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EQUIPMENT ENERGY EFFICIENCY

Equipment Energy Efficiency Gas Committee Cost-Benefit Analysis

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

Discussion draft for stakeholder comment issued under the auspices of the Ministerial Council on Energy

JUNE 2007

Prepared by Syneca Consulting for AGO

This cost-benefit analysis was prepared by Syneca Consulting for the Australian Greenhouse Office, representing the Equipment Energy Efficiency (E3) Committee under the Ministerial Council on Energy of the Australian federal, state and territory governments and the New Zealand Government.

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Submissions will be accepted until close of business **Monday 6 August 2007.**

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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
DPMC	Department of the Prime Minister and Cabinet
EES	Energy Efficient Strategies Pty Ltd
E2WG	Energy Efficiency Working Group
E3	Equipment Energy Efficiency Program
GAMAA	Gas Appliance Manufacturers Association of Australia
GHG	greenhouse gas
GiWH	gas instantaneous water heater
GsWH	gas storage water heater
GWA	George Wilkenfeld and Associates Pty Ltd
GWH	gas water heater
HWS	hot water system
L	litres
MCE	Ministerial Council on Energy
MEA	Mark Ellis & Associates
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
OBPR	Office of Best Practice Regulation
WPM	with proposed measures
MJ	megajoules – 10^6 joules
MT	megatonnes – 10^6 tonnes
NGS	National Greenhouse Strategy
REC	renewable energy certificate
SEAV	Sustainable Energy Authority Victoria (now Sustainability Victoria)
TJ	terajoules – 10^{12} joules
WPM	with proposed measures

Request for industry comments and data

Australian and New Zealand government agencies responsible for product energy efficiency are currently investigating whether to mandate the energy performance of Gas Water Heaters that are imported or manufactured by Australia and New Zealand.

This document aims to communicate to stakeholders the most important issues and questions relating to the regulatory proposal and to seek stakeholder comment and industry/market data to better inform the development of the regulatory proposal.

This document is called a 'Cost-Benefit Analysis' (CBA) and has been issued by the Equipment Energy Efficiency (E3) Committee reporting to the Ministerial Council on Energy of the Australian federal, state and territory governments and the New Zealand Government. The CBA is a discussion draft providing the rationale for the regulatory proposal. The CBA and stakeholder responses to it will be used to prepare a regulatory impact statement (RIS) (see http://www.obpr.gov.au for RIS requirements) on the introduction of Minimum Energy Performance Standards (MEPS) for domestic gas water heaters imported and sold in Australia and New Zealand. The proposal will be considered by the Ministerial Council on Energy and, if endorsed, will result in Australian state and territory legislation and New Zealand legislation being amended to prohibit from sale products that do not meet the standards.

Stakeholders are invited to make written comments on the proposal. The Australian Greenhouse Office (AGO) in Australia and the Energy Efficiency and Conservation Authority (EECA) in New Zealand are managing the process of obtaining stakeholder views and data on the regulatory proposal. The AGO and EECA will accept written submissions from stakeholders until close of business **Monday 6 August 2007** on any of the issues raised in the document. If there is sufficient interest, public meetings addressing the proposal will be held in Sydney, Melbourne and Auckland at dates to be determined.

In particular, this CBA document contains various assumptions on gas water heater technologies, sales, industry and market structure, etc. In the absence of other data from stakeholders, these assumptions will form the basis of the next phase in the regulatory process, which is the Consultation RIS. The Consultation RIS and any further stakeholder responses will then be used to prepare the Decision RIS considered by the Ministerial Council on Energy.

Please address you written submissions to:

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Executive summary

It is proposed that Minimum Energy Performance Standards (MEPS) be applied to gas water heaters (GWH), with the practical effect of excluding GWH with energy ratings of less than 5 stars. It is proposed that the measure be implemented by prohibiting both the import and manufacture of such appliances from October 2008, and that compliance be determined by a new regulatory standard containing methods of test for energy efficiency to replace parts of Australian Standard AS 4552, *Gas fired water heaters for hot water supply and/or central heating.* Safety requirements under AS 4552 will be a pre-requisite for energy efficiency testing.

