CO_2-e saved (c)	2011-20 T	−$20.7	+$7.8	NA (e)	−$21.0	+$10.5	NA (e)
	2011-20 C	−$40.5	−$8.1	NA (e)	−$40.0	−$5.9	NA (e)
	2011-30 T	−$44.3	−$19.9	NA (e)	−$44.1	−$19.7	NA (e)
	2011-30 C	−$45.3	−$21.7	NA (e)	−$44.9	−$20.5	NA (e)
Increase in average water heater cost	2011-20	$512 (29%)	$138 (9%)	NA (e)	$449 (26%)	$90 (6%)	NA (e)
Increase in low-income household water heater cost (d)	2011-20	$M 142	$M 39	NA (e)	$M 119	$M 25	NA (e)
Impact on local manufacturing		Neutral	Negative	NA (e)	Neutral	Negative	NA (e)
Impact on installation activity		Positive	Positive	NA (e)	Positive	Positive	NA (e)
Net impact on employment		Positive	Neutral	NA (e)	Positive	Neutral	NA (e)
Administrative complexity		Simplest	More complex	NA (e)	Simplest	More complex	NA (e)

(a) T=analysis truncated at end of period. C= lifetime energy use for water heater cohorts installed up to 2020 taken into account. (b) Net Present Value at 7% discount rate. (c) Negative values indicate that value of energy savings alone cover the abatement costs. (d) Total increase in capital costs of water heater purchases by households with income less than $40k. Will be exceeded by NPV of energy savings to those households. (e) Models B and C represent different water heaters market conditions, so not valid to average monetary outputs. Interpolation of emissions outcomes is valid, since models use same emissions intensities.

Impacts on the water heater industry

The projected increase in capital costs would mean an increase in revenues to water heater manufacturers, importers and installers. All suppliers of electric storage water heaters also supply other types, so none would be excluded from the market by the proposed measure. The largest suppliers both import and manufacture locally, so would gain irrespective of how the growth in market value were distributed.

While some manufacturers may be negatively impacted, the overall net impact on local water heater manufacture is expected to range from neutral under Model B to negative under Model

C. However, any negative impacts under Model C would probably be less than the positive impacts on local manufacturing from the stimulation of solar and heat pump demand by government rebates in recent years.

The impact on installation activity, which is more labour-intensive than manufacture and more evenly distributed across jurisdictions, would be positive under both Model B, which indicates a higher solar market share, and under Model C. Therefore the net employment implications of S2 and S3 range between positive and neutral, even without rebates.

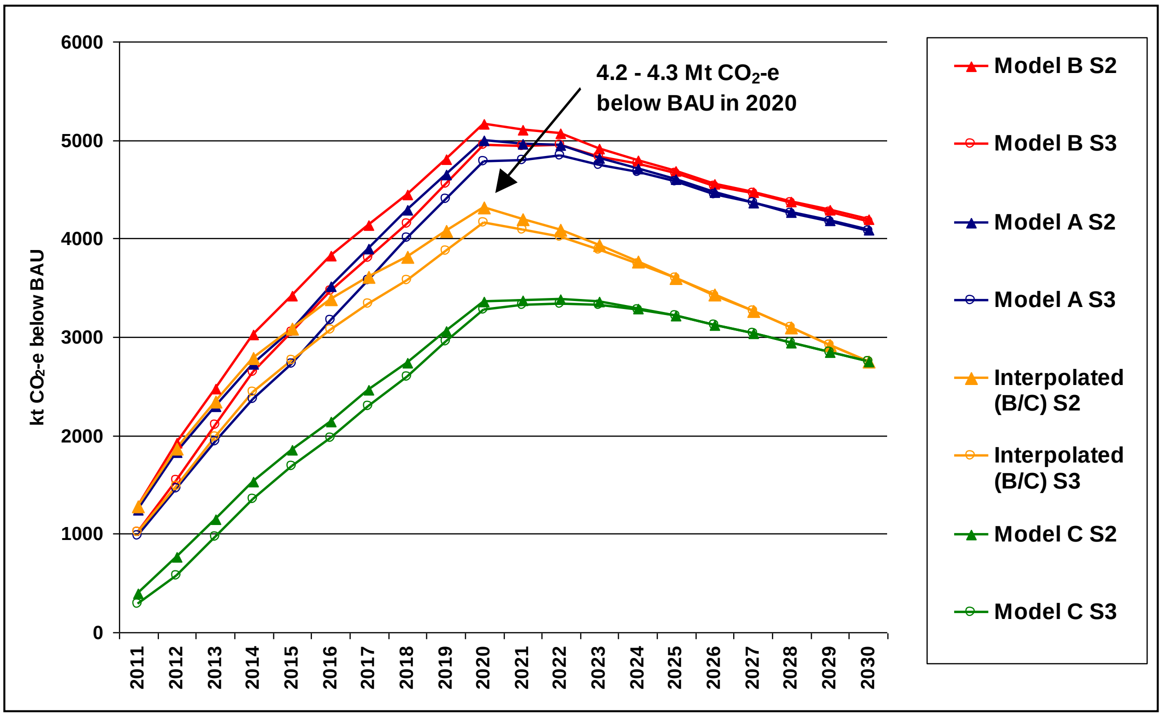

Figure E1 Projected greenhouse gas reduction from water heaters, existing houses

Compliance and Administration

The obligation to comply with the proposed plumbing regulations will rest with any person installing a water heater, but the main compliance burden would be on plumbers and other installers such as electricians and gas-fitters.

Extended phase-out (S3) differs from Rapid phase-out (S2) in that there is a two year period where the measure applies in some areas but not others. While this adds complexity to administration and compliance, an extended implementation period allows early impacts to be monitored and administration to be fine tuned by the time the measure becomes universally applicable.

Sensitivities and Risks

The projected energy costs used in this RIS incorporate the most recent price increases granted by the Australian Energy Regulator and the impacts, beginning in 2013, of carbon pricing measures with effects similar to those projected by Treasury under a 'CPRS-5' scenario (aiming for national emissions to be 5% lower than the 2000 levels by 2020). Price increases already granted have a greater impact than future carbon-related costs, so the RIS findings are relatively robust irrespective of carbon pricing assumptions.

For solar water heaters there are some risks of poor matching of product selection and performance to hot water demand and climate conditions, and poor installation. The level of plumber and installer expertise is progressively improving as familiarity with solar installations grows, but the risks could be reduced with further intensive training programs.

The primary compliance obligation will fall on plumbers and other installers. There is a risk that some will be unaware of their requirements, especially in the early stages. There will also be a continuing risk that some will choose not to comply, either on their own initiative or in response to customer requests or demands. These risks would be highest in stage one of the Extended phase-out scenario (S3) but can be minimised through clear rules and guidelines, training programs, and monitoring by the appropriate inspectors. Jurisdictions which rely on random rather than universal inspection of plumbing work may need to consider increasing the rate of inspections in the early phases of implementation.

There is a risk that some householders will adopt LPG solely because it is the lowest capital cost option, and not because it is the most cost-effective long term option. Low-income and rental households could be left with high operating costs which leaves them especially vulnerable. The extent of this will not become apparent until the electric water heater phase-out extends to areas without a natural gas supply. If necessary, monitoring programs and the early development of policy responses would mitigate this risk.

Recommendations

The quantitative analysis indicates that the adoption and implementation of a rapid phase out of existing hot water heaters from Class 1 buildings (ie houses) would deliver the greatest net benefit to the community as a whole. While this option would support a rapid transition towards the exclusion of electric hot water heaters from the replacement market after 2010 there would be constraints in implementation due to timing. A rapid implementation in 2011 would be difficult for the water heater manufacturing industry, importers of water heaters, councils, plumbers, electricians and other stakeholders to implement. Staged implementation would provide for additional time to educate installers as to their obligations under the new rules, thus increasing the probability of compliance.

In addition, the staged implementation option will provide a greater opportunity to jurisdictions to develop administrative structures and programs to assist groups that may be vulnerable such as low income households not connected to gas. Hence, the rapid phase out is not put forward as the preferred option but rather an adjusted version of it that takes account of these limitations is recommended as likely to deliver the highest net community benefit. Noting: that the National Hot Water Strategic Framework allows for '…individual jurisdictions may opt to bring forward the program including introducing more stringent requirements.' (MCE 2008)

Therefore, following consideration of additional cost-benefit modelling, and review of the submissions made by industry and other stakeholders in response to the Consultation RIS, it is recommended that:

1. In view of the effectiveness of reducing emissions, and the overall cost-effectiveness for householders, greenhouse gas-intensive water heaters should be phased out from Class 1 buildings (i.e. houses) through prohibiting the installation of electric resistance water heaters, with certain exemptions.
2. In view of the advantages of a staged implementation, the phase-out should be implemented in two stages; the first stage from 2010 and the second from 2012.

3. In view of the time required to develop uniform national regulations, each Australian jurisdiction should implement the first stage under its own plumbing regulations, and the second stage through common provisions, such as those which may be developed for the Plumbing Code of Australia.
4. Each jurisdiction should determine its own rules for the first stage of implementation, based on criteria such as location and/or gas connection status, targeting houses where compliance options are likely to be wider and cheaper.
5. The second stage should apply across the entire jurisdiction, subject to certain exemptions.
6. The second stage should preferably take effect at the same time across all implementing jurisdictions. This would minimise disruption to the market and the water heater industry.
7. Given that there is already a method of calculating the greenhouse gas intensity of water heaters in the Building Code of Australia (BCA), the list and method for the phase out should be similar to that of the BCA.
8. The same general exemptions provided for new Class 1 buildings in the BCA, would apply to existing buildings. These include rules under which electric resistance water heaters can be installed in defined situations, or where the electricity is supplied directly from renewable sources.
9. Jurisdictions should develop guidelines and administrative procedures for assessing and granting special exemptions, in cases where installing any water heater other than electric would be unsafe or excessively costly.
10. Where solar or heat pump water heaters are installed, the performance requirements should be similar to those applying to new Class 1 buildings in the BCA.
11. In view of the need to inform installers of the regulatory obligations and to increase skills in anticipation of growing demand for non-electric water heater types, information and training programs on the proposed phase-out should be developed and implemented for plumbers and installers.
12. In order to make householders more aware of their options when it comes time to replace their water heaters, information programs on the proposed phase-out and replacement options should be developed and targeted to households with electric water heaters.

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Glossary

ABCB	Australian Building Codes Board
AGA	Australian Gas Association
AS	Australian Standard
BCA	Building Code of Australia
BAU	Business as Usual
Capital cost	Sum of purchase price and installation cost
Class 1 BCA	Detached, row, terrace or town houses, hostels and boarding homes
Class 2 BCA	Apartments
COAG	Council of Australian Governments
Cohort	A group of water heaters installed in a specified year or period
DCCEE	Department of Climate Change and Energy Efficiency
DEWHA	Department of the Environment, Water, Heritage and the Arts
DR	Discount rate
DTS	Deemed to satisfy
ESWH	Electric storage water heater
F&M	*Factors and Methods Workbook* published occasionally by the Australian greenhouse Office
GH	Greenhouse
GWA	George Wilkenfeld and Associates
GSWH	Gas storage water heater
HH	Household
HPWH	Heat pump water heater (where water is heated mainly by a vapour compression process, although may be boosted by other means)
Interp.	Interpolation between outputs of Model B and Model C, indicating a transition (rather than a mean or average)
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
MCE	Ministerial Council on Energy
MEPS	Minimum Energy Performance Standards
Model A	Cost-benefit modelling carried out for the Consultation RIS
Model B	Model A results updated with later energy price and greenhouse gas-intensity projections
Model C	Cost-benefit modelling carried out for the Decision RIS
Mt CO_2-e	Million tonnes of CO_2 – equivalent emissions
MRET	Mandatory Renewable Energy Target (succeeded by RET)
NIEIR	National Institute of Economic and Industry Research
NPV	Net present value
OP	Off-peak (electricity tariff)
ORER	Office of the Renewable Energy Regulator
REC	Renewable Energy Certificate (as determined by ORER)
RET	Renewable Energy Target
RIS	Regulation Impact Statement
S1	Scenario 1. Also called S1 BAU (no regulations)
S2	Scenario 2. Also called S2 Rapid (rapid implementation)
S3	Scenario 3. Also called S3 Extended (extended implementation)
S-EWH	Solar water heater with electric boost
S-GWH	Solar water heater with gas boosting
SWH	Storage water heater (where water heated by electricity, gas, solar energy or any combinations is stored hot for later use)
WH	Water heater
WHIP	Water Heater Industry Proposal

1. Introduction

Background

The Council of Australian Governments (COAG) in the National Framework on Energy Efficiency (December 2008) and again reinforced under the National Strategy for Energy Efficiency (July 2009) agreed to investigate the phase-out greenhouse-intensive water heaters in Australian homes to assist householders to save money on energy bills and contribute to reducing Australia's greenhouse gas emissions.

This Decision Regulatory Impact Statement (RIS) has been prepared to communicate the potential costs and benefits arising from the proposed phase-out of greenhouse gas intensive hot water heaters from existing Australian homes (Class 1 dwellings). Class 1 dwellings under the Building Code of Australia are classified as detached, row, terrace or town houses, along with hostels and boarding homes.

National agreement to the phase-out was subject to further investigation on the costs and benefits of implementing a two stage phase out for existing homes. Stage 1 would commence in 2010 and would require that electric resistance hot water systems no longer be installed in any existing Class 1 homes that have access to reticulated gas. Stage 2 would require that from 2012, electric hot water systems no longer be installed in any existing Class 1 homes, except where an exemption applies. The Ministerial Council on Energy (MCE) will make a final decision on the merits of implementing the phase-out nationally.

A separate RIS was prepared and agreed to by the Building Ministers Forum in 2009 for the phase-out of greenhouse intensive water heaters in new homes. The Phase-out for new dwellings is to be implemented through the Building Code of Australia. State and Territory governments have undertaken to implement the new residential standards no later than May 2011.

Domestic Water Heater Market Characteristics

Domestic water heating is the supply of hot water for personal washing, showering, cooking, dishwashing, clothes washing and similar uses. There are over 7 million separate domestic water heaters installed in Australian houses, and a further 1 million in apartments and other accommodation (see further data in Annexe 1).

Water heating accounts for nearly 23% of the energy used in Australian households and about 22% of the greenhouse gas emissions from household energy use. 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. Because electricity is the most greenhouse-intensive form of delivered energy, it accounted for nearly 80% of the emissions from water heating.

The main factors influencing annual water heaters sales are the construction of new homes, major renovations and the replacement of existing water heaters at the end of their service lives, which differs by type (Annexe 2). It is estimated that about 75% of water heater sales are for the replacement of an existing unit, 20% are installed in new houses and 5% installed during renovation of an existing house.

Market share by water heater type

Electric storage water heaters accounted for about 53% of the total national water heater stock in 2008, and for about half of annual sales until 2006. By 2010, however, the market share had fallen to about 29% (Annexe 1). After 2006, electric storage water heaters lost market share to both natural gas and solar, in response to regulations for new homes in several States and rebate and incentive schemes. If the current regulations and incentives were removed, electric storage water heaters would most likely recover much of its historical market share.

The stock share of water heater types varies considerably from State to State (Figure 1). The State with the highest gas water heater share is Victoria, followed by WA and SA. The electric water heater share is highest in Tasmania, followed by QLD and NSW. The NT is unique in that its gas reticulation network is very limited, and about half of its water heaters are solar.

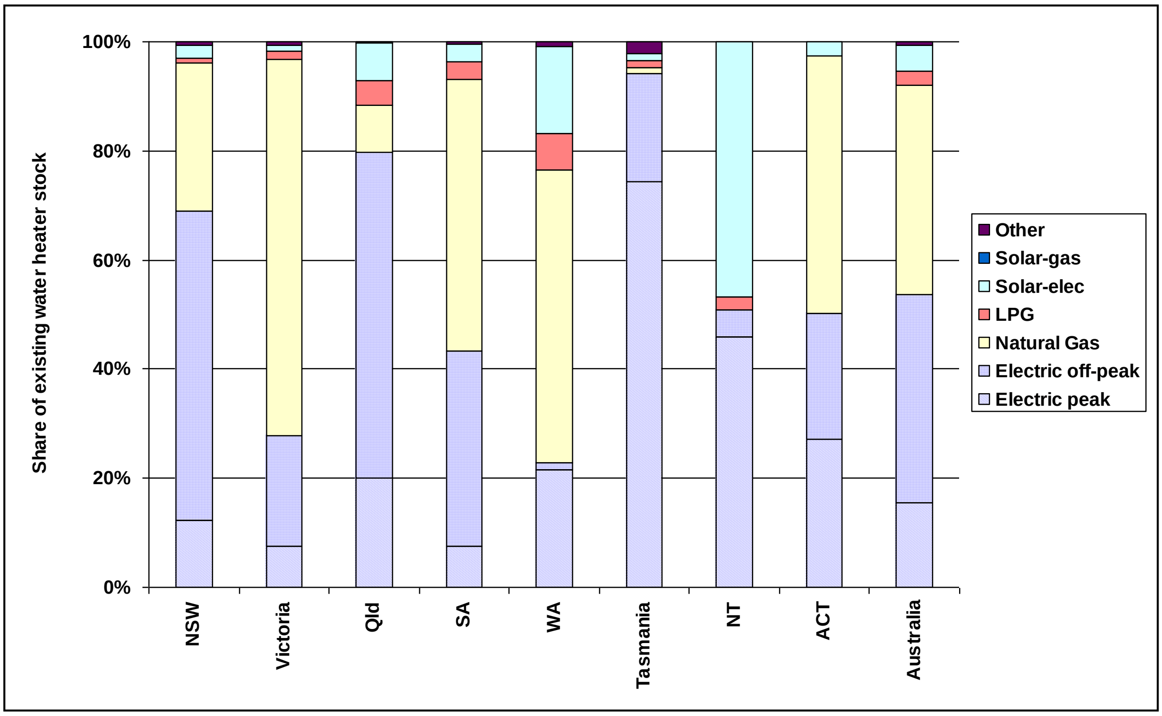


Figure 1 Share of existing water heater stock by State and Territory, 2008

Water Heater Choice

While building rates and failure rates determine the total number of new water heaters installed each year, the types chosen depend on individual purchase decisions (BIS Shrapnel 2006, 2006a, 2006b, 2008, 2010 and Winton 2008). Consumer research on the purchase decision is detailed in Annexe 1.

Replacement decisions are usually rushed, because the very high value which occupants place on continuing availability of hot water limits the time available for research, selection and installation. Decisions tend to be made under capital constraint: failures are rarely anticipated or budgeted for, so the cheapest capital cost option is often preferred even if it is known to have higher lifetime costs. The most common replacement is ‘like for like’ (Table 1).

Intermediaries exert a major influence on replacement choice. BIS (2010) reports that when a water heater fails 31% of home occupants contact a plumber, 23% a hot water specialist, 14% an energy retailer and 4% a builder: only about 21% go to the types of retailers or specialised stores that would normally be the first point of contact for the purchase of large appliances.

Table 1 Share of water heater replaced with same type

Type of water replaced	2006	2008	2010(b)
Electric	79%	63%	51%
Gas (a)	95%	96%	78%
Solar	76%	87%	78%
All types	86%	78%	66%

Source: BIS (2008,2010). (a) Includes cases where the type of gas WH changes. (b) Lower 'like for like' replacement in 2009-10 reflects influence of Commonwealth and State rebate schemes. Pattern likely to return to trend if/when rebates are removed.

Greenhouse intensity of water heaters

Water heaters are distinguished by the form of energy used (e.g. electricity or natural gas), physical configuration, capacity, level of energy efficiency, whether it maintains a volume of hot water ready for use (storage type) or heats as needed (instantaneous type) and other factors. These are detailed in Annexe 2. For the purposes of this RIS the most significant difference is the greenhouse gas emissions associated with heating water.

The aim of the proposed measure is the phase-out of 'greenhouse-intensive water heaters'. 'Greenhouse-intensity' refers to the amount of greenhouse gas produced when using an appliance. For an electric appliance the emissions occur at the power station, while for a gas or LPG appliance most of the emissions occur at the appliance itself.

In this RIS, the metric for defining a greenhouse-intensive water heater, is the same as in the 2010 Building Code of Australia (BCA), i.e. one where the greenhouse intensity exceeds 100 g CO_2-e/MJ of thermal energy. This metric takes into account both the forms of energy used and the water heater's own performance and efficiency.

Figure 2 illustrates the emissions intensity, for 'medium' hot water use (40 MJ thermal energy per peak day), in the States and solar zones which together cover about 85% of Australian houses. It shows that electric water heaters give by far the highest emissions, but the ranking and relative differences between the other technologies depend on zone and State.

In summary:

- Water heaters divide into two discrete groups according to greenhouse gas-intensity – conventional electric water heaters and all others;
- The differences in greenhouse-intensity between these two groups are greater than the differences within a technology type;
- On this basis, electric water heaters constitute the 'greenhouse-intensive' group, so the objective of phasing out greenhouse-intensive water heaters can be achieved by phasing out electric resistance water heaters; and
- The adoption of the same greenhouse-intensity metric as in the BCA (100 g CO_2-e/MJ) is justified for replacement water heaters.

These conclusions are true at both the current levels of greenhouse gas intensity of the electricity supply, and remain true for the levels of intensity projected under until well past 2030 under the CPRS, except possibly in Tasmania.[2]

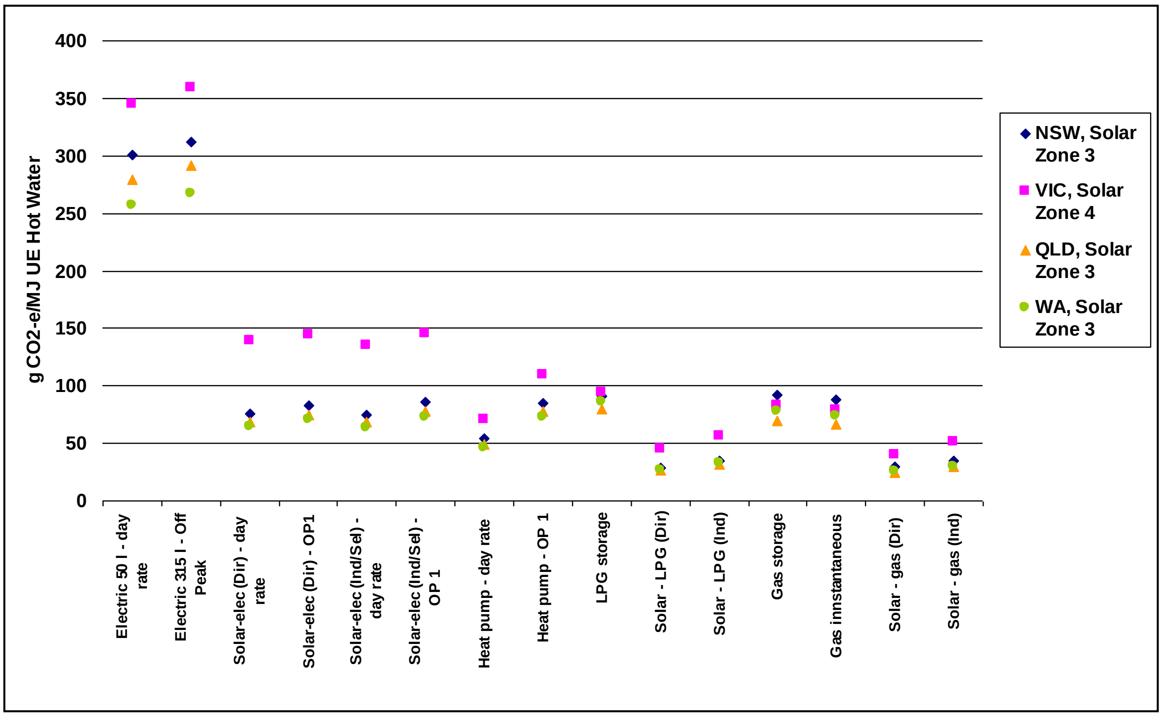


Figure 2 g CO_2-e/MJ of hot water delivered, selected states and solar zones

Calculated for 40 MJ/day delivery. Emissions calculated using falling emissions-intensity as projected in CPRS modelling (Treasury 2008), averaged over the period 2011-2020. DIR = direct-heating solar panels. IND = Indirect-heating solar panels with heat exchange fluid, suitable for frost areas. Sel = Selective surface collectors. Greenhouse intensities for those gas and solar-gas water heaters which use electricity for standby energy, combustion fans or pumps include electricity-related emissions.

Energy Labelling, MEPS, RECs and Rebates

There are several programs and initiatives which try to influence water heater purchasers towards certain types of water heaters – especially solar – or toward the more energy-efficient models within types.

At present only gas water heaters carry energy labels to indicate their relative efficiency. These labels are a voluntary industry label. A Minimum Energy Performance Standard (MEPS) level of 4 stars is currently proposed for gas water heaters, to be implemented after December 2010 (E3 2010). Electric water heaters do not carry labels, since all convert energy to heat with close to 100% efficiency and all have similar heat losses, due to the implementation in 1999 of MEPS for heat loss. For solar water heaters, the physical labelling of products is complicated by the fact that systems generally consist of several components, and system performance can only be determined if the characteristics of each component are known. However, it is feasible to label the performance of entire systems in product literature or on websites.

[2] If future hydro development is constrained in Tasmania, additional demand for electricity will be met by fossil-fuel generators located either in Victoria or in Tasmania. The marginal intensity of adding or avoiding a kWh of future electricity use will be *higher* than the historical average.

The Mandatory Renewable Energy Target (MRET) scheme, introduced by the Commonwealth Government on 1 April 2001, provides for the creation of Renewable Energy Certificates (RECs), with the number of RECs depending on the calculated performance of each model or system. The typical solar or heat pump water heater purchaser receives a REC subsidy of between $900 and $1400.

In addition to the RECs value, which is available for every solar and heat pump water heater installation in Australia (whether in a new or existing home), some jurisdictions also offer rebates or other assistance to purchasers. These are usually only available for the replacement of an existing electric storage water heater (Table 23, Table 24). Some States also offer assistance to purchasers of conventional gas water heaters, if replacing an existing electric storage water heater. These schemes are detailed in Annexe 3.

2. The Problem

The present pattern of water heater choice results in significantly higher economic costs to the community and higher greenhouse gas emissions than if consumers selected the options with the lowest lifetime costs.

Water heater replacements generally occur in a crisis situation where the system suffers a catastrophic failure. Replacement decisions are usually rushed, because the high value which occupants place on the continuing availability of hot water limits the time taken for research, selection and installation. Buyers often select the cheapest capital cost option even if they know it to have higher lifetime costs. The most common replacement is 'like' for 'like'.

The water heater market is also characterised by information failure and by principal-agent issues. For new dwellings, these market failures have been addressed by a range of State regulations which either prohibit or constrain the installation of electric water heaters. However the problem remains for replacement sales, which make up 75 to 80% of the water heater market.

3. Objectives of the Regulations

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

- bringing about reductions in greenhouse gas emissions from water heating in existing houses below current projections;
- reducing the cost of abatement; and
- helping households adjust to the impacts of rising energy prices.

The specific objectives of the proposed regulation are to:

- Provide a streamlined and consistent national approach to performance standards on the greenhouse-intensity of water heaters;
- Provide net economic and environmental benefits to the community; and
- Reduce the greenhouse-intensity of water heaters without compromising appliance safety, quality or functionality.

4. Government Policy on 'Greenhouse-intensive' water heaters

Current Policy

In December 2008 the Ministerial Council on Energy (MCE) 'agreed to a number of important initiatives under the National Framework for Energy Efficiency including:…a National Hot Water Strategic Framework' (MCE 2008).

> '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.
>
> Both the HVAC and the Hot Water initiatives will be subject to full stakeholder consultation and appropriate Regulatory Impact Statements' (MCE 2008).

In addition, the National Hot Water Strategic Framework allows for the following:

> '…individual jurisdictions may opt to bring forward the program including introducing more stringent requirements.' (MCE 2008)

This commitment was reaffirmed by the Council of Australian Governments (COAG) under the *National Strategy on Energy Efficiency* published in July 2009.

The policy framework agreed to by MCE has enabled Tasmania to take account of particular circumstances applying in that State. Based on National Greenhouse Accounts (NGA) emission factors, the government of Tasmania maintains that the greenhouse intensity of that state's public electricity system is low, due to its historically high proportion of hydro-electric power generation, and has determined that no regulatory provisions will be introduced in Tasmania to apply the phase-out. As a result, the national modelling in this RIS includes water heater sales, energy use and emissions projections for Tasmania, but these remain identical to the BAU case.

State Governments in South Australia and in Queensland have already commenced the phase out of greenhouse intensive hot water systems through State plumbing regulations. Details of their current policies are found in Annexe 3.

The Proposed Regulation

The proposal is to regulate against the installation of greenhouse-intensive water heaters in existing Class 1 buildings (i.e. houses). Class 1 dwellings under the Building Code of Australia are classified as detached, row, terrace or town houses, along with hostels and boarding homes. The regulations may take effect at different times in different regions or parts of States, but part of the objective is to co-ordinate the implementation to minimise adjustment costs for industry and householders.

The types of water heaters permitted in existing houses under the proposed regulations would be similar to those permitted in new houses under rules already in force in several jurisdictions.

The Consultation RIS recommended a two stage implementation process. Stage 1 would be implemented at the end of 2010 through existing State and Territory plumbing regulations, and Stage 2 would be implemented at the end of 2012, through one or more of the following:

- The Plumbing Code of Australia (PCA). However, the PCA does not have full national coverage, as the plumbing regulators in WA and the NT have not adopted it or committed to adopting it;
- COAG in April 2009 recommended, subject to a RIS, the consolidation of building, plumbing, electrical and telecommunications regulations into a 'National Construction Code'. This work has not been completed but if endorsed nationally, the PCA would be incorporated into the National Construction Code;
- Special State and Territory regulations, with identical or consistent provisions;
- Special national regulations; or
- Application of the existing energy labelling and MEPS regulations, to prohibit the sale of electric resistance storage water heaters (or of water heaters larger than the maximum volume that may be permitted in certain situations).

While the form of the regulation is still open to some extent, the intent is to prevent the installation of greenhouse intensive water heaters in existing dwellings, except in situations where other options are unavailable or prohibitively expensive.

There is already a wide range of cost-effective low-intensity water heater technologies on the market, so it is not necessary to wait for the introduction of new technology. The minimum lead time for implementation is therefore related to non-technical issues, such as the time required:

(a) for development and implementation of the necessary regulations;

(b) to make stakeholders including manufacturers, importers and suppliers, plumbers and other installers aware of the regulations; and

(c) to integrate the proposed measures with other programs with similar or related objectives, such as rebates and incentives.

Regulatory Options

The variants on the policy options and implementation dates are summarised in Table 2. These are organised into a number of distinct scenarios for modelling purposes.

- **S1 (BAU)** models actual market behaviour given the observed tendencies to replace like with like, resist high capital purchases and under-value investment in more efficient water heaters. S1 simulates a case in which no jurisdictions have requirements for replacement water heaters, other than SA and QLD. Effects of RECs (at a constant price of $40) are included because these are underpinned by legislation, but effects of rebates are excluded.

- **S2 (Rapid)** models a single-step implementation in which the measure nominally takes effect throughout all jurisdictions except Tasmania at the end of 2010, or within 6 months after the end of 2010 (Modelling is not precise enough to capture timing differences of less than 6 months).

- **S3 (Extended)** models a phased implementation. The first phase commences end of 2010. Second phase 2 years later. Phase 1 only applies to households which are connected to natural gas or located in areas with natural gas available. Phase 2 applies in all areas except Tasmania. This scenario was recommended in the Consultation RIS.

The Consultation RIS also modelled S0, which simulated a ‘perfect’ market, and S4, the Water Heater Industry Proposal (WHIP) (see Annexe 5), neither is repeated in this Decision RIS. All modelling has been carried out on a State by State basis, and some modelling has been done for gas and non-gas areas separately, so the policies of different States can be captured.

The Government of Tasmania has decided not to implement the phase-out. However, water heater sales, stocks, energy use and emissions projections for Tasmania are still included in the modelling to give true national totals. The values for Tasmania in S2 and S3 are unchanged from the BAU case (S1).

South Australia has implemented measures which will affect a higher share of households than would be impacted under Phase 1 of S3, but a lower share than would be impacted in Phase 2 of S3 or under S2. This is because the rules and selection criteria differ from those that would be adopted nationally. The analysis in this RIS estimates the additional impact for SA of implementing the national phase-out, within the limits of the modelling approach.

In January 2010, Queensland implemented measures which will partially give the outcomes expected in Phase 1 of S3, but has not committed to the rules proposed for Phase 2. The reduction in impact as a result of Queensland partially implementing the first phase of S3 one year earlier than other jurisdictions is not considered sufficient to warrant separate modelling.

Table 2 Replacement water heater options under various scenarios

Scenario	Description	Regions	2011, 2012	After 2012
S1 BAU	No regulations or purchase restrictions	Gas-available	Unrestricted	Unrestricted
		No gas	Unrestricted	Unrestricted
S2 Rapid	Rapid implementation at end of 2010 (a)	Gas-available	No electric	No electric
		No gas	No electric	No electric
S3 Extended	Phased implementation 2010 - 2012	Gas-available	No electric	No electric
		No gas	Unrestricted	No electric

(a) Or within 6 months of end of 2010

5. Cost-Benefit Analysis

Modelling approach

The modelling aims to simulate the likely behaviour of water heater purchasers in response to changes in water heater capital costs and energy running costs, based on past patterns of behaviour. The models were run with only current regulations in place (the 'Business as Usual' or BAU case) and then with electric water heaters removed from the market. The analysis focuses on the private costs and benefits to householders. The relationship of private to societal costs is covered in Annexe 6.

The modelling undertaken for the Consultation RIS by the National Institute of Economic and Industry Research (NIEIR) was based on 2008 dollars, and on electricity price projections that pre-dated the latest network price determinations of the Australian Energy Regulator (AER 2009a, 2009b, 2010, 2010a, 2010b). This is termed 'Model A.'

Model A has been included in this analysis for completeness only, as it was included in the consultation RIS. The main models to be considered for the decision RIS are models B and C (see Table 3 below).Following the consultation process, further modelling was undertaken to explore a broader range of possible outcomes, including the higher take-up of LPG water heaters (Table 3). 'Model B' is identical to Model A except that it is based on 2010 dollars, updated energy price and greenhouse intensity projections, and takes into account the deferral of carbon pricing.

'Model C' simulates how the market would behave if buyers had foreknowledge of rapidly rising energy prices, but still discounted them heavily in favour of lower capital cost purchases. Buyers may well continue to choose water heaters much as in Models A and B for some time, until their electricity price expectations adjust to the new price trends. The actual financial consequences of the choices, however, will be determined by the energy costs in Model C.

Model B indicates what would happen if buyers continue to behave as in the recent past, while Model C projects expected energy-price-induced changes in behaviour. It is likely that water heater buyers will take about a decade to move from Model B behaviour to Model C. The simplest way to represent this shift is to interpolate a transition from one curve to the other.

Table 3 Models A, B and C

Model	Discount rates	Energy prices	Other	Outcomes
MODEL A	7%, 3%, 11% (a)	Previous projections (2008$)	Used in Consultation RIS	Favours solar, heat pump
MODEL B	7%, 3%, 11%	Revised projections (2010$)	Identical to A except for revised energy prices, emissions	Favours solar, heat pump
MODEL C	7%, 3%, 11%	Revised projections (2010$)	Complete re-run, re-definition of gas regions, water heater demand	Favours gas, LPG

(a) Model A results with discount rates of 6%, 3% and 9% were published in Consultation RIS.

All scenarios are modelled at the State and Territory level, and then aggregated to national totals. Differences in State water heater regulations and phase-out policies can be represented by combining different scenarios. To reflect the impact for SA of moving from its existing rules to the national phase-out, the national BAU case in Model C excludes electric water heaters in gas-available regions of SA (Table 4), although the existing SA rules apply by postcode rather than by area of natural gas availability so the match is not exact. Gas/non-gas disaggregation is not possible in Model B. **As the final outcomes are likely to be between the Model B and C projections,** this approach gives a reasonable indication of the likely impacts on SA, even if neither model gives a perfect match.

Table 4 Scenario definition by jurisdictions, Model C

Scenario	NSW	Vic	Qld (b)	SA	WA	Tas (a)	NT	ACT
S1 (BAU)	S1	S1	S1	S2 for gas areas S1 for non-gas	S1	S1	S1	S1
S2 (Rapid phase-out)	S2	S2	S2	S2 for gas areas S2 for non-gas	S2	S1	S2	S2
S3 (Extended phase-out)	S3	S3	S3	S2 for gas areas S3 for non-gas	S3	S1	S3	S3

(a) Tasmania is not participating in the phase-out, so no change from BAU in S2 or S3 (b) Effects of existing Queensland rules close to defined scenarios, so separate modelling not necessary.

Modelling Periods

Costs and benefits have been projected for all water heater replacements expected to occur in Australia from the end of 2010 to the end of 2030, the legislated end point of the Renewable Energy Target. Results are presented for four time periods:

- 2010-2020: 10 years truncated (designated 10T);
- 2010-2020: 10 years cohort run-out (designated 10C);
- 2010-2030: 20 years truncated (designated 20T); and
- 2010-2030: 20 years cohort run-out (designated 20C).

A time period is ‘truncated’ if only the monetary costs and benefits incurred up to the cut-off date are taken into account. The ‘cohort’ analyses take into account the benefits for water heaters installed by the cut-off date, which will return benefits for up to 14 years after that date (the maximum service life assumed). The 10T analysis is the most severe test because it truncates the stream of benefits in 2020. All analyses show a rising benefit/cost ratio the longer the proposed measure is in place.

Input Assumptions

Capital Costs and RECS

Capital cost is the sum of purchase price and installation costs, less the value of RECs. The capital costs of conventional electric and gas water heaters can be determined from advertised prices. The costs of solar-electric, solar-gas and heat pump water heaters are more difficult to determine, because there are over 6,800 distinct solar models. Solar water heater capital costs have been built up from market surveys (ES 2007, 2008) and component cost modelling, and verified from data collected by the NSW and Victorian solar hot water rebate programs.[3]

For solar and heat pump water heaters the net purchase price is estimated as the pre-RECs purchase price less the value of RECs. This is the product of number of RECs in the Zone

[3] 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 110,000 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). NSW only recorded a single capital cost (purchase plus installation) whereas Victoria recorded separate cost components.

where installed by a nominal value to buyers of $39 per REC, at $2010 prices (it is assumed that intermediaries retain $1 of the $40 regulated REC price).

Energy Prices

All energy prices are expressed in real 2010 dollars. The 2010 energy prices match the published electricity and gas tariffs that took effect in each State and Territory on 1 July 2010.

Price trends to 2014 were projected on the basis of the latest price determinations (or draft determinations) published by Australian Energy Regulator (AER), the Independent Pricing and Regulatory Tribunal of NSW (IPART) and other regulators. Electricity price trends beyond 2014 were projected on the assumption of continuing rises in network costs (but at a lower rate than in 2010-2014, on the assumption that planned programs to manage peak demand will be successful) and rising generation costs (driven by the rising share of new renewable energy in the generation mix).

At the time of writing, it was Commonwealth Government policy to reconsider a CPRS no earlier than 2013. This Decision RIS has been prepared on the assumption that the CPRS, or a carbon pricing measure with similar impacts on energy prices, will be implemented from 2013. Annexe 7 gives further details on price assumptions and projections.

Greenhouse Gas Intensity

The greenhouse gas-intensity of electricity supply is projected to decline in response to the RET and carbon pricing measures, except in Tasmania, where, where intensity is projected to increase. The national weighted trend is illustrated in Annexe 7. The emissions intensities of natural gas and LPG are taken from DCC (2009), and are assumed to remain constant.

Water Heater Service Life

Following a review of the literature and discussions with manufacturers, the following service lives were adopted for mains pressure water heaters installed in 2011 and later:

- 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.

Refer to Annex 7 for further detail on Input Assumptions

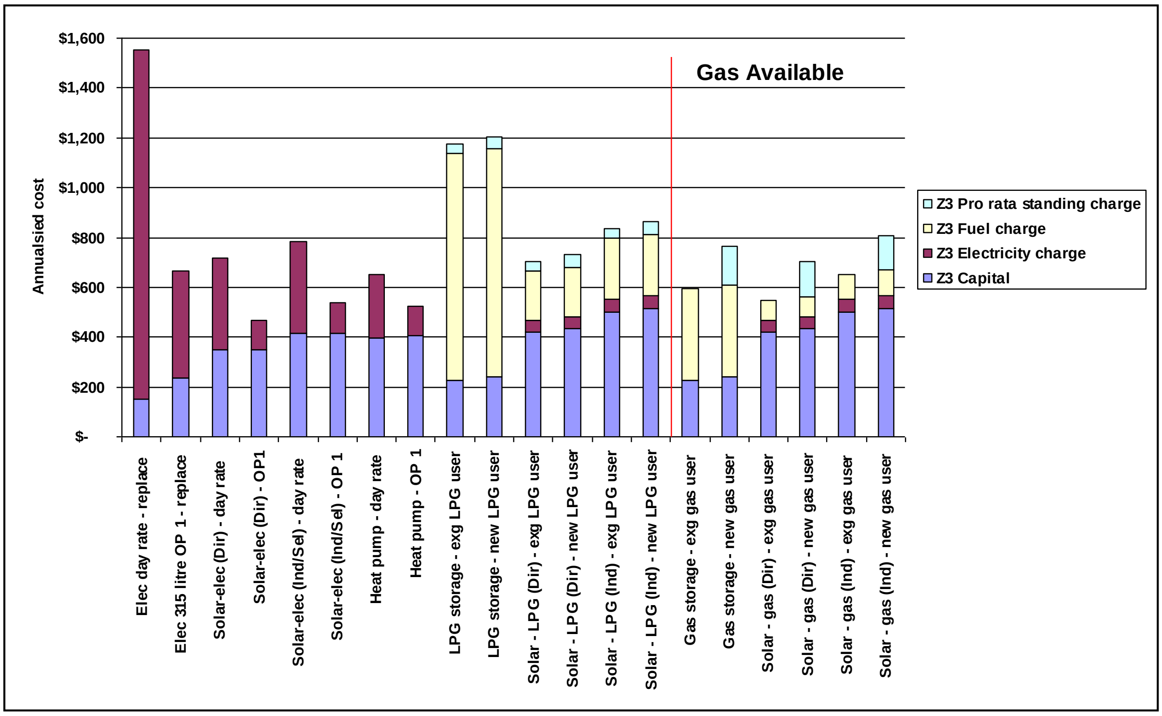
Findings

Water heating options for individual households

For each State and Solar Zone, the costs of options to replace a failed electric water can be illustrated by a diagram such as Figure 3. This indicates 'annualised cost', which equalizes the differences in service lifetimes of different technologies and the expected service life of gas connections, using an Internal Rate of Return of 7% (equivalent to a 7% discount rate).

The annualised energy charges are the average projected energy price over the service life of the water heater, calculated by multiplying the projected energy tariff for that State (c/MJ) by the MJ/yr which a water heater of that type uses to deliver about 200 litres of hot water per day (medium delivery) or 100 litres per day (low delivery).

Figure 3 Annualised cost of water heating options, NSW, Zone 3, Medium delivery



(Model C inputs)

OP1=Off-peak (restricted hours) tariff.. Dir=Direct heating solar collector. Ind=Indirect heating solar collector (with non-freeze heat exchange fluid, for frost protection). Sel=Selective surface collector. Capital costs are net of REC's values

Whether a house has natural gas available is a major factor in the cost of compliance with the proposed regulation. It is estimated that, nationally, about 52% of houses are not connected to natural gas, and of these about three in ten are connectable. Of the 48% of houses already connected to natural gas, four in five use gas for water heating, and one in five use electricity.

Households already using gas for water heating will be mostly unaffected by the proposal because up to 95% of them would replace with gas in any case (Table 1). LPG would also be available, but there would be no point in using LPG if natural gas were available: the capital cost would be about the same but the LPG running cost would be far higher.

