Queensland

Petroleum and Gas (Production and Safety) Amendment Regulation (No. 4) 2011

Regulatory Impact Statement for* SL 2011 No. 242

made under the

Petroleum and Gas (Production and Safety) Act 2004

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* Under the *Statutory Instruments Act 1992*, section 46(1)(h), a regulatory impact statement (RIS) need not be prepared for proposed subordinate legislation if it only provides for, or to the extent it only provides for, a matter involving the adoption of an Australian or international protocol, standard, code, or intergovernmental agreement or instrument, if an assessment of the benefits and costs has already been made and the assessment was made for, or is relevant to, Queensland.

A RIS was not prepared for the above item of subordinate legislation on the basis that it provides for the adoption of an Australian Standard however a RIS was prepared for the Equipment Energy Efficiency Committee, which reports to the Ministerial Council on Energy, in relation to the subject matter.

The RIS prepared in relation to the subject matter may be viewed at the following site—

http://www.ret.gov.au/Documents/mce/_documents/quicklinks/Gas_Water_Heater_RIS.pdf

Copies of the RIS provided to the Queensland Government are attached.

Regulatory Impact Statement

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Proposal to Introduce a Minimum Energy Performance Standard for Gas Water Heaters

Issued by the Equipment Energy Efficiency Committee under the auspices of the Ministerial Council on Energy

26 October 2009

This Regulatory Impact Statement was prepared by Syneca Consulting for the Equipment Energy Efficiency Committee. This Committee reports to the Ministerial Council on Energy, comprising the energy ministers of the Australian federal, state and territory governments, and of the New Zealand government.

Melanie Slade
Chair, Equipment Energy Efficiency Committee
Department of Environment, Water, Heritage and the Arts

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Glossary

AGA	Australian Gas Association
AGO	Australian Greenhouse Office
AS/NZS	Australian Standard/New Zealand Standard
BAU	business as usual
CfAF	Council for the Australian Federation
COAG	Council of Australian Governments
CO_2-e	carbon dioxide equivalent
CPRS	Carbon Pollution Reduction Scheme
DPMC	Department of the Prime Minister and Cabinet
EES	Energy Efficient Strategies Pty Ltd
EF	energy factor
E2WG	Energy Efficiency Working Group
E3	Equipment Energy Efficiency Program
GAMAA	Gas Appliance Manufacturers Association of Australia
GANZ	Gas Association of New Zealand
GHG	greenhouse gas
GiWH	gas instantaneous water heater
GJ	gigajoules – 10^9 joules
GsWH	gas storage water heater
GWA	George Wilkenfeld and Associates Pty Ltd
GWH	gas water heater
HWS	hot water system
IEA	International Energy Agency
kL	kilolitre
kt	kilotonne
L	litres
MCE	Ministerial Council on Energy
MEA	Mark Ellis & Associates
MED	Ministry of Economic Development
MEPS	minimum energy performance standard
MMA	McLennan Magasanik Associates Pty Ltd
MoU	Memorandum of Understanding
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NETT	National Emissions Trading Taskforce

NGACs	NSW Greenhouse Abatement Certificates
NZEECS	New Zealand Energy Efficiency and Conservation Strategy
OBPR	Office of Best Practice Regulation
MJ	megajoules – 10^6 joules
Mt	megatonnes – 10^6 tonnes
NGS	National Greenhouse Strategy
PJ	petajoules – 10^{15} joules
REC	renewable energy certificate
SEAV	Sustainable Energy Authority Victoria (now Sustainability Victoria)
SEGWHAI	Super Efficient Gas Water Heating Appliance Initiative
SKM	Sinclair Knight Merz
TJ	terajoules – 10^{12} joules
TTMRA	Trans Tasman Mutual Recognition Agreement
USEPA	US Environmental Protection Agency
UNFCCC	United Nations Framework Convention on Climate Change
VHK	Van Holsteijn en Kemna – consultants to the European Commission for the Eco-Design for Water Heaters project
WPM	with proposed measures
WoSM	without specific measures
WSM	with specific measures

Executive summary

This is a regulatory impact statement (RIS) for a proposal to introduce minimum energy performance standards (MEPS) for domestic gas water heaters (GWH) in Australia and New Zealand. The RIS has been prepared by the Equipment Energy Efficiency Committee (E3 Committee) under the Ministerial Council on Energy (MCE) of the Australian federal, state and territory governments and the New Zealand Government.

A consultation RIS was released for public comment in August 2008[1]. Suppliers of gas storage water heaters (GsWH) objected strongly to the main proposal in the consultation RIS, which would have required storage WH to have a minimum energy rating of 5 stars. Suppliers of gas instantaneous water heaters (GiWH) were more accepting of the proposal. In response to the comments on the consultation RIS, E3 now proposes MEPS at 4 stars.

MEPS will ensure that the worst performing products (in terms of energy consumption) are either modified to improve their energy efficiency or replaced with more efficient products. But there will continue to be effective competition between suppliers and between GsWH and GiWH. Substantial energy savings can be realised by adopting MEPS at the proposed level, for specified types of domestic gas water heaters.

Proposal
E3 proposes to implement MEPS that require GWH to achieve a minimum energy rating of 4 stars, from October 2010, which is an option that is acceptable to all affected suppliers. A star rating label will be needed on all GWH covered by the proposed MEPS. Currently, efficiency labels are only required in Australia – they will become mandatory on both Australia and New Zealand. AS4552 will become a joint Australian and New Zealand standard (AS/NZS 4552).

The labelling regime has applied to GWH in Australia since 1988, as defined by AS4552, *Gas fired water heaters for hot water supply and/or central heating*. GWH are rated from one to six stars. Each additional star denotes a 7% reduction (improvement in efficiency) in energy consumption relative to a baseline of one star. For example, a 1 star unit uses 28,900 MJ of energy per year. The reductions for 5 star and 6 star are 28% and 36%, corresponding to 20,808 MJ/year and 18,785 MJ/year respectively.

The least efficient of the GWH on the market have 3 stars and the best products are now off the scale at almost 7 stars. (E3 recognises the need to reform the labelling provisions to better reflect the range of efficient GWH on the market. Industry would also like to have labelling to show the difference efficiencies between the storage and instantaneous technologies. However, labelling reform will be considered at a later time and is not included in the current proposal.)

This RIS reports on four MEPS options. The proposed MEPS at 4 stars is ‘option 1’ (22,831 MJ) and is most favoured by industry. This RIS also reports assessments for MEPS at 5 stars, 5.2 stars and 5.5 stars – denoted options 2, 3 and 4 respectively. Option 2 (5 stars) would also be implemented from October 2010. Option 3 (5.2 stars) is in two stages, with MEPS at 4 stars from October 2010 and the higher MEPS from October 2013; and similarly for option 4 (5.5 stars).

The proposal applies only to products that are designed for residential and small commercial applications. Specifically excluded are products that fall outside the scope of the existing gas labelling requirements or are primarily designed for use in caravans,

[1] Available at http://www.energyrating.gov.au/library/details200807-ris-gwh.html

mobile homes and recreational vehicles. These products will be considered for later inclusion in the MEPS regime.

GsWH that are installed internally have also been excluded, pending further consideration of the availability of affordable replacements that are significantly more energy efficient.

Option 2 is the option that E3 has worked towards over several years. It has been the focus of most discussion with suppliers. Options 3 and 4 have not been formally tested with suppliers and E3 has less confidence in its assessment of these options.

This proposal has been delayed by the process of assessing and revising the energy rating test, which was found to lack rigor and to be unreliable. E3 expects a new test procedure to be finalised in early 2010 and proposes that there be transition arrangements that allow continued manufacture and importation to existing ratings for a limited period.

The problem addressed by the regulation

The proposal is an element of the Equipment Energy Efficiency Program (known as E3), which is an element in the energy efficiency and climate change strategies of both Australia and New Zealand. The program is jointly managed and funded by the Australian Commonwealth, state and territory governments and the New Zealand Government. More efficient products means less demand for energy leading to increased security of supply and ultimately lower carbon emissions.

Significant impediments exist at the household level for better uptake of more efficient gas water heaters, and this stops both countries from making real inroads into carbon abatement and reducing demand on energy supply. Energy accounts for about 74%[2] of the life-cycle costs of heater operation, but households need to perform a reasonably sophisticated calculation to understand its significance and determine the value of higher efficiency, involving estimates of energy use, energy prices, asset lives and discount rates. Replacement heaters are often purchased in circumstances where the existing heater has failed and the household is without hot water; the heater may be purchased on the user's behalf by a builder or landlord who is concerned only to minimise the capital cost; and, unlike whitegoods, consumers can seldom inspect water heaters and their energy labels on the shop floor.

In these circumstances, regulatory intervention can deliver cost effective energy saving and greenhouse abatement. Table EX.1 reports indicators of the scale of the issue, taking the period to 2020 as the 'analytical horizon'. In this period, Australians will install about 1.9 million GWH that could be made more efficient by at least one of the MEPS options, and they will generate about 28.2 Mt CO_2-e on a whole-of-life basis, that is, before the last of them is retired from service, sometime in the late 2030s. In the same period, New Zealanders will install about 190,000 GWH that could be made more efficient by at least one of the MEPS options, and they will generate about 2.3 Mt CO_2-e on a whole-of-life basis. But the New Zealand mix is different, since there is much greater penetration of GiWH than in Australia and GiWH are more energy efficient.

The emissions in absence of MEPS are about 0.5% and 0.36%, for Australia and New Zealand respectively, of the total emissions that are expected in the period 2011 to 2020.

[2] The details of this calculation are provided on page 16 of the RIS.

TABLE EX.1 WHOLE-OF-LIFE GREENHOUSE EMISSIONS IN THE ABSENCE OF MEPS, FROM GWH THAT ARE EXPOSED[1] TO AT LEAST ONE MEPS OPTION

Type of water heater	GsWH		GiWH			Total
Energy rating category, pre-MEPS[2]	*3 stars*	*5-5.2 stars*	*4 stars*	*5-5.2 stars*	*5.2-5.5 stars*	
Australia						
Sales of GWH that are exposed to MEPS[1], 2010-20[3] ('000)	718.3	223.7	12.3	573.9	373.2	1,901.3
Gas consumption (PJ)	155.6	53.2	2.9	127.7	81.6	421.1
Emissions (Mt CO_2-e)	10.4	3.6	0.2	8.6	5.5	28.2
New Zealand						
Sales of GWH that are exposed to MEPS[1], 2010-20[3] ('000)	0.433	2.234	0.43	115.73	75.90	194.7
Gas consumption (PJ)	0.094	0.532	0.103	25.756	16.602	43.1
Emissions (Mt CO2-e)	0.005	0.028	0.005	1.373	0.885	2.3

Notes:
1. By focussing on sales of GWH that are "exposed to at least one MEPS option" we put aside any GWH that do not fall within scope of the any MEPS option. These are existing stocks of GWH, any sales of GWH that will occur before the MEPS can be introduced, including carry-over and subsequent sale of supplier stocks that are unsold at the time of implementation, and sales of GWH with such high energy ratings (5.5+ stars) that they will not be affected by any MEPS option.
2. The energy ratings are pre-MEPS, which means that product breakdowns are in terms of the energy ratings that would be observed in the absence of MEPS.
3. For the purposes of the assessment the MEPS are assumed to expire in 2020, putting the focus on sales in the period to 2020. But note that some of the GWH that are purchased in this period will remain in operation until the mid-2030s and our estimates of costs, energy use and emissions are on whole-of-life basis, until the retirement of all GWH that are purchased in the period to 2020.

The objective

The objective is to cost-effectively reduce energy consumption and greenhouse gas emissions to levels below those projected under a business as usual scenario, by improving the energy efficiency of domestic gas water heaters. Measures that do not increase the life-cycle cost of appliances are considered to be cost-effective. This means that, for the householder, the value of the energy savings is equal to or more than the incremental purchase price of a more efficient appliance.

There are several related considerations.

- Consumers need to adjust to prospective increases in the cost of energy, for example, arising from Australia's Carbon Pollution Reduction Scheme and a similar pricing mechanism in New Zealand.
- New Zealand needs to avoid becoming a 'dumping ground' for inferior products, which may happen if Australia adopts the measures but New Zealand does not.
- The measures need to be efficiently designed, minimising adverse impacts on suppliers and on product quality and function. The measures also need to be clear and comprehensive, minimising potential for confusion or ambiguity for users and suppliers.

Policy alternatives

The proposed measures are specific to a particular group of water heating technologies. One alternative is to forego any such specific intervention and rely instead on generic or cross-sectoral policies such as emissions trading or broad-based information and educational approaches. This option is implicitly included in the assessment since it defines the 'base case', or what is projected to happen in the absence of specific measures.

It is recognised that there will be some increase in efficiency in the base case, without measures. Specifically, it is assumed that GiWH will continue to increase their market share at the expense of less efficient GsWH, and that the energy efficiency of GiWH will continue to improve. Already, 25% of GiWH models are at 5.5 stars of better and are therefore not exposed to any of the MEPS options. It is assumed that Australians will purchase 356,000 of these GWH in the period to 2020, with whole-of-life emissions of 5.1 Mt CO_2-e. New Zealanders are assumed to purchase 73,000 GWH with the higher ratings, and generate emissions of 1.0 Mt CO_2-e. These sales are not included in table EX.1.

Other options for specific intervention have also been considered but not assessed in detail. They have been screened out for the following reasons.

- Specific information and education programs can complement MEPS but are not an effective substitute. Labelling is the strongest instrument but is largely invisible to consumers in the case of water heaters.
- There is no realistic prospect that other regulatory forms – such as self-regulation or regulation by industry bodies – will be effective. Experience teaches that suppliers engage most effectively with the E3 Program when there is the prospect of regulation by 'black letter' law.

Hence, E3's impact analysis has been framed to compare the four MEPS options with the baseline scenario.

Impact analysis

Table EX.2 summarises the main finding from the impact analysis. Note that impacts are expressed as changes in quantities of interest. For example, the value of energy savings is expressed as a reduction in energy expenditure, that is, a negative number.

For Australia, E3 finds that:

- Option 1 is beneficial, with net benefits of $A124 million and a benefit-cost ratio of 6.3.
- Option 2 delivers significant additional benefits. The benefit/cost ratio is lower but the key number is the net present value, which is higher.
- Option 3 is superior to option 1 but inferior to option 2. However, this is only because the move to 5+ stars is delayed to 2013, not because of any inherent negative effect. Our incremental analysis indicates that the move from 5 stars to 5.2 stars is financially neutral at worst.
- Option 4 returns the highest net present value.

The high returns to MEPS at 5.2 or 5.5 stars are because GiWH can achieve these levels of efficiency at relatively low cost. However, E3 has less confidence in its assessment that GsWH can be cost-effectively raised to these levels of efficiency, and without major disruption to existing industry structures. There are no GsWH on the market with energy ratings that exceed 5.2 stars.

For New Zealand, E3 finds that:

- Options 1 and 2 provide very small benefits. The MEPS would affect only a small number of 3-star external GsWH, about 400, and a similar number of external GiWH that would otherwise have energy ratings of 4 stars. Most of New Zealand's stock of 3-star GsWH is installed internally and has been excluded from the MEPS.

- Despite the small benefits, the GWH industry is keen to have MEPS and labelling aligned with Australia so that the NZ market does not become a 'dumping ground' for less efficient appliances (i.e. market regression or undercutting).
- Options 3 and 4 are more attractive for New Zealand, since they bring GiWH within scope of the MEPS, and these dominate the New Zealand market.

The same caveats apply to options 3 and 4 in New Zealand and Australia, regarding the feasibility of GsWH at better than 5.2 stars, but carry much less weight in New Zealand because the sales of these products are very small and declining.

The measures contribute 1 to 3 Mt CO_2-e to abatement in Australia, depending on the option, but are much more variable in New Zealand, where the range is 600 to 95,000 tonnes CO_2-e. These contributions are small in relative terms, in the range 0.02% to 0.05% of Australia's expected emissions in 2011-20, and 0.0001% to 0.0150% of New Zealand's expected emissions in 2011-20.

TABLE EX.2 IMPACT ANALYSIS, BY MEPS OPTION

MEPS option	*Option 1*	*Option 2*	*Option 3*	*Option 4*
2010 MEPS	*4-star*	*5-star*	*4-star*	*4-star*
2013 MEPS	*no change*	*no change*	*5.2-star*	*5.5-star*
Australia				
Sales exposed to MEPS, 2010-2020 ('000)	718.3	730.5	1,528.1	1,901.3
Lifetime energy				
gas consumption (PJ)	-17.13	-31.41	-31.87	-43.43
emissions (Mt CO_2-e)	-1.149	-2.106	-2.137	-2.913
Lifetime expenditure, present value ($M)				
cost to the taxpayer	0.37	0.37	0.37	0.37
business compliance costs	0.65	0.65	0.65	0.65
incremental cost of water heaters	22.2	79.8	79.0	126.9
household expenditure on energy	-147.1	-269.6	-256.9	-337.4
total	-123.9	-188.8	-176.9	-209.4
Investment analysis				
net present value ($M)	123.9	188.8	176.9	209.4
benefit/cost ratio	6.3	3.3	3.2	2.6
New Zealand				
Sales exposed to MEPS, 2010-2020 ('000)	0.43	0.87	118.8	194.7
Lifetime energy				
gas consumption (PJ)	-0.0104	-0.0256	-0.4729	-1.7804
emissions (Mt CO_2-e)	-0.0006	-0.0014	-0.0252	-0.0949
Lifetime expenditure, present value ($M)				
cost to the taxpayer	0.05	0.05	0.05	0.05
business compliance costs	0.00	0.00	0.00	0.00
incremental cost of water heaters	0.04	0.13	1.84	6.82
household expenditure on energy	-0.15	-0.35	-4.90	-18.10
total	-0.06	-0.16	-3.01	-11.23
Investment analysis				
net present value ($M)	0.06	0.16	3.01	11.23
benefit/cost ratio	1.6	1.9	2.6	2.6

Sensitivity analysis
E3 has conducted sensitivity analysis for a wide range of plausible variations in underlying assumptions and consider that the findings are robust. This includes examination of impacts on typical households under realistic operating conditions.

Response to stakeholder feedback
E3 considers that the option 1 will be broadly acceptable to industry. It addresses the issue that has been most contentious, which is the impact of 5-star MEPS on the continued viability of GsWH production in Australia and New Zealand.

The other issues that were raised in the consultation process were of secondary importance. But E3 will respond appropriately as resources permit. For example:

- E3 reviewed and revised some costing parameters. The most significant was to adopt more realistic estimates of hot water usage.
- E3 is aware of the importance of the energy labelling arrangements to some suppliers and is committed to reforming these arrangements.
- Issues of timing have been addressed by deferring implementation to October 2010.
- E3 notes the on-going concern about the adequacy of the compliance enforcement effort.

Recommendations
E3 recommends the adoption of option 1, which is to implement MEPS at 4 stars from October 2010.

1 The problem

This Decision Regulatory Impact Statement (RIS) assesses the benefits of a proposal by the Equipment Energy Efficiency (E3) Committee to mandate minimum energy performance standards (MEPS) for gas water heaters (GWH). A RIS is required whenever new or more stringent mandatory measures are proposed by government. Under guidelines agreed by all Australian jurisdictions and New Zealand, product regulation is undertaken only where the benefits outweigh the costs to the community. In this case, the cost of improving the energy efficiency of GWH needs to be outweighed by the energy and greenhouse gas emissions savings over the life of these appliances.

This document includes E3's responses to stakeholder comment on the consultation RIS that E3 published in August 2008[3]. The submissions and responses are summarised in chapter 6.

1.1 Energy efficiency policy in Australia and New Zealand

This regulatory proposal cannot be assessed in isolation; it forms part of a co-ordinated response by governments to undertaking regulatory measures for any energy-using product that are cost-effective and meet agreed environmental and energy goals.

Australia
Australia's greenhouse abatement and climate change policies have evolved steadily since the release of the National Greenhouse Response Strategy in 1997. The paper received overall bipartisan support, including support for national energy efficiency measures.

On 11 March 2008, Australia's ratification of the Kyoto Protocol was officially recognised by the United Nations Framework Convention on Climate Change (UNCCC). Under Kyoto, Australia is obliged to limit its greenhouse gas emissions in 2008-2012 to 108 per cent of 1990 emission levels. The Australian Government has also released a report demonstrating how Australia intends to measure the reductions in emissions required under Kyoto titled Australia's Initial Report under the Kyoto Protocol.

In October 2008, the Council of Australian Governments (COAG) agreed to develop the National Strategy for Energy Efficiency, to accelerate energy efficiency efforts across all governments and to help households and businesses prepare for the introduction of the incoming Carbon Pollution Reduction Scheme (CPRS). Streamlined roles and responsibilities for energy efficiency policies and programs will be agreed in early 2009. The strategy will be implemented by June 2009, ensuring that programs assisting households and businesses to reduce their energy costs are in place before the CPRS is introduced.

Most recently, the CPRS White Paper stated that:

> *Energy efficiency is the final piece of the emissions reduction strategy. Energy use is the key driver of emissions growth in Australia. The Renewable Energy Target and CCS will reduce the emissions produced and released in generating energy, but there is also considerable scope to increase the efficiency of energy use. Using energy more efficiently can significantly reduce the cost of greenhouse gas abatement and ease the transition to a low-carbon economy ...*
>
> *There are several impediments to the uptake of energy efficiency measures, including gaps in the information available to households and businesses to make*

[3] Available at http://www.energyrating.gov.au/library/details200807-ris-gwh.html

> *informed decisions. By becoming more energy efficient, households can reduce the cost impacts of the Scheme. Prior to the commencement of the Scheme, the Government will deliver household energy efficiency initiatives building on existing programs.* (CPRS White Paper, Dec 2008, Vol 2, page 110)

New Zealand's policy context
The MEPS and labelling program is expected to reduce the energy use of products sold in New Zealand and in doing so:

- Reduce overall national energy demand - This will:
  - Result in enhanced security of supply and decreased need to invest in new energy supply infrastructure.
  - Reduce the need to run fossil fuelled generation – particularly during periods of high demand or supply shortage,
  - Make it easier for New Zealand to achieve its target of 90% renewable electricity generation by 2025 – by reducing the absolute amount of renewable electricity required to meet the target.
- Reduce energy costs to consumers in households, businesses and transport as a result of lower appliance and product operating costs.
- Provide consumers with the means to make more informed purchase decisions by allowing comparison of energy use between similar products and by allowing for running costs to be considered alongside the upfront purchase costs
- Help New Zealand to meet its international greenhouse gas emissions reduction commitments at least cost to the taxpayer
- Help energy users to better manage the impact of future energy prices, which are likely to incorporate a price on greenhouse gas emissions and reduced availability of cheap supply options
- Improve the productivity and competitiveness of New Zealand businesses (through the use of energy efficient equipment)

The MEPS and labelling programme also:

- Improves the competitiveness and marketability of businesses that supply products to markets that are driven by growing consumer demand for products with lower carbon/greenhouse footprints (through the supply of energy efficient products)
- Gives manufacturers, suppliers and retailers the means and incentive to market energy efficient products
- Gives manufacturers, suppliers and retailers the confidence to invest in the development and marketing of even more energy efficient products - by raising standards of minimum product energy performance and labelling over time.

New Zealand and the response to climate change
The New Zealand Emissions Trading Scheme has been designed and legislation was passed in September 2008. The newly elected Government has established a special select committee to review[4] the Scheme and related climate change matters in order to build a broader consensus on how to make more effective progress on climate change issues.

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) details specific work streams to achieve the goals of the New Zealand Energy Strategy (NZES) – including a focus on better products as part of a range of initiatives to improve end-use energy efficiency in the residential, commercial and industrial sectors[5]. The current review

[4] The terms of reference for the review can be found at parliament's website at www.parliament.nz/en-NZ/SC/Details/EmissionsTrading/.
[5] The NZEECS can be viewed at: http://www.eeca.govt.nz/sites/all/files/nzeecs-07.pdf. The NZES can be viewed at: http://www.med.govt.nz/upload/52164/nzes.pdf

of the NZES will put more emphasis on the government's priorities of increasing economic growth and energy security.

The MCE moves beyond 'No Regrets' energy efficiency measures
In October 2006, the Ministerial Council on Energy (MCE) of Australian federal, state and territory and New Zealand energy ministers agreed to new criteria for assessing new energy efficiency measures. The MCE replaced its previous 'no regrets' test (that a measure have private benefits excluding environmental benefits which are greater than its costs) with the criteria that the MCE would consider *...new energy efficiency measures which deliver net public benefits, including low-cost greenhouse abatement measures that do not exceed the cost of alternate measures being undertaken across the economy*.

This policy means the MCE will consider new regulatory measures that may have net up-front costs but have greater private economic and greenhouse benefits over the long term.

Equipment Energy Efficiency Program
The proposed regulation is an element of the Equipment Energy Efficiency Program (E3), formerly known as National Appliance and Equipment Energy Efficiency Program (NAEEEP). E3 embraces a wide range of measures aimed at increasing the energy efficiency of products used in the residential, commercial and manufacturing sectors in Australia and New Zealand. E3 is an initiative of the MCE, comprising ministers responsible for energy from all jurisdictions, and is an element of both Australia's National Framework for Energy Efficiency (NFEE) and the New Zealand Energy Efficiency and Conservation Strategy. It is organised as follows:

- Implementation of the program is the direct responsibility of the Equipment Energy Efficiency Committee (referred to as the E3 Committee), which comprises officials from Australian federal, state and territory government agencies and representatives from New Zealand. These officials are responsible for implementing product energy efficiency initiatives in the various jurisdictions.
- The E3 Committee reports through the Energy Efficiency Working Group (E2WG) to the MCE and is ultimately responsible to the MCE.
- The MCE has charged E2WG to manage the overall policy and budget of the national program.
- The Australian and New Zealand members of the E3 Committee work to develop mutually acceptable labelling requirements and MEPS. New requirements are incorporated in Australian and New Zealand Standards and developed within the consultative machinery of Standards Australia.
- The program relies on state and territory legislation for legal effect in Australia, enforcing relevant Australian Standards for the specific product type. National legislation performs this task in New Zealand.

To be included in the program, appliances and equipment must satisfy certain criteria relating to the feasibility and cost effectiveness of intervention. These include potential for energy and greenhouse gas emissions savings, environmental impact of the fuel type, opportunity to influence purchase, the existence of market barriers, access to testing facilities, and considerations of administrative complexity. Policy measures are subject to a cost-benefit analysis and consideration of whether the measures are generally acceptable to the community.

E3 provides stakeholders with opportunities to comment on specific measures as they are developed by issuing reports (including fact sheets, technical reports, cost-benefit analyses and regulatory impact statements) and by holding meetings. Regulation of gas water heaters has been discussed with suppliers for many years.

1.2 Profile of gas water heaters

Product technologies[6]
Two water heating technologies fall within the scope of the proposed measures: storage heaters and instantaneous or continuous heaters.

Gas storage water heaters (GsWH) Gas storage water heaters consist of an insulated tank with typical storage capacities ranging from 90 to 260 litres, a gas burner at the base of the tank to heat the water, and a heat exchanger/flue that usually rises through the centre of the storage tank. When a hot water tap is turned on, cold water enters the bottom of the tank, displacing hot water through an outlet at the top of the tank. Re-heating of the water inside the tank is controlled by a thermostat.

Gas instantaneous water heaters (GiWH) Gas instantaneous water heaters do not have a tank to store heated water and so are more compact than storage systems. When a hot water tap is turned on, cold water flows into the unit and a high-powered gas burner is ignited, generally by means of a continuously burning pilot or some form of electronic ignition (either mains powered or powered independently). The units currently available have rated hot water deliveries of up to 32 litres/minute (based on a temperature rise of 25°C), depending on their intended application.

Advanced water heating technology has created a distinction between conventional and condensing gas water heaters. Condensing technology extracts so much heat from the flue gasses that they cool to the point of forming a condensate. This involves the use of secondary heat exchangers in GiWH and spiralling heat exchangers in GsWH. There are also intermediate configurations that have been labelled ‘near-condensing’ or ‘advanced non-condensing’. USEPA says that near-condensing and condensing water heaters reduce energy consumption by up to 30% relative to conventional GsWH that are available in the US[7].

Bosch introduced the first condensing GiWH to Australia and New Zealand over recent years.

Product standards and labelling - Australia
Energy labelling is a mandatory part of GWH certification in Australia and is organised as follows.

> *... All states require ... certification before any mass-produced domestic appliance can be made available for sale or installation, therefore energy labelling (and compliance with MEPS) of nominated gas appliances is mandatory. The Standards require the label to be affixed in a prominent position on the appliance, but this does not extend to point-of-sale display.*
>
> *The gas water heater label scales were revised in 1988, and the label underwent a minor review of star presentation in 1999 to allow display of part star ratings. A recent revision of the test methodology for instantaneous water heaters is effective from 21 March 2003.* (AGO 2003: page 17)

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[6] Much of the technical, market and impact information that is presented in the remainder of this chapter is drawn from the following documents.

- *Energy labelling & minimum energy performance standards for domestic gas appliances*, Report to SEAV compiled by a team led by Mark Ellis and Associates, November 2002
- *Driving Energy Efficiency Improvements to Domestic Gas Appliances*, AGO Discussion Paper, July 2003
- *NFEE - Energy efficiency improvement potential case studies, residential water heating,* Report to SEAV by George Wilkenfeld and Associates, February 2004

[7] From ENERGY STAR website, 29 July 2009
http://www.energystar.gov/index.cfm?c=gas_cond.pr_savings_benefits

Annual energy consumption is determined according to the test method defined in Australian Standard *AS4552 – Gas fired water heaters for hot water supply and/or central heating*. This originated as a test procedure of the Australian Gas Association that was developed in the 1980s and was first published by Standards Australia as *AS4552* in 2000. The most recent edition was published in December 2005 and this was expanded to cover safety requirements for boilers. The majority of GWH have been tested to the 2000 edition of the standard. The standard covers all aspects of these products including safety, performance, MEPS and energy labelling.

AS4552 does not apply to GWH with a gas consumption rate in excess of 500 MJ/hour (for example, extremely large instantaneous units). The effect is to eliminate water heating equipment that is designed for large commercial and industrial applications, many of which are likely to be specially configured or designed for specific applications and would not be regarded as mass-produced products.

The Australian Gas Association (AGA) is the major certifier of GWH in Australia and publishes selected details in its *Directory of AGA Certified Products*, including date certified, model name, annual energy consumption, star rating and the type of gas. The website of a second certifier, SAI Global, reports similar details for a small number of GWH. A third certifier, the Queensland Gas Association, has yet to certify any GWH under *AS4552*.

The certifiers reported 187 certifications at the time of writing, comprising 66 GsWH and 121 GiWH. However, we excluded the following from consideration.

- GWH not subject to energy tests: The energy testing and labelling requirements of *AS4552* do not apply to GsWH with gas consumption in excess of 50 MJ/hour, or to GiWH models with gas consumption in excess of 250 MJ/hour. The effect is to confine the energy testing and labelling regime to GWH that are designed primarily for residential and small commercial applications, removing about 7% of the entries from AGA's lists of certified GsWH and GiWH. (AGA does not report energy ratings for two other product categories – gas-boosted solar water heaters and the boilers for that are used for some combination of central heating and water heating – indicating that these products do not fall within scope of the energy testing and labelling requirements.)
- GWH for caravans and mobile homes: Five of the GsWH are for small water heaters that are designed for use in caravans and mobile homes. These are excluded from consideration because (a) it is unclear whether the existing energy testing procedures of *AS4552* can be confidently applied to the small storage units, (b) the options of improving efficiency at reasonable cost are severely constrained by the lack of space in recreational vehicles and (c) E3 regulations for other product types are normally for products used in stationary applications.
- Obsolete and duplicate certifications: We eliminated entries for appliances that are no longer sold, based on examination of product lists from supplier websites and follow-up calls to sales staff. We also took that opportunity to identify and remove duplicate entries where possible, that is, where the same model is rebadged for marketing reasons and appears two or more times in the certified list.

The revised list contains 32 entries for GsWH appliances and 57 entries for GiWH appliances. Figures 1.1 and 1.2 show the distribution of energy consumption and star ratings for appliances on the revised list, separately identifying appliances that are designed for external and internal installation. The significance of this distinction is that (a) the fluing arrangements for internally installed GsWH may constrain the ability to extract more heat from the flue gases and limit options for increasing energy efficiency, and (b) there can be significant additional costs of replacing internally installed storage units with more efficient units.

FIGURE 1.1 STANDARDISED ENERGY CONSUMPTION OF <u>EXTERNALLY INSTALLED</u> GWH, BY TYPE AND DATE OF CERTIFICATION

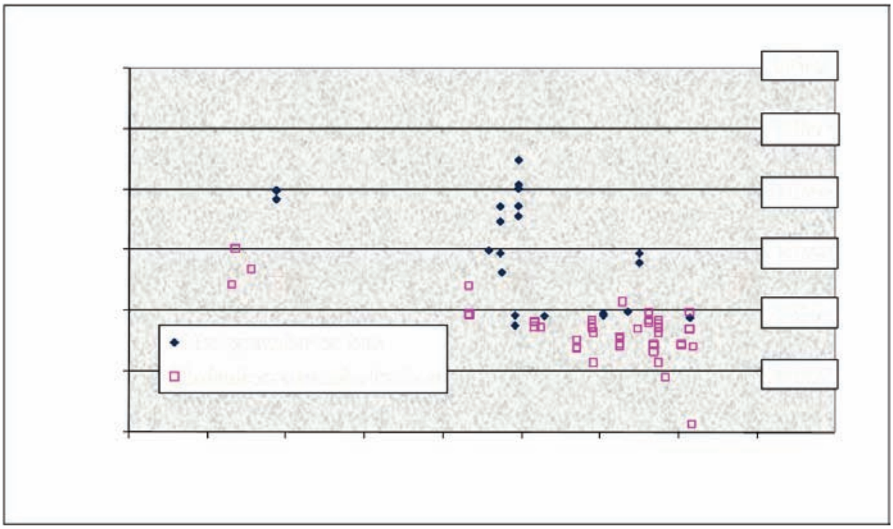
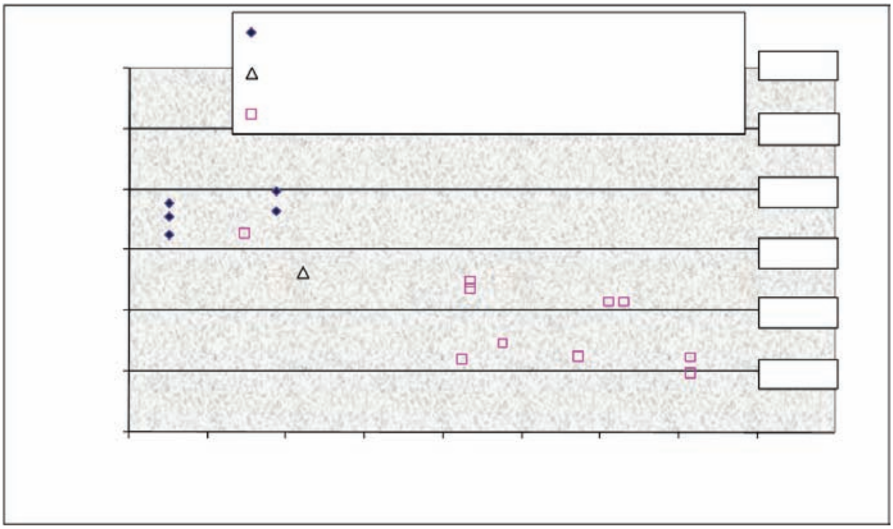


FIGURE 1.2 STANDARDISED ENERGY CONSUMPTION OF <u>INTERNALLY INSTALLED</u> GWH, BY TYPE AND DATE OF CERTIFICATION



Regarding the interpretation of figures 1.1 and 1.2, note that:

- The labelling requirements of *AS4552* refer to a heater that is assumed to consume 28,900 MJ/year to perform the standardised heating task, which is to deliver 37.7 MJ/day of hot water or 13,761 MJ/year. This is the energy needed to deliver 200 litres/day of hot water at a temperature rise of 45°C. Any GWH returning a test result of 28,900 MJ/year, or more, is assigned one star. The task efficiency of a reference GWH is 47.6% (=13,761/28,900).

- The rating scale provides for up to six stars, in equal step reductions of 2,023 MJ/year, which is 7% of the reference level. Thus, the highest rating of 6 stars is achieved when the energy consumption is reduced by 35% relative to the reference heater (= 5 steps * 7%), reducing energy use to 18,785 MJ/year and raising task efficiency to 73.26% (=13,761/18,785).
- The older certification dates can be misleading. Some suppliers retain the original certification numbers and dates when upgrading their models, possibly for administrative simplicity. There are certainly cases where models have been redesigned for greater efficiency but the original certification numbers and dates have been retained.
- Comparison of recent editions of the AGA product directory indicates that the certifications for a number of 4-star GsWH have been revived. All three of the main GsWH suppliers – Aquamax, Dux and Rheem – have 4-star certifications.
- Two suppliers recently introduced GiWH that would qualify for more than six stars. The suppliers are Bosch (6.9 stars) and Rinnai (6.1 stars). However the current labelling arrangements impose a maximum of six stars.