It is further proposed that existing GWH with energy ratings of at least 4.5 stars under the existing AS 4552 can continue to be imported or manufactured in the period October 2008 to October 2010. The temporary relaxation to 4.5 stars is to account for the uncertainty in the current methods of test under AS 4552, identified by a comparative testing round-robin study commissioned by the Australian Greenhouse Office in 2005. There is a shorter transition period, to October 2009, for products that are registered to the existing standard between July 2007 and October 2008.

The proposal applies only to a sub-set of 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, mobile homes and recreational vehicles. These products will be considered for inclusion in the MEPS regime at a later date.

This report provides a cost-benefit analysis (CBA) of the proposal.

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 climate change strategies of both Australian and New Zealand. The program is jointly managed and funded by the Australian Commonwealth, State and Territory governments and the New Zealand government.

Based on the modelling undertaken for this CBA, Australia's greenhouse emissions from GWH will increase by 71% in the period from 1990 to 2010, which is the mid-year of the first commitment period under the Kyoto protocol (2008-2012). Emissions will increase by a further 15.7% in the decade to 2020. The Australian Government is committed to meeting its Kyoto target for the nation as a whole, which is to limit emissions growth to 8% in the period 1990 to 2010.

Australia's total greenhouse emissions in 2010 are projected to be 603 MT CO_2-e. Emissions from GWH will contribute 0.83% of that amount.

Under BAU conditions, New Zealand's greenhouse emissions from gas water heaters are expected to increase by 118% in the decade to 2010, and by a further 28% in the decade to 2020. Emissions are estimated to reach 0.47MT CO_2e in 2010, which is 0.6% of the forecast for total New Zealand emissions in 2010.

There are significant failures in the market for energy efficient GWH. Energy accounts for about 74% of the lifetime 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.

There are also significant impediments to gathering the required information. 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.

Market research commissioned by the E3 Program has reported that the gas energy label is ineffective, particularly in comparison with its counterpart for electrical goods, which is the widely recognised Energy Label.

The objective

The objective of the proposed regulation is greenhouse abatement, subject to the following constraints:

- The measures need to be cost-effective for the community.
- The measures need to be efficiently designed, minimising adverse impacts on manufacturers and suppliers, and minimising adverse impacts on product quality and function.
- The measures need to be clear and comprehensive, minimising potential for confusion or ambiguity for users and suppliers.

Policy alternatives

Alternative policy approaches have been assessed as follows:

- 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.
- While it is likely that a national greenhouse emissions trading scheme will be introduced during the life of the regulation, putting a price on greenhouse gas emissions, the Prime Ministerial Task Group on Emissions Trading has recently argued the case for complementary measures, including efficiency regulations. The National Emissions Trading Taskforce, which reports to the Premiers and Chief Ministers of all Australian States & Territories had previously come to the same conclusion.
- 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.
- The E3 Program considers that there are unacceptable risks in introducing MEPS at 4 stars. Suppliers have all but vacated the 4 star market, leaving consumers to choose between 3 star and 5 star units. It would be a step backwards to encourage redevelopment of 4 star products, and would encourage downgrading of some purchases from 5 stars to 4 stars. In contrast, a 5 star MEPS takes advantage of the range of product that is already available at that level, and builds on recent growth in that market.

Impact analysis - Australia

We estimate that, in response to the measures, a total of 0.87 million gas water heaters (GWH) will be upgraded from 3.2 stars to 5.4 stars in the period from 2009 to 2020. As indicated by figure 1, the effect is to moderate the growth of emissions in the decade to 2020. They increase by 12.2%, compared with a 15.7% increase that is expected in the business as usual case.

The cumulative contribution to greenhouse abatement, over the life of the units that are affected by the measures, is 2.3 Mt CO_2-e.

Table 1 reports the results of the cost-benefit analysis at the national level. It is highly favourable, with net benefits of $128.8 million and a benefit-cost ratio of 2.5.