The phase-out will mainly impact houses with electric water heaters not already connected to natural gas. The proportion of these houses in each State is shown in Annexe 7. NSW and QLD have nearly 78% of all the electric water heaters in non-connectable households in

Australia, so will be the most highly impacted States. By contrast, a very high proportion of electric water heating households in Victoria, SA, WA and the ACT are in gas-connected or connectable households, which will usually have the lowest cost compliance options.

The relative ranking of options by lifetime cost is much the same in each State and in each Solar Zone, and not affected by volume of hot water used. Where natural gas is available, either conventional gas, heat pump or solar-electric is the least cost complying option. Where gas is not available, heat pump or solar-electric water heaters are the least cost compliance options. Conventional LPG is always more costly because of the high fuel cost, although solar-LPG is comparable with day-rate electric water heating in many cases (but a more costly compliance option than solar-electric or heat pump).

In non-gas areas, households may be no worse off through the exclusion of electric storage water heaters, if they install a heat pump or solar-electric instead. The higher running costs of LPG would make it less economic except where occupancy was intermittent and/or hot water use is low (although this price disadvantage reduces over time as electricity prices rise). LPG would also offer a fallback option in areas or buildings where for some reason solar or heat pump water heaters were unacceptable, or the local climate made them ineffective.

The annualised cost profile of electric, natural gas and LPG water heaters is dominated by energy cost, whereas for solar and heat pump water heaters capital cost dominates. Many householders will prefer (or be advised to adopt) the lowest capital cost compliance option, even if has a higher annualised cost. In some cases they will do so because they are unaware of the annualised cost and in some cases they will do so because they are capital constrained.

Assistance to overcome the capital constraint – whether rebates or financing options repayable via energy bills – will increase the share of households taking solar or heat pump options. The value of such assistance is not factored in, for reasons previously discussed.

National Impacts

Composition of Water Heater Stock

The differences between S2 and S1 indicate the impact of a 'rapid phase-out' strategy in which electric water heaters are excluded from all regions from the end of 2010. The differences between S3 and S1 indicate the impact of an 'extended phase-out' strategy in which electric water heaters are excluded from gas-available regions after 2010, and from non-gas regions after 2012.

Figure 4 illustrates the projected stock of water heaters in the S1 BAU scenario under Model B. In Model C (illustrated in Annexe 8) rising electricity prices drive customers away from electric water heaters at a higher rate than in Model B and also increase the running cost of solar-electric and heat pump water heaters, so their running cost advantages over conventional gas and LPG water heaters are greatly reduced while their capital cost *dis*advantages remain. Therefore, in Model C the market moves more to the fuel alternatives than in Model B: to natural gas where it is available and LPG where it is not. This occurs in both the BAU and the phase-out scenarios.

Figure 5 illustrates the effect of removing electric water heaters from the option mix in 2010 (S2). In Model B the main shift is to solar-electric and heat pump water heaters, although LPG also grows, as the lowest capital cost option in non-gas areas. The gas share increases slightly, as does solar-gas. Model C shows a much higher share for natural gas and LPG water heaters, a smaller share for solar-gas and almost negligible shares for solar-electric and heat pump. This is because the higher running costs of heat pump and solar-electric make them less financially attractive options than in Model B. Delaying the phase-out in non-gas areas by 2 years (S3) makes very little difference to the overall outcomes.

The replacement of a failed water heater is a non-discretionary purchase, so the total number of water heaters sold each year is more or less constant. Purchasers prevented from buying an electric water heater will need to buy a water heater of a different type, and the model projects the choices that householders are likely to make.

Table 5 shows how the share of non-electric water heaters would be distributed over the period 2011 (the projected sales are in Annexe 9). In Model B, the sales that would have gone to electric are diverted roughly equally to gas, solar-electric, heat pump and LPG, with a small share going to solar-gas. In Model C, solar-electric and heat pump are less attractive compared to the fuel alternatives because electricity prices are significantly higher, so over half the diversions go to LPG, and over a third to natural gas. Solar-gas picks up about the same market share, because it retains its running cost advantage over conventional natural gas, its direct competitor.

Table 5 Market share gains by water heater types, 2011-2020

Model	**Scenario**	**% electric sales diverted**	**% of diverted sales going to other water heater types**						
			Gas	Sol-elec	Sol-gas	Heat pump	LPG	Solar	Solar+HP
Model B	S3 (Extended)	90%	21%	24%	7%	20%	28%	31%	51%
	S2 (Rapid)	95%	18%	25%	8%	22%	27%	32%	55%
Model C	S3 (Extended)	90%	37%	0%	6%	1%	56%	6%	7%
	S2 (Rapid)	95%	36%	0%	6%	1%	57%	6%	7%

Model B is highly favourable to solar and heat pump, while Model C is highly favourable to natural gas and LPG, so they represent the extremes of likely outcomes. It should also be noted that both models exclude the effects of rebates for solar and heat pump purchases, which if available would reduce the diversion of sales to LPG.

Capital Costs

The shift in market share from electric to other types of water heaters will change both purchase and installation costs. In Model B, which projects a strong shift to solar and heat pump, the estimated increase in average water heater capital costs (net of REC's values) compared with S1 is $512 per household for S2 and $449 for S3 (Table 6). In Model C, which projects a shift to natural gas and LPG water heaters rather than solar and heat pump, the increase in water heater capital costs is much less, and mainly caused by the cost of additional gas connections. The estimated increase in average water heater capital costs, compared with the BAU scenario, is $153 per household (S2) and $115 (S3) (Table 6).

The highest capital cost impacts are on households in the higher income brackets. This is because the model links the probability of preferring a higher-price system such as solar to household income (see Annexe 3). Impacts on the lower income brackets are slightly lower, partly due to this income effect and also because these households have a greater tendency to be located in natural gas areas. In most scenarios the cost impacts on owner-occupied households are somewhat higher than for rental households, except in Model C S3, where the reverse is the case.

Figure 4 Projected water heater stock, Scenario 1 (BAU) – Model B

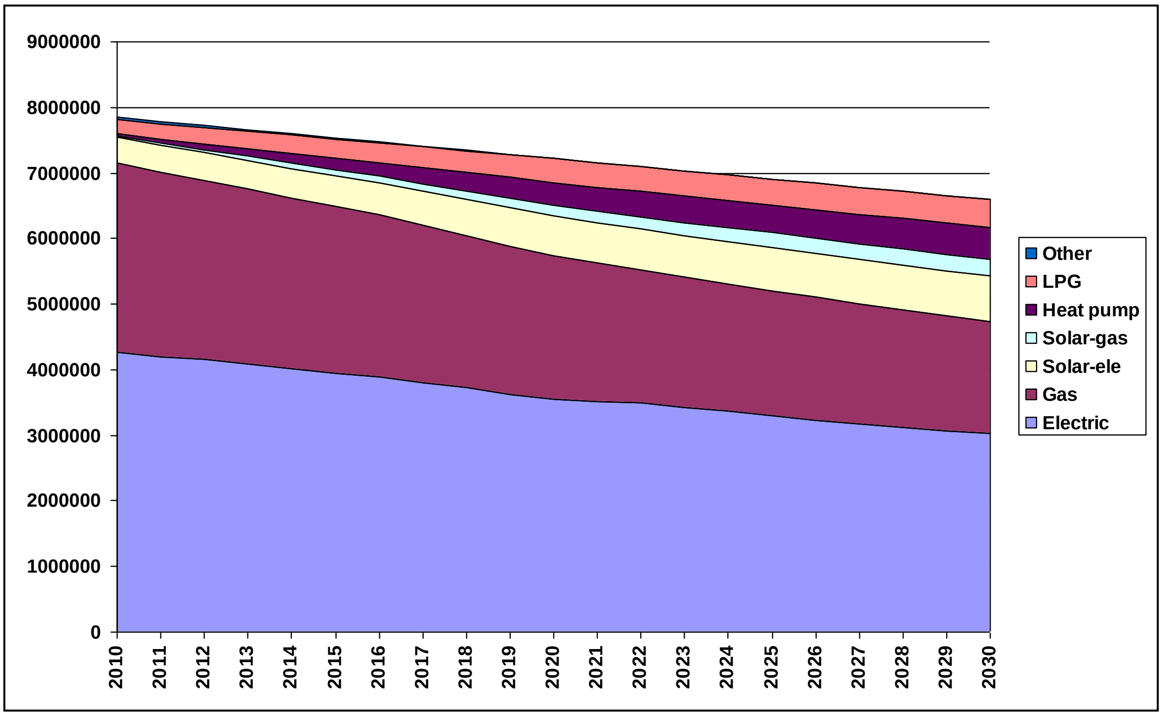


Figure 5 Projected water heater stock, Scenario 3 (Extended) – Model B

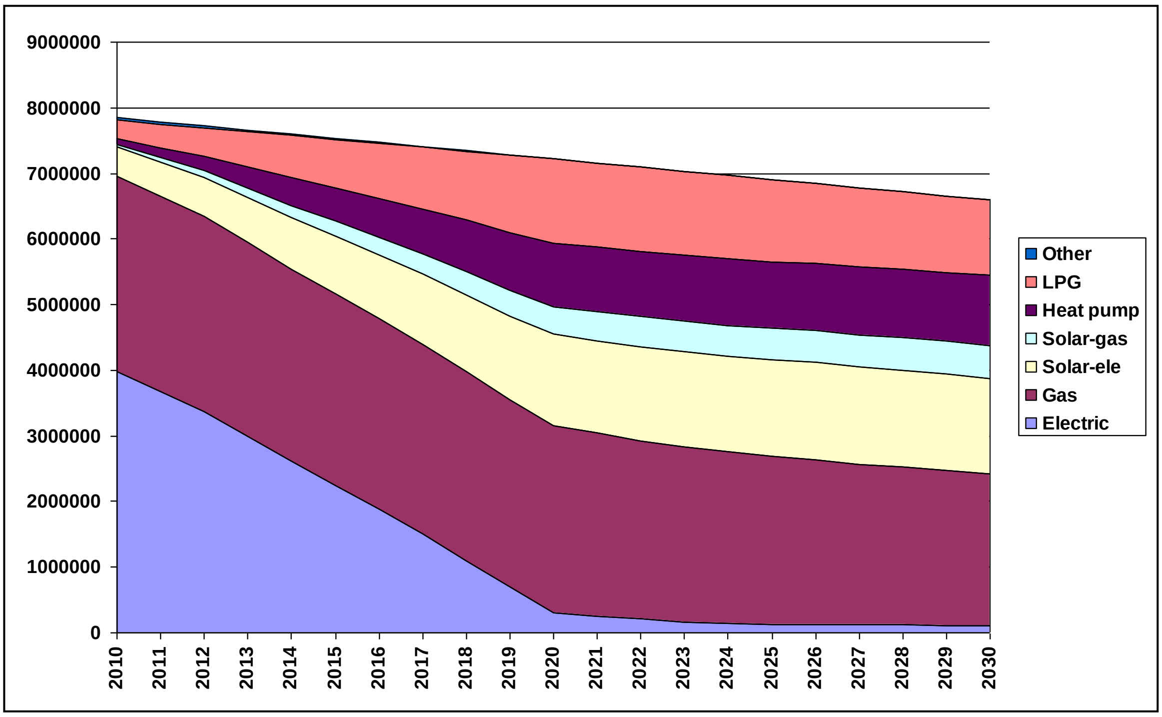


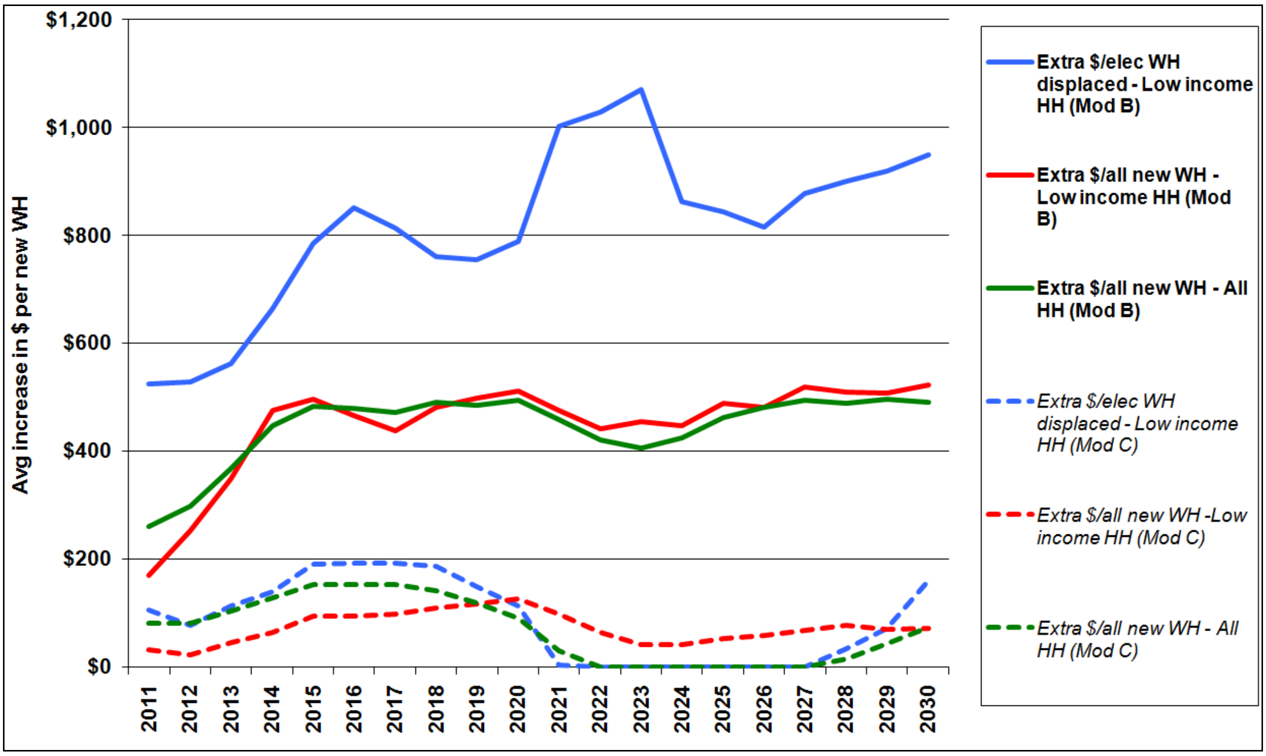
Figure 6 illustrates the capital cost impacts on those households with annual incomes of less than $40,000, who would otherwise have replaced an electric water heater with the same, but who are prevented from doing so by the proposed regulations. In Model B, the average increase in water heater capital cost for this group is about $520 in 2011 rising to more than $1,000 by 2023 (variations about this trend line are due to modelling effects).

The average cost impacts on all households, including low-income households, are much lower under Model C. The average capital cost impact on lower income households' peaks at about $200 per household, or 80% less than the peak in Model B. It is likely that the outcome will be between the two models, indicating an increase in capital cost of $400 to $600 per affected low-income household, without taking rebates into account. For comparison, the combined value of Commonwealth and State rebates currently available to households replacing electric water heaters range from $1,200 to $2,200 in NSW and $1,000 to $2,600 in Victoria (Table 23, Table 24).

Table 6 Change in average water heater capital costs, 2011-20, compared with S1

Category	Model B S2 (Rapid)	Model B S3 (Extended)	Model C S2 (Rapid)	Model C S3 (Extended)
<$20k	$ 508	$ 440	$ 153	$ 133
$20-40k	$ 534	$ 450	$ 125	$ 55
$40-60k	$ 478	$ 447	$ 115	$ 104
$60-80k	$ 524	$ 463	$ 203	$ 116
$80-100k	$ 508	$ 469	$ 211	$ 196
>$100k	$ 520	$ 429	$ 238	$ 237
All Households	$ 512	$ 449	$ 153	$ 115
Owners	$ 522	$ 451	$ 141	$ 120
Renters	$ 482	$ 439	$ 189	$ 101

Figure 6 Projected capital cost impacts on low-income groups, S3 Extended



Benefit/Cost Ratios

Energy Cost Savings and Net Costs

The phase-out is projected to increase household expenditure on replacement water heaters, but also reduce energy use and energy costs. Figure 7 and Figure 8 indicate the national annual capital cost impacts compared with BAU, the projected energy cost impacts and the change in net costs (i.e. capital cost increase less energy cost saving). Impacts are plotted in the year they occur, in undiscounted 2010 dollars. The effects of discounting are discussed later.

Figure 7 Projected change from BAU scenario: capital, energy and net costs, Model B

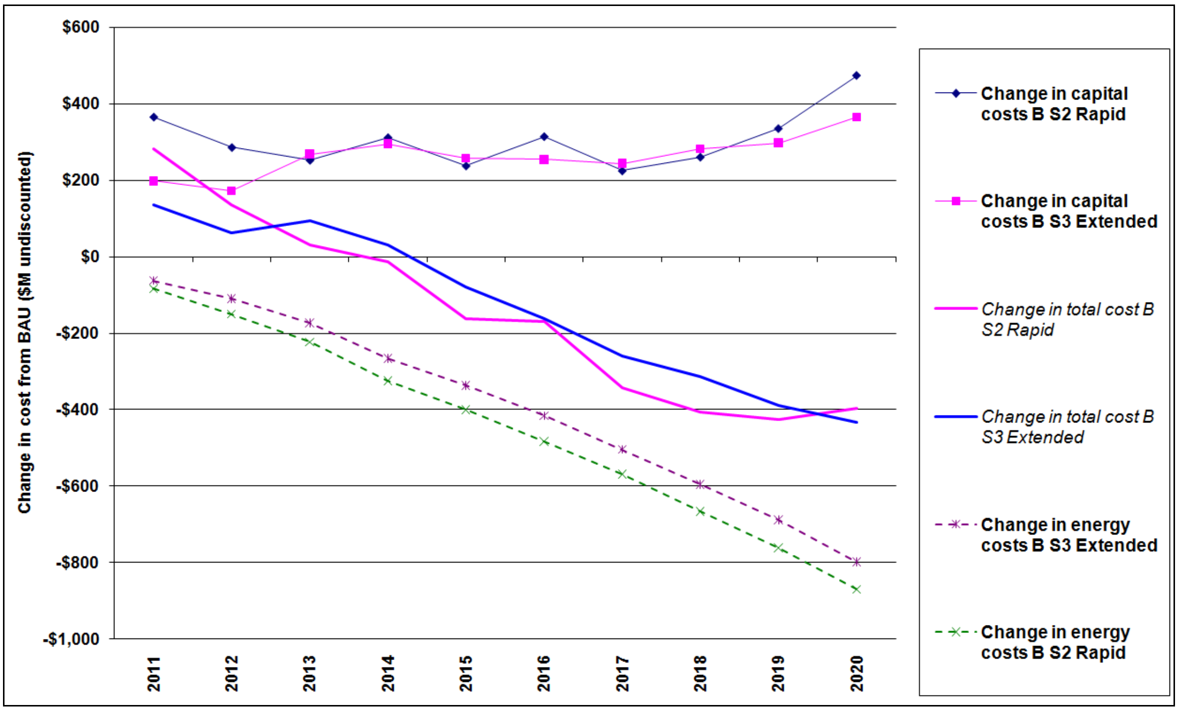
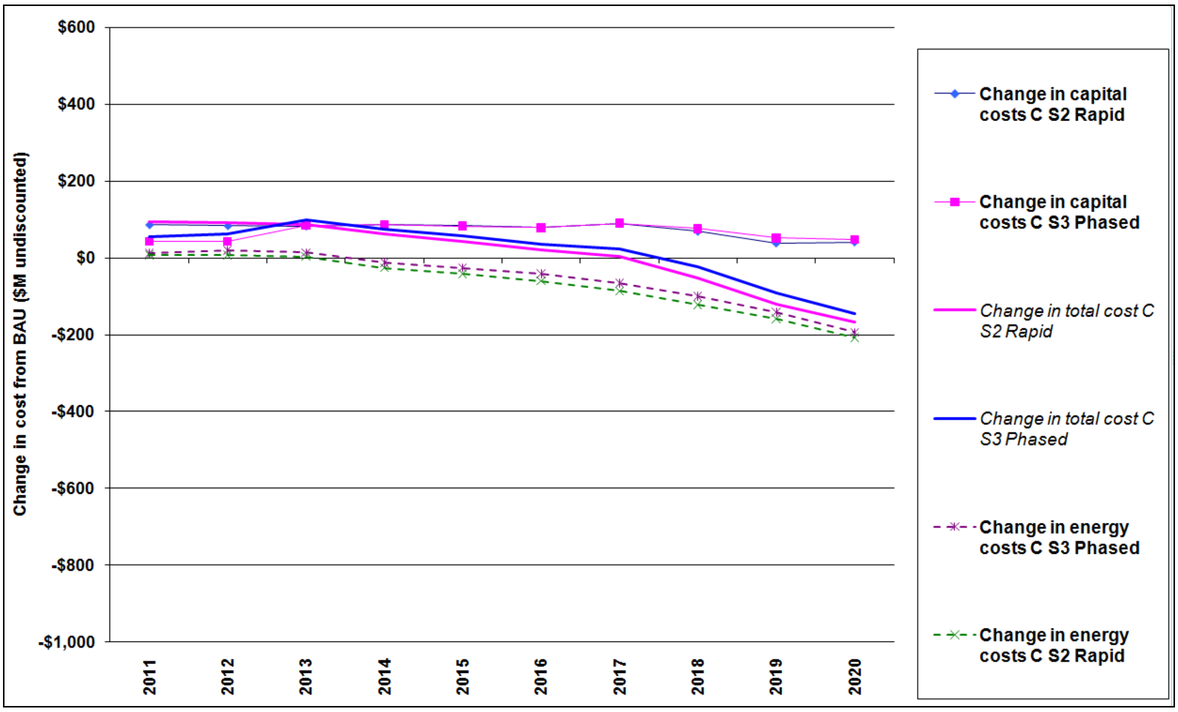


Figure 8 Projected change from BAU scenario: capital, energy and net costs, Model C



In Model C the trend is towards natural gas and LPG water heaters rather than towards solar and heat pump as in Model B, so the increase in water heater capital costs is much more modest – about $M 75 per year instead of $M 300. In Model C there is a greater shift away from electricity even in the S1 (BAU) scenario, which limits the potential for further shifts in S2 and S3. Therefore the energy savings are also more modest.

This means that net monetary benefits (energy savings less higher capital costs) for Model C are sometimes close to zero or even negative (i.e. both capital costs and energy costs increase slightly), and small differences in modelling can be magnified as artificially high or low benefit/cost (B/C) ratios.

The net present value of projected national capital and energy costs under Models B and C are summarised in Table 7 and Table 8 respectively. If the NPV of the energy saving exceeds the NPV of the additional capital costs the measure has a B/C ratio of 1 or more, i.e. the benefits outweigh the costs. In Model B all national B/C ratios exceed 1. The changes in total net costs range from – $M 657 to – $M 4,621. (Negative total net cost compared with BAU represents a net societal benefit).

Model C shows much lower changes in both capital costs and energy costs due to the phase-out than does Model B. The changes in total net cost range from + $M 188 (i.e. the costs of water heating services are *higher* than in the BAU scenario) to – $M 1,365. Because the deviations from neutral are relatively small, the B/C ratios tend to be more variable than in Model B: lower than Model B in the shorter term but higher in the longer term. In both models, there are only minor differences between S2 and S3 in B/C ratio, net monetary benefit and greenhouse gas savings.

Where the B/C ratio is greater than 1, the nominal cost of abatement per tonne of CO_2-e avoided is negative, because the value of energy saved more than pays for the increase in the capital cost of water heaters. Only where the B/C ratio is less than 1 is there is a positive abatement cost. The measure returns a positive abatement cost only in Model C, and then only under the most restricted time span (T10). There the cost is up to $10.5 per tonne, which is about a quarter of the abatement costs of renewable generation.[4]

Table 7 National costs and benefits of proposals, 2011-2020, Model B

Time span	**Scenario**	**$M Net Present Value at 7% discount rate**					**$M change from BAU**			**B/C ratios**	**Mt CO_2-e saved**	**$/t saved (a)**
		Purchase	Install	Capital	Energy	Total	Capital cost	Energy cost	Total net cost			
T10	S1 BAU	$5,831	$2,771	$8,602	$20,567	$29,169	$0	$0	$0			
	S2 Rapid	$6,972	$3,760	$10,732	$17,723	$28,455	$2,130	-$2,844	-$714	1.3	34.5	-20.7
	S3 Extend	$6,749	$3,651	$10,400	$18,112	$28,513	$1,798	-$2,455	-$657	1.4	31.3	-21.0
C10	S1 BAU	$5,831	$2,771	$8,602	$26,864	$35,467	$0	$0	$0			
	S2 Rapid)	$6,972	$3,760	$10,732	$22,283	$33,015	$2,130	-$4,582	-$2,452	2.2	60.6	-40.5
	S3 Extend	$6,749	$3,651	$10,400	$22,814	$33,214	$1,798	-$4,050	-$2,252	2.3	56.3	-40.0
T20	S1 BAU	$8,660	$4,151	$12,811	$32,277	$45,088	$0	$0	$0			
	S2 Rapid	$10,182	$5,442	$15,623	$25,878	$41,502	$2,812	-$6,398	-$3,586	2.3	80.9	-44.3
	S3 Extend	$9,939	$5,333	$15,272	$26,411	$41,683	$2,461	-$5,866	-$3,405	2.4	77.2	-44.1
C20	S1 BAU	$8,660	$4,151	$12,811	$35,493	$48,304	$0	$0	$0			
	S2 Rapid	$10,182	$5,442	$15,623	$28,060	$43,683	$2,812	-$7,433	-$4,621	2.6	102.1	-45.3
	S3 Extend	$9,939	$5,333	$15,272	$28,624	$43,896	$2,461	-$6,869	-$4,408	2.8	98.3	-44.9

7% discount rate. (a) Negative values indicate that value of energy savings covers the increase in capital costs

[4] Based on typical REC prices of $40 per MWh, and electricity supply intensity of 1t CO_2-e/MWh delivered.

Table 8 National costs and benefits of proposals, 2011-2020, Model C

Time span	Scenario	$M Net Present Value at 7% discount rate					$M change from BAU			B/C ratios	Mt CO_2-e saved	$/t saved (a)
		Purchase	Install	Capital	Energy	Total	Capital cost	Energy cost	Total net cost			
T10	S1 BAU	$4,721	$2,206	$6,927	$19,965	$26,892	$0	$0	$0			
	S2 Rapid	$4,694	$2,771	$7,465	$19,577	$27,042	$539	-$388	$151	0.7	19.4	7.8
	S3 Extend	$4,656	$2,749	$7,405	$19,675	$27,080	$478	-$290	$188	0.6	18.0	10.5
C10	S1 BAU	$4,721	$2,206	$6,927	$26,198	$33,125	$0	$0	$0			
	S2 Rapid)	$4,694	$2,771	$7,465	$25,378	$32,844	$539	-$820	-$281	1.5	34.5	-8.1
	S3 Extend	$4,656	$2,749	$7,405	$25,505	$32,910	$478	-$693	-$215	1.4	36.4	-5.9
T20	S1 BAU	$6,889	$3,246	$10,135	$31,683	$41,818	$0	$0	$0			
	S2 Rapid	$6,801	$3,858	$10,659	$30,149	$40,809	$524	-$1,533	-$1,009	2.9	50.8	-19.9
	S3 Extend	$6,760	$3,840	$10,600	$30,253	$40,853	$464	-$1,430	-$965	3.1	49.1	-19.7
C20	S1 BAU	$6,889	$3,246	$10,135	$34,988	$45,124	$0	$0	$0			
	S2 Rapid	$6,801	$3,858	$10,659	$33,099	$43,759	$524	-$1,889	-$1,365	3.6	63.0	-21.7
	S3 Extend	$6,760	$3,840	$10,600	$33,199	$43,799	$464	-$1,789	-$1,325	3.9	64.6	-20.5

7% Discount rate. (a) Negative values indicate that value of energy savings covers the increase in capital costs

By Household

Impacts on households can be calculated by dividing the national impacts by the number of water heaters installed. Under Model B (Table 9), the average net *benefit* per household ranges from $95 (T10, S3) to $356 (C20, S2). The Cohort analyses give a more accurate indication of the average greenhouse saving over the lifetime of water heaters: this is between 7.6 and 8.8 tonnes CO_2-e per water heater installed. Under Model C the impact per household ranges from a net $29 increase in cost (T10, S3) to a cost reduction of $111 (C20, S2). In other words, the cost impacts of Model C are much smaller. The average Cohort greenhouse reductions are also smaller: between 5.1 and 5.6 tonnes CO_2-e per household.

Table 9 NPV of average impacts of proposals per household, 2011-2020

Time span	Scenario	Model B					Model C				
		Capital cost rise	Energy cost saving	Total cost change	B/C ratio	Avg t CO_2-e saved	Capital cost rise	Energy cost saving	Total cost change	B/C ratio	Avg t CO_2-e saved
T10	S2 (Rapid)	$309	-$413	-$104	1.3	5.0	$83	-$59	$23	0.7	3.0
(a)	S3 (Extended)	$261	-$357	-$95	1.4	4.5	$73	-$44	$29	0.6	2.7
C10	S2 (Rapid)	$309	-$665	-$356	2.2	8.8	$83	-$126	-$43	1.5	5.3
(a)	S3 (Extended)	$261	-$588	-$327	2.3	8.2	$73	-$106	-$33	1.4	5.6
T20	S2 (Rapid)	$216	-$492	-$276	2.3	6.2	$43	-$125	-$82	2.9	4.1
(b)	S3 (Extended)	$190	-$452	-$262	2.4	5.9	$38	-$116	-$79	3.1	4.0
C20	S2 (Rapid)	$216	-$572	-$356	2.6	7.9	$43	-$154	-$111	3.6	5.1
(b)	S3 (Extended)	$190	-$529	-$339	2.8	7.6	$38	-$145	-$108	3.9	5.3

7% discount rate. National impacts divided by number of water heaters installed (a) 2011-2020 (b) 2011-2030.

Sensitivity tests by Jurisdiction

The national B/C ratio for S3 is in the range 0.6 to 3.9, depending on the Model (B or C) and the time period of analysis (10T, 10C, 20T or 20C). In seven of eight cases the B/C ratio exceeds 1, indicating a very high probability that the monetary benefits will exceed the costs at a discount rate of 7%.

The B/C ratios vary by jurisdiction, as indicated in Table 10. B/C ratios of 1 or higher are highlighted in green, and those below 1 in orange. Jurisdictional B/C ratios range up to 5.2 (10C), 8.4 (20C), 3.0 (10T) and 8.4 (20T). All jurisdictions show B/C ratios greater than 1, indicating that the phase-out would be cost-effective, under at least half the time period analyses. Victoria, WA and NT show B/C ratios above 1 in all analyses.

In Model B, which favours solar and heat pump, Victoria and WA have the highest B/C ratios, and ACT the lowest. This is partly because Victoria and WA have high gas availability, so more households have access to the least costly compliance option: for QLD and NSW the reverse is true. The low B/C ratios for the ACT are due to a narrow difference between electricity and gas prices. In Model C, which favours natural gas and LPG, Victoria has the highest B/C ratios because of high gas availability. Some states show zero B/C for some time periods, because there are small increases in both capital and energy costs, leading to higher rather than lower total NPV.

For SA, the zero B/C ratio in Model C is due to the fact that the impacts of measures already implemented in SA are fully taken into account, so there is no apparent benefit in adopting the national rules. (In fact, due to differences in the water heater selection criteria, Model C unavoidably over-states the impacts of the existing SA measures and so under-states the benefits of implementing the national phase-out. Conversely, Model B over-states the benefits). The actual impacts for SA, as for other States, will lie between Models B and C.

Figure 9 and Figure 10, plotted to the same vertical scale, show the differences in B/C ratios between Models B and C for each jurisdiction, and how sensitive they are to discount rates of 3%, 7% and 11%. The lowest discount rate gives the highest B/C ratios in each case, while the highest discount rate gives the lowest B/C ratios. Figure 9 shows the discount rate spread for Model B. For Australia as a whole, the B/C ratio range is from 1.2 to 3.4, with a median value of 2.1. This indicates that the measure is nationally cost-effective under the most stringent test.

Figure 10 shows the discount rate spread for Model C. The spread is much wider than for Model B, with a national range from 0.5 to 5.8, with a median value of 1.7.

Table 10 Scenario 3 B/C ratios, Model B

	Model B				Model C			
	10T	10C	20T	20C	10T	10C	20T	20C
NSW	1.3	2.2	2.4	2.8	0.2	0.9	3.6	4.8
VIC	1.7	2.7	2.8	3.2	3.0	5.2	7.3	8.4
QLD	1.4	2.3	2.4	2.8	0.0	0.0	0.9	1.5
SA	1.4	2.2	2.3	2.7	0.0	0.0	0.0	0.0
WA	1.5	2.5	2.6	3.1	1.6	2.5	2.8	3.3
TAS	NA	NA	NA	NA	NA	NA	NA	NA
NT	1.0	1.7	1.9	2.2	1.0	1.7	1.8	2.0
ACT	0.3	0.6	0.6	0.8	1.3	2.2	2.6	3.1
Australia	**1.4**	**2.3**	**2.4**	**2.8**	**0.6**	**1.4**	**3.1**	**3.9**

7% discount rate. '0' indicates increase in capital cost as well as increase in running cost.

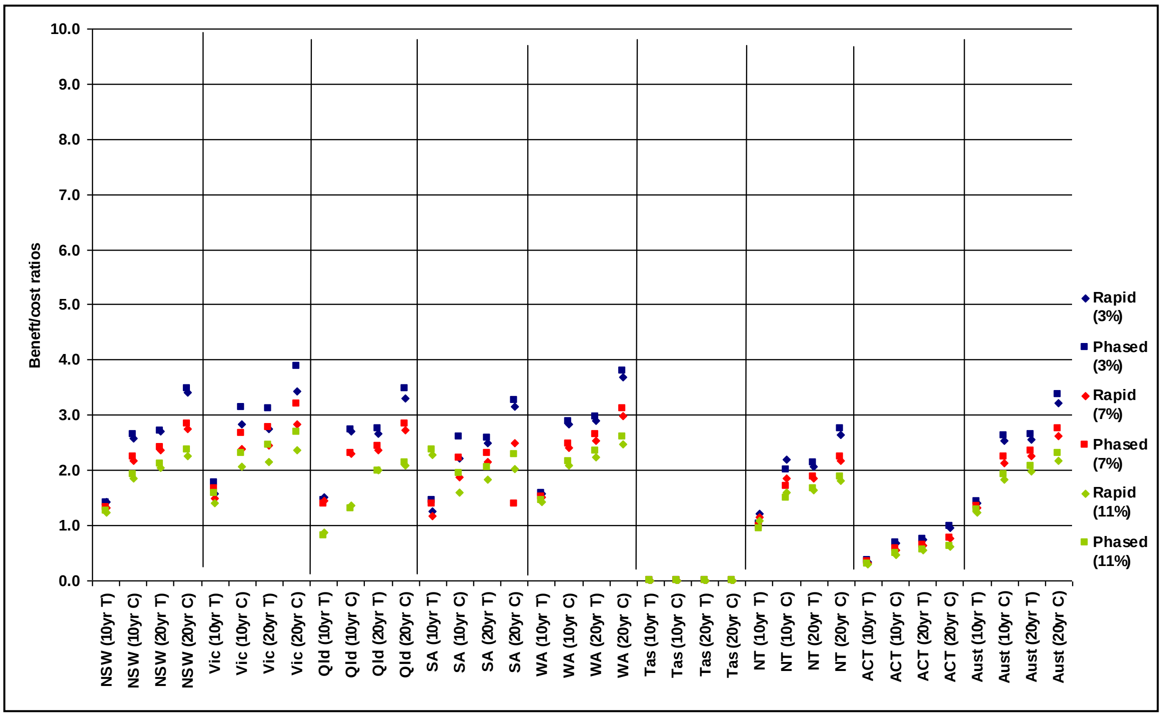


Figure 9 Variation of Benefit/Cost ratios with discount rate, Model B

Phase-out not implemented in Tasmania.

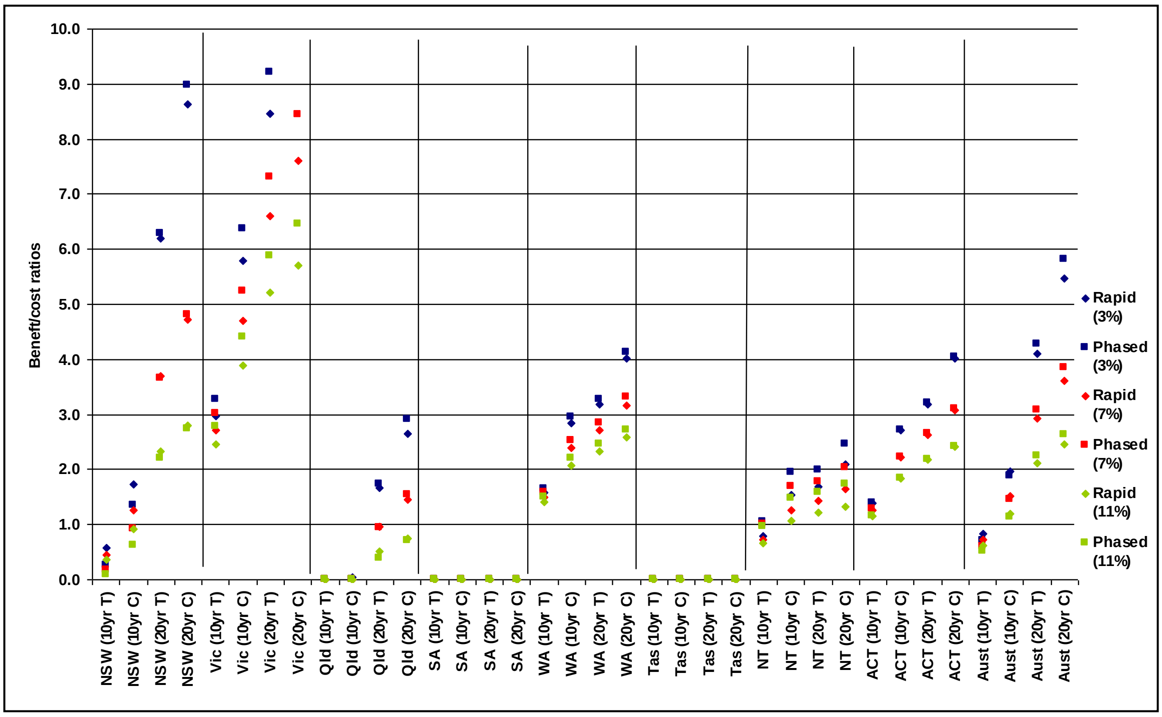


Figure 10 Variation of Benefit/Cost ratios with discount rate, Model C

Phase-out not implemented in Tasmania. Impacts in SA compared with present regulations.

Greenhouse impacts

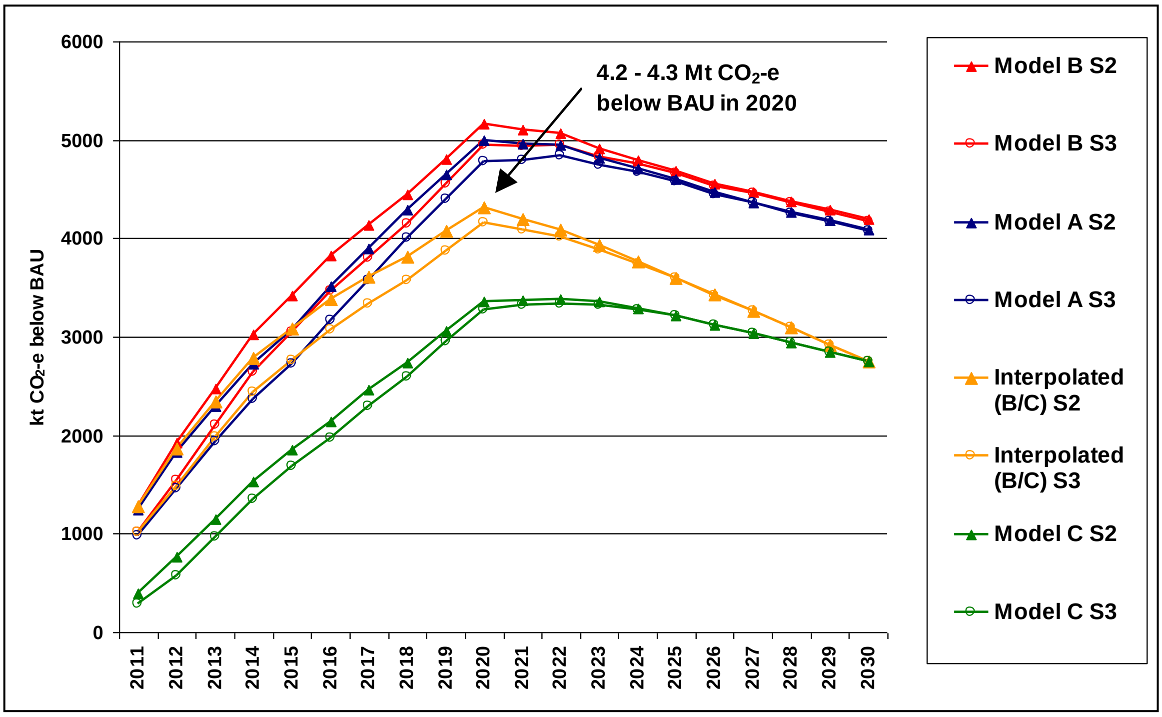
Figure 11 illustrates the emissions reductions under S2 (Rapid phaseout) and S3 (Extended phaseout) under each of Models A, B and C, and the 'Interpolated' trend line which indicates the most likely emissions reduction trajectory.

Significantly lower greenhouse savings are projected under Model C, despite slightly higher emissions intensities, because higher electricity prices motivate more households to go to natural gas and LPG in the BAU scenario, so the scope for further emissions savings via the phase-out is lower. However, the modelling assumes some fore-knowledge of energy prices. Given how infrequently householders are exposed to water heater purchases, it is likely that the water heater market will take about a decade to move from Model B behaviour to Model C. The 'interpolated' trend line in Figure 11 captures this shift.

The projected emissions reductions peak in about 2020, when the last of the existing electric water heaters in existing houses are replaced, and then begin to decline because new low-emissions water heaters will replace old low-emissions water heaters, not electric water heaters. The projected emissions reductions in S3 (Extended) are slightly less than under S2 (Rapid), because electric water heaters are permitted to remain in the stock for a further two years.

The projected emissions reduction in each jurisdiction is indicated in Annexe 8. NSW and QLD together account for between 68% and 81% of the national emissions savings, depending on the Model.

Figure 11 Projected greenhouse gas reduction from water heaters, existing houses



6. Stakeholder Impacts

Industry Impacts

Supplier Competition

With Extended implementation (S3), the proposed measure would reduce the residential sector sales of large electric storage water heaters by 50% to 70% in 2011 and 2012, and then exclude them from the market entirely from 2013 (except in Tasmania). All manufacturers of large electric water heaters also produce at least one complying type, so none would be excluded from the market (Annexe 8).

Small electric storage water heaters (50 litres or less) could still be used as supplementary water heaters at remote supply points, but not as the primary water heater. However, most of the market for small electric water heaters is in apartments (Class 2 dwellings), which are not affected by the measure. Continuing manufacture of small electric water heaters should remain economic for the time being.

Non-electric water heaters are well established in the market already, so there would be no shortage of product choice. There are 45 models of gas storage water heater on the Australian Gas Association register, and 92 models of gas instantaneous water heater. There are over 6,800 solar-electric, solar-gas and heat pump water heaters registered with Office of the Renewable Energy Regulator (ORER). There are at least six suppliers of heat pumps in Australia with a range of single and split systems designed for both internal and outside use. This range of types and configurations increases the chance that complying households will find a suitable system.

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.

Manufacture

The main Australian manufacturing sites for water heaters and their components are:

- Rheem: Rydalmere in Sydney (electric, solar and heat pump); Welshpool in Perth (solar); Scoresby in Melbourne (gas) and Moorabbin in Melbourne (Aquamax gas water heaters);
- Dux: Moss Vale, NSW (all product types).
- Beasley (solar water heater manufacturer owned by Rinnai): Adelaide.
- Saxon: Zillmere in Brisbane (heat exchange water heaters, heat pumps).