External appliances account for 82% of the entries in the truncated list of certified appliances, split about 35:65 between storage and instantaneous models. The simple average[8] of their star ratings is 4.8 stars, with GsWH and GiWH averaging 3.9 stars and 5.2 stars respectively. 83% of the GiWH are 5 stars or more, but only 25% of the GsWH – see figure 1.1. Most certifications since 2000 have been at 5 stars or better, with the recent exception of two GsWH that were registered in 2006 with 4.1 and 4.2 stars and older four star units that have been re-registered over the last 6 months.

Internal appliances account for 18% of the certifications, split about 40:60 between GsWH and GiWH. The unweighted average of their star ratings is 4.5, with mains pressure GsWH and GiWH averaging 3.4 stars and 5.2 stars respectively. There is a single GsWH of the gravity feed type that is installed in the ceiling of a house, with a rating of 4.4 stars. Five of the 16 internal appliances have 5 stars, all being GiWH. Another four internal appliances have 4.5-5 stars, all GiWH. All GsWH of the mains pressure type have less than 4 stars and 80% are less than 3.5 stars.

Most GiWH certifications date from the late 1990s and coincide with the application of computer technology to GiWH, with many providing precise temperature control to the user, modulating gas burners and therefore much lower minimum flow rates. These developments remedied two weaknesses of the first generation of GiWH – the early heaters did not ignite until a significant flow rate was achieved and, once ignited, the water temperature varied with the water flow.

There is a cluster of GiWH with certification dates from the mid-1980s and with energy ratings in the range of 4-4.5 stars. These seem to be the only remaining GiWH with permanent pilot ignition. The elimination of a permanent pilot light, which ignites the burner on demand but burns continuously itself, offers a significant energy saving. It can be replaced with electronic ignition, battery ignition or a device that uses the flow of water to generate a spark on demand.

Product standards and labelling – New Zealand

The New Zealand Building Code requires that GWH installed in new dwellings meet the requirements of New Zealand Standard NZS4305:1996, which refers to AGA102 for the method of measurement. The requirements are:

- GWH with 200 litres of storage or more shall have a minimum conversion efficiency of 70% and a maximum gas consumption rate of 1.26 MJ/hour in standby mode.

[8] The simple average is potentially misleading because it is not sales weighted.

- Smaller GWH shall have a minimum conversion efficiency of 75% and a maximum gas consumption rate of 0.97 MJ/hour in standby mode.
- Gas instantaneous water heaters shall have a minimum conversion efficiency of 75%.

The energy efficiency of GWH is not otherwise regulated or publicly disclosed in New Zealand. However suppliers must declare that appliances comply with safety regulations and declared appliances are listed on the website of Safety New Zealand. Our assessment of energy efficiency was informed by matching New Zealand's declared products with the products that have been certified in Australia, which provides the energy ratings. We also consulted with individual suppliers of unmatched products.

We conclude from this review that the range of GWH on the New Zealand market is similar to that in Australia.

Suppliers of gas water heaters
GsWH are manufactured in both Australia and New Zealand, and all but one of the GsWH certifications are from the three suppliers – Rheem, Dux and Aquamax. The remaining certification is for a small Perth-based company that seems not to be a going concern.

The bulky nature of GsWH means that high transport costs tend to limit opportunities for import competition. But New Zealand imports a small number of GsWH, mainly from Australia, and we have anecdotal evidence that hot water storage tanks are sometimes imported to Australia.

In contrast, the vast majority of GiWH are imported, mainly from Japan. Bosch and Rinnai have the longest history in this market, particularly Bosch. Dux and Rheem have obtained certifications for a range of these products since the late 1990s. Two Japanese suppliers, Tagaki and Chofu, have certifications dating from 2006 and 2007 respectively, and are now marketing products under several brand names. Bosch, Rinnai and Rheem appear to be the major suppliers to both the New Zealand and Australian markets, and market the same range of products in both markets.

There are also smaller Australian suppliers of GiWH that assemble units from imported components. Two of these operate from Melbourne and Sydney – Douglas & Company and Servgas – and supply small markets for internal replacement units in flats. Primo-Tech is a new entrant to the GiWH market. It has manufacturing facilities in Perth and made its first sales in 2007/08.

There are two small New Zealand importers, Abergas and What Power Crisis. Abergas imports a small range of GiWH and GsWH brands that are owned by Paloma. Paloma is the Japanese multinational company that owns Rheem.

Overall, there are 12 suppliers to the Australian market, one supplying GsWH only, eight supplying GiWH only, and three supplying both. There are five suppliers to the New Zealand market, three supplying GiWH only and two supplying both. The New Zealand suppliers are either owned by multinational companies or dealerships for such companies.

1.3 GWH stocks and sales

1.3.1 Australia

This section presents projections for stocks and sales of GWH in Australia in the absence of any further specific measures to increase the energy efficiency of GWH and reduce emissions. We refer to these as WoSM projections and distinguish between WoSM and WSM projections.

- *WoSM scenarios* are scenarios for future energy use and emissions 'Without Specific Measures', but including the efficiency promoting effects of Australia's CPRS and other greenhouse policies that are not specific to particular energy end-uses such as water heating.
- *WSM scenarios* are scenarios for future energy use and emissions 'With Specific Measures', including the effects of not only non-specific measures but also measures that are specific to particular end uses.

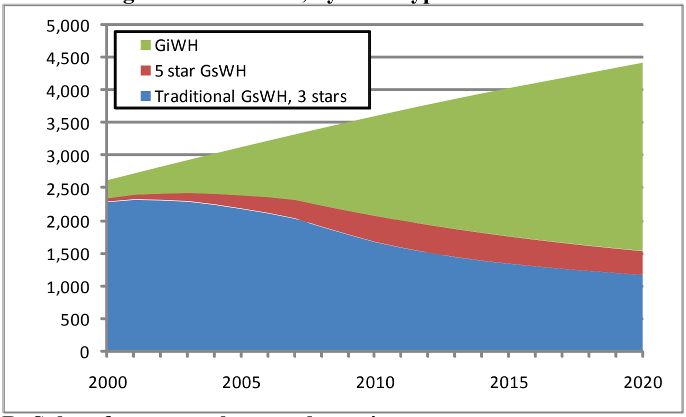
Figure 1.3 presents our WoSM projections for stocks and sales of GWH in Australia. Note the following:

- The projection for the stock to GWH (panel A of figure 1.3) is that reported in the recently published national baseline study of residential energy use (EES 2008). The stock of GWH is projected to increase by 26% from 3.5 million in 2009 to 4.4 million in 2020. This is mostly the consequence of a growing population. GWH penetration increases marginally from 41.6% of households in 2009 to 43.6% in 2020.
- GWH sales increase less sharply, by 12.5% from 288,000 in 2009 to 324,000 in 2020. This reflects a slower growth in GWH after a long period of high growth in penetration, in the 30 years to 2020.
- Three broad types of GWH are distinguished in panels A and B. The first is the traditional GsWH with a 3-star energy rating that dominated the market until the mid 1990s. GiWH had only a small market share, reflecting unattractive aspects of their performance, particularly in terms of temperature and flow control. The application of electronics to GiWH from the mid-1990s not only dealt effectively with these functional concerns but also improved energy efficiency, resulting in the rapid expansion of the market for GiWH over the last decade. The earlier models were at the 4-star level but the majority are now at 5 stars. GsWH suppliers responded by introducing GsWH with 5-star energy ratings.
- The outlook is for further improvements in the energy efficiency of GiWH. Almost a quarter of GiWH models are rated at 5.5 stars or better, including two models at about 6.1 stars and one at 6.9 stars. We assume that these will a significant minority share of the market in 2020 – see panel C of figure 3.1.
- In contrast, GsWH suppliers say that there is no immediate prospect of increasing the energy efficiency of GsWH beyond the level of 5.2 stars. Hence our WoSM scenario is for there to be (a) a relatively small and steadily declining market for 5-star GsWH, reflecting the dominance of GiWH in markets for the most efficient GWH, and (b) a market for 3-star GsWH that also declines steadily.
- It seems that the 4-5 star portion of the market would be entirely vacated under WoSM conditions. All GsWH suppliers have registered 4-star models with AGA but none are actually supplied. (As noted earlier, some 4-star registrations that had been cancelled have now been re-registered, possibly in preparation for MEPS at 4 stars). There is a small market for 4-star GiWH that are installed internally but suppliers say that these are now being phased out and replaced with internal GiWH at 5 stars or better.

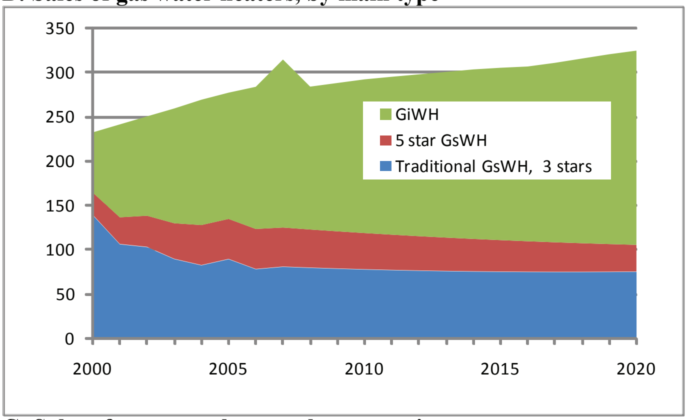
Overall, the outlook is for a bimodal GWH market comprising a 3-star segment that is entirely GsWH and a 5-star segment that is dominated by GiWH. The split is roughly 25%:75% in the period 2010 to 2020 – or 800,000 at 3 stars and 2.5 million at 5 stars or better.

FIGURE 1.3 PROJECTED STOCKS & SALES OF GAS WATER HEATERS: AUSTRALIA, WITHOUT SPECIFIC MEASURES ('000)

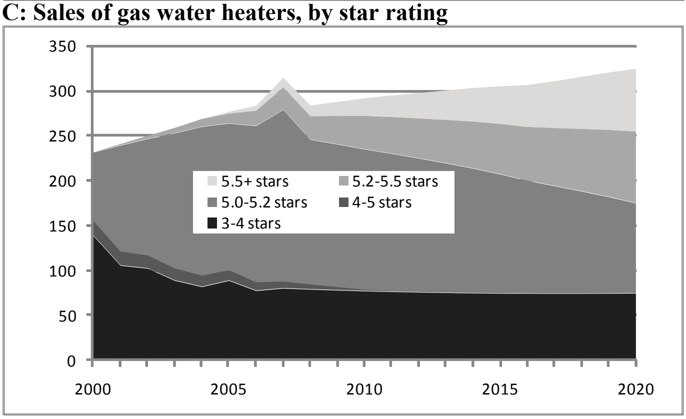
A: Stock of gas water heaters, by main type



B: Sales of gas water heaters, by main type



C: Sales of gas water heaters, by star rating



Mix of external and internal GWH
The significance of the distinction between internally and externally installed GWH is that improving the efficiency of internal GWH presents additional challenges for manufacturers and installers, and additional costs for households. We have spoken to all significant suppliers of internal GWH, of both the storage and instantaneous type, and understand that internal GWH are for niche markets that number in the several hundred or several thousand per year. Total sales are about 8,000 a year, roughly comprised as follows:

- Internal GsWH of the mains pressure type, replacement only – 3,250/year.
- Internal GsWH of the gravity feed type (installed in ceilings, replacement only) – 250/year.
- Small internal GiWH of the 'under-sink' type, replacement only – 500/year.
- Other internal GiWH for replacement purposes – 2,000/year.
- Internal GiWH in new and refurbished dwellings (only where it is not feasible to install an external unit) – 2,000/year.

The sub-markets for the replacement of obsolete products are in decline. Total sales of all internal GWH may be of the order of 50,000 over the period 2010-20, which is 1.5% of the cumulative tally for GWH, 3.3 million. Implicitly, the vast majority of GWH sales will be for externally installed units.

Uncertainties
The projections reported in this RIS are a revised version of the projections that were reported in the consultation RIS, using the national baseline study of residential energy use that was published in the meantime. This facilitated a considerable simplification of the analysis and presentation but resulted in no significant changes. We also used the latest version of AGA's *Product Directory* (February 2009) to revise the projections for GiWH with 5.5 stars or better. Again, there were no significant changes.

But there are uncertainties. GiWH could take a larger share of the market before equilibrium is established; including a larger share of the market for 3-star GsWH. There could be a stronger response to price signals and product improvements – particularly the effect of the CPRS on gas tariffs and further improvements in GiWH. But there are significant impediments and limits to the further increases in the GiWH share of the market for replacement GsWH. GiWH are not always like-for-like replacements for GsWH. They generally require the installation of electric power and, because they use gas at a faster rate, often require the upgrading of gas pipes. There are also significant market failures, documented in section 1.6.

On the other hand, there is the prospect of other policy measures that will drive significant increases in GWH penetration, and have not been fully factored into the latest baseline study. The prospective phasing out of electric water heaters would significantly expand the market for GWH. GiWH would be the main beneficiary but sales of GsWH would also be somewhat higher.

We use sensitivity analysis to express our sense of these uncertainties.

1.3.2 New Zealand

This section presents projections for stocks and sales of GWH in New Zealand in the absence of any further specific measures to increase the energy efficiency of GWH and reduce emissions. We refer to these as WoSM projections and distinguish between WoSM and WSM projections.

- *WoSM scenarios* are scenarios for future energy use and emissions 'Without Specific Measures', but including the efficiency promoting effects of Australia's

CPRS and other/New Zealand greenhouse policies and commitments that are not specific to particular energy end-uses such as water heating.

- *WSM scenarios* are scenarios for future energy use and emissions 'With Specific Measures', including the effects of not only non-specific measures but also measures that are specific to particular end uses.

Key findings from the Household Energy End-Use Project (HEEP)
New Zealand's HEEP survey collected data on all aspects of domestic energy use, including for hot water. The data was collected from 1995 to 2005 and published in a series of reports by BRANZ.

HEEP's random sample of 400 dwellings contained a total of 443 HWS, with 9% of dwellings having two units and 1% having three. However, not all systems were operational and many of the multiple installations were combinations of wood-fired appliances plus electric or gas appliances. These data indicate that GWH penetration of New Zealand households is about 13%, with GsWH and GiWH at 8% and 5% respectively (BRANZ 2005: page 94). There would be a reasonable degree of statistical uncertainty, since the sample contains only 34 GsWH and 20 GiWH. Another source of uncertainty is that the data was collected over a decade and provides no information about trends over this period. The breakdown by type is doubtful, since there has been a major shift in favour of GiWH over this period.

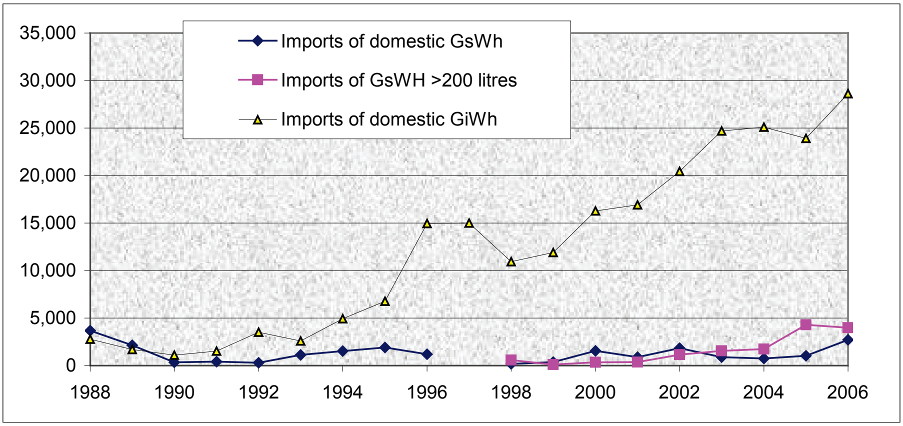
The following research findings from the HEEP project are relevant in the present context.

- Of households with hot water cylinders, including both gas and electric, 91% were installed internally and 80% were in a cupboard inside the house. The standing heat losses from internal cylinders contribute to house winter space heating (depending on their pipework/flue structure) and this was found to be considerable proportion in some cases: 66% of households used the space around the cylinder for linen or clothes storage.
- 94% of the GsWH were in the size range that also dominates the Australian market, with 135 or 170 litres of storage. The sample includes only two units outside this range and two units where storage capacity could not be determined. The outliers comprised one unit with a 75 litres of storage and one of industrial size, with 350 litres of storage.
- The split between GsWH units with 135 or 170 litres of storage is 60:40 in favour of the smaller unit.
- 40% of the GsWH were low pressure units and these correlate with the use of bottled gas. The combination of low pressure and installation in a cupboard is achieved by installing a feeder tank in the ceiling space or a pressure-reduction valve on the mains connection. In contrast to the Australian situation, low pressure units are not generally installed above the ceiling.

Increasing penetration and sales of GWH
It is apparent that GWH penetration of New Zealand households is increasing. The number of households connected to mains gas increased by 5.2% a year from 2000 to 2005, raising mains gas penetration from 12.6% of households in 2000 to 15.3% in 2005. LPG is well established on the South Island, where mains gas is not available. In addition to bottled LPG there is increasing penetration of reticulated LPG in new housing estates. In a recent joint submission to government, the LPG and Gas Associations of New Zealand report that the LPG market has grown by 50% over the past five years and that almost 75% of new homes on the South Island use gas (GANZ 2007: page 12).

Almost all GWH are imported to New Zealand. The only exceptions are internal GsWH that are manufactured in New Zealand, numbering about 2,000 a year. This means that import data tell the story – see figure 1.8. Assuming that the entire stock of water heaters must turn over every 12 or 13 years, these data suggest that about 250,000 GWH are installed in New Zealand homes. This represents market penetration of about 17%, somewhat higher than the 13% that HEEP recorded for 1995-2005.

FIGURE 1.4 IMPORTS OF GWH TO NEW ZEALAND: 1988 TO 2006*



Note
* There is a break in series affecting the data for GsWH. The sub-categories were defined as 'domestic' and 'other' before 1997 and then redefined as 'less than 200 litres' and 'greater than 200 litres'. It has been assumed that the 'domestic' series, pre-1997, is the precursor of the 'less than 200 litres' series, post-1997.

Projected penetration and sales of GWH

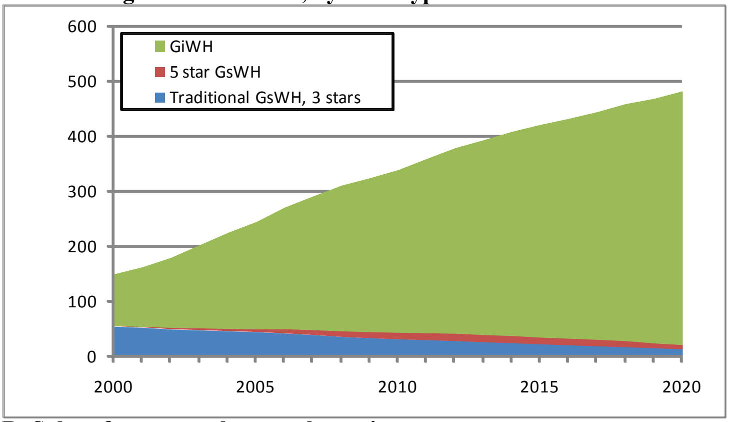
Figure 1.5 presents our WoSM projections for stocks and sales of GWH in New Zealand. Note the following:

- It is envisaged that penetration will continue to grow but at a decreasing rate and that penetration will increase from about 17% now to about 27% in 2020. This is consistent with a further increase in sales, to almost 45,000 a year. Sales continue to grow strongly because, given the history of increasing penetration, replacement sales will become significant.
- This projection may be conservative. New Zealand gas interests say there is considerable scope to further increase mains gas take-up by households that already have access to gas, and that the residential market for LPG will grow at 10% a year (GANZ 2007: page 12). In a report on alternatives to augmentation of electricity supplies, SKM (2004: page 24) say that mains gas take-up by households with access to gas is 40% in Auckland and 70% in Wellington.
- The strong switch in favour of GiWH seems permanent. Based on discussions with suppliers, GsWH have become niche markets and will not recover. We assume they will decline linearly to zero over the period to 2020. This means that, of the approximately 500,000 GWH that will be sold in the period to 2020, only 25,000 (5%) will be GsWH – 15,000 internal GsWH and 10,000 external GsWH.

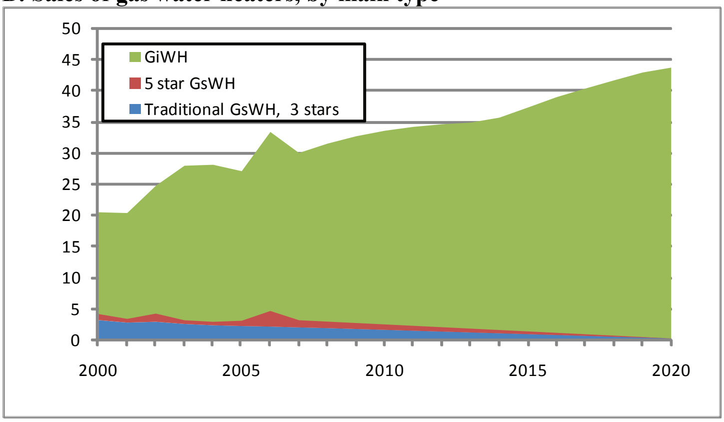
This is in sharp contrast to projections for the Australian market, where GsWH will remain significant. An important difference between the two markets is that GsWH are made in Australia on a much larger scale. GsWH are bulky items and suffer a significant cost disadvantage as imported goods to New Zealand. The GsWH that are manufactured in New Zealand – about 2,000 internal GsWH a year – remain strongly competitive in their niche market. It appears that only 10-20 internal GsWH are imported to New Zealand each year.

FIGURE 1.5 PROJECTED STOCKS & SALES OF GAS WATER HEATERS: NEW ZEALAND, WITHOUT SPECIFIC MEASURES ('000)

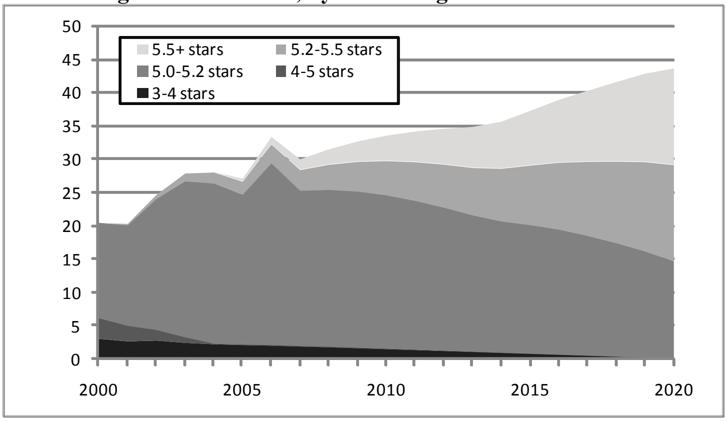
A: Stock of gas water heaters, by main type



B: Sales of gas water heaters, by main type



C: Sales of gas water heaters, by star rating



Small and declining sales of GWH with less than 4 stars
With respect to the energy efficiency profile of the New Zealand market, we understand the situation as follows:

- <u>External GsWH</u>: There are several suppliers of GsWH to this small market – Rheem, CJ Energy Services (agent for Dux) and Abergas (agent for Ruud). Import data indicate that sales have averaged 1,400/year over the past five years and suppliers have indicated that less than 100 of these would have less than 4 stars. The baseline scenario is for the sale of 6,100 external GsWH in the period 2010-20, 550 of which will be at less than 4 stars and none in the range of 4-5 stars.
- <u>Internal GsWH</u>: The relatively few appliances that are imported from Australia – no more than 10-20 a year – have ratings of about 3 stars. The remainder are made in New Zealand and have not been energy tested. But the supplier believes that they would also be rated at about 3 stars. Current sales are 2,000/year but declining, and the baseline scenario is for 9,750 of these units to be sold in the period 2010-20.
- <u>External GiWH</u>: The major suppliers are the same for New Zealand and Australia, as is the product range. One product uses a pilot light and the proposed measures would require it to be removed ahead of its normal replacement schedule. One other small importer (What Power Crisis) has annual sales of about 200 units that are imported from China. They have not been energy tested. The baseline scenario is for the sale of 400,000 external GiWH in the period 2010-20, 570 of which will be 4-5 stars and none less than 4 stars.
- <u>Internal GiWH</u>: The major suppliers are the same for New Zealand and Australia, as is the product range. There is only one product with less than 5 stars and we understand that it is scheduled to be replaced with a 5-star product under normal process of product renewal, independently of regulation.

In summary, the baseline scenario is that 10,300 GWH with less than 4 stars would be sold in the period to 2010-20, comprising 9,750 internal GsWH, 550 external GsWH and zero GiWH. Another 570 GiWH will be in the range 4-5 stars. (As explained in chapter 3, it is proposed that internal GsWH be exempt from the MEPS.)

1.4 Contribution to growth of greenhouse emissions

1.4.1 Australia

The Australian Government is committed to meeting a 108% Kyoto target for the nation as a whole, that is, across all sectors and all emissions sources. However, the proposed measures will not make an appreciable contribution to meeting that commitment, since they would not take effect until October 2010.

Looking beyond the Kyoto target, significant sales of GWH are exposed to MEPS in the period from 2011 to 2020, depending on their energy rating. Table 1.1 provides estimates of the various product categories that may be affected by the MEPS options that are being considered. Note that the 'analytical horizon' for this RIS is the life of GWH that are purchased in the period to 2020, some of which will remain in service into the late 2030s. The estimates in this table are for the whole of the life of the GWH that are exposed to MEPS and are purchased in the period to 2020.

It is difficult to put the whole-of-life emissions of these GWH (28.2 Mt CO_2-e) into the context of total annual emissions, since GWH are long lived assets that contribute to emissions over a decade or more, depending on how long they are in service. However, the expected emissions from these GWH (28.2 Mt CO_2-e), under WoSM conditions, is about 0.5% of Treasury's estimate of Australia's emissions under the CPRS in the period 2011 to 2020, which is 5,600 Mt CO_2-e.

GWH with 5.5 or more stars are not exposed to the MEPS being considered in this RIS. It is estimated that 356,000 of these GWH will be purchased in the period to 2020, with whole-of-life emissions of 5.1 Mt CO_2-e.

1.4.2 New Zealand

The bottom panel of table 1.1 provides the corresponding analysis for New Zealand, also under WoSM conditions. The GWH that are exposed to one or other of the MEPS options, and purchased in the period to 2020, will generate emissions of 2.29 Mt CO_2-e. This is about 0.36% of the Ministry for the Environment's estimate of New Zealand's emissions in the period 2011-20, which is 633.1 Mt CO_2-e. Our sales projections include sales of another 73,000 GWH with energy ratings of 5.5 stars or higher, which will not be exposed to any of the MEPS options. They will generate an additional 0.82 Mt CO_2-e.

TABLE 1.1 WHOLE-OF-LIFE GREENHOUSE EMISSIONS FROM GWH THAT ARE EXPOSED[1] TO MEPS IN THE PERIOD TO 2020– AUSTRALIA, WOSM SCENARIO

Type of water heater	*GsWH*		*GiWH*			Total
Energy rating category, pre-MEPS[2]	*3 stars*	*5-5.2 stars*	*4 stars*	*5-5.2 stars*	*5.2-5.5 stars*	
Australia						
Sales of GWH that are exposed to MEPS[1], 2010-20[3] ('000)	718.3	223.7	12.3	573.9	373.2	1,901.3
Gas consumption (PJ)	155.6	53.2	2.9	127.7	81.6	421.1
Emissions (Mt CO_2-e)	10.4	3.6	0.2	8.6	5.5	28.2
New Zealand						
Sales of GWH that are exposed to MEPS[1], 2010-20[3] ('000)	0.433	2.234	0.43	115.73	75.90	194.7
Gas consumption (PJ)	0.094	0.532	0.103	25.756	16.602	43.1

Emissions (Mt CO2-e)	0.005	0.028	0.005	1.373	0.885	2.3

Notes:
1. By focussing on sales of GWH that are "exposed to at least one MEPS option" we put aside any GWH that do not fall within scope of the any MEPS option. These are existing stocks of GWH, any sales of GWH that will occur before the MEPS can be introduced, including carry-over and subsequent sale of supplier stocks that are unsold at the time of implementation, and sales of GWH with such high energy ratings (5.5+ stars) that they will not be affected by any MEPS option.
2. The energy ratings are pre-MEPS, which means that product breakdowns are in terms of the energy ratings that would be observed in the absence of MEPS.
3. For the purposes of the assessment the MEPS are assumed to expire in 2020, putting the focus on sales in the period to 2020. But note that some of the GWH that are purchased in this period will remain in operation until the mid-2030s and our estimates of costs, energy use and emissions are on whole-of-life basis, until the retirement of all GWH that are purchased in the period to 2020.

1.5 Impediments to energy efficiency in the GWH market

Despite the recent history of increasing efficiency and the prospect of further improvements, the market for gas water heaters may still be regarded as failing to minimise the lifecycle costs of providing domestic hot water. We deal here with issues of imperfect information and split incentives. Section 1.6 deals separately with the question of whether the CPRS that is proposed for Australia will overcome these impediments.

Imperfect information

Consumers are self-motivated to minimise the cost of hot water services, including the energy costs, but cannot do so without good information. However, fairly demanding calculations are required to make a fully informed assessment of alternative water heaters. It requires information about future heated water loads, the efficiency of alternative water heaters, the relationship between heated water loads and efficiency, energy prices, asset lives and discount rates, a good basis for trusting the sources of such information, and the ability to do the arithmetic. The question is the extent to which households are able to 'do the sums' in this way. We have considered the following matters.

Infrequent purchases and aggregated energy bills

Lack of prior information is not critical where consumers have opportunities to learn quickly and cheaply from experience and experimentation. For example, consumers can get rapid feedback on their choice of coffee: each purchase is relatively cheap and feedback on the product, via tasting, is immediate. In contrast, water heaters have relatively long lives of about 10-15 years and are purchased infrequently, and feedback on energy performance is impeded by the fact that (a) consumers are not billed separately for the energy used by each appliance, (b) the energy bill is also periodic, at intervals of 2 or 3 months, and (c) the interpretation of energy bills is complicated by seasonal variation in energy consumption and the payment of varying marginal tariffs under block tariff arrangements. Water heaters are therefore at the more difficult end of the spectrum of purchasing decisions. Specifically, a water heater is more a 'credence good' or an 'experience good', as opposed to a 'search good'[9].

- The attributes of a search good can be determined prior to use, for example, a greeting card.
- The attributes of an experience good can be determined only with use, for example, motor vehicles and other durables that consumers value for their whole-of-life performance, including ongoing reliability and costs of operation and maintenance.
- The attributes of credence goods may never be discovered – for example, a medical procedure – or may be determined only after a very long delay.

[9] This distinction originated with an article by Philip Nelson (Nelson 1970).

The intrinsic characteristics if water heaters are such that much depends on the quality of the pre-purchase assessment of options. Consider that, for typical GWH that will be affected by the regulation, the lifetime energy costs comprise about 74% of the total lifetime costs of the heater.[10] The remaining 26% is the capital cost of the heater. Energy costs should therefore be a significant consideration in the purchase decision, given almost three times more weight than the capital cost.

Sizeable minority without the required pre-purchase assessment skills
With respect to the pre-purchase assessment of water heaters, it is reasonable to expect that some proportion of the population does not have the required skills in gathering and analysing information. While E3 has not directly tested these specific skills in the general population, results of the ABS survey of adult literacy and life skills (ABS Cat 4428.0) indicate that a significant minority would find it difficult to gather the required information and make the required calculations. Specifically, on tests of literacy and numeracy, the ABS estimated that the following proportions of the adult population in private dwellings are at Level 1 or Level 2, on a scale from Level 1 to Level 5 where Level 1 is the least skilled and Level 5 is the most skilled.

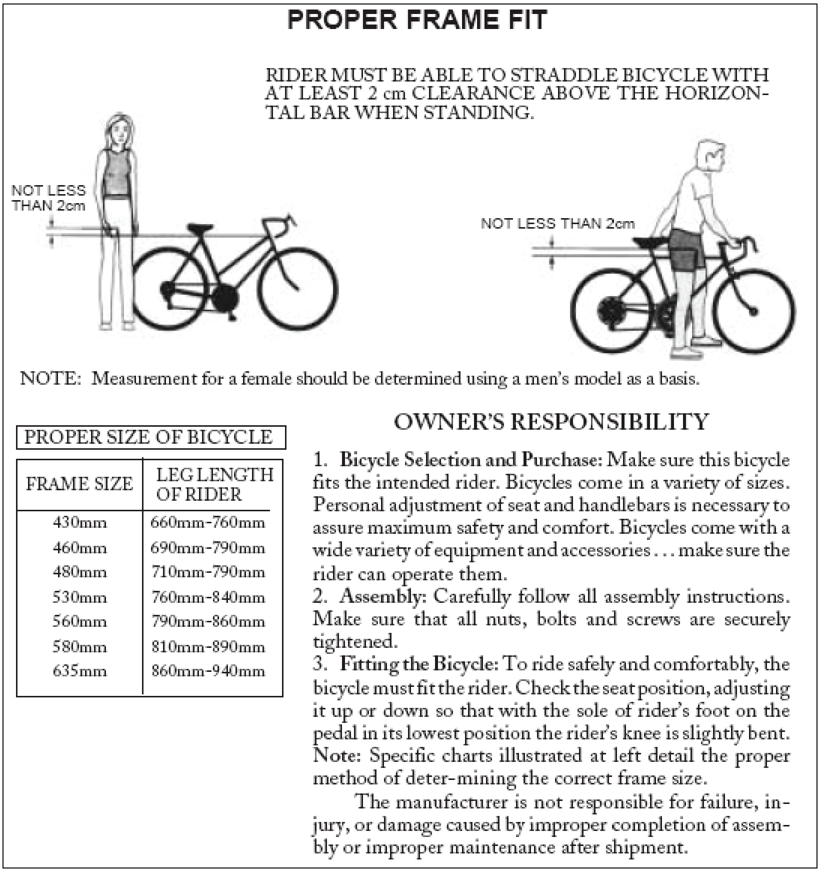
- prose literacy – 46.4%
- document literacy – 46.8%
- numeracy – 52.5%

To have a sense of what these numbers mean it is necessary to review the Level 3 tasks: these are the 'next most difficult' tasks that could not be performed by survey respondents on Levels 1 and 2. Examples of the Level 3 tasks are provided in a report jointly published by Statistics Canada and the OECD – *Learning a Living: First Results of the Adult Literacy and Life Skills Survey*[11] – and the interested reader should refer to that publication for a detailed explanation. For the purposes of this RIS, however, the following indicate the difficulty of Level 3 tasks.

- Prose literacy: One of the prose literacy tasks at the lower end of Level 3 refers the reader to the following page from a bicycle's owner's manual to determine how to ensure the seat of a bicycle is in the proper position. The respondent needs to identify, in writing, that the seat is in the proper position when the sole of rider's foot is on the pedal in its lowest position and the rider's knee is slightly bent.

[10] The details of this calculation for a typical heater are as follows:
- The average new heater costs about $909, including GST.
- Annually, a 3.4-star heater uses 24,000 MJ of gas under standard test conditions. At the Australian average price of 1.38 cents/MJ, the annual cost is $324, including GST.
- Over a life of 13 years, and discounting future costs at 7.5% a year, the present value of the annual gas expense is $2,633.
- The total lifetime cost is therefore $3,542, split 74%:26% between energy and capital costs.

[11] http://www.oecd.org/LongAbstract/0,3425,en_2649_37455_34867439_1_1_1_37455,00.html
The International Adult Literacy Survey (IALS) was a large-scale co-operative effort by governments, national statistical agencies, research institutions and the Organisation for Economic Co-operation and Development (OECD). The development and management of the survey were co-ordinated by Statistics Canada and the Educational Testing Service of Princeton, New Jersey.



PROPER FRAME FIT

RIDER MUST BE ABLE TO STRADDLE BICYCLE WITH AT LEAST 2 cm CLEARANCE ABOVE THE HORIZONTAL BAR WHEN STANDING.

NOT LESS THAN 2cm

NOT LESS THAN 2cm

NOTE: Measurement for a female should be determined using a men's model as a basis.