FIGURE 1 - IMPACT ON EMISSIONS GROWTH: 2010 TO 2020

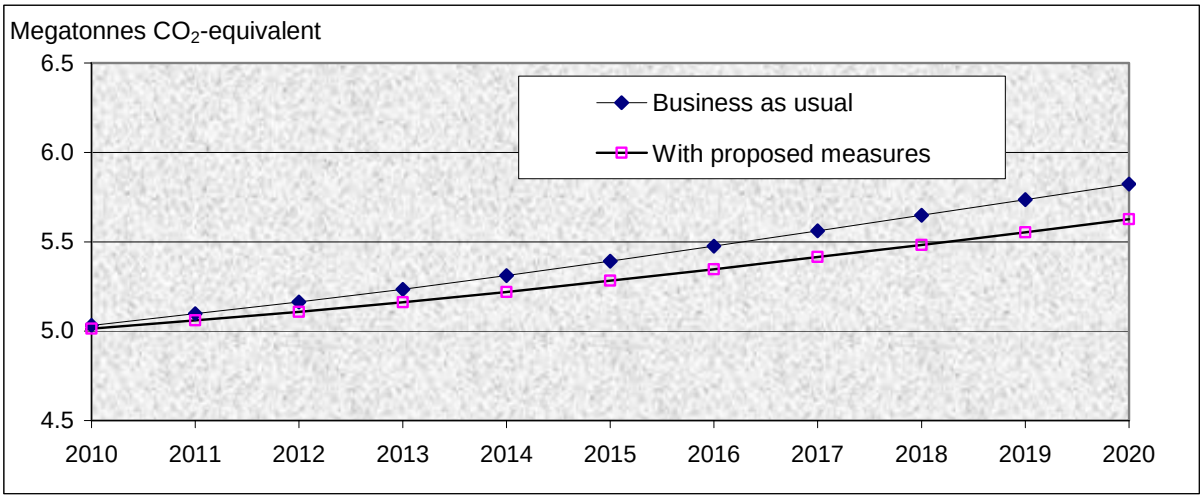

TABLE 1 - SUMMARY STATEMENT OF THE COST-BENEFIT ANALYSIS

Present values (discount rate = 7.5%)	
cost to the taxpayer ($M)	+0.37
business compliance costs ($M)	+0.47
incremental cost of hot water heaters ($M)	+83.9
household expenditure on energy ($M)	-213.7
Investment analysis	
total benefits ($M)	+213.7
total costs ($M)	+84.8
net present value ($M)	+128.8
benefit-cost ratio	2.5

There are uncertainties and suppliers are encouraged to comment on the CBA's assumptions and findings. For example the CBA finds or assumes that:

- The proportion of households with GWH continues to increase, approaching 42% in 2020.
- Gas storage water heaters will retain 50% of the market for GWH in the longer term.
- There are further reductions in the market share of GWH with less than 5 stars, declining from about 35% in 2005 to 25% in 2020.
- Most gas instantaneous water heaters with less than 5 stars will be phased out within the next few years. The measures will largely impact solely on gas storage water heaters with less than 5 stars.
- The business compliance ('red tape') costs are not large in relative terms but may sum to $0.6 million in the period to 2020, with a present value of $0.5 million. They relate to additional testing and certification costs
- While GWH with the shorter 5 year warranty are generally only available in 3 star versions, there is no significant impediment to making the shorter warranties available in 5 star versions.

- It is assumed that the energy consumed under test conditions provides a reasonable measure of the energy used under actual operating conditions.
- There is a minority of consumers in niche and declining markets where there is uncertainty about the availability of 5 star products and costs may be higher. Our baseline scenario is that the financial impact on these customers will be neutral at worst.
- For the average user of 3 star units with 135 or 170L storage capacity, energy savings are of the order of 15% and the increase in the cost of upgraded heaters will not be significantly greater than 15%. The incremental price is about $157, including GST.

Note that a favourable cost-benefit ratio follows immediately when this last point is married with the observation that energy comprises 74% of the whole of life cost of the heaters under consideration. This means that a 15% reduction in energy use will reduce the whole of life cost by about 11.1% (= 15% * 74%), and a 15% increase in the purchase price will increase the whole of life cost by about 3.9% (= 15% * 26%). This is the essence of the baseline estimate and suggests that the lifetime cost is reduced by 7.2% (= 11.1% - 3.9%) and that the benefit-cost ratio is about 2.8 (= 11.1% / 3.9%). This ratio is reduced to 2.5 as a result of various fixed costs of program development and increased costs in niche segments that face additional barriers in raising efficiency.