Local manufacturers have recently expanded capacity and employment in response to the growing demand for solar and heat pump water heaters created by rebate schemes. There could be some loss of production and employment if electric water heater production ceased, but this would be wholly or partially offset by growth in demand for other water heater types.

All the storage pressure tanks used in larger electric, gas, solar-electric and solar-gas water heaters are made in Australia, so if the proposed measure shifts market share from electric storage to other storage types this would mitigate the impact on the manufacture of locally made pressure tanks. The continuing manufacture of pressure tanks would also mean that a proportion could still be equipped with electric resistance elements, so markets not participating in the phase-out could continue to be supplied.

Growth in the solar-electric and heat pump market would benefit local manufacture. According to Rheem about 80% of solar arrays and heat pumps are locally made.[5] Growth in the natural gas and LPG market would also benefit local manufacture, since 45% of gas and LPG water heater sales are locally made storage types, but it would also increase the demand for instantaneous water heaters, all of which are imported (mainly from China, some from Europe). Any shift to instantaneous water heaters would however increase competition in the Australian water heater market as a whole, since that is the only segment not dominated by a single company. Growth in solar-gas would benefit both instantaneous water heater imports (used as boosters in about 90% of solar-gas units) and local pressure tank manufacture.

The projected impact on local manufacture depends on the proportion of the market growth which local manufacturer can retain (see Annex 9). Table 11 explores a 'higher' manufacturing case where imports of solar arrays and heat pumps are restricted to the same absolute number as under the BAU case, and a 'lower' manufacturing case in which imports retain a 20% share of the solar and heat pump markets.

Table 11 Manufacture and installation impacts, Models B and C

	Market growth share captured by local firms	**Model B**			**Model C**		
		S1 BAU	S2 Rapid	S3 Extend	S1 BAU	S2 Rapid	S3 Extend
Major components, million units (a)		7.5	8.7	8.5	6.9	7.1	7.1
Change in major components		NA	+1.2	+1.0	NA	+0.2	+0.2
Local manufacture share	Higher(b)	80%	70%	69%	73%	52%	53%
	Lower(c)	80%	65%	66%	73%	51%	52%
Locally manufactured components, million units	Higher(b)	6.0	6.0	5.9	5.0	3.7	3.7
	Lower(c)	6.0	5.6	5.6	5.0	3.6	3.7
Change in major component manufacture, million units	Higher(b)	NA	0.0	-0.1	NA	-1.4	-1.3
	Lower(c)	NA	-0.4	-0.4	NA	-1.4	-1.3

Source: See Annexe 8. All values millions of component units (a) Corresponding to Table 81 and Table 82 (b) If component import numbers remain at BAU levels. (c) If component import rates remain at BAU levels.

Under Model B, in the 'higher' case, the number of major components manufactured locally remains about the same under both Rapid and Extended phase-out. Under the 'lower' case the number of major components manufactured locally is 6% to 7% lower. Note that this does not take account of the value of components, but these are roughly comparable. Under Model C, the number of major components manufactured locally falls by 26% to 28% under either Rapid or Extended phase-out. Both models assume an absence of rebates, which would significantly increase the demand for locally made solar and heat pump water heaters.

Installation

The same number of water heaters would be installed annually for the first decade of the proposed measure as in the BAU scenario, but the shift in product types would change the demand for installation skills and services. After a decade the rate of replacement would fall slightly, because low-emissions water heaters have a longer service life than electrics.

The increase in the use of gas and LPG water heating would increase the demand for gas plumbing work. In its submission on the Consultation RIS, Rheem estimated that new natural gas connection work alone would create a demand for 630 additional tradespersons.

[5] http://www.ipart.nsw.gov.au/files/Submission%20-%20Climate%20Change%20Mitigation%20Measures%20-%2016%20February%202009%20-%20Rheem%20Australia%20-%20Gareth%20Jennings%20-%20APD.PDF

All water heaters except gas storage require some electrical work, so there would continue to be high demand for electrical skills. A growing proportion of installations would also require additional skills such as solar installation (requiring roof work and expertise in siting and connection of system components) or refrigeration expertise (for some heat pumps).

Solar water heater installation is particularly labour intensive, because there are extra components in addition to what amounts to a full electrical or gas water heater installation, and it often requires two people to lift the collectors on to the roof. Contractors have already reported increasing their employee and apprentice numbers in response to the current surge in demand for solar water heaters prompted by rebates. The geographical impact on installation employment would be more or less in proportion to the increase in solar take-up, which under Model B would be substantial in each State.

Table 12 summarises the impacts on installation activity. Given that installation costs largely reflects labour costs, it is estimated that a gas or heat pump installation generates about 1.5 times the employment of an electric water heater replacement, and a solar water heater three times. On this basis installation employment would increase by 33% to 37% under Model B and 17% to 18% under Model C.

Net Employment Effects

While the demand for complete water heaters should remain largely unchanged, the demand for major water heater components should increase under the phase-out. The share of this increase that is locally manufactured will depend on whether purchases are diverted mainly to solar and heat pump (Model B) or to natural gas and LPG (Model C). Local manufacturers are already expanding capacity in the solar and heat pump markets and so should be in a strong position to compete.

Under Model B it is projected that the impacts on local manufacture would be largely neutral, and the impacts on installation employment would be strongly positive. Using the simple equivalence formula embodied in Table 12, it is projected that there would be about a net 20% positive impact on employment. Under Model C, impacts on local manufacture would be negative, but this would be balanced by an increase in installation employment, so the overall impact would be neutral. It should be noted that these impacts assume a cessation of current solar water heater rebates. If rebates continued, the employment impacts of the phase-out would be significantly more positive.

Table 12 Estimates of Installation and aggregated employment impacts

	Model B			Model C		
	BAU	S2	S3	BAU	S2	S3
Electric installations	3.7	0.1	0.5	2.9	0.1	0.3
Gas & LPG installations	2.1	3.7	3.7	3.0	5.5	5.4
Heat pump installations	0.3	1.1	1.0	0.0	0.1	0.1
Solar installations	0.7	1.8	1.7	0.5	0.7	0.7
Total Installations	6.8	6.8	6.8	6.4	6.4	6.4
Electric installations	3.7	0.1	0.5	2.9	0.1	0.3
Gas & LPG installations(a)	3.2	5.6	5.6	4.5	8.3	8.0
Heat pump (a)	0.5	1.7	1.5	0.0	0.1	0.1
Solar (b)	2.0	5.5	5.1	1.5	2.1	2.1
Weighted installations	9.4	12.9	12.6	8.9	10.6	10.5
Change		137%	133%		118%	117%
Component manufacture(c)	6.0	6.0	5.9	5.0	3.7	3.7
Combined (d)	15.4	19.0	18.5	14.0	14.2	14.2
Change		123%	120%		102%	102%

All values millions. (a) Employment weighting of 1.5 compared with electric water heater changeover. (b) Employment weighting of 3.0 (c) From Table 11. (d) Assume similar employment benefits for manufacture of a major water heater component and installation of an electric water heater.

Plumbers and Other Installers

As water heaters are connected to the domestic water supply they come within the scope of State and Territory plumbing regulations, and this is the proposed mode of implementation (see Annexe 4). Plumbers and water heater installers replacing electric water heaters would need to be aware of their obligations and take the following steps.

In Scenario 3 (Phased Implementation), during 2011 and 2012:

1. Check whether the house is in a zone where the installation of electric water heaters is permissible (as it would be in some areas until 2012);

2. If in an area where the installation of an electric water heater is not universally permissible, check whether the installation is covered by a general exemption, or if there is a case for applying for a special exemption;
3. If the water heater type selected is heat pump or solar, ensure that the model meets the required performance criteria.
4. If the water heater is an electric water heater subject to general exemption, ensure that the model does not exceed the size criteria;
5. Install the water heater in accordance with all relevant codes and standards;
6. Meet any reporting, certification or compliance obligations

After 2012, step 1 would no longer apply. If the measure were implemented in one stage (S2 Rapid) installers would not be required to carry out Step 1 above, but otherwise the procedure would be the same.

Plumbers and installers would need enough information to advise customers on their options, as well as to meet compliance obligations. They already take steps to keep up to date with changes to the Building, Plumbing and Electrical Codes, including State variations.

Regulators usually publicise relevant changes, and could readily use the same channels to promote these provisions. This would require some planning and training either by government agencies directly or via industry and trade associations or registered training organisations. These programs could be streamlined, and scope for confusion reduced, if the rules for water heater replacements and new houses were aligned.

Learning about compliance processes and obligations would obviously impose some costs on plumbers and installers, as would the additional time and inquiry processes needed to complete water heater replacements. While initial training costs may be borne by the installers themselves, in due course costs would be passed on to customers.

In the longer term, the plumbing and installation industry would benefit from the higher installation fees and higher demand for labour that would come from a rising proportion of gas, solar and – to a lesser extent – heat pump installations.

Householders

Owner-Occupiers

In 2010 about 30% of water heaters sold were electric (Table 19). This market share would be expected to increase if rebates were removed. In total, it is expected that around 33% of Australian houses will be affected by the phase-out.

Households will only be required to replace their existing electric water heater when it breaks down. This could occur up to 10 years after the phase-out is implemented, as this is the typical service life of an electric water heater. The majority of homeowners may first become aware of the phase-out when their electric hot water system fails, through discussing options with their plumber or installer.

It is likely that the phase-out will be facilitated by existing policies such as: the requirement to install non-electric water heaters in new homes; RECs; and Commonwealth and State rebates – each of which have already increased consumer acceptance and market share of non-electric water heaters.

Plumbers or installers may unwittingly or wilfully install a replacement electric water heater illegally. This option would be removed if the production of large electric storage water heaters ceased. Householders may also request special exemption. The extent to which this happens will depend on: the rules and time frames for determining such cases; if there are provisions for requesting exemptions *after* a new water heater is installed; and the consequences, if any, of the request being eventually denied. It is not possible to speculate about these impacts as jurisdictions are still to develop and enforce these arrangements.

Most homeowners will probably accept the phase-out and would consider their options. The main factors in deciding options for a replacement hot water system include:

- Possibility: such as accessibility to natural gas or appropriate roof orientation;
- Acceptability: including aesthetics (panels on the roof) and regulation (heat pump noise restrictions) [6];
- Practicality: which of the acceptable options are the quickest to install; and
- Capital cost.

Speed of replacement has historically been a major factor reinforcing the tendency to replace electric with electric. Heat pump water heaters can usually be installed almost as quickly as electric, especially if the same location is suitable.

Marketing and competition among non-electric water heater suppliers would be expected to intensify if the phase-out is implemented. Suppliers of natural gas and solar water heaters have developed strategies to install water heaters speedily. Some gas utilities install a gas water heater the same day and operate it from a compressed natural gas bottle until the connection crew arrives (usually within 48 hours). Solar water heater suppliers have offered to install a temporary electric water heater until the solar installation can be arranged.[7] Regulations in each jurisdiction would need to allow for temporary water heaters in these situations, as the *Queensland Plumbing and Wastewater Code* has done (QPW 2009).

Houses which are already connected to gas, or in a natural gas area, will usually have access to the lowest capital and running cost option. Homeowners who replace an electric water heater with either a solar or heat pump water heater would face higher capital costs, but these would be offset by lower running costs. These higher costs could be minimised through existing Commonwealth and State rebates, if they remain available. Receipt of rebates could be an issue however, as some claims (such as for Commonwealth rebates) can only be made after installation. In Victoria the rebate is provided as a point of sale discount.

If rebates are reduced, targeted geographically or by income or discontinued entirely, then some non-qualifying households may have difficulty in raising the capital. Gas utilities could offer installation and financing packages where households could repay the costs through their initial gas bills. Similarly, solar and heat pump water heater suppliers could set up their own financing options so the capital could be repaid through energy savings. One major solar water heater supplier already offers an arrangement whereby the buyer pays 25% of the capital cost up front and the balance over 12 to 18 months.[8] Another financing option could be interest-free loans.[9]

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[6] Standard AS/NZS 5125 *Heat Pump Water Heaters – performance assessment* is currently being developed by Standards Australia. There is an opportunity to include the testing and reporting of noise levels in the standard, so installers and buyers would be able to take this into account in model choice.

[7] See for example http://www.solahartmarion.com.au/

[8] http://www.solahart.com.au/solahart-for-your-home/smartpay.aspx

[9] http://www.westpac.com.au/green-loans/

LPG could be the most cost-effective option for households with very low hot water use or with intermittent use (e.g. for holiday homes). Under Model C, the energy price disadvantage between electricity and LPG would close rapidly due to increasing electricity costs, but many households using LPG would face higher running costs, at least for a time. Furthermore, there are no programs to universally subsidise LPG running costs for low-income groups, as most states have for electricity and gas prices. It may be possible to compensate low income households for higher energy costs, through existing welfare or special assistance programs.

All impacts stated above could be minimised through: prior planning to reconfigure existing public programs, development of new programs if necessary; and working with the private sector to encourage (or expand) financing or loans schemes. Options to encourage owners of electric water heaters to think about alternative technologies would also be useful. Energy utilities could also assist through targeted mail-outs to off-peak tariff customers, as some have already begun to do so.[10]

Tenants and Rental Owners

For tenant households renting privately, the owner will be an additional stakeholder in the water heater replacement process. The tenant will usually be the first to notice when the water heater fails, and will contact the owner or the rental agent. The owner will then work through much the same process as an owner-occupier (see above).

The main difference will be that the owner will usually prefer the lowest capital cost option. If forced to a higher capital cost option, there will be a preference to recover the incremental cost from the tenant as higher rental increases than would otherwise have occurred. The extent to which this is possible will depend on the competitiveness of the rental market. If not, the owner may have to accept a slightly lower net rental yield.

The Commonwealth rebate rules state that:

- ‘An owner-occupier, landlord or tenant can apply for the rebate as long as the dwelling where the hot water system is installed is a principal place of residence.
- Government organisations are not eligible for the rebate.

The ability of a tenant to apply for a rebate and receive the payment is useful in cases where, say, the owner’s initial preference is to replace an electric with another electric, but the tenants are willing to meet part or all of the additional capital costs of a solar or heat pump because they stand to benefit from the running cost savings so long as they remain at the property.

The continuation of the Commonwealth rebate is uncertain, but the example shows that there are ways of sharing costs and benefits between rental owners and tenants.

The most vulnerable group of rental households are those in non-gas areas without the means to apply for solar or heat pump rebates – even if these continue to be available. In these instances the owner may well install LPG, in the knowledge that the running costs, however high, will be borne by the tenants.

[10] http://www.energyaustralia.com.au/State/NSW/Residential/Products-and-services/~/media/Files/Residential/Energywise/ENA0707_EnergyWise15_WEB_final.ashx

Low-Income Households

NIEIR disaggregates households in each State and Territory into six income categories and by owners/renters (Table 13). The number of water heaters in each household category is shown Annexe 8. The differences across income categories are relatively small, although higher income households and owners have a slightly higher ratio of gas water heaters, partly because they are more concentrated in inner urban areas.

The phaseout of greenhouse-intensive water heaters is projected to be about equally cost-effective for all household income groups, with slightly greater benefit for the lowest incomes (less than $20k) and the highest (more than $100k). This may reflect the concentration of those households in urban areas where natural gas is available. For the group of households considered 'low income' (less than $40k) the Scenario 3 B/C ratios are higher than for the middle and upper income groups. Under Model B the higher capital costs from preferring solar and heat pump water heaters once electric water heaters are phased out are matched or exceeded by the value of energy savings.

Under Model C, where diverted sales go mainly to natural gas and LPG, both costs and benefits are much smaller. Hence B/C ratios calculated for separate income and tenancy groups vary widely on the basis of a few tens of millions of dollars difference in the NPV of capital and energy cost projections, especially in the $20-40k group. The differences for owner and renter categories are analysed further in Annexe 8.

Table 13 Class 1 dwellings by income and tenancy group

Category	Share of all HH	% Owners	% Renters
HH <$20k	19.3%	68.2%	31.8%
HH $20-40k	24.1%	69.1%	30.9%
HH $40-60k	19.1%	73.9%	26.1%
HH $60-80k	15.5%	79.1%	20.9%
HH $80-100k	9.9%	84.6%	15.4%
HH >$100k	12.1%	88.3%	11.7%
Total households	**100.0%**	**75.3%**	**24.7%**

Source: NIEIR modelling for this RIS. Incomes at 2010, in 2010 dollars

Table 14 B/C ratios for Extended Phase-out (S3) by Household Income

Income Category	Model B				Model C			
	10T	10C	20T	20C	10T	10C	20T	20C
$0-20k	1.6	1.9	2.4	3.0	0.7	2.2	3.1	3.8
$20-40k	1.3	1.7	2.3	3.0	1.2	6.3	17.3	21.7
$40-60k	1.3	1.5	2.2	2.5	0.8	2.7	5.2	6.5
$60-80k	1.2	1.4	1.8	2.5	0.5	1.6	3.3	4.2
$80-100k	1.2	1.5	2.1	2.7	0.4	0.9	1.8	2.3
>$100k	1.4	1.9	2.3	2.8	0.6	0.9	1.8	2.2
Total (a)	**1.4**	**2.3**	**2.4**	**2.8**	**0.6**	**1.4**	**3.1**	**3.9**

7% discount rate (a) Calibrated to Table 10

Energy Utilities

By excluding electric water heaters, the proposed regulations would reduce the average consumption of electricity in existing 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 offset 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, space heating and cooling loads are heaviest. The proposed measure would mean that this capability would be reduced, but the impact on the electricity networks could be mitigated by the following:

- day-rate electric water heaters, which are currently able to operate during peak periods, would also be excluded by the proposed measure, leading to some reduction in their contribution to peak load;
- much of the diversion would go to natural gas and LPG 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 from those end uses;
- 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 potential for solar-electric and heat pump water heaters to contribute to winter loads. This can be managed by ensuring that the water heaters are adequately sized (as the proposed rules would require) and, where possible, connected to a restricted hours tariff or a time-of-use tariff that discourages operation during peak periods.

Some water heater types do not operate well under restricted-hours (‘Off Peak 1’) tariffs. Heat pumps generally heat more effectively under extended-hours (‘Off Peak 2’) or continuous supply. Furthermore they are less suited to night time operation under OP1 due to noise, although this could be addressed through noise testing and labelling. Low night-time temperatures in some areas also reduce heat pump efficiency. For solar-electric, operation on a restricted hours tariff will somewhat reduce the solar contribution, especially in households where hot water demand peaks in the evenings.

Ultimately, the best way to manage electricity demand from any source is not through restricted hours tariffs but through a combination of dynamic electricity pricing and the ability of appliances to respond automatically to price signals (‘demand response’). This is one of the main reasons basis for current developments on Smart Grids and smart metering. On the appliance side, Standards Australia is developing a Demand Response standard for electric, heat pump and solar-electric water heaters, which will enable them to receive utility load control signals so they can be de-energised during high-price events, as well as energised during periods when electricity prices dip, as can occur during peaks in renewable generation.[11]

The National Framework for Energy Efficiency working group for the Equipment Energy Efficiency Program(E3) is currently investigating the costs and benefits of mandating the demand response interface for electric and electric-boosted water heaters, as well as air conditioners and other products. This would address many of the concerns of the electricity utilities, by offering a low-cost means of avoiding water heater peak demand problems while maintaining tariff flexibility.

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[11] AS4755.3.3 (in draft) *Interaction of demand response enabling devices and electrical products—Operational instructions and connections for electric and electric-boosted water heaters.*

7. Consultations

Consultation Process

Stakeholders have been aware of government policies to discourage electric water heating for several years. The water heater industry has been aware of the proposal to phase out electric hot water services since 2007. The plumbing sector has been involved in consultation processes to assist in the development of training programs to encourage a smooth transition to low emission technologies. The proposed measure is consistent with these policies.

The Consultation Regulation Impact Statement was issued for public comment in January 2010, together with a schedule of public consultation forums. Between 10 and 19 February public forums were held in all capital cities except Hobart. A total of 127 people registered attendance. (List of registered attendees - Annex 9)

The Consultation RIS requested comment on the recommendations and also posed a series of questions on which submissions were sought. Attendees at the consultation forums were encouraged to prepare written submissions. Submissions were received from:

- 4 water heater manufacturers (Rheem, Dux, Stiebel Eltron, Endless Solar);
- Energy Networks Association (electricity networks);
- Plumbing Industry Association of South Australia;
- the Gas Industry Alliance, comprising Energy Networks Association (gas networks), the Australian Pipelines Industry Association (APIA), the Australian Petroleum Production and Exploration Association (APPEA), LPG Australia and the Gas Appliance Manufacturers Association of Australia (GAMAA);
- 8 gas and/or electricity suppliers: APA Group, AGL, Country Energy, Energex, EnergyAustralia, Envestra, Ergon, Integral Energy,
- 1 environmental group (Moreland Energy Foundation)
- 4 members of the public

82 organisations and individuals took part in the forums and/or made a written submission. The main points made in response to the recommendations and the additional questions in the Consultation RIS are summarised below.

Main Issues and Responses

Nearly all respondents supported, or at least did 'not oppose' the phaseout of greenhouse-intensive water heaters in areas with low-cost alternative options, i.e. natural gas. In many cases the support was conditional on certain concerns being addressed.

Most (but not Rheem) also supported, or did not oppose, at least one additional phase, but there was a range of views on:

- How soon a first phase could reasonably start: most indicated that '2010' seemed too soon, and some cited the home insulation scheme as an example of the 'problems of rushed implementation;'
- The minimum interval to the next phase (but most accepted 2 years);
- Whether there should be only one subsequent phase or more than one;
- Whether phasing should remain in step across jurisdictions; and
- Whether some regions, household types or electric water heater types should be permanently exempted from the first or the subsequent phases.

In some cases support for the measure was conditional on:

- The continuing inclusion of solar and heat pump water heaters in the RET scheme (Rheem and Dux);
- The exclusion of heat pumps (but not solar) from the RET scheme (Endless Solar, most electricity utilities, LPG and gas interests);
- The cessation of all other mechanisms which ‘distort’ the water heater market, i.e. the RET scheme and rebates (ENA, some electricity utilities);
- The continuation of solar and heat pump rebates (Dux);
- Adequate training for plumbers and installers

The support of the electricity supply industry was conditional on the phaseout being accompanied by measures to control the potential peak load impact of solar-electric, heat pumps and small electric water heaters). Some recommended mandating demand response (AS4755) interfaces for these types.

Many submissions (other than heat pump water heater manufacturers) questioned the quality, longevity and performance of heat pumps and indicated that these would need to improve, given that heat pumps are likely to be a preferred replacement option.

Several pointed out that low-income households would be disproportionately impacted either because of limited access to capital at time of water heater breakdown, or commitment to high-cost LPG fuel (although the Gas Industry Alliance stated that most LPG use is in warmer areas where hot water consumption is lower than the average used in modelling, so the annual costs are much lower).

The only submission which focussed on the actual cost-benefit modelling was a report commissioned by Rheem (Access Economics 2010). This did not find fault with the methodology itself or the energy price projections, but pointed out the following:

- The discount rates modelled should have been 3%, 7% and 11% according to OBPR rules. [Response: this has been done for Decision RIS].
- Sensitivity of outcomes to assumptions about LPG takeup. Access Economics demonstrates sensitivity of B/C ratios if LPG takeup is what Rheem claims it will be (about 67% of takeups diverted from electric) compared with what Consultation RIS modelling indicates (28%) and some intermediate points. [Response: Model C in this Decision RIS tests a high-gas and high-LPG scenario].
- Energy price projections will be different if CPRS does not proceed [Response: all energy prices have been updated for the Decision RIS].
- The modelling should quantify the value of additional RECs that the measure would generate, because RECs are a cross-subsidy from electricity users. [Response: the RET scheme is legislated to remain until at least 2030 anyway, so each additional REC created by this proposal only displaces a REC created by another measure. The only way that the proposal could increase the overall burden of cross-subsidy on electricity users is if it created more RECs than the total RET requirement, and if REC-liable parties have to buy all Small Renewable Energy Target RECs created (SRECS includes those created by water heaters).

  The projected sales of all water heater types over the period 2011-2020, including REC-creating solar and heat pump water heaters, are summarised in Annexe 9 (Table 81 and Table 82). The highest share of REC demand that would be satisfied by water heaters (Model B, S2) is 32%, and the more probable average is about 20%. Therefore the additional RECs created under the proposed phaseout would not increase the overall market demand for RECs, and therefore would have no impact on the cross-subsidy

required to support the RET.
As a third-order effect, electricity users could be better off if the cost of SRECs (currently fixed at $40, but subject to review) turns out to be lower than the cost of LRECs, and worse off if vice versa, but it is not possible to predict which will occur. Also, it is noted that the actual Rheem submission *opposes* removal of solar and heat pump water heaters from RET eligibility].

- The Cost of increased 'water wastage' from higher take-up of instantaneous water heaters should be included. [Response: this is examined in Annexe 8].
- Access Economics states that measure is not cost-effective if the cost of abatement per tonne to any group of householders (e.g. LPG adopters) is higher than the 'benchmark' abatement price of $76/tonne determined in a McKinsey report. [Response: the report in question has no particular status, and it is not necessary to demonstrate that all households will be better off. COAG (2007) states that 'decision makers should adopt the option which provides the greatest net benefit to the community' and 'decisions .... should be informed by an assessment of the effectiveness of the proposed action'. In addition, a staged implementation allows opportunity for further measures to protect the most vulnerable of those that may be worse off].
- Access Economics states that the cost to manufacturing industry (ie to Rheem) should be taken into account. It endorses Rheem's contention that:

  'If Stage 2 goes ahead as recommended by DEWHA **(and without Heat pumps and 4 star gas as a viable consumer alternative)** then it will result in the following [original emphasis]:

  – …A reduction in Rheem's Australian production of 27% resulting in a net loss of 144 jobs and an economic cost of $ 197 million…
  – …A physical adjustment cost to Rheem of $ 47.2 million…'[and other points]

  [Response: It has now been determined that 4 star gas water heaters will remain on the market and heat pumps will continue to attract RECs, so the impact on Rheem's manufacture of conventional water heaters will obviously be much less than 144 jobs and $M 47. Furthermore, all manufacturers benefit from the employment-creation effects of other government programs. Rheem alone reportedly created 350 new jobs in the first half of 2009 in response to the Commonwealth solar rebate scheme: 60 of these were at Rydalmere in NSW, where electric water heaters are manufactured.[12]

  Any financial impact from the proposed measure should be seen in the context of the full range of measures impacting on the market. It is estimated that in 2008/09 alone, the Australian solar and heat pump water heater markets benefited by $M 124 from RECs and by $M 81 from Commonwealth and State rebate programs.[13] Rheem brands have over 60% of the solar market and over 50% of the heat pump market (BIS 2010), so all else being equal the company's sales would benefit by over $M 120 *per year* from subsidies provided by electricity users and taxpayers.

  Also, if negative employment impacts on one manufacturer or sector are taken into account, so should the positive employment impacts for other manufacturers, water heater installers and (as Access Economics notes) even LPG delivery drivers.]

Other issues raised are summarised in Annexe 8.

[12] http://www.economicstimulusplan.gov.au/infocus/pages/if_300709_rheem.aspx.
[13] Unpublished estimates by GWA for Water Heater Implementation Group, June 2009.

8. Conclusions and Recommendations

Conclusions

Effectiveness and Cost-Effectiveness

Electric resistance water heaters are the most greenhouse-intensive water heaters and therefore represent an obvious focus to reduce emissions from households. Therefore phasing out greenhouse gas-intensive water heaters essentially means phasing out electric resistance water heaters.

The proposed phase-out appears to be cost-effective under nearly all scenarios and discount rates, with benefit/cost ratios rising over time. This is because average water heater capital costs rise once the measure is implemented, but energy savings build up over time. B/C ratios are projected to increase over time to 2.8-2.9 under Model B, and to 3.6-3.9 under Model C (7% discount rate).

The proposed measure is projected to reduce greenhouse gas emissions from water heating by nearly one third, or 79-82 Mt CO_2-e, up to 2030. This is equivalent to 1.4% of the national emissions from stationary energy combustion.[14] The phase-out of electric water heaters would account for about 15% of the total emissions impact of the E3 program to 2020, making it the largest single new reduction measure (Table 15). The reduction in 2020 is projected to be about 4.2-4.3 Mt CO_2-e below BAU.

Table 15 Comparison of greenhouse impacts with E3 Program

	Cumulative greenhouse reduction 2009-20		**Greenhouse reduction in 2020**	
	Mt CO_2-e	% of total	Mt CO_2-e	% of total
Impact of other E3 measures	163.0	85%	15.8	79%
Impact of water heater phase-out (S3)	28.0	15%	4.2	21%
Combined impact	191.0	100%	20.0	100%

Implementation

Implementation of a first stage at the end of 2010 is consistent with Commonwealth Government, MCE and COAG policy, which envisages a phased implementation in which a portion of replacement cases would become subject to the regulation in 2010, and all replacements would be affected from 2012.

The benefits of a staged (‘Extended’) implementation are:

- The opportunity to monitor the impact of the measure on the first group/s and refine or modify the application to later group/s;
- Allowing more time to inform stakeholders and householders, and allowing more time for householders to make informed decisions;
- Where some groups face higher compliance costs, deferring those costs; and
- Allowing time for the market to introduce new products (e.g. smaller heat pumps).

On the other hand the potential costs, compared with a ‘Rapid’ implementation, are:

[14] 2008 National Greenhouse Gas Inventory; ://www.climatechange.gov.au/~/media/publications/greenhouse-acctg/national-greenhouse-gas-inventory-2007.ashx

- Locking in higher greenhouse gas emissions – and in some cases, higher running costs – for the life of the electric water heaters installed during the first stage;
- The costs of developing, publicising, administering and verifying compliance with a regime that enables householders, plumbers and other stakeholders to determine whether the measure applies to them. This administrative infrastructure would have a life of only two years, after which it would be necessary to remind stakeholders that it no longer applied.

One reason for preferring a Rapid to Extended implementation may be the proportion of homes impacted in Phases 1 and 2. Jurisdictions which have only a small proportion of homes impacted under Stage 2, may find it administratively simpler to implement the phase-out in one step.

Exemptions

Apart from the general exemptions that would allow the use of electric water heaters in defined circumstances, there may be special cases which do not meet the general criteria but where the installation or use of any form of water heating other than electric resistance may be impractical, unsafe or prohibitively expensive. The SA requirements for water heater replacements in existing homes already contain provisions for special cases to be referred for Ministerial or administrative decision. All jurisdictions would need to adopt provisions of this kind.

Jurisdictions could also consider exempting areas such as alpine districts, where natural gas is not available and the severity of the local climate could compromise the performance of some models of heat pumps or solar-electric water heaters, leaving LPG as the only workable alternative if electric water heaters are prohibited. There are relatively few houses in such areas, which could be readily identified by postcode.

National Harmonisation

While there is no guarantee that all jurisdictions will adopt them, implementing the proposed regulations would offer the possibility of national consistency, and if adopted by some or all States would reduce the costs of complying with differing provisions.

If the national measures on which States have agreed in principle (i.e. those covered in this RIS) do not proceed, it would be expected that the jurisdictions with current requirements for replacement water heaters (SA and Queensland) would retain them. It is also likely that those with water heater requirements for new buildings (NSW, Victoria and WA) would in due course also adopt provisions for replacement water heaters. As with new buildings, these are likely to differ from each other, so increasing the scope for confusion and higher compliance costs to all parties.

The proposal provides a basis for jurisdictions to harmonise their requirements and to gain the following benefits:

- manufacturers and importers can plan for a nationally co-ordinated approach and minimise their transition costs in terms of product range;
- wholesalers and retailers will be able to rationalise their stock holdings and distributions;
- plumbers and installers will be faced with the same rules irrespective of their areas of operation, so reducing the risk of non-compliance;

- supplementary policies (e.g. for financing) can be developed nationally rather than by jurisdiction;
- jurisdictional administrative arrangements (e.g. exemption rules) can be streamlined and harmonised; and
- the costs to consumers will be lower to the extent that a share of the benefits of lower supplier, distributor and installer costs are passed on to them.

Interaction with other measures

Water heaters are generally purchased by or on the advice of plumbers or other intermediaries who have little or no incentive to take the information on energy labels into account. Home owners would rarely visit a showroom to inspect a physical sample. Therefore energy labelling would not achieve the objectives of the measure.

While MEPS have been shown to be effective in increasing the level of efficiency of products of specific types and energy forms, they have traditionally operated only within technology and energy types, not across them. The achievement of the objectives of the proposal rely on influencing choice towards low greenhouse forms of water heating, regardless of technology type or energy form. Therefore traditional MEPS alone would not achieve the objectives of the measure.

Even though energy labelling and MEPS are not an alternative to the proposed regulation, the measure would be strengthened by labelling or MEPS for the complying water heater types, such as heat pumps, which may be relatively unfamiliar to buyers.

The current Commonwealth and State rebates for the purchase of solar, heat pump and in some cases gas water heaters, while effective, vary significantly in nearly all aspects of design, amounts available and eligibility criteria. If the phase-out of greenhouse-intensive water heaters were implemented through rebates alone, ever-increasing levels of rebate would be required to secure each additional takeup, leading to higher costs per marginal tonne of greenhouse abatement.

Even though rebates are not an alternative to the proposed regulation, the measure may be implemented without rebates or in combination with rebates. Rebates may be general, or targeted according to income or other household factors.

Summary of Impacts

The main aspects of the scenarios are summarised in Table 16. The Consultation RIS presented the results of one market model (Model A), but this Decision RIS presents the results of an updated version of Model A (called Model B) as well as substantially revised model (Model C). The main difference is that under Model B, purchasers respond to the exclusion of electric water heaters by preferring solar and heat pumps, whereas in Model C, higher electricity prices tend to drive purchasers more towards natural gas and LPG.

On the main objective of the measure, greenhouse gas reduction, S2 (Rapid phaseout) indicates slightly higher reductions than S3 (Extended phaseout). On the other hand, S3 is somewhat more cost-effective than S2. The differences between the two scenarios are small enough so that Governments may wish to give weight to other criteria, such as the value of fine-tuning the measure during a process of phased implementation.

Table 16 Assessment of options against main criteria

Criterion	Year or Period (a)	S2 (Rapid Phaseout) - Changes from S1 (BAU) Scenario			S3 (Extended Phaseout) – Changes from S1 (BAU) Scenario		
		Model B	Model C	Interpolated	Model B	Model C	Interpolated
Cumulative greenhouse reduction compared with S1	2011-20 T	34.5 Mt	19.4 Mt	30.5 Mt	31.3 Mt	18.0 Mt	28.0 Mt
	2011-20 C	60.6 Mt	34.5 Mt	54.3 Mt	56.3 Mt	36.4 Mt	51.1 Mt
	2011-30 T	80.9 Mt	50.8 Mt	65.6 Mt	77.2 Mt	49.1 Mt	62.5 Mt
	2011-30 C	102.1 Mt	63.0 Mt	82.0 Mt	98.3 Mt	64.6 Mt	78.7 Mt
% emissions reduction compared with S1	2011-20 T	29%	17%	26%	26%	16%	24%
	2011-20 C	36%	21%	32%	33%	22%	30%
	2011-30 T	37%	25%	31%	35%	24%	30%
	2011-30 C	39%	26%	33%	37%	27%	31%
Emission reductions achieved in 2020	2020	5.2 Mt	3.4 Mt	4.3 Mt	4.9 Mt	3.4 Mt	4.2 Mt
NPV Net benefit (cost) (b)	2011-20 T	$M 714	($M 151)	NA (e)	$M 657	($M 188)	NA (e)
	2011-20 C	$M 2,452	$M 281	NA (e)	$M 2,252	$M 215	NA (e)
	2011-30 T	$M 3,586	$M 1,009	NA (e)	$M 3,405	$M 965	NA (e)
	2011-30 C	$M 4,621	$M 1,365	NA (e)	$M 4,408	$M 1,325	NA (e)
Benefit/cost ratios (b)	2011-20 T	1.3	0.7	NA (e)	1.4	0.6	NA (e)
	2011-20 C	2.2	1.5	NA (e)	2.3	1.4	NA (e)
	2011-30 T	2.3	2.9	NA (e)	2.4	3.1	NA (e)
	2011-30 C	2.6	3.6	NA (e)	2.8	3.9	NA (e)
Implied $/tonne CO_2-e saved (c)	2011-20 T	−$20.7	+$7.8	NA (e)	−$21.0	+$10.5	NA (e)
	2011-20 C	−$40.5	−$8.1	NA (e)	−$40.0	−$5.9	NA (e)
	2011-30 T	−$44.3	−$19.9	NA (e)	−$44.1	−$19.7	NA (e)
	2011-30 C	−$45.3	−$21.7	NA (e)	−$44.9	−$20.5	NA (e)
Increase in average water heater cost	2011-20	$512 (29%)	$138 (9%)	NA (e)	$449 (26%)	$90 (6%)	NA (e)
Increase in low-income household water heater cost (d)	2011-20	$M 142	$M 39	NA (e)	$M 119	$M 25	NA (e)
Impact on local manufacturing		Neutral	Negative	NA (e)	Neutral	Negative	NA (e)
Impact on installation activity		Positive	Positive	NA (e)	Positive	Positive	NA (e)
Net impact on employment		Positive	Neutral	NA (e)	Positive	Neutral	NA (e)
Administrative complexity		Simplest	More complex	NA (e)	Simplest	More complex	NA (e)

(a) T = analysis truncated at end of period. C=lifetime energy use for water heater cohorts installed up to 2020 taken into account. (b) Net Present Value at 7% discount rate. (c) Negative values indicate that value of energy savings alone cover the abatement costs. (d) Total increase in capital costs of water heaters purchases by households with income less than $40k. Will be exceeded by NPV of energy savings to those households. (e) Models B and C represent different water heaters market conditions, so not valid to average monetary outputs. Interpolation of emissions outcomes is valid, since models use same emissions intensities.

A value for CO_2-e emissions has been internalised in this cost-benefit analysis to the extent that the emission permit prices projected under a CPRS or similar measure are expected to impact on retail energy prices. If the value of the energy cost saving exceeds the capital cost increase (i.e. B/C ratio is 1 or more) there are no further costs of greenhouse gas reductions, and the $/tonne avoided is a negative value. If the B/C ratio is less than 1 there is an implied cost, and the $/tonne avoided is a positive value.

In Model B, S2 and S3 give −$20.7 to −$45.3 per tonne avoided. In Model C, the range is +$7.8 to +$10.5 per tonne avoided over the period 2011-2020 T, but once energy savings increase, the $/tonne avoided value becomes negative over the 2011-20 C and 2011-30 T periods (i.e. the greenhouse savings become 'free').

Impacts on Consumers
The water heaters that would take the place of the electric resistance types would cost about the same to purchase and install (LPG), slightly more (natural gas, heat pump) or significantly more (solar). They would cost less to run (solar, heat pump), about the same (natural gas) or significantly more (LPG). The extremes of the likely consumer response to the phase-out of electric water heaters are defined by:

- Model B: consumers prefer solar and heat pump water heaters, with high capital cost increases but also high energy savings;
- Model C: consumers prefer natural gas and LPG water heaters, with much lower capital cost increases but also lower energy savings.

The cost-benefit analyses in this RIS have taken into account the value of RECs but not rebates. In Model B the market moves towards solar and heat pump despite the lack of rebates, and it is projected that average water heater purchase prices over the period 2011-20 would be $512 (29%) higher under S2 and $449 (26%) higher under S3. In Model C the market moves towards natural gas (where available) and LPG, instead of solar, and the increase in average water heater purchase prices is significantly less: $138 (9%) higher under S2, and $90 (6%) higher under S3. The likely outcome is between Models B and C.

For many water heater purchasers the higher initial capital cost will be an impost, even if the NPV of lifetime energy cost savings more than compensates. The annual increase in national water heater capital costs to low-income households over the first 10 years of implementation is estimated at $M 142 per year for S2 and $M 119 per year for S3 under Model B, but only $M 39 and $M 25 respectively under Model C. By comparison, the total value of Commonwealth and State rebates to solar and heat pump water heater purchasers in 2009 is estimated at $M 246.

Impacts on Industry
The employment implications are neutral to positive. The net impact on local water heater manufacture is expected to range from essentially neutral under Model B to negative under Model C. The impact on installation activity, which is more labour-intensive and more evenly distributed across jurisdictions, would be positive under all scenarios, but especially under Model B, which indicates a higher solar market share.

The obligation to comply with these rules, once they are incorporated in the plumbing regulations, will rest with plumbers and installers. Compliance can be verified by current processes for inspecting plumbing work (or a proportion of it), which may need to be expanded to deal with the additional workloads.

Sensitivities and Risks

Energy and Capital Costs
The conclusions of this Decision RIS are based on the most recent energy prices and energy price projections, and the latest announced timing of the CPRS (or similar carbon pricing measure). Whether a carbon price is implemented or not has relatively little impact on the energy price projections, so this is not a point of major sensitivity.

Water heater capital cost estimates are based on today's costs (with rebate effects excluded). Solar water heating is a mature technology with a significant market, and the manufacture of one of the principal components – pressure tanks – is already highly integrated with the manufacture of conventional water heater components. There may be some scope for further returns to scale in the manufacture of some solar components, but these could be offset by a reduction in the scale of pressure tank manufacture as the demand for conventional storage systems falls.

Product performance
Compared with electric water heaters, more care is required to select heat pump and solar water heaters that are suitable for specific hot water demand and climate conditions. For heat pump water heaters this would be assisted by labels which identify which models are suitable for which climate zones and which tariff classes (continuous or restricted hours). For solar water heaters there are some risks of poor installation.

The level of plumber and installer expertise is progressively improving as familiarity with solar installations grows, but the risks could be reduced with further intensive training programs. Solar collectors in particular need to be correctly oriented and free of over-shadowing, and the system components correctly connected. The level of plumber and installer expertise is progressively improving as familiarity with solar installations grows, but the risks would be reduced with further intensive training programs.

Compliance
The primary compliance obligation will fall on plumbers and installers. There will be a risk that some will be unaware of the requirements, especially in the early stages, and that some will choose not to comply with the regulations, either on their initiative or in response to customer requests or demands. The risk of this would be highest in stage one of the Extended Implementation scenario (S3), while large electric storage water heaters were still widely available. The general and special exemption provisions will provide a permanent compliance risk.

These risks can be minimised through clear rules and guidelines, training programs for plumbers and installers, and monitoring by plumbing inspectors. In jurisdictions which rely on random rather than universal inspection of plumbing work, the rate of inspections may need to be increased in the early phases of implementation.

If there are 650,000 replacements per year and 5% are randomly inspected at $100 per visit the total cost would be $M 3.25 per year compared with total additional capital costs of between $M 80 and $M 280 per year for S3 (see Figure 44), i.e. between 1% and 4%. This would be the maximum, because:

- inspection costs could be (and probably would be) integrated with general plumbing work inspections in those jurisdictions that already have an effective regime;
- it should be possible to target inspections to the households where an electric has been replaced, rather than all hot water replacements;
- inspection rates could be lowered from 5% random to say 2 to 3% after first 2 years, once installers become more familiar with the rules; and
- from year 3 the manufacture of large electric water heaters could cease, so the scope for non-compliance may be limited to the use of small electric water heaters in situations not properly covered by exemptions. This could be monitored indirectly through requiring reporting of annual sales of small electric water heaters.

LPG
There is a risk that some householders will adopt LPG solely because it is the lowest capital cost option, not because it is the most cost-effective option for them. If so, they could be left with high operating costs. Low-income households and rental households may be especially vulnerable. The extent of this will not become apparent until the electric water heater phase-out extends to areas without a natural gas supply. However, monitoring programs and early development of policy responses, should they turn be necessary, would mitigate this risk.