PROPER SIZE OF BICYCLE

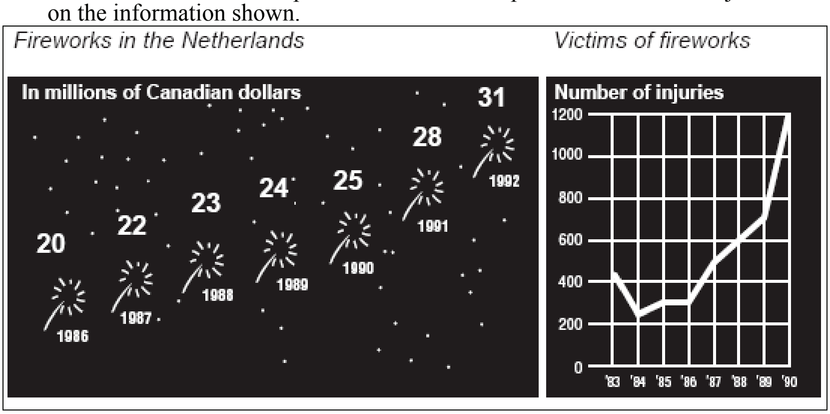
FRAME SIZE	LEG LENGTH OF RIDER
430mm	660mm-760mm
460mm	690mm-790mm
480mm	710mm-790mm
530mm	760mm-840mm
560mm	790mm-860mm
580mm	810mm-890mm
635mm	860mm-940mm

OWNER'S RESPONSIBILITY

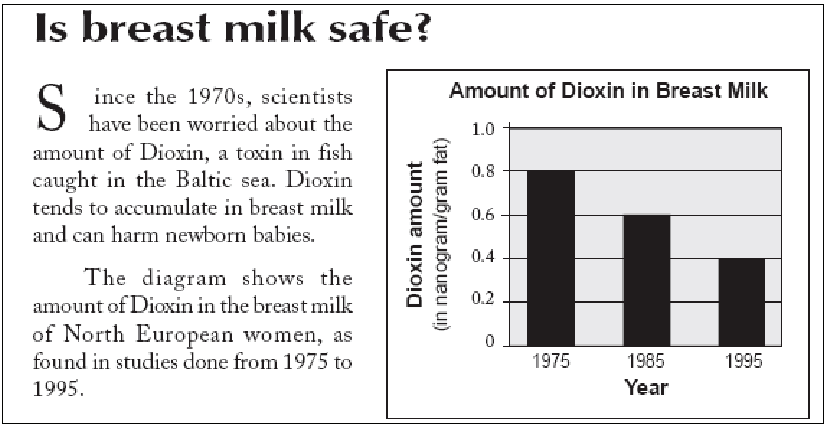
1. **Bicycle Selection and Purchase:** Make sure this bicycle fits the intended rider. Bicycles come in a variety of sizes. Personal adjustment of seat and handlebars is necessary to assure maximum safety and comfort. Bicycles come with a wide variety of equipment and accessories . . . make sure the rider can operate them.
2. **Assembly:** Carefully follow all assembly instructions. Make sure that all nuts, bolts and screws are securely tightened.
3. **Fitting the Bicycle:** To ride safely and comfortably, the bicycle must fit the rider. Check the seat position, adjusting it up or down so that with the sole of rider's foot on the pedal in its lowest position the rider's knee is slightly bent. Note: Specific charts illustrated at left detail the proper method of deter-mining the correct frame size.

The manufacturer is not responsible for failure, injury, or damage caused by improper completion of assembly or improper maintenance after shipment.

- Document literacy: A document literacy task from the middle of Level 3 required the reader to look at the following charts involving fireworks from the Netherlands and to write a brief description of the relationship between sales and injuries based on the information shown.



- <u>Numeracy</u>: One of the numeracy tasks at the lower end of Level 3 referred to the following graph and accompanying text on the levels of dioxin in breast milk. Respondents were not required to calculate the amount of change over each of the periods, just describe in their own words the change in the levels of dioxin (e.g., decreased, increased, stayed the same).



Is breast milk safe?

Since the 1970s, scientists have been worried about the amount of Dioxin, a toxin in fish caught in the Baltic sea. Dioxin tends to accumulate in breast milk and can harm newborn babies.

The diagram shows the amount of Dioxin in the breast milk of North European women, as found in studies done from 1975 to 1995.

These Level 3 tasks in literacy and numeracy seem relatively easy in comparison to the tasks that are required to make an informed assessment of alternative water heaters, indicating that a significant minority of the population cannot confidently make the required assessments of water heaters.

We also note that a numeracy task involving compound interest was assigned to Level 5.

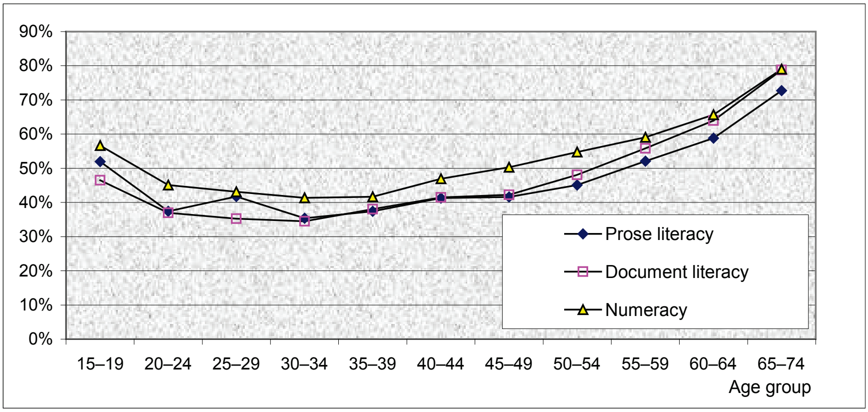
The ABS survey also tested problem solving ability but, unfortunately, the source documentation (Statistics Canada *et al*: 2005) does not report the degree of problem solving that characterises Level 1 and Level 2. However, one of the scenarios used to assess problem solving was the planning of a family reunion, which involved the completion of a set of tasks that seems no more demanding than making an informed assessment of water heaters. The specific tasks for the respondent were to:

- set the date for the reunion allowing for the prior commitments of six relatives
- consider relatives' suggestions for a specific outing (a hike) and decide on a convenient location for the outing
- plan what needs to be done before booking your flight
- answer relative's questions about travelling by plane
- book your flight
- make sure your ticket is correct
- plan your own trip to the airport

The ABS found many could not complete all of these planning tasks – 34.9% of Australians were at Level 1 on problem solving and 70.1% were at Level 1 or Level 2, but now on a scale of Level 1 to Level 4. This suggests that many Australians cannot confidently assess energy efficiency issues that seem to be of at least commensurate difficulty, such as the assessment of water heaters.

Other general findings are that skill levels are positively related to education and labour force participation, and negatively related to age beyond 30 years. Figure 1.13 reports the latter finding.

FIGURE 1.6 PROPORTION OF AUSTRALIANS AT SKILL LEVELS 1 OR 2*, BY AGE



Source: ABS Cat 4882.0 *Adult skill and life skills survey*
Note:
* For each literacy domain, proficiency is measured on a scale ranging from 0 to 500 points. To facilitate analysis, these continuous scores have been grouped into 5 skill levels with Level 1 being the lowest measured level of literacy.

Urgency of heater replacements
Water heaters generally fail without warning and, because heated water is a basic need, replacement becomes an urgent matter. This is reflected in the prominence of advertisements for 'same day' replacement services. This suggests that it is often difficult for consumers to assess energy efficiency to the degree that they may otherwise prefer.

Importantly, the market for GWH with less than 5 stars is primarily a replacement market.

Split incentives
There are circumstances where water heater selections are delegated to people who do not pay the energy bills and may avoid the consequences of a poor decision, creating a problem of split incentives. In a recent report on 'principal-agent' problems in energy efficiency decisions, the International Energy Agency (IEA 2007) explained the problem as follows.

> *Split incentives occur when participants in an economic exchange have different goals or incentives. This can lead to less investments in energy efficiency than could be achieved if the participants had the same goals. A classical example in energy efficiency literature is the 'landlord-tenant problem', where the landlord provides the tenant with appliances, but the tenant is responsible for paying the energy bills. In this case, landlords and tenants face different goals: the landlord typically wants to minimise the capital cost of the appliance (with little regard to energy efficiency), and the tenant wants to maximise the energy efficiency of the appliance to save on energy costs.*
>
> *Split incentives occur in the property ownership market, where many homeowners and businesses have limited incentive to invest in efficiency measures because they do not expect to stay in their building long enough to realise the payback from investments in energy efficiency. Split incentives also occur in the hotel industry,*

> *where the occupant seeks to maximise comfort and does not directly pay for the room's energy use. The hotel owner, on the other hand, does face the energy costs – which is why many hotels typically install compact fluorescent lamps and keys that deactivate a room's energy use when removed from their slots.* (IEA 2007: page 25)

The IEA report is an innovative attempt to quantify the split incentive problem in energy efficiency and includes a case study of residential water heaters in the US (IEA 2007: chapter 8). IEA found that there was little information on the selection of water heaters and it is fair to say that the resulting IEA estimates are little more than an educated guess. IEA assumed that there is a split incentive problem in the following circumstances.

- water heaters installed in rental dwellings;
- water heaters installed in new owner-occupied dwellings; and
- emergency replacement of water heaters in owner-occupied dwellings

On this figuring, 87.5% of the installed stock of water heaters is subject to some form of the split incentive problem. IEA takes for granted that there will be no serious consideration of energy efficiency options for emergency replacements, which are assumed to account for 60% of replacement decisions.

IEA may have overstated the problem but too little is known about the selection of water heaters to make a more definitive estimate. Split incentives remain a significant problem even if confined to rental properties. Based on a special tabulation from the 2005 ABS survey of environmental issues (ABS Cat 4602.0), 26% of dwellings with GWH are rental properties.

It may be argued that renters can penalise poor decisions by seeking out more energy efficient properties for rent or purchase, but it requires them to be informed and vigilant and to incur extra search costs. However, while we are not aware of any systematic study of renter behaviour in this respect, it seems reasonable to assume that renters who have difficulty in assessing the financial case for energy efficiency have even more difficulty in converting that assessment into a rental premium for energy efficient properties. IEA also pointed out that landlords can simply remove energy labels or unscrupulously make false claims that appliances are efficient (IEA 2007: page 33). It is subsequently difficult for renters to verify performance and enforce their rights in respect of such claims.

Market failure and the WoSM scenario
Market failures are factored into our account of outlook under WoSM conditions, as expressed in sections 1.3 and 1.4. In the Australian market for example:

- We have allowed for only a modest continuation of the recent shift in the market towards 5-star GWH. The market share of GWH with less than 4 stars is 23% in 2020, down from about 32% in 2005.
- The average efficiency rating of new GsWH is only 4 stars in 2020.
- There will be almost a complete renewal of the installed stock of GWH in the period to 2020, but its average efficiency is still less than 5 stars.

1.6 Role of energy efficiency programs after CPRS is introduced

In 2007, the Australian Government formally announced its intention to introduce a Carbon Pollution Reduction Scheme (CPRS, previously known as the Emissions Trading Scheme) by 2010. Economic literature suggests such a scheme can be used as an effective policy tool for internalising the costs associated with greenhouse gas emissions. However, even under a CPRS, there may still be a role for complementary policies.

Energy efficiency measures have been proven in some circumstances as a cost-effective method for households and businesses to reduce energy consumption while delivering greenhouse gas abatement. All other things being equal, the increase in costs of energy resulting from a CPRS should encourage households and businesses to improve the efficiency of their energy use. However, in some instances, market failures and/or other factors may act to mitigate some of the impacts of a CPRS, and therefore complementary energy efficiency measures may be appropriate.

For example, the presence of split incentives (such as between building owners and tenants) may lessen the effectiveness of a CPRS in delivering an 'optimal' investment in energy efficiency in tenanted dwellings.

In other instances, the transaction costs of investing in energy efficiency may outweigh the marginal benefits of such investments, even in a CPRS environment. For example, the potential energy savings to consumers may be small, relative to the time and effort required to calculate the associated life cycle costs when purchasing a product. In this circumstance, it is possible that a CPRS will not deliver an optimal investment in energy efficiency. A similar situation can arise if there is imperfect information, such as a lack of comparative energy consumption data on energy bills.

Taking into account the above factors, in some situations it is possible that the increase in electricity prices induced by a CPRS may result in a relatively small rise in demand for energy efficient products. Therefore it is possible that the carbon abatement costs induced by complementary energy efficiency measures may be lower than those induced solely under a CPRS. In such cases, it may be beneficial to consider energy efficiency policies, including MEPS and energy labelling, in conjunction with a CPRS.

CPRS and the market for gas water heaters

CPRS will not adequately address failures in the market for gas water heaters. This is because there is nothing in CPRS that deals directly with the underlying market failures. Specifically, CPRS does not:

- reform energy metering and billing practices in a way that provides users with prompt feedback on amount and cost of the gas that is used by their water heater;
- improve the literacy and numeracy skills of users to the point where they can calculate the costs and benefits of more efficient water heaters;
- motivate landlords to provide more efficient water heaters that will reduce the energy bills paid by tenants; or
- provide users with more time to consider their options when faced with an urgent need to replace a water heater that has failed.

It follows that measures such as MEPS and energy labelling may continue to assist users in their efforts to manage energy costs pressures, including the additional pressures that a CPRS will impose.

2 Objectives of government action

2.1 Objective

In Australia the objective of government action is to contribute to economically efficient and cost-effective greenhouse abatement. The assessment of efficiency and cost effectiveness includes consideration of both the direct financial impact and any effects on health, safety and the environment.

In New Zealand the objective of government action is to contribute to cost-effective reductions in energy demand, reduced energy costs for the end user, and greenhouse gas abatement. The assessment of cost effectiveness includes consideration of both the direct financial impact and any effects on health, safety and the environment.

2.2 Assessment criteria

Energy saving and GHG abatement measures are considered to be cost-effective if they do not increase the life-cycle cost of appliances. This means that the value of the energy savings to the user is not less than the incremental purchase price of a more efficient appliance.

For Australia, the contribution to emissions abatement is explicitly included in the value of energy savings. It is valued at Treasury's estimates of the projected emissions charge under the CPRS.

For New Zealand, the contribution to emissions abatement is not explicitly valued.

Several secondary assessment criteria are also applied:

1. Does the option address market failures?
2. Does the option minimise negative impacts on product quality and function?
3. Does the option minimise negative impacts on manufacturers and suppliers? For example, the measures need to be clear and comprehensive, minimising the potential for confusion or ambiguity for users and suppliers.

3 Options that may achieve the objectives

This chapter explains the need to revise the method of testing that is used to determine the energy ratings of GWH (section 3.1), explains the proposed regulation (section 3.2), examines possible alternatives (3.3), and shortlists the options that are considered feasible (3.4). The shortlisted options 'go forward' to impact assessment in chapters 4 and 5, for Australia and New Zealand respectively.

3.1 Revision of the energy rating test

The GWH addressed in this proposal must comply with Australian Standard *AS4552 – Gas fired water heaters for hot water supply and/or central heating* for safety, performance and energy requirements. Standards Australia committee AG-001 is preparing a new energy test procedure for gas water heaters which will form the basis of future government regulation for energy efficiency. That work, including a new energy test method and an associated regulatory standard will be finalised in early 2010, including all consultation procedures.

A major focus for this work is the revision of the energy test method. Particular concerns about the existing energy test, which dates from the early 1980s, are that:

- It is unnecessarily cumbersome and costly.
- There is unacceptable variation in the results reported by different laboratories.
- Several errors and ambiguities of a technical nature have been identified which result in larger than expected uncertainty for some key parameters.
- An accurate result for the start-up phase of instantaneous water heaters is difficult. This is critical to the comparative rating of GsWH and GiWH, since they differ significantly in their start-up configuration and behaviour.

E3 is providing significant financial, technical and administrative support for the work, including funding for laboratory tests and analysis. E3 intends that the new standard, particularly the energy test method, will provide a sound basis for MEPS.

3.2 Proposed regulation

3.2.1 Minimum energy performance standards (MEPS)

The existing Australian Standard *AS4552* imposes certain minimum requirements on the efficiency of gas burners and on the rate of gas consumption needed to maintain the temperature of stored hot water. These prescriptive requirements effectively impose MEPS of 1 or 2 stars, depending on which edition of *AS4552* applied at the time of certification[12].

E3 proposes to introduce performance-based MEPS at 4 stars from October 2010. The precise details cannot be known until the new standard is finalised, which means that the option is expressed as the intention to impose a MEPS that employs the new test method

[12] Water heaters have been certified under two editions of *AS4552*: *AS4552-2000* and *AS4552-2005*. Under *AS4552*-2000, the base MEPS requirement was 1 star for a standard GsWH. An increase of the minimum permitted burner efficiency from 70% to 75% was introduced in the 2005 edition, increasing the MEPS to about 2 stars. The vast majority of products certified by AGA to date will be to the 2000 edition of the standard and hence the nominal 1 star minimum efficiency. The maximum start-up energy for GiWH is not specified in the standard, so there was no minimum star rating for GiWH. But the efficiency of GiWH is such that this is of no practical consequence.

and standard for compliance purposes, and that the new MEPS will be broadly equivalent to 4 stars under the existing test and standard. This undertaking is to minimise uncertainty about the new test procedures. Suppliers can be confident that a 4-star product that is certified to the existing standard will need, at most, only minor improvements to tank insulation or the efficiency of the gas burner in order to be certified to the new standard.

The annual gas consumption of a 4-star GWH is 22,831 MJ under standard test conditions, which is 21% lower than the gas consumption of a 1 star GWH and 15% lower than that of a 2 star GWH. It would require a 4-8% increase in the energy efficiency of the least efficient GWH that are now available, most of which are GsWH on 2.9-3.5 stars.

Two new parts to AS 4552:2005 are under development and will become joint Australian-New Zealand standards:

AS/NZS 4552.2 – Energy consumption test for MEPS purposes; and
AS/NZS 4552.3 – MEPS requirements

AS/NZS 4552.3 is anticipated for publishing in late 2009 or early 2010 and AS/NZS 4552.2 is anticipated for publishing in mid 2010. The intention is that these new parts will become the sole standards for the purpose of determining MEPS compliance. Implementation of the new standards will occur upon listing of the new standards in the schedule of each jurisdiction's regulations. It is anticipated that AS/NZS 4552.3 will come into effect through regulation in October 2010 and AS/NZS 4552.2 is anticipated to come into effect through regulation not less than 12 months after its publication date.

Transitional arrangements have been designed to accommodate uncertainty about when AS/NZS 4552.2 will be available and the need for suppliers to have a reasonable period in which to re-test their existing compliant GWH to the new standard.

The effect of these transitional arrangements is to create three categories of product for regulatory purposes.

- Category 1: These are all GWH models which are legally manufactured or imported into Australia or New Zealand prior to October 2010. They may continue to be supplied or sold without restriction beyond this date, to run down stock.
- Category 2: These are GWH models which are legally manufactured or imported into Australia or New Zealand between October 2010 and the date when AS/NZS 4552.2 comes into effect through regulation. They must achieve an energy consumption of not more than 22,831 MJ/year under AS 4552:2005 (4 stars). After AS/NZS 4552.2 comes into effect through regulation, they may not be manufactured or imported but can continue to be supplied or sold without restriction to run down stock.
- Category 3: These are GWH models manufactured or imported into Australia or New Zealand after AS/NZS 4552.2 comes into effect through regulation. These GWH must be compliant with AS/NZS 4552.2 and must achieve an energy consumption of not more than 22,831 MJ/year. This category encompasses:

  (a) registrations of all new product; and
  (b) re-registrations of existing product to allow continued manufacture or import.

3.2.2 Labelling

Victoria instigated energy labelling for GWH in 1981 and, by 1995, that scheme had evolved into its current form as an Australia-wide mandatory labelling program that is embedded in *AS4552* and administered by AGA. The label has a 6 star design that is visually consistent with the label that is used for electrical appliances but has a different colour. Section 1.2 of this RIS explains the regulatory arrangements.

The proposed measures do not alter the labelling provisions in *AS4552* but make them mandatory for New Zealand. A number of suppliers have, at various points in the consultation process, expressed their support for mandatory labelling in Australia and for its extension to New Zealand. None expressed a contrary view.

E3 agrees that labelling should continue but considers that the labelling scheme needs to be reformed. E3 does not have a specific proposal at this stage but invited comment on a proposed approach that was outlined in the consultation RIS. Specifically, it was proposed that the energy star ratings be recalibrated to better reflect the range of feasible efficiencies. E3 considers that water heaters with borderline compliance should be assigned no more than 1.5 or 2 stars, which means that heaters that are now labelled as 4-star would be reassigned to this lower level. E3 also considers that there should be a meaningful gap between heaters with borderline compliance and those that achieve the higher levels of efficiency that can be achieved with gas condensing technology. There would need to be a gap of 2 or 2.5 stars between the lower and higher levels of efficiency.

It is recognised that recalibration of the energy rating scale can disrupt marketing arrangements and strategies, particularly where there are perceptions that products and suppliers have been downgraded. E3 undertakes to work with suppliers to facilitate the introduction of a recalibrated rating scale and to minimise the potential for misunderstanding. Energy labelling will be incorporated in the standards that the Australian and New Zealand jurisdictions use to regulate for MEPS.

The consultation RIS did not elicit any significant response to the proposed approach, other than statements from GiWH suppliers on the importance of a labelling scheme.

3.2.3 Exclusions

The following types of GWH are excluded from the proposal:

1. GsWH with a gas consumption rate in excess of 50 MJ/hour.
2. GiWH with a gas consumption rate in excess of 250 MJ/hour.
3. GsWH with a storage capacity of less than 30 litres.
4. GiWH with a nominal delivery rate of less than 7.5 litres per minute.
5. Internal GsWH.

The first two exclusions reflect the scope of the labelling requirements of *AS4552.* As yet, no consideration has been given to the testing requirements that may be appropriate for GWH that are outside these limits.

The second two exclusions have the effect of excluding GWH that are designed primarily for caravans, mobile homes and recreational vehicles generally.

The final exclusion recognises that there are unresolved challenges in the manufacture and installation of internal GsWH that are significantly more energy efficient than existing products, and doubts about whether the small volume of sales justifies the effort.

All the exclusions are provisional. The E3 Program will review the first four in due course, with a view to broadening the MEPS to include larger commercial and industrial appliances, central heating boilers, boilers that are used to provide both central heating and a hot water service, and appliances for mobile applications.

Regarding the exclusion for internal GsWH, E3 will ask Standards Australia committee AG-001 for advice on the suitability of existing test methods and the appropriate level of

MEPS in order to meet E3's criteria of feasibility and cost effectiveness. MEPS will not be applied to internal GsWH before October 2011.

3.3 Alternative policy options

The WoSM option[13] is implicitly short-listed, that is, the option of not implementing measures that are specific to residential water heating, such as MEPS and labelling. It provides the base case against which all feasible options are compared. The remaining options, other than the proposed regulation, are to vary the level or timing of the MEPS, adopt alternative regulatory forms, use market-based instruments such as taxes or subsidies to either penalise the selection of less efficient heaters or reward the selection of more efficient heaters, or use information and education campaigns to influence consumer behaviour.

3.3.1 Level and timing of MEPS

E3 has considered the possibility of MEPS at levels other than 4 stars – specifically, 5 stars, 5.2 stars, 5.5 stars and 7 stars. Some have been considered as 2-stage MEPS. Following is the complete list.

Option 1: 4 stars from October 2010

Option 2: 5 stars from October 2010

Option 3: 4 stars from October 2010 and 5.2 stars from October 2013

Option 4: 4 stars from October 2010 and 5.5 stars from October 2013

Discarded option: 4 stars from October 2009 and 7 stars from October 2013

The history of the various options is as follows.

- E3's first preference was for MEPS at 5 stars (option 2) and this has been the focus of almost all discussions with suppliers over recent years. Important considerations were that (a) there was the prospect of like-for-like replacements for almost all 3-star GWH at the 5-star level, and (b) for all practical purposes, GWH suppliers had abandoned the 4-star segment of the market. But there has been strong supplier resistance that is centred on unresolved claims about the potentially adverse impact of 5-star MEPS on the continued viability of storage technologies and their suppliers. E3 subsequently turned its attention to options for staged MEPS, set initially at 4 stars but subsequently reset to a higher level.
- The discarded option (4 stars from October 2009 and 7 stars from October 2013) is one such option. It was included in the consultation RIS but recognising that it is uncertain whether a 7-star MEPS is economically feasible. E3 put the proposal on the condition that the period to 2013 would be accepted as a reasonable timeframe for the required product development. Suppliers criticised this option as unworkable and E3 agrees that it is unworkable without their support. It has now been deleted from the list of feasible options.
- E3 subsequently devised options 3 and 4, putting the second stage of MEPS at either 5.2 stars or 5.5 stars. The significance of 5.2 stars is that, while this is the highest rating that GsWH have achieved to date, that achievement suggests that GsWH may generally achieve 5.2 stars and still provide affordable like-for-like replacements for 3-star GsWH. The significance of 5.5 stars is that GiWH have clearly demonstrated a capacity to achieve 5.5-6 stars without using condensing technology, suggesting that 5.5 stars is the highest minimum that might be contemplated for more stringent MEPS in the future.

[13] The distinction between WoSM (without specific measures) scenarios and WSM (with specific measures) scenarios is explained in section 1.3 of this RIS.

- The remaining option is to defer consideration of a more stringent future MEPS and revert to single-staged MEPS at 4 stars. This is the proposition that E3 now favours. However, credible options for a second round of MEPS at 5.2 or 5.5 stars are included in the shortlist.

Comparison with overseas MEPS for GWH

US and Canadian MEPS for GsWH

The US implemented MEPS for GsWH in January 2004, and these have since been adopted by Canada. Differences in energy test methods complicate the comparison with Australian energy ratings. However, based on a 2002 report to Sustainability Victoria (MEA *et al* 2002), the US MEPS are in the range 3-4 stars, depending on the storage capacity of the water heaters that are being compared. Specifically, the US MEPS seems to be the equivalent of about 3 stars for GsWH with 170 litres of storage, 3.5 to 4 stars for GsWH with 135 litres of storage, and about 4 stars or higher for GsWH with 90 litres of storage.

This variation by storage capacity arises from differences in how allowance is made for the fact that all GsWH, regardless of storage capacity, are tested at fixed daily loads[14]. This test condition artificially raises the measured efficiency of small GsWH because their standing losses are averaged over a larger load than small GsWH are designed to accommodate. The US MEPS therefore include a storage adjustment factor that lowers the minimum requirement for larger GsWH. It is expressed in terms of a minimum Energy Factor (EF, or ratio of output energy to input energy), as follows.

Minimum EF = 0.67 – 0.0019 × rated storage volume in gallons

It is important to understand that this does not mean that the US MEPS are more stringent for smaller GsWH. The intention is to have the same level of stringency for all sizes but adjust for a test condition that artificially favours smaller GsWH.

In contrast, Australia's energy rating system makes no such adjustment. It is easier for small GsWH to achieve any particular star rating.

MEA recommended Australian MEPS at about the same level as the US MEPS. However, it should be noted that:

- The MEA report said that only a couple of Australian models would meet the 2004 US MEPS (MEA *et al* 2002: page 26). The situation has now changed. There is a considerable range of products with 5-star ratings – see figures 1.1 and 1.2.
- The MEA report said that a large number of models in both Canada and the US already complied with the 2004 US MEPS, demonstrating that they were clearly feasible (MEA *et al* 2002: page 26).
- In November 2006 the US EPA commenced another round of rule-making for residential water heaters, intending to further increase the US MEPS.
- We followed up with DoE and the US office of *Reed Construction Data*, seeking evidence of what happened to the price of GsWH after the new standards were introduced in the US. The informal advice from the DoE was that, while they have no hard data, the anecdotal evidence is that the observed increase in prices has been small, if any. The informal advice from *Reed Construction Data* was the same. We were told that, while there have been significant price changes in response to steel shortages and high copper prices, there was no noticeable effect from the increase in energy conservations standards.

[14] The energy tests prescribe 200 litres/day in Australia and 64.3 US gallons/day (243.4 litres/day) in the US. However, the difference in standard loads is not important. What matters is how the rating systems allow for the fact that smaller GsWH are actually designed for smaller loads, and larger GsWH are actually designed for larger loads.

It seems likely that the 2004 US MEPS have had minimal impact, requiring that the issue be reopened. The US Department of Energy (DoE) is required to publish a final rule no later than March 2010 and recently released a consultation document for the new MEPS[15].

- For GsWH, DoE has assessed options that would reduce gas consumption by 5-10% relative to the existing US MEPS. Assuming that the existing US MEPS are at 3-4 stars in terms of the Australian rating system, the new US MEPS would be at 3.5-5 stars.
- For GiWH, the options being considered would reduce gas consumption by 10% in one case but by 20-27% for all other options, relative to the existing US MEPS. Importantly, the outlook is for zero sales of GiWH at the existing MEPS level and even at new MEPS that are 10-20% more stringent. This strongly suggests that the new US MEPS will move more sharply for GiWH than for GsWH. It highlights an important difference between the approaches adopted here and in the US, which is that there is more variation and flexibility in the US approach. The stringency of the existing US MEPS varies with the size of GsWH and between GsWH and GiWH. In future, there is the prospect of a wider gap between the US MEPS for GsWH and GiWH. In contrast, the discussion in Australia and New Zealand has been in terms of the same MEPS for all GsWH and GiWH.
- DoE has also provided an assessment of condensing water heaters that would reduce gas consumption by 23.4% and 32.6%, relative to the existing US MEPS, for GsWH and GiWH respectively. These are 'maximum technology' options and the costs are such that DoE does not regard them as feasible options.

Our sense of these proposals is that DoE is examining options for setting the US MEPS at less than 5 stars for GsWH and at more than 5 stars for GiWH, in terms of the Australian energy rating system. Thus, as far as can be determined at this stage, the MEPS proposed by E3 are broadly similar for GsWH but not for GiWH.

Japan and China

GiWH dominate the Japanese and Chinese markets for GWH, and energy efficiency standards are confined to these types. GsWH are exempted.

- The Japanese Top Runner program set the 2006 energy efficiency target for GiWH at 'close to condensing' – 83%. Importantly, this is a sales-weighted average and would require a proportion of sales to exceed the target. Japanese gas utilities are independently targeting sales of 3.5 million condensing water heaters by 2010.
- China has been reported as contemplating MEPS for GiWH, at 88% in 2008 and 95% in 2015. Average efficiency is currently 86.9%.

There is uncertainty about how these metrics relate to US and Australian measures. However, it suggests that countries without a significant legacy of GsWH have set more demanding standards for GiWH.

Other overseas initiatives

SEGWHAI targets - US

The Super Efficient Gas Water Heating Appliance Initiative[16] (SEGWHAI) aims to develop and implement the next generation of cost-effective, high-efficiency, replacement GsWH, for residential applications in the US. The early work done by SEGWHAI has been funded by the California Energy Commission's Public Interest Research Program (PIER). The project steering committee includes representatives from the three major water heater manufacturers in the US, industry organisations, state regulators, gas utilities and industry experts. It seems that SEGWHAI's main output so far is a report on the market development activities that would be needed to extend high efficiency technologies

[15] DoE's *Residential Heating Products Preliminary Technical Support Document* is available at http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_prelim_tsd.html

[16] http://www.segwhai.org/

into the residential market, including the specification of Tier 1 and Tier 2 energy efficiency criteria (Valley Energy Efficiency Corporation 2007).

The proposed market development activities are not regulatory, at least at this stage. They seem to comprise:

- efficiency criteria that provide a focus for product development;
- ENERGY STAR® specifications for gas storage water heaters;
- funding support for product development;
- financial incentives for product purchase, mainly utility customer rebates and government tax credits; and
- institutional and stakeholder networking.

Table 3.1 reports the proposed energy efficiency criteria. The Tier 1 criterion (Energy factor[17] (EF) = 0.70) is at the low end of the range of efficiencies that SEGWHAI says could be achieved by non-condensing gas storage water heaters. The feasible upper limit for such technologies is considered to be EFs in the range 0.72-0.77. A GsWH achieves Tier 1 by replacing standing pilot with spark ignition; dampered flue (takes to EF of 0.72); better/more tank insulation; low leakage flue dampers or induced draft blowers (takes EF to 0.76). The Tier 2 SEGWHAI scenarios involve a helical internal flue, maximum insulation or a 'side arm'[18], taking EF to 0.82, 0.85 and 0.89 respectively.[19]

TABLE 3.1 US ENERGY EFFICIENCY CRITERIA

Rated volume	*151 litres (40 US gallons)*	*189 litres (50 US gallons)*
Energy efficiency requirement (Energy Factor)		
1991 US MEPS	0.54	0.53
2004 US MEPS	0.59	0.58
SEGWHAI Tier 1	0.70	0.70
ENERGY STAR®	0.80	0.80
SEGWHAI Tier 2	0.82	0.82
% energy savings relative to 2004 US MEPS		
SEGWHAI Tier 1	15.1%	17.9%
ENERGY STAR® & Federal tax credits	25.8%	28.1%
SEGWHAI Tier 2	27.6%	29.9%

US ENERGY STAR®

In a recent draft analysis of the ENERGY STAR® criteria for gas water heaters, USEPA has proposed a minimum EF of 0.80 (USEPA 2007). This applies exclusively to GiWH and to condensing GsWH. (ENERGY STAR® is allowed to 'pick winners'.) This is also the Energy Factor that triggers a $US300 tax credit from the US Federal Government. At present the only qualifying models are GiWH. All the available condensing GsWH exceed the size limit for residential appliances.

Eco-Design for Water Heaters - Europe

Eco-Design for Water Heaters (EDfWH) is a study commissioned by the European Commission and undertaken by a Netherlands-based consultancy, Van Holsteijn en Kemna (VHK 2007). It is a comprehensive study in many respects.

[17] The energy factor is the ratio of 'output energy' to 'input energy' under the test conditions employed in the US and Canada.
[18] We have not found anything in the SEGWHAI report explaining how the side arm differs between the Tier 1 and Tier 2 scenarios. See Valley Energy Efficiency Corporation 2007: page 90.
[19] Actually, the SEGWHAI report is somewhat confusing. In other places it says the maximum EF for a non-condensing heater is 0.7 and that a medium efficiency condensing heater has an EF of 0.82. See page 19. Hopefully, these matters will be sorted out when the report is finalised. We have the April 2007 version and the 'final final' has not been released.

- EDfWH encompasses all water heating technologies and fuels, including all combinations of gas, electric and solar water heaters in both storage and instantaneous configurations.
- EDfWH encompasses all sizes of residential water heater, from the very smallest that may be used in dwellings without showers through to combi-heaters that are used to supply both hot water and space heating.
- The policy recommendations that are most fully developed are for MEPS and labelling, but there are also recommendations for promotions, educational activities and financial incentives, particularly to address any issues of affordability and to smooth the transition process. EDfWH classified the available technologies in terms of cost and policy focus.
  - least life cycle cost (LLCC) technology – plausible target for MEPS (EDfWH determined that condensing technology for GWH does not yet qualify as LLCC and is not suitable for MEPS.)
  - best available technology (BAT) – medium term target more suited to promotional measures than regulation
  - best not yet available technology (NBAT) – long-term possibilities that help define scope and nature of possible measures

EDfWH recommended minimum energy efficiency targets that are uniform for all water heating technologies and fuels, but on a sliding scale that is more stringent for larger water heaters and less stringent for smaller water heaters. The size of water heaters is classified in terms of their capacity to meet particular hot water loads that are classified to one of nine classes that range from XXS (extra extra small) to 4XL (presumably, 4×extra large) – see table 3.2. Comparison with E3's proposed MEPS for GWH is complicated by differences in test methods but it appears that the EDfWH proposal is for MEPS of no more than 3 stars when applied to GWH. As yet, however, there are no policy proposals in the public domain. EDfWH was finalised in September 2007[20].

TABLE 3.2 PROPOSED EUROPEAN TARGETS FOR THE ENERGY EFFICIENCY OF WATER HEATERS

Hot water load profile	*Daily hot water load (L/day)*	*Largest tapping required (L)**	*Proposed target for minimum energy efficiency (%)*
XXS	40.1	2	24%
XS	40.1	5	27%
S	40.1	9	30%
M	111.8	24	44%
L	223.6	62	50%
XL	365.0	76	58%
XXL	468.2	107	68%
3XL	894.4	215	74%
4XL	1788.8	430	92%

Note:
* The load profile is also defined by particular tapping patterns and the largest rate of flow that is required.

E3's assessment of the overseas policy models
E3 considers that none of the overseas policy models provide a suitable template for Australia and New Zealand. There is a basic issue of timeliness: none of the overseas work

[20] See http://www.ecohotwater.org for the final report, dated October 2007.

is at a stage where it can be usefully adapted to the needs of Australia and New Zealand. And there are fundamental differences in approach. On the one hand, North American and Asian countries have substantially decoupled the MEPS for GsWH and GiWH. At the other extreme, the European proposal is to implement a MEPS schedule that is the same for all technologies and fuels, coupling gas, electric and solar water heaters, and both storage and instantaneous technologies. Historically, the Australian approach is to have uniform regulations for GsWH and GiWH and to deal with other water heating technologies and fuels as entirely separate issues.