Impact analysis – New Zealand
The major differences between New Zealand and Australia are (a) the market share of GWH with less than 5 stars is much lower in New Zealand, but (b) a larger proportion of these less efficient appliances are GsWH of the internal type without obvious 5 star replacements.

The BAU scenario is that 16,400 GWH with less than 5 stars would be sold in the period to 2020, comprising 15,000 internal GsWH, 700 external GsWH and 700 external GiWH. This is about 3% of the approximately 500,000 GWH that New Zealanders will install in the period to 2020. The replacement of these 16,400 units with 5 star appliances would reduce total emissions over the period to 2020 by 0.07MT CO_2e, from 7.04MT to 6.97MT. This is a reduction of 1% and is commensurate with the small proportion of GWH sales that will be less than 5 stars.

The financial impact on New Zealand is uncertain. It may be significantly negative and, if positive, cannot be large. It is the sum of (a) two small positive amounts associated with external GWH, with a combined net present value about $250,000, (b) a very small amount associated with internal GsWH imported from Australia, and possibly not much different from zero, and (c) a highly uncertain outcome associated with internal GsWH manufactured in New Zealand, but which may be significantly negative.

Consultation
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 machinery of Standards Australia that is familiar to industry, and the technical details will be developed in close consultation with industry, aiming to finalise by October 2007. This provides 12 months notice before implementation in October 2008.

A number of issues have been identified above and are explicitly mentioned in the text of the document. These will be the focus of further consultations with industry before the E3 Gas Committee puts its recommendations to government.

Draft recommendations
It is recommended that the measures be developed expeditiously, aiming to publish revised methods of test in a new energy efficiency standard (replacing parts of AS 4552), two or three months before the measures are implemented in October 2008.

There should be early consideration of options to moderate impacts on customers in niche and declining markets without obvious and affordable 5 star product options at the present time.

1 The problem

1.1 National policy response to global warming

In October 2006, an important change in the criteria for assessing new energy efficiency measures was made by the Ministerial Council on Energy (MCE) of Australian federal, state and territory and New Zealand governments. 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 means the MCE will consider new measures that may have net up-front costs but have greater private economic and greenhouse benefits over the long term on the basis that prudent investment now may avoid more costly intervention later. More detail of this decision is provided below.

Australia's response to climate change
The development of Australian policy leading up to the current Ministerial Council on Energy position on new energy efficiency measures is described in this section.

The Australian Government's initial response to concerns about the environmental, economic and social impacts of global warming was set out in the Prime Minister's statement of 20 November 1997, *Safeguarding the Future: Australia's Response to Climate Change.* The Prime Minister noted that the Government was seeking *"…realistic, cost-effective reductions in key sectors where emissions are high or growing strongly, while also fairly spreading the burden of action across the economy."* He also stated that the Government is "*…prepared to ask industry to do more than they would otherwise be prepared to do, that is, go beyond a 'no regrets'*[1]*, minimum cost approach where this is sensible in order to achieve effective and meaningful outcomes."* This "no regrets" test was a key part of the guidelines adopted by the Council of Australian Governments (COAG) in 1997 that any initiative proposed by the MCE, including standards and labelling measures under the Equipment Energy Efficiency Program, must meet.

In 1998 the Australian Government released *The National Greenhouse Strategy* (NGS) that was endorsed by the Australian Government and state and territory governments and committed them to an effective national greenhouse response. Progress under the NGS was reported to the Council of Australian Governments (CoAG). Many key elements of the NGS were implemented successfully, but, over time, the Australian Government identified a range of emerging climate change priorities that required attention at the federal government level. Similarly, there was acknowledgment that state and territory jurisdictional boundaries necessitated state/territory level climate change action plans and these were developed.