Recommendations

Following consideration of additional cost-benefit modelling, and review of the submissions made by industry and other stakeholders in response to the Consultation RIS, the following recommendations are essentially unchanged from those in the Consultation RIS:

It is recommended that:

- In view of the effectiveness of reducing emissions, and the overall cost-effectiveness for householders, greenhouse gas-intensive water heaters should be phased out from Class 1 buildings (i.e. houses) through prohibiting the installation of electric resistance water heaters, with certain exemptions.
- In view of the advantages of a staged implementation, the phase-out should be implemented in two stages; the first stage from 2010 and the second from 2012.
- In view of the time required to develop uniform national regulations, each Australian jurisdiction should implement the first stage under its own plumbing regulations, and the second stage through common provisions, such as those which may be developed for the Plumbing Code of Australia.
- Each jurisdiction should determine its own rules for the first stage of implementation, based on criteria such as location and/or gas connection status, targeting houses where compliance options are likely to be wider and cheaper.
- The second stage should apply across the entire jurisdiction, subject to certain exemptions.
- The second stage should preferably take effect at the same time across all implementing jurisdictions. This would minimise disruption to the market and the water heater industry.
- Given that there is already a method of calculating the greenhouse gas intensity of water heaters in the Building Code of Australia (BCA), the list and method used for the phase-out should be similar to that of the BCA.
- The same general exemptions provided for new Class 1 buildings in the BCA, would apply to existing buildings. These include rules under which electric resistance water heaters can be installed in defined situations, or where the electricity is supplied directly from renewable sources.

- Jurisdictions should develop guidelines and administrative procedures for assessing and granting special exemptions, in cases where installing any water heater other than electric would be unsafe or excessively costly.
- Where solar or heat pump water heaters are installed, the performance requirements should be similar to those applying to new Class 1 buildings in the BCA.
- In view of the need to inform installers of the regulatory obligations and to increase skills in anticipation of growing demand for non-electric water heater types, information and training programs on the proposed phase-out should be developed and implemented for plumbers and installers.
- In order to make householders more aware of their options when it comes time to replace their water heaters, information programs on the proposed phase-out and replacement options should be developed and targeted to households with electric water heaters.

9. Review

If a phased implementation approach is adopted, the logical time to review the operation of the measure is towards the end of the first phase, prior to the implementation of the second.

The proposed measure interacts with a number of other programs and policies which are themselves evolving, including:

- Carbon pricing: the assumptions about the effects of a carbon price from 2013 are based on Treasury's 2008 modelling of the impacts of a CPRS, then proposed for implementation in 2012. These assumptions may need to be revised once proposals for carbon pricing are clarified.
- The Commonwealth and State solar and heat pump water heater rebate schemes: the assumptions about these, and the decision to omit them from the cost-benefit modelling, are based on current stated policy for the duration of these programs. These assumptions may need to be revised if there are policy changes.

As with all other regulation, the impact of the measures should be monitored by Governments. The effects of phase one on the water heater buyers and on manufacturers, importers, plumbers and installers should be monitored, to ensure that there is compliance and that there are no unforeseen or disproportionate impacts.

Certain compliance patterns have been assumed, based on the best information currently available, and it will be necessary to check how suppliers, installers, home-owners, tenants and rental owners do in fact respond. For example, if the rate of installation of LPG water heaters increases more rapidly than expected, this would be evidence that buyers are being unknowingly committed to high energy prices, and specific policy responses may be warranted.

Once phase two is implemented, the operation of the program and the policy settings should be re-evaluated every five years or so, although will be little scope for further greenhouse gas reduction in water heating once electric resistance water heaters are excluded from the market. If the greenhouse gas intensity of the electricity supply system falls more rapidly than anticipated, and the price of emissions rise more rapidly than anticipated, the greenhouse and cost relativities between natural gas, solar-electric and heat pump water heaters may change. However, that is not expected to occur until after 2030.

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Annexe 1 Domestic Water Heater Market Characteristics

1.1 Stocks, Sales and Energy Use

Domestic hot water in houses is supplied by one or more separate water heaters. Apartments may have their own water heaters, or be served from a central water heater system that serves the entire building. All houses and about 61% of apartments have their own water heater and the other 39% of apartments are served from central systems (Table 17). 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 12; this 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). Because electricity is the most greenhouse-intensive form of delivered energy, it accounted for nearly 80% of the emissions from water heating (Figure 13). *Note: RIS does not include apartments in the phaseout.*

Table 17 Estimated number of dwellings and residential water heaters, Australia

	Number of Dwellings (a)	With own WHs (b)	Served by Central WH	Number of CWHs
Separate houses	6,262,719	6,262,719	NA	NA
Attached houses	783,023	783,023	NA	NA
Apartments	1,236,542	750,207	486,335	16,141
Other private residences	144,271	144,271	NA	NA
	8,426,555	7,940,220	486,335	16,141

Source: GWA calculations based on Census 2006. (a) Includes unoccupied dwellings, which make up 9% of houses and 13% of apartments at any given time. (b) National average about 1.02 water heater per house

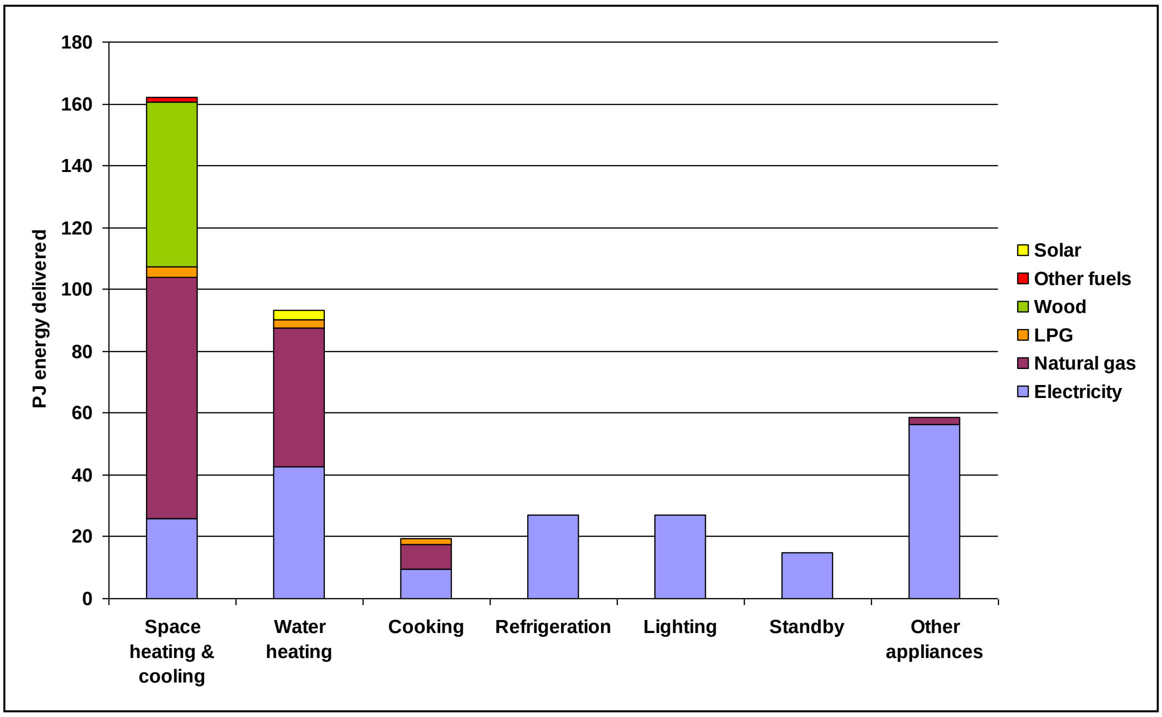


Figure 12 Energy used in the residential sector, Australia 2008

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

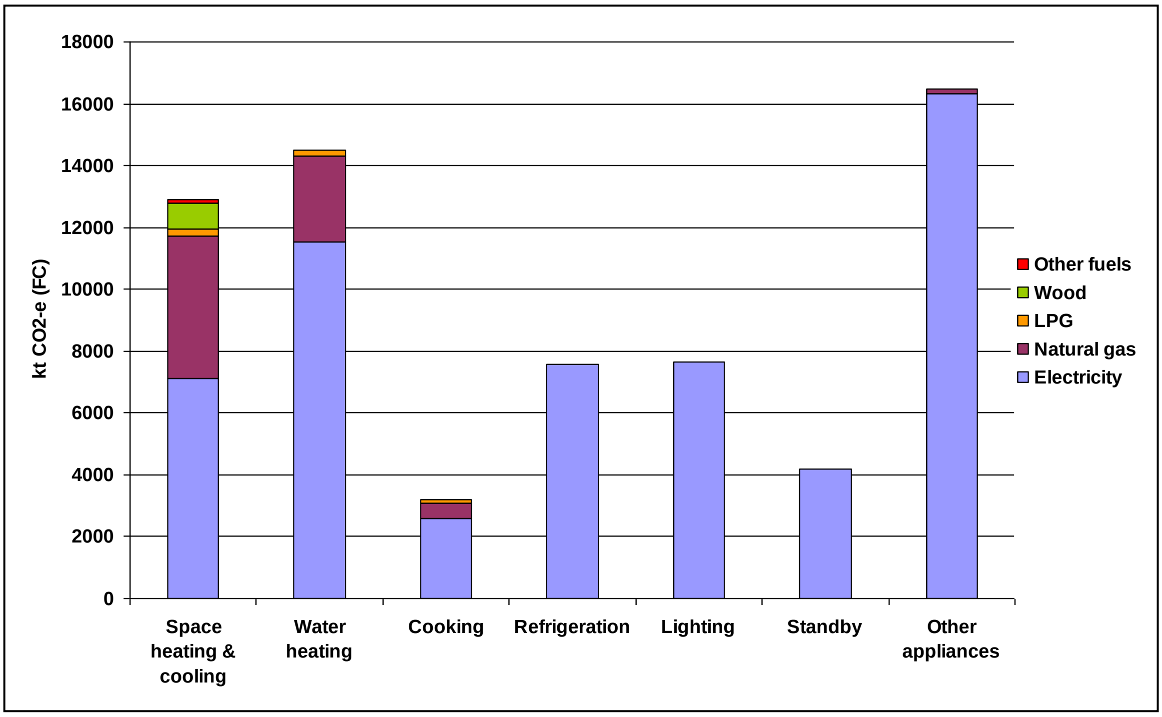
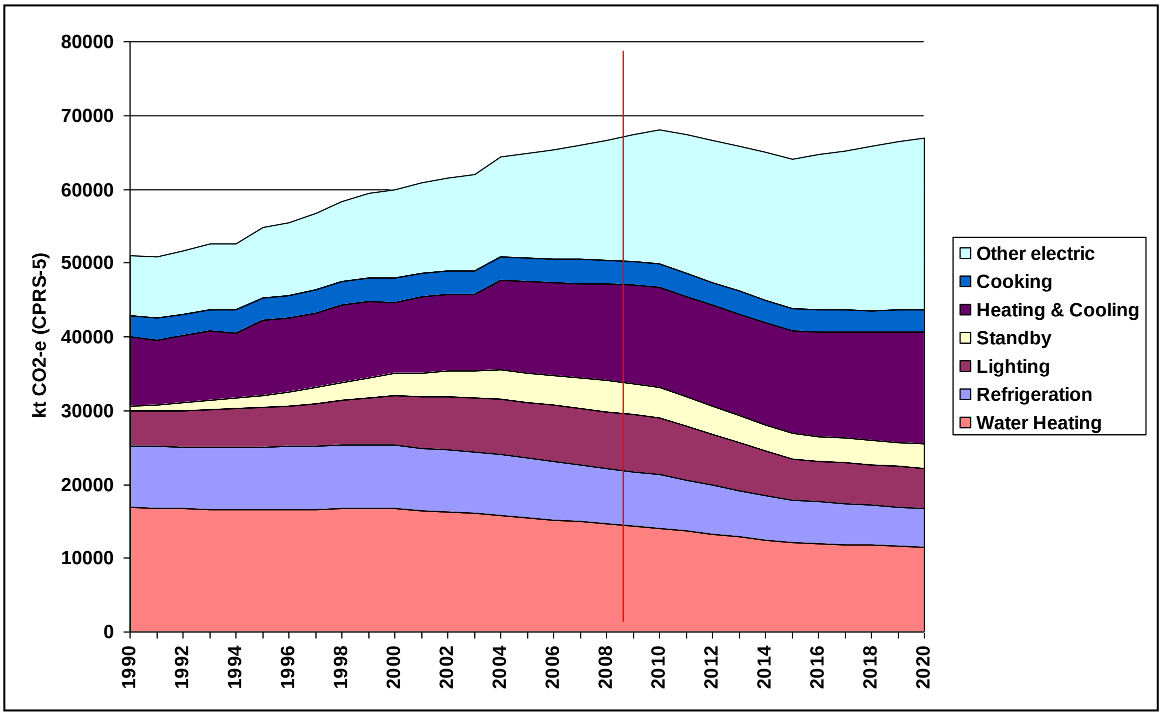


Figure 13 Greenhouse gas emissions from residential sector energy use, Australia 2008

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

Figure 14 Emissions by residential energy end uses, Australia 1990-2020



Source: EES (2008)

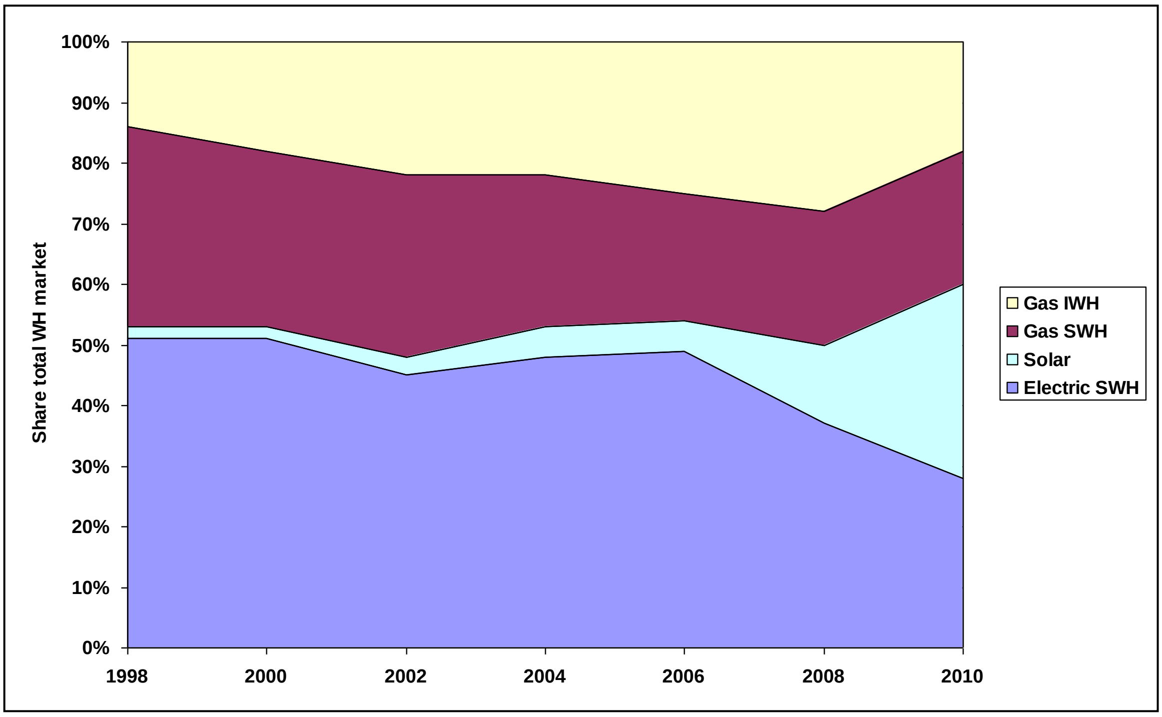


Figure 15 Water heater market share by type, Australia

Source: BIS (2006, 2008, 2010)

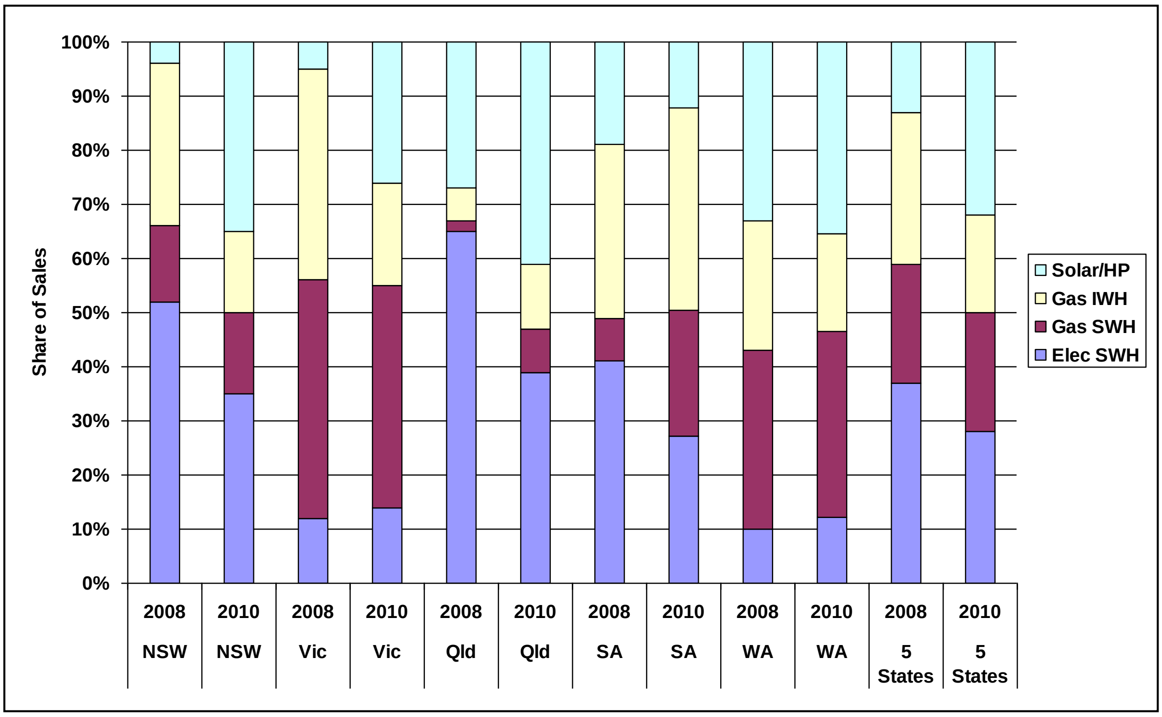


Figure 16 Share of water heater sales, 5 States, 2008 and 2010

Source: BIS (2008) – No data for Tasmania, NT or ACT

Table 18 Water heater sales, Australia 2007-08

	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	5655	69.2%	520	104	388	27	13.8%	51.3%	3.6%	69%
Private rental+other tenancy	2150	26.3%	190	35	148	7	4.6%	19.5%	0.9%	25%
Public tenancy	371	4.5%	30	4	26	1	0.5%	3.4%	0.1%	4%
	8175	100.0%	740	143	562	35	19.4%	75.9%	4.7%	100%

Source: Author estimate based on BIS (2008; BIS 2010 reports almost identical market size), ABS (2008); includes separate water heaters in Class 1 and Class 2, but excludes central water heaters for Class 2

Table 19 Estimated share of Australian water heater stock and sales, 2007-10

	Stock June 2008	Sales 2007-08	Sales 2007-08	Sales 2009-10(a)	Sales 2009-10(a)
Electric	53%	37%	274,000	29%	216,000
Natural Gas and LPG	40%	50%	370,000	41%	308,000
Solar, Heat Pump and Other	7%	13%	96,000	30%	219,000
Total	100%	100%	740,000	100%	743,000

Source: Author estimate based on BIS (2008, 2010), ABS (2008) (a) Reflects influence of Commonwealth and State rebate schemes. Pattern likely to return to trend if/when rebates are removed

1.2 Water Heater Choice

Winton (2008) researched the extent of buyer engagement in the purchase of the previous water heater and the intended engagement in the purchase of the next water heater. He found that only 40% of householders (scaled to ABS data) took an active part in the selection of their current water heater, 20% were passive purchasers and 40% took no part because the water heater was already there when they moved in (Figure 17). As the survey only covered occupants, it did not assess the degree of engagement of the owners of rental homes. However, it would be expected that most owner-renters would want to minimise their replacement capital cost rather than the lifetime cost, so would be even less concerned with running costs than owner-occupiers. The less engaged the purchaser, the more likely that the water heater will be electric (Figure 18).

Where home-owners make a water heater selection, they face the likelihood that they will not be in that house long enough to fully gain the benefits of a water heater with low energy costs. About one in six households move in each year, and the average time in the same dwelling is between 6 and 7 years.[15] Statistically, the water heater replacement could occur in any year of tenure. A 10-year service life water heater (typical of electric storage types) will probably serve the current owner for only 3 to 4 years, and the next owner/s for 6 to 7 years. A 14-year service life water heater (typical of solar-gas types) will probably only benefit the installing owner for 3 to 4 years, and then serve the next owner/s for 10 to 11 years.

Homeowners can only be sure of capturing the full energy benefits of higher capital cost water heaters if they can be confident of recovering the additional cost in the home sale price. There is no evidence that this is the case. Homeowners discount the value of energy savings

[15] http://www.abs.gov.au/ausstats/abs@.nsf/featurearticlesbytitle/D2799C9AA38B5E0DCA25741700118E71?OpenDocument

because they may not be in the dwelling long enough to recover the costs of a higher capital option (i.e. they act as the ‘agent’ for the subsequent occupant, who will capture most of the benefit). Consequently there is a tendency among both engaged buyers and intermediaries to undervalue future energy costs and to replace the water heater with one of the same type. The persistence and size of the inefficiencies associated with water heater choice leads to the conclusion that market failure is pervasive and significant.

Figure 17 Reported householder engagement in previous water heater purchase

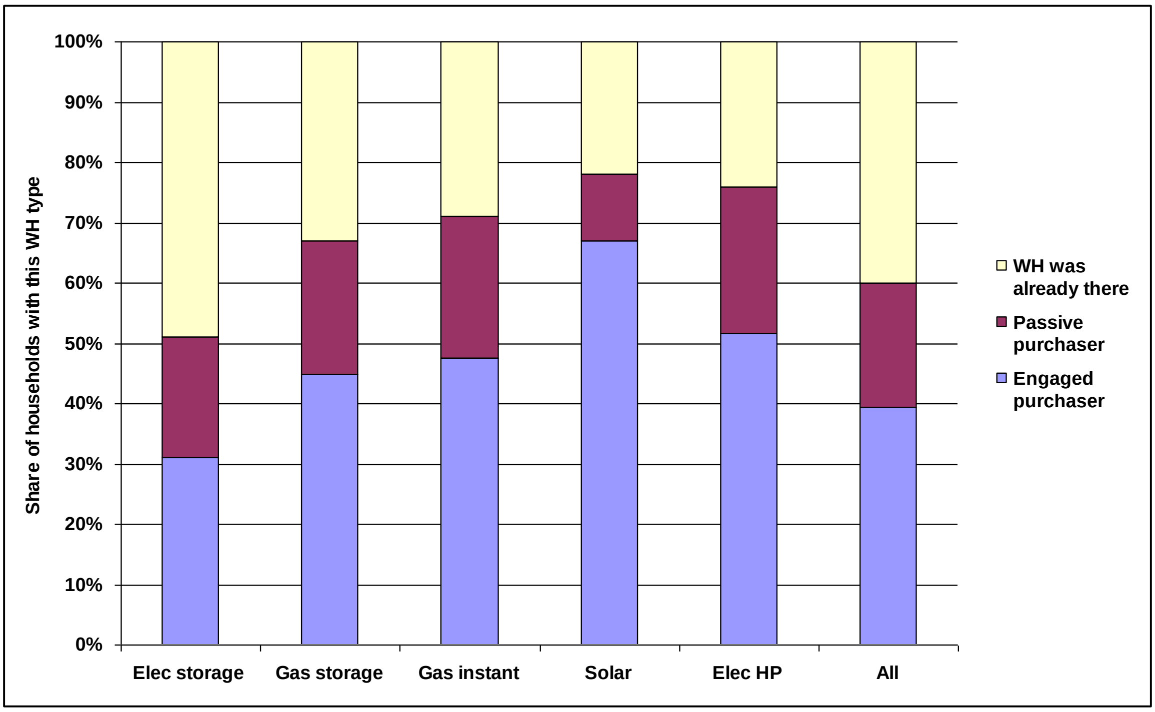
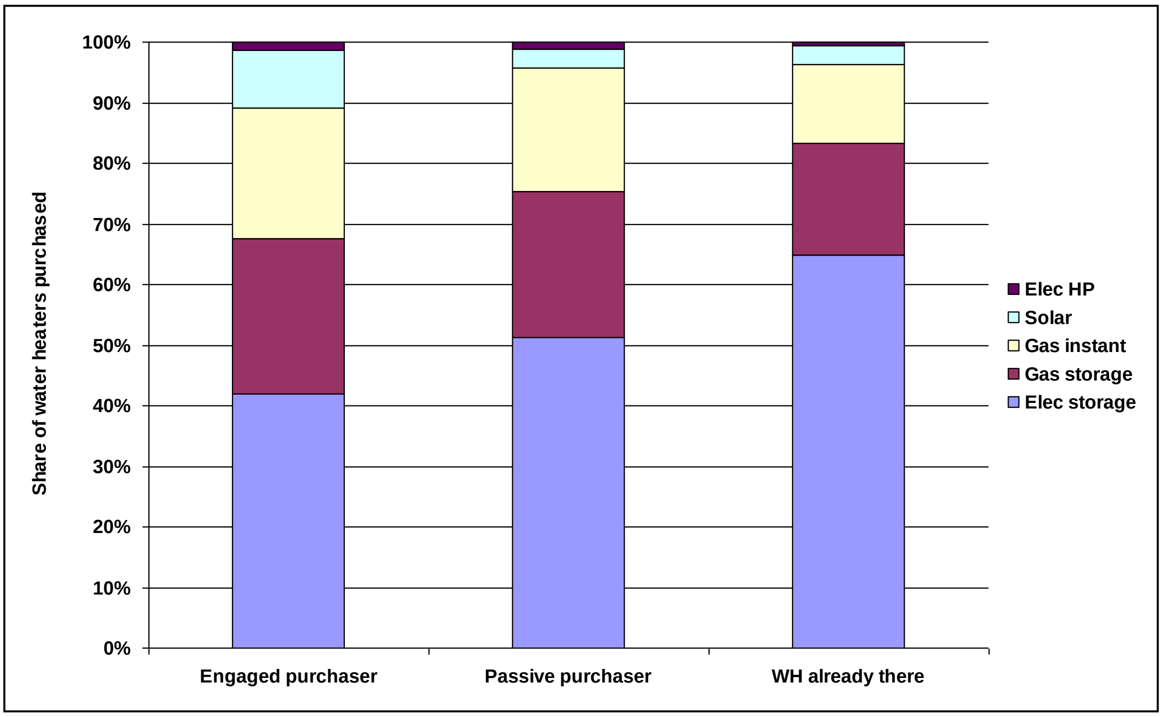


Figure 18 Water heater preferences by class of purchaser


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Share of water heaters purchased
Engaged purchaser
Passive purchaser
WH already there
Elec HP
Solar
Gas instant
Gas storage
Elec storage

Annexe 2 Water Heater Types and Greenhouse-Intensity

2.1 Water Heater Types

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 heats the water as required (‘instantaneous’ or ‘continuous flow’);
- water storage capacity (e.g. litres) or ‘delivery’ capacity (e.g. 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 (e.g. ‘continuous’ or ‘day rate’ electricity) or whether it is designed to work with a time-constrained supply (e.g. ‘restricted hours’ or ‘off-peak’ electricity);
- the maximum rate of energy transfer (e.g. kW for electric types, MJ/hr for gas);
- for storage types, the rate at which heat is lost from the stored water (‘standing loss’);
- whether the system is capable of collecting radiant (solar) energy, and if so by what means (e.g. 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 ‘thermosiphon’ 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 (e.g. 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 (e.g. many 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.

Of all the common means of heating water, the simplest technology is the electric storage water heater. Electric water heaters have a number of attractions: 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, given the high greenhouse intensity of electricity supply.

Table 20 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 20 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 labeling
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.

The energy consumption of gas water heaters varies 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 requires physical tests of burner efficiency and maintenance rate (a proxy for storage tank heat loss). 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.

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

- performance of the solar collectors;
- performance of the boosting equipment (which may be capable of functioning as a complete electric or gas water heater on its own);
- control and interaction of solar and conventional elements, including pumping energy; and
- hot water load (both magnitude and profile, i.e. 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 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.[16]

AS/NZS 4234 defines four Solar Climate Zones, each of which uses a references city with regard to an annual record of dry-bulb and wet-bulb temperatures, solar insolation, and cold water inlet temperatures. The addition of a fifth Zone, covering Tasmania, the ACT and the alpine and tableland regions of Victoria and NSW is being considered. A test standard for quantifying air source heat pump water heater parameters for use in AS/NZS 4234 is in draft (DR AS/NZS 5125) and publication is expected soon.

Table 21 Australian Solar 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, Brisbane	4,587,000	697,000
4	Melbourne	WA, SA, Vic	Melbourne	1,370,400	144,100
5 (b)	Canberra	ACT, Vic, Tas, NSW	Canberra, Hobart	509,700	28,200
Total				7,011,500	920,700

(a) 2006 Census data mapped to climate zones by author (b) Additional zone proposed: Appendix H, AS/NZS 4234, 20 July 2009

2.2 Efficiency and Greenhouse intensity

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 gas intensity of electricity supply varies from State to State (Figure 19) and changes over time, but a regulatory definition of 'greenhouse-intensive' needs to refer to a simple and stable method of calculation so that water heater suppliers and installers can verify their compliance with it.

The annual energy use and efficiency of a wide range of water heater types has been calculated by Thermal Design Pty Ltd, using the TRNSYS simulation model. This RIS draws on four separate studies (TD 2007, 2007a, 2009, 2009a), totalling nearly 1200 discrete simulations. The efficiency range for conventional electric and gas water heaters is fairly narrow across types (Table 22). 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 conventional water heaters and heat pumps, task efficiency increases gradually with delivery, all else being equal. For solar water heaters

[16] 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.

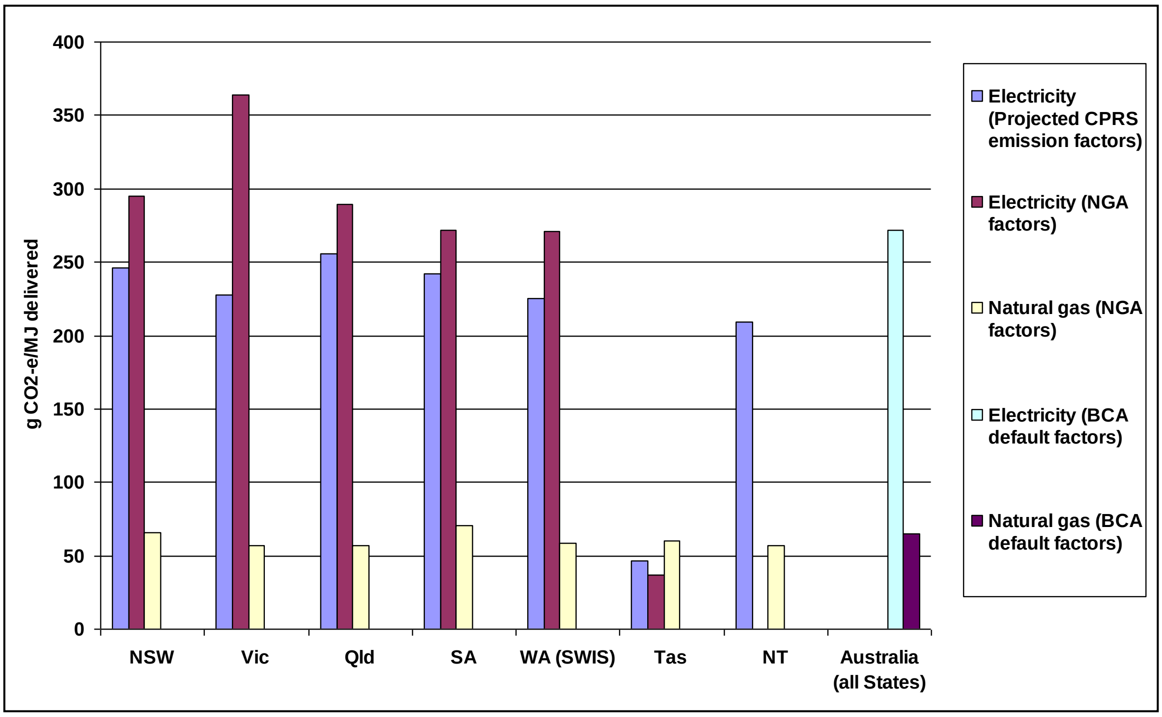
on the other hand, task efficiency increases steeply as delivery declines, and falls as delivery increases.

Table 22 Indicative range of modelled water heater task efficiencies

Type	Highest Efficiency	Lowest Efficiency	Range, high to low
Electric storage (off peak) (a)	0.90	0.70	0.20
Electric storage (continuous) (a)	0.90	0.78	0.12
Gas instantaneous (b)	0.75	0.60	0.15
Gas storage (b)	0.78	0.55	0.23
Heat pump	3.5	2.2	1.3
Solar-electric (evacuated tubes)	6.0	1.5	4.5
Solar-gas (flat plate, small) (b)	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

Source: TD (2007, 2007a, 2009, 2009a). Efficiency varies with delivery and other factors. (a) Efficiency is less than 100% due to standing heat losses. (b) Efficiencies for natural gas and LPG are identical.

Figure 19 Greenhouse gas intensity factors, electricity and natural gas



Source: DCC (2009), Treasury (2008), GWA (2007)

Annexe 3 Influences on water heater design and selection

3.1 Mandatory Requirements

Five States and the ACT have requirements governing the types of water heaters that may be installed in new dwellings. South Australia and Queensland have also adopted requirements for the replacement of existing water heaters.

In July 2008 South Australia introduced rules which required that, from 1 July 2009, most replacements be low emission types such as heat pump or solar (meeting minimum RECs requirements) or high efficiency gas (5* or better). Conventional electric water heaters can now only be installed for Metropolitan or 'near Adelaide' homes where the system being replaced is located inside the dwelling or in the roof space or, if outside, is within 3 metres of neighbours' windows or doors. The ratio of homes in exempt categories is unknown, as is the ratio of householders making use of exemptions.

Conventional electric water heaters are allowed as replacements for electric water heaters in 'Regional' and 'Remote" houses, in multi-storey flats and in dwellings owned by SA Housing Trust (there is a published list of postcodes classified as 'Metropolitan', 'Regional' and 'Remote'). A further element of the regulations is that all showers connected to the replacement water heater must have a 3-star WELS rated shower head or a flow restrictor (unless the system is gravity-fed rather than mains pressure).

The Queensland Plumbing and Wastewater Code requires provides for 'hot water systems with a low greenhouse gas emissions impact' to be installed 'at replacement of existing hot water systems for Class 1 buildings from 1 January 2010' (QPW 2009). The application of the Code to replacement water heaters is restricted to buildings where 'the distributor advises the hot water system installer that natural reticulated gas can be supplied to the property's gas meter at no cost to the building owner.'[17]

If these conditions are satisfied, the 'acceptable solutions' for replacement systems are solar, heat pump (no minimum RECs requirement) or a gas (5* or better). In 2007 the Queensland Government announced that the measure would eventually be extended to areas without gas reticulation (Qld 2007).

3.2 The Renewable Energy Target (RET) Scheme

The Mandatory Renewable Energy Target (MRET) scheme was introduced by the Commonwealth Government on 1 April 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 September 2009 the Australian Parliament passed the *Renewable Energy (Electricity) Amendment Act 2009* which will increase the renewable energy target to 45,000 GWh per annum by 2020, to remain at that level until 2030. The Office of the Renewable Energy Regulator (ORER), which is a statutory agency within the Climate Change portfolio, administers the Act and its regulations.

[17] Where an electric water heater located in a gas reticulated area fails during its warranty period it may be replaced by another electric water heater. It is permissible to install a temporary water heater for up to 60 days, to allow an interim electric water heater or a gas water heater operating from a compressed natural gas bottle to be used until the gas connection is completed.

The Act 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.

Solar-electric, solar-gas and electric heat pump water heaters are able to create RECs, while other types of water heater are not. Until recently the value per REC was determined by both the long term contract and spot market. In June 2010 the Commonwealth amended the Act so that from January 2011 the RET will be separated into two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). Solar and heat pump water heaters will be able to create RECs at fixed price of $40 (to be reviewed after 2015). This means that the typical solar and heat pump water heater purchaser will continue to receives a REC subsidy of between $900 and $1400.

3.3 Rebates and Incentives

In addition to the RECs value, which is available for every solar and heat pump water heater installation in Australia (whether in a new or existing home), some jurisdictions also offer rebates or other assistance to purchasers. These are usually only available for the replacement of existing electric storage water heater. Some States also offer assistance to purchasers of conventional gas water heaters, if replacing an existing electric storage water heater.

Commonwealth

In July 2007 the Commonwealth Government began to offer means-tested rebates of $1,000 to householders replacing electric hot water systems in existing privately owned homes. In February 2009 the Government introduced its Energy Efficient Homes package[18], which offered either free ceiling insulation up to a value of $1600 or a rebate of $1600 for a solar water heater or $1,000 for a heat pump water heater, if replacing an electric water heater, payable after installation. It was reported that in the first 6 months of the program there were over 53,000 applications for water heater rebates.[19] In February 2010 the scheme was replaced by the Energy Efficient Homes Package, changing the amounts available from the Commonwealth as indicated in Table 23.

NSW

In October 2007 the NSW Government began to offer rebates to householders replacing existing electric water heaters with gas, solar or heat pump water heaters. The rebate program is currently due to finish at the end of June 2011. The water heater types, categories and main conditions are summarised in Table 24. The rebate eligibility conditions and amounts were stable from 1 October 2007 until 14 January 2010, when the amounts were equalised at $ 300 for all types and there were minor adjustments to the eligibility and payment criteria. The scheme paid over 110,000 rebates over the 27 months to March 2010 (Table 25). Solar-gas had the least uptake despite the highest rebate offer. Of the households which selected a water heater using gas (ie the sum of gas and solar-gas claimants), 79% opted for conventional gas

[18] http://www.environment.gov.au/energyefficiency/index.html
[19] Advice from DSE Victoria and http://www.economicstimulusplan.gov.au/infocus/pages/if_300709_rheem.aspx

and less 21% for solar–gas. Only 5% of the solar water heaters rebated used gas boosting and over 95% used electricity.

Table 23 Commonwealth general rebate categories and amounts

Water Heater Type	July 2007- 3 Feb 2009	3 Feb 2009- 4 Sept 2009	4 Sept 2009- 19 Feb 2010	From 19 Feb 2010
Solar-electric, Solar-gas, >= 20 RECs	$ 1,000	$ 1,600	$ 1,600	$ 1,000
Heat pump, >= 20 RECs		$1,600	$ 1,000	$ 600
Eligibility	Means tested	Owners only (a)	Owners only (a)	Owners only (a)
Mode of Payment	Reimbursement on proof or payment	Reimbursement on proof or payment	Reimbursement on proof or payment	Reimbursement on proof or payment

Source: DEWHA 2009 (a) Tenant can apply with written permission of owner. Homeowners who have already accessed the insulation benefit are ineligible.

Table 24 State and Territory water heater rebates, 2010

Jurisdiction	Duration	Payment	Conditions (a)
NSW – solar	Since Oct 2007	$600-1200 (i)	Solar or HP to replacing EWH
NSW – gas	Since Oct 2007	$300	5* Gas to replace EWH
Victoria - metro	Since Oct 2007	$900-1500	Change from gas also eligible (b)
Victoria - regional	Since June 2008	$400-1600	Restricted to HH not taking CW rebate (c)
Victoria – gas	Since Oct 2007	$400-700 (h)	5* gas to replace EWH (d)
Queensland – solar	Since Apr 2010 (e)	$600-1000	NA
SA – solar	Current	$500	Available to pensioners
SA – gas	Current	$500-700	5* gas to replace EWH (d)
WA – solar	June 2005-June 2013	$500-700	For solar-gas/LPG only; new homes also
Tasmania – solar	No solar rebates(f)	NA	NA
NT – solar	No solar rebates(g)	NA	NA
ACT – solar or gas	Current	$500	Must also spend $1,000 on other measures

(a) Solar (any boost) or heat pump to replace existing electric water heater, unless otherwise stated. (b) Rebate only paid for installation of solar-gas. (c) From May 2009, only HH which have taken CW insulation rebate and so are no longer eligible for CW water heater rebate. (d) Higher payment for concession card holders. (e) State Government offers $600 rebate for the purchase of a solar or heat pump replacing an electric storage water heater, or $1,000 for qualifying pensioner or low-income households. Brisbane City Council offers $400 rebates. (f) Hobart City Council offers rebates. (g) Offers to purchase RECS at fixed price. (h) Plus $300 for installation in some apartment situations. (i) Payment based on number of RECs; since 15 Jan 2010, $300 rebate applies irrespective of type.

Table 25 NSW Rebate Scheme – Takeups Oct 2007 to Mar 2010

WH type	Number	Avg Cap (a)	Avg Rebate	Avg Net	Avg RECs
Gas	10,270	$ 1,664	$ 300	$ 1,364	NA
Heat pump	41,521	$ 3,574	$ 737	$ 2,837	30
Solar-elec	55,546	$ 4,110	$ 847	$ 3,263	34
Solar-gas	2,670	$ 5,197	$ 956	$ 4,241	39
	110,007	$ 3,706	$ 757	$ 2,949	29

GWA analysis of raw data supplied by NSW Department of Environment and Climate Change (a) Includes effect of RECS value, if applicable

Victoria

The Victorian rebate scheme is available to householders who replace an existing electric or gas water heater.[20] Victoria's large reticulated natural gas network has resulted in the majority of homes having a gas water heater rather than electric, and homes with gas water heaters are not eligible for the Commonwealth solar hot water rebate, so this limits the scope for takeup. The scheme paid 17,500 rebates from June 2008, when the more generous regional rebate program started, to March 2009. Table 26 analyses the nearly 7,500 rebates paid to March 2009.

In May 2009 the eligibility criteria were changed to prevent 'double-dipping' with the Commonwealth scheme. Rebates for replacement of an electric water heater with solar or heat pump are now restricted to households that have taken the Commonwealth insulation rebate, and so are permanently excluded from taking the water heater rebate. Only a minority of electric water heater replacements in Victoria are likely to meet this criterion, given the high ratio of insulated homes, so it will mean a significant reduction in Victorian State rebate payments for solar. However, rebates will continue for gas to solar-gas and other fuels (eg oil, LPG) to solar, which are not eligible for Commonwealth rebates.

Table 26 Victorian Rebate Scheme – Takeups June 2008 to March 2009

Scheme	WH type	Number	Avg Cap $(a)	RECs $(b)	Rebate $	Net $	Avg RECS
Regional	Heat pump	3405	$3,924	$1,044	$2,223	$696	28
Regional	Solar-elec	1258	$5,289	$1,035	$2,235	$2,039	27
Regional	Solar-gas	2230	$5,482	$1,111	$2,305	$2,058	28
Metro	Solar-gas	594	$6,096	$1,081	$1,347	$3,736	35
Vic Total		7487	$4,790	$1,065	$2,180	$1,568	29

GWA analysis of raw data supplied by Sustainability Victoria (a) Before RECs value deducted (b) RECS value passed on the purchaser in the purchase transaction (some values reported, some estimated by SV).

Queensland

On 1 July 2009, the Queensland Government commenced the *Queensland Solar Hot Water Program*. Householders replacing an electric water heater could purchase a standard solar or heat pump hot water system for $500 (fully installed), or $100 for eligible pensioners and low income earners (GWA 2009). The financing of the program relied on the Queensland Government capturing the value of RECs and the Commonwealth $1600 payment, so only those households were eligible which met the Commonwealth criteria, and which had not applied for a home insulation grant. The scheme was abandoned in February 2010, when the Commonwealth *Energy Efficient Homes* scheme was terminated and the solar and heat pump rebates reduced.