There are also significant differences in regulatory stringency. It appears that Japan and China are taking the most aggressive approach, effectively requiring the adoption of condensing technology, albeit in markets that do not have a substantial legacy of GsWH. E3 finds that it is unable to mount a credible argument for the more aggressive option and that there would be strong supplier resistance.

3.3.2 Information and education

As explained in section 3.2.2, GWH are subject to a mandatory energy labelling in Australia and it is proposed to extend these arrangements to New Zealand. However, E3 considers that the scheme needs to be reformed to better reflect the range of product efficiencies that are now available. Better promotion would also enhance the scheme's effectiveness. E3 used the consultation RIS to explain its approach to reform at some future time, but received no comment from suppliers.

The further issue is whether the proposed MEPS should be abandoned in favour of an information-based approach, comprising some combination of labelling and other information and education measures. In forming a view on this option, E3 has taken account of overseas experience and the results of recent reviews.

Overseas labelling programs
Compared with other types of appliances, labelling of water heaters is not a policy option that is used extensively in other countries. Of 30 countries that were reviewed by E3 in an earlier study of labelling and standards program (Harrington and Damnics 2001), only nine (30%) had labelling programs for water heaters. To the extent that labelling effectiveness is revealed by the implementation of labelling programs, the hierarchy is as follows:

1. Refrigerators – 30 countries (100%)[21]
2. Freezers, lamps – 21 countries (70%)
3. Clothes washers – 19 countries (63%)
4. Room air conditioners – 16 countries (53%)
5. Clothes dryers, dishwashers – 14 countries (47%)
6. Integrated clothes washer dryers, computers – 12 countries (40%)
7. Copiers, fax machines, monitors – 10 countries (33%)
8. Ballasts, televisions, <u>water heaters</u> – 9 countries (30%)

Water heaters use much more energy than many other appliances that are much more likely to be subject to labelling. This suggests a generally adverse assessment of the effectiveness of energy labelling for water heaters.

2000 GWA review of gas labelling
George Wilkenfeld & Associates assessed the effectiveness of the gas labelling scheme as it applied to GWH in the period to 1999 (GWA 2000). The following findings are relevant for this RIS.

[21] The study reported only on countries with labelling and standards programs. Labelling for refrigerators was the common element in all programs.

- The model-weighted average efficiency of external GsWH was virtually unchanged over the period 1987-1999, at about 3.4 stars. The trend line is flat (GWA 2000: page 20). Importantly, external GsWH are the main focus of the proposed regulation.
- In contrast, the average for external GiWH improved steadily, increasing by 0.7 stars to 4.2 stars.
- It is apparent that suppliers often took the minimum step of raising the efficiency of products to the next 'whole star' level – for example, to 2.0 stars, 3.0 stars or 4.0 stars. This is indicated by the clustering of energy ratings at or slightly above the whole star ratings.
- The effect of labelling on buyer behaviour and average efficiency could not be established. Consumer response to the gas label had not been monitored to the same degree as for the electrical label.

Developments since 1999
The record of product registrations shows that the average efficiency of GiWH improved sharply after 1999, to the point where almost all GiWH now have energy ratings of 5-6 stars. The model-weighted average efficiency of external GsWH also improved modestly, to 3.7 stars, largely because GsWH suppliers expanded their range of 5-star products. (Recent re-registrations of 4-star GsWH, probably in response to the prospect of MEPS at 4 stars, would have raised the average a little further.)

Our view is that exogenous technological improvement in the efficiency of GiWH has been the main driver, not labelling. The use of electronics has greatly improved the performance of GiWH, not just in terms of energy efficiency but also in terms of temperature and flow control. GiWH are not manufactured in Australia and these developments occurred overseas, independently of developments in the Australian market. The observed expansion in the range of GsWH with 5 stars appears to have been a supplier response to sharper competition from GiWH and it is likely that the existence of the labelling scheme has sharpened the need for a competitive response. This interpretation of recent developments has been put directly to a meeting of suppliers and was not contradicted.

It should also be noted that E3 has been discussing regulatory options with suppliers for several years and that may have contributed to suppliers expanding their range of GsWH with 5 stars.

2006 Artcraft review of gas labelling
The more recent review of gas labelling (Artcraft 2006) found that only 15% of people were able to recall the gas label unprompted, rising to 20% when prompted. Even in Victoria, with the highest rate of gas connection (92%), prompted awareness is only 26%. Artcraft described the research methodology as follows.

> *With gas and water about to join electricity as resources covered by mandatory efficiency labelling, a series of quantitative studies were commissioned investigating awareness and use of the labels among the general public, recent buyers of appliances, retailers, and installers of appliances.*
>
> *A series of six surveys were designed and conducted, mainly by telephone using a structured questionnaire format. The overall study involved 3,460 members of the general public, (1,730 electrical appliance buyers, 1,730 gas appliance buyers in Australia and New Zealand) and 500 retailers and installers in Australia. Random sub-samples were drawn in each city using an electronic phone book with an inbuilt sampling function. At the analysis stage, data was weighted to realign the samples with population proportions. A sub-sample of 200 general public was interviewed face-to-face to validate questions on prompted recall of the labels,*

> *producing results within 1% of the main samples. The interviews were conducted in September and October 2005.* (Artcraft 2006: page 1)

These findings contrast with almost universal recognition of the energy label for electrical appliances. 94% of Australian consumers recall the electrical label unaided, rising to 96% when prompted, on a par with leading market brands and high profile celebrities. 88% of consumers say that they use the labelling information at some point in appliance selection processes.

Failure to recall the gas label would not be a problem if the replacement transaction occurred in a way that brought the label to the consumer's attention. However, it is unusual for consumers to see the gas label before purchase. Water heaters are not 'shop floor' items and do not have the same consumer exposure as other types of household appliance. And, as noted, the urgent need for a replacement limits the opportunity to absorb and assess labelling information.

Much then depends on whether the installers who are invited to quote are motivated to educate consumers about the range of products that are available, inviting them to stop and think about the possible advantages of buying a more expensive unit that is more energy efficient. We are sceptical about that prospect, mainly because of the urgency of most replacements, the lack of repeat business (at least for 10-15 years), and because the customer does not see the label. This suggests that there may be little opportunity or incentive for installers to establish their credentials to the level needed to promote energy efficiency or, indeed, any aspect of their product other than that it is an established brand at a good price and available for quick installation. Suppliers did not respond to E3's invitation, in the consultation RIS, to comment on the (a) strength of installer incentives to promote energy efficiency in the context of a replacement transaction, and (b) whether anything is to be learned by further researching installer behaviour.

Conclusion
The bi-modal nature of the GWH market seems to have become entrenched, with the large majority of models and sales being at either 3 stars or 5 stars. Based on the above considerations, E3 considers that there is no reasonable prospect that a reformed labelling scheme would have an impact on the sales of 3-star products that is comparable with the impact of MEPS, and several years would be lost in testing a doubtful proposition.

In general, E3 uses energy labelling to complement MEPS, not as a substitute for MEPS. Labelling and MEPS have different roles, one being to encourage development of high efficiency options, the other being to put a floor under low efficiency options.

3.3.3 Appliance subsidies and levies

Another means of increasing the uptake of energy efficient products is to increase the life-cycle cost (purchase plus operating costs) of inefficient products, relative to their more efficient counterparts. Broad options are to impose a levy on energy purchases. Another is to impose a levy on the purchase of inefficient appliances or to subsidise the purchase of efficient appliances.

Three of the state governments – Queensland, Victoria and Western Australia – subsidise the installation of solar water heaters and 5-star GWH. (See appendix A for details). These are targeted programs that are aimed at replacing electric water heaters or encouraging take-up of solar water heaters. Requirements that replacement GWH be 5 stars are minor to the main purpose of these interventions, which is to replace electric water heaters. The Queensland intervention is restricted to a limited number of households on a first-come-first-served basis. None of the programs aim to replace existing GWH with more efficient units.

In a review of policies for energy efficient homes, IEA says most of its members use a variety of policies but that the most widely adopted policies are information and awareness, labelling and MEPS, with the latter defined to include voluntary agreements. It says that other procurement programs and financial incentives are used much less frequently and for limited durations (IEA 2003: page 55). Financial incentives are mostly implemented by state and local authorities and by utilities, and take the form of rebates. This accurately describes Australia. The IEA report contains no examples of financial penalties (levies) on the purchase of inefficient household appliances.

Levies and subsidies have ‘in principle' attractions relative to MEPS. In particular they would allow households with a particular preference for an inefficient appliance – on grounds of low use or costs of changeover – to obtain the preferred appliance by paying the levy or refusing the subsidy. Nevertheless, E3 has not examined the feasibility of deploying financial measures to influence consumer decisions for long periods in mass markets. The main reason to doubt that such work would be productive is the administrative complexity and rigour of an ongoing program that requires large amounts of money to change hands. Labelling and standards programs use existing regulatory mechanisms and are much less demanding on the taxpayer.

E3 believes that there would be no support for policy work of this kind and can only provide a more detailed analysis of such options if and when that situation changes.

Conclusion
E3 is unable to shortlist plausible options for market-based interventions, or provide detailed analysis of any such options. That would require extensive consultation at the highest levels of government and ultimately, like emissions trading, would require a change of policy at the national level.

3.3.4 Alternative regulatory forms

Regulatory forms with a substantial voluntary component
The proposed arrangement, relying on black-letter law, is standard operating procedure for the E3 Program. It uses the administrative and legislative machinery that is familiar to Australian and New Zealand industry, being Australian/New Zealand Standards and the legislative instruments that the Australian states and territories and New Zealand use to reference these standards and give them legal effect.

It has been E3's experience that suppliers do not respond to regulatory proposals with a substantial voluntary component – such as self-regulation, quasi-regulation or co-regulation. There is no tradition of government/industry co-operation on the matters under consideration, and no history of industry associations that exercise significant persuasive or disciplinary power to ensure compliance with commitments that are entered into voluntarily.

A related consideration is that, according to the local staff of foreign-owned companies, it is extremely difficult to induce head office to address such matters unless there is an explicit regulatory requirement in prospect.

This general lesson has been reinforced in the present case. When it became apparent in 2006 that there would be significant delays in revising the standard, E3 proposed that suppliers devise a voluntary program of retiring the least efficient water heaters, and offered assistance to work through the issues. Suppliers simply did not respond to this offer and E3 concluded that there was no prospect of significant voluntary change.

Voluntary agreements have been used extensively in the European Union but not as a matter of preference. Historically, IEA has explained that:

> *Unlike for labels, there is currently no framework regulation for MEPS in the EU and thus each additional MEPS requirement has to be introduced as a separate piece of primary regulation. ... Because of the arduous and time-consuming process of developing MEPS legislation for individual products, the Commission has often sought instead to negotiate voluntary agreements with industry. These implore the majority of manufacturers supplying the product to the EU market to either cease manufacture of less efficient equipment or raise the fleet average of their product lines or both. Thus far, negotiated agreements on seven products have been concluded. (IEA 2003: page 65).*

The European Union has since established (in 2005) a framework for setting minimum design requirements, including energy efficiency, for all energy using products in the residential, tertiary and industrial sectors. A number of measures have now been implemented – for lighting products, set-top boxes and the standby mode of appliances. As discussed in section 3.3.1, the preliminary analytical work for regulating water heaters was completed in late 2007.

E3 has tried and failed to make progress on the basis of a voluntary agreement. It does not have a workable proposition to put forward for detailed analysis.

Building regulations
The Australian Building Codes Board is examining options for including hot water systems in the energy efficiency requirements of the Building Code of Australia.

The New Zealand Building Code includes provisions for minimum levels of energy efficiency for gas water heaters. The minimum energy efficiency is specified in the standard NZS4305:1996. The introduction of gas water heating MEPS would not cause any integration issues with New Zealand building regulations. MEPS would control the efficiency of gas water heaters that can be imported or manufactured in New Zealand, while the Building Code controls the efficiency of gas water heaters that are installed in new buildings.

E3 considers that any unresolved integration issues should not delay a decision on the proposed measures. It is sensible for building regulators and product regulators to separately consider these issues. This is because new construction presents low cost ‘greenfields’ options for emissions abatement, unconstrained by the additional cost factors that often apply to the upgrading of existing buildings. Whatever the decisions taken by product regulators, building regulators should separately consider the standards that are appropriate for new buildings.

3.4 Shortlist of feasible options

Based on the above discussion, the only feasible options are:

- *WoSM option:* This is the option of not implementing any further measures that are specific to gas water heating. Their energy efficiency would still evolve but mainly in response to price signals from the CPRS in Australia and similar to similar carbon pricing signals overseas.
- *WSM options:* E3 has identified four options for implementing specific measures.

    Option 1: 4-star MEPS from October 2010

    Option 2: 5-star MEPS from October 2010

    Option 3: 4-star MEPS from October 2010, 5.2-star MEPS from October 2013

    Option 4: 4-star MEPS from October 2010. 5.5-star MEPS from October 2013

> Suppliers would have the benefit of transitional arrangements under each of these options, allowing 12 months for pre-existing products to be registered under the revised energy rating test.

E3 seeks to (a) identify feasible specific measures that may deliver net benefits relative to the WoSM scenario, and (b) identify the option that provides the greatest net benefits. Note that the WoSM option is the default option. It becomes the preferred option if there are no WSM options that cost-effectively improve on the WoSM scenario. The next two chapters report E3's assessment of the WSM options, for Australia and New Zealand respectively.

4 Impact analysis: Australia

The measures are assumed to apply during the 11 year period from 2010 to 2020. This chapter reports impacts at each stage in the process by which abatement is achieved, and provides a comparative analysis of the four short-listed options. Appendix F summarises the impact analysis for each State and Territory under E3's favoured option (option 1).

4.1 Cost to the taxpayer

Table 4.1 provides estimates for the incremental cost of including GWH in the E3 program, which is taxpayer funded. E3 estimates that, in the period to 2009, it will spend $290,000 to develop the proposals and facilitate the revision of *AS4552*, with a major component being the program of laboratory testing to evaluate the existing test procedures and inform the development of new test procedures.

The continuing costs are for check-testing, maintenance of the product register, and the maintenance of stakeholder relationships. All incremental costs to taxpayers will be incurred at the Commonwealth level. The registration and enforcement tasks at the state and territory level are not materially altered.

E3 have high confidence in these estimates.

TABLE 4.1 COST TO THE TAXPAYER OF INCLUDING GWH IN THE E3 PROGRAM

	Cumulative total to 2009 ($)	*Annually, 2010-2020 ($/year)*
Laboratory tests (store surveys to 2006 and combination of store surveys and compliance testing after 2006)	$150,000	$12,500
Industry consultation (to formulate testing procedures, standards and agree on timetables)	$50,000	$1,000
Analysis and publications (strategy documents, impact statements)	$50,000	$1,000
Program administration	$40,000	$5,500
Total	**$290,000**	**$20,000**

4.2 Business compliance costs

The Council of Australian Governments (COAG) requires each RIS to provide estimates of the administrative and paperwork costs incurred by a business in meeting regulatory requirements, defined as follows:

- *Notification:* costs of reporting transactions before or after the event
- *Education:* maintaining awareness of regulations and regulatory changes
- *Permission:* applying for and obtaining permission
- *Purchases:* materials and equipment required for compliance

- *Record keeping:* keeping statutory documents up to date
- *Enforcement:* facilitation of audits and inspections
- *Publication and documentation:* displays and labels
- *Procedural:* required compliance activities such as fire drills and safety inspections

Regulators throughout Australia approve appliances for sale by recognising the certification processes operated by AGA and others,[22] which means that suppliers already incur costs under most of these headings. It is assumed that these procedures will not be affected. But there will be incremental costs of both a once-only and continuing nature. All these will be incremental costs of obtaining permissions – to test and certify continuing products against the new standard, to test and certify new products that will be introduced in the transition period, and to test and certify products that will be introduced in the subsequent period to 2020. There will be ongoing costs for the latter because the new energy test will be more exhaustive and costly than the existing test.

There are two sources of uncertainty about the incremental permission costs. First, there is uncertainty about how suppliers will respond. This will be a mix of product rationalisation, the partial redesign or 'tweaking' of existing products (for example, to marginally increase efficiency or to alter existing 3-star products to provide a range of 4-star products with 5-year warranties), and full product redesign. The incremental compliance cost is different in each case.

Second, there is uncertainty relating to the structure of fees for testing and certification. For example, the testing of a group of products may require a full test for only one member of the group, costing about $15,000, plus incremental costs of about $5,000 per additional member of the group, depending on design commonalities. It may cost $3,000 to $5,000 to retest a model or family of models that have been 'tweaked', and a similar amount where the test is solely to determine the energy rating of a product. Certifier charges are also structured around a base charge of about $3,000 for a related family of products, which means that the charge per product depends on the number of products in the family group. Importers sometimes engage a consultant to co-ordinate the application for certification and would pay fees of $4,000 for a family of products, but with as 25% discount for single products, and charges of $500-$1,000 for product modifications. We include these in the cost of certification and use the consultant's fee as a proxy for the paperwork costs incurred by suppliers who make applications directly. Table 4.2 summarises the unit cost assumptions that E3 adopted.

Table 4.3 presents our findings and is organised around four broad types of products – existing products that will comply with the MEPS but need to be retested (panel 2), products that will be partially redesigned or fully redesigned (panels 3 & 4), and new products that are introduced after 2010 but will require a more costly energy test (panel 5). The total compliance cost for each category of product is obtained by multiplying the number of products by the average incremental permission cost. The following broad judgments are incorporated in table 4.3:

- For GsWH, it is assumed that one third of non-complying products are replaced by new products that would, under WoSM conditions, have been introduced in the relevant timeframe. (The underlying assumption is that average product life is nine years and that one third of products will be replaced in the three years to October 2010.) Of the remaining two thirds, one half is by partial redesign of existing 5-star products and one half is by full redesign.
- We understand there will be some rationalisation of the GiWH range of product but no significant impact on the rate at which new products are introduced.

[22] The function of the certifier is to assess whether the product meets the requirements of a certification scheme, including relevant standards. The supplier engages the certification process by submitting an application in the approved form, complete with drawings, test results and other technical information.

TABLE 4.2 INPUTS TO THE BUSINESS COST CALCULATION

Category	*Task*	*Cost input ($/product)*	*Sources*
Permission	Once-only energy re-test for complying product	$3,000-$6,000	Test lab
Permission	Once-only re-certification of complying product	$1,500-$3,000	AGA and certification consultant
Permission	Once-only energy test for 'tweaked' product	$1,500	Test lab
Permission	Once-only certification of 'tweaked' product	$1,500	AGA and certification consultant
Permission	Once-only energy test for redesigned product	$10,000	Test lab
Permission	Once-only certification of re-designed product	$3,000	AGA and certification consultant
Permission	On-going energy test for new products	$1,500-$3,000	Test lab
Permission	On-going certification for new products	$750-$1,500	AGA and certification consultant

- Average testing and certification costs are commensurate with the available price information, but assuming that discounts apply to product groups.
- Intermediate and small suppliers pay higher unit prices for testing and certification (per product) because they have fewer products per certification.

Total additional expenditure is $770,100 over the period to 2020. These outlays have a present value of $648,500. Our confidence in this estimate is medium to high, since it has attracted no adverse comment from suppliers when presented in the consultation RIS.

Note that table 4.3 reports separately for three broad categories of supplier – major, intermediate and small – that have been defined according to the number of products registered in April 2007.

It should also be noted that COAG's concern is to monitor the administrative and paperwork burden imposed by the particular form of regulatory transaction between government and business. These compliance costs are defined to exclude the costs of developing and testing new products, except for the cost of the final certification test. The costs of product development are assumed to be recovered from consumers and are counted as part of the price premium that is paid for more energy efficient products. These are included in the assessment of impacts on consumers (section 4.4) and would be counted twice if included here.

TABLE 4.3 ESTIMATE OF BUSINESS COMPLIANCE COSTS – AUSTRALIA

	Category of supplier			*Total*
	Large	*Intermediate*	*Small*	
1. Supplier characteristics				
Number of suppliers	3	3	4	10
Average products per supplier	16.0	4.3	1.0	
Total products	48	13	4	65
2. Re-testing & certification of complying products (once-only)				
Averages				
products per supplier	5.0	4.3	0.6	
energy tests ($, permission cost)	3,000	4,000	6,000	
certification ($, permission cost)	1,500	2,000	3,000	
Totals				
products	15	13	2.4	30.4
energy tests ($, permission cost)	45,000	52,000	14,400	111,400
certification ($, permission cost)	22,500	26,000	7,200	55,700
3. Testing & certification of partially redesigned products (once-only)				
Averages				
products per supplier	2.3	-	-	
energy tests ($, permission cost)	1,500			
certification ($, permission cost)	1,500			
Totals				
products	7			7
energy tests ($, permission cost)	22,500			22,500
certification ($, permission cost)	22,500			22,500
4. Testing & certification of fully redesigned products (once-only)				
Averages				
products per supplier	2.7	-	-	
energy tests ($, permission cost)	10,000			
certification ($, permission cost)	3,000			
Totals				
products	8			8
energy tests ($, permission cost)	150,000			150,000
certification ($, permission cost)	45,000			45,000
5. Incremental ongoing costs (per year to 2020)				
Averages				
new products per supplier	3.2	0.9	0.2	
energy tests ($, permission cost)	1,500	2,000	3,000	
certification ($, permission cost)	750	1000	1500	
Totals				
new products per year	9.6	2.6	0.8	13
energy tests ($, permission cost)	14,400	5,200	2,400	22,000
certification ($, permission cost)	7,200	2,600	1,200	11,000
Present value				
energy tests ($, permission cost)	105,342	38,040	17,557	160,939
certification ($, permission cost)	52,671	19,020	8,779	80,470
6. Present value of all costs ($)				
Energy tests ($, permission cost)	322,842	90,040	31,957	444,839
Certification ($, permission cost)	142,671	45,020	15,979	203,670
Total	**465,513**	**135,060**	**47,936**	**648,509**

4.3 Impacts on competition and trade

Competition
There are three broad ways in which regulations can adversely affect the quality of market competition to meet consumer demand for hot water systems. Regulations can reduce competition by:

1. eliminating product options that cannot be replaced with like-for-like products that are more energy efficient but otherwise have the same features as the prohibited products;
2. reducing the number of suppliers that effectively compete in the market, increasing the market power of the remaining suppliers.

Like-for-like replacements
Regarding the first matter, our baseline assessment of costs and benefits assumes that like-for-like replacements will not always be available for GsWH with 90 litres of storage capacity. (See section 4.4 for the impact analysis for these consumers. They account for about 2.5% of sales.) This judgment may be pessimistic, particularly if MEPS are set at the lower level of 4 stars. Suppliers are understandably reluctant to disclose their assessment of product options and say how they will respond competitively when the regulation is introduced, making it difficult to assess these effects before implementation.

There are lesser risks affecting the replacement of two other types of water heater if the MEPS is set at 5 stars or better.

- 3-star and 4-star GsWH are generally available with 5-year warranties, whereas with the exception of one Aquamax appliance, 5-star GsWH have 10-year warranties. However, we understand that there are minimal material and manufacturing differences between products with shorter and longer warranties, and no significant impediment to the production of 5-star GsWH with 5-year warranties.
- One supplier produces a range of internal GiWH with ratings of 4.5-4.9 stars for a small replacement market of several thousand units a year, but for which there is no like-for-like substitute at 5 stars. However, the supplier considers that complying products will become available before the transition period expires.

E3 assumes that, for these two sub-markets, like-for-like replacements will be developed at reasonable cost. There has been no adverse comment on these assumptions.

Finally, the main GsWH suppliers (Dux, Rheem Australia and Rheem NZ) say that the proposal has unintended adverse consequences for water efficiency. They say that the measure will accelerate the transition to GiWH and that GiWH are less water efficient. This is because, unlike the storage heater which has hot water 'ready to go', the instantaneous type 'ramps up' to its operating temperature and cold water is dumped in the meantime. A more detailed explanation is provided in chapter 6, which summarises supplier comments and reports E3's response. Briefly, however, E3's view is that:

- The water losses associated with GiWH can be minimised through regulation but that this will be addressed separately through the WELS (Water Efficiency Labelling and Standards) program, not E3.
- The cost of such losses is adequately covered by the sensitivity analysis and would not materially affect E3's positive assessment of the benefits to users.

Otherwise, it is important that the proposed regulation is performance-based. It sets a threshold for minimum energy performance and does not constrain the manner in which the minimum level of performance is achieved. It follows that the regulation does not discriminate between suppliers, other than in respect of the energy efficiency of their products. A related consideration is that the new energy rating test will provide for more accurate comparison of storage and instantaneous appliances, which levels the playing field and enhances competition.

<u>Reduced competition</u>
Regarding the second matter, several companies have expressed concerns about effects on their viability and competitiveness.

Morcraft Industries is a small Perth-based company with a single GsWH certification at 3-stars. The proprietor expressed concerns about continued viability when phoned (in May 2007) for comment on the original proposal to introduce MEPS at 5 stars. Morcraft did not respond to the consultation RIS and E3 again phoned for comment on the revised proposal to introduce MEPS at 4 stars. We understand the situation for Morcraft as follows.

- Morcraft is confined to the replacement market, since 5 star GWH are required in new construction. Morcraft manufactures about 120 GsWH per year, suggesting revenues of about $100,000 per year and providing employment for one or two workers at most.
- The Morcraft product was upgraded from 2.1 stars to 3 stars in 2007, including some improvements to insulation. The proprietor has no immediate plans to further upgrade the product, was unaware of the proposed changes to the energy rating test, and unaware of the proposed MEPS and timing.
- Morcraft has not considered how to respond to the proposed regulatory changes but expressed concerns about continued viability if MEPS at 4 stars is introduced. Of particular concern is the cost of shipping products to Melbourne laboratories for energy rating tests.

The proposed measures may put Morcraft out of this line of business but that is not known, even to Morcraft. Morcraft has such a small share of the market for GsWH – about 0.1% – that its withdrawal would have no significant impact on competition.

Dux, Rheem Australian and Rheem NZ say that, because the major impact of MEPS is to increase the efficiency and cost of GsWH, they will be less competitive relative to GiWH and their market share will decline relative to GiWH. This will inhibit the development and production of storage-based water heating technologies, including solar hot water systems, and it will accelerate a trend that threatens its manufacturing operation, which employs nearly 1,000 people. These concerns are now exacerbated by the proposed phase-out of electric water heaters, where storage heaters dominate.

A more detailed explanation is provided in chapter 6. Briefly, however, E3 considers that, while the GsWH suppliers seem to have downplayed some important countervailing considerations, E3 cannot credibly assess commercial judgements of this kind. E3 has therefore developed the proposal for MEPS at 4 stars. It has the support of Dux, Rheem Australia and Rheem NZ.

Envestra is a gas distributor and is concerned that the proposal will discourage the further roll-out of the gas network and the take-up of gas by households with access to gas. Again, a more detailed explanation is provided in chapter 6. Briefly, however, E3 considers that any adverse effect is overstated because the 3-star GsWH that would be phased out are largely confined to the replacement market, which means that they have minimal impact on the economics of extensions to gas networks and the rate of gas take-up on new housing estates. Also, these concerns are moderated significantly if the MEPS is set at 4 stars.

Impacts on small producers
With the exception of Morcraft, the smaller producers that are listed in the profile of GWH products (section 1.2) appear not to have concerns about their continued viability. Three are suppliers of GiWH that are already rated at 5.5 stars or better. The only remaining

small supplier – HWS Australia – produces internal GsWH that have been excluded from the proposal.

GATT issues
The proposal needs to be consistent with Australia's international obligations under the Technical Barriers to Trade (GTBT) Agreement, which is part of the General Agreement on Tariffs and Trade (GATT). Article 2 of the GTBT Agreement relates to the preparation, adoption and application of technical regulations by central governments and provides for matters like the even-handed treatment of imports and domestically produced products, the avoidance of unnecessary obstacles to international trade, the development and use of international standards where possible, acceptance of the regulations of other countries where possible, and the adoption of performance-based regulation where possible.

Based on the following considerations, the proposed regulations are fully consistent with the GTBT Agreement:

- E3 reviewed the standards that are applied in Europe, North America and Japan and found that none have been developed to the point where they provide an acceptable basis for MEPS regulation in Australia and New Zealand.[23] Either they are specific to local definitions of the heating task[24] (Europe) or they have yet to provide adequately for instantaneous designs (North America).
- Australia's approach to the reform of the energy test may provide the basis for an international standard. The intention is to develop a test that measures the underlying determinants of the overall energy efficiency of a GWH, allowing performance to be simulated and measured for any heating task, and dispensing with local definitions of the heating task.
- The proposed regulation is performance-based. As such, it does not discriminate between importers and domestic manufacturers.

Trans-Tasman Mutual Recognition Arrangement (TTMRA)
The only further issue is that Australia and New Zealand have different arrangements for the regulation of gas appliance safety, to the point where gas appliances have an exemption under the TTMRA. For gas water heaters, the practical effect is that all products that Australian safety regulators allow to be sold in Australia can also be sold in New Zealand, but not all products that New Zealand safety regulators allow to be sold in New Zealand can also be sold in Australia.

The proposed energy efficiency regulations will not alter this situation, nor will they be affected by it. The proposed MEPS will be mandated using stand-alone Standards, under the various energy efficiency regulations of the States, Territories and New Zealand. Lloyd Harrington[25] has explained that the revised energy rating tests will require simple safety checks for the purposes of the rating test - for electrical connections, gas leaks and carbon monoxide. This means that the adoption of the proposed regulations by both New Zealand and Australia, as intended, is not a *de facto* imposition of Australian safety standards on products sold in New Zealand.

New Zealand and Australian officials are working towards resolution of the differences with respect to safety regulation and the removal of the exemption that now applies to gas appliances under the TTMRA. The proposed regulation does not make that task any more difficult or less difficult. They are separate issues.

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[23] These findings have yet to be published. The account given here is based on personal communications with E3's technical consultants, Lloyd Harrington (Energy Efficient Strategies) and Peter King (Enertech).
[24] The heating task refers to the operational circumstances under which the test is performed, for example, relating to the number and amount of hot water draw-offs, and allowed recovery times.
[25] Lloyd Harrington is a technical advisor to the AGO represents the AGO on the relevant committees of Standards Australia.

4.4 Consumer impact

This section deals separately with the impact on consumers in all segments of the market that would be affected by MEPS, but starts with a brief statement of methodology.

4.4.1 Overview of methodology

Annualised life cycle cost

The life cycle cost (LCC) of a hot water service is the sum of four cost elements, (1) water heater, (2) installation costs, (3) gas and electricity costs, and (4) maintenance costs. LCC is usually expressed in present value terms, which is the amount of an up-front payment that would cover all future costs of the hot water service, including energy, but discounted to allow for the fact that present dollars are more valuable than future dollars. LCC can also be expressed as the annualised equivalent of the present value amount. This is the periodic payment that, if paid annually for the period of the hot water service, would have same present value as the up-front payment. We report cost estimates in terms of annualised LLC because it facilitates the comparison of water heaters with different lives. Our reporting of impacts – that is, the effect of MEPS in raising the energy efficiency of a water heater – is usually in terms of changes in capital and energy costs. This means that cost reductions (usually energy) are reported as negative numbers, and cost increases (usually capital) are reported as positive numbers. The only exception is the reporting of the 'investment analysis' in terms of a net present value: a positive net present value indicates a net benefit.

Installation and maintenance costs are generally ignored on the assumption that they are roughly the same for complying and non-complying GWH of the same type. The only exception is where more efficient GiWH have electronic controls and need to be connected to electricity.

A discount rate of 7.5% is used in the discounting and annualising calculations.

Key parameters

Appendix B provides a more detailed statement of methodology. In brief, however, the main points are as follows:

- *Hot water usage:* The baseline figuring reported in the consultation RIS was based on the assumption that the average household uses 200 litres of hot water per day, which is the amount prescribed in AS4234 for the purposes of the energy rating test. Two suppliers – Dux and Rinnai – commented that this is likely to be an overestimate but, historically, had been adopted in the absence of any better information. (See our summary of the consultation process, section 6.5.3, for more detail.) E3 has now adopted more realistic estimates of hot water usage, drawing on a finding in the baseline study that the average Australian household uses 110 litres/day. This is an average across all households including small households and apartment dwellers who are more likely to use the smaller electric water heaters. For the purposes of this RIS, it has been assumed that there is a spread of hot water loads across the various GsWH: 100 litres/day for the 90 litre GsWH, 125 litres/day for the 135 litre GsWH, and 140 litres/day for 170 litre GsWH. Average hot water usage is put at 125 litres/day for GiWH. As it happens, the assessment is not sensitive to assumptions about hot water usage. This is because the main difference between GsWH at 3, 4 and 5 stars is the size of their standing loss. The standing loss is the heat that is lost from stored hot water regardless of how much hot water is drawn off. Measures to reduce standing losses, such as additional tank insulation, are effective even if no hot water is drawn off.
- *Water heater efficiency:* The records of product certifiers provide basic information about the efficiency of GWH, including differences between GiWH and GsWH, differences between internal and external GWH, and the number of models in the various efficiency ranges of interest. Depending on the stringency, MEPS will

eliminate some of these options and it has been assumed that users will replace old non-complying units with new complying units with the lowest permitted level of efficiency. The estimates are not sensitive to this assumption, since the least efficient complying units are generally close to the minimum required level of efficiency.

- *Energy tariffs:* Energy savings are valued at the marginal tariff. The average gas tariff is estimated at 1.8 cents/MJ. This is somewhat higher than the figure used in the consultation RIS and was developed with reference to Treasury modelling of the impact of CPRS, as reported in *Australia's Low Pollution Future: the economics of climate change mitigation* (Treasury 2008). The Treasury projections allow for both an increase in the price of gas and the projected emissions charge.
- *Incremental cost of more efficient GWH:* We used the concept of a price/efficiency ratio to model the impact of MEPS on the cost of GWH. This is the ratio of the increase in the price of the GWH to the increase in the efficiency of the GWH. For example, a price/efficiency ratio of 1.0 indicates that a 10% increase in efficiency is accompanied by a 10% increase in price. Similarly ratio of 0.5 indicates that a 10% increase in efficiency is accompanied by a 5% increase in price, and a ratio of 2.0 indicates that a 10% increase in efficiency is accompanied by a 20% increase in price. The lower ratio (0.5) is assumed to apply to the transition from 3-star GsWH to 4-star GsWH. The intermediate ratio (1.0) is assumed to apply to the transition from 4-star GsWH to 5-star GsWH and to GiWH in the range 4.5 stars to 5.5 stars. The higher ratio is assumed for any improvement in GsWH beyond 5.2 stars, which is unexplored territory in terms of the GsWH that are now on the Australian market. As discussed in appendix B, this approach seems to generate conservative (that is, high) estimates of the price increases when compared with the available price and cost data.
- *Asset life:* GWH with 5 and 10 year warranties are assumed to have asset lives of 11 and 15 years respectively.

4.4.2 Internal GWH

E3 is confident that MEPS at 4 stars will have no effect on markets for internal GWH, either GsWH or GiWH.

- As explained in section 3.2.3, E3 proposed to exclude internal GsWH from the new MEPS. The early cost benefit analysis for this option is reported in appendix C.
- There would be no sales of GiWH at less than 4 stars under WoSM conditions.

E3 considers that MEPS at 5.0, 5.2 or 5.5 stars would probably have no effect on markets for internal GWH, and certainly no more than a minimal effect.

- Again, internal GsWH are excluded.
- With the exception of the products of one supplier, all internal GiWH are already at 5.5 stars or better.
- We discussed the issue with the remaining supplier, who has products that were originally introduced in the mid-1990s and have energy ratings in the range 4.5-4.8 stars. We understand that these will be phased out before the MEPS are implemented, and replaced with high performance products.

4.4.3 External GsWH

E3 has assessed the impact of each MEPS option on each of five segments of the market for external GsWH as follows.

- 90 L external GsWH, 5 year warranty
- 135 L external GsWH, 5 year warranty

- 170 L external GsWH, 5 year warranty
- 135 L external GsWH, 10 year warranty
- 170 L external GsWH, 10 year warranty

Table 4.4 reports the impact analysis for typical households with each of these types of GsWH. Note that there are two parts to each panel of results. The top part reports energy use and the annualised cost of water heating at each level of efficiency that is of interest. The bottom part reports the incremental impact of shifting the typical household from one level of efficiency to the next highest levels. The amounts in the bottom part are the differences between the amounts in the relevant columns of the top part.

Currently there are no external GsWH in the market at the 4-star level or at 5.2 or more stars. Hence there are only two types of households in the existing market.

- There are households that would have purchased 3-star GsWH under WoSM conditions and are exposed to MEPS options at all of the efficiency levels that are reported in table 4.4.
- There are households that would have purchased 5-star GsWH under WoSM conditions and are exposed only to MEPS options at 5.2 stars or 5.5 stars.

The key findings are.