In 2004, the Australian Government released a new climate change strategy as articulated through its Energy White Paper, *Securing Australia's Future*, and the 2004-05

[1] The Productivity Commission has defined 'No regrets' policy options as measures that … *have net benefits (or at least no net cost) in addition to addressing the enhanced greenhouse effect. A more intuitive interpretation of 'no regrets' measures could be that they are actions which would still be considered worthwhile even in the absence of concerns about the potential adverse impact of global warming.* (PC 1997: page vii). This may involve imposing additional business costs on suppliers if the resulting more efficient products deliver a net benefit to the wider community.

Environment Portfolio Budget. Some elements of the earlier NGS were included in the new strategy. As a critical element of the Australian Government's climate change strategy, the new energy policy represented the refinement of strategic themes pursued in relation to energy under the NGS, including energy market reform, the development of low-emissions and renewable technologies, and improvements to end-use energy efficiency. Further, the Australian Government stated it was committed to meeting its Kyoto target of limiting greenhouse gas emissions growth to 108% of 1990 levels on average over the period 2008 to 2012.

Since that time, CoAG has remained on of the primary fora for progressing Australian, state and territory government collaboration on climate change issues requiring inter-jurisdictional attention. Significant progress has been made under the CoAG climate change agenda since CoAG's agreement in June 2005 to establish a new Senior Officials Group to consider ways to further improve investment certainty for business, encourage renewable energy and enhance cooperation in areas such as technology development, energy efficiency and adaptation. This work culminated in the January 2006 CoAG climate change action plan. In addition, climate change issues requiring national coordination have been managed through a number of inter-governmental ministerial councils including the Ministerial Council on Energy.

The Australian Government's climate change strategy is the mechanism through which Australia will meet its international commitments as a party to the *United Nations Framework Convention on Climate Change*. The Government has an overall target of limiting Australia's emissions in 2008-2012 to 108% of its 1990 emissions. This is a 30% reduction on the projected "business as usual" (BAU) outcomes in the absence of interventions.

Over 2006, the national policy debate over introducing a carbon price in Australia continued with the state and territory governments proposing an emissions trading scheme, and the Australian Government holding a nuclear energy enquiry and announcing its own emissions trading inquiry by the *Task Group on Emissions Trading*.

On 3 June 2007, the Prime Minister announced that the Australian Government will implement a domestic emissions trading system beginning no later than 2012, and will set a long term aspirational target for reducing national emissions in 2008. The Australian Government is beginning to develop the system now.

As concluded in the Report of the Task Group on Emissions Trading, MEPS will complement the emissions trading scheme:

- *"Emissions trading is not a panacea. A comprehensive response will involve complementary measures that address market failures not corrected by the emissions trading scheme. ... There will also be a continuing role for policies that improve information, awareness and adoption of energy-efficient vehicles, appliances and buildings." (p 12)*
- *"Beyond information-based policies, energy efficiency policies could target areas where market barriers are likely to be more fundamental and enduring. This is likely to be in areas where consumers make infrequent decisions and where it is difficult to judge the energy and emissions implications. There is a good case for continuing the development of well-designed and consistent regulated minimum energy standards for buildings and household appliances. Purchases of energy-efficient products can have a large impact on aggregate emissions over time, and reduce the impact on household budgets of any rise in carbon prices." (p 135)*

New Zealand's response to climate change

New Zealand ratified the Kyoto Protocol on 19 December 2002, and has committed to reducing its greenhouse gas emissions back to 1990 levels, on average, over the period 2008 to 2012 or to take responsibility for any emissions above this level if it cannot meet

this target. The introduction of minimum energy performance standards for household appliances continues to form part of New Zealand's climate change strategy, as part of implementing the National Energy Efficiency and Conservation Strategy (NEECS).