The Queensland government has now introduced a $600 rebate for the purchase of a solar or heat pump replacing an electric storage water heater, or $1,000 for qualifying pensioner or low-income households.[21] This is additional to the Commonwealth rebate. Queensland also had a *Gas Installation Rebate Scheme*, which paid a rebate of up to $500 to homeowners installing gas appliances replacing electric, and some non-electric appliances, in existing homes. The scheme closed on 31 August 2009.

[20] Details are at http://www.resourcesmart.vic.gov.au/for_households/rebates.html
[21] http://www.brightthing.energy.qld.gov.au/solar-hot-water-rebate.html

Other Jurisdictions

Of the other jurisdictions, WA offers a rebate for solar, and only for solar-gas or solar-LPG, not solar-electric or heat pump. The ACT offers a $500 rebate for solar or heat pump, but only if the householder also spends at least $1,000 on other energy efficiency measures as well.

Between March 2001 and June 2008 the SA Government offered a rebate of $700 for the purchase of a solar or heat pump water heater. Unlike the Commonwealth rebate, this SA rebate was also available for new homes, and for replacing gas with solar-gas in existing homes. The general SA rebate scheme was discontinued in June 2008, but replaced with a $500 rebate offer to qualifying low-income owner-occupier households.[22]

Other means of support

Solar water heaters receive indirect support from a number of 'white certificate' schemes in which electricity retailers in NSW, Victoria and SA are required to participate. The Victorian Energy Efficiency Target (VEET) scheme allows the creation of certificates where working electric water heaters are replaced with solar-electric, solar-gas, heat pump, solar-LPG or high efficiency gas water heaters. Certificates can also be created by replacing working gas water heaters with solar-gas, installing solar retrofit kits to a working electric water heater or solar pre-heaters on any water heater.[23]

Effectiveness of Incentives

While the magnitude and conditions for water heater rebates vary by jurisdiction and over time, the price support from the creation of RECS is 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) or as a replacement for an existing system. RECs appear to have been effective in increasing the takeup of solar and heat pump water heaters, according to the industry itself. In its submission on the RET legislation, Rheem stated:

> 'The current MRET scheme has been a triumph in encouraging the adoption of solar water heater by Australian households, with Rheem's internal estimates suggesting the annual sales of solar water heaters nationally have increased from 20,000 to 100,0000… during the life of the scheme.'[24]

The implementation of the NSW, Victorian Commonwealth rebates has further increased the takeup of solar and heat pump, but it is not known what proportion of recipients are 'free riders', who would have purchased solar without any subsidy, or for whom the RECs subsidy would have been sufficient.

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[22] http://www.dtei.sa.gov.au/energy/media/documents/solar_hot_water_rebate/shwr_application_form.pdf
[23] http://www.esc.vic.gov.au/NR/rdonlyres/E2480219-86C0-4B11-9942-20C6D63BD184/0/PRCExplanatoryNoteoncreatingVEECSfromprescribedactivitiesv1220090306.pdf
[24] http://www.climatechange.gov.au/renewabletarget/consultation/sub_ret/31RheemAustraliaPtyLtd.pdf

Annexe 4 Policy Options

4.1 Phased Implementation Criteria

If 'gas availability' becomes the criterion for applicability during the first stage of a two-stage ('Extended') phase-out , it will be necessary to define the term with regard to it space, time and possibly cost (as Queensland has done), and there could be some scope for confusion and requests 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. Gas may not actually be available at the time a water heater fails, but may be potentially available within a short period if requested from the gas supplier. For this reason Queensland allows for use of a temporary water heater for up to 60 days. Each State and Territory would need to develop rules and procedures to handle these situations.

In many cases, the most cost-effective compliance option will be natural gas – especially if it is already connected to the dwellings – so a home owner or plumber has every incentive to verify whether gas is available or to negotiate for its connection.

4.2 Exemptions

Government policy envisages the continuing use of electric water heaters 'where the greenhouse intensity of the public electricity supply is low' (COAG 2009a). A building, district or region not connected to the main grid may get its electricity supply from a renewable energy source such as wind or hydro power. In these cases an electric resistance water heater would meet a 100 g CO_2-e/MJ performance requirement (if adopted). 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 g CO_2-e/MJ supplied to the water heater, to allow for storage heat losses in the water heater itself.[25]

Tasmania is the only State with a greenhouse intensity of electricity supply below 80 g CO_2-e/MJ (at least on a 'historical average' basis, if not on a marginal intensity basis). However, Tasmania is also the only State where average intensity is projected to rise, and it is expected to exceed 80 g CO_2-e/MJ by 2024.

Irrespective of the greenhouse gas-intensity of the local electricity supply, it would be reasonable to permit the use of electric resistance water heaters 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. While building regulations aim to improve plumbing layouts in new homes, many existing houses have 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

[25] Whether an electricity consumer elects to pay a premium for 'GreenPower' has no bearing on the actual greenhouse gas energy intensity of the electricity supplied to or at a specific site or building. It would however be possible to develop a simple method for estimating whether on-site renewable generation would meet the 100 g CO_2-e/MJ criteria. For example, grid-connected homes with typical 1.5 kW PV arrays produce about 1,300 to 1,600 kWh per year in NSW, depending on location, compared with average annual household electricity use for non-gas households of about 8,000 to 10,000 kWh (IPART 2008). This means 75% to 85% of electricity use would come from the grid, giving a weighted emissions intensity well over 200 g CO_2-e/MJ electricity used, over 250 g CO_2-e per MJ delivered by an electric storage water heater at that site.

before the water reaches an acceptable temperature, so resulting in both energy and water wastage.

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 associated with the actual hot water drawn off.

The most efficient form of electric resistance water heating in these exceptional situations would be the instantaneous type, because it would not have standing losses. Where electric storage water heaters continue to be used, limiting their size would limit the standing heat loss, according to the current MEPS scales.

The rules for new Class 1 buildings in the BCA allow for the use of electric water heaters of up to 50 litres storage in circumstances where the home is small (one bedroom or less) or the water heater serves a remote point *and* there is also a low-emission water heater installed. It would be reasonable to adopt similar provisions in the proposed measure.

Where one water heater fails in an existing dwelling with two or more electric water heaters, it is not always possible to judge objectively whether the unit being replaced is the main water heater or a secondary unit. However, a prohibition on the installation of electric water heaters of greater than 50 litres in Class 1 homes would given an incentive for the homeowner, in consultation with the plumber, to select the most appropriate water heater for the task – a small electric unit in some cases, but a larger unit meeting the greenhouse gas-intensity criterion in most cases, where higher hot water delivery and lower running costs are needed.

4.3 Mode of Implementation

The COAG *National Strategy on Energy Efficiency* states that:

> 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 (COAG 2009a).

As water heaters are connected to the domestic water supply they come within the scope of State and Territory plumbing regulations. It proposed that the objectives of the proposed measure will be achieved by inserting provisions in the appropriate plumbing regulations. In case of a phased implementation, each individual jurisdiction would amend its plumbing codes and regulations to prohibit plumbers from installing water heaters other than in accordance with the proposed rules. The second phase would most likely be implemented via uniform provisions in the Plumbing Code of Australia (PCA).

The PCA is in some respects the counterpart of the BCA. However, it does not yet have full national coverage, as the plumbing regulators in WA or the NT have not yet adopted the PCA (NSW has recently announced its intention to do so). Furthermore, the State and Territory plumbing regulations do not reference the main plumbing performance standard (AS/NZS 3500 Plumbing and Draining Parts 1-4 2003, and Part 5 2000) in a consistent way (Table 27).

Table 27 Adoption of the Plumbing Code of Australia by States and Territories

State/Territory	Adoption of the Plumbing Code of Australia
NSW	Intending. (a) The *NSW Code of Practice for Plumbing and Drainage* adopts 'AS3500:2003 and amendments and Part 5 2000'
Victoria	Yes. Parts A, B, C, D (with restrictions), E and G
Queensland	Yes. Parts A, B, C and G
SA	Yes. Parts A, B, C, F2 and G
WA	No. The regulations call up AS3500:2003 Parts 1,2, and 4
Tasmania	Yes. The Tasmanian Plumbing Code references and varies the BCA.
NT	No. The NT Building Regulations call up AS 3500
ACT	Yes. Parts A, B, C and G

Source: ACG (2009) (a) NSW DECC, personal communication

AS 3500 does have some degree of coverage in all jurisdictions, which reference it – at least in part – via their own plumbing regulations. Once the Standards Australia committee/s responsible for AS3500 agrees to insert the proposed rules for water heater installation into the Standard, the States can reference the relevant sections, either via the PCA or directly.

It is intended that the BCA and the PCA will eventually converge into a unified National Construction Code (NCC). In April 2009 COAG '…endorsed a series of reforms, recommended by the Business Regulation and Competition Working Group (BRCWG)…[including]…a further step towards the development of a National Construction Code, which will consolidate building, plumbing, electrical and telecommunications regulations, through the release of a consultation RIS.'

If and when the NCC is developed, it would be expected that all provisions of the PCA would migrate over to it, including those covering water heaters.

Annexe 5 Regulatory Options Modelled

Water Heater Industry Proposal (WHIP)

Prior to the preparation of the Consultation RIS, the two largest suppliers of water heaters, Rheem and Dux, proposed a set of measures covering both new and replacement water heaters. These were:

2010

1. Ongoing Inclusion of renewable water heaters in RET scheme
2. Minimum 4 Star MEPS for Gas Water Heaters throughout Australia
3. Ban on Electric water heaters in Class 1 homes in gas reticulated areas

2012

4. Mandatory renewables in all class 1 New Homes
5. Mandatory renewables as replacements in Class 1 rental homes
6. $1000 Means Tested solar conversion incentive for non reticulated area electric replacements

Proposals 1, 2 and 4 above were considered outside the scope of the Consultation RIS, because they were not directly relevant to the proposed measure. (In fact the continuing eligibility of renewable water heaters to create RECs in the RET scheme has since been confirmed, and 4 star MEPS are now proposed for gas water heaters).

Proposal 3 matches Government policy, and is considered in this RIS. Proposal 5 was modelled for the Consultation RIS, but the eligibility criterion – whether a property is a ‘rental home’ – was considered impractical and unenforceable, given that a plumber or installer would need to be held legally responsible for determining this. Proposal 6 bears on the possible supplementary policy mechanisms which may accompany the proposed measure, which are outside the scope of this RIS.

Annexe 6 Cost-Benefit Analysis – Modelling Approach

6.1 Modelling Scope

The modelling covers the stock of houses in existence in 2010 and which remain in a substantially unaltered condition. This stock diminishes at a rate of 0.5% to 0.8% per year, as homes are demolished or altered. The selection of water heaters for new homes and in substantially altered homes is not covered by the measures proposed in this RIS but by the Building Code of Australia and local regulations such as BASIX in NSW.

6.2 Private and Public Costs

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

(a) the purchase price of the water heater;
(b) the cost of installing the water heater;
(c) the cost of connecting the building to a natural gas or LPG supply, if required for the water heater and not already present (water and electricity supply are assumed to be always present);
(d) payments for water, electricity, natural gas, LPG or other fuels; and
(e) the cost of repairing and maintaining the water heater.

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 the risk of exposure to accidental scalding. These can be ignored because the options under consideration have broadly similar quality characteristics.

Externalities

A key external cost associated with a water heater is its contribution to greenhouse emissions. An important external benefit is the potential to positively influence the direction and pace of technological change and thereby reduce future costs, including the benefits of production on a larger scale. These costs are no longer entirely external now once governments implement measures designed to internalise them and so bring private costs more into alignment with societal costs.

This RIS assumes that the greenhouse externality will be internalised once a CPRS or similar measure imposes an appropriate CO_2-e emissions price on energy users. It may be argued that such a measure may not signal the full potential risk or cost of the damages of global climate change. However the only indication to date of a government position on these costs is the one implicit in the design of the CPRS (Treasury 2008).[26]

[26] At the time of writing, it was Commonwealth Government policy to reconsider a CPRS no earlier than 2013. The Consultation RIS was prepared with the expectation that the CPRS-5 scenario modelled by Treasury (2008) would be implemented in 2012. For continuity, this Decision RIS has been prepared on the assumption that the CPRS, or a carbon pricing measure with similar impacts on energy prices, will be implemented from 2013.

Network costs

Electricity and gas tariffs include charges to recover not just energy production and generation costs but also networks costs, ie the costs of the poles, wires, transformers, pipes and pumps that transmit and distribute energy from generators and other producers to end users. These charges are regulated and network regulators may seek to vary network charges in response to measures that change the amount of energy that the networks expect to carry or in the peak loads facing the network.

Electricity network charges are projected to increase significantly over the next 5 years due to recent decisions of the Australian Energy Regulator (AER 2009a, 2009b, 2010, 2010a, 2010b). These are driven mainly by the need to replace ageing infrastructure and to accommodate greater summer peaks and a worsening load factor due to household air conditioner use. While water heating load does not bear directly on recent price determinations, future changes in the water heating load – unless accompanied by demand response measures, as discussed later – could exacerbate peak problems.

Gas network charges in each State are projected to remain constant, on the assumption that the increase in gas demand from a higher rate of electric to gas water heater replacement in areas already reticulated would be largely offset by rises in the efficiency of all gas use. In areas not yet reticulated, new networks will be over-sized to cover all projected use, not just hot water, so the measure on its own will not increase network costs or charges.

One likely effect of the proposed measure is a higher rate of connection of existing 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 house (ABCB 2007).

Annexe 7 Cost-Benefit Analysis – Input Assumptions

7.1 Energy price and greenhouse intensity projections

When the cost-benefit modelling for the Consultation RIS 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 Treasury (2008).

Treasury includes projections of the greenhouse gas intensity of electricity generation, developed by McLennan Magasanik Associates (MMA 2008). These were used to develop emissions intensity trends for electricity delivered in each State. Projections showed that emissions intensity of electricity supply would decline by about 22% by 2020 under CPRS-5. In April 2010, the Government announced the deferral of the introduction of the CPRS until the end of the Kyoto commitment period in 2010.[27] DCCEE has directed that the modelling for the Decision RIS should proceed on the assumption that a CPRS in the form proposed for commencement in 2010 will be implemented in 2013. This has required revision of the energy price and greenhouse gas-intensity projections used in the Consultation RIS.

The revised greenhouse gas intensity trends for electricity supply were estimated by delaying the start of the downward trend in emissions intensity in each State and territory by 3 years. This gives a projected weighted emissions intensity of electricity supplied for water heating that is 6.5% higher than in the Consultation RIS in 2015, 2.1% higher in 2020 and 1.8% higher in 2030 (Figure 20).

Dominant factors in the revision of electricity price projections were AER determinations. Figure 21 and 22 illustrate the range of State and Territory electricity prices used in the Consultation and Decision RIS respectively. The weighted average electricity price (the heavy black line) tracks the lower part of the price range because the majority of electricity delivered to water heaters is purchased at off-peak rates. Figure 23 compares the weighted electricity price projections in the two RISs in 2010$. In the near term, the impact of AER price determinations far exceeds the impact of the CPRS, which shows as a step change in 2014.

Recent electricity price rises in NSW, for example, will have increased the cost of off-peak electric water heating by $80 per year by 2012. Treasury (2008) projected that the then-proposed CPRS would 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 (Figure 12) this implies that electric water heating costs could increase by a further $65 per year. An electric water heater purchased in 2012 could cost $1,450 *more* to run over its typical 10 year service – an increase that is nearly as much as the initial capital cost.

The publicity surrounding the recent increase in energy (especially electricity) prices, and the potential for further rises could increase consumer awareness of energy prices and so provide incentives for investment in more efficient technology. However, this is severely limited by lack of awareness of the water heating share of energy costs.

The quarter of householders that live in rented accommodation are not in a position to respond to price changes through technological changes. Of the three quarters that are theoretically in a position to respond, and consider a form of water heater other than the type already installed, few are likely to be aware of the projected energy consumption and costs, and so the great majority will make sub-optimal choices.

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[27] http://www.climatechange.gov.au/minister/wong/2010/transcripts/April/tr20100428e.aspx

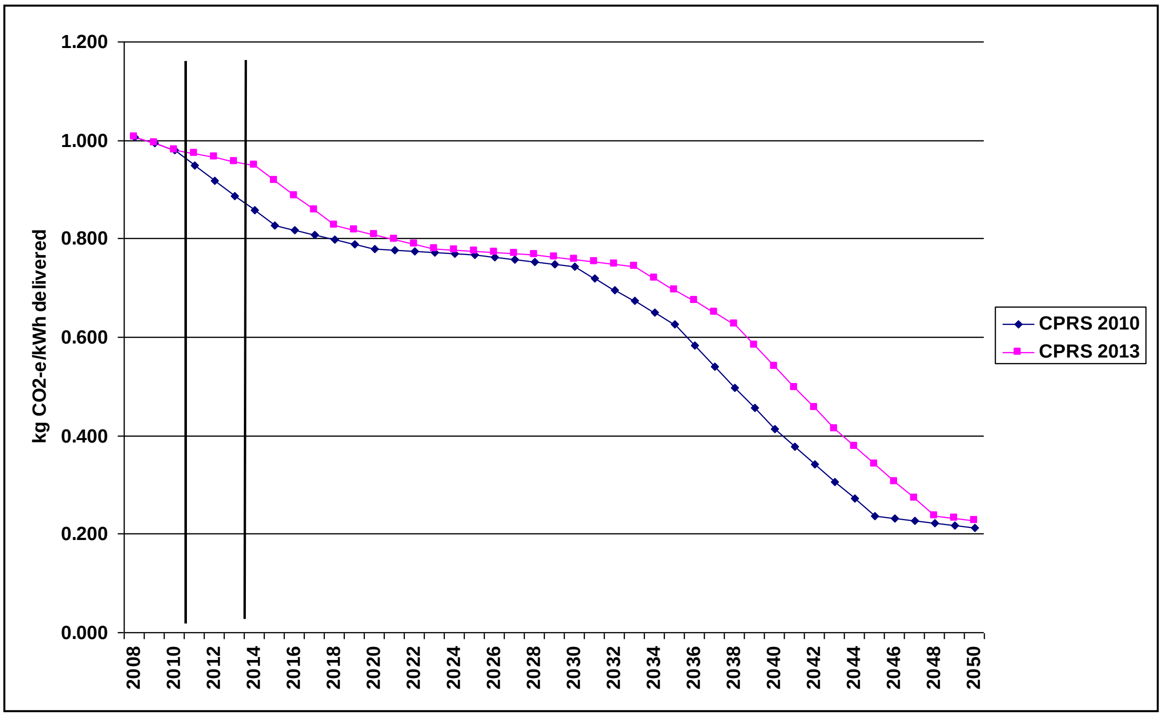


Figure 20 Projected sales-weighted emissions intensity of electricity delivered, Australia

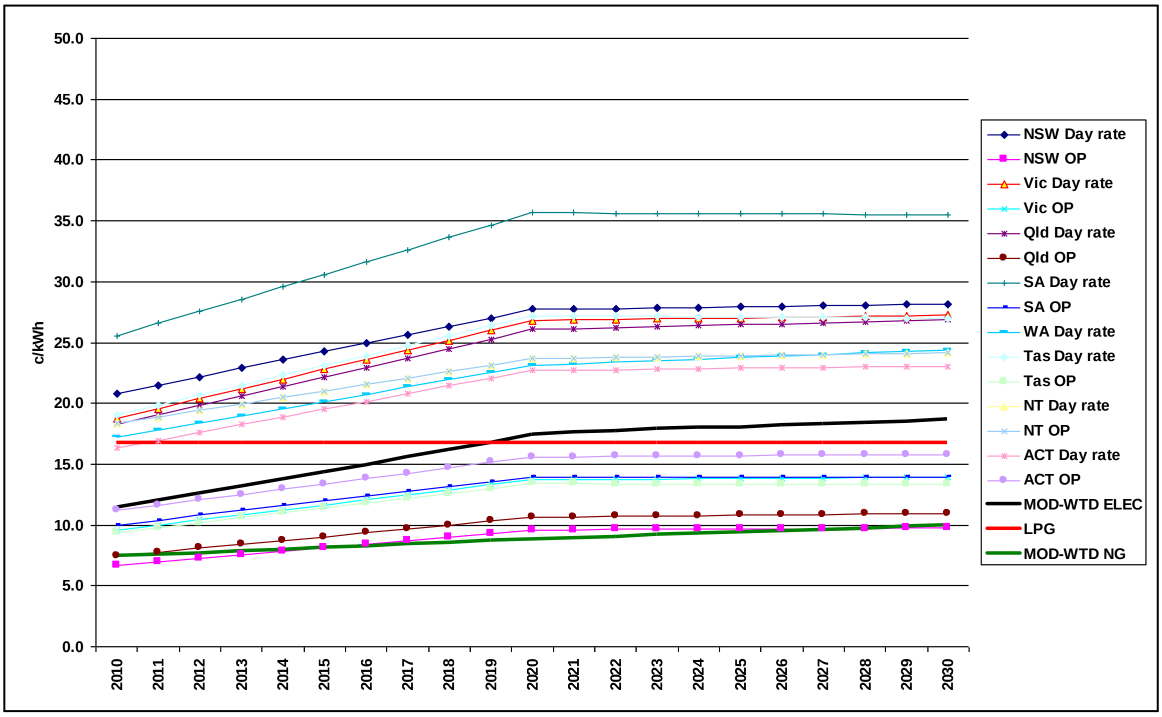


Figure 21 Projected energy prices, Consultation RIS (2008$)

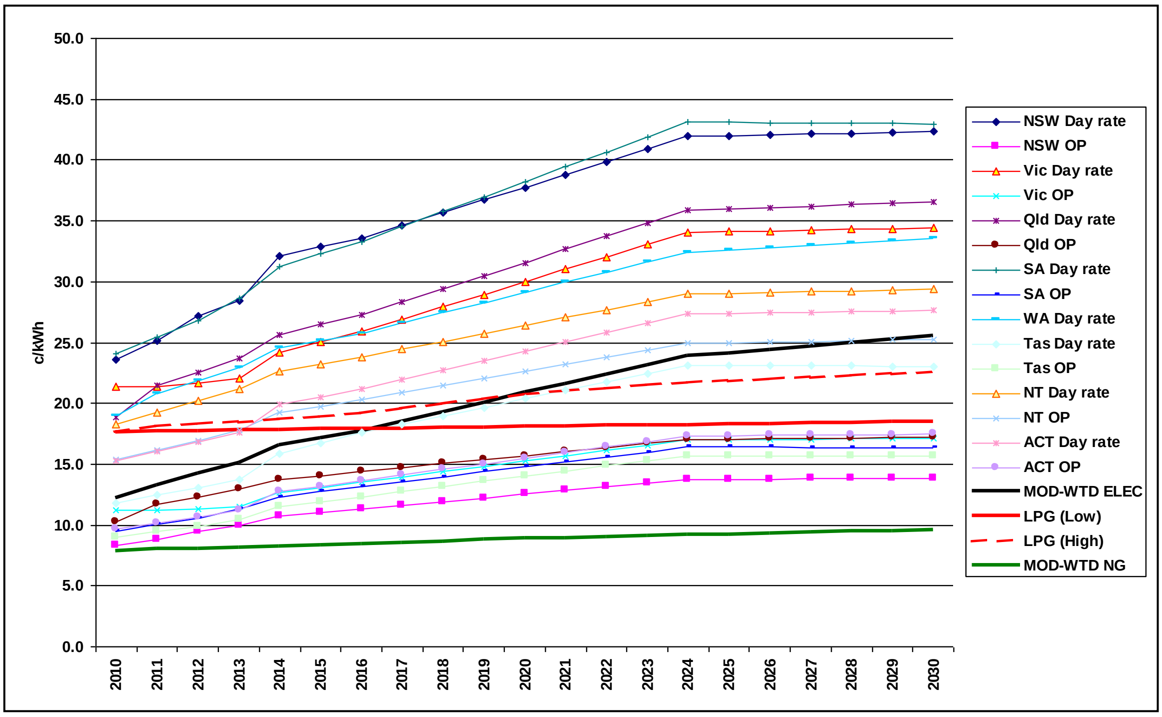


Figure 22 Projected energy prices, Decision RIS (2010$)

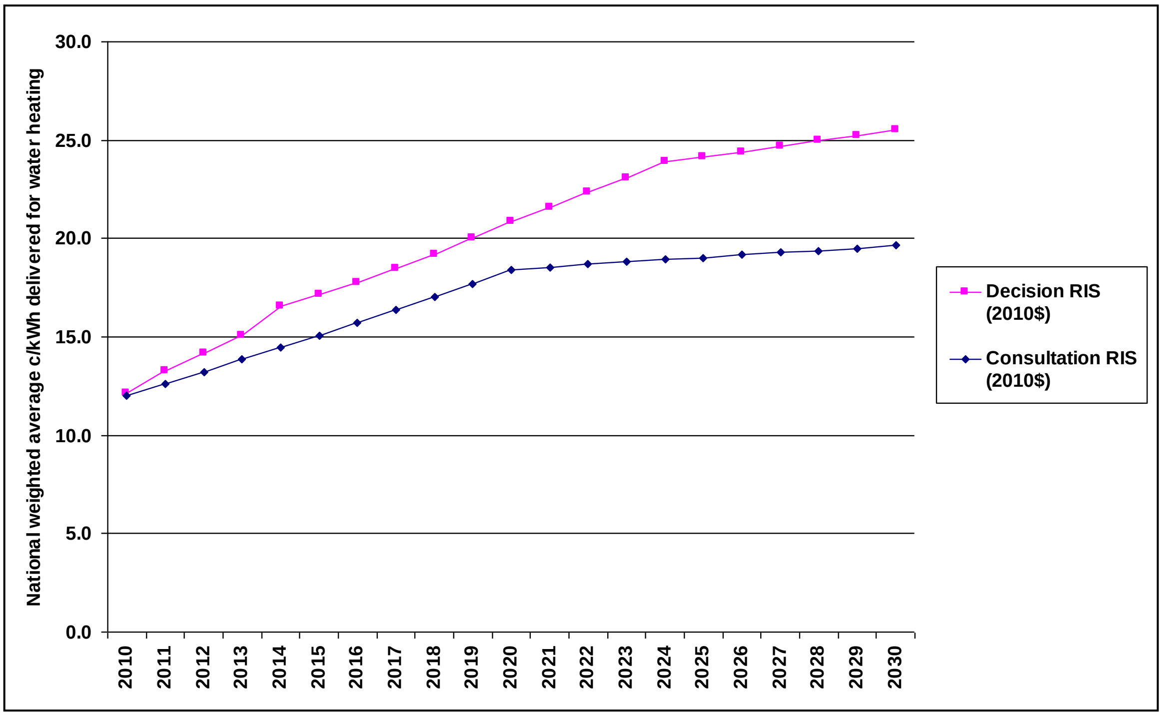


Figure 23 Projected weighted electricity price, Consultation and Decision RIS

7.2 Natural gas availability

The proposal will impact on the water heating options available to householders who would otherwise have installed an electric storage water heater. This represented about 37% of water heater purchasers in 2008 (Table 19). Although 51% of Australian houses currently have an electric water heater, the market was already trending away from electric even before solar water heater rebates were introduced. The phase out only impacts on those who would still replace electric with electric, but could not exercise this choice. Of course, the impact will not be immediate, because households only experience a constraint on their choice when their existing electric water heater fails. Assuming a 10 year service life for electric water heaters, this means that about one tenth of the stock fails each year, so about 3.7% (10% of 37%) of households would be impacted in any one year.

Whether a house has natural gas available is a major factor in the cost of compliance with the proposed regulation. It is estimated that, nationally, about 52% of houses are not connected to natural gas, and of these about three in ten are connectable (Figure 24). Of the 48% of houses already connected to natural gas, four in five use it for water heating, and one in five use electricity. Households already using gas for water heating will be mostly unaffected by the proposal because about 95% of would replace with gas in any case, but if they do want to change they will have the full range of options available, including solar-gas, solar-electric and heat pump. LPG would also be available, but there would be no point in using LPG if natural gas were available: it would be an identical water heater, the capital cost would be about the same but the LPG running cost would be far higher.

NSW and Queensland have nearly 78% of all the electric water heaters in non-connectable households in Australia, so will be the most highly impacted States (
Table 28 to Table 30). By contrast, a very high proportion of electric water heating households in Victoria, SA, WA and the ACT are in gas-connected or connectable households, which will usually have the lowest cost compliance options

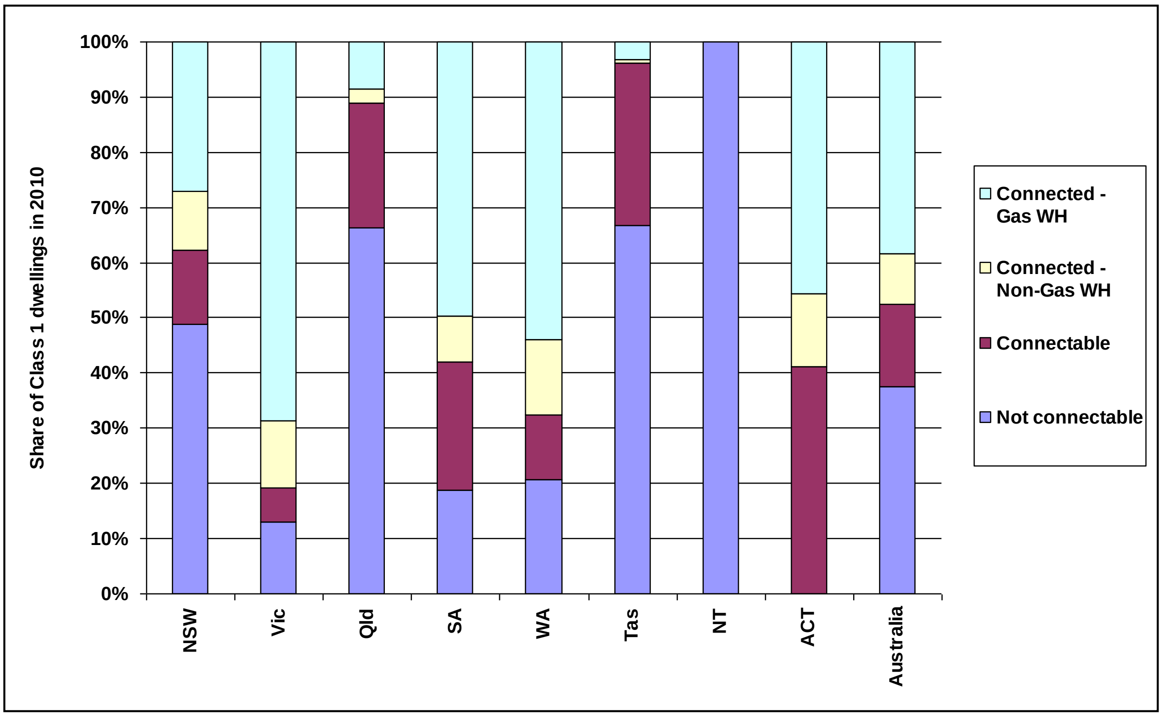


Figure 24 Share of Existing Houses by Gas-Connection Status

Figure 25 Share of electric water heaters by house gas-connection status, 2010

Table 28 Households with electric storage water heaters, 2010, Model C

	Not connectable (a)		In Connectable dwellings (b)		In gas-connected dwellings		Total	
NSW	934	41.6%	273	27.3%	208	36.9%	1415	37.2%
VIC	194	8.6%	112	11.2%	214	37.9%	520	13.6%
QLD	813	36.2%	308	30.8%	36	6.3%	1157	30.4%
SA	85	3.8%	135	13.5%	44	7.8%	264	6.9%
WA	67	3.0%	68	6.8%	49	8.6%	184	4.8%
TAS	122	5.4%	57	5.7%	1	0.1%	180	4.7%
NT	30	1.4%	0	0.0%	0	0.0%	30	0.8%
ACT	0	0.0%	47	4.7%	13	2.3%	61	1.6%
Aust	2245	100.0%	1000	100.0%	564	100.0%	3809	100.0%
Share	58.9%		26.3%		14.8%		100.0%	

All values thousands (a) Consultation RIS estimated 1,729,000 'not connectable' HH and 481,000 'possibly connectable'. The two categories are now combined as 'not-connectable'. (b) Consultation RIS estimated 968,000 'probably connectable' HH. This category has been re-designated as 'connectable'.

Table 29 Capital City Households with electric storage water heaters, 2010, Model C

	Not connectable		In Connectable dwellings		In gas-connected dwellings		Total	
NSW	429	48.6%	167	24.6%	131	32.8%	727	37.1%
VIC	26	2.9%	48	7.0%	150	37.4%	223	11.4%
QLD	340	38.5%	218	32.3%	24	5.9%	582	29.7%
SA	29	3.3%	115	17.0%	39	9.7%	183	9.3%
WA	15	1.6%	58	8.6%	43	10.8%	116	5.9%
TAS	27	3.0%	23	3.5%	0	0.0%	50	2.6%
NT	18	2.0%	0	0.0%	0	0.0%	18	0.9%
ACT	0	0.0%	47	7.0%	13	3.3%	61	3.1%
Aust	883	100.0%	677	100.0%	400	100.0%	1960	100.0%
Share	45.0%		34.5%		20.4%		100.0%	

All values thousands

Table 30 Non-Capital City Households with electric storage water heaters, 2010, Model C

	Not connectable		In Connectable Dwellings		In gas-connected dwellings		Total	
NSW	505	37.1%	107	33.0%	77	46.9%	688	37.2%
VIC	168	12.3%	64	19.9%	64	39.1%	296	16.0%
QLD	473	34.7%	90	27.7%	12	7.2%	574	31.1%
SA	56	4.1%	19	5.9%	6	3.4%	81	4.4%
WA	53	3.9%	10	3.0%	5	3.2%	68	3.7%
TAS	95	7.0%	33	10.3%	0	0.3%	129	7.0%
NT	12	0.9%	0	0.0%	0	0.0%	12	0.7%
ACT	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Aust	1362	100.0%	323	100.0%	164	100.0%	1849	100.0%
Share	73.7%		17.5%		8.9%		100.0%	

All values thousands

7.3 Capital Costs

The Australia-wide weighted average capital costs (purchase plus installation less value of RECs to users) for each main type of water heater generated by the costing model are illustrated in Figure 26. The corresponding values extracted from the databases of the NSW and Victorian rebate schemes also shown (NSW supplied data on rebates for gas as well as solar/HP; Victoria supplied data on solar/HP rebates only). The closeness of the fit increases the confidence in the cost-benefit modelling.

For modelling purposes, the value of RECs have been taken into account but not the value of Commonwealth and State rebates. The existence and the pricing of RECs have a regulatory basis, unlike the solar rebate schemes, which can be varied or terminated at any time.

The introduction of the Mandatory Renewable Energy Target (MRET) scheme in April 2001 enabled the owners of new solar and heat pump water heaters to create RECs. The number of RECs is determined by the performance of the system in the solar zone in which it is installed, in accordance with the register kept by Office of the Renewable Energy Regulator, ORER. The typical solar and heat pump water heater purchaser receives a REC subsidy of between $900 and $1400, but depends on.

- Whether the water heater purchaser chooses to create and sell the RECs, or assigns the rights to the water heater supplier, installer. broker or other intermediary.
- Where the RECs are retained, the price obtained by the water heater purchaser,
- Where the RECs are assigned to the water heater supplier, the prices obtained by the supplier. These may be determined under long term contracts (e.g. between large water heater installation companies and electricity utilities with MRET liabilities) or by spot market prices.

The RECs assignee will usually take some of the RECs value to cover financial servicing costs (e.g. brokerage and holding costs) and the risk that RECs values may be lower at the time of disposal than the value paid to the water heater buyer. Until now RECs have been sold under both long term contracts and on the spot market. Contract prices, volumes and conditions are confidential, but reported spot prices have been highly variable (Figure 27).

It is likely that smaller firms selling on the spot market will need to retain more of the expected RECs value to cover financial costs and risks than larger companies, which have higher RECs volumes and more options for longer term contracts. Historical value retention estimates range from about 25% (GWA 2009) to about 7.5% (Access Economics 2010).

In June 2010 the Commonwealth amended the Renewable Energy (Electricity) Act so that from January 2011 the RET will be separated into two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). Solar and heat pump water heaters will be able to create RECs at fixed price of $40. As there will be no price risk for REC assignees, it is likely that the share of RECs value they retain should decline significantly. For this Decision RIS, it is assumed that only 2.5% of value will be retained, and $39 per REC will be passed on to buyers. This is indicated by the horizontal red line in Figure 27.

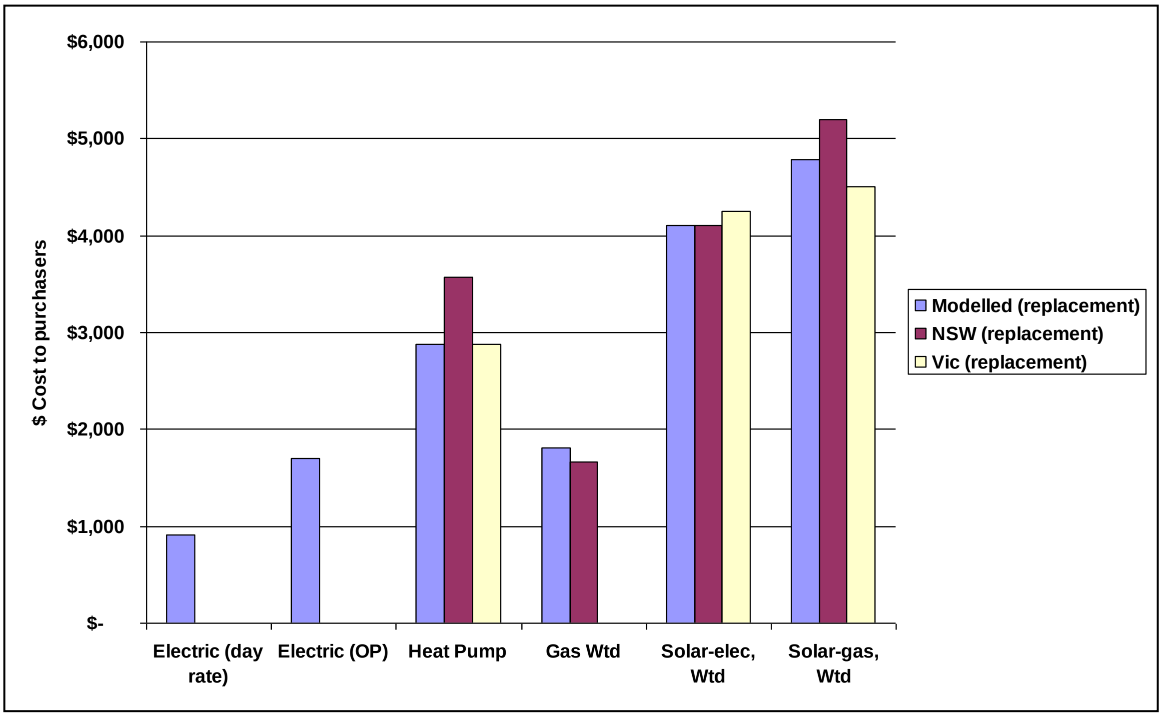


Figure 26 Modelled and actual water heater capital costs, 2010

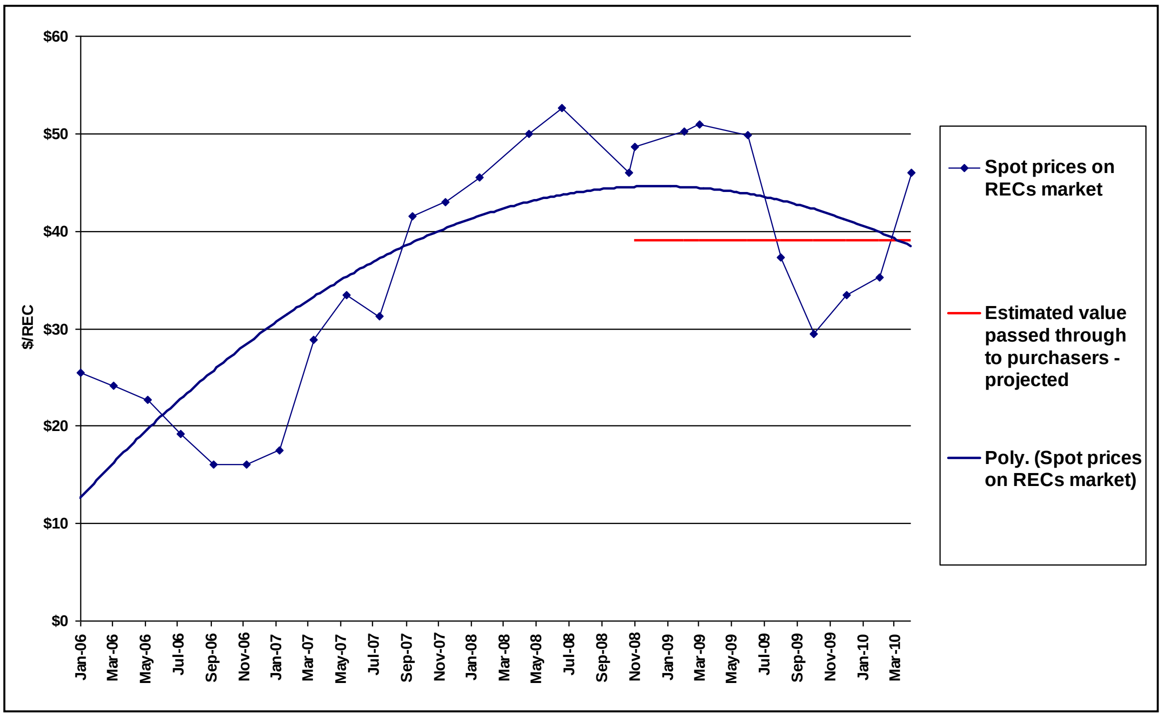


Figure 27 Historical RECs spot market prices

Spot prices from *Eco-Generation*

7.4 Hot Water Demand and Solar Zoning

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.

EES (2008) estimates that the average household energy use for water heating of all households has been trending down, and is projected to fall further. The modelling for this RIS internally categorises households into 'small' or medium' users and allocates a water heater type accordingly. The estimated total electricity and gas consumption for household water heating in 2010 in S1 (the BAU scenario) closely matched the EES national estimate for the same year.

There was some differentiation in individual State and Territory demand for hot water in the Consultation RIS by the fact that hot water usage – for conventional as well solar and HP water heaters - was based on the dominant solar zone in that State. To improve the differentiation of hot water use by State, each State was divided into gas-available and non-gas zones, and in some cases these were assigned to different solar zones (ACT is all-gas and NT is all non-gas).

A further hot water demand weighting factor, calculated as half of the ratio of average household hot water energy to national average hot water demand modelled in EES (2008), was also applied. The combined effect of these changes, summarised in Table 31, turned out to be relatively minor in comparison with the impacts of energy price revisions.

Table 31 Summary of region-specific inputs

Zone	Dominant solar Zone	Hot water use factor
NSW Gas	3	+3%
NSW No-gas	3	+3%
VIC Gas	4	+7%
VIC No-gas	3	+7%
Qld Gas	3	-10%
Qld No-gas	1	-10%
SA Gas	3	-7%
SA No-gas	3	-7%
WA Gas	3	-3%
WA No-gas	2	-3%
Tas Gas	4	+10%
Tas No-gas	4	+10%
NT No-gas	1	-11%
ACT Gas	3	+10%

Annexe 8 Cost-Benefit Analysis -Findings

For each State and Solar Zone, the costs of the options to replace a failed electric water in can be illustrated by a diagram such as Figure 3, 28, 29 and 30. These indicate ‘annualised cost’, which equalise the differences in service lifetimes of different technologies (ranging from 10 years for conventional electric to 14 years for solar-gas).

The annualised capital cost of a water heater comprises the following components:

- The net purchase price of the water heater: this includes the estimated pre-RECs purchase price less the value of RECs. This is the product of number of RECs in the Zone where installed by the nominal value to buyers ($39 per REC, at $2010 prices).
- The installation cost of the water heater: for electric water heaters (the basis for comparison) this is the cost of replacement in the same position. The installation cost of any type replacing an electric is higher. If a new connection to natural gas is required, there is an additional connection charge, but the impact of this on the annualised installation cost is low, because the connection is assumed to last for 50 years, and there is a probability that it will also be used for space heating and cooking in due course.