- 4-star MEPS reduces the cost of hot water service in all households that are exposed to 4-star MEPS. Average household costs fall by $20-30/year.
- 5-star MEPS reduces the cost of hot water service in all households that are exposed to 5-star MEPS. The incremental cost saving, from 4 to 5 stars, is $10-20/year. The combined cost saving, from 3 to 5 stars, is $30-50/year.
- The addition of a second stage of MEPS, at 5.2 or 5.5, stars does not further reduce the cost of hot water services for the average households. But nor do they significantly increase the cost. The financial impacts are marginal.

E3 is confident that the assessments for MEPS options 1 and 2 are reliable, at 4 or 5 stars. However, there is uncertainty about options 3 and 4, at 5.2 or 5.5 stars, since 5.2 stars is the highest rating that GsWH have achieved to date: there are no GsWH with energy ratings of 5.5 stars. Plausibly, the cost of GsWH at these higher levels of efficiency would be such that the GiWH would generally be preferred, and higher MEPS would trigger the collapse of GsWH production.

TABLE 4.4 IMPACT ANALYSIS FOR THE AVERAGE AUSTRALIAN HOUSEHOLD - EXTERNAL GSWH

Pane A: External GsWH, 90 L, 5 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	100	100	100	100	100
Av. efficiency of water heater (stars)	3.25	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	16,236	14,400	12,952	12,696	12,166
Annual emissions (tonnes CO2e)	1.09	0.97	0.87	0.85	0.82
Capital cost	$935	$1,037	$1,150	$1,183	$1,250
Annualised life cycle cost ($/year)					
Capital	$119	$132	$146	$150	$159
Energy	$313	$278	$250	$245	$235
Total	$432	$410	$396	$395	$394
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-1,837	-1,447	-257	-530
Annual emissions (tonnes CO2e)		-0.12	-0.10	-0.02	-0.04
Capital cost		$102	$113	$33	$68
Annualised life cycle cost ($/year)					
Capital		$13	$14	$4	$9
Energy		-$35	-$28	-$5	-$10
Total		-$23	-$14	-$1	-$2

Panel B: External GsWH, 135 L, 5 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	120	120	120	120	120
Av. efficiency of water heater (stars)	3.14	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	18,046	15,970	14,481	14,217	13,672
Annual emissions (tonnes CO2e)	1.21	1.07	0.97	0.95	0.92
Capital cost	$990	$1,037	$1,150	$1,183	$1,250
Annualised life cycle cost ($/year)					
Capital	$126	$132	$146	$150	$159
Energy	$348	$308	$279	$274	$264
Total	$474	$440	$426	$425	$423
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-2,075	-1,489	-264	-545
Annual emissions (tonnes CO2e)		-0.14	-0.10	-0.02	-0.04
Capital cost		$47	$113	$33	$68
Annualised life cycle cost ($/year)					
Capital		$6	$14	$4	$9
Energy		-$40	-$29	-$5	-$11
Total		-$34	-$14	-$1	-$2

... table continues over the next two pages

Panel C: External GsWH, 170 L, 5 year warranty					
	3 stars	4 stars	5 stars	5.2 stars	5.5 stars
Daily hot water load (litres)	140	140	140	140	140
Av. efficiency of water heater (stars)	2.95	4.03	5.09	5.25	5.55
Annual gas consumption (MJ)	20,202	18,113	16,068	15,759	15,179
Annual emissions (tonnes CO2e)	1.35	1.21	1.08	1.06	1.02
Capital cost	$1,117	$1,165	$1,310	$1,351	$1,428
Annualised life cycle cost ($/year)					
Capital	$142	$148	$167	$172	$182
Energy	$390	$350	$310	$304	$293
Total	$532	$498	$477	$476	$475
Incremental impact of MEPS		3 to 4 stars	4 to 5 stars	5 to 5.2 stars	5.2 to 5.5 stars
Annual gas consumption (MJ)		-2,089	-2,045	-309	-580
Annual emissions (tonnes CO2e)		-0.14	-0.14	-0.02	-0.04
Capital cost		$49	$145	$41	$77
Annualised life cycle cost ($/year)					
Capital		$6	$18	$5	$10
Energy		-$40	-$39	-$6	-$11
Total		-$34	-$21	-$1	-$1

Panel D: External GsWH, 135 L, 10 year warranty					
	3 stars	4 stars	5 stars	5.2 stars	5.5 stars
Daily hot water load (litres)	120	120	120	120	120
Av. efficiency of water heater (stars)	3.14	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	18,046	15,970	14,481	14,217	13,672
Annual emissions (tonnes CO2e)	1.21	1.07	0.97	0.95	0.92
Capital cost	$1,110	$1,157	$1,270	$1,303	$1,370
Annualised life cycle cost ($/year)					
Capital	$141	$147	$161	$166	$174
Energy	$348	$308	$279	$274	$264
Total	$489	$455	$441	$440	$438
Incremental impact of MEPS		3 to 4 stars	4 to 5 stars	5 to 5.2 stars	5.2 to 5.5 stars
Annual gas consumption (MJ)		-2,075	-1,489	-264	-545
Annual emissions (tonnes CO2e)		-0.14	-0.10	-0.02	-0.04
Capital cost		$47	$113	$33	$68
Annualised life cycle cost ($/year)					
Capital		$6	$14	$4	$9
Energy		-$40	-$29	-$5	-$11
Total		-$34	-$14	-$1	-$2

Panel E: External GsWH, 170 L, 10 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	140	140	140	140	140
Av. efficiency of water heater (stars)	2.95	4.03	5.09	5.25	5.55
Annual gas consumption (MJ)	20,202	18,113	16,068	15,759	15,179
Annual emissions (tonnes CO2e)	1.35	1.21	1.08	1.06	1.02
Capital cost	$1,117	$1,165	$1,310	$1,351	$1,428
Annualised life cycle cost ($/year)					
Capital	$142	$148	$167	$172	$182
Energy	$390	$350	$310	$304	$293
Total	$532	$498	$477	$476	$475
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-2,089	-2,045	-309	-580
Annual emissions (tonnes CO2e)		-0.14	-0.14	-0.02	-0.04
Capital cost		$49	$145	$41	$77
Annualised life cycle cost ($/year)					
Capital		$6	$18	$5	$10
Energy		-$40	-$39	-$6	-$11
Total		-$34	-$21	-$1	-$1

4.4.4 External GiWH

Table 4.5 reports the impact analysis for typical households with GiWH. There is no 3-star GiWH in the market, which accounts for the empty columns at 3 stars in table 4.5. But there are GiWH at all of the other levels, which means that there are three types of households.

- Households that would have purchased 4-star GsWH under WoSM conditions are exposed to MEPS at 5 stars, 5.2 stars and 5.5 stars.
- Households that would have purchased 5-star GsWH under WoSM conditions and are exposed to MEPS at 5.2 stars and 5.5 stars.
- Households that would have purchased 5.2-star GsWH under WoSM conditions and are exposed to MEPS at 5.5 stars.

The key findings are.

- 4-star MEPS have no effect.
- 5-star MEPS reduces the average household's cost of hot water by about $13/year.
- The addition of a second stage of MEPS at 5.2 or 5.5 stars is also cost reducing. The marginal effects are small, of the order of $2-4/year, because the efficiency gains are small.

E3 is confident that these assessments are reliable but acknowledges that the assessments of MEPS at 5.2 stars or better have not been tested in public consultation. The cost assessment are probably conservative, since there is no evidence of significant price differences that are related to efficiency differences in the range 5 to 5.5 stars. In fact, some of the evidence is perverse, indicating that the more efficient GiWH are cheaper.

TABLE 4.5 IMPACT ANALYSIS FOR THE AVERAGE AUSTRALIAN HOUSEHOLD - EXTERNAL GIWH

Pane A: External GiWH, 10 year warranty				
	4 stars	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	125	125	125	125
Av. efficiency of water heater (stars)	4.35	5.12	5.31	5.64
Annual gas consumption (MJ)	14,881	13,910	13,672	13,253
Annual emissions (tonnes CO2e)	1.00	0.93	0.92	0.89
Capital cost	$1,047	$1,088	$1,108	$1,143
Annualised life cycle cost ($/year)				
Capital	$110	$115	$117	$121
Energy	$287	$268	$264	$256
Total	$398	$383	$381	$376
Incremental impact of MEPS		*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-971	-238	-419
Annual emissions (tonnes CO2e)		-0.07	-0.02	-0.03
Capital cost		$41	$20	$35
Annualised life cycle cost ($/year)				
Capital		$4	$2	$4
Energy		-$19	-$5	-$8
Total		-$14	-$2	-$4

4.5 Nationwide impact

The nationwide impacts are calculated by 'scaling up' the impacts that have been reported for typical households in each of the product segments. They are scaled up according to the sales projections that are reported in chapter 1. Some of the product segments are more important than others.

- The market for 90L GsWH is a niche market for replacement units and confined to households that are either relatively small or located in mild and warm climates, such as parts of Queensland. Sales are about 3,250/year, and declining. The sales projection indicates that the proposed MEPS would affect sales of 15,000 units in the period 2020.
- The market for 135 L and 170 L GsWH is much larger. The sales projection indicates that MEPS would affect sales of 703,000 units in the 3-star segment and 224,000 units in the 5-star segment.
- The market for 4-star GiWH is small. The measures would affect sales of only 8,000 units.
- The other two GiWH segments are much larger. The measures would affect sales of 574,000 units in the 5/5.2-star segment and sales of 373,000 units in the 5.2/5.5-star segment.

The sales projections include a further large segment of GiWH at 5.5 stars or better, estimated at 356,000. These are not exposed to any of the options.

Tables 4.6 and 4.7 present estimates of the nationwide impacts.

Incremental impacts
Table 4.6 is somewhat hypothetical in the sense that it is concerned only with the impacts from 2013, after both stages of the MEPS have been fully implemented. But it is informative because:

- It avoids the confusion that arises when comparing measures with different start dates.
- It reports the incremental changes that are associated with each level of MEPS – that is, reporting separately for successive increments, from 3-star to 4-star MEPS, from 4-star to 5-star MEPS, from 5-star to 5.2-star MEPS, and from 5.2-star to 5.5-star MEPS. This avoids the confusion that arises when comparing measures that are cumulative but varying combinations of the various increments[26].

Table 4.6 makes clear that there is a basic difference between GsWH and GiWH. Specifically, the investment analysis indicates that GsWH deliver attractive returns to MEPS up to 5 stars but not at 5.2 stars or better. GsWH can deliver significant reductions in gas consumption and emissions beyond 5 stars but E3 cannot make a credible case that this can be done cost-effectively. In contrast, GiWH deliver attractive returns to MEPS up to 5.5 stars, on all criteria.

Cumulative impacts
Table 4.7 reports the associated cumulative impact of the MEPS. Note that:

- The cumulative analysis includes the cost to taxpayers and the business compliance costs.
- The investment analysis is positive in all cases.
- Option 2 (5-star MEPS) delivers a better return than option 1 (4-star MEPS).

[26] However, note that, while the impacts are reported incrementally, the sales are necessarily cumulative. For example, a 3-star GsWH is exposed to MEPS from 4-stars through to 5.5 stars and the separate impacts are reported at each stage in table 4.12.

- Option 3 (4/5.2-star MEPS) delivers a lesser return than option 2 (5-star MEPS). This is largely because the contribution from the 5-star increment is delayed to 2013, not because of any negative consequences of the increment from 5 to 5.2 stars. The latter has a financially neutral effect.
- Option 4 (4/5.5 stars) is superior to all other options, reflecting the large contribution from more efficient GiWH at this level of efficiency.

But, as discussed in relation to the impacts on consumers, there is considerable uncertainty about the price of GsWH that are required to achieve 5.2 stars or more, and also about the market response.

TABLE 4.6 NATIONWIDE INCREMENTAL ANALYSIS OF MEPS OPTIONS: AUSTRALIA, FROM 2013

MEPS increment	*3 stars to 4 stars*	*4 stars to 5 stars*	*5 stars to 5.2 stars*	*5.2 stars to 5.5 stars*
GsWH				
Sales exposed to MEPS, 2013-2020 ('000)	718.3	718.3	941.9	941.9
Lifetime energy				
gas consumption (PJ)	-11.84	-9.73	-2.60	-5.16
emissions (Mt CO2e)	-0.794	-0.653	-0.174	-0.346
Lifetime expenditure, undiscounted ($M)				
capital	24.0	62.3	26.0	51.4
gas	-228.5	-187.8	-50.2	-99.5
total	-204.5	-125.5	-24.2	-48.1
Lifetime expenditure, present value ($M)				
capital	13.6	35.1	14.7	29.1
gas	-90.3	-74.2	-19.0	-37.7
total	-76.7	-39.1	-4.3	-8.6
Investment analysis				
net present value ($M)	76.7	39.1	4.3	8.6
benefit/cost ratio	6.7	2.1	1.3	1.3
GiWH				
Sales exposed to MEPS, 2013-2020 ('000)		12.3	586.2	959.3
Lifetime energy				
gas consumption (PJ)		-0.12	-2.22	-6.40
emissions (Mt CO2e)		-0.008	-0.149	-0.430
Lifetime expenditure, undiscounted ($M)				
capital		0.32	11.61	33.51
gas		-2.29	-42.79	-123.61
total		-1.97	-31.18	-90.10
Lifetime expenditure, present value ($M)				
capital		0.18	6.66	18.92
gas		-0.81	-15.08	-42.85
total		-0.63	-8.42	-23.94
Investment analysis				
net present value ($M)		0.6	8.4	23.9
benefit/cost ratio		4.5	2.3	2.3

TABLE 4.7 NATIONWIDE CUMULATIVE ANALYSIS OF MEPS OPTIONS: AUSTRALIA

MEPS option	*Option 1*	*Option 2*	*Option 3*	*Option 4*
2010 MEPS	*4-star*	*5-star*	*4-star*	*4-star*
2013 MEPS	*no change*	*no change*	*5.2-star*	*5.5-star*
Sales exposed to MEPS, 2010-2020 ('000)	718.3	730.5	1,528.1	1,901.3
Lifetime energy				
gas consumption (PJ)	-17.13	-31.41	-31.87	-43.43
emissions (Mt CO_2-e)	-1.149	-2.106	-2.137	-2.913
Lifetime expenditure, undiscounted ($M)				
cost to the taxpayer	0.41	0.41	0.41	0.41
business compliance costs	0.77	0.77	0.77	0.77
incremental cost of water heaters	34.9	125.6	135.3	220.2
household expenditure on energy	-330.7	-606.1	-615.1	-838.2
total	-294.6	-480.5	-479.8	-618.0
Lifetime expenditure, present value ($M)				
cost to the taxpayer	0.37	0.37	0.37	0.37
business compliance costs	0.65	0.65	0.65	0.65
incremental cost of water heaters	22.2	79.8	79.0	126.9
household expenditure on energy	-147.1	-269.6	-256.9	-337.4
total	-123.9	-188.8	-176.9	-209.4
Investment analysis				
net present value ($M)	123.9	188.8	176.9	209.4
benefit/cost ratio	6.3	3.3	3.2	2.6

4.6 Sensitivity analysis

The sensitivity analysis is organised under two headings, reporting separately for the estimates of nationwide and household impacts.

4.6.1 Sensitivity analysis of nationwide estimates

Table 4.8 reports the sensitivity analysis at the national level for option 1. Similar analyses for the remaining options are reported in appendix D. The discussion in this section is in relation to option 1 (MEPS at 4 stars).

The analysis indicates that the findings are robust. The benefit-cost ratio for option 1 remains above 5.1 under reasonable alternative settings for the key variables.

The contribution to abatement is sensitive to the stock and sales scenario. The phasing out of electric water heaters would enhance the measures, since a proportion of electric water heaters would otherwise be replaced with 3-star GsWH. A more rapid decline of the market for 3-star GsWH under WoSM conditions would reduce the effectiveness of the measures.

The financial benefits are large relative to the costs under all scenarios. This is largely because the cost of upgrading GsWH from 3 stars to 4 stars is relatively small. Suppliers have recently re-registered their 4-star GsWH (which had previously been deregistered) and seem well-placed to bring 4-star GsWH back into production. Also, the measures use the familiar administrative machinery of Standards Australia and product certifiers.

TABLE 4.8 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – AUSTRALIA, OPTION 1 (MEPS AT 4 STARS)

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	718.3	-17.1	-1.15	147.1	23.2	123.9	6.3
Discount rate							
0%	718.3	-17.1	-1.15	330.7	36.1	294.6	9.2
5%	718.3	-17.1	-1.15	189.3	26.6	162.7	7.1
10%	718.3	-17.1	-1.15	116.2	20.4	95.9	5.7
Stock and sales scenario							
phase out of electric water heaters	813.8	-19.4	-1.30	165.2	25.9	139.4	6.4
faster phase out of 3-star GsWH	560.8	-13.4	-0.90	116.9	18.8	98.2	6.2
Gas tariff							
-10%	718.3	-17.1	-1.15	132.4	23.2	109.2	5.7
+10%	718.3	-17.1	-1.15	161.8	23.2	138.7	7.0
Incremental cost of GWH							
+25%	718.3	-17.1	-1.15	147.1	28.6	118.5	5.1
-25%	718.3	-17.1	-1.15	147.1	17.8	129.3	8.3
Hot water load							
-33%	718.3	-16.3	-1.09	140.1	23.2	116.9	6.0
+33%	718.3	-17.9	-1.20	154.1	23.2	130.9	6.6
Estimates of energy savings							
-10%	718.3	-15.4	-1.03	132.4	23.2	109.2	5.7
+10%	718.3	-18.8	-1.26	161.8	23.2	138.7	7.0

4.6.2 Variable impact on individual households

Table 4.9 reports the sensitivity analysis of the impact of option 1 on households. The benefits are such that the analysis remains strongly positive for all plausible variations in assumptions.

Note that we tested for wide variation in the hot water load. This includes a small allowance for regional variations in the heating task due to regional variations in the temperature of cold water.

TABLE 4.9 SENSITIVITY ANALYSIS OF HOUSEHOLD IMPACTS – AUSTRALIA, OPTION 1

	Annualised capital ($)	*Annualised energy ($)*	*Annualised cost of hot water ($)*
Baseline	$6.16	-$40.07	-$33.91
Discount rate			
0%	$4.40	-$40.07	-$35.67
5%	$5.55	-$40.07	-$34.52
10%	$6.78	-$40.07	-$33.29
Incremental cost of GWH			
+25%	$7.67	-$40.07	-$32.41
-25%	$4.65	-$40.07	-$35.42
Hot water load			
-33%	$6.16	-$38.17	-$32.01
+33%	$6.16	-$41.98	-$35.82
Estimates of energy savings			
-10%	$6.16	-$36.07	-$29.91
+10%	$6.16	-$44.08	-$37.92
Gas tariff			
Natural gas			
NSW	$6.16	-$37.58	-$31.42
VIC	$6.16	-$30.52	-$24.36
QLD	$6.16	-$50.46	-$44.30
SA	$6.16	-$40.07	-$33.91
WA	$6.16	-$44.02	-$37.86
TAS	$6.16	-$42.77	-$36.61
NT	$6.16	-$42.98	-$36.82
ACT	$6.16	-$41.94	-$35.78
Cheapest region	$6.16	-$30.32	-$24.15
Most expensive region	$6.16	-$58.97	-$52.81
LPG	$6.16	-$98.84	-$92.68

5 Impact analysis: New Zealand

The measures are assumed to apply during the 11 year period from 2010 to 2020. This chapter reports impacts at each stage in the process by which abatement is achieved, and provides a comparative analysis of the four short-listed options.

The assessments for both New Zealand and Australia are based on the assumption that both countries either accept or reject the proposal. There has been no detailed assessment of impacts if one adopts the proposal and the other rejects the proposal. Probably, New Zealand's decision is of minor consequence for Australia but Australia's decision is of some consequence for New Zealand. For example, stocks of less efficient products could be dumped on the New Zealand market if Australia adopts the proposed MEPS but New Zealand does not.

5.1 Cost to the taxpayer

The incremental cost to the New Zealand taxpayer will be small and relates mainly to program development and the sharing of the costs of check-testing and product registration.

Subject to further consideration by EECA, we have assigned a notional figure of NZ$50,000 to the New Zealand taxpayer.

5.2 Business compliance costs

New Zealand does not require compliance with *AS4552* at present. However, inspection of the declared appliances list (Safety New Zealand website) indicates that the vast majority of new products already comply with the energy efficiency aspects of the Australian standard *AS4552* or one of its precursors, including Australian Gas Standard AG102. This is because major suppliers provide the same products to Australia and New Zealand but certify them in Australia. It appears that the only exceptions are the internal GsWH that are manufactured in New Zealand by Rheem NZ, and which are now excluded from the proposal, and a range of external GsWH that Abergas imports from the United States. Neither of these products is sold or certified in Australia.

Abergas is a small supplier that could be exposed to significant additional compliance costs for a small number (10-20 a year) of GsWH with a US brand (Ruud). The additional costs may be prohibitive for Abergas. The energy rating tests would probably need to be conducted in an Australian laboratory and, allowing for transport costs, would cost at least NZ$20,000. It seems unlikely that these costs can be recovered from sales of 10-20 a year and these imports will cease. Abergas commented on the consultation RIS but not in relation to this issue. In subsequent contact, they indicated they could make up business from sales of other products.

Another small supplier, What Power Crisis, imports smaller GiWH for caravans and for dwellings in remote and off-grid locations. Sales are about 200 per year and have been certified against the relevant Australian Standard, *AS4552*. What Power Crisis is not sure of their energy ratings. Probably, they are rated at 5 stars and What Power Crisis is only exposed to MEPS at 5.2 stars or more. What Power Crisis did not make a submission and has not responded to invitations to provide further information.

The only further issue is that Australia and New Zealand have different arrangements for the regulation of gas appliance safety, to the point where gas appliances have an exemption under the TTMRA. But this is not a significant impediment to trade in GWH between the two countries, since most products are jointly marketed in both countries and are necessarily certified to Australian standards. The only products that are sold in New Zealand and not certified to Australian standards are either provisionally excluded from the proposal (internal GsWH made in New Zealand) or imported in very small numbers (10-20 GsWH/year imported by Abergas). Most importantly, the implementation of the proposed MEPS does not require New Zealand to abandon its arrangements for the regulation of gas appliance safety. Lloyd Harrington[27] has explained the revised energy rating tests will require simple safety checks – for electrical connections, gas leaks and carbon monoxide. These do not override New Zealand's arrangements for the regulation of gas appliance safety and there are no 'compliance cost' complications.

In summary, the incremental compliance costs are trivial in most cases. This is because most of the GWH that will be affected by the proposal are marketed jointly in both New Zealand and Australia. All significant costs of energy testing and labelling will be incurred for the Australian market.

5.3 Impact of mandatory labelling

We spoke to two of the major suppliers about the impact of the labelling requirements. Both said that the impact would be trivial. Rheem NZ said that, because labels are applied in the Australian factory and there is no separate production run for products exported to New Zealand, the Australian-sourced product is already distributed with labels. Rinnai NZ said that they favoured labelling and that it would be a trivial matter to have New Zealand product labelled in the same production runs as the product destined for the Australian market. The costs would be measured in cents/GWH and it may be cheaper not to have a separate production run for New Zealand. Rinnai NZ does not expect any change in the cost of imported products. We assume the other major suppliers, Bosch and Dux, are in the same situation.

E3 considers that the incremental cost of energy labelling will be insignificant.

It is reasonable to assume that there will be positive benefits that outweigh the costs but the amount is uncertain and cannot be estimated at this stage. Part of the problem is that labelling scheme will be reformed and it is sensible to defer more detailed consideration until E3 has completed that work. And, as indicated in section 3.3.2, E3 considers that labelling is less effective for water heaters than for other types of appliance. This is because water heaters do not have the 'shop floor' exposure that we associate with whitegoods and other household appliances, restricting the consumer's ability to use energy labels to make efficiency comparisons. Energy labelling of water heaters is not a policy option that is widely used in other countries.

5.4 Consumer impact of MEPS

This section deals separately with the impact on consumers in all segments of the market that would be affected by MEPS, but starts with a brief statement of methodology.

5.4.1 Overview of methodology

Annualised life cycle cost

The life cycle cost (LCC) of a hot water service is the sum of four cost elements, (1) water heater, (2) installation costs, (3) gas and electricity costs, and (4) maintenance costs. LCC is usually expressed in present value terms, which is the amount of an up-front payment that would cover all future costs of the hot water service, including energy, but

[27] Personal communication. Lloyd Harrington is a technical consultant to the E3 program and E3's representative on the relevant standards committees.

discounted to allow for the fact that present dollars are more valuable than future dollars. LCC can also be expressed as the annualised equivalent of the present value amount. This is the periodic payment that, if paid annually for the period of the hot water service, would have same present value as the up-front payment. We report cost estimates in terms of annualised LLC because it facilitates the comparison of water heaters with different lives. Our reporting of impacts – that is, the effect of MEPS in raising the energy efficiency of a water heater – is usually in terms of changes in capital and energy costs. This means that cost reductions (usually energy) are reported as negative numbers, and cost increases (usually capital) are reported as positive numbers. The only exception is the reporting of the 'investment analysis' in terms of a net present value: a positive net present value indicates a net benefit.

Installation and maintenance costs are generally ignored on the assumption that they are roughly the same for complying and non-complying GWH of the same type. The only exception is where more efficient GiWH have electronic controls and need to be connected to electricity.

A discount rate of 6% is used in the discounting and annualising calculations.

Key parameters
Appendix B provides a more detailed statement of methodology. In brief, however, the main points are as follows:

- *Hot water usage:* The baseline figuring reported in the consultation RIS was based on the assumption that the average household uses 200 litres of hot water per day, which is the amount prescribed in AS4234 for the purposes of the energy rating test. E3 has now adopted more realistic estimates of hot water usage, drawing on Australian research that puts average household use of hot water at 110 litres/day (EES 2008: page 86). This is an average across all households including small households and apartment dwellers who are more likely to use the smaller electric water heaters. For the purposes of this RIS, it has been assumed that there is a spread of hot water loads across the various GsWH: 100 litres/day for the 90 litre GsWH, 125 litres/day for the 135 litre GsWH, and 140 litres/day for 170 litre GsWH. Average hot water usage is put at 125 litres/day for GiWH. As it happens, the assessment is not sensitive to assumptions about hot water usage. This is because the main difference between GsWH at 3, 4 and 5 stars is the size of their standing loss. The standing loss is the heat that is lost from stored hot water regardless of how much hot water is drawn off. Measures to reduce standing losses, such as additional tank insulation, are effective even if no hot water is drawn off.
- *Water heater efficiency:* The records of product certifiers provide basic information about the efficiency of GWH, including differences between GiWH and GsWH, differences between internal and external GWH, and the number of models in the various efficiency ranges of interest. Depending on the stringency, MEPS will eliminate some of these options and it has been assumed that users will replace old non-complying units with new complying units with the lowest permitted level of efficiency. The estimates are not sensitive to this assumption, since the least efficient complying units are generally close to the minimum required level of efficiency.
- *Energy tariffs:* Energy savings are valued at the marginal tariff. The weighted average gas tariff is estimated at 1.8 cents/MJ, including an allowance for LPG.
- *Incremental cost of more efficient GWH:* We used the concept of a price/efficiency ratio to model the impact of MEPS on the cost of GWH. This is the ratio of the increase in the price of the GWH to the increase in the efficiency of the GWH. For example, a price/efficiency ratio of 1.0 indicates that a 10% increase in efficiency is accompanied by a 10% increase in price. Similarly, a ratio of 0.5 indicates that a 10% increase in efficiency is accompanied by a 5% increase in price, and a ratio of 2.0 indicates that a 10% increase in efficiency is accompanied by a 20% increase in

price. In the Australian counterpart to this analysis, the lower ratio (0.5) is assumed to apply to the transition from 3-star GsWH to 4-star GsWH: the intermediate ratio (1.0) is assumed to apply to the transition from 4-star GsWH to 5-star GsWH and to GiWH in the range 4.5 stars to 5.5 stars: and the higher ratio is assumed for any improvement in GsWH beyond 5.2 stars, which is unexplored territory in terms of the GsWH that are now available. As discussed in appendix B, this approach seems to generate conservative (that is, high) estimates of the price increases when compared with the available price and cost data. The same approach was used for New Zealand, with one exception. Based on supplier advice, the price differential between 3 star and 5 star GsWH was put at NZ$350.

- *Asset life:* GWH with 5 and 10 year warranties are assumed to have asset lives of 11 and 15 years respectively.

5.4.2 Internal GWH

E3 is confident that MEPS at 4 stars will have no effect on markets for internal GWH, either GsWH or GiWH.

- As explained in section 3.2.3, E3 proposed to exclude internal GsWH from the new MEPS. The early cost benefit analysis for this option is reported in appendix C.
- There would be no sales of internal GiWH at less than 4 stars under WoSM conditions.

E3 considers that MEPS at 5.0, 5.2 or 5.5 stars would probably have no effect on markets for internal GWH, and certainly no more than a minimal effect.

- Again, internal GsWH are excluded.
- With the exception of the products of one supplier, all internal GiWH are already at 5.5 stars or better.
- We discussed the issue with the remaining supplier whose products were originally introduced in the mid-1990s and have energy ratings in the range 4.5-4.8 stars. We understand that these will be phased out before the MEPS are implemented, and replaced with high performance products.

5.4.3 External GsWH

E3 has assessed the impact of each MEPS option on each of five segments of the market for external GsWH as follows.

- 90 L external GsWH, 5 year warranty
- 135 L external GsWH, 5 year warranty
- 170 L external GsWH, 5 year warranty
- 135 L external GsWH, 10 year warranty
- 170 L external GsWH, 10 year warranty

Table 4.4 reports the impact analysis for typical households with each of these types of GsWH. Note that there are two parts to each panel of results. The top part reports energy use and the annualised cost of water heating at each level of efficiency that is of interest. The bottom part reports the incremental impact of shifting the typical household from one level of efficiency to the next highest levels. The amounts in the bottom part are the differences between the relevant columns of the top part.

The existing range of external GsWH is such that there are now only two types of households.

- There are households that would have purchased 3-star GsWH under WoSM conditions and are exposed to MEPS options at all of the efficiency levels that are reported in table 5.1.
- There are households that, under WoSM conditions, would have purchased GsWH with energy ratings of 5-5.2 stars and are exposed only to MEPS options at 5.2 stars or 5.5 stars.

The key findings are:

- 4-star MEPS reduce the cost of hot water service in all households that are exposed to 4-star MEPS. Average household costs fall by NZ$21-35/year. (about 400 households - see section 5.5)
- 5-star MEPS reduce the cost of hot water service in all households that are exposed to 5-star MEPS. The incremental cost saving, from 4 to 5 stars, is NZ$5-20/year. The combined cost saving, from 3 to 5 stars, is NZ$25-55/year. (over 2000 households)
- The addition of a second stage of MEPS, at 5.2 or 5.5, stars does not further reduce the cost of hot water services for the average household. But nor do they significantly increase the cost. The financial impacts are marginal.

E3 is confident that the assessments for MEPS options 1 and 2 are reliable, at 4 or 5 stars. However, there is uncertainty about options 3 and 4, at 5.2 or 5.5 stars, since 5.2 stars is the highest rating that GsWH have achieved to date: there are no GsWH with energy ratings of 5.5 stars. Plausibly, the cost of GsWH at these higher levels of efficiency would be such that the GiWH would generally be preferred, and higher MEPS would trigger the collapse of GsWH production.

TABLE 5.1 IMPACT ANALYSIS FOR THE AVERAGE NEW ZEALAND HOUSEHOLD - EXTERNAL GSWH

Pane A: External GsWH, 90 L, 5 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	100	100	100	100	100
Av. efficiency of water heater (stars)	3.25	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	16,236	14,400	12,952	12,696	12,166
Annual emissions (tonnes CO2e)	0.87	0.77	0.69	0.68	0.65
Capital cost	$1,070	$1,249	$1,483	$1,525	$1,612
Annualised life cycle cost ($/year)					
Capital	$128	$149	$177	$182	$193
Energy	$390	$346	$311	$305	$292
Total	$518	$495	$488	$487	$485
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-1,837	-1,447	-257	-530
Annual emissions (tonnes CO2e)		-0.10	-0.08	-0.01	-0.03
Capital cost		$180	$233	$42	$87
Annualised life cycle cost ($/year)					
Capital		$21	$28	$5	$10
Energy		-$44	-$35	-$6	-$13
Total		-$23	-$7	-$1	-$2

... table continues over the next 2 pages ...

Panel B: External GsWH, 135 L, 5 year warranty					
	3 stars	4 stars	5 stars	5.2 stars	5.5 stars
Daily hot water load (litres)	120	120	120	120	120
Av. efficiency of water heater (stars)	3.14	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	18,046	15,970	14,481	14,217	13,672
Annual emissions (tonnes CO2e)	0.96	0.85	0.77	0.76	0.73
Capital cost	$1,133	$1,249	$1,483	$1,525	$1,612
Annualised life cycle cost ($/year)					
Capital	$135	$149	$177	$182	$193
Energy	$433	$383	$348	$341	$328
Total	$569	$533	$525	$524	$521
Incremental impact of MEPS		3 to 4 stars	4 to 5 stars	5 to 5.2 stars	5.2 to 5.5 stars
Annual gas consumption (MJ)		-2,075	-1,489	-264	-545
Annual emissions (tonnes CO2e)		-0.11	-0.08	-0.01	-0.03
Capital cost		$117	$233	$42	$87
Annualised life cycle cost ($/year)					
Capital		$14	$28	$5	$10
Energy		-$50	-$36	-$6	-$13
Total		-$36	-$8	-$1	-$3

Panel C: External GsWH, 170 L, 5 year warranty					
	3 stars	4 stars	5 stars	5.2 stars	5.5 stars
Daily hot water load (litres)	140	140	140	140	140
Av. efficiency of water heater (stars)	2.95	4.03	5.09	5.25	5.55
Annual gas consumption (MJ)	20,202	18,113	16,068	15,759	15,179
Annual emissions (tonnes CO2e)	1.08	0.97	0.86	0.84	0.81
Capital cost	$1,277	$1,394	$1,627	$1,678	$1,774
Annualised life cycle cost ($/year)					
Capital	$153	$167	$195	$201	$212
Energy	$485	$435	$386	$378	$364
Total	$638	$601	$580	$579	$576
Incremental impact of MEPS		3 to 4 stars	4 to 5 stars	5 to 5.2 stars	5.2 to 5.5 stars
Annual gas consumption (MJ)		-2,089	-2,045	-309	-580
Annual emissions (tonnes CO2e)		-0.11	-0.11	-0.02	-0.03
Capital cost		$117	$233	$51	$96
Annualised life cycle cost ($/year)					
Capital		$14	$28	$6	$11
Energy		-$50	-$49	-$7	-$14
Total		-$36	-$21	-$1	-$2

Panel D: External GsWH, 135 L, 10 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	120	120	120	120	120
Av. efficiency of water heater (stars)	3.14	4.29	5.10	5.25	5.55
Annual gas consumption (MJ)	18,046	15,970	14,481	14,217	13,672
Annual emissions (tonnes CO2e)	0.96	0.85	0.77	0.76	0.73
Capital cost	$1,270	$1,387	$1,620	$1,662	$1,750
Annualised life cycle cost ($/year)					
Capital	$152	$166	$194	$199	$209
Energy	$433	$383	$348	$341	$328
Total	$585	$549	$541	$540	$537
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-2,075	-1,489	-264	-545
Annual emissions (tonnes CO2e)		-0.11	-0.08	-0.01	-0.03
Capital cost		$117	$233	$42	$87
Annualised life cycle cost ($/year)					
Capital		$14	$28	$5	$10
Energy		-$50	-$36	-$6	-$13
Total		-$36	-$8	-$1	-$3

Panel E: External GsWH, 170 L, 10 year warranty					
	3 stars	*4 stars*	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	140	140	140	140	140
Av. efficiency of water heater (stars)	2.95	4.03	5.09	5.25	5.55
Annual gas consumption (MJ)	20,202	18,113	16,068	15,759	15,179
Annual emissions (tonnes CO2e)	1.08	0.97	0.86	0.84	0.81
Capital cost	$1,277	$1,394	$1,627	$1,678	$1,774
Annualised life cycle cost ($/year)					
Capital	$153	$167	$195	$201	$212
Energy	$485	$435	$386	$378	$364
Total	$638	$601	$580	$579	$576
Incremental impact of MEPS		*3 to 4 stars*	*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-2,089	-2,045	-309	-580
Annual emissions (tonnes CO2e)		-0.11	-0.11	-0.02	-0.03
Capital cost		$117	$233	$51	$96
Annualised life cycle cost ($/year)					
Capital		$14	$28	$6	$11
Energy		-$50	-$49	-$7	-$14
Total		-$36	-$21	-$1	-$2

5.4.4 External GiWH

Table 5.2 reports the impact analysis for typical households with GiWH. There is no 3-star GiWH in the market, which accounts for the empty columns at 3 stars in table 5.2. But there are GiWH at all of the other levels, which means that there are three types of households.