As it has been in place since 2001, the NEECS was recently reviewed. The review concluded a replacement Strategy was both necessary and timely. In December 2007 the New Zealand Minister of Energy released the Draft New Zealand Energy Efficiency and Conservation Strategy (NZEECS), which proposes ways to promote energy efficiency, energy conservation and the use of renewable sources of energy. It includes measures to reduce electricity demand, address energy use in transport, buildings and industry, and promote greater consideration of sustainable energy in the development of land, settlements and energy production. The strategy is available at http://www.eeca.govt.nz/about/national-strategy/release-of-draft-nzeecs.html

The draft strategy is a key part of the Government's response to global climate change, the need for enhanced security of energy supply and rising energy prices. The draft NZEECS is being developed within the framework of the Draft New Zealand Energy Strategy. It presents sector-based action plans that would support the energy efficiency, energy conservation and renewable energy objectives set out in the draft New Zealand Energy Strategy, which are: 1. maximising how efficiently we use our energy to safeguard affordability, economic productivity and our environment; and 2. maximising the proportion of energy that comes from our abundant renewable energy sources.

Equipment Energy Efficiency Program (known as E3)
The proposed regulation is an element of the E3 Program. This program targets the energy efficiency of appliances and equipment in the residential, commercial and industrial sectors to reduce energy consumption and greenhouse gas emissions. Its main tools are mandatory energy efficiency labelling and minimum energy performance standards (MEPS), but it also employs voluntary measures such as endorsement labelling, training and support to promote the best available products.

The E3 Program is an initiative of the Ministerial Council on Energy (MCE) and an element of both Australia's National Framework for Energy Efficiency and New Zealand's National Energy Efficiency and Conservation Strategy. It is organised as follows:

- The program is the direct responsibility of the E3 Committee, which comprises officials from 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 Ministerial Council on Energy (MCE). MCE comprises Ministers with responsibility for implementing the NGS in this field.
- 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. This involves the use of state and territory legislation to enforce relevant Australian Standards for the specific product type.
- 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.

The broad policy directions of the E3 Program were reviewed in 1998/99 and again in 2000/01, with recommendations brought together in two 'Future Directions' documents (NAEEEC 1999 and NAEEEC 2001). The MCE subsequently endorsed certain changes, directing the E3 Committee to adopt specific policies with respect to product coverage, communication, and procedures for developing and implementing new measures.

This mandate was refreshed in 2004 under Stage 1 of the National Framework for Energy Efficiency (NFEE) to include products using a wider range of fuel types, including gas, and is likely to be expanded further under Stage 2 of the National Framework for Energy Efficiency.

At its October 2006 meeting, the MCE provided guidance on the overall mandate for NFEE Stage Two [including MEPS]:

> *... 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. … The next stage of NFEE implementation may include measures that go beyond those used so far in pursuing the adoption of cost-effective energy efficiency and greenhouse abatement measures.*

Product coverage
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 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 community cost benefit analysis and consideration of whether the measures are generally acceptable to the community.

For many years the E3 program and its predecessor[2] focused on electrical appliances and equipment. In 2004 the Australian Government announced an expansion of the program to include gas appliances and some commercial equipment – *Securing Australia's Energy Future* (DPMC 2004: page 111). Subsequently, MCE released its strategy for improving the energy efficiency of gas appliances – *Switch on Gas: 2005-2015* (AGO 2004a).

Communication & procedures
The E3 program provides stakeholders with opportunities to comment on specific measures as they are developed.

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include gas appliances and some commercial equipment – *Securing Australia's Energy Future* (DPMC 2004: page 111). Subsequently, MCE released its strategy for improving the energy efficiency of gas appliances – *Switch on Gas: 2005-2015* (AGO 2004a) which signalled the intention of all Ministers to bring gas appliances and equipment into the Equipment Energy Efficiency program.

Communication & procedures
The E3 Program provides stakeholders with opportunities to comment on specific measures as they are developed.

1.2 Profile of gas water heater (GWH) products

This profile is for the Australian market. Chapter 5 contains all analysis relating to New Zealand.

Product technologies[4]
Two water heating technologies fall within 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 in size than storage systems. When a hot water tap is turned on, cold water flows into through the unit and a high-powered gas burner is ignited, generally by means of a continuously burning pilot or some for 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 45°C), depending upon their intended application.

Two other technologies fall outside the scope of the measures. These are gas-boosted solar hot water heaters and boilers. Some Australian households use such boilers to provide heating or a combination of heating and hot water, but their dominant use is heating.