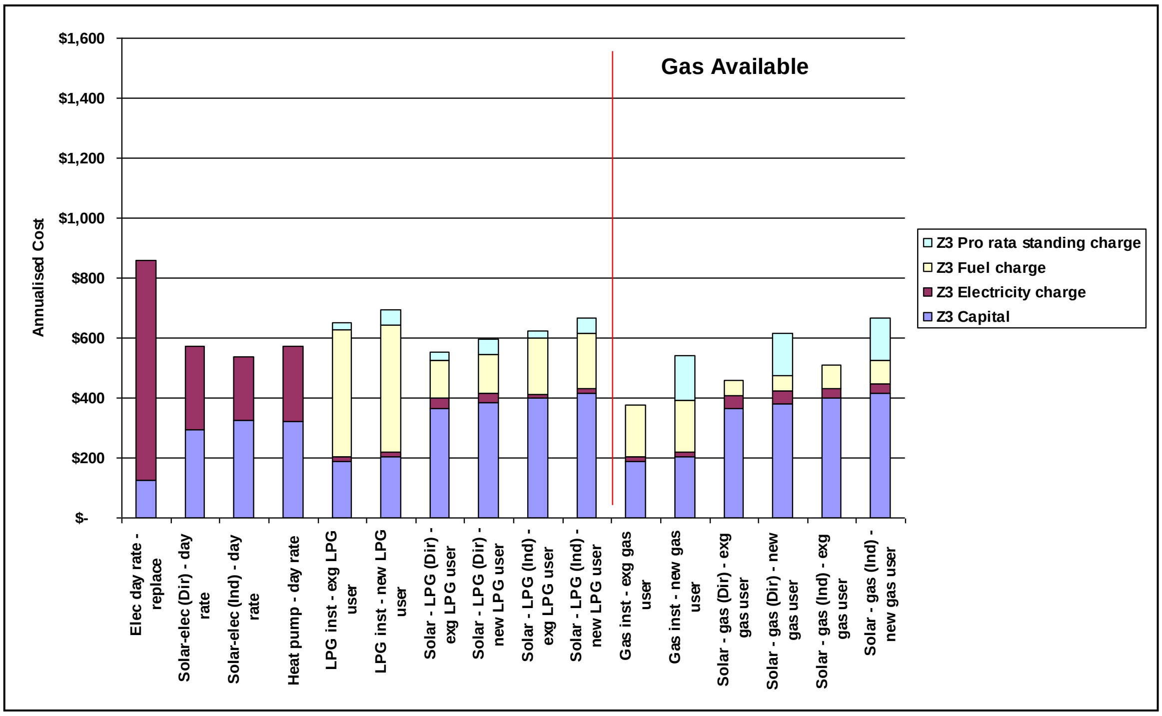
The annualised capital cost is then calculated based on the expected service life of the water heater and the expected service life of the gas connection, using an Internal Rate of Return of 7% (equivalent to a 7% discount rate).

The annualised energy charges are the average projected energy price over the service life of the water heater, calculated by multiplying the projected energy tariff for that State (c/MJ) by the MJ/yr which a water heater of that type is estimated to use to deliver 200 litres of water per day in that climate Zone, adjusted by the factor in Table 31 (for Medium delivery) or 110 litres/day, adjusted by the factor in Table 31 (for Low delivery). Electricity and fuel costs are shown separately.

The annualised standing charge component for natural gas water heaters is only incurred where the water heater is the first natural gas appliance in the house, and takes account of the probability that gas will also be used for space heating and cooking in due course. Even so, where water heating gas use is low (e.g. solar-gas) and expected gas use for space heating is also low; the standing charge can be a larger share of the annual fuel cost than the actual energy charge. The same principles apply to water heaters using LPG, except that the standing charge covers cylinder rentals.

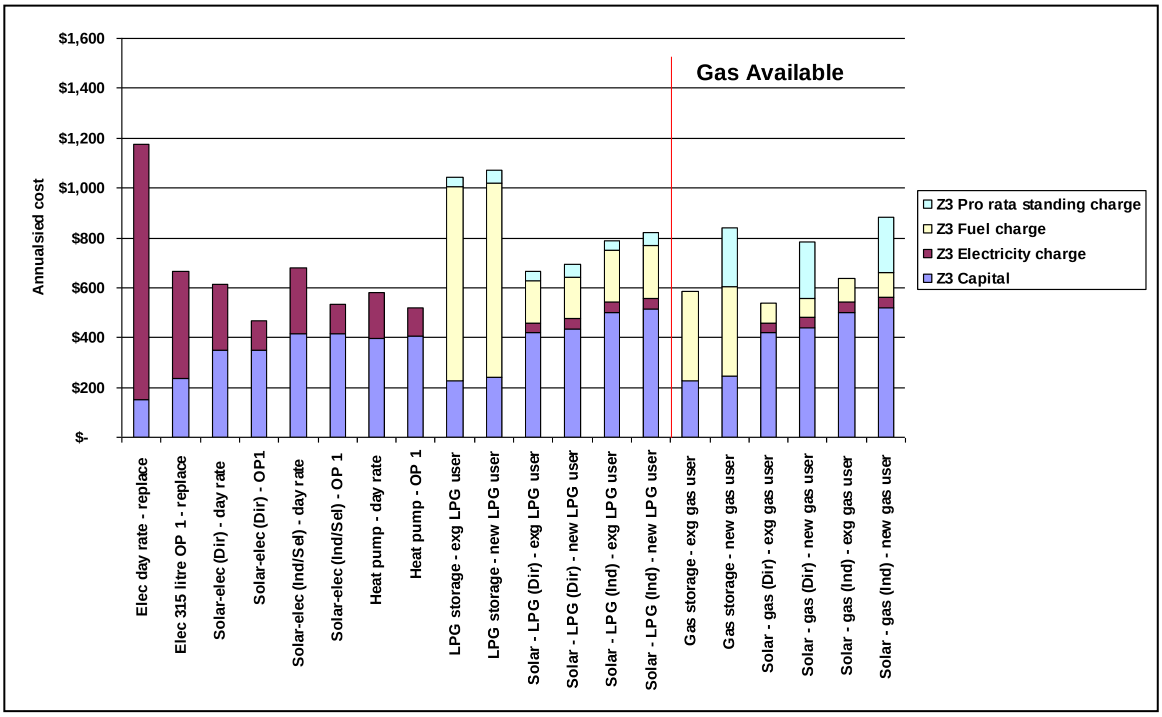
The annualised costs of replacement electric water heaters is at the left side of each diagram. The cost of replacement options where natural gas is not available are to the left of the vertical red line. All options on the graph (other than electric) would be available where natural gas is available.

Figure 28 Annualised cost of water heating options, NSW, Zone 3, Low delivery (Model



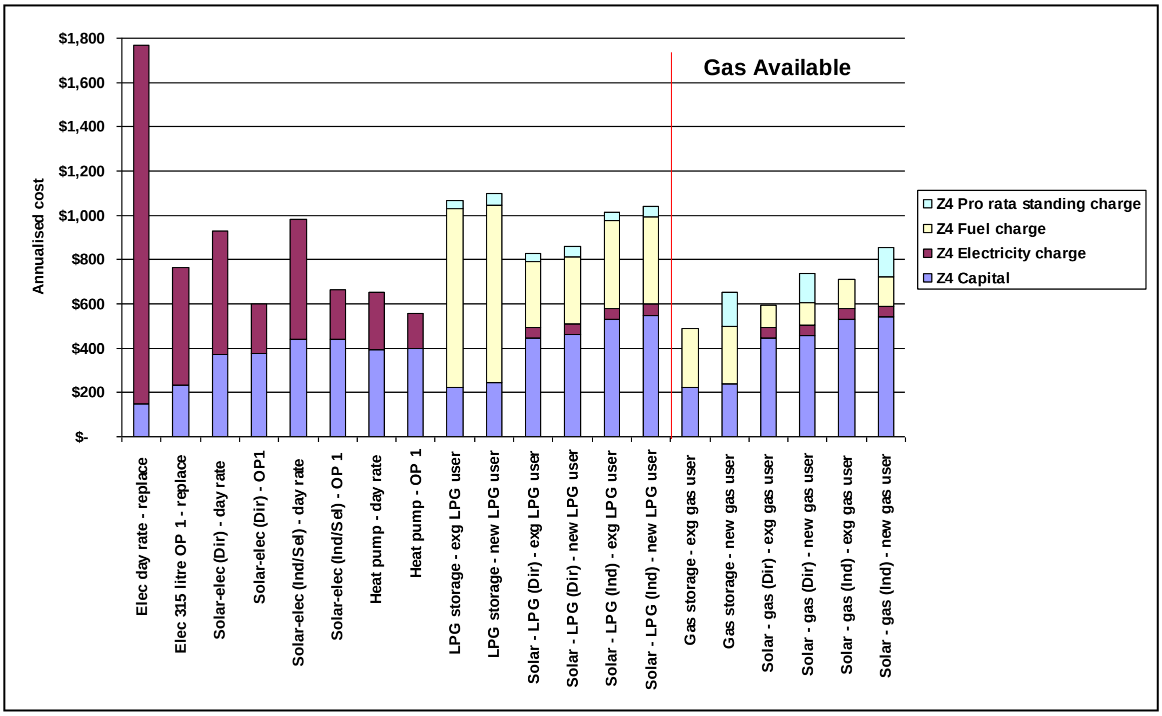
C inputs)

Figure 29 Annualised cost of water heating options, Queensland, Zone 3, Medium



delivery (Model C inputs)

Figure 30 Annualised cost of water heating options, Victoria, Zone 4, Medium delivery



(Model C inputs)

The annualised cost profile of the conventional water heating options is dominated by energy costs, whereas for solar and heat pump models it is capital costs that dominate. Many householders will prefer (or be advised to adopt) the lowest capital cost compliance option, even if it is the highest in annualised costs. In some cases they will do so because they are unaware of the projected annualised cost and in some cases they will do so because they are capital constrained. Of course, the offer of assistance to overcome the capital constraint – such as a rebate for the purchase of a solar or heat pump water heater – will increase the share of households taking those options.

The selection of a water heater that is not the most cost-effective type for that household is not confined to low capital cost options. Even without rebates, some householders will voluntarily adopt higher-cost solar or heat pump water heating options that are not cost-effective for them compared to the alternatives. Therefore, when modelling the national impacts – the aggregated responses of all households to the proposed measure – it cannot be assumed that they will all take the most cost-effective or even the lowest capital cost compliance option available to them.

Impacts on Water Heater Stocks

The following section shows the Model A results from the Consultation RIS along with the Model C results. Some of these diagrams are also included in the main text, but repeated here to assist comparison with other scenarios. Model B embodies identical stock and sales trends to Model A, but with the same revised energy price and emissions projections as Model C.

Figure 31 and Figure 32 illustrates the BAU scenario, which builds in the level of inertia, general resistance to higher capital other behaviours observed in the actual market. In this scenario electric water heaters continue to be available.

The higher electricity prices in Model C drive customers away from electric water heaters at a higher rate than in Model A. Rising electricity prices also increase the running cost of solar-electric and heat pump water heaters, so their running cost advantages over conventional gas and LPG water heaters are greatly reduced, while their capital cost *dis*advantages remain. Therefore, Model C shows the market moving more to the fuel alternatives than does Model A: natural gas where it is available and LPG where it is not. This occurs in both the BAU and the phase-out scenarios.

Figure 33 and Figure 34 indicate the effect of removing electricity from the option mix in 2010 (S2). In Model A the greatest shift is to solar-electric and heat pump, although LPG also grows, as the lowest capital option in non-gas areas. The gas share increases slightly, as does solar-gas. Model C shows a much higher share for natural gas and LPG than does Model A, a smaller share for solar-gas and almost negligible shares for solar-electric and heat pump. This is because the higher running costs of heat pump and solar-electric make them less financially attractive options than in Model A (remembering that all cases exclude the impact of rebates). Figure 35 and Figure 36 show that delaying the phase-out of electric water heaters in non-gas areas by 2 years (S3) makes very little difference to the overall outcomes.

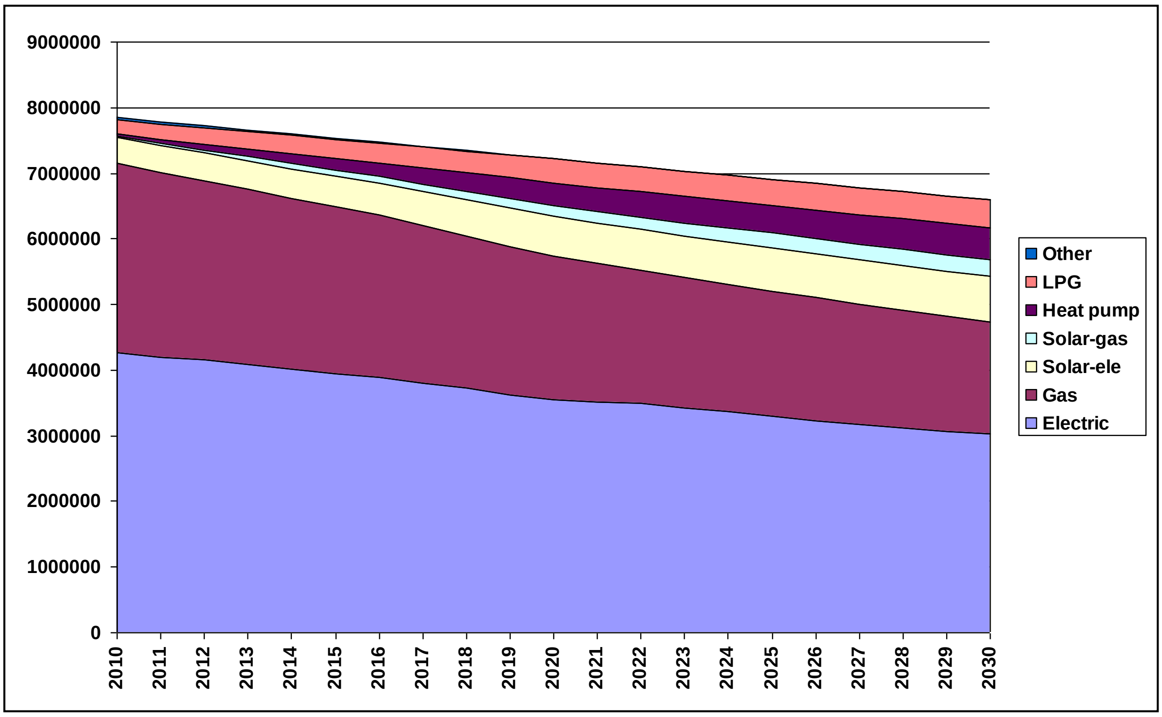
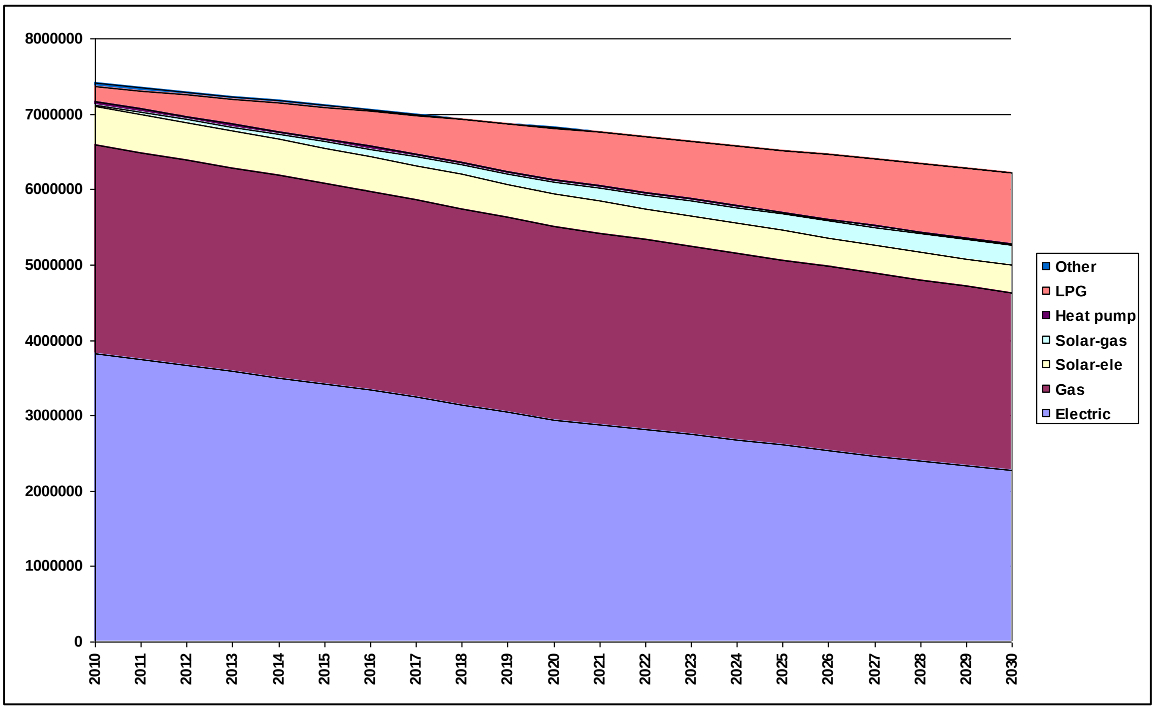


Figure 31 Projected water heater stock, Scenario 1 (BAU) – Model A & B

Figure 32 Projected water heater stock, Scenario 1 (BAU) – Model C



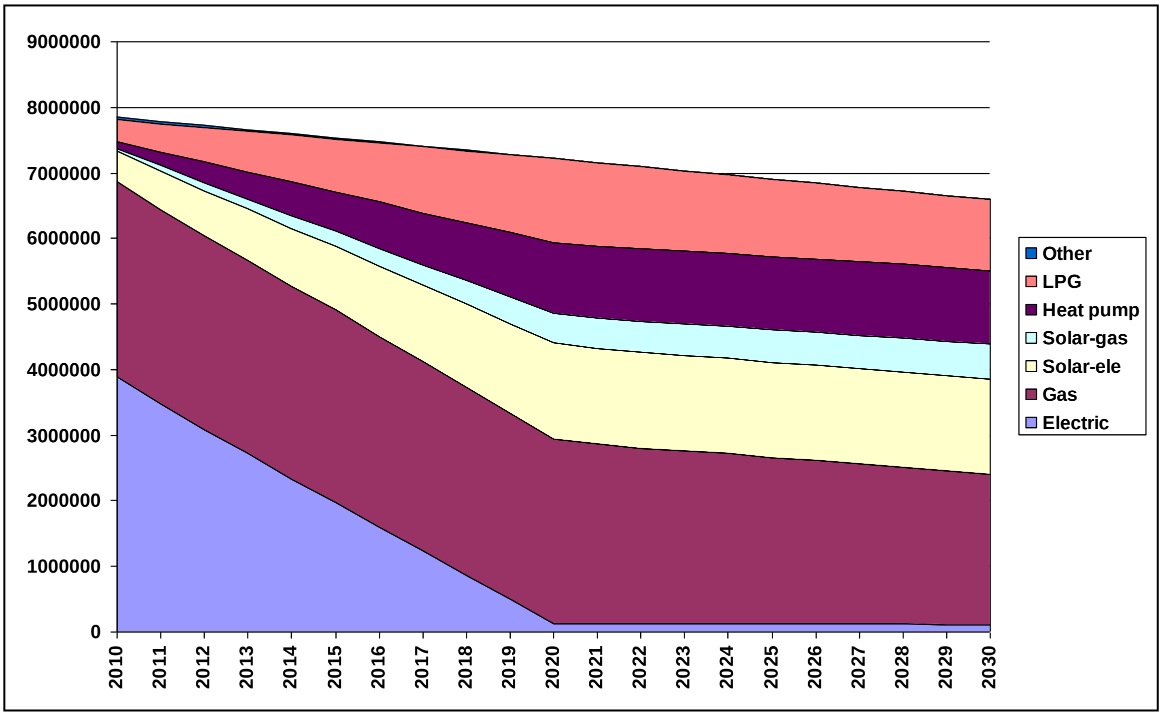


Figure 33 Projected water heater stock, Scenario 2 (Rapid) – Model A & B

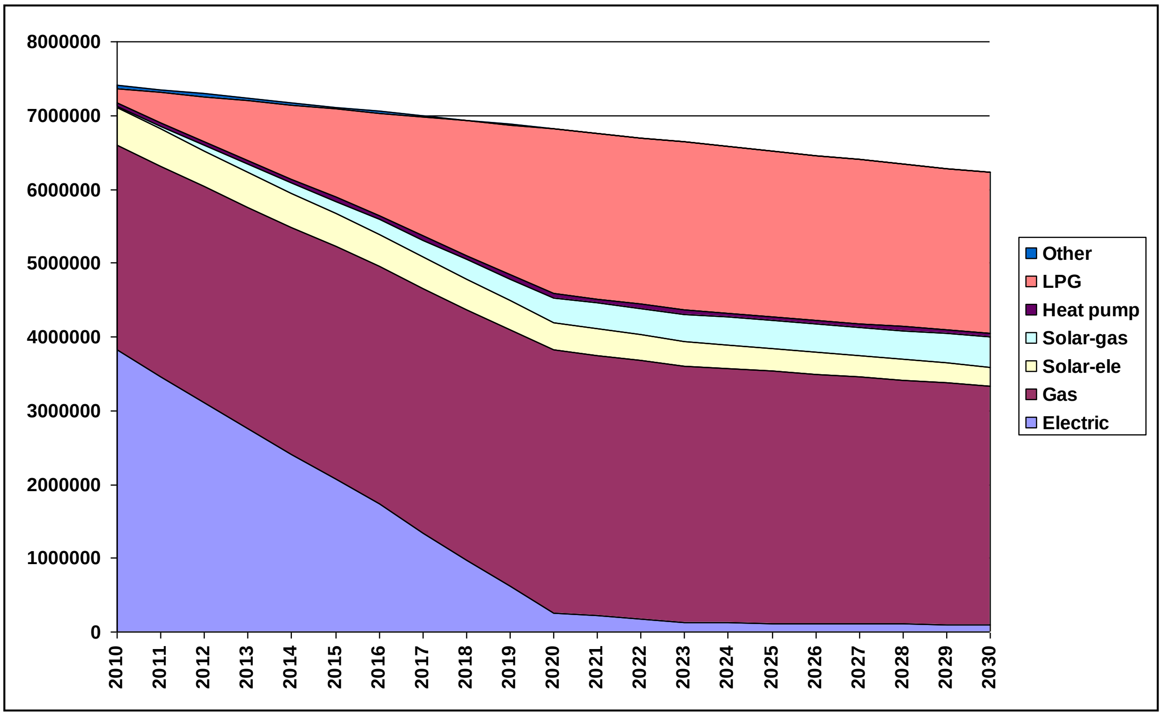


Figure 34 Projected water heater stock, Scenario 2 (Rapid) – Model C

Figure 35 Projected water heater stock, Scenario 3 (Extended) – Model A & B

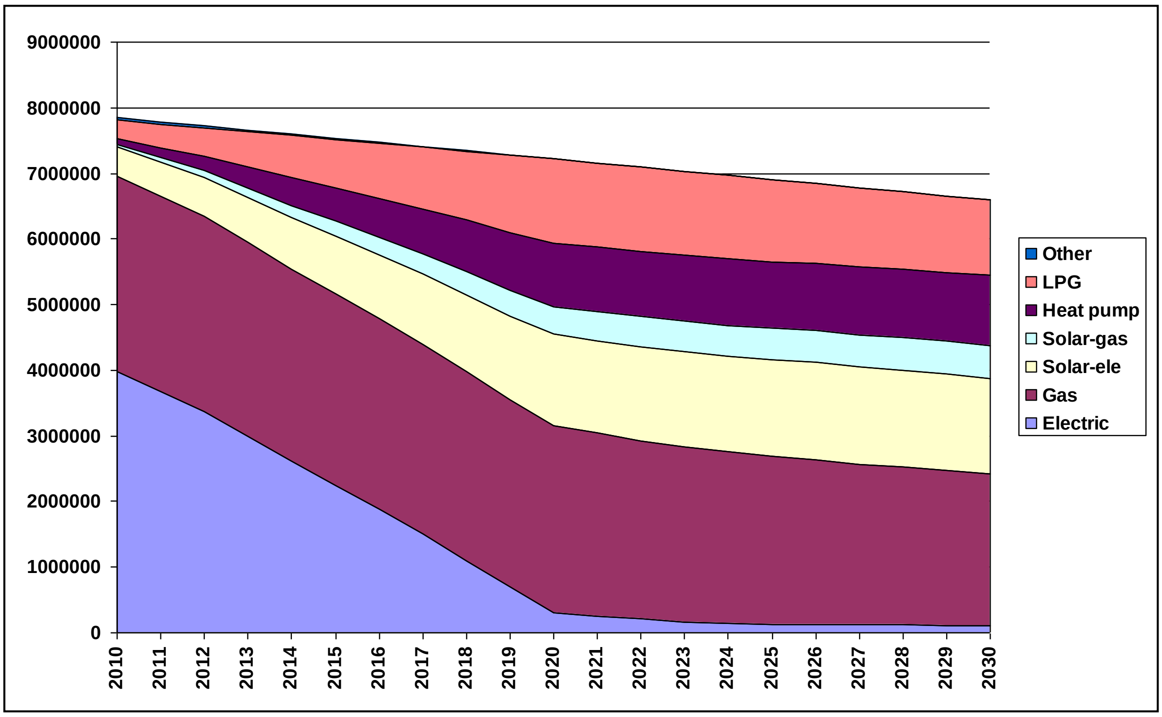
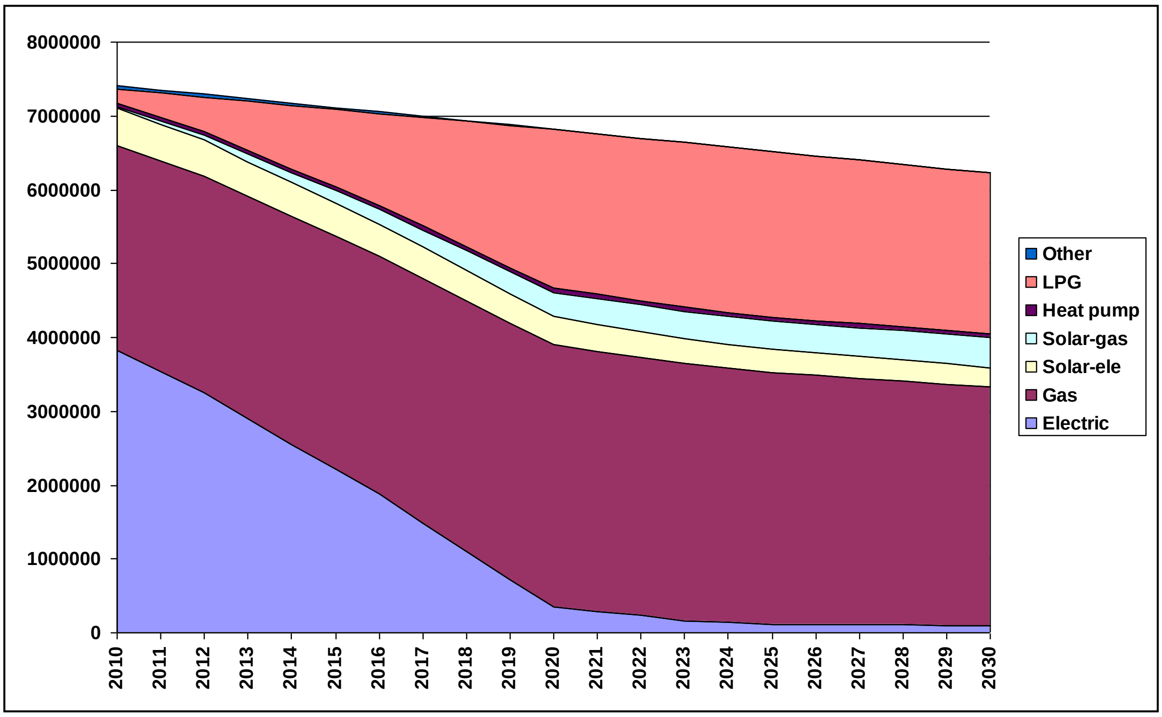


Figure 36 Projected water heater stock, Scenario 3 (Extended) – Model C



Impacts on Water Heater Sales

Figure 37 indicates projected annual water heater sales to the replacement market from 2011 to 2030. If all water heater types had a uniform service life the curve would be smooth. The fluctuations are caused by the fact that a large number of solar water heaters were installed between 2007 and 2010. These will all come up for replacement around 2021-2024, and then the replacement market will dip for a year or two.

Once customer who would have purchased electric water heaters are unable to do so, those purchases will be diverted to other types.
Figure 38 and

Figure 39 show the increase in demand for non-electric water heaters over the period 2011-2020 that will be needed, to make up the 3.2 to 3.8 million sales diverted from electric water heaters.

In Model A and B, the sales that would have gone to electric are diverted roughly equally to gas, solar-electric, heat pump and LPG, with a small share going to solar-gas. In Model C, solar-electric and heat pump are less attractive compared to the fuel alternatives because electricity prices are significantly higher, so over half the diversions go to LPG, and over a third to natural gas. Solar-gas picks up about the same market share, because it retains its running cost advantage over conventional natural gas, its direct competitor.

Models A and B are highly favourable to solar and heat pump, while Model C is highly favourable to natural gas and LPG, so they represent the extremes of likely outcomes. It should also be noted that both models exclude the effects of rebates for solar and heat pump purchases, which if available would reduce the diversion of sales to LPG.

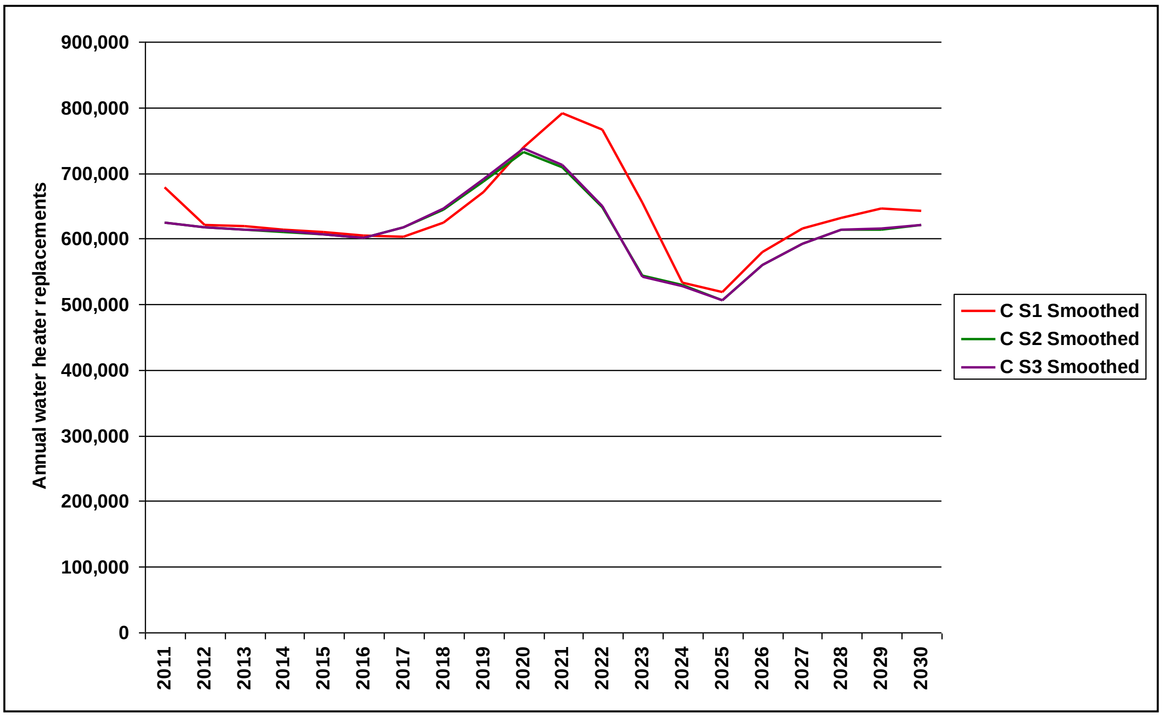
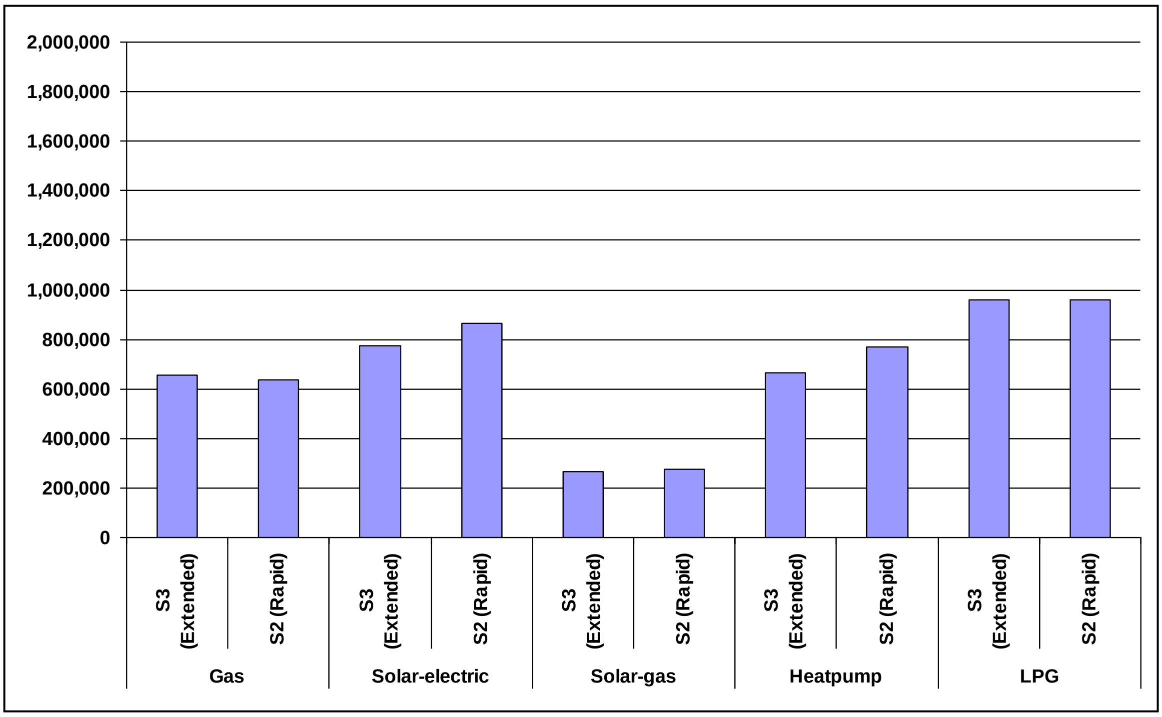


Figure 37 Water heater sales to pre-2011 houses, Australia, Model C

Figure 38 Projected change in total sales over period 2011-2020, Model A & B



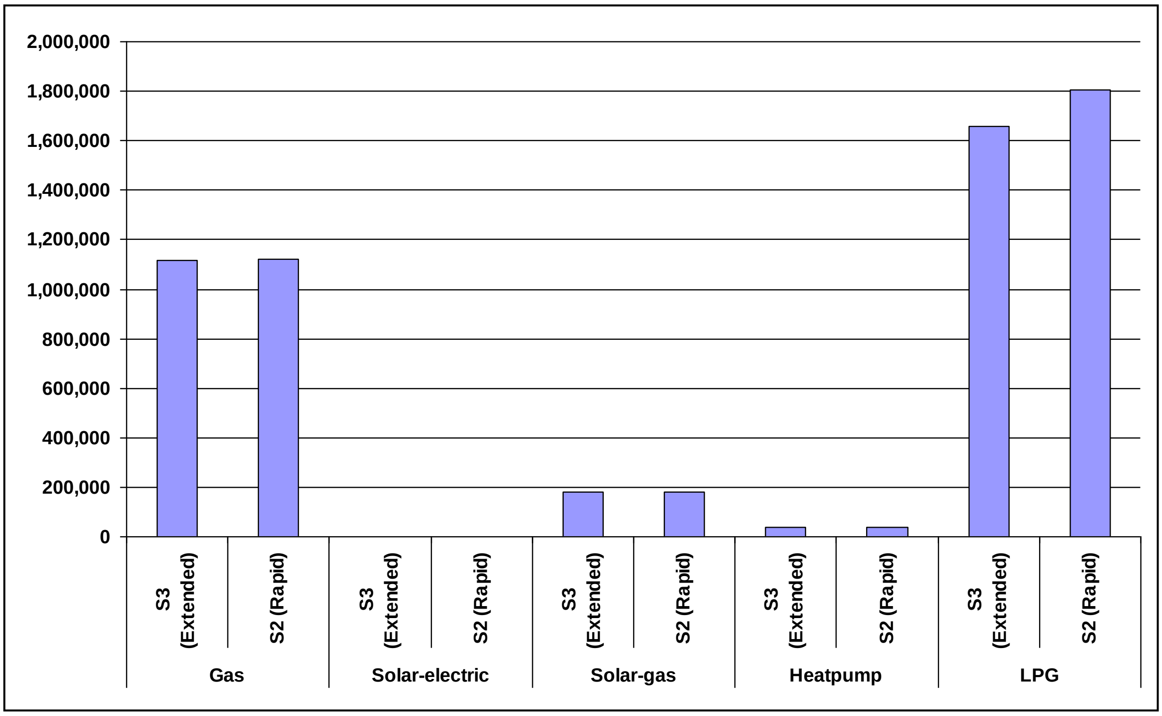


Figure 39 Projected change in total sales over the period 2011-2020, Model C

Impacts on Capital Costs
The shift in market share from electric to other types of water heaters will change both purchase and installation costs. In Model A&B, which projects a strong shift to solar and heat pump, the estimated increase in average water heater capital costs, compared with the BAU scenario, is $519 per household (S2) and $449 (S3) (Table 6, Figure 40, Figure 41). This is averaged over the period 2011-2020, by which time almost every electric water heater will have been replaced, and across both gas and non-gas areas, so households without access to gas could face significantly higher additional capital costs.

In Model C, which projects a shift to natural gas and LPG water heaters rather than solar and heat pump, the increase in water heater capital costs is much less, and mainly caused by the cost of additional gas connections. The highest capital cost impacts are on households in the higher income brackets. This is because the model links the probability of preferring a higher-price system such as solar to household income. The impacts on the lower income brackets are slightly lower, partly due to this income effect and also because these households have a greater tendency to be located in natural gas areas. In most scenarios the impacts on owner-occupied households are somewhat higher than for rental households, except in Model C S3, where the reverse is the case.

Figure 42 and Figure 43 indicate the total annual increase in water heater capital costs for all households replacing water heaters between 2011 and 2020. These would also be the minimum annual expenditures required if, for example, governments wished to compensate householders for the total capital cost impacts of the proposed measures. In Model A&B, which projects a shift to solar and heat pump, the amount is about $M 280 per year (under S3). In Model C, which projects a shift to natural gas and heat pump, the amount is about $M 80 per year.