- Households that would have purchased 4-star GsWH under WoSM conditions are exposed to MEPS at 5 stars, 5.2 stars and 5.5 stars.
- Households that would have purchased 5-star GsWH under WoSM conditions and are exposed to MEPS at 5.2 stars and 5.5 stars.
- Households that would have purchased 5.2-star GsWH under WoSM conditions and are exposed to MEPS at 5.5 stars.

The key findings are.

- 4-star MEPS have no effect.
- 5-star MEPS reduces the average household's cost of hot water by about NZ$20/year (about 430 households).
- The addition of a second stage of MEPS at 5.2 or 5.5 stars is also cost reducing. The marginal effects are small, of the order of NZ$4-6/year, because the efficiency gains are small.

E3 is confident that these assessments are reliable but acknowledges that the assessments of MEPS at 5.2 stars or better have not been tested in public consultation. The cost assessment are probably conservative, since there is no evidence of significant price differences that are related to efficiency differences in the range 5 to 5.5 stars. In fact, some of the evidence is perverse, indicating that the more efficient GiWH are cheaper.

TABLE 5.2 IMPACT ANALYSIS FOR THE AVERAGE NEW ZEALAND HOUSEHOLD - EXTERNAL GIWH

Pane A: External GiWH, 10 year warranty				
	4 stars	*5 stars*	*5.2 stars*	*5.5 stars*
Daily hot water load (litres)	125	125	125	125
Av. efficiency of water heater (stars)	4.35	5.12	5.31	5.64
Annual gas consumption (MJ)	14,881	13,910	13,672	13,253
Annual emissions (tonnes CO2e)	0.79	0.74	0.73	0.71
Capital cost	$1,198	$1,245	$1,268	$1,308
Annualised life cycle cost ($/year)				
Capital	$116	$121	$123	$127
Energy	$357	$334	$328	$318
Total	$473	$455	$451	$445
Incremental impact of MEPS		*4 to 5 stars*	*5 to 5.2 stars*	*5.2 to 5.5 stars*
Annual gas consumption (MJ)		-971	-238	-419
Annual emissions (tonnes CO2e)		-0.05	-0.01	-0.02
Capital cost		$47	$23	$40
Annualised life cycle cost ($/year)				
Capital		$5	$2	$4
Energy		-$23	-$6	-$10
Total		-$19	-$4	-$6

5.5 Nationwide impact

The nationwide impacts are calculated by 'scaling up' the impacts that have been reported for typical households in each of the product segments. They are scaled up according to the sales projections that are reported in chapter 1. Some of the product segments are more important than others.

- The New Zealand market for 90L GsWH is very small and may be zero. We have assigned a zero weight for the purposes of estimating nationwide impacts. (Even in the much larger Australian market, there is only a niche market for replacement 90L units, confined to households that are either relatively small or located in mild and warm climates, such as parts of Queensland.)
- The market for 135 L and 170 L GsWH is also small. The sales projection indicates that MEPS would affect sales of 430 units in the 3-star segment and 2,200 units in the 5-star segment.
- The market for 4-star GiWH is also small, about 430 units sold before 2020.
- The remaining two GiWH segments are much larger. The measures would affect sales of 116,000 units in the 5/5.2-star segment and sales of 76,000 units in the 5.2/5.5-star segment.

The sales projections include a further large segment of GiWH at 5.5 stars or better, estimated at 73,000. These are not exposed to any of the options.

Tables 5.3 and 5.4 present estimates of the nationwide impacts.

Incremental impacts
Table 5.3 is somewhat hypothetical in the sense that it is concerned only with the impacts from 2013, after both stages of the MEPS have been fully implemented. But it is informative because:

- It avoids the confusion that arises when comparing measures with different start dates.
- It reports the incremental changes that are associated with each level of MEPS – that is, reporting separately for successive increments, from 3-star to 4-star MEPS, from 4-star to 5-star MEPS, from 5-star to 5.2-star MEPS, and from 5.2-star to 5.5-star MEPS. This avoids the confusion that arises when comparing measures that are cumulative but varying combinations of the various increments[28].

The incremental investment analysis indicates that GsWH deliver attractive returns to MEPS up to 4 stars but not at 5 stars or better. The marginal returns at 5 stars is in contrast to the Australian situation, and reflects the larger cost premium that New Zealand suppliers say will apply to products that New Zealand imports from Australia. GsWH can deliver somewhat larger reductions in gas consumption and emissions beyond 5 stars but E3 cannot make a credible case that this can be done cost-effectively.

GiWH deliver attractive returns to MEPS up to 5.5 stars, on all criteria.

Cumulative impacts
Table 5.4 reports the associated cumulative impact of the MEPS. Note that:

- The cumulative analysis includes the cost to taxpayers and the business compliance costs, although the latter have been assessed as so minor that they can be put at zero.

[28] However, note that, while the impacts are reported incrementally, the sales are necessarily cumulative. For example, a 3-star GsWH is exposed to MEPS from 4-stars through to 5.5 stars and the separate impacts are reported at each stage in table 4.12.

- The analysis is positive in all cases but the impacts of options 1 and 2 are so small that the cost to taxpayers is a large proportion of the costs.
- As discussed in relation to the impacts of consumers, there is considerable uncertainty about the price of GsWH that are required to achieve 5.2 stars more, and also about the market response.
- Options 3 and 4 are superior, reflecting the large contribution from more efficient GiWH at this level of efficiency.

TABLE 5.3 NATIONWIDE INCREMENTAL ANALYSIS OF MEPS OPTIONS: NEW ZEALAND, FROM 2013

MEPS increment	*3 stars to 4 stars*	*4 stars to 5 stars*	*5 stars to 5.2 stars*	*5.2 stars to 5.5 stars*
	GsWH			
Sales exposed to MEPS, 2013-2020 ('000)	0.43	0.43	2.7	2.7
Lifetime energy				
gas consumption (PJ)	-0.0042	-0.0034	-0.0105	-0.0208
emissions (Mt CO2e)	-0.0002	-0.0002	-0.0006	-0.0011
Lifetime expenditure, undiscounted ($M)				
capital	0.02	0.04	0.11	0.22
gas	-0.10	-0.08	-0.25	-0.50
total	-0.08	-0.04	-0.14	-0.28
Lifetime expenditure, present value ($M)				
capital	0.01	0.03	0.07	0.15
gas	-0.05	-0.04	-0.11	-0.23
total	-0.04	-0.01	-0.04	-0.08
Investment analysis				
net present value ($M)	0.038	0.014	0.040	0.080
benefit/cost ratio	3.7	1.5	1.5	1.5
	GiWH			
Sales exposed to MEPS, 2013-2020 ('000)		0.43	116.16	192.06
Lifetime energy				
gas consumption (PJ)		-0.0027	-0.4419	-1.2867
emissions (Mt CO2e)		-0.0001	-0.0236	-0.0686
Lifetime expenditure, undiscounted ($M)				
capital		0.01	2.65	7.70
gas		-0.06	-10.60	-30.88
total		-0.06	-7.96	-23.18
Lifetime expenditure, present value ($M)				
capital		0.01	1.68	4.83
gas		-0.03	-4.51	-12.97
total		-0.02	-2.83	-8.14
Investment analysis				
net present value ($M)		0.02	2.83	8.14
benefit/cost ratio		5.3	2.7	2.7

TABLE 5.4 NATIONWIDE CUMULATIVE ANALYSIS OF MEPS OPTIONS: NEW ZEALAND, 2010 TO2020

MEPS option	*Option 1*	*Option 2*	*Option 3*	*Option 4*
2010 MEPS	*4-star*	*5-star*	*4-star*	*4-star*
2013 MEPS	*no change*	*no change*	*5.2-star*	*5.5-star*
Sales exposed to MEPS, 2010-2020 ('000)	0.43	0.87	118.8	194.7
Lifetime energy				
gas consumption (PJ)	-0.0104	-0.0256	-0.4729	-1.7804
emissions (Mt CO_2-e)	-0.0006	-0.0014	-0.0252	-0.0949
Lifetime expenditure, undiscounted ($M)				
cost to the taxpayer	0.05	0.05	0.05	0.05
business compliance costs	0.00	0.00	0.00	0.00
incremental cost of water heaters	0.05	0.17	2.87	10.79
household expenditure on energy	-0.25	-0.61	-11.35	-42.73
total	-0.15	-0.44	-8.48	-31.94
Lifetime expenditure, present value ($M)				
cost to the taxpayer	0.05	0.05	0.05	0.05
business compliance costs	0.00	0.00	0.00	0.00
incremental cost of water heaters	0.04	0.13	1.84	6.82
household expenditure on energy	-0.15	-0.35	-4.90	-18.10
total	-0.06	-0.16	-3.01	-11.23
Investment analysis				
net present value ($M)	0.06	0.16	3.01	11.23
benefit/cost ratio	1.6	1.9	2.6	2.6

5.6 Sensitivity analysis

The sensitivity analysis is organised under two headings, reporting separately for the estimates of nationwide and household impacts.

5.6.1 Sensitivity analysis of nationwide estimates

Table 5.5 reports the sensitivity analysis at the national level for option 1. Similar analyses for the remaining options are reported in appendix E. The discussion in this section is in relation to option 1 (MEPS at 4 stars).

The analysis indicates that the findings are reasonably robust. The benefit-cost ratio for option 1 remains above 1.3 under reasonable alternative settings for the key variables.

The financial benefits are large relative to the costs under all scenarios. This is largely because the cost of upgrading GsWH from 3 stars to 4 stars is relatively small. Suppliers have recently re-registered their 4-star GsWH (which had previously been deregistered) and seem well-placed to bring 4-star GsWH back into production. Also, the measures use the familiar administrative machinery of Standards Australia and product certifiers.

We have not tested for sensitivity to variations in the sales projections. The New Zealand market for 3-star external GsWH is very small.

TABLE 5.5 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – NEW ZEALAND, OPTION 1 (MEPS AT 4 STARS)

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	0.43	-0.0104	-0.0006	0.15	0.09	0.06	1.6
Discount rate							
0%	0.43	-0.0104	-0.0006	0.25	0.10	0.15	2.5
5%	0.43	-0.0104	-0.0006	0.19	0.09	0.09	2.0
10%	0.43	-0.0104	-0.0006	0.11	0.08	0.02	1.3
Gas tariff							
-10%	0.43	-0.0104	-0.0006	0.13	0.09	0.04	1.5
+10%	0.43	-0.0104	-0.0006	0.16	0.09	0.07	1.8
Incremental cost of GWH							
+25%	0.43	-0.0104	-0.0006	0.15	0.10	0.05	1.5
-25%	0.43	-0.0104	-0.0006	0.15	0.08	0.07	1.8
Hot water load							
-33%	0.43	-0.0099	-0.0005	0.14	0.09	0.05	1.5
+33%	0.43	-0.0109	-0.0006	0.15	0.09	0.06	1.7
Estimates of energy savings							
-10%	0.43	-0.0093	-0.0005	0.13	0.09	0.04	1.5
+10%	0.43	-0.0114	-0.0006	0.16	0.09	0.07	1.8

5.6.2 Variable impact on individual households

Table 5.6 reports the sensitivity analysis of the impact of option 1 on households. The benefits are such that the analysis remains positive for all plausible variations in assumptions.

Note that we tested for wide variation in the hot water load. This includes a small allowance for regional variations in the heating task due to regional variations in the temperature of cold water.

TABLE 5.6 SENSITIVITY ANALYSIS OF HOUSEHOLD IMPACTS – NEW ZEALAND, OPTION 1 (MEPS AT 4 STARS)

	Annualised capital ($)	*Annualised energy ($)*	*Annualised cost of hot water ($)*
Baseline	$13.96	-$49.94	-$35.98
Discount rate			
0%	$10.61	-$49.94	-$39.33
5%	$12.24	-$49.94	-$37.70
10%	$16.33	-$49.94	-$33.61
Incremental cost of GWH			
+25%	$13.96	-$44.95	-$30.99
-25%	$13.96	-$54.93	-$40.98
Hot water load			
-33%	$17.44	-$49.94	-$32.49
+33%	$10.47	-$49.94	-$39.47
Estimates of energy savings			
-10%	$13.96	-$47.56	-$33.61
+10%	$13.96	-$52.31	-$38.36
Gas tariff			
Natural gas			
Cheapest region	$13.96	-$24.35	-$10.39
Most expensive region	$13.96	-$50.98	-$37.02
LPG	$13.96	-$93.64	-$79.68

6 Consultation

This chapter explains the industry consultations relating to the broad strategies for improving the efficiency of gas appliances, and explains the subsequent consultations relating specifically to MEPS for GWH. It also summarises stakeholder comments and criticisms on the cost-benefit analysis that E3 published in June 2007, and on the consultation document that E3 published in August 2008, and E3's responses to those comments and criticisms.

6.1 History of gas program consultations

For historical reasons, energy efficiency programs for gas appliances have always been administered by the industry body, AGA. Since 2002, however, the Australian Greenhouse Office has worked with Sustainability Victoria and Energy Safe Victoria to review the labelling and MEPS scheme for gas appliances and explore how to make it a more effective driver of energy efficiency. The milestones in this process were as follows:

1. *Mid-2002:* Mark Ellis and Associates (MEA *et al* 2002) reported on the potential for more efficient domestic gas appliances and the effectiveness of existing arrangements in promoting efficiency. MEA recommended more stringent MEPS for GWH, noting that the existing MEPS dated from 1983, that there had been significant technical developments since 1983, and most models on the Australian market did not comply with MEPS that the US introduced in January 2004. MEA also recommended that the labelling arrangements be revitalised, for example, with re-rating to reflect the actual spread of water heater efficiencies.
2. *November 2002:* The MEA report provided a focus for industry consultations. A government-industry working group formed as a result, aiming to make the gas program more effective. The group comprised AGO, Sustainability Victoria, VOGS and the two industry bodies, AGA and GAMAA.
3. *November 2003:* The working group released a discussion paper in July 2003 (AGO 2003). The group reported that *...Both key government agencies and gas industry organisations agree on the need for action, and on the general measures which are required to establish a national gas appliance efficiency scheme. Further consultation with stakeholders is necessary to refine current proposals, to determine priorities and timetables for action, and to ensure that the transition to a new regulatory regime is appropriately managed*. (AGO 2003: page 29) It also proposed a timetable for the development of a strategic plan and elements of a forward work plan. The consultation period extending to November 2003 and included stakeholder workshops in Sydney, Melbourne and Adelaide.
4. *December 2004:* MCE released its strategy for improving the energy efficiency of gas appliances – *Switch on Gas: 2005-2015* (AGO 2004a). Its highest priorities included agreement on *...test methods and MEPS and labelling requirements for domestic gas water heaters, room and ducted heaters…*and agreement on the implementation date (AGO 2004a: page 7).
5. *April 2005:* The E3 Committee released a draft work program for public comment (AGO 2005) and workshopped the document at a Melbourne forum in April 2005. Regarding specific products, it assigned priority to the development of a test method for new water heaters, then moving quickly to develop new MEPS and labelling proposals for water heaters. These tasks were scheduled for completion by March 2006.
6. *October 2006:* The E3 Committee released a revised draft work program for public comment (AGO 2006) at a gas industry forum in Melbourne. Representatives from

the Australian Greenhouse Office directly engaged with lead industry groups, the Gas Appliance Manufacturers Association of Australia and the Australian Gas Association in the process of revising the document. The revised document contains revised program elements for the final 18 months of the original 3-year work plan as a consequence of the administrative and regulatory basis of the program, new information about gas appliance technology and testing, and gas consumer response to energy labels.

6.2 Responses to voluntary and proposed mandatory MEPS levels

6.2.1 Supplier response to voluntary MEPS

The E3 work program provided for development of a new GWH test method by November 2005, development of new labelling and MEPS proposals by January 2006, completion of the associated RIS process by July 2006, and commencement of a check-testing program in September 2006. However, this schedule was de-railed by a round-robin of tests that revealed unacceptable differences in the results from different laboratories. It was in this context that, at a GAMAA conference in Melbourne on 30 August 2006, E3 proposed to suppliers that they voluntarily retire the least efficient water heaters from the market.

E3 subsequently commissioned a preliminary cost-benefit analysis of feasible measures to retire the least efficient units (Syneca 2006), and offered to provide funding for any further investigations that suppliers considered useful. That document examined options for voluntarily setting MEPS at either 4 stars or 5 stars with introduction in either 2008 or 2009. It was made available to suppliers in October 2006. Suppliers made minor comments on the preliminary cost-benefit analysis, correcting assumptions about the product range, but did not ask for any additional work and otherwise ignored the offer to implement MEPS on a voluntary basis.

E3 subsequently developed a number of mandatory MEPS proposals at various levels of stringency for domestic GsWH (external only) and GiWH (internal and external). These are distinct technologies, tested for compliance against the same MEPS but using different test methods. The remainder of this section is organised to review comments on the various options, starting with the most stringent.

6.2.2 Stakeholder views on MEPS at 7 stars (16,762 MJ/yr)

E3 included an option with second stage MEPS at 7 stars in the consultation RIS, but expressed its own reservations and uncertainties about the feasibility of MEPS at 7 stars.

There was no support for any proposal involving 7-star MEPS. Seven of the fourteen respondents to the consultation RIS expressed reservations or simply dismissed 7star MEPS as unworkable. All of the major suppliers dismissed 7-star MEPS as unworkable. E3 has now discarded the 7-star option.

6.2.3 Stakeholder views on MEPS at 5 stars (20,808 MJ/yr), 5.2 stars (20,403 MJ/yr) or 5.5 stars (19,797 MJ/yr)

The consultation RIS and the earlier CBA included proposals for 5-star MEPS but there has been no public consultation about MEPS at 5.2 or 5.5 stars.

In respect of MEPS at 5 stars, the general position is that the two main GsWH suppliers (Dux and Rheem) expressed strong opposition, while the main GiWH suppliers (Bosch and Rinnai) are supportive. This difference reflects their relative competitive advantages in the supply of 5-star GWH. It can be safely inferred that Dux and Rheem would also oppose MEPS at 5.2 or 5.5 stars. And it may be reasonably suspected that manufacturers of GiWH would be less supportive of the higher MEPS, although that has not been tested in public consultation.

There are two exceptions to the general pattern of response.

- The smallest of the GsWH suppliers, Aquamax, expressed support for 5-star MEPS. Aquamax was the first to introduce 5-star GsWH and has operated in that market segment for many years.
- Invensys Controls is a supplier of components to water heater manufacturers, and expressed support provided the lead time is at least 12 months.

Earlier submissions from Dux were also supportive of 5-star MEPS but its position had changed in response to the consultation RIS.

Others expressed support for MEPS as a general proposition, possibly without understanding the significance of the various star ratings (in relation to their current products' performance), or expressed a preference for 5-star MEPS relative to an unworkable 7-star MEPS.

Dux and Rheem Australia argue their case in terms of (a) the adverse effect on the competitive position of Australian manufacturers and on Australian manufacturing jobs, (b) social equity, and (c) the additional water that is used by GiWH. Rheem New Zealand expressed its support for this position but has less at stake since it manufactures only internal GsWH, which are exempt.

Impact on Australian manufacturing jobs
Dux and Rheem Australia claim that:

- 5-star MEPS will significantly increase the cost of GsWH relative to GiWH. GsWH require condensing technology to advance much beyond 5 stars whereas GiWH hit this barrier at 6 stars.
- Users would therefore respond to the price differential by replacing their 3-star GsWH with 5-star GiWH, not with 5-star GsWH, and production of GsWH would be significantly reduced.
- These losses are in a policy environment that will strongly promote, if not mandate, the phasing out of electric water heaters, further reducing the market for storage water heaters.
- The reduction in the production of storage units would lead to the loss of economies of scale and scope, increasing the cost of solar water heaters, and the loss of expertise and resources for the development of solar water heaters. Hence there are flow-on effects to other products.

These issues are unresolved. Dux and Rheem reject the notion that their competitive position remains strong in the market for replacement GsWH where the use of GiWH is impeded by high change-over costs. (GiWH require electric power to run the electronics and higher capacity gas services.) They also reject the notion that growing markets for heat pump and solar water heaters will substantially replace and sustain the market for storage units, or that there are economies to be had by rationalising production at the 5-star level.

E3 is not able to independently assess these claims by Dux and Rheem Australia, and accepts that the prospective phase-out of electric water heaters would be a major concern for these suppliers. This is the main reason for putting a new proposal for MEPS at 4 stars, which has the support of Dux and Rheem.

Social equity
Dux and Rheem Australia also draw attention to the burden of the additional upfront cost to users of GsWH, although that is somewhat at odds with their proposition that users would substantially avoid the additional cost by switching to GiWH.

E3 recognises that MEPS will generally increase the capital cost of energy-using equipment but considers that, after taking the value of energy savings into account, the whole-of-life costs of water heaters is reduced.

Impact on water usage
Dux and Rheem Australia say that increased take-up of GiWH will increase the water losses that are associated with their use. There are additional water losses because, unlike the storage heater which has hot water 'ready to go', the instantaneous type 'ramps up' to its operating temperature and cold water is dumped in the meantime. There are evaporation losses from GsWH but Rheem estimates that a GiWH uses an additional 20.7 litres of water per day under standard test conditions, and that this is a conservative estimate of actual losses. Rheem further estimates that the aggregate loss is 1.7 billion litres a year, or 5% of domestic internal usage, if 75% of GWH are converted to GiWH.

E3's assessment of this issue is as follows:

- There is no published research that independently assesses the water efficiency of GsWH and GiWH and investigates all aspects of the issue. Plausibly, for example, the 'dial a water temperature' feature of GiWH reduces the losses incurred as the user juggles the hot and cold to obtain and maintain the right temperature from GsWH.
- The marginal tariffs charged by Australia's major water utilities vary from about 70 cents/kL to 130 cents/kL and have an unweighted average of 94 cents/kL. Taking a round number estimate of $1/kL, the annual cost of 20.7 litres/day is $7.55, that is, 7.55 kL valued at $1/kL. This is small relative to the expected energy savings under standard test conditions, which we estimate at about $50/year, and would not alter E3's positive assessment of the proposal.

E3's response is:

- Given doubts about the impact on market shares and the extent of the additional losses, E3 has not included a dollar estimate of the excess water losses in the baseline assessment of the proposal. The additional uncertainty is addressed in the sensitivity analysis.
- The water losses associated with GiWH can be minimised through regulation, but this will be dealt with separately through the WELS (Water Efficiency Labelling and Standards) program, not E3.

WELS is assessing options for including GiWH in the scheme. Initial consultancy work has been conducted to define the technology, map the industry and identify the different approaches taken to managing water wastage. This work identified a lack of data on the volume of water discharged by these appliances before they reach set temperature. WELS is currently conducting laboratory testing of a selection of GiWH, at a variety of water pressures and test conditions, to collect this baseline data on water wastage. That data will inform subsequent cost benefit analysis of water efficiency labelling for these products.

6.2.4 Stakeholder views on MEPS at 4 stars (22,831 MJ/yr)

The option of MEPS at 4 stars has not been separately tested in public consultation, only as part of a staged proposal that included a future increase to 7 stars. However it is clear that external GsWH suppliers are supportive and it is reasonable to expect GiWH suppliers to be less supportive of 4-star MEPS than 5-star MEPS. This reflects the relative competitive advantages of GsWH and GiWH suppliers.

6.2.5 Stakeholder views on the exclusion of internal GsWH

GsWH suppliers

Several GsWH suppliers commented on the feasibility of MEPS for internal GsWH.

- Dux said the market for internal mains pressure water heaters – both GsWH and GiWH – was small and declining, and the development of more energy efficient product was not commercially justified.
- HWS Australia said the same for the small number of low-pressure ceiling-mounted GsWH that it produces for the South Australian market. These units are often installed snugly between roof trusses and some have since been surrounded with air-conditioning ducts, greatly reducing the scope to add additional insulation.
- Rheem and Rheem NZ also said that the extension of MEPS to internal water heaters was not warranted.

GiWH suppliers

Rinnai NZ supply GiWH and objected to the exclusion of internal GsWH, arguing that (a) the exclusion confers an unfair competitive advantage (that is, no compliance and upgrading costs) on an inefficient product, (b) it is a lost opportunity to save energy and reduce greenhouse emissions, since internal GsWH can be replaced with internal GiWH, and (c) the claimed contribution to space heating is exaggerated.

Rinnai NZ went on to say that, if internal GsWH are excluded from MEPS, they would be restricted to like-for-like replacement of existing 3-star internal GsWH and should be subject to labelling requirements so consumers can make a direct comparison between types.

E3 response

E3 recognises that technical feasibility is an issue for internal GsWH. The cost-benefit analysis noted the additional costs and the possibility that some gas heaters will be replaced with electric heaters, which would be perverse.

E3 considers that it is not cost-effective to provide a more detailed analysis of these issues in the regulatory impact statement and has simply excluded internal GsWH from the proposal, with the understanding that they will be investigated for MEPS in future. E3 proposes that these matters be further considered by Standards Australia committee AG-001 (Gas Appliances). AG-001 should have regard for the following matters:

- Whether test methods need to take account of hidden benefits of internal water heaters, such as contributions to the space heating task and the reduction in heat and water losses from pipes when the heater is closer to hot water outlets.
- Whether test methods should take account of differences in the ambient conditions of external and internal installations. (HWS Australia claims that ceiling installations are inherently more efficient because of the higher temperatures in ceiling spaces.)
- Whether there are practical and affordable means of improving energy efficiency, taking account of the cost of possibly needing to modify the internal space that contains the heater.
- That change-over to imported more efficient internal storage heaters would be costly (for example, because of different fittings) and that local production runs just for the NZ market would be small.
- That condensing technologies already exist overseas and have been required under the UK building code for several years. High efficiency ENERGYSTAR internal

storage models are available in the US, indicating the technology has been available in that country for long enough to define top performing models[29].

- Whether there are likely to be perverse effects, such as replacement with electric heaters.
- The appropriate labelling arrangements for internal GsWH.

Regardless of how these matters may be assessed, AG-001 should also have regard for the small and declining sales of these heaters, and the cost-effectiveness of efforts to resolve these matters in a manner that provides a rigorous basis for government intervention. As discussed in chapter 1, the appliances and equipment included in the E3 Program must satisfy certain criteria relating to the feasibility and cost-effectiveness of intervention. These include the potential for energy and greenhouse savings, environmental impact of the fuel type, opportunity to influence purchase, the existence of market barriers, access to testing facilities, and considerations of administrative complexity.

6.3 Other matters

6.3.1 Policy approach, policy coordination and policy priorities

Some respondents questioned the selection of policy instruments.

The Gas Association of New Zealand raised issues of policy coordination, in particular, the need for a more integrated approach to product certification and mutual recognition (including matters other than energy efficiency, such as product safety), and the need for integrated testing and certification facilities. The importance of installation practices for water heater performance was also mentioned. The LPG Association of New Zealand expressed the same concerns.

There were also questions about the integration of MEPS with changes to both the Australian and New Zealand building codes, particular from New Zealand where the proposed changes to the building code are more advanced.

Some Australian respondents said that the proposed measures were poorly targeted or may have perverse effects on greenhouse abatement.

- Envestra is a gas distributor and is concerned about the impact of lower gas sales (per customer) and higher prices for gas appliances on the economics of existing networks and of network extensions to new subdivisions. Envestra is concerned that the measures may discourage the take-up of gas and inhibit the roll-out of the gas network. This has the perverse effect of discouraging the switch from electric to gas appliances.
- Envestra also says that measures to positively encourage the switch from electric to gas appliances would be more effective, such as a ban on electric water heaters where reticulated gas is available.
- Rinnai calculated the potential for larger gains to be had by replacing electric water heaters with gas water heaters, claiming that a program of financial incentives aimed at households that are already connected to gas would reduce greenhouse emissions by 13 times more than the proposed measure.
- Rheem compared the proposed measures with the replacement of electric water heaters in gas reticulated areas, and found that the latter had slightly more impact.

[29] http://www.eswaterheaters.com/consumers.html

- Rheem and Rheem NZ say the measures will reduce economies of scale in the production of storage units and thereby compromise the development and production of solar water heaters.

Several New Zealand respondents also said that the direct use of gas as an efficient fuel should be promoted as it contributes less to greenhouse gas emissions than burning gas to manufacture electricity. Abergas posed a number of issues for New Zealand fuels policy, including the demand for hot water as the population ages and the contribution of heat pump/solar water heaters to peak loads on electricity generation and distribution systems.

E3's response

The efficiency of certification of compliance procedures is an ongoing concern. However, compliance costs have been assessed as very reasonable in this case and the bigger issues of certification of compliance procedures are not matters that E3 can effectively address. E3 uses the available standards machinery and funds upgrades where appropriate, for example, to improve methods of test.

Regarding greenhouse abatement priorities, the proposed measures should not be regarded as a substitute for alternative programs and policies. There is obviously scope for more to be done using instruments other than MEPS and labelling, but that does not diminish the contribution of MEPS and labelling. On the contrary, as the switch is made from electricity to gas it becomes progressively more important to use gas efficiently. Efficiency choices that are made now cannot be reversed for many years.

Regarding the proposition that more efficient gas appliances discourage the rollout of the gas network, E3's response is that:

- 3-star GsWH are mainly sold into the replacement market, which means that few would be installed in homes that are newly connected to gas or where a gas water heater is newly installed. It seems unlikely, therefore, that there will be significant adverse effects on the economics of network extensions.
- It is the role of the competition regulators in each of the jurisdictions to determine network prices that provide an economic return to network operators, and to adjust those prices in response to changing circumstances, such as changes in gas throughput.
- The E3 program applies also to electrical appliances, reducing electricity throughput, and has similar effects on the economics of operating electricity networks.

Regarding the issue of perverse effects on the development and production of cylinders for solar water heaters, the revised proposal for MEPS at 4 stars seems to alleviate these concerns.

On the issue of integration with the building code, E3 considers that the unresolved issue of integration should not delay a decision on the proposed measures. It is sensible for building regulators and product regulators to separately consider these issues. This is because new construction presents low cost 'greenfields' options for emissions abatement, unconstrained by the additional cost factors that often apply to the upgrading of existing buildings. Whatever the decisions taken by product regulators, building regulators should separately consider the standards that are appropriate for new buildings.

6.3.2 Product labelling

E3 has a strong view that labelling cannot replace MEPS in this case. That point is argued in section 3.3.2 of this RIS. Two GiWH suppliers – Bosch and Rinnai NZ – said that energy labels provide useful information to customers and should be retained. E3 agrees but has not given the issue priority. GsWH suppliers are non-committal on labelling. While supporting 5-star MEPS in principle, Aquamax expressed a preference for labelling and informational measures, leaving the consumer to decide.

As discussed in section 3, E3 does not have a specific proposal on labelling at this stage but, in the consultation RIS, invited comment on its general approach. To recap, it is now proposed that mandatory labelling requirements be retained for Australia and extended to New Zealand, but recalibrated to better reflect the current range of efficiencies. E3 considers that water heaters with borderline compliance should be assigned no more than 1.5 or 2 stars, which means that heaters that are now labelled as 4-star would be reassigned to this lower level. E3 also considers that there should be a meaningful gap between heaters with borderline compliance and those that achieve the higher levels of efficiency that can be achieved with gas condensing technology. There would need to be a gap of 2 or 2.5 stars between the lower and higher levels of efficiency.

It is recognised that recalibration of the energy rating scale can disrupt marketing arrangements and strategies, particularly where there are perceptions that product and suppliers have been downgraded. (Abergas raised this issue.) E3 undertakes to work with suppliers to facilitate the introduction of a recalibrated rating scale and to minimise the potential for misunderstanding. Recalibration will be investigated further after October 2010.

6.3.3 Timing and transition arrangements

Several comments were made.

- The Plumbers Merchants Association in New Zealand is concerned that the lead time to implementation may be too short, leaving plumbing wholesalers with non-complying stock that they will need to sell at fire-sale prices.
- Rinnai is concerned that changes to the method of test will require product modifications that, while minor in terms of energy ratings, would still be time consuming. Again, lead time may be too short.
- Invensys Controls also said that 12 months is the minimum acceptable lead time.

E3's response is that the first point is based on a misunderstanding. Products that have been manufactured or imported before the implementation date can be sold at any subsequent time. The grandfathering clause in NZ regulations allows continued sale for as long as stock lasts.

On the issue of lead time, E3's response is that (a) the implementation date can be deferred if the lead time threatens to be much shorter than12 months, and (b) it is proposed to allow products that comply under the old standard and method of test (at the appropriate MEPS) to be manufactured or imported for 12 months after implementation. Suppliers of existing products will therefore have at least 2 years to adjust marginally non-complying products to the requirements of the new standard.

Of course, MEPS at 4 stars would moderate the concerns of Rinnai and other GiWH suppliers about timing.

6.3.4 Breach of contractual commitments

One supplier asked about the effect of MEPS on its commitment to replace heaters on a like-for-like basis during warranty periods. MEPS apply only to the manufacture and import of products. Manufacturers may, at their discretion, retain stock of pre-MEPS products for the purpose of fulfilling warranties and, so long as no sales transaction occurs, the MEPS will not impede the fulfilment of warranties. Replacement units are treated as spare parts, not as a new purchase.

6.3.5 Modelling assumptions, revisions and corrections

Several of the major suppliers have commented on aspects of the assessment methodology, including various assumptions and projections. The main issues are:

- Projected sales of GWH
  - Rinnai noted differences between the consultation RIS and the baseline projections in another report, *Energy Use in the Australian Residential Sector 1986-2020*, that was released at about the same time. Rinnai also said that the prospect of higher GWH sales in response to phase-out of electric water heaters in Australia had been ignored, and that projected sales of 3-star GWH had been underestimated.
  - Bosch said they agreed with the estimates of GWH stocks and market shares, saying they were within 10% of their own estimates.
  - Rheem Australia said that projected sales of 3-star GWH had been overestimated and that sales of GiWH would be stronger.
  - Dux suggested that there be a reconsideration of the factors that have driven demand for GWH in the past, being investment in gas networks, industry promotion and the interest created by innovative GiWH and 5-star GsWH, all of which have started to wane.
- Incremental cost of more efficient GWH
  - Dux said that the estimates of additional appliance costs seemed reasonable but that there may be additional costs of installation where exact replacements are not available.
- Cost to the taxpayer
  - Dux said there was a need for more check testing of compliance, which is a cost to the taxpayer.
- Hot water usage
  - Dux commented on the assumption that the figure for average daily draw-off of hot water that is used for testing purposes (200 litres a day) is a reasonable measure of actual usage. This has been accepted in the past only because there are no estimates that are generally regarded as providing a fair and accurate measure of domestic hot water use.
  - Rinnai says that it is well understood in the industry that the average daily draw-off of hot water that is used for testing purposes (200 litres a day) is not a reasonable measure of actual usage, and that actual usage '… is in fact 140 litres'.
- Discounting future energy savings
  - Dux said that some households ignore longer term benefits and that effects on such households can be estimated by ignoring benefits that accrue after the first five years in the life of a more efficient heater. Implicitly, this is an issue of the appropriate rate of discount applied to future benefits.

E3 response

There is unavoidable uncertainty about the magnitude and composition of GWH sales in future, and obvious interest in projections for sales of GsWH with less than 3 stars. However, E3 has now aligned its projections with the baseline study, *Energy Use in the Australian Residential Sector 1986-2020,* and considers that remaining uncertainties are best dealt with via sensitivity analyses – sections 4.6 and 5.6.

E3 has also updated its price information for GWH and considers that its estimates of incremental GWH costs are conservatively high.

E3 also checked its estimates of costs to the taxpayer and consider they are reasonable. Importantly, only the initial check-test is a cost to the taxpayer: follow-up testing is at the expense of the supplier.

E3 has now adopted more realistic estimates of hot water usage, drawing on a finding in the baseline study that the average Australian household uses 110 litres/day (EES 2008: page 86). This is an average across all households including small households and apartment dwellers who are more likely to use the smaller electric water heaters. For the purposes of this RIS, it has been assumed that there is a spread of hot water loads across the various GsWH: 100 litres/day for the 90 litre GsWH, 125 litres/day for the 135 litre GsWH, and 140 litres/day for 170 litre GsWH. Average hot water usage is put at 125 litres/day for GiWH.

As it happens, the assessment is not sensitive to assumptions about hot water usage. This is because the main difference between GsWH at 3, 4 and 5 stars is the size of their standing losses. This is the heat that is lost from stored hot water regardless of how much hot water is drawn off. Measures to reduce standing losses, such as additional tank insulation, are effective even if no hot water is drawn off.

Regarding the issue of discounting, the RIS tests for sensitivity to the standard range of discount rates.

7 Conclusion and recommendations

The primary assessment criteria are that the measures deliver the maximum reduction in energy use and greenhouse emissions, subject to the constraint that the measures are not less cost-effective than other abatement measures.

Tables 7.1 and 7.2 reports E3's assessment of the 4 options against these and various secondary criteria, for Australia and New Zealand respectively.