Product testing and labelling
The AGA certifies gas water heaters and publishes selected details in its *Directory of AGA Certified Products*, the latest edition being for April 2007[5] . For certified GWH it lists the certification number, date certified, model name, annual energy consumption, star rating and the type of gas. 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 AGA test procedure AG102 which was developed in the 1980's and was first published by Standards Australia as AS4552 in 2000.

[4] 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

[5] Two other certifiers, SAI Global and the Queensland Gas Association, have yet to certify GWH that fall within scope of the proposed measure.

The most recent edition was published in December 2005 and this was expanded to cover safety requirements for boilers. The vast majority of products included in the AGA certified directory 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.

The energy rating and labelling regime is organised as follows:

> *… Energy labelling is a mandatory part of appliance certification by the AGA. All states require AGA 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)

Australian Standard AS 4552 does not apply to GWH with gas input rate consumption in excess of 500 MJ/hour (effectively 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 fall into the category of mass produced products.

A total of 153 appliances are recorded in the April 2007 edition of the Directory, comprising 68 appliances of the storage type and 85 appliances of the instantaneous type. However, the following have been excluded 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 8% of the entries from the certified list of appliances.
- GWH for caravans and mobile homes: Five of the entries on the certified list are for small water heaters that are designed for use in caravans and mobile homes, comprising four of the storage type and one of the instantaneous type. These are excluded from consideration for the time being because, (a) it is unclear whether the existing energy testing procedures of AS4552 cannot be confidently applied to the small storage units, and (b) the options of improving efficiency at reasonable cost are severely constrained buy the lack of space in recreational vehicles (c) E3 regulations for other product types are normally targeted at 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 30 entries for GiWH appliances. Figures 1.1 and 1.2 show the distribution of energy consumption and energy efficiencies 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 GWH may constrain the ability to options for extracting more heat from the combustion process flue gases and thereby limit options

for increasing energy efficiency, and (b) there can be significant additional costs of replacing internally installed storage units where a like-for-like replacement is difficult.