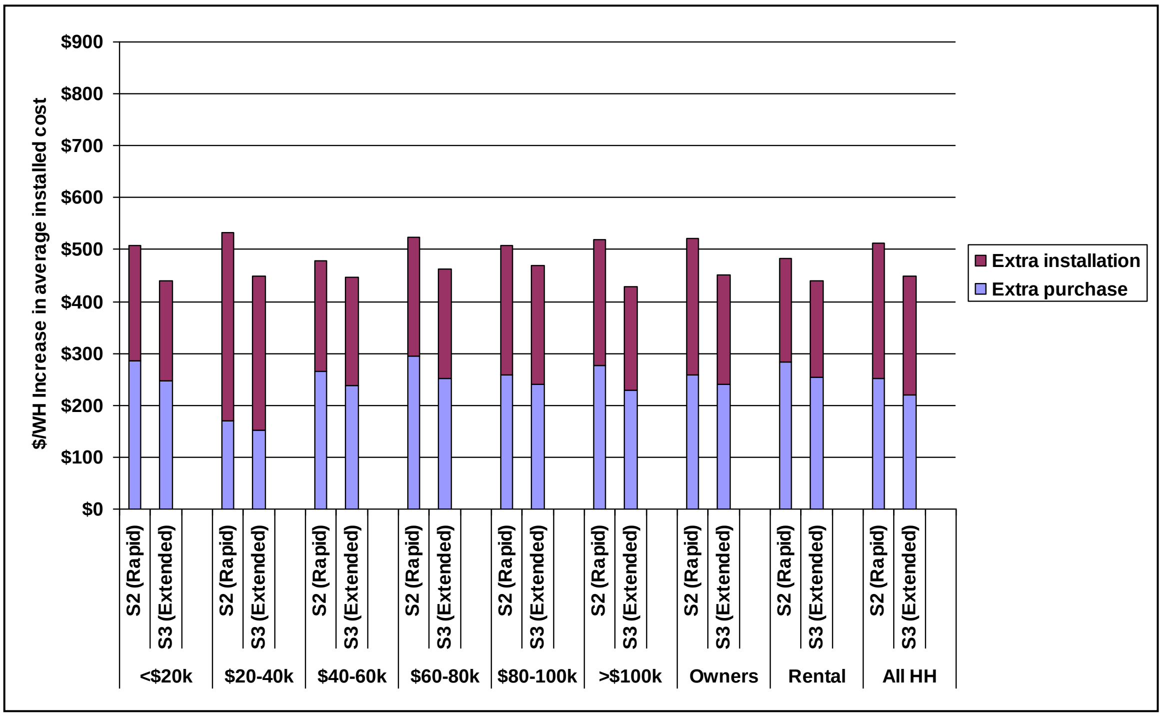


Figure 40 Change in average water heater capital costs, 2011-20, Model A & B

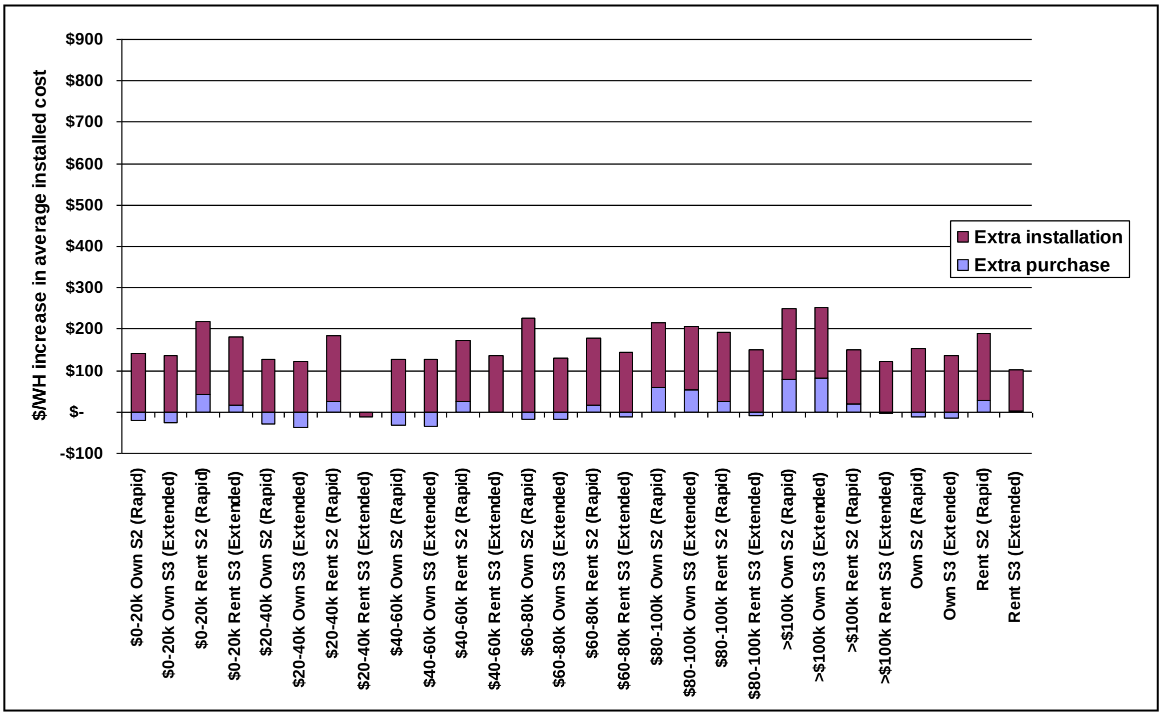
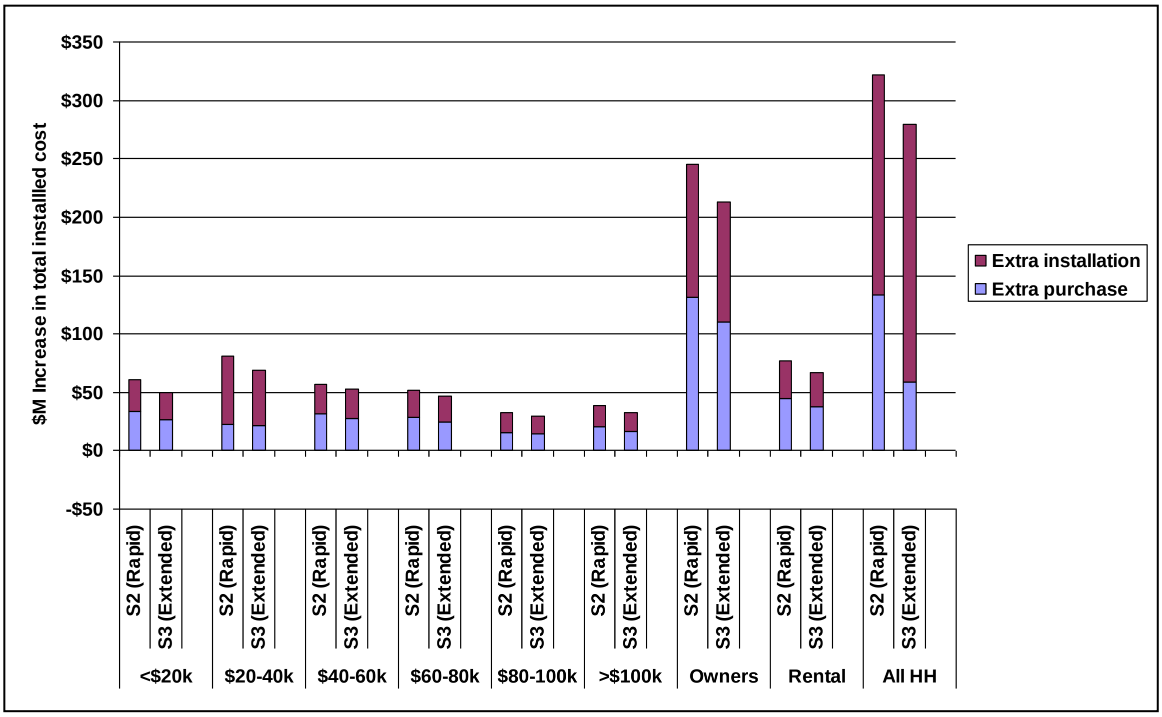


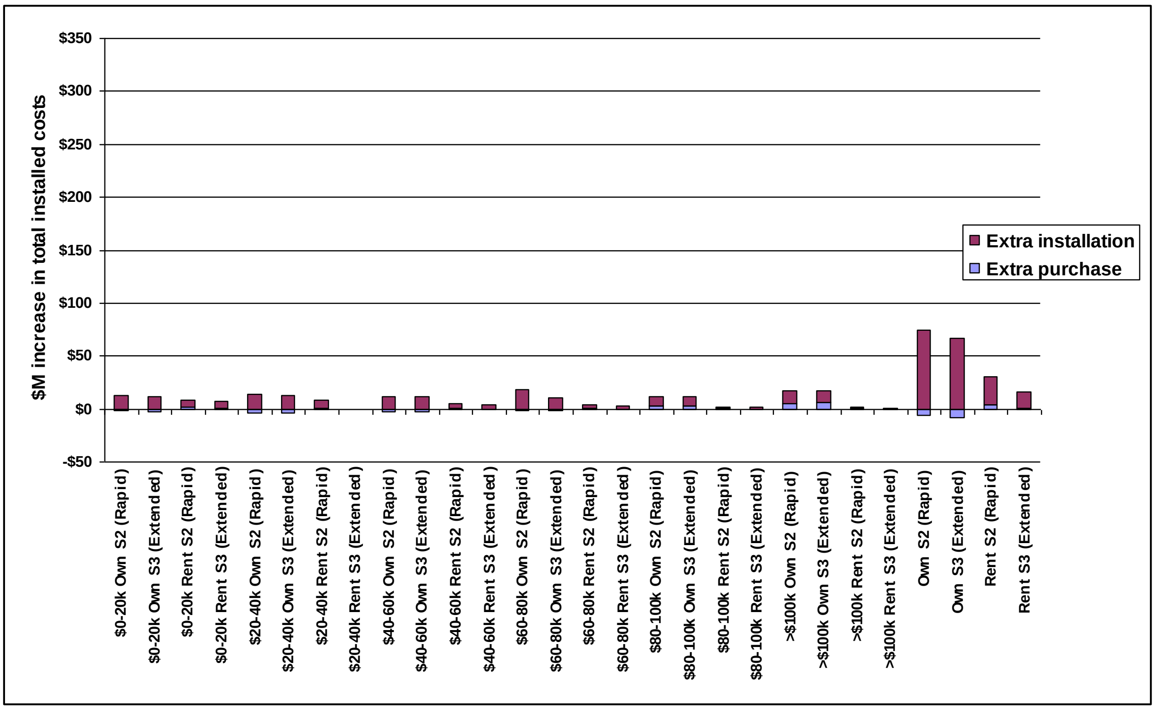
Figure 41 Change in average water heater capital costs, 2011-20, Model C

Figure 42 Change in total annual water heater capital costs, 2011-20, Model A



(Consultation RIS)

Figure 43 Change in total annual water heater capital costs, 2011-20, Model C



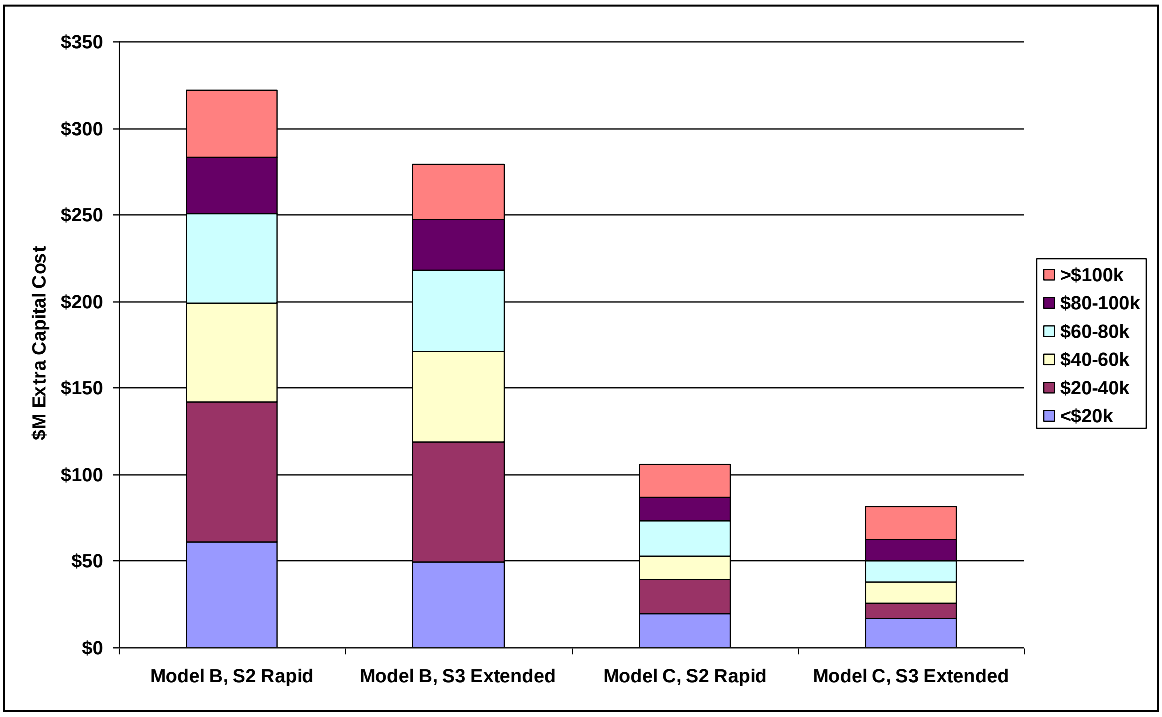
In Model A&B, all income groups and owners and renters bear a roughly proportionate share of the increase in capital costs (Table 32). In Model C (S3) a somewhat higher share is borne by higher income groups and by owners.

Figure 44 illustrates the total national increase in capital costs of water heaters purchased between 2010 and 2020 that would be caused by the withdrawal of electric water heaters from the market, by household income category.

Table 32 Share of total increase in capital costs borne by income categories

Income category	% of Households	% of total capital cost increment			
		Model A&B S2 (Rapid)	Model A&B S3 (Extend)	Model C S2 (Rapid)	Model C S3 (Extend)
<$20k	19%	19%	18%	18%	21%
$20-40k	24%	25%	25%	18%	11%
$40-60k	19%	18%	19%	13%	16%
$60-80k	16%	16%	17%	19%	14%
$80-100k	10%	10%	10%	13%	16%
>$100k	13%	12%	11%	18%	23%
All HH	100%	100%	100%	100%	100%
Owning	75%	76%	76%	70%	78%
Renting	25%	24%	24%	30%	22%

Figure 44 Change in total annual water heater capital costs, 2011-20 by household



income category

Benefit/Cost Ratios – All Models

The net present value of the projected capital and energy costs are given in Table 7 (under Model B) and Table 8 (Model C). Table 33 reproduces the values in the Consultation RIS, which were calculated using a central discount rate of 6% (with sensitivity checks at 3% and 9%). Table 34 presents the same data recalculated at a discount rate of 7%. The differences are not significant.

Table 33 National costs and benefits of proposals, 2011-2020, Model A (6%) (Consultation RIS)

		$M Net Present Value at 6% discount rate					$M change from BAU Scenario			B/C ratios	Mt CO_2-e saved	$/t saved (a)
		Purchase	Install	Capital	Energy	Total	Capital cost	Energy cost	Total net cost			
T10	S1 BAU	$6,125	$2,910	$9,036	$18,074	$27,109	$0	$0	$0			
	S2 Rapid	$7,405	$3,979	$11,384	$15,946	$27,330	$2,349	-$2,128	$220	0.9	32.5	6.8
	S3 Extend	$7,179	$3,862	$11,041	$16,208	$27,249	$2,006	-$1,865	$140	0.9	29.4	4.8
C10	S1 BAU	$6,125	$2,910	$9,036	$24,014	$33,050	$0	$0	$0			
	S2 Rapid)	$7,405	$3,979	$11,384	$20,431	$31,815	$2,349	-$3,584	-$1,235	1.5	57.8	-21.4
	S3 Extend	$7,179	$3,862	$11,041	$20,817	$31,858	$2,006	-$3,197	-$1,192	1.6	53.6	-22.2
T20	S1 BAU	$9,386	$4,502	$13,888	$28,733	$42,621	$0	$0	$0			
	S2 Rapid	$11,144	$5,934	$17,079	$23,873	$40,952	$3,191	-$4,860	-$1,669	1.5	77.9	-21.4
	S3 Extend	$10,906	$5,814	$16,720	$24,280	$41,000	$2,832	-$4,453	-$1,621	1.6	74.4	-21.8
C20	S1 BAU	$9,386	$4,502	$13,888	$31,906	$45,794	$0	$0	$0			
	S2 Rapid	$11,144	$5,934	$17,079	$26,203	$43,282	$3,191	-$5,702	-$2,512	1.8	98.6	-25.5
	S3 Extend	$10,906	$5,814	$16,720	$26,647	$43,367	$2,832	-$5,259	-$2,427	1.9	94.9	-25.6

(a) Negative values indicate that value of energy savings covers the increase in capital costs

Table 34 National costs and benefits of proposals, 2011-2020, Model A (7%)

		$M Net Present Value at 6% discount rate					$M change from BAU Scenario			B/C ratios	Mt CO_2-e saved	$/t saved (a)
		Purchase	Install	Capital	Energy	Total	Capital cost	Energy cost	Total net cost			
T10	S1 BAU	$5,831	$2,771	$8,602	$17,225	$25,827	$0	$0	$0			
	S2 Rapid	$7,051	$3,790	$10,841	$15,228	$26,068	$2,239	-$1,997	$241	0.9	32.5	7.4
	S3 Extend	$6,833	$3,675	$10,508	$15,476	$25,984	$1,906	-$1,749	$157	0.9	29.4	5.3
C10	S1 BAU	$5,831	$2,771	$8,602	$22,451	$31,053	$0	$0	$0			
	S2 Rapid)	$7,051	$3,790	$10,841	$19,174	$30,014	$2,239	-$3,277	-$1,039	1.5	57.8	-18.0
	S3 Extend	$6,833	$3,675	$10,508	$19,531	$30,039	$1,906	-$2,920	-$1,014	1.5	53.6	-18.9
T20	S1 BAU	$8,660	$4,151	$12,811	$26,489	$39,300	$0	$0	$0			
	S2 Rapid	$10,289	$5,483	$15,772	$22,119	$37,891	$2,961	-$4,370	-$1,409	1.5	77.9	-18.1
	S3 Extend	$10,061	$5,366	$15,428	$22,493	$37,920	$2,617	-$3,996	-$1,380	1.5	74.4	-18.6
C20	S1 BAU	$8,660	$4,151	$12,811	$29,030	$41,841	$0	$0	$0			
	S2 Rapid	$10,289	$5,483	$15,772	$23,985	$39,757	$2,961	-$5,045	-$2,084	1.7	98.6	-21.1
	S3 Extend	$10,061	$5,366	$15,428	$24,388	$39,816	$2,617	-$4,642	-$2,025	1.8	94.9	-21.3

(a) Negative values indicate that value of energy savings covers the increase in capital costs

Table 35 Energy and capital cost as proportion of total NPV

		Model B		Model C	
		Energy cost	Capital cost	Energy cost	Capital cost
T10	S1 BAU	71%	29%	74%	26%
	S2 Rapid	62%	38%	72%	28%
	S3 Extend	64%	36%	73%	27%
C10	S1 BAU	76%	24%	79%	21%
	S2 Rapid)	67%	33%	77%	23%
	S3 Extend	68%	32%	77%	23%
T20	S1 BAU	72%	28%	76%	24%
	S2 Rapid	62%	38%	74%	26%
	S3 Extend	63%	37%	74%	26%
C20	S1 BAU	73%	27%	78%	22%
	S2 Rapid	64%	36%	76%	24%
	S3 Extend	65%	35%	76%	24%

Derived from Table 7 and Table 8

By Household (National)

Impacts can be expressed on a per household basis by dividing the national impacts by the number of water heaters to be installed over the corresponding period. Under Model B (Table 9), the Extended phaseout scenario (S3) gives an average net *benefit* per household ranging from $95 (T10, S3) to $ 356 (C20, S2). The Cohort analyses give a more accurate indication of the average greenhouse saving over the lifetime of water heaters: this is between 5 and 8 tonnes CO_2-e. Under Model C the impact per household ranges from a net $23 increase in cost to a cost reduction of $111. In other words, the cost impacts of Model C are close to neutral.

Table 36 Per household impacts of proposals, 2011-2020, Model A (6%) (Consultation RIS)

		Change from BAU Scenario			B/C ratios	tonnes CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 341	−$ 309	$ 32	0.9	4.7
	S3 (Extended)	$ 291	−$ 271	$ 20	0.9	4.3
C10	S2 (Rapid)	$ 341	−$ 519	−$ 177	1.5	8.4
	S3 (Extended)	$ 291	−$ 462	−$ 171	1.6	7.8
T20	S2 (Rapid)	$ 246	−$ 374	−$ 129	1.5	6.0
	S3 (Extended)	$ 218	−$ 343	−$ 125	1.6	5.7
C20	S2 (Rapid)	$ 246	−$ 439	−$ 194	1.8	7.6
	S3 (Extended)	$ 218	−$ 405	−$ 187	1.9	7.3

Table 37 Per household impacts of proposals, 2011-2020, Model A (7%)

		Change from BAU Scenario			B/C ratios	tonnes CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 325	-$ 290	$ 35	0.9	4.7
	S3 (Extended)	$ 277	-$ 254	$ 23	0.9	4.3
C10	S2 (Rapid)	$ 228	-$ 337	-$ 109	1.5	8.4
	S3 (Extended)	$ 202	-$ 308	-$ 106	1.5	7.8
T20	S2 (Rapid)	$ 325	-$ 476	-$ 151	1.5	6.0
	S3 (Extended)	$ 277	-$ 424	-$ 147	1.5	5.7
C20	S2 (Rapid)	$ 228	-$ 389	-$ 161	1.7	7.6
	S3 (Extended)	$ 202	-$ 358	-$ 156	1.8	7.3

By Jurisdiction

Table 38 to Table 41 summarise B/C ratios by jurisdiction for S3, under Models A, B and C. B/C ratios of 1 or higher are highlighted in green, and those below 1 in orange. Models B and C, which use the latest energy price projections and a discount rate of 7%, give jurisdictional B/C ratios ranging up to 3.0 (10 year Truncated) and 5.2 (10 year Cohort), 7.3 (20 year Truncated) and 8.4 (20 year Cohort).

Table 38 Scenario 3 B/C ratios, Model A (6%) (Consultation RIS)

	10T	10C	20T	20C
NSW	0.8	1.5	1.5	1.8
VIC	1.6	2.6	2.5	2.9
QLD	0.5	0.9	0.9	1.1
SA	1.1	1.8	1.7	2.0
WA	1.2	2.1	2.0	2.4
TAS	1.0	1.7	1.5	1.8
NT	0.8	1.4	1.5	1.7
ACT	0.3	0.6	0.6	0.7
Australia	**0.9**	**1.6**	**1.6**	**1.9**

B/C ratios calculated at 6% discount rate. . '0' indicates small increase in capital costs as well as small increase in running cost.

Table 39 Scenario 3 B/C ratios Model A (7%)

	10T	10C	20T	20C
NSW	0.8	1.4	1.4	1.7
VIC	1.6	2.5	2.4	2.7
QLD	0.5	0.8	0.8	1.0
SA	1.1	1.8	1.7	1.9
WA	1.2	2.0	1.9	2.4
TAS	1.0	1.6	1.5	1.7
NT	0.7	1.4	1.5	1.7
ACT	0.3	0.6	0.5	0.7
Australia	**0.9**	**1.5**	**1.5**	**1.8**

B/C ratios calculated at 7% discount rate. '0' indicates small increase in capital costs as well as small increase in running cost.

Table 40 Scenario 3 B/C ratios, Model B (7%)

	10T	10C	20T	20C
NSW	1.3	2.2	2.4	2.8
VIC	1.7	2.7	2.8	3.2
QLD	1.4	2.3	2.4	2.8
SA	1.4	2.2	2.3	2.7
WA	1.5	2.5	2.6	3.1
TAS	NA	NA	NA	NA
NT	1.0	1.7	1.9	2.2
ACT	0.3	0.6	0.6	0.8
Australia	**1.4**	**2.3**	**2.4**	**2.8**

B/C ratios calculated at 7% discount rate. '0' indicates small increase in capital costs as well as small increase in running cost.

Table 41 Scenario 3 B/C ratios, Model C (7%)

	10T	10C	20T	20C
NSW	0.2	0.9	3.6	4.8
VIC	3.0	5.2	7.3	8.4
QLD	0.0	0.0	0.9	1.5
SA	0.0	0.0	0.0	0.0
WA	1.6	2.5	2.8	3.3
TAS	NA	NA	NA	NA
NT	1.0	1.7	1.8	2.0
ACT	1.3	2.2	2.6	3.1
Australia	**0.6**	**1.4**	**3.1**	**3.9**

B/C ratios calculated at 7% discount rate. '0' indicates small increase in capital costs as well as small increase in running cost.

In Model B, which favours solar and heat pump, Victoria and WA have the highest B/C ratios, and ACT the lowest. This is partly because Victoria and WA have high gas availability, so more households have access to the least costly compliance option: for Queensland and NSW the reverse is true. The low B/C ratios for the ACT are due to comparatively lower energy prices. All jurisdictions show a reduction in total NPV(indicating a reduction in the total costs of water heating services to householders) from the phaseout, under all or most time period analyses, other than the ACT (Table 38).

In Model C, which favours natural gas and LPG, Victoria and SA have the highest B/C ratios because of high gas availability. Some states show zero B/C for some analyses, because there are small increases in both capital and energy costs, leading to higher rather than lower total NPV. For NSW and Queensland Model C shows a slight increase in water heating costs in the shorter time frame, but a reduction in the longer time frame. Tasmania shows an increase in costs under all scenarios.

Table 42 Change in total NPV of water heating services, Model B (7% discount)

		NSW	VIC	QLD	SA	WA	Tas	NT	ACT	AUST
10T	S2	-2.4%	-3.0%	-4.1%	-1.5%	-3.1%	NA	-1.2%	8.8%	-2.5%
	S3	-1.9%	-3.6%	-2.9%	-2.6%	-2.9%	NA	0.2%	8.4%	-2.3%
10C	S2	-7.0%	-6.9%	-10.2%	-6.1%	-7.2%	NA	-5.8%	5.0%	-7.2%
	S3	-6.0%	-7.3%	-8.3%	-6.9%	-6.9%	NA	-4.5%	4.7%	-6.6%
20T	S2	-8.3%	-7.6%	-11.0%	-7.8%	-8.5%	NA	-6.3%	4.2%	-8.3%
	S3	-7.4%	-8.1%	-9.8%	-8.0%	-8.5%	NA	-6.1%	4.0%	-7.8%
20C	S2	-10.0%	-9.0%	-13.0%	-9.6%	-10.2%	NA	-8.1%	2.7%	-10.0%
	S3	-9.1%	-9.4%	-11.8%	-9.7%	-10.2%	NA	-8.0%	2.5%	-9.5%

Table 43 Change in total NPV of water heating services, Model C (7% discount)

		NSW	VIC	QLD	SA	WA	Tas	NT	ACT	AUST
10T	S2	1.1%	-2.0%	3.8%	0.9%	-1.6%	NA	1.6%	-1.1%	0.8%
	S3	1.6%	-2.1%	3.9%	0.9%	-1.7%	NA	0.0%	-1.1%	0.9%
10C	S2	-0.4%	-3.5%	2.5%	0.9%	-3.7%	NA	-1.2%	-4.1%	-0.3%
	S3	0.1%	-3.6%	2.8%	0.9%	-3.8%	NA	-2.6%	-4.0%	-0.2%
20T	S2	-2.7%	-4.3%	0.1%	0.7%	-4.6%	NA	-1.9%	-5.5%	-1.6%
	S3	-2.3%	-4.3%	0.1%	0.7%	-4.7%	NA	-3.1%	-5.4%	-1.5%
20C	S2	-3.4%	-4.7%	-0.7%	0.6%	-5.4%	NA	-2.7%	-6.5%	-2.0%
	S3	-3.0%	-4.8%	-0.7%	0.6%	-5.5%	NA	-3.7%	-6.4%	-1.9%

Table 44 NSW Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 338	-$ 451	-$ 112	1.3	7.0
	S3 (Extended)	$ 273	-$ 362	-$ 89	1.3	6.2
C10	S2 (Rapid)	$ 338	-$ 734	-$ 396	2.2	12.5
	S3 (Extended)	$ 273	-$ 611	-$ 338	2.2	11.5
T20	S2 (Rapid)	$ 237	-$ 558	-$ 322	2.4	9.1
	S3 (Extended)	$ 204	-$ 491	-$ 286	2.4	8.6
C20	S2 (Rapid)	$ 237	-$ 651	-$ 414	2.7	11.4
	S3 (Extended)	$ 204	-$ 579	-$ 375	2.8	10.9

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 45 NSW Per household impact of proposals, Model C (State)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 96	-$ 44	$ 52	0.5	4.8
	S3 (Extended)	$ 88	-$ 15	$ 73	0.2	4.5
C10	S2 (Rapid)	$ 96	-$ 121	-$ 24	1.3	8.7
	S3 (Extended)	$ 88	-$ 81	$ 7	0.9	9.1
T20	S2 (Rapid)	$ 39	-$ 145	-$ 106	3.7	7.0
	S3 (Extended)	$ 34	-$ 126	-$ 91	3.6	6.8
C20	S2 (Rapid)	$ 39	-$ 185	-$ 146	4.7	8.7
	S3 (Extended)	$ 34	-$ 166	-$ 131	4.8	8.9

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 46 NSW Per household impacts of proposals, Model C (Gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 172	-$ 428	-$ 256	2.5	5.0
	S3 (Extended)	$ 172	-$ 428	-$ 257	2.5	5.0
C10	S2 (Rapid)	$ 172	-$ 716	-$ 544	4.2	9.5
	S3 (Extended)	$ 172	-$ 716	-$ 544	4.2	9.5
T20	S2 (Rapid)	$ 81	-$ 535	-$ 454	6.6	7.3
	S3 (Extended)	$ 81	-$ 536	-$ 455	6.6	7.3
C20	S2 (Rapid)	$ 81	-$ 618	-$ 537	7.6	9.4
	S3 (Extended)	$ 81	-$ 619	-$ 538	7.7	9.4

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 47 NSW Per household impacts of proposals, Model C (Non-gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 29	$ 294	$ 323	0.0	4.6
	S3 (Extended)	$ 15	$ 347	$ 362	0.0	4.0
C10	S2 (Rapid)	$ 29	$ 404	$ 434	0.0	8.0
	S3 (Extended)	$ 15	$ 475	$ 489	0.0	8.7
T20	S2 (Rapid)	$ 2	$ 201	$ 203	0.0	6.6
	S3 (Extended)	-$ 7	$ 237	$ 231	0.0	6.3
C20	S2 (Rapid)	$ 2	$ 199	$ 201	0.0	8.1
	S3 (Extended)	-$ 7	$ 235	$ 229	0.0	8.5

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 48 VIC Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 260	-$ 388	-$ 128	1.5	4.2
	S3 (Extended)	$ 230	-$ 384	-$ 155	1.7	4.1
C10	S2 (Rapid)	$ 260	-$ 622	-$ 362	2.4	7.0
	S3 (Extended)	$ 230	-$ 612	-$ 382	2.7	6.8
T20	S2 (Rapid)	$ 182	-$ 445	-$ 263	2.4	4.6
	S3 (Extended)	$ 159	-$ 440	-$ 281	2.8	4.5
C20	S2 (Rapid)	$ 182	-$ 516	-$ 333	2.8	5.7
	S3 (Extended)	$ 159	-$ 509	-$ 350	3.2	5.6

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 49 VIC Per household impact of proposals, Model C (State)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 45	-$ 123	-$ 78	2.7	1.4
	S3 (Extended)	$ 40	-$ 121	-$ 81	3.0	1.4
C10	S2 (Rapid)	$ 45	-$ 213	-$ 168	4.7	2.5
	S3 (Extended)	$ 40	-$ 211	-$ 171	5.2	2.6
T20	S2 (Rapid)	$ 24	-$ 157	-$ 133	6.6	1.7
	S3 (Extended)	$ 21	-$ 156	-$ 134	7.3	1.7
C20	S2 (Rapid)	$ 24	-$ 181	-$ 157	7.6	2.1
	S3 (Extended)	$ 21	-$ 180	-$ 158	8.4	2.2

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 50 VIC Per household impacts of proposals, Model C (Gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 37	-$ 172	-$ 135	4.7	1.3
	S3 (Extended)	$ 38	-$ 172	-$ 135	4.6	1.3
C10	S2 (Rapid)	$ 37	-$ 290	-$ 253	7.8	2.4
	S3 (Extended)	$ 38	-$ 290	-$ 253	7.7	2.4
T20	S2 (Rapid)	$ 17	-$ 204	-$ 186	11.7	1.6
	S3 (Extended)	$ 18	-$ 204	-$ 186	11.4	1.6
C20	S2 (Rapid)	$ 17	-$ 233	-$ 216	13.4	2.1
	S3 (Extended)	$ 18	-$ 233	-$ 215	13.1	2.1

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 51 VIC Per household impacts of proposals, Model C (Non-gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 90	$ 133	$ 223	0.0	2.0
	S3 (Extended)	$ 53	$ 147	$ 200	0.0	1.6
C10	S2 (Rapid)	$ 90	$ 188	$ 277	0.0	2.9
	S3 (Extended)	$ 53	$ 205	$ 258	0.0	3.4
T20	S2 (Rapid)	$ 59	$ 100	$ 159	0.0	2.2
	S3 (Extended)	$ 40	$ 110	$ 150	0.0	2.0
C20	S2 (Rapid)	$ 59	$ 103	$ 162	0.0	2.4
	S3 (Extended)	$ 40	$ 113	$ 153	0.0	2.6

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 52 QLD Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 361	-$ 520	-$ 159	1.4	6.0
	S3 (Extended)	$ 298	-$ 410	-$ 112	1.4	5.2
C10	S2 (Rapid)	$ 361	-$ 831	-$ 470	2.3	10.7
	S3 (Extended)	$ 298	-$ 686	-$ 388	2.3	9.6
T20	S2 (Rapid)	$ 256	-$ 605	-$ 349	2.4	7.6
	S3 (Extended)	$ 218	-$ 529	-$ 312	2.4	7.2
C20	S2 (Rapid)	$ 256	-$ 696	-$ 441	2.7	9.6
	S3 (Extended)	$ 218	-$ 618	-$ 400	2.8	9.2

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 53 QLD Per household impact of proposals, Model C (State)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 105	$ 36	$ 141	0.0	4.3
	S3 (Extended)	$ 86	$ 60	$ 146	0.0	3.8
C10	S2 (Rapid)	$ 105	$ 10	$ 115	0.0	7.5
	S3 (Extended)	$ 86	$ 40	$ 127	0.0	8.1
T20	S2 (Rapid)	$ 56	-$ 54	$ 2	1.0	6.0
	S3 (Extended)	$ 46	-$ 43	$ 3	0.9	5.7
C20	S2 (Rapid)	$ 56	-$ 81	-$ 25	1.4	7.4
	S3 (Extended)	$ 46	-$ 71	-$ 25	1.5	7.6

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 54 QLD Per household impacts of proposals, Model C (Gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 187	-$ 244	-$ 57	1.3	4.6
	S3 (Extended)	$ 187	-$ 242	-$ 55	1.3	4.6
C10	S2 (Rapid)	$ 187	-$ 427	-$ 239	2.3	8.7
	S3 (Extended)	$ 187	-$ 425	-$ 238	2.3	8.7
T20	S2 (Rapid)	$ 106	-$ 344	-$ 238	3.3	6.7
	S3 (Extended)	$ 106	-$ 345	-$ 239	3.3	6.7
C20	S2 (Rapid)	$ 106	-$ 403	-$ 297	3.8	8.6
	S3 (Extended)	$ 106	-$ 405	-$ 299	3.8	8.6

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 55 QLD Per household impacts of proposals, Model C (Non-gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 71	$ 153	$ 224	0.0	4.2
	S3 (Extended)	$ 44	$ 187	$ 231	0.0	3.5
C10	S2 (Rapid)	$ 71	$ 193	$ 264	0.0	7.0
	S3 (Extended)	$ 44	$ 235	$ 279	0.0	7.8
T20	S2 (Rapid)	$ 35	$ 65	$ 101	0.0	5.7
	S3 (Extended)	$ 21	$ 82	$ 103	0.0	5.3
C20	S2 (Rapid)	$ 35	$ 52	$ 88	0.0	6.9
	S3 (Extended)	$ 21	$ 67	$ 89	0.0	7.2

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 56 SA Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 331	-$ 391	-$ 60	1.2	3.7
	S3 (Extended)	$ 263	-$ 365	-$ 102	1.4	3.5
C10	S2 (Rapid)	$ 216	-$ 465	-$ 249	2.2	4.7
	S3 (Extended)	$ 192	-$ 443	-$ 251	2.3	4.6
T20	S2 (Rapid)	$ 331	-$ 618	-$ 287	1.9	6.5
	S3 (Extended)	$ 263	-$ 585	-$ 322	2.2	6.3
C20	S2 (Rapid)	$ 216	-$ 542	-$ 326	2.5	6.0
	S3 (Extended)	$ 192	-$ 519	-$ 327	2.7	5.8

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 57 SA Per household impact of proposals, Model C (State, from NR)(b)

		Change from S1 Capital cost	Energy cost	Total cost	B/C ratios(a)	t CO_2-e saved per HH
T10	S2 (Rapid)	$ 41	-$ 122	-$ 81	3.0	2.0
	S3 (Extended)	$ 36	-$ 116	-$ 80	3.2	1.9
C10	S2 (Rapid)	$ 41	-$ 217	-$ 176	5.3	3.7
	S3 (Extended)	$ 36	-$ 209	-$ 173	5.8	3.8
T20	S2 (Rapid)	$ 21	-$ 177	-$ 155	8.3	2.9
	S3 (Extended)	$ 19	-$ 174	-$ 154	9.0	2.8
C20	S2 (Rapid)	$ 21	-$ 209	-$ 188	9.8	3.6
	S3 (Extended)	$ 19	-$ 206	-$ 187	10.6	3.7

(a) '0' indicates increase in capital costs as well as increase in running cost. (b) Compared with impact of current regulations in SA

Table 58 SA Per household impact of proposals, Model C (State, from BAU) (b)

		Change from S1 Capital cost	Energy cost	Total cost	B/C ratios(a)	t CO_2-e saved per HH
T10	S2 (Rapid)	$ 13	$ 19	$ 31	0.0	0.5
	S3 (Extended)	$ 7	$ 25	$ 32	0.0	0.4
C10	S2 (Rapid)	$ 13	$ 23	$ 36	0.0	0.8
	S3 (Extended)	$ 7	$ 32	$ 38	0.0	0.9
T20	S2 (Rapid)	$ 8	$ 8	$ 16	0.0	0.6
	S3 (Extended)	$ 5	$ 12	$ 17	0.0	0.6
C20	S2 (Rapid)	$ 8	$ 6	$ 15	0.0	0.7
	S3 (Extended)	$ 5	$ 11	$ 16	0.0	0.8

(a) '0' indicates increase in capital costs as well as increase in running cost. (b) Compared with impact of current regulations in SA

Table 59 SA Per household impacts of proposals, Model C (Gas Zone, from NR)(b)

		Change from S1 Capital cost	Energy cost	Total cost	B/C ratios(a)	t CO_2-e saved per HH
T10	S2 (Rapid)	$ 35	-$ 178	-$ 142	5.0	2.0
	S3 (Extended)	$ 38	-$ 179	-$ 142	4.8	2.0
C10	S2 (Rapid)	$ 35	-$ 304	-$ 269	8.6	3.8
	S3 (Extended)	$ 38	-$ 306	-$ 268	8.2	3.7
T20	S2 (Rapid)	$ 16	-$ 233	-$ 217	14.3	2.8
	S3 (Extended)	$ 18	-$ 235	-$ 217	13.1	2.8
C20	S2 (Rapid)	$ 16	-$ 272	-$ 256	16.7	3.6
	S3 (Extended)	$ 18	-$ 274	-$ 256	15.3	3.6

(a) '0' indicates increase in capital costs as well as increase in running cost. (b) See Table 57

Table 60 SA Per household impacts of proposals, Model C (Non-gas Zone)

		Change from S1 Capital cost	Energy cost	Total cost	B/C ratios(a)	t CO_2-e saved per HH
T10	S2 (Rapid)	$ 61	$ 88	$ 149	0.0	2.2
	S3 (Extended)	$ 31	$ 120	$ 152	0.0	1.8
C10	S2 (Rapid)	$ 61	$ 112	$ 174	0.0	3.6
	S3 (Extended)	$ 31	$ 153	$ 184	0.0	4.1
T20	S2 (Rapid)	$ 40	$ 37	$ 78	0.0	3.0
	S3 (Extended)	$ 25	$ 58	$ 83	0.0	2.7
C20	S2 (Rapid)	$ 40	$ 30	$ 70	0.0	3.5
	S3 (Extended)	$ 25	$ 51	$ 75	0.0	3.8

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 61 WA Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 290	-$ 437	-$ 147	1.5	2.7
	S3 (Extended)	$ 267	-$ 402	-$ 135	1.5	2.5
C10	S2 (Rapid)	$ 205	-$ 520	-$ 315	2.5	3.6
	S3 (Extended)	$ 190	-$ 502	-$ 312	2.6	3.5
T20	S2 (Rapid)	$ 290	-$ 700	-$ 410	2.4	4.9
	S3 (Extended)	$ 267	-$ 659	-$ 392	2.5	4.6
C20	S2 (Rapid)	$ 205	-$ 611	-$ 406	3.0	4.8
	S3 (Extended)	$ 190	-$ 592	-$ 402	3.1	4.6

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 62 WA Per household impact of proposals, Model C (State)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 135	-$ 202	-$ 67	1.5	1.3
	S3 (Extended)	$ 128	-$ 201	-$ 73	1.6	1.2
C10	S2 (Rapid)	$ 135	-$ 322	-$ 188	2.4	2.3
	S3 (Extended)	$ 128	-$ 322	-$ 194	2.5	2.4
T20	S2 (Rapid)	$ 88	-$ 240	-$ 152	2.7	1.9
	S3 (Extended)	$ 86	-$ 243	-$ 157	2.8	1.8
C20	S2 (Rapid)	$ 88	-$ 280	-$ 191	3.2	2.4
	S3 (Extended)	$ 86	-$ 284	-$ 198	3.3	2.5

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 63 WA Per household impacts of proposals, Model C (Gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 112	-$ 250	-$ 137	2.2	1.3
	S3 (Extended)	$ 116	-$ 254	-$ 138	2.2	1.3
C10	S2 (Rapid)	$ 112	-$ 399	-$ 287	3.5	2.4
	S3 (Extended)	$ 116	-$ 403	-$ 287	3.5	2.4
T20	S2 (Rapid)	$ 70	-$ 294	-$ 224	4.2	1.9
	S3 (Extended)	$ 72	-$ 297	-$ 225	4.1	1.9
C20	S2 (Rapid)	$ 70	-$ 341	-$ 272	4.9	2.5
	S3 (Extended)	$ 72	-$ 345	-$ 273	4.8	2.5

(a) ‘0’ indicates increase in capital costs as well as increase in running cost.

Table 64 WA Per household impacts of proposals, Model C (Non-gas Zone)

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 210	-$ 39	$ 170	0.2	1.2
	S3 (Extended)	$ 168	-$ 22	$ 147	0.1	0.9
C10	S2 (Rapid)	$ 210	-$ 62	$ 148	0.3	1.8
	S3 (Extended)	$ 168	-$ 46	$ 123	0.3	2.3
T20	S2 (Rapid)	$ 152	-$ 54	$ 99	0.4	1.8
	S3 (Extended)	$ 132	-$ 56	$ 76	0.4	1.6
C20	S2 (Rapid)	$ 152	-$ 66	$ 87	0.4	2.1
	S3 (Extended)	$ 132	-$ 71	$ 61	0.5	2.3

(a) ‘0’ indicates small increase in capital costs as well as small increase in running cost.

Table 65 NT Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 360	-$ 412	-$ 52	1.1	3.5
	S3 (Extended)	$ 331	-$ 324	$ 6	1.0	2.6
C10	S2 (Rapid)	$ 264	-$ 487	-$ 224	1.8	4.8
	S3 (Extended)	$ 244	-$ 460	-$ 216	1.9	4.3
T20	S2 (Rapid)	$ 360	-$ 665	-$ 305	1.8	6.3
	S3 (Extended)	$ 331	-$ 565	-$ 235	1.7	5.1
C20	S2 (Rapid)	$ 264	-$ 573	-$ 310	2.2	6.3
	S3 (Extended)	$ 244	-$ 548	-$ 304	2.2	5.8

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 66 NT Per household impact of proposals, Model C

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 231	-$ 168	$ 63	0.7	3.7
	S3 (Extended)	$ 191	-$ 191	-$ 0	1.0	2.8
C10	S2 (Rapid)	$ 231	-$ 294	-$ 62	1.3	5.2
	S3 (Extended)	$ 191	-$ 321	-$ 130	1.7	6.2
T20	S2 (Rapid)	$ 159	-$ 227	-$ 68	1.4	4.2
	S3 (Extended)	$ 138	-$ 246	-$ 107	1.8	3.7
C20	S2 (Rapid)	$ 159	-$ 262	-$ 103	1.6	4.8
	S3 (Extended)	$ 138	-$ 282	-$ 143	2.0	5.2

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 67 ACT Per household impacts of proposals, Model B

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 308	-$ 100	$ 208	0.3	2.0
	S3 (Extended)	$ 297	-$ 99	$ 198	0.3	2.0
C10	S2 (Rapid)	$ 229	-$ 146	$ 82	0.6	2.8
	S3 (Extended)	$ 220	-$ 143	$ 77	0.6	2.7
T20	S2 (Rapid)	$ 308	-$ 172	$ 136	0.6	3.6
	S3 (Extended)	$ 297	-$ 170	$ 127	0.6	3.6
C20	S2 (Rapid)	$ 229	-$ 174	$ 55	0.8	3.6
	S3 (Extended)	$ 220	-$ 169	$ 50	0.8	3.6

(a) '0' indicates increase in capital costs as well as increase in running cost.

Table 68 ACT Per household impacts of proposals, Model C

		Change from S1			B/C ratios(a)	t CO_2-e saved per HH
		Capital cost	Energy cost	Total cost		
T10	S2 (Rapid)	$ 192	-$ 244	-$ 52	1.3	3.8
	S3 (Extended)	$ 190	-$ 242	-$ 52	1.3	3.8
C10	S2 (Rapid)	$ 192	-$ 424	-$ 232	2.2	6.5
	S3 (Extended)	$ 190	-$ 421	-$ 231	2.2	6.5
T20	S2 (Rapid)	$ 124	-$ 327	-$ 203	2.6	4.2
	S3 (Extended)	$ 122	-$ 323	-$ 201	2.6	4.2
C20	S2 (Rapid)	$ 124	-$ 382	-$ 258	3.1	5.1
	S3 (Extended)	$ 122	-$ 377	-$ 255	3.1	5.1

(a) '0' indicates increase in capital costs as well as increase in running cost.

By Income Category

Under Model B, the higher energy price projections increase the B/C ratios slightly, despite the change from 6% to 7% discount rate (Table 14). The increase is slightly greater for lower income groups than higher income groups. Under Model C, where the diverted sales go mainly to natural gas and LPG, both costs and benefits are much smaller, so B/C ratios calculated for separate income and tenancy groups ratios vary widely on the basis of a few tens of millions of dollars difference in the NPV of capital and energy cost projections, especially in the $20-40k group. The most reliable values in Table 69 to Table 72 are those on the 'All' columns. On this basis, low-income groups appear to have significantly higher B/C ratios than high income groups.

Table 69 B/C ratios by Household Income, 10 years Truncated, Model C

Income Category	S2 (Rapid)			S3 (Extended)		
	Owned	Rented	All	Owned	Rented	All
$0-$20k	0.1	1.4	0.7	0	1.6	0.7
$20-$40k	0	1.4	0.7	0	NA	1.2
$40-$60k	0.2	2.2	1.0	0.1	2.2	0.8
$60-$80k	0.1	1.2	0.3	0.2	1.5	0.5
$80-$100k	0.4	1.4	0.5	0.3	1.5	0.4
>$100k	0.4	2.6	0.6	0.4	2.9	0.6
ALL	0.2	1.6	0.7	0.2	2.6	0.7

NA cannot be calculated because both capital and energy costs are lower. 0 indicates that both capital and energy costs are higher, and there is no benefit.