E3 recommends that option 1 be adopted, implementing MEPS at 4 stars. This is the least demanding of the options and is somewhat lower than the MEPS at 5 stars that E3 has worked towards over several years. However, as explained in section 6.2.3, suppliers of GsWH objected strongly to MEPS at 5 stars. Dux and Rheem Australia argued their case in terms of (a) the adverse effect on the competitive position of Australian manufacturers and on Australian manufacturing jobs, (b) social equity, and (c) the additional water that is used by GiWH. Rheem New Zealand expressed its support for this position but has less at stake since it manufactures only internal GsWH, which are exempt.

E3 rejects the arguments relating to social equity and water consumption but is not able to independently assess the claims regarding adverse effect on the competitive position of Australian manufacturers and on Australian manufacturing jobs. The impact analysis in the RIS does not allow for or quantify the impact of the proposal on the competitive position of Australian manufacturers and on Australian manufacturing jobs. If these unquantified impacts are taken into account, it is likely that the overall net benefits of the options considered may change, thus altering the preferred option. E3 accepts that the prospective phase-out of electric water heaters would also be a major concern for suppliers of storage water heaters. These are the reasons for putting a new proposal for MEPS at 4 stars, which has the support of Dux and Rheem. New Zealand industry mostly exceed MEPS at 4 stars, hence a 5 star MEPS would achieve a greater transformation of the market. However, New Zealand industry nonetheless supports the proposed MEPS as a means to align regulations and costs with Australia, and between major New Zealand industry players.

TABLE 7.1 ASSESSMENT SUMMARY – AUSTRALIA

Option 1	*Option 2*	*Option 3*	*Option 4*
Do the measures reduce greenhouse emissions?			
All of the options will reduce greenhouse emissions, but by varying amounts. The whole-of-life contributions to emissions abatement are as follows.			
1.1 Mt CO_2-e	2.1 Mt CO_2-e	2.1 Mt CO_2-e	2.9 Mt CO_2-e
Do the measures reduce the lifecycle cost of appliances?			
All of the options will reduce the lifecycle cost of water heaters, but by varying amounts. The estimates for options 3 and 4 are uncertain because E3 has not been able to confidently assess the cost of gas storage water heaters at 5.2 or 5.5 stars. There are no such products on the Australasian market now. The attractive returns to options 3 and 4 reflect the large contribution from gas instantaneous water heaters and the relatively low cost of increasing their efficiency. Gas instantaneous water heaters with 5.5 stars to 7 stars are available now. The aggregate reductions in lifecycle cost are as follows.			
\$124 million (benefit/cost ratio = 6.3)	\$189 million (benefit/cost ratio = 3.3)	\$177 million (benefit/cost ratio = 3.2)	\$209 million (benefit/cost ratio = 2.6)
Do the measures address market and regulatory failures?			
The measures address significant failures in the market for GWH. Households need to perform a reasonably sophisticated calculation to understand the significance of energy costs, involving estimates of energy use, energy prices, asset lives and discount rates. There are significant impediments to making a fully informed decision, for example: replacement heaters are often purchased in circumstances where the existing heater has failed and the household is without hot water; the heater may be purchased by a builder or landlord who is concerned only to minimise the capital cost; and, unlike whitegoods, consumers can seldom inspect water heaters and their energy labels on the shop floor.			
No additional comment	No additional comment	No additional comment	No additional comment
Does the option minimise negative impacts on product quality and function?			
There are several issues of product quality and function. First, gas storage water heaters with 5-year warranties are generally available at the 3-star level (90% of sales) but not at the 5-star level, where 10 years is the norm. However, it is assumed that a full range of models with 5-year warranties will be made available at the 5-star level, preserving the current range of product choice. Second, 5-star replacements may not be generally available for a minority of users with the smallest (90 litres) gas storage water heaters. These users will need to replace their water heaters with the next size, 135 litres. The combined sales are currently about 2.5% of the market and declining. Third, certain internally installed GsWH have been excluded from the proposal in response to concerns about the availability of affordable replacements.			

Option 1	*Option 2*	*Option 3*	*Option 4*
No additional comment	No additional comment	No additional comment	No additional comment

Do the measures minimise adverse effects on suppliers?

This proposal is the first initiative arising from the program of reform that industry and government embarked on in 2002, with extensive consultation throughout. It engages the standards machinery that is familiar to industry, and the technical details are being developed in close consultation with industry, aiming to finalise in late 2009.

Timing is always an issue and the schedule has been relaxed in response to supplier concerns.

Options 2, 3 and 4 raise additional issues.

No additional comment	Suppliers of gas storage water heaters have objected strongly to MEPS at 5 stars, claiming significant adverse effects on their continued competitiveness of storage technologies and on-going production in Australia. Suppliers of gas instantaneous water heaters are supportive.	Option 3 has not been formally tested with suppliers. But it is reasonable to expect stronger objections from suppliers of gas storage water heaters, although moderated by the delay in implementation of the second stage of more demanding MEPS.	Option 4 has not been formally tested with suppliers. But it is reasonable to expect stronger objections from suppliers of gas storage water heaters, although moderated by the delay in implementation of the second stage of more demanding MEPS.

TABLE 7.2 ASSESSMENT SUMMARY – NEW ZEALAND

Option 1	*Option 2*	*Option 3*	*Option 4*
Do the measures reduce greenhouse emissions?			
All of the options will reduce greenhouse emissions, but by varying amounts. The whole-of-life contributions to emissions abatement are as follows.			
0.0006Mt CO_2-e	0.0014 Mt CO_2-e	0.0252 Mt CO_2-e	0.0949 Mt CO_2-e
Do the measures reduce the lifecycle cost of appliances?			
All of the options will reduce the lifecycle cost of water heaters, but by varying amounts. The estimates for options 3 and 4 are uncertain because E3 has not been able to confidently assess the cost of gas storage water heaters at 5.2 or 5.5 stars. There are no such products on the Australasian market now. The attractive returns to options 3 and 4 reflect the large contribution from gas instantaneous water heaters and the relatively low cost of increasing their efficiency. Gas instantaneous water heaters with 5.5 stars to 7 stars are available now. The aggregate reductions in lifecycle cost are as follows.			
$0.06 million (benefit/cost ratio = 1.6)	$0.16 million (benefit/cost ratio = 1.9)	$3.01 million (benefit/cost ratio = 2.6)	$11.23 million (benefit/cost ratio = 2.6)
Do the measures address market and regulatory failures?			
The measures address significant failures in the market for GWH. Households need to perform a reasonably sophisticated calculation to understand the significance of energy costs, involving estimates of energy use, energy prices, asset lives and discount rates. There are significant impediments to making a fully informed decision, for example: replacement heaters are often purchased in circumstances where the existing heater has failed and the household is without hot water; the heater may be purchased by a builder or landlord who is concerned only to minimise the capital cost; and, unlike whitegoods, consumers can seldom inspect water heaters and their energy labels on the shop floor.			
No additional comment	No additional comment	No additional comment	No additional comment
Does the option minimise negative impacts on product quality and function?			
There are several issues of product quality and function. First, gas storage water heaters with 5-year warranties are generally available at the 3-star level (90% of sales) but not at the 5-star level, where 10 years is the norm. However, it is assumed that a full range of models with 5-year warranties will be made available at the 5-star level, preserving the current range of product choice. Second, 5-star replacements may not be generally available for a minority of users with the smallest (90 litres) gas storage water heaters. These users will need to replace their water heaters with the next size, 135 litres. These is a small and declining market for 90 litre products in Australia but, as far as E3 can ascertain, virtually no market in New Zealand.			

Option 1	*Option 2*	*Option 3*	*Option 4*
Third, certain internally installed GsWH have been excluded from the proposal in response to concerns about the availability of affordable replacements.			
No additional comment	No additional comment	No additional comment	No additional comment
Do the measures minimise adverse effects on suppliers?			
This proposal is the first initiative arising from the program of reform that industry and government embarked on in 2002, with extensive consultation throughout. It engages the standards machinery that is familiar to industry, and the technical details are being developed in close consultation with industry, aiming to finalise in late 2009. Timing is always an issue and the schedule has been relaxed in response to supplier concerns.			
No additional comment	Suppliers of gas storage water heaters have objected strongly to MEPS at 5 stars, claiming significant adverse effects on their continued competitiveness of storage technologies and on-going production in New Zealand. Suppliers of gas instantaneous water heaters are supportive.	Option 3 has not been formally tested with suppliers. But it is reasonable to expect stronger objections from suppliers of gas storage water heaters, although moderated by the delay in implementation of the second stage of more demanding MEPS.	Option 4 has not been formally tested with suppliers. But it is reasonable to expect stronger objections from suppliers of gas storage water heaters, although moderated by the delay in implementation of the second stage of more demanding MEPS.

8 Implementation and review

General administrative arrangements
Australia's national scheme for mandatory energy labelling and minimum energy performance standards relies on state and territory legislation for legal effect. The jurisdictions have also agreed to a set of administrative guidelines. While not legally binding, they aim to promote a uniform approach, consistent outcomes and to minimise compliance costs. The E3 Program released the latest guidelines in May 2005 (NAEEEC 2005). The key administrative arrangements are:

1. The technical details of the MEPS are contained in Australian and New Zealand Standards that are incorporated by reference into the state and territory legislation. These standards do not vary between states. The format and content of the standards are also familiar to industry, as are the operations of Standards Australia.
2. Changes to the technical detail in Standards are subject to transition periods that are negotiated between industry and government.
3. To minimise trade barriers, state and territory regulatory agencies support a policy of adopting international standards wherever appropriate.
4. Grandfathering arrangements are adopted, allowing reasonable time for the phasing out of non-complying stock and changing over of labels.
5. All states and territories accept the registration of an appliance undertaken in another state.
6. State and territory regulatory agencies have set target periods within which they aim to process applications.
7. Proposed changes in administrative and operating practice are subject to consultation between states.

Product-specific compliance and enforcement activities
The E3 Program organises its compliance and enforcement activities as follows:

1. Compliance monitoring takes the form of a program of check testing by accredited laboratories.
2. Equipment is selected for check testing on the basis of risk factors rather than randomly. The risk factors are as follows:
   - history of success and failure in check tests;
   - age of models, with newer models given greater attention, reflecting the prospect of longer life in the market;
   - high volume sales;
   - claims of high efficiency;
   - complaints.
3. There are several sanctions. There is a 'shaming' option involving publication of failed brands or models in the AGO annual report. The second option is deregistration by the state authorities, subject to show-cause procedures. Subsequent sale of deregistered appliances would be a criminal offence. Re-registration of models that are subject to MEPS is subject to new registration tests. The third option involves legal action by the ACCC.
4. Standard statistical criteria are applied to deal with normal variation in the performance of equipment selected for check testing. (A sample of only one is selected initially, with a further sample of three selected if the first fails.)

5. Laboratories that produce misleading tests results may also be denied further registration business.

General monitoring and benchmarking of impacts and effectiveness
In the past the E3 Program has periodically commissioned an omnibus evaluation of overall effectiveness. The last of these was published in June 2003 (NAEEEC 2003), titled W*hen you can measure it, you know something about it: Projected impacts 2000-2020.* The general aims of such an exercise are to document expected impacts, estimate costs and benefits, and compare outcomes with earlier projections. It commits the E3 Program to examination of the appliance register and store survey data, and comparative review of trends in appliance efficiency.

The program has since advised industry that the 2003 exercise was the last of the omnibus reviews and will be replaced by piecemeal reviews. The first of these will address air-conditioners and fridges. A review of arrangements for HWS has yet to be scheduled.

Annually, the E3 Program holds a consultation forum and invites stakeholders to raise concerns about its operation and impacts.

Less frequently, the E3 Program reviews program fundamentals. The most recent exercise of this kind was a major research-based review and scoping of future directions for a wide range of appliance efficiency labels in Australia and NZ.

The program also takes occasional opportunities to benchmark its activities with programs in other countries.

Regulatory review
Review functions are not centralised: each state and territory has its own arrangements for review. The 'subordinate legislation' Acts in several states provide for the automatic revoking of regulations after 10 years. These states are Victoria, SA, Queensland and Tasmania. NSW requires that all regulations contain sunset clauses. The remaining jurisdictions have no general requirement but may include sunset clauses case by case.

All jurisdictions have some parliamentary machinery for the systematic review of regulations, such as a 'Legislation Review Committee'. Arrangements for agency or inter-agency review are more variable. Only Victoria has a specific body charged with regulatory oversight, which is the Victorian Competition and Efficiency Commission. This work is undertaken by an inter-departmental committee in the NT. Otherwise, however, the review process uses a parliamentary secretariat to raise issues and solicit public comment.

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- *Task 4 – Technical Analysis*
- *Task 6 – Design Options*

APPENDIX A: GOVERNMENT PROGRAMS AFFECTING CHOICE OF HWS

	Selection of HWS in new dwellings	*Selection of replacement HWS*
C'wealth	Renewable Energy Certificates: available for installing a solar hot water, including heat pump HWS, in a new home. Value depends on the market for RECs but may be about $500.	Renewable Energy Certificates: for installing a solar hot water, including heat pump HWS. (From 11 September 2006, RECs are not restricted to replacement of electric HWS.)
NSW	BASIX: sets targets for thermal comfort, energy and water use of new houses. Typical single dwelling meets energy target if it: (a) includes efficient HWS - solar or 5-star gas; and (b) uses natural heating, cooling and lighting.	NGACs: This scheme requires NSW electricity retailers and others to meet mandatory targets for reducing or offsetting emissions from the electricity they supply or use. Retailers can earn abatement certificates by running programs that replace electric HWS with gas HWS or gas-boosted solar HWS.
Victoria	5-star housing: requires a 5-star energy rating for the building fabric of a new house, plus water savings measures and the installation of either a rain water tank or a solar hot water service.	High efficiency gas hot water rebate: for rural, regional and outer suburban areas, to replace electric day rate or wood-fuelled HWS with a 5-star GWH. Provides $700 to concession card holders and $400 to non-concession card holders. Solar hot water rebate: for replacing existing gas or solid fuel HWS, or converting an existing HWS to solar. Provides up to $1500 depending on the size and performance.
QLD	Sustainable housing measures: require low-emission HWS, either: (a) 5-star GWH (b) heat pump or solar HWS achieving at least 22 RECs for 3+ bedrooms or 14 RECs for 1 or 2 bedrooms	Gas Installation Rebate: $500 to be paid to 7,500 customers in existing houses, for replacement of electric HWS and/or cooking appliances with efficient gas appliances. Probably, GWH will need to be 5 stars. Phase out of electric HWS from 2010: This is a recently announced element of Queensland's Climate Change Strategy. Replacement HWS will need to be greenhouse-friendly. Switching will initially be voluntary in areas without mains gas.
SA	Greenhouse gas performance requirements for water heaters: From July 2008, the majority of domestic water heater installations need to meet greenhouse gas and flow rate performance standards. Most new or replacement water heaters need to be 5-star gas, solar or electric heat pump systems. In some cases, conventional electric and low efficiency gas water heaters are permitted.	Greenhouse gas performance requirements: These requirements apply to both new and replacement water heaters. Solar Hot Water Rebate Scheme: $500 rebate on the cost of a new solar or electric heat pump water heater system. The scheme targets low income households, defined as households with certain concession cards.
WA	5-Star Plus requirements for new homes From 1 September 2007, a house must meet the BCA's 5-star energy efficiency standards and have a low greenhouse HWS such as: (a) a solar hot water system; (b) a 5-star rated gas hot water system; or (c) a high energy-efficient electric heat pump. Solar hot water heater subsidy: Existing arrangement is same as for replacement HWS. Given the 5-Star Plus regulation, the future of this program is under consideration.	Solar hot water heater subsidy: $500 for gas-boosted solar water heaters, and $700 for bottled LP gas-boosted solar water heaters used in areas without reticulated gas.

APPENDIX B MODELLING ASSUMPTIONS

The impact analysis is based on a number of assumptions about hot water usage, the efficiency, cost and durability of GWH, and energy tariffs.

B.1 Hot water usage

This RIS makes assumptions about hot water usage that are somewhat different to those used in the consultation RIS. The adjustments are in response to estimates of hot water usage that were published in a recent national baseline study on residential energy consumption (EES 2008: page 86).

This study estimated that the average household uses 110 litres of hot water per day and that daily usage is declining at the rate of 1.1 litres per year, mainly due to increasing water efficiency but also because the average Australian household is getting smaller. The study calculated the effect of the trend to smaller households using a simple formula to express the relationship between hot water loads and household size, assuming that, at any particular time, half of the average load is fixed across size categories and the other half is related to household size.

These findings from the national baseline study have been incorporated in this RIS, as follows.

- *Average hot water load:* The consultation RIS assumed that the average household uses hot water at the rate of 200 litres per day, which is the quantity that AS4234 prescribes for the purposes of the energy rating test. The figuring reported in this RIS is consistent with the lower figure of 110 litres per day.
- *Reduction in household hot water usage:* The projected reduction in average household usage is of less significance since this RIS is most concerned with the impact on users of particular appliances. The main effect of the projected reductions will be to alter the mix of appliances, increasing sales of smaller GWH and reducing sales of larger GWH. This effect is of second order importance and not readily estimated with the available data on product mix. It is best handled via sensitivity analysis.
- *Variation in hot water load by household size:* The relationship between hot water loads and household size has been used to differentiate the load for the various categories of GsWH. Specifically:
  - It has been assumed that the average load for the 90 litre GsWH is 100 litres per day, 120 litres per day for the 135 litre GsWH, and 140 litres per day for the 170 litre GsWH. These have been determined by taking supplier recommendations for sizing GsWH, which vary by household size, and using the formula from the baseline study to determine the corresponding hot water load.
  - It has been assumed that the average load for GiWH is 125 litres per day.

  The weighted average is somewhat greater than 110 litres per day, but that is consistent with the expectation that electric water heaters are used disproportionately by smaller households, particularly in multi-unit dwellings, which means that GWH are used disproportionately by larger households and the average load on GWH is somewhat above average.

Sensitivity testing has been conducted over a wide range of hot water loads, plus/minus 33% of the specified usage. This allows for known regional variation in the temperature of cold water, which increases the heating task for the water heater, and behavioural variations associated with the duration of showers, the use of hot water for clothes washing and the like. These variations are not well documented but probably significant.

B.1 Efficiency of water heaters

The public records of product certifiers can be interrogated to provide basic information about the efficiency of GWH, including differences between GiWH and GsWH, differences between internal and external GWH, and the number of models in the efficiency groups of interest. Depending on the stringency, MEPS will eliminate some of these options and it has been assumed that users will replace non-complying units with units that marginally comply. The least efficient complying units are generally close to the minimum required level of efficiency, reflecting the tendency for star ratings to be clustered around the various rating thresholds – 3 stars, 4 stars and 5 stars.

There is uncertainty about the energy savings that MEPS will deliver, and the source of the uncertainty is different for GsWH and GiWH.

For GsWH, the uncertainty arises because the efficiency of a GsWH can be increased by either reducing its standing loss or increasing its thermal efficiency. The standing loss is the heat that is lost from a hot storage tank, which means that the gains from better insulation or other loss reducing measures are independent of hot water usage. In contrast, thermal efficiency is the efficiency of converting the energy content of gas into hot water and the gains are partly dependant on the amount of hot water that is used[30]. Increases in thermal efficiency deliver smaller savings at lower loads. We used gas consumption schedules from Rheem's *Hot Water Manual* (Rheem 2006: table 3.4) to, in effect, define the combinations of loss reductions and efficiency increases that characterise more efficient GsWH. As it happens, lower standing losses are the main contributor to the performance of 5-star Rheem GsWH. This is supported by other confidential evidence that GsWH differ more in terms of standing losses than thermal efficiency.

For GiWH, the uncertainty arises because the efficiency of a GiWH can be increased by either reducing its start-up losses or increasing its thermal efficiency. There are start-up losses because it takes a few seconds for the GiWH to start producing usable hot water and under-heated water is dumped in the meantime. In principal, therefore, the gains from both loss reducing and efficiency increasing measures depend on user behaviour, since the gains to the former increase with the number of tappings and the gains to the latter increase with hot water usage. To define the mix, we used the results of energy modelling that was recently commissioned by Sustainability Victoria to characterise the range of GiWH in the market (Thermal Design 2009). This latest figuring regards the standing losses as determined solely by the number of tappings, with no scope for further reductions, which means that gas bills can be reduced mainly by increasing the thermal efficiency of GiWH. This simplifies our modelling task since, for any given household, the number of tappings is independent of the efficiency of the water heater. We made a nominal allowance for the start-up losses and modelled the energy savings solely in terms of increases in the thermal efficiency. The latter vary in direct proportion to hot water usage.

B.3 Gas tariffs - Australia

The value of energy savings to households is calculated at the marginal gas tariff, which varies by time and place. In particular, wholesale gas prices will increase as domestic gas markets are further integrated with international markets, and with the introduction of the CPRS. And the cost of delivery varies considerably between jurisdictions, between metropolitan and regional consumers, and by type of gas.

Wholesale prices

Figures B.1 and B.2 report projections for the wholesale price of natural gas and LPG. The former are Treasury projections, developed for Treasury's analysis of the economics of climate change mitigation. The latter are a conservative interpretation of recent movements in LPG prices.

[30] The gains are only partly dependant on the amount of hot water that is used because increases in thermal efficiency also reduce the standing losses, in the sense less gas is consumed to replace standing losses.

Figure B.1 Wholesale price of natural gas (cents/MJ)

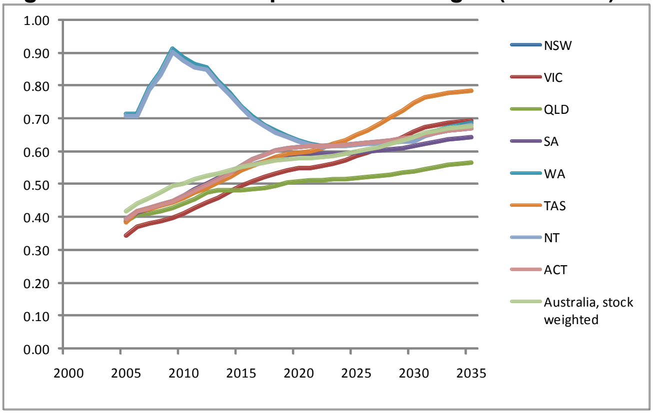
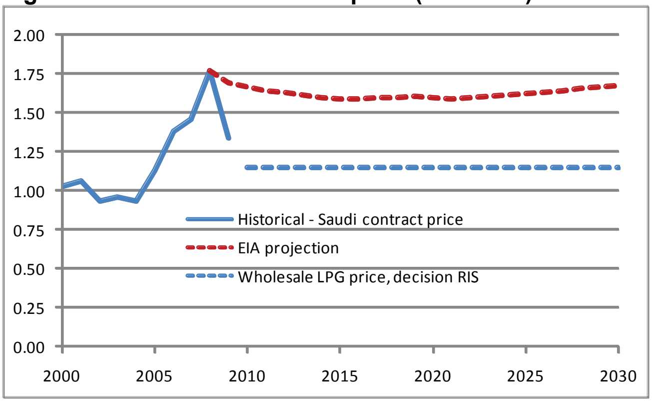


Figure B.2 International LPG price (cents/MJ)



The background to the natural gas projections is that, while natural gas is traded internationally, Australian suppliers require LNG (liquefied natural gas) facilities in order to participate in the international market. LNG facilities have been established in Western Australia, linking WA suppliers to global markets. Treasury assumes that LNG facilities will be developed on the east coast, raising east coast prices to world levels as long term contracts expire.

> *South eastern gas supplies are assumed to be gradually depleted over the next 20 years, with gas increasingly sourced from Queensland. In addition, LNG facilities are assumed to be developed in Queensland, with a moderate degree of LNG penetration assumed, reaching 10 Mtpa LNG capacity. Consequently, east coast gas prices are assumed to converge to international gas prices in 2029-30. Differences in gas transmission costs amongst states, reflecting distance from fuel sources, mean that fuel prices are not equalised across states.* (Treasury 2008: page 242)

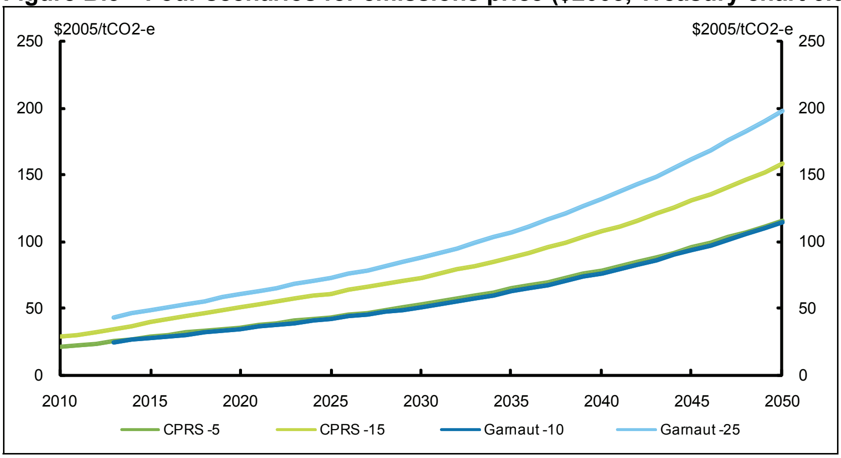
Figure B.1 shows the expected effect. All wholesale prices are in the range $6-8/GJ by 2030, or 0.6-0.8 cents/MJ. This is a significant increase on existing east coast prices, which are about 0.4 cents/MJ. WA prices are temporarily somewhat higher due to infrastructure constraints but are expected to fall back to 0.6-0.7 cents/MJ.

LPG is already traded internationally and Australia's wholesale LPG prices move with international prices. Figure B.2 shows the increase in the Saudi Aramco contract price over recent years, expressed here in Australian cents per MJ. Prices increased sharply after 2004 but collapsed in late 2008: the average price was down to 1.33 cents/MJ in the first four months of 2009. A price of 1.15 cents/MJ is plausible for the longer term – see the projection in figure B.2. This is somewhat lower than might be inferred from the most recent global reviews by the International Energy Agency (IEA 2008) and the US Energy Information Administration (EIA 2008), but these were published before the onset of the financial crisis. For example, figure B.2 shows the EIA projection for US prices spliced onto the historical record, indicating prices of 1.6-1.7 cents/MJ for the period to 2030. The figure of 1.15 cents/MJ is significantly lower but preserves a proportion of the increase observed in recent years, and conservatively values the gas savings that are delivered by more efficient GWH on LPG.

<u>Emissions price</u>
Figure B.3 reports the projected emissions prices that also need to be incorporated into gas prices. We used the most conservative of these, CPRS-5, which assumes that Australia's medium-term target is 5 per cent below 2000 levels by 2020. For GWH that are purchased in the period to 2020, some of which will remain in service into the 2030s, this typically adds about 0.3 cents/MJ to the price of gas. It is assumed that, with gas prices determined internationally, the emissions charge under the CPRS will be passed fully onto users.

Note that Treasury reported its emissions price projections in 2005 prices. We rebased these to 2008/09 by adding 10%.

Figure B.3 Four scenarios for emissions price ($2005, Treasury chart 6.3)



Source: (Treasury 2008) Treasury explained the various scenarios as follows:
Australia's emission reduction targets in these scenarios are 10 per cent below 2000 levels by 2020 and 80 per cent below by 2050 for stabilisation at 550 ppm (Garnaut -10); and 25 per cent below 2000 levels by 2020 and 90 per cent below by 2050 for stabilisation at 450 ppm (Garnaut -25). ... The other two scenarios, CPRS-5 and CPRS-15, examine the potential costs of Australia's Carbon Pollution Reduction Scheme within a more realistic multi-stage global framework. ... Australia's long-term emission reduction target in both scenarios is 60 per cent below 2000 levels by 2050. CPRS -5 assumes a slower start to global emission reductions and stabilisation at 550 ppm; Australia's medium-term target is 5 per cent below 2000 levels by 2020. CPRS -15 assumes a faster start and stabilisation at 510 ppm; Australia's medium-term target is 15 per cent below 2000 levels by 2020. (Treasury 2008: page xi)

Delivery charges

There is further variation in gas tariffs that relates to the mode of delivery. The most expensive mode is bottled LPG, adding about 3 cents/MJ and taking the delivered price of LPG to 4.5 cents/MJ, including GST. The cheapest mode is via gas networks with high customer density (customers per kilometre of pipe) and high average gas usage. Metropolitan Victoria has these characteristics. Network charges add about 0.65 cents/MJ in these circumstances, taking the delivered price to about 1 cent/MJ, including GST. Intermediate charges (1.5-2.5 cents/MJ) are paid by users on low volume or low density networks in Queensland, and by users on the reticulated LPG networks that are being installed on some new housing estates in Queensland, South Australia and Western Australia.

We calculated a range of delivery charges as difference between wholesale gas prices and typical gas tariffs, and assumed that this component is fixed in real terms for the period of the analysis.

‘Equivalent fixed’ gas tariffs

We used the concept of an ‘equivalent fixed price’ to simplify the cash flow analysis of situations involving changing prices over time. Specifically, we converted any series of changing prices into a fixed price that has the same present value as the price series. To illustrate, suppose that the marginal electricity tariff is 15 cent/kWh but increasing at 1% per year and will be 17.2 cents/kWh when the heater is due for replacement in 15 years. It can be shown that the equivalent fixed price is 15.9 cents/kWh – that is, fixed at 15.9 cents/kWh for each of the 15 years, for the discount rate of 7% that is being used in this RIS – and that discounted cash flow calculations yield the same results for both the changing and fixed series.

In effect, the user is regarded as forming a view about future energy prices and converting that into a set of ‘equivalent fixed prices’ that is appropriate to the time and place of the decision. Given the likelihood that current choices will constrain future options – for example, due to the retrofit costs of switching fuels or installing more efficient appliances in the future – it is assumed that it is sensible to look ahead 15 or 20 years when selecting a water heater. We adopted 15 years as the default time horizon. However, the impact estimates are not sensitive to this assumption.

Table B.1 reports the ‘equivalent fixed’ marginal gas tariffs that have been used throughout this RIS. Most of the analysis is in terms of the overall weighted average, 1.93 cents/MJ. We test for sensitivity to a range of other marginal tariffs.

Table B.1 ‘Equivalent fixed’ marginal gas tariffs in 2015, looking ahead by 15 years (cents/MJ)

	Mains gas			*LPG*	*Mains gas & LPG*
	Lower cost networks	*Higher cost networks*	*Weighted average*		
NSW	1.70	2.18	1.81	4.76	1.99
VIC	1.46	1.54	1.47	4.76	1.67
QLD	2.32	2.84	2.43	4.76	2.58
SA	1.93	1.93	1.93	4.76	2.11
WA	2.07	2.57	2.12	4.76	2.28
TAS	2.06	2.06	2.06	4.76	2.23
NT	2.07	2.58	2.07	4.76	2.24
ACT	2.02	2.02	2.02	4.76	2.19
Australia (weighted av.)	**1.46**	**2.84**	**1.74**	**4.76**	**1.93**

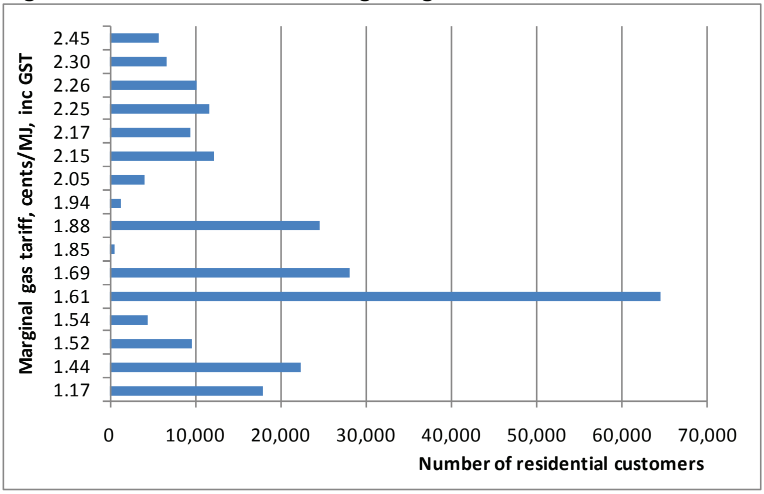
B.4 Gas tariffs – New Zealand

Natural gas

New Zealand's Ministry of Economic Development (MED) periodically publishes estimates of average residential prices for natural gas, the most recent being the average price in 2007 – 3.5 cents/MJ, including GST. MED also publishes gas price schedules for residential customers on the various gas networks, most recently for September 2008. The prices paid by average customers (defined as using 25,200 MJ/year) range from 2.76 to 3.88 c/MJ, including GST. However, these averages include the fixed supply charges that do not vary with consumption. Marginal gas tariffs are somewhat lower.

We therefore reviewed a selection of the tariff schedules that are published on retailer websites. The customer-weighted average of the marginal tariffs is 1.67 cents/MJ, including GST, ranging from a low of 1.17 cents/MJ to a high of 2.45 cents/MJ. Figure B.5 shows the distribution of marginal gas tariffs. (Note that figure B.4 reports the number of customers against specific individual tariffs, not ranges.)

Figure B.4 Distribution of marginal gas tariffs, residential sector



The gas networks that were covered in this review had 196,000 residential customers. This is a large proportion of New Zealand's 230,000 residential natural gas users, which is the estimate provided in the June 2008 edition of MED's *Energy Data File*. The LPG Association of NZ says that another 80-90,000 households use LPG, which is priced at NZ$100-110/45 kg bottle, or 4.5-4.9 cents per MJ. The weighted average price for both natural gas and LPG is 2.4 cents/MJ and that is the figure used for the baseline assessment in this RIS. We test for sensitivity over the range of prices: 1.2 cents/MJ to 4.9 cents/MJ.

B.5 Incremental cost of more efficient GWH - Australia

The cost analysis is confined to external GsWH since internal GsWH are excluded from the analysis.

The additional cost of external GsWH has been estimated as follows.

- *Market segments:* Five market segments were defined in terms of the various combinations of storage capacity and warranty period that are now available.
  - 90 litres, 5 year warranty
  - 135 litre, 5 year warranty
  - 135 litre, 10 year warranty
  - 170 litre, 5 year warranty

    - 170 litre, 10 year warranty

- *Installation costs:* Installation costs are generally ignored, on the assumption that they are independent of energy ratings. Like-for-like replacements will be available to the extent that there will be no need to alter arrangements for the supply of water and electricity.
- *Price of GsWH with 5-year warranties and 3-star energy ratings:* These prices were equated with prices reported in the 2008 edition of Rawlinson's *Construction Cost Guide*. Including GST, the prices are $935.00, $990.00 and $1,116.50 for 90,135 and 170 litre GsWH respectively.
- *Incremental price of GsWH with 10-year warranties:* Based on the price information provided by major plumbing supplier (Reece), the incremental cost of the extra five years of warranty was put at $120.
- *Price increment for upgrading each market segment to comply with MEPS:* We used the concept of a price/efficiency ratio to model the impact of MEPS on the cost of GWH. This is the ratio of the increase in the price of the GWH to the increase in the efficiency of the GWH. For example, a price/efficiency ratio of 1.0 indicates that a 10% increase in efficiency is accompanied by a 10% increase in price. A ratio of 0.5 indicates that a 10% increase in efficiency is accompanied by a 5% increase in price, and a ratio of 2.0 indicates that a 10% increase in efficiency is accompanied by a 20% increase in price.
    - The lower ratio (0.5) is assumed to apply to the transition from 3-star GsWH to 4-star GsWH.
    - The intermediate ratio (1.0) is assumed to apply to the transition from 4-star GsWH to 5-star GsWH.
    - The higher ratio (2.0) is assumed for any improvement in GsWH beyond 5.2 stars, which is unexplored territory in terms of the GsWH that are now on the Australian market.

The additional cost of GiWH has been estimated as follows.

- *Market segments:* There are two market segments, internal and external GiWH. However, we understand that the efficiency of internal GsWH is such that they will not be affected and can be excluded from the analysis. The analysis is therefore reduced to one market segment, external GiWH.
- *Installation costs:* Installation costs are ignored, on the assumption that they are independent of energy ratings. Like-for-like replacements will be available to the extent that there will be no need to alter arrangements for the supply of water and electricity.
- *Price of GiWH with 5-5.2 star energy rating ratings:* This price was set at the average reported by a major plumbing supplier.
- *Price increments and decrements for GiWH with other energy ratings:* Again, we used price/efficiency ratios to estimate prices for GiWH with other relevant energy ratings. The intermediate ratio (1.0) is assumed for GiWH in the range 4.5 stars to 5.5 stars.

This approach seems to generate conservative (that is, high) estimates of the price increases when compared with the available cost and price data, to which we now turn.

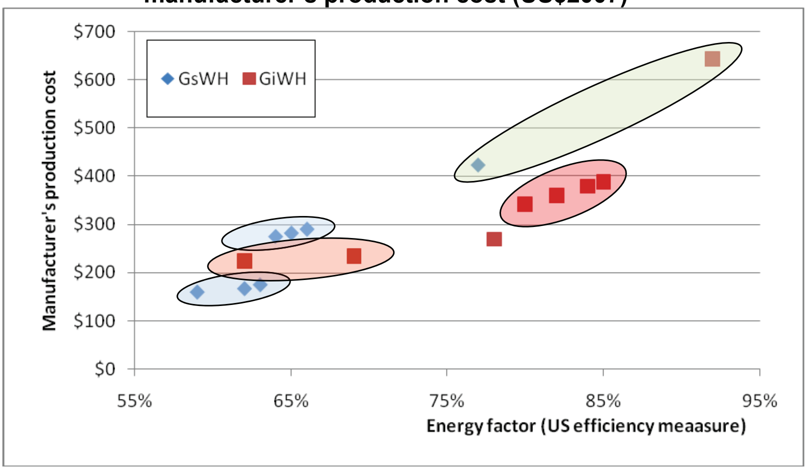
<u>US estimates of incremental cost</u>
Figure B.5 and table B.5 present the results of analysis that the US Department of Energy recently published (DoE 2009) to inform the rule-making processes that will introduce new energy conservation standards for residential water heaters, no later than March 31, 2010. Regarding figure B.5, note that:

- The costs are the manufacturer's production costs only, excluding the mark-ups that are applied by the manufacturer, distributor, contractor and builder. Retail prices, including mark-ups are more than double the production costs.
- For a given manufacturing cost, GiWH are generally more efficient than GsWH.
- The two most expensive units – the GsWH at $425 and the GiWH at $643 – employ condensing technology and are not further considered. Options for setting MEPS at this level have been discarded as unworkable.
- The cheapest units of each type – the GsWH at $160 and the GiWH at $225 – are the configurations that marginally comply with the existing US MEPS.
- All but one of the non-condensing options can be grouped to one of four groups, two groups of GsWH and two groups of GiWH, as indicated on the figure. There are sharp cost increases at the margins between the groups, particularly for GsWH. The discontinuity is associated with use of electrical components to increase efficiency – electronic ignition and power vents[31].

Table B.5 provides more detail about the technological combinations that DoE considered (excluding the condensing option). We identified broad technology options and calculated cost/efficiency ratios that seem to be specific to specific technologies. Note the following:

- The cost/efficiency ratios for GiWH (where the 'cost' is the manufacturer's production cost) are less than 1.0 up to efficiency level 2 and about 2.0 thereafter. This suggests that the corresponding price/efficiency ratios are less than 0.5 and less than 1.0 respectively. This is because the various mark-ups in the supply chain raise the final selling price to at least twice the level of production costs. This assumes, of course, that mark-ups are not increased proportionally. We assume that there are only minor additional downstream costs – such as the additional cost of financing inventories and of handling more bulky products – and that mark-ups are substantially unchanged.

Figure B.5 US estimates of the relationship between energy efficiency and manufacturer's production cost (US$2007)



[31] *Power vents can be designed either as induced or forced draft systems. An induced draft fan is installed downstream of the draft diverter in the venting system and pulls flue gases through the flue. A forced draft fan is upstream of the combustion chamber and supplies the correct fuel-to-air ratio for combustion. Both methods improve efficiency by increasing turbulence in the flue gases.* (DoE 2009: page *3-50)*

Table B.5 US estimates of relationship between energy efficiency and manufacturer's production cost (US$2007)

				Cost/efficiency ratios (ratio of % change in cost to % change in EF)			
Efficiency level	*Efficiency factor (EF)*	*Technology*	*Manufacturer's production costs (2007$US)*	*Improved insulation (GsWH) or heat exchanger (GiWH)*	*Electronic ignition*	*Electronic ignition & power vent*	*Direct vent*
			GsWH				
Baseline	59%	Standing Pilot and 1" Insulation	$160				
1	62%	Standing Pilot and 1.5" Insulation	$167	0.86 (B'line to 1)			
2	63%	Standing Pilot and 2" Insulation	$175	2.97 (1 to 2)			
3	64%	Electronic Ignition, Power Vent, and 1" Insulation	$276			8.56 (B'line to 3)	
4	65%	Electronic Ignition, Power Vent and 1.5" Insulation	$283	1.62 (3 to 4)		14.36 (1 to 4)	
5	66%	Electronic Ignition, Power Vent, and 2" Insulation	$291	1.84 (4 to 5)		13.92 (2 to 5)	
			GiWH				
Baseline	62%	Standing Pilot	$225				
1	69%	Standing Pilot and Improved Heat Exchanger Area	$235	0.39 (B'line to 1)			
2	78%	Electronic Ignition & Improved Heat Exchanger	$270		0.78 (1 to 2)		
3	80%	Electronic Ignition and Power Vent	$343			1.81 (B'line to 3)	
4	82%	Electronic Ignition, Power Vent, Improved Heat Exchanger Area	$361	2.10 (3 to 4)			
5	84%	Electronic Ignition, Power Vent, and Improved Heat Exchanger Area	$379	2.04 (4 to 5)			
6	85%	Electronic Ignition, Power Vent, Direct Vent, & Improved Heat Exchanger Area	$388				2.04 (4 to 6)

- There is more variation in the cost/efficiency ratios for GsWH. Those associated with the use of electrical components (electronic ignition and power vents) are quite high (8.56 to 13.92), and suggest price/efficiency ratios in the range 4.0 to 7.0. However, E3 has not considered options that would require these changes. There is not only a significant price increase but also the cost of connecting to electricity.
- The remaining options for GsWH are associated with cost/efficiency ratios of no more than 3.0, suggesting price/efficiency ratios of no more than 1.5.

Differences in testing procedures and product mix[32] assumptions means that we cannot confidently translate these findings into cost estimates under Australian and New Zealand conditions. However, they do provide a degree of confidence that our price estimates are conservative. Specifically we use price/efficiency ratios that are high relative to the US evidence.

We also note that there is also a long history of US regulatory authorities overestimating the cost impact of regulatory proposals. A review of the impacts of US MEPS noted that ... *Looking at the trends, it is difficult to see an impact on price from DoE standards in most cases* (Meyers *et al* 2002: page 21). Regarding the impact of the existing US MEPS, we followed up with DoE and the US office of *Reed Construction Data*, seeking evidence of what actually happened to the price of GsWH after the new standards were introduced. The informal advice from the DoE is that, while they have no hard data, the anecdotal evidence is that the observed increase in prices has been small, if any. The informal advice from *Reed Construction Data* is the same. We were told that, while there have been significant price changes in response to steel shortages and high copper prices, there was no noticeable effect from the increase in energy conservation standards. But we note the possibility that most manufacturers had few changes to make because their products already complied with the MEPS. In fact, a 2002 report to Sustainability Victoria noted that a large number of models in both Canada and the US already complied with the 2004 US MEPS (MEA *et al* 2002: page 26)

<u>Australian price comparisons - GsWH</u>
Our initial analysis of prices was confined to GsWH, since GiWH were substantially unaffected by the 5-star proposal. Catalogues and price lists were collected from appliance manufacturers, plumbing suppliers, energy retailers and online retailers, including outlets of a major plumbing supplier (Reece). Certain price differences can be reasonably attributed to a single appliance attribute – such as efficiency or warranty period – because the GsWH are identical in other respects, such as storage capacity and model ‘family’.

Table B.6 reports the results of one such exercise, focused on differences in the price of 3-star and 5-star GsWH, and providing estimates of average price difference in the range $100-$130. We have assumed price/efficiency ratios that generate somewhat larger differences, in the range $150-$200. Again, the impact assessment is based on assumptions that are conservative. But note that the underlying comparisons returned highly variable results. In one instance, a 5-star model was temporarily priced at only $1 more than its 3-star equivalent as part of a product promotion. Another source returned a difference of $203 for the same comparison.

We made further price checks in preparing this RIS, confirming that our approach is conservative. The difference in price between 3-star and 5-star GsWH was only $30-$40 for one major supplier.

[32] There is greater use of internal GsWH in the US, often installed in basements.

Table B.6 Price comparisons for 3-star and 5-star GsWH, AU$2008

Brand	*Product upgrade*	*3-star price ($)*	*5-star price ($)*	*Price difference ($)*	*Source**
		135 litre			
Rheem	Optima 811 TO Stellar	1,165.2	1166.0	0.7	Reece 1
Rheem	Optima 811 TO Stellar	1,078	1,177	99	Reece 2
Rheem	Optima 811 TO Stellar	947	1,150	203	Hot water on-line
Rheem	Optima 811 TO Stellar	900	1,050	150	Energy Australia
Dux	Proflo 111 Marathon TO Prodigy Storage	1,017	1,184	167	Reece 1
Dux	Proflo 111 Marathon TO Prodigy Storage	1,074	1,179	105	Reece 2
Dux	Proflo 111 Marathon TO Prodigy Storage	931	1,120	189	HW specialist
		170 litre			
Rheem	Optima 811 TO Stellar	1,232	1,365	132	Reece 1
Rheem	Optima 811 TO Stellar	1,080	1,200	120	Hot water on-line
Rheem	Optima 811 TO Stellar	1,025	1,115	90	Energy Australia
Dux	Proflo 111 Marathon TO Prodigy Storage	1,147	1,184	37	Reece 1
Dux	Proflo 111 Marathon TO Prodigy Storage	1,186	1,260	74	Reece 2
Dux	Proflo 111 Marathon TO Prodigy Storage	1,054	1,194	140	HW specialist
		Unweighted averages			
135 litre				131	
170 litre				99	
All				116	

Note:
* Prices were obtained from two Reece distributors, hence the references to ‘Reece 1’ and ‘Reece 2’.

Australian price comparisons - GiWH
Figure B.6 presents the results of a similar exercise for GiWH. The two highest prices (at about $2,000) can be ignored. These are the first units on the Australian market that use condensing technology and have energy ratings that greatly exceed any of the MEPS that are being considered. The remaining observations are in the range of interest: MEPS options at 5 stars, 5.2 stars and 5.5 stars are being considered.

Superficially, the data in the relevant range suggests that more efficient GiWH will be cheaper. This is strongly counter-intuitive. It is more likely that efficiency differences are swamped by other variations in product characteristics. The wholesaler that we spoke to said that brand familiarity is the likely explanation. It happens that the less efficient GiWH (5-5.2 stars) are well-established in the market and sell at a premium over the more efficient GiWH (5.5 stars) that have been introduced more recently. Also, the range of efficiencies is small (5 to 5.5 stars) and it may be unreasonable to expect any underlying cost differences to be detectable amongst the typical noise of market prices.

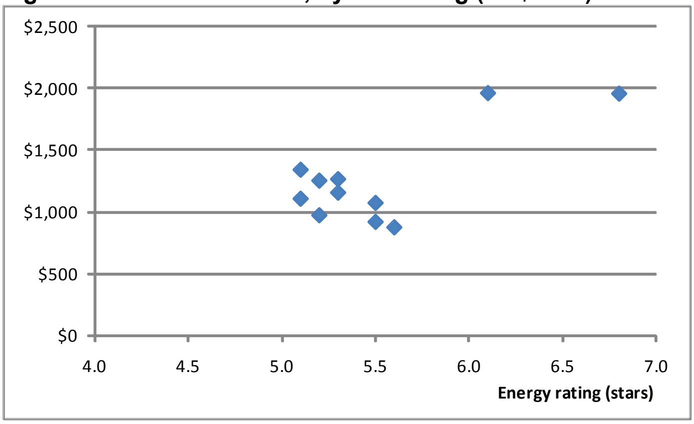
At best we can say that our pricing assumptions are easily consistent with the US data and are not contradicted by the Australian data.

Supplier comments on cost estimates
The one supplier who commented on the cost estimates (Dux) agreed that the estimates of incremental appliance costs were reasonable. In a follow-up phone interview, Dux

explained their comment related to a small number of situations where the larger 5-star heater may not be easily accommodated in the available space and there would be additional installation costs.

Overall, we are confident that the prices of more efficient GWH have been assessed conservatively.

Figure B.6 Price of GiWH, by star rating (AU$2009)



B.6 Incremental cost of more efficient GWH – New Zealand

For GiWH, it is assumed that the New Zealand prices are the same as Australian prices after adjusting for the average rate of currency exchange over the last 5 years, which is NZ$1.144 to AU$1.00. GiWH are largely imported to both countries, from the same suppliers and for the same products.

For GsWH, we have relied on supplier advice that price differential will be roughly twice the amounts that would be expected on the basis of an exchange rate conversion. The GsWH that will be affected by the proposed measures are mostly imported from Australia and in very small volumes. It is anticipated that the measures will affect sales of less than 1,000 GsWH.

B.7 Asset lives and discount rates

For the purposes of discounted cash flow analysis, 'the present' is taken to be 2009 and the future values are discounted at the rates prescribed for Australia and New Zealand, 7.5% and 6% respectively.

GWH with 5 and 10 year warranties are assumed to have asset lives of 11 years and 15 years respectively. This is consistent with estimates of average asset lives of about 12 years.

APPENDIX C IMPACT ASSESSMENTS FOR INTERNAL GSWH THAT HAVE BEEN EXCLUDED FROM THE PROPOSAL

This appendix contains the impact assessment for internal gas water heaters that were included in the CBA but have now been excluded from the proposal.

Virtually all new GsWH are now installed outside the dwelling and many that were originally installed in the ceiling or laundry have been relocated outside. But there remains a declining market for internal replacement units. This is the cheapest replacement option, since it requires no changes to the gas and water lines. The issue is whether suppliers can upgrade these small volumes at reasonable cost. Options for venting the combustion gases are more limited when the heater is indoors, making it more difficult to reduce the amount of waste heat that escapes with the combustion gases.

We deal separately with the gravity feed type and the mains pressure type. The former are installed in the ceiling. We also deal separately with Australia and New Zealand

Australia
<u>Internal GsWH, gravity feed type</u>
HWS Australia Pty Ltd is the sole supplier of these units and produces about 250 a year for the replacement market, mainly in South Australia. One appliance is certified, with a certification date of 1988 and an energy rating of 4.4 stars.

We have had a single brief discussion with the manager of HWS, Bill Riach. He considers that it may be possible to achieve a 5-star rating – for example, by increasing the insulation – but emphasised there were severe dimensional constraints. The incremental cost may also be greater for small production runs than for units that are produced in tens of thousands.

For the baseline assessment we have assumed that this appliance is upgraded by 0.6 stars (from 4.4 stars to exactly 5 stars), that the upgrade occurs at the end of the transition period (October 2010), and that the incremental cost of these units equals the value of the energy savings. The impact on this market segment can then be stated as follows:

Impact on average customer

- Incremental cost of heater - $160
- Energy savings – 1,214 MJ/year
- Value of energy savings – $18.26/year (SA marginal tariff of 1.5 cents/MJ)
- Present value of energy savings – $160 (asset life of 13 years, discount rate of 7.5%)
- Net financial cost/benefit – $0
- Benefit cost ratio – 1.0

Aggregate impact

- Additional sales of 5-star units to 2020 – 1,250 (assumes a declining market)
- Present value of incremental cost – $142,000
- Present value of energy savings – $142,000
- Net financial cost/benefit – $0
- Benefit cost ratio – 1.0

Internal GsWH, mains pressure type

Suppliers of the mains pressure type of internal GsWH have indicated that, given the low volume of these sales (about 3,250/year, for replacement only) and that the market is declining, it may not be commercially feasible to produce a 5-star version of this product.

To test this proposition it is necessary to consider the options that are available to customers if they are unable obtain a 5-star replacement when their existing internal GsWH fails. There seem to be four options.

- The GsWH can be relocated outdoors, incurring the additional cost of changes to gas and water lines.
- The internal GsWH may be replaced with an external GiWH, also incurring costs of changes to gas and water lines. These may need to be rerouted and upgraded to supply gas and water at the higher rates required by GiWH. While some of these appliances also need to be connected to electricity, the cheapest product seems to be the 'hydro' range of heaters, which use the flow of water to generate a spark for igniting the burner.
- The internal GsWH may be replaced with an internal GiWH. Internal GiWH are more expensive than the external GiWH and may require the gas and water supply to be upgraded. There may also be changes to the fluing arrangements. Again, the cost of adding a power supply is avoided by selecting from the 'hydro' range of heaters.
- The customer can convert to an electric hot water system.

To better understand this problem, we conducted informal phone interviews with plumbers in Sydney and Melbourne. They emphasise that the additional costs are highly specific to the particular situation and that they always inspect the site before quoting. While reluctant to provide general indications, they say that external relocation of the GsWH generally costs about $500. One suggested a range of $200-$600 and another said the cost could go to $1,000 in particularly difficult circumstances.

It is not always feasible to install an external GsWH, for reasons of space or height above ground (for multiple-storey dwellings). Some corporate bodies also limit the customer's options for aesthetic reasons. The customer may then install a GiWH, either internal or external. Again, plumbers emphasise the site-specific nature of these costs, but the general feedback is that the additional costs are $1,500-$2,000 for external GiWH and $2,000-$2,500 for internal GiWH.

Regarding the electric option, price data (*Reed Construction Data* 2006) suggest that the installed cost of an electric appliance is $200-$300 lower than an equivalent gas appliance. For replacement units, however, this saving is substantially offset by the cost of running power to the electric heater. More importantly, the energy costs of electric units are much higher and may add $100 to the annual energy bill.[33] The present value of these additional amounts over the life of a heater is about $750.

These options are not attractive. However, if sufficiently unattractive, consumers must be willing to pay a significant premium for an internal replacement with a 5-star rating. The commercial question for suppliers is:

- Will a 5-star version of the internal GsWH cost 'thousands more', which means that it cannot compete with the options canvassed above?
- Or will a 5-star version cost somewhat more – say, $200 – and therefore be assessed by suppliers as commercially viable and likely to strongly preferred to options canvassed above?

[33] GWA (2005a) provides a detailed assessment of the running costs of alternative water heating technologies.

There is some evidence that GWH can be produced on a small scale and still sell at prices that are not radically different to the prices charged for units that are produced on a large scale. For example, the gravity feed model produced by HWS Australia Pty Ltd sells for about $900, which is similar to the price charged for mass-produced appliances. While the HWS design is simpler than comparable mains pressure units, the difference in underlying costs seems to be hundreds per unit, not thousands per unit.

Given the uncertainties, our baseline assessment is that the net financial impact on customers in this sub-market is zero. Given the possibility that there may be some increase in the use of electric hot water systems, the impact on greenhouse emissions is also put at zero.

New Zealand

Internal GsWH manufactured in New Zealand

While there has been no systematic review of options for increasing the energy efficiency of these installations at reasonable cost, the manufacturer considers that there are no promising options. He says that:

- Replacement with an external appliance, either GsWH or GiWH, is at the cost of new pipes for water and gas that can add NZ$1,500-NZ$2,500 to the cost of conversion, and may also require electric power.
- These units cannot be easily replaced with internal GsWH imported from Australia, even supposing that the Australian products are upgraded to 5 stars. The locally manufactured units are designed in the US fashion, with fittings on the top of the unit, whereas Australian appliances have fittings on the side and cannot be easily fitted into existing cupboard spaces. Importation of these bulky items would also add at least NZ$200 to the cost.
- The incremental cost of upgrading the local product would be high. Price differentials in the market for external GsWH suggest that the increase would be NZ$300-400, without allowing for either the need to recover the development costs from a small production run or the constraints imposed by the restrictions on appliance size and fluing arrangements for internal units.

A further uncertainty is the HEEP finding that internal GsWH contribute to the space-heating task during winter.[34] This means that space-heating appliances must at least partially compensate for reductions in cylinder energy losses, particularly where the cylinder is relocated outdoors.

The additional testing costs, for compliance purposes, have already been noted and put at NZ$20,000.

It should be noted that the potential for lower energy bills is non-trivial. They would be comparable with the estimate for external GsWH, which is $690 over the life of the heater. This suggests there is some scope for cost-effective increases in energy efficiency.

Internal GsWH imported from Australia

There are very few sales to New Zealand, 10-20/year. The baseline estimate for this market segment is for a net financial impact of zero and a benefit cost ratio of 1.0, as for Australia.

[34] BRANZ reports this finding in relation to the combination of gas and electric cylinders. The New Zealand manufacturer of internal GsWH has advised that these findings would apply equally well to the sub-set of these cylinders that are gas-fired.

APPENDIX D SENSITIVITY ANALYSIS FOR OPTIONS 2, 3 AND 4 - AUSTRALIA

TABLE D.1 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – AUSTRALIA, OPTION 2

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	730.5	-31.4	-2.11	269.6	80.8	188.8	3.3
Discount rate							
0%	730.5	-31.4	-2.11	606.1	126.8	479.3	4.8
5%	730.5	-31.4	-2.11	346.9	93.1	253.8	3.7
10%	730.5	-31.4	-2.11	212.9	70.6	142.3	3.0
Stock and sales scenario							
phase out of electric water heaters	826.0	-35.6	-2.39	302.6	90.5	212.1	3.3
faster phase out of 3-star GsWH	573.1	-24.5	-1.65	214.5	64.6	149.9	3.3
Gas tariff							
-10%	730.5	-31.4	-2.11	242.6	80.8	161.8	3.0
+10%	730.5	-31.4	-2.11	296.5	80.8	215.7	3.7
Incremental cost of GWH							
+25%	730.5	-31.4	-2.11	269.6	100.6	169.0	2.7
-25%	730.5	-31.4	-2.11	269.6	61.0	208.6	4.4
Hot water load							
-33%	730.5	-29.9	-2.00	256.5	80.8	175.7	3.2
+33%	730.5	-32.9	-2.21	282.6	80.8	201.8	3.5
Estimates of energy savings							
-10%	730.5	-34.5	-2.32	296.5	80.8	215.7	3.7
+10%	730.5	-28.3	-1.90	242.6	80.8	161.8	3.0

TABLE D.2 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – AUSTRALIA, OPTION 3

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	1528.1	-31.9	-2.14	256.9	80.0	176.9	3.2
Discount rate							
0%	1528.1	-31.9	-2.14	615.1	136.5	478.6	4.5
5%	1528.1	-31.9	-2.14	337.4	94.8	242.5	3.6
10%	1528.1	-31.9	-2.14	198.9	67.9	131.0	2.9
Stock and sales scenario							
phase out of electric water heaters	1886.3	-37.0	-2.48	295.1	92.8	202.3	3.2
faster phase out of 3-star GsWH	1425.2	-25.4	-1.70	206.5	64.9	141.6	3.2
Gas tariff							
-10%	1528.1	-31.9	-2.14	231.2	80.0	151.2	2.9
+10%	1528.1	-31.9	-2.14	282.6	80.0	202.6	3.5
Incremental cost of GWH							
+25%	1528.1	-31.9	-2.14	256.9	100.2	156.6	2.6
-25%	1528.1	-31.9	-2.14	256.9	60.0	196.9	4.3
Hot water load							
-33%	1528.1	-29.7	-1.99	240.1	80.0	160.1	3.0
+33%	1528.1	-34.1	-2.28	273.7	80.0	193.7	3.4
Estimates of energy savings							
-10%	1528.1	-35.1	-2.35	282.6	80.0	202.6	3.5
+10%	1528.1	-28.7	-1.92	231.2	80.0	151.2	2.9

TABLE D.3 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – AUSTRALIA, OPTION 4

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	1901.3	-43.4	-2.91	337.4	128.0	209.4	2.6
Discount rate							
0%	1901.3	-43.4	-2.91	838.2	221.4	616.8	3.8
5%	1901.3	-43.4	-2.91	448.1	152.5	295.6	2.9
10%	1901.3	-43.4	-2.91	258.6	108.1	150.4	2.4
Stock and sales scenario							
phase out of electric water heaters	2410.1	-51.9	-3.48	398.2	152.7	245.5	2.6
faster phase out of 3-star GsWH	1835.4	-36.8	-2.46	285.0	109.7	175.3	2.6
Gas tariff							
-10%	1901.3	-43.4	-2.91	303.7	128.0	175.7	2.4
+10%	1901.3	-43.4	-2.91	371.1	128.0	243.2	2.9
Incremental cost of GWH							
+25%	1901.3	-43.4	-2.91	337.4	161.5	175.9	2.1
-25%	1901.3	-43.4	-2.91	337.4	95.2	242.2	3.5
Hot water load							
-33%	1901.3	-38.9	-2.61	304.7	128.0	176.7	2.4
+33%	1901.3	-48.0	-3.22	370.1	128.0	242.1	2.9
Estimates of energy savings							
-10%	1901.3	-47.8	-3.20	371.1	128.0	243.2	2.9
+10%	1901.3	-39.1	-2.62	303.7	128.0	175.7	2.4

APPENDIX E SENSITIVITY ANALYSIS FOR OPTIONS 2, 3 AND 4 – NEW ZEALAND

TABLE E.1 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – NEW ZEALAND, OPTION 2

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	0.87	-0.0256	-0.0014	0.35	0.18	0.16	1.9
Discount rate							
0%	0.87	-0.0256	-0.0014	0.61	0.22	0.39	2.8
5%	0.87	-0.0256	-0.0014	0.46	0.20	0.26	2.3
10%	0.87	-0.0256	-0.0014	0.25	0.17	0.09	1.5
Gas tariff							
-10%	0.87	-0.0256	-0.0014	0.31	0.18	0.13	1.7
+10%	0.87	-0.0256	-0.0014	0.38	0.18	0.20	2.1
Incremental cost of GWH							
+25%	0.87	-0.0256	-0.0014	0.35	0.22	0.13	1.6
-25%	0.87	-0.0256	-0.0014	0.35	0.15	0.20	2.3
Hot water load							
-33%	0.87	-0.0225	-0.0012	0.31	0.18	0.12	1.7
+33%	0.87	-0.0287	-0.0015	0.39	0.18	0.21	2.1
Estimates of energy savings							
-10%	0.87	-0.0282	-0.0012	0.38	0.18	0.20	2.1
+10%	0.87	-0.0230	-0.0015	0.31	0.18	0.13	1.7

TABLE E.2 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – NEW ZEALAND, OPTION 3

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	118.83	-0.4729	-0.0252	4.90	1.89	3.01	2.6
Discount rate							
0%	118.83	-0.4729	-0.0252	11.35	2.92	8.43	3.9
5%	118.83	-0.4729	-0.0252	7.33	2.34	5.00	3.1
10%	118.83	-0.4729	-0.0252	3.00	1.45	1.56	2.1
Gas tariff							
-10%	118.83	-0.4729	-0.0252	4.41	1.89	2.52	2.3
+10%	118.83	-0.4729	-0.0252	5.39	1.89	3.50	2.9
Incremental cost of GWH							
+25%	118.83	-0.4729	-0.0252	4.90	2.36	2.55	2.1
-25%	118.83	-0.4729	-0.0252	4.90	1.43	3.47	3.4
Hot water load							
-33%	118.83	-0.3237	-0.0173	3.37	1.89	1.48	1.8
+33%	118.83	-0.6220	-0.0332	6.43	1.89	4.54	3.4
Estimates of energy savings							
-10%	118.83	-0.5201	-0.0227	5.39	1.89	3.50	2.9
+10%	118.83	-0.4256	-0.0277	4.41	1.89	2.52	2.3

TABLE E.3 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS – NEW ZEALAND, OPTION 4

	Upgraded GWH ('000)	*Energy use (PJ)*	*Greenhouse emissions (Mt CO_2-e)*	Total financial benefits ($M)	Total financial costs ($M)	Net present value ($M)	Benefit/cost ratio
Baseline scenario	194.72	-1.7804	-0.0949	18.10	6.87	11.23	2.6
Discount rate							
0%	194.72	-1.7804	-0.0949	42.73	10.84	31.89	3.9
5%	194.72	-1.7804	-0.0949	27.34	8.58	18.76	3.2
10%	194.72	-1.7804	-0.0949	10.95	5.18	5.77	2.1
Gas tariff							
-10%	194.72	-1.7804	-0.0949	16.29	6.87	9.42	2.4
+10%	194.72	-1.7804	-0.0949	19.91	6.87	13.04	2.9
Incremental cost of GWH							
+25%	194.72	-1.7804	-0.0949	18.10	8.59	9.51	2.1
-25%	194.72	-1.7804	-0.0949	18.10	5.15	12.94	3.5
Hot water load							
-33%	194.72	-1.2056	-0.0643	12.28	6.87	5.41	1.8
+33%	194.72	-2.3551	-0.1255	23.92	6.87	17.05	3.5
Estimates of energy savings							
-10%	194.72	-1.9584	-0.0854	19.91	6.87	13.04	2.9
+10%	194.72	-1.6023	-0.1044	16.29	6.87	9.42	2.4

APPENDIX F BREAKDOWN OF IMPACTS BY JURISDICTION: OPTION 1

Impacts have been allocated to jurisdictions in proportion to their share of the GWH stock in 2005. The estimates of energy use are for GsWH only. Given differences in the rate of growth of GWH penetration between jurisdictions, there is no sound basis for allocating their energy use across jurisdictions.

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUST
				BAU energy use (PJ, GsWH only)					
2000	8.60	21.30	2.60	4.60	6.30	0.04	0.03	0.60	44.07
2001	9.10	21.50	2.60	4.60	6.50	0.04	0.03	0.70	45.07
2002	9.50	21.60	2.70	4.50	6.60	0.03	0.04	0.70	45.67
2003	9.80	21.80	2.60	4.40	6.70	0.04	0.03	0.70	46.07
2004	10.10	21.90	2.70	4.40	6.60	0.04	0.03	0.80	46.57
2005	10.30	22.10	2.70	4.50	6.70	0.04	0.02	0.90	47.26
2006	10.50	22.30	2.80	4.40	6.80	0.05	0.02	1.00	47.88
2007	10.70	22.10	2.90	4.30	6.80	0.06	0.02	1.00	47.89
2008	10.80	21.90	2.90	4.20	6.60	0.07	0.02	1.00	47.50
2009	10.90	21.70	2.90	4.20	6.60	0.08	0.02	1.00	47.40
2010	11.01	21.52	3.00	4.10	6.61	0.09	0.03	1.00	47.35
2011	11.12	21.16	3.01	4.01	6.52	0.09	0.03	1.00	46.94
2012	11.25	20.93	3.02	3.93	6.54	0.10	0.03	1.00	46.80
2013	11.38	20.70	3.02	3.94	6.36	0.10	0.03	1.01	46.55
2014	11.51	20.58	3.13	3.86	6.38	0.10	0.03	1.01	46.60
2015	11.54	20.35	3.24	3.78	6.40	0.10	0.03	1.01	46.46
2016	11.67	20.22	3.25	3.79	6.33	0.10	0.03	1.01	46.41
2017	11.80	20.20	3.26	3.71	6.35	0.10	0.03	1.01	46.46
2018	11.93	20.07	3.37	3.72	6.37	0.10	0.03	1.02	46.62
2019	12.06	20.05	3.38	3.64	6.49	0.10	0.03	1.02	46.77
2020	12.29	20.02	3.49	3.66	6.51	0.10	0.04	1.12	47.23
				WSM energy use (PJ, GsWH only)					
2000	8.60	21.30	2.60	4.60	6.30	0.04	0.03	0.60	44.07
2001	9.10	21.50	2.60	4.60	6.50	0.04	0.03	0.70	45.07
2002	9.50	21.60	2.70	4.50	6.60	0.03	0.04	0.70	45.67
2003	9.80	21.80	2.60	4.40	6.70	0.04	0.03	0.70	46.07
2004	10.10	21.90	2.70	4.40	6.60	0.04	0.03	0.80	46.57
2005	10.30	22.10	2.70	4.50	6.70	0.04	0.02	0.90	47.26
2006	10.50	22.30	2.80	4.40	6.80	0.05	0.02	1.00	47.88
2007	10.70	22.10	2.90	4.30	6.80	0.06	0.02	1.00	47.89
2008	10.80	21.90	2.90	4.20	6.60	0.07	0.02	1.00	47.50
2009	10.90	21.70	2.90	4.20	6.60	0.08	0.02	1.00	47.40
2010	11.00	21.50	3.00	4.10	6.60	0.09	0.03	1.00	47.31
2011	11.10	21.10	3.00	4.00	6.50	0.09	0.03	1.00	46.82
2012	11.20	20.80	3.00	3.90	6.50	0.10	0.03	1.00	46.53
2013	11.30	20.50	3.00	3.90	6.30	0.10	0.03	1.00	46.13
2014	11.40	20.30	3.10	3.80	6.30	0.10	0.03	1.00	46.03
2015	11.40	20.00	3.20	3.70	6.30	0.10	0.03	1.00	45.73
2016	11.50	19.80	3.20	3.70	6.20	0.10	0.03	1.00	45.53
2017	11.60	19.70	3.20	3.60	6.20	0.10	0.03	1.00	45.43
2018	11.70	19.50	3.30	3.60	6.20	0.10	0.03	1.00	45.43
2019	11.80	19.40	3.30	3.50	6.30	0.10	0.03	1.00	45.43
2020	12.00	19.30	3.40	3.50	6.30	0.10	0.03	1.10	45.73

table continues

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUST
					Energy savings (GJ)				
2010	7,553	18,708	2,284	4,040	5,533	37	24	527	38,706
2011	22,698	56,217	6,862	12,141	16,628	110	72	1,584	116,311
2012	52,729	130,597	15,941	28,204	38,627	257	167	3,679	270,202
2013	82,550	204,454	24,957	44,154	60,472	402	262	5,759	423,010
2014	112,204	277,900	33,922	60,016	82,196	546	356	7,828	574,968
2015	141,736	351,044	42,850	75,812	103,830	690	450	9,889	726,302
2016	171,571	424,938	51,870	91,771	125,686	835	545	11,970	879,186
2017	201,370	498,741	60,879	107,709	147,515	980	640	14,049	1,031,883
2018	231,173	572,557	69,890	123,651	169,348	1,125	734	16,128	1,184,607
2019	261,023	646,487	78,914	139,617	191,214	1,270	829	18,211	1,337,565
2020	290,958	720,628	87,964	155,629	213,144	1,416	924	20,299	1,490,962
					Emissions abatement (t CO_2-e)				
2010	539	1,190	157	298	336	2	1	38	2,561
2011	1,618	3,575	472	896	1,009	7	4	113	7,695
2012	3,760	8,306	1,097	2,081	2,345	15	9	262	17,875
2013	5,886	13,003	1,717	3,259	3,671	24	14	411	27,984
2014	8,000	17,674	2,334	4,429	4,989	33	19	558	38,037
2015	10,106	22,326	2,948	5,595	6,302	41	24	705	48,048
2016	12,233	27,026	3,569	6,773	7,629	50	29	853	58,162
2017	14,358	31,720	4,188	7,949	8,954	59	34	1,002	68,264
2018	16,483	36,415	4,808	9,125	10,279	68	39	1,150	78,367
2019	18,611	41,117	5,429	10,304	11,607	76	44	1,298	88,486
2020	20,745	45,832	6,052	11,485	12,938	85	50	1,447	98,634
					Value of energy savings ($'000)				
2010	0.15	0.30	0.08	0.09	0.14	0.00	0.00	0.01	0.76
2011	0.44	0.89	0.23	0.26	0.41	0.01	0.00	0.03	2.28
2012	1.03	2.07	0.54	0.60	0.96	0.01	0.01	0.07	5.29
2013	1.62	3.23	0.85	0.93	1.51	0.02	0.01	0.12	8.29
2014	2.20	4.40	1.16	1.27	2.05	0.03	0.01	0.16	11.26
2015	2.77	5.55	1.46	1.60	2.59	0.03	0.02	0.20	14.23
2016	3.36	6.72	1.77	1.94	3.13	0.04	0.02	0.24	17.22
2017	3.94	7.89	2.07	2.27	3.68	0.05	0.03	0.28	20.21
2018	4.53	9.06	2.38	2.61	4.22	0.05	0.03	0.33	23.20
2019	5.11	10.23	2.69	2.95	4.77	0.06	0.03	0.37	26.20
2020	5.70	11.40	3.00	3.29	5.31	0.07	0.04	0.41	29.20
					Additional appliance cost ($'000)				
2010	0.185	0.405	0.064	0.100	0.139	0.001	0.001	0.012	0.908
2011	0.367	0.802	0.126	0.199	0.276	0.002	0.001	0.024	1.797
2012	0.727	1.591	0.251	0.394	0.547	0.003	0.003	0.048	3.564
2013	0.722	1.580	0.249	0.391	0.543	0.003	0.003	0.048	3.539
2014	0.719	1.572	0.248	0.389	0.540	0.003	0.003	0.047	3.520
2015	0.716	1.565	0.247	0.388	0.538	0.003	0.003	0.047	3.506
2016	0.713	1.559	0.246	0.386	0.536	0.003	0.003	0.047	3.493
2017	0.712	1.557	0.245	0.386	0.535	0.003	0.003	0.047	3.489
2018	0.712	1.558	0.246	0.386	0.535	0.003	0.003	0.047	3.490
2019	0.713	1.560	0.246	0.386	0.536	0.003	0.003	0.047	3.495
2020	0.715	1.564	0.247	0.387	0.538	0.003	0.003	0.047	3.505

ENDNOTES

1 Laid before the Legislative Assembly on . . .

2 The administering agency is the Department of Employment, Economic Development and Innovation.