Table 70 B/C ratios by Household Income, 10 years Cohort, Model C

Income Category	S2 (Rapid)			S3 (Extended)		
	Owned	Rented	All	Owned	Rented	All
$0-$20k	0.3	4.0	2.0	0.2	4.7	2.2
$20-$40k	0.3	4.6	2.4	0	NA	6.3
$40-$60k	0.4	5.9	2.7	0.3	7.0	2.7
$60-$80k	0.2	4.3	0.9	0.3	5.7	1.6
$80-$100k	0.5	4.4	1.0	0.4	5.6	0.9
>$100k	0.5	6.6	0.9	0.5	8.3	0.9
ALL	0.4	4.7	1.6	0.3	8.8	1.5

NA cannot be calculated because both capital and energy costs are lower. 0 indicates that both capital and energy costs are higher, and there is no benefit.

Table 71 B/C ratios by Household Income, 20 years Truncated, Model C

	S2 (Rapid)			S3 (Extended)		
	Owned	Rented	All	Owned	Rented	All
$0-$20k	1.6	3.8	2.8	1.5	4.4	3.1
$20-$40k	1.7	4.7	3.4	1.9	NA	17.3
$40-$60k	2.7	5.9	4.7	2.9	6.9	5.2
$60-$80k	0.6	4.2	1.3	2.1	5.1	3.3
$80-$100k	1.3	4.5	1.9	1.2	5.3	1.8
>$100k	1.4	6.5	1.8	1.3	7.7	1.8
ALL	1.3	4.7	2.9	1.6	8.7	3.1

NA cannot be calculated because both capital and energy costs are lower. 0 indicates that both capital and energy costs are higher, and there is no benefit.

Table 72 B/C ratios by Household Income, 20 years Cohort, Model C

	S2 (Rapid)			S3 (Extended)		
	Owned	Rented	All	Owned	Rented	All
$0-$20k	2.3	4.4	3.5	2.3	5.1	3.8
$20-$40k	2.7	5.4	4.3	3.1	NA	21.7
$40-$60k	4.1	6.9	5.8	4.5	8.0	6.5
$60-$80k	0.9	4.9	1.6	3.1	5.9	4.2
$80-$100k	1.6	5.2	2.3	1.6	6.2	2.3
>$100k	1.7	7.5	2.2	1.7	8.9	2.2
ALL	1.8	5.4	3.6	2.3	10.1	3.8

NA cannot be calculated because both capital and energy costs are lower. 0 indicates that both capital and energy costs are higher, and there is no benefit.

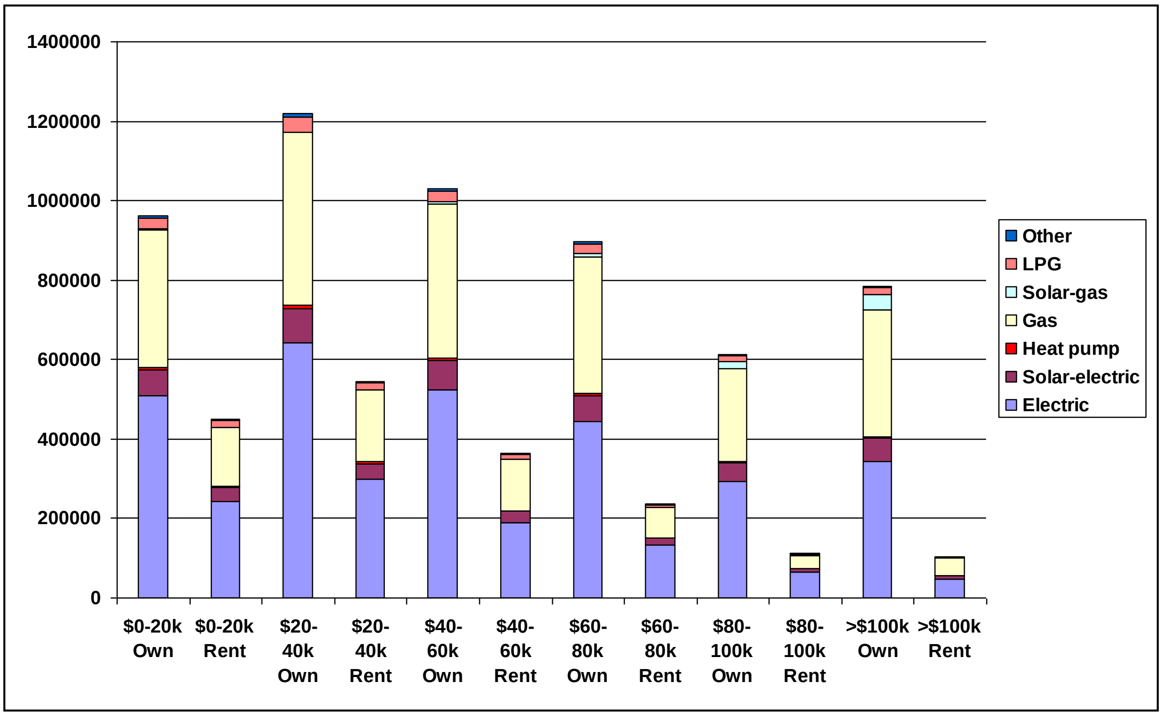


Figure 45 Number and type of water heater owned by households by income levels

Greenhouse impacts

Figure 46 shows the projected emissions under each main scenario. Emissions in the Business as Usual scenarios are projected to decline, mainly due to a continuing shift away from electric water heating but also partly because of falling average hot water use, the progressive demolition of pre-2011 houses and declines in the greenhouse gas-intensity of electricity supply.

Energy use in Model A and B is identical, but Model B BAU emissions are slightly higher than Model A, because the deferral of the CPRS means that emissions intensities fall more slowly. The BAU emissions baseline in Model C is somewhat lower than Model B, because higher electricity prices drive householders away from electric water heating more rapidly.

Model B in effect shows what would happen if buyers continued to behave as in the recent past. Model C simulates how the market would behave if buyers had foreknowledge of rapidly rising energy prices, but still discounted them heavily in favour of lower capital cost purchases. It is likely that buyers will continue to choose water heaters much as in the original modelling (i.e. Model A) for some time, until their electricity price expectations adjust to the new reality. The actual financial and greenhouse consequences of the choices will be determined by the energy costs and emissions intensities in Model C.

Given how infrequently householder are exposed to water heater purchases, it is likely that the water heater market will take about a decade to move from Model B behaviour to Model C. The 'interpolated' trend line in Figure 11 captures this shift. Model C, however, indicates significantly lower greenhouse savings despite the slightly higher emissions intensities, because the BAU Scenario in Model C shows more customers going to LPG and NG of their own accord, so the scope for further reduction via the phase-out is lower.

The projected emissions reductions peak in about 2020, when the last of the existing electric water in CL1 houses are replaced, and then begin to decline because new water heaters replace low-emissions rather than electric water heaters. Figure 47 to Figure 50 illustrate the projected emissions savings by jurisdiction under Models B and C, for the S3 (Extended) only. The projected emissions reductions are slightly less than under S2 (Rapid), because electric water heaters are permitted to remain in the stock for a further 2 years. The Interpolation trajectory is the one considered most likely.

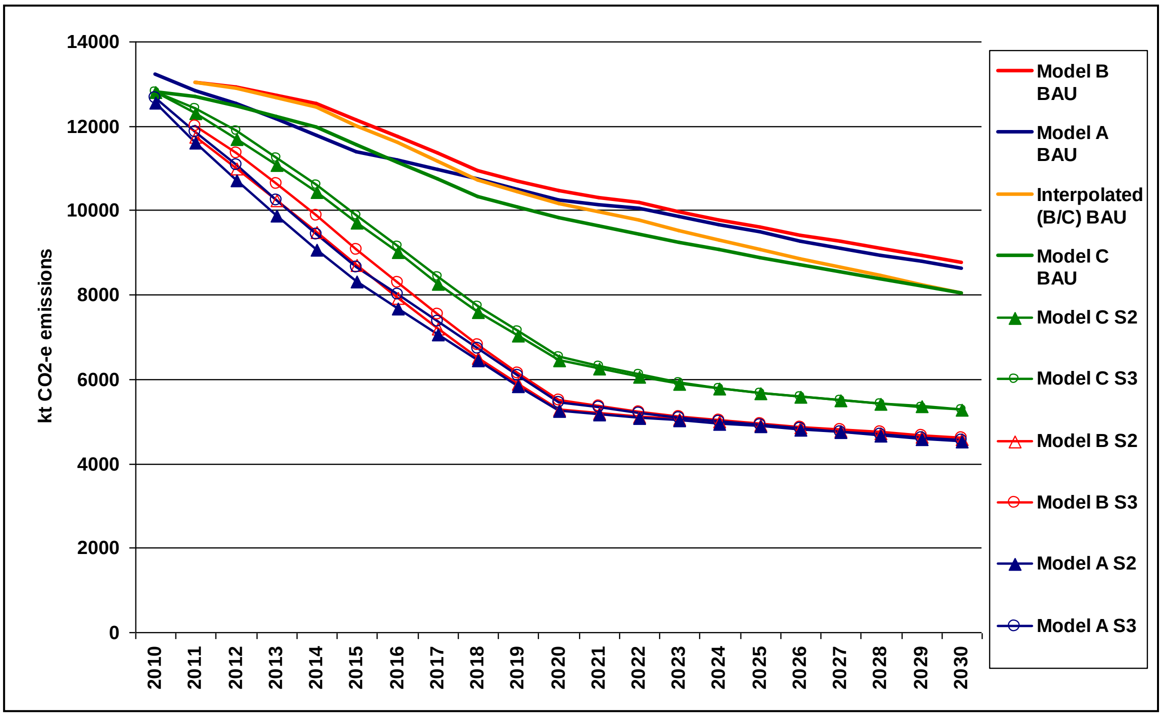
Table 73 Emissions and reductions in 2020 (Mt CO_2-e)

MODEL	A	B	C	Interpolated
S1 BAU	10.2	10.4	9.8	10.1
Mt CO_2-e Reductions compared with S1				
S2 Rapid	5.0	5.2	3.4	4.3
S3 Extended	4.8	4.9	3.4	4.2
% Reductions compared with S1				
S2 Rapid	49%	49%	34%	42%
S2 Extended	47%	47%	34%	41%

Table 74 and Table 75 summarises the emissions reduction by jurisdiction for S2 and S3. It covers the same periods as illustrated in the diagrams, so the savings are truncated at 2030. NSW and Queensland together account for between 68% and 78% of the national emissions savings, depending on the Model. In some Models Tasmania shows a negative saving, because higher-emissions natural gas or LPG would be substituted for electric water heaters, and by convention, electricity in Tasmania has been assigned a low emissions-intensity.

A preliminary assessment of the impacts of phasing out electric water heaters was included in the latest estimate of the Equipment Energy Efficiency Program (E3 2009). At that time the measure was provisionally called 'Greenhouse and Energy Mandatory Standards' (GEMS). Table 15 compares the impacts calculated in this RIS with the preliminary estimates and with the rest of the E3 program. This RIS estimates that cumulative greenhouse reduction to 2020 will similar to the preliminary estimate, and the impact in 2020 will be 16% higher.

Figure 46 Projected emissions, Models A, B, C



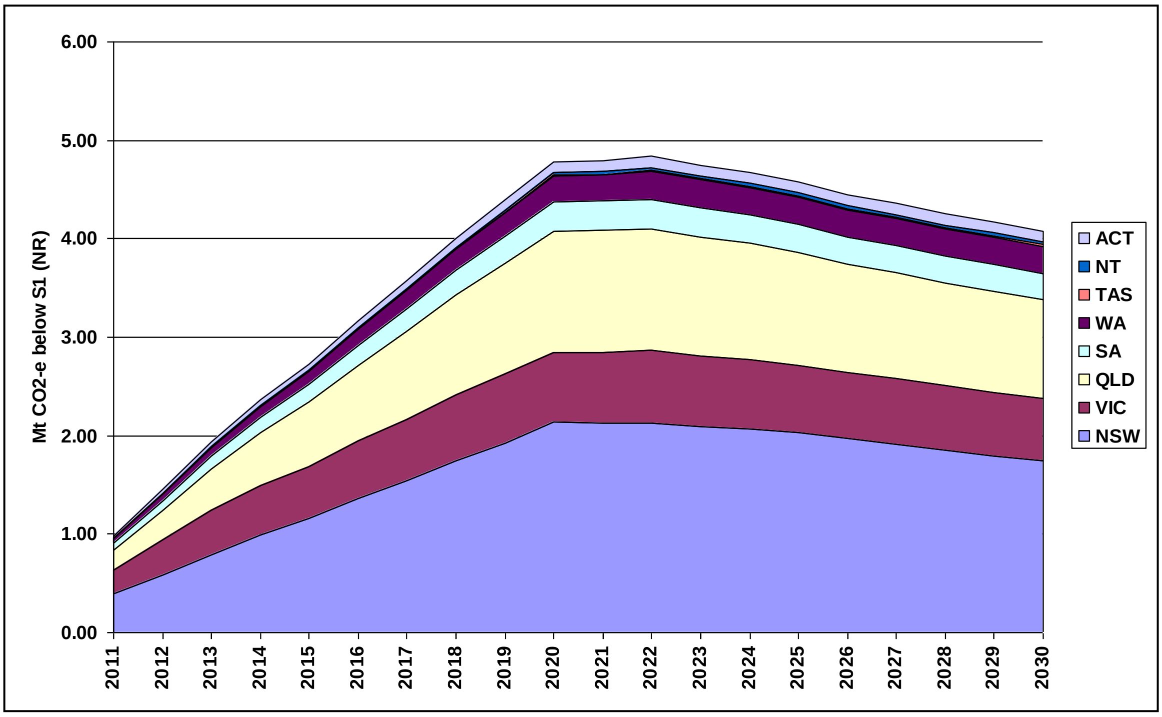


Figure 47 Projected reduction in emissions by jurisdiction, S3, Model A

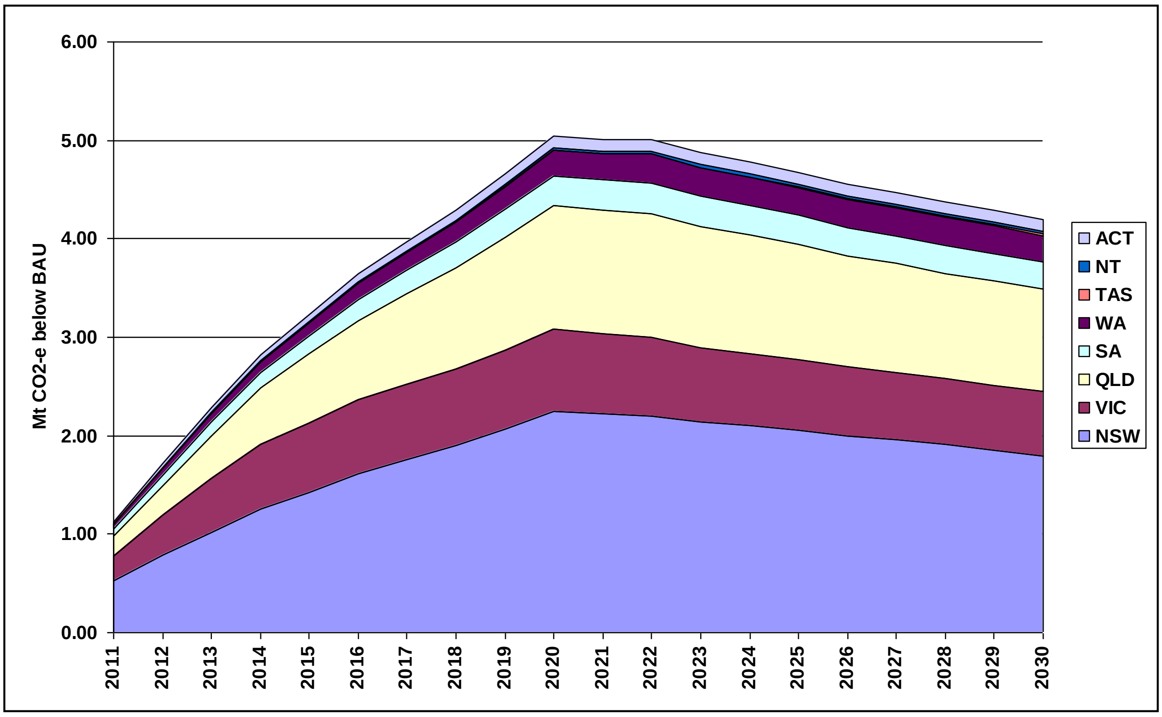


Figure 48 Projected reduction in emissions by jurisdiction, S3, Model B

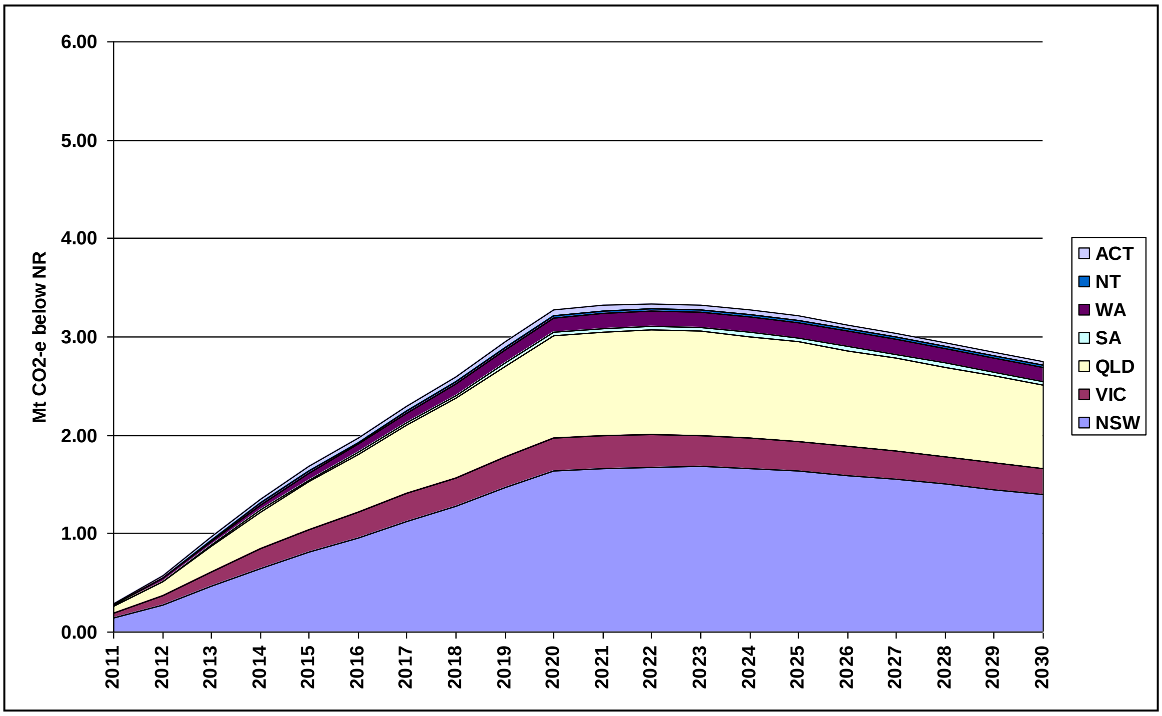
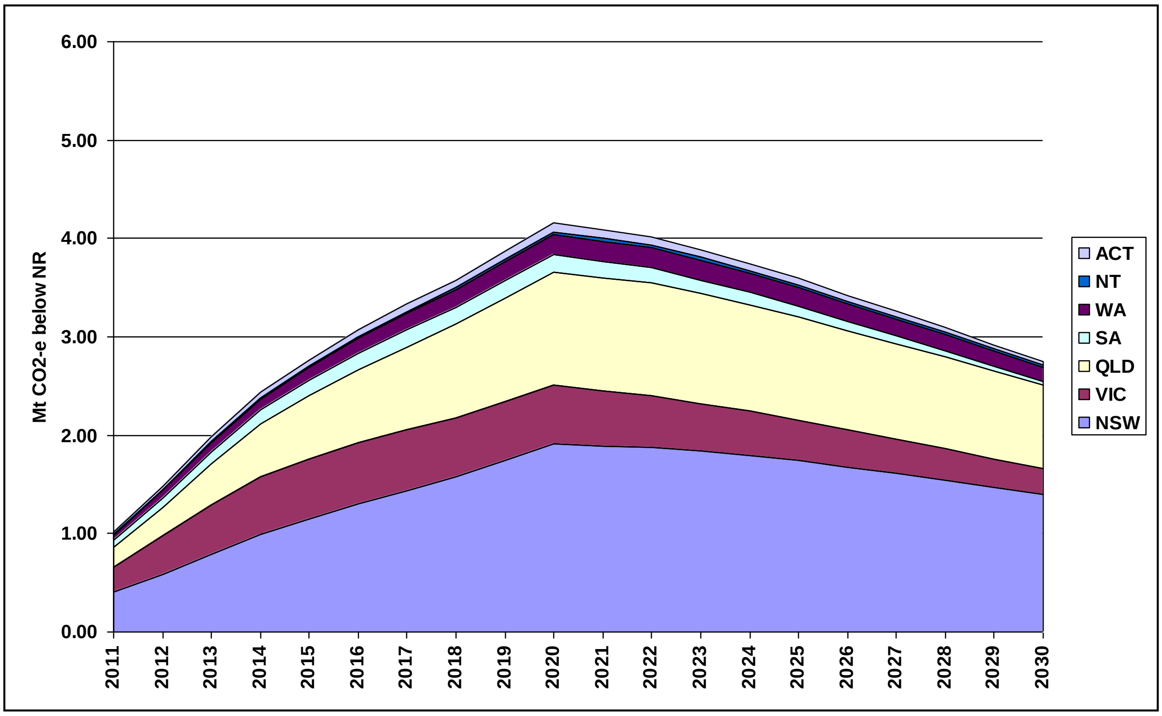


Figure 49 Projected reduction in emissions by jurisdiction, S3, Model C

Figure 50 Projected reduction in emissions by jurisdiction, S3, Interpolated (Model B,



Model C)

Table 74 Projected Emissions Reduction by Jurisdiction, C20, S2

	MODEL A		MOD B		MOD C		Interpolated (Mod B,C)	
NSW	43.2	43.8%	43.9	43.0%	31.7	49.0%	37.8	46.1%
VIC	15.9	16.2%	17.5	17.1%	6.5	10.0%	12.0	14.7%
QLD	24.8	25.2%	25.4	24.8%	19.5	30.1%	22.7	27.7%
SA	6.1	6.2%	6.4	6.3%	0.8	1.2%	3.2	3.8%
WA	5.6	5.6%	5.9	5.8%	3.0	4.7%	4.1	5.0%
TAS	NA	0.0%	NA	0.0%	NA	0.0%	NA	0.0%
NT	0.5	0.5%	0.6	0.6%	0.5	0.8%	0.5	0.6%
ACT	2.4	2.4%	2.5	2.4%	1.1	1.6%	1.6	1.9%
AUST	98.6	100.0%	102.1	100.0%	63.0	97.5%	82.0	100.0%

Table 75 Projected Emissions Reduction by Jurisdiction, C20, S3

	MODEL A		MOD B		MOD C		Interpolated (Mod B,C)	
NSW	41.3	43.5%	42.1	42.8%	32.4	50.1%	36.2	46.0%
VIC	15.6	16.4%	17.0	17.3%	6.6	10.2%	11.9	15.1%
QLD	23.5	24.7%	24.1	24.6%	20.2	31.2%	21.5	27.3%
SA	6.0	6.4%	6.3	6.4%	0.8	1.2%	3.1	3.9%
WA	5.5	5.8%	5.8	5.9%	3.1	4.8%	4.0	5.1%
TAS	NA	0.0%	NA	0.0%	NA	0.0%	NA	0.0%
NT	0.5	0.5%	0.5	0.5%	0.6	0.9%	0.5	0.6%
ACT	2.4	2.5%	2.5	2.5%	1.1	1.7%	1.6	2.0%
AUST	94.9	100.0%	98.3	100.0%	64.6	100.0%	78.7	100.0%

Fuel availability
The modelling indicates that under the maximum possible shift to fuel technologies, the household sector consumption natural gas and LPG combined would increase by up to 10 PJ per year by 2030. Australia is projected to remain a net exporter of both liquefied natural gas (LNG) and LPG throughout the modelling period. Consumption of natural gas within Australia is projected to grow by nearly 1,290 PJ/annum between 2008 and 2030 (ABARE 2010), so 10 PJ represent less than 1% of this growth. Neither is there likely to be any constraint on LPG availability, given that net exports are projected to increase from 41 PJ/yr in 2008 to 92 PJ/yr in 2030.[28]

While all States have local electricity generation sources, not all have local natural gas supplies. NSW imports nearly all of its natural gas from the Cooper Basin in SA and Queensland and from the Gippsland Basin in Victoria. In considering the availability of natural gas in NSW, the Independent Pricing and Regulatory Tribunal (IPART), noted:

> During the 2007-2010 regulatory periods, the limited transmission capacity to Sydney for winter 2008 acted as a major barrier to entry. However, capital works have since been undertaken to expand the pipeline capacity in NSW. Other significant developments in gas transmission infrastructure are also planned, including further capacity expansion, and new pipelines, including the Queensland to Hunter Gas Pipeline (QHGP) to connect Queensland coal seam methane fields with the Gunnedah basin and Newcastle.
>
> The significant investment and increased interconnection with new gas sources suggest that it is unlikely that access to upstream gas supplies or network infrastructure will act as a material constraint on market entry and expansion. This will also help the diversification of options available to retailers in terms of potential gas supply sources (IPART 2010).

From this it is concluded that natural gas and LPG availability would not be a constraint in the event of an increase in the demand for those fuels.

Water Consumption
In its submission on the Consultation RIS for Rheem, Access Economics (2010) stated that the cost of increased water use due to a shift from storage to instantaneous water heaters should be included in the costs of the proposed measure, and that 'more than one million households will increase their water usage by 8% to 10% due to wastage'.

Storage water heaters lose about 5 litres of water per day through their relief valves, due to the expansion of water as it is heated up. Instantaneous water heaters do not have expansion losses, but there is often some 'wastage' of the initial flow of water whenever the unit is turned on, because it reaches the user at less than the desired temperature. Water heater are also subject to 'pipe losses' from clearing the sub-temperature water between the water heater and the user. Due to size, flue or solar panel considerations, some water heater types can be installed closer to drawoff points than others, and so will have lower pipe losses, but for a given plumbing configuration pipe losses are the same irrespective of water heater type.

[28] There are however constraints on balancing imports and exports by geographical region and between automotive LPG, which is a mix of butane and propane, and propane for stationary use LPG.

If it is assumed that the main difference in water loss is due to the difference between the characteristics of storage and instantaneous types, then a policy which encourages more of one type than the other will impact on water consumption. Table 76 indicates that there could be 0.97 million more IWHs installed under the extended phaseout scenario S3 under Model B, and 1.51 million more under Model C.

Only a minority of the sub-temperature water produced by IWHs is actually wasted, because a large share of it goes to 'volumetric' uses such as filling basins, baths, clothes washers and dishwashers, where lower temperature water at the beginning of a draw-off is balanced by higher temperatures towards the end (or not mixing in as much cold). Estimates of the amount of hot water actually wasted vary widely, from about 2 kl/yr for all types of water heaters (Allen Consulting 2010) to 11 kl/yr for an IWH compared with a SWH (Table 77). The substitution of an IWH for a SWH could increase indoor water consumption by between 2.7% and 6.4% (and *total* water consumption by less).

Table 76 Projected SWH and IWH water heater installations, 2011-2020

	Model B			Model C		
	S1	S2	S3	S1	S2	S3
Storage	5856676	4895248	4881924	4973913	3370792	3458905
Instantaneous	1200013	2161441	2174765	1585704	3188825	3100712
Extra Instantaneous	NA	961429	974752	NA	1603121	1515008

Source : NIEIR modelling

Table 77 Estimates of hot water wastage of IWH compared with SWH

		Min	Max
IWH sub-temp water delivery (a)	litres/day	35	70
Wastage (50%) (b)	litres/day	17.5	35
SWH storage loss (a)	litres/day	5	5
Extra water loss	litres/day	12.5	30
Extra water loss	kl/yr	4.6	11.0
Increase in average indoor use (c)		2.7%	6.4%

(a) Szann (2010) (b) GWA (2004) (c) In relation to national annual average indoor use of 170 kl/yr (GWA 2010). Outdoor water consumption is highly variable from State to State.

Table 78 summarises the cost of the potential increase in water wastage due to the proposed measure, for water heaters installed between 2011 and 2020. Under Model B the NPV ranges from $M 86 to $M 207, or between 2% and 3% of the benefit of the energy saved. Under Model C the NPV ranges from $M 56 to $M 133, or between 3% and 8% of the value of energy saved. While these impacts cannot be ignored, they are within the general range of variability and uncertainty, and do not significantly impact on the magnitude or ranking of costs and benefits.

Table 78 Indicative cost of additional water consumption

	Model B		Model C	
	Min	Max	Min	Max
Extra GL (2011-2034) (a)	96.8	232.3	62.3	149.4
Extra $M water cost (b)	$184	$441	$118	$284
NPV Extra water cost (c)	$86	$207	$56	$133
NPV energy saving S3, 10C (d)	$4,248(d)	$4,248(d)	$1,647(e)	$1,647(e)
Water cost compared with energy saving	2%	5%	3%	8%

(a) For all Additional IWHs installed 2011-2020 (Table 76). (b) At $1.90/kl, undiscounted. (c) At discount rate of 7%. (d) See NPV Net benefit, 2011-20 C, Table 16.

Annexe 9 Stakeholder Impacts and Consultations

9.1 Electric Water Heater Manufacture

None of the manufacturers or importers of electric storage water heaters would be excluded from the market, because all of them supply one or more other water heater types (Table 79). The manufacture of electric and other types of water heaters is highly integrated, both commercially and technically. All mains pressure water heater types consist of one to three of the following basic components:

- A pressure tank for storing water; in electric, gas, LPG, heat pump, solar-electric and some solar-gas water heaters the primary or supplementary heat source is located in the tank. In some solar-gas units the tank has no heater of its own, but stores water pre-heated by solar for supply to the 'in-line' booster. Gas-heated storage water heater tanks differ from others in that they have a central flue;
- An instantaneous gas water heater (whether natural gas or LPG) on its own, or as an 'in line' solar booster;
- For solar water heaters, a solar collector array consisting of one or more flat plates or a manifold with between 10 and 30 evacuated tubes.

Solar or heat pump water heaters will also have additional components according to their design and configuration. Split solar designs have a solar controller and pump, which accounts for some electricity use in addition to the thermal boost energy. Electric heat pump water heaters have what amounts to a small air conditioning unit, either housed in the same casing as the tank or separate, and connected by refrigerant or water lines. Some also have an additional electric booster that operates at low temperatures.

Table 79 Complying product types made by electric water heater suppliers

Supplier and Brands	Solar-elect	Solar-gas	Gas Instant	Gas Storage	Heat Pump
Rheem,Vulcan, Aquahot, Panther, Paloma, Aquamax, Solahart, Edwards	✓	✓	✓	✓	✓
Dux, Radiant, Mercury	✓	✓	✓	✓	✓
Rinnai, Beasley, Suntech	✓	✓	✓	-	-
Saxon	✓	-	-	-	✓
Everlast (supply tanks to others)	-	✓	✓	-	-
Everhot, Reece	-	✓	✓	-	-
Chromagen (a)	✓	✓	✓	-	-

Source: Extracted by author www.energyrating.gov.au and supplier websites. (a) Only importer of water heater storage tanks; import range is restricted to the smaller volumes not used in solar configurations.

9.2 Additional Consultation Comments

Moreland Energy Foundation pointed out that the Residential Tenancies Acts in each jurisdiction could be used as a possible mechanism for ensuring that owners of rental households do not introduce LPG as a low-capital way to comply. It also advocated the mandatory adoption of water-efficiency measures at time of water heater replacement.

Most respondents nominated a type or types of water heater which they see as a problem (Table 80). The reasons appear to be either commercial (i.e. the 'problem' type is a direct competitor), based on electricity network impacts (contribution to peak demand, loss of energy revenue) or, in the case of private respondents, negative experiences with installation of solar water heaters.

The Gas Industry Alliance (GIA), ENA and ALPGA submissions indicated that the energy efficiency of heat pumps was overstated and the running costs understated (backed by analysis by Pitt+Sherry). The GIA also proposed slightly different service life assumptions (without supporting evidence).

Table 80 'Problem' water heaters nominated by respondents

Respondent	'Problem' types nominated	Stated (or probable) reason
Dux	LPG; instantaneous	(LPG competes with HP; imported instant. competes with locally-made storage)
Endless Solar	HP; gas, 'low-quality' solar	(all types compete with this supplier's evacuated tube solar products)
Stiebel Eltron	Gas	(Competitor with HP)
Country Energy	HP, solar	Potential peak load issues; poor performance of HP in colder areas
Integral	HP, solar	Potential peak load issues
Envestra	HP	(Competitor with gas)
Plumbers SA	Solar	'Plumbers don't like installing it'
Individuals	Solar	Incorrect installations
ENA, GIA, APA	HP	Potential peak load issues; poor performance of HP in colder areas
Rheem	LPG; instantaneous	(LPG competes with HP; imported instant. competes with locally-made storage)
Ergon	HP, solar	Potential peak load issues
Energex	HP, solar	Potential peak load issues
APA Group	HP	(Competitor with gas)

Other issue raised:

- Dux recommends that electric water heaters installed indoors be exempted. [Response: as this covers 22% of electric water heaters, it would seriously reduce the effectiveness of the measure].
- It should be permitted to replace an electric instantaneous with another. [Response: administratively complex with little practical gain].
- A condition of RECs eligibility should be that the supplier is prepared to give a 10 year guarantee. [Response: beyond scope of this RIS].
- To encourage solar water heaters for smaller homes, the '20 REC minimum' criterion for access to rebates should be relaxed. [Response: REC rules are beyond the scope of this RIS].
- Non-metro electricity networks need longer adjustment time because of need to plan for supply system changes (e.g. SWER lines, voltage taps on transformers). [Response: States are best placed to consider local issues in adjustments to timing].
- Rebates (for solar or HP) should not be offered to household which have access to gas. [Response: rebate issues are beyond the scope of this RIS].
- Other hot water saving measures should also be mandated: relocate HWS to reduce plumbing runs, install pipe lagging and low-flow shower heads. [Response: beyond the scope of this RIS].

- Households with grid-connected renewables should be exempt. [Response: this is considered and rejected earlier in this Decision RIS].
- Address poor information in home audits that recommends replacing gas water heaters with solar water heaters. [Response: this Decision RIS recommends that a public information program proceed, but not the content of that program].
- Publicise ‘advance signs of failure.’ [Response: there are no known ‘advance signs’].

9.3 Water Heater Component Manufacture

If each storage tank, solar collector ‘array’ (each array could be 2 panels) and each instantaneous gas/LPG water heater and solar/gas in-line booster is treated as a single ‘component’ for manufacturing purposes, it is possible to estimate the total number of major components required under each scenario. In Model B (favouring solar and heat pump) 7.8 million new components would be required between 2011 and 2020 in the No Regulations scenario (S1), 9.0 million in S2 and 8.9 million in S3 (Table 81). In Model C (favouring gas and LPG) it is 7.1 million in S1, 7.3 million in S2 and 7.3 million in S3 (Table 82).

Local manufacture supplies the entire market for gas storage water heaters, which would gain significantly under S2 and S3. Gas storage will be advantaged by the fact that some conversions from electric to gas water heating will be in houses with existing gas connections, which may be unable to cope with the high MJ/hr gas flow capacity needed by IWHs. Of course, all new gas connections will be higher capacity.

Local manufacture supplies almost the entire market for storage pressure tanks, so although there is no significant import competition it could lose some production if the market gain by locally made solar and heat pump units is less than the market loss from the phase-out of electric units.

Two types of solar collectors dominate the solar market: flat plate collectors, which are mostly locally made, and evacuated tubes which are now all imported. Under Model B it is projected that the demand for solar collector arrays would be about 174% higher than S1 under S2 and 159% higher under S3. Under Model C the demand for solar collector arrays would be about 35% higher than S1 under both S2 and S3.

The extent to which local manufacturers could maintain or increase their share of a growing solar market would depend on their ability to maintain panel sales against evacuated tubes, and to compete against imported panels. There are signs that this is likely to be the case: in June 2009 Rheem announced an expansion of solar water heater manufacturing at Welshpool (Perth) and Rydalmere (Sydney).[29]

There is also significant heat pump manufacture in Australia by Rheem, Dux and Saxon (Table 79). In late 2009 Dux and Saxon increased production capacity and manufacturing employment.[30] Specialist heat pump importers include Stiebel Eltron (based in Germany). Quantum Energy Limited and Siddons Solarstream used to manufacture locally but now import heat pumps from China.

[29] http://www.economicstimulusplan.gov.au/infocus/pages/if_300709_rheem.aspx
[30] http://www.economicstimulusplan.gov.au/infocus/pages/if_011009_solar.aspx

Table 81 Projected demand for water heaters and components 2011-2020, Model B

	S1 BAU	Share	S2 Rapid	Change from S1	S3 Extend	Change from S1
Electric storage	3809750	54%	0	-100%	219963	-94%
Gas storage	808116	11%	1129635	40%	1151707	43%
Gas instant	987697	14%	1380666	40%	1407642	43%
Solar-elec	537748	8%	1455878	171%	1373096	155%
Heat pump	371434	5%	1226526	230%	1087806	193%
Solar-gas (in-tank boost)	15592	0%	44439	185%	42171	170%
Solar gas (in-line boost)	140324	2%	399953	185%	379536	170%
LPG storage	173713	2%	638816	268%	627646	261%
LPG instant	212315	3%	780776	268%	767123	261%
Total	7056689	100%	7056689	0%	7056689	0%
Total storage tanks	5716352		4495295	-21%	4502388	-21%
Total gas instant units	1340337		2561394	91%	2554301	91%
Total solar arrays	693664		1900270	174%	1794802	159%
Total Major Components	7,750,353		8,956,959	16%	8,851,491	14%

Table 82 Projected demand for water heaters and components 2011-2020, Model C

	S1 BAU	Share	S2 Rapid	Change from S1	S3 Extend	Change from S1
Electric storage	2893607	45.2%	143549	-95%	293804	-90%
Gas storage	1022678	16.0%	1420062	39%	1417244	39%
Gas instant	1249939	19.5%	1735632	39%	1732187	39%
Solar-elec	355164	5.5%	354335	0%	353998	0%
Heat pump	28329	0.4%	63159	123%	63945	126%
Solar-gas (in-tank boost)	15695	0.2%	33351	112%	33330	112%
Solar gas (in-line boost)	141253	2.2%	300162	112%	299969	112%
LPG storage	315878	4.9%	1061414	236%	996362	215%
LPG instant	386073	6.0%	1297284	236%	1217776	215%
Total	6408614	100.0%	6408949	0%	6408614	0%
Total storage tanks	4631349		3075871	-34%	3158683	-32%
Total gas instant units	1777265		3333078	88%	3249931	83%
Total solar arrays	512111		687849	34%	687297	34%
Total Major Components	6920725		7096797	3%	7095911	3%

9.4 Consultation Participants

Brisbane attendees [29], 15 February 2010:	John Phillpotts, Energex
Murray Craig, Solar Centre	Steve Whittle, Energex
Adrian Hart, MPAQ	Bob Graham, McLennan Magasanik Associates
Graham Jones, Qld Dept Infrastructure & Planning	Bill Watson, MPAQ
Joe DeArporut, Solahart Industries	Lisa In, resident
Ian Martin, Elgas Ltd	Esther Biest, BCQ
Glenn Day, Stiebel Eltron	Nicola Christopherson, BCQ
Ranioro Guarnieri, Stiebel Eltron	Chris Harris, BCQ
Lachlan Duff, Kleenheat Gas	Gary Lemmon, Rinnai
John Perren, Elgas Ltd	Tony Pfeiffer, Ergon Energy
Steve Kevin, Robert Bosch	Michael Sachs, Saxon
Kel McNamara, KLM Energy Service	Matthew Rockson, Energex
Josh Hankey, APA Group	Kathryn Mellick, QUT
Rachel Leaver, Energex	David Thompson, Ergon Energy
Claire McIndie, Energex	Mark Paterson, Energex

Canberra attendees [6], 10 February 2010:	**Darwin attendees [13], 16 February 2010:**
Stephen Rush, Elgas	James Brohier, NT Dept Lands & Planning
Warring Neilson, Elgas	Peter Hadfield, NT Dept Lands & Planning
Michael Roberts, Elgas	Lachlan Cooke, NT Dept Construct. & Infrastructure
Len Place, Dux	Mal Reichie, NT Dept Primary Industries
Les Blackley, Retired Plumbing Teacher	Anita Rhook, Rhooky's Plumbing
Larissa Cassidy, DRET (Committee member)	Peter Naylor, Excel NT
	Des Martin, Architectural Water Solutions
Sydney attendees [17], 11 February 2010:	Craig Mulligan, NT Dept Construc. & Infrastructure
Wayne Elliott, Country Energy	Janese Walkley, Solahart/Rheem
Chris Dalitz, Country Energy	Brian Petrie, H P Design
Bob Cook, Country Energy	Robin Smith, NT Worksafe
Simon Terry, Dux Hot Water	Ray Simpson, CDU Plumbing Dept
Karl Morrison, Endless Solar	M Sloane, NT Chief Minister's Dept
Ian Maloney, Elgas Ltd	**Perth attendees [11], 18 February 2010:**
Robert Simpson, Energy Australia	John Moss, Rheem Australia
L J Loch, Quantum	Anna Huband, Office of Energy
Doug Thompson, NFEE Program Manager	Sam Coughlan, RET Australia
Matt Jackson, Dux Hot Water	John Lees, Australian Fieldwork
Peter Harcus, Jemena	Aaron Pilgrim, Aircommand Aust
Steve Swann, Solahart	Karl Bach, EPA
Tim Aldrich, Industry & Investment NSW	Danellis Jones, Building Commission
Joyce Fu, Ethnic Communities Council	Angela Heymans, Building Commission
Barney Maph, Efficient Living	Mike Read, Plumbers Licensing Board
Rob Beggs, Daikin	Graeme Cantelo, Plumbers Licensing Board
Alan Law, Rheem Aust Pty Ltd	Chris Moynihau, Elgas
Melbourne attendees [25], 12 February 2010:	**Adelaide attendees [26], 19 February 2010:**
Robert Van Aken, Microheat Technologies	Michael Seneca, Edwards Solar Hot Water
David Spree, AGL Energy	Chris Goode, Solahart Industries
Frank Dunch, Green Invest	Andrew Collini, Quantum Energy Technology
Ross Brierty, Green Invest	Vince Devellis, Aquamax
Peter Gavin, Reece	Mark Zeitz, TAFE SA
Nilanga De Silva, Essential Services Commission	Shirley Trebilcock, Housing SA (DFC)
Alistair Munro, private	Corinna Pereira, Housing SA (DFC)
Matt Bailey, Solahart	Romano Edgar, Dux
Govind Mettsay, MEFL	Ron Lenhart, Housing SA (DFC)
Palen Young, Primaform	Don Sims, TAFE SA
Andrew Nielson, Ceramic Fuel Cells Ltd	Glen Holder, DTEI Energy Division
Mark Donaldson, Going Solar	Kay McBryde, consumer
Mike Bids, independent	Louis Visintin, Maesbury Plumbers
David Paws, Etrog Consulting	Wayne Margitich, Rheem Australia
Michael Llewelyn, Envesrta/APA Group	Charles Shergold, Rinnai Australia
Cheyl Perrett, AFS	Dominic Beshard, Hills Solar
Jo Patterson, PIC	Craig Potter, Dux
Debra Wilson, PIC	Rod Gilman, TAFE SA
Kyle Garland, DSE	Craig de Laine, Envestra
Hazel Williams, public	Matt Sexton, Rheem Australia
Ellen Clarke, public	Andrew Clarke, PIA
Bruce Easton, Ecovantage	Paul Worthington, PIA
Tony Westmore, ACOSS	Lean Pendlebury, Rinnai
Ruta Kanape, householder	Jacqui Nathan, Training Prospects
Maria Cugnetto, Utility Metering Association	Patrick Benness, Gasworks Salisbury
	Peter Gayen, APA Group