FIGURE 1.1 STANDARDISED ENERGY CONSUMPTION OF EXTERNALLY INSTALLED GWH, BY TYPE AND DATE OF CERTIFICATION

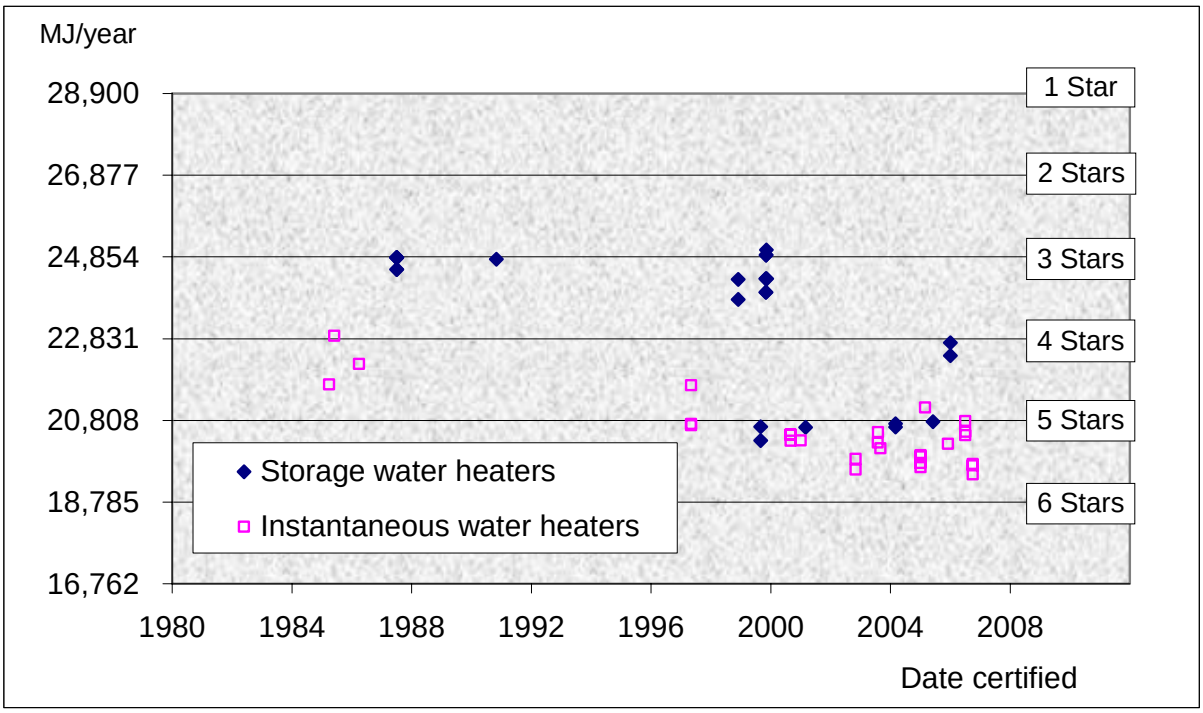
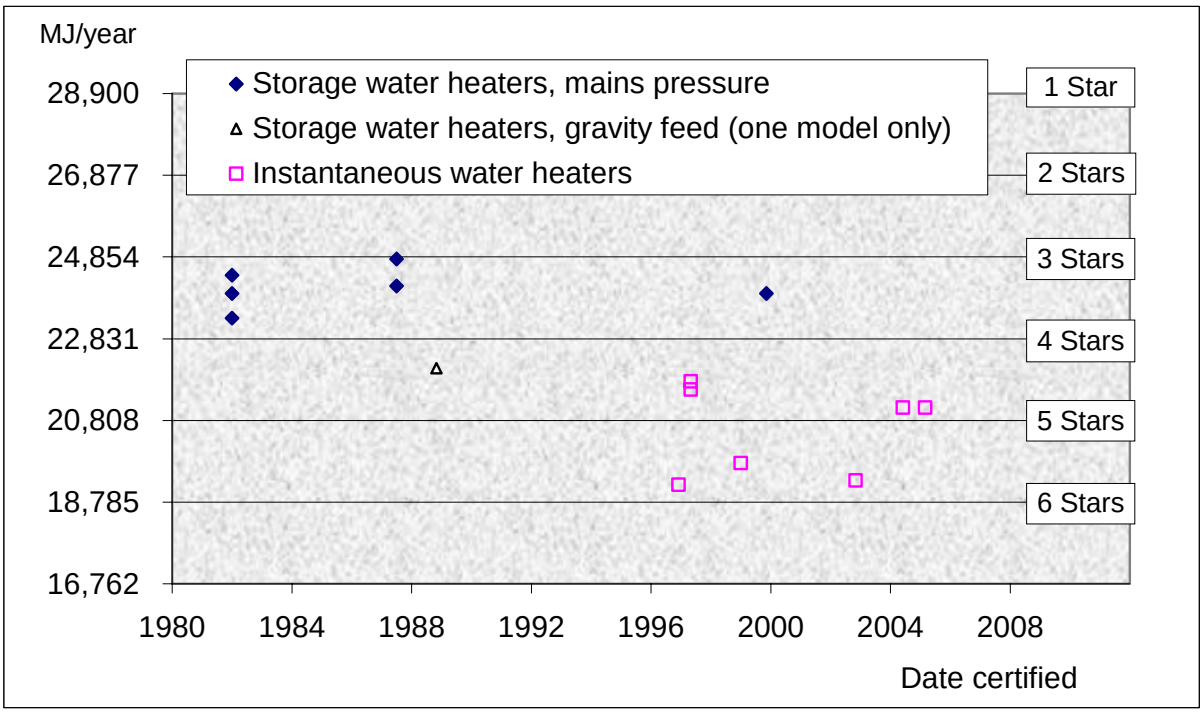


FIGURE 1.2 STANDARDISED ENERGY CONSUMPTION OF INTERNALLY INSTALLED GWH, BY TYPE AND DATE OF CERTIFICATION



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

- The labelling requirements of AS4552 refer to a reference heater that is assumed to consume 28,900 MJ/year to perform the standardised heating task (delivery of 37.7

KJ/day of hot water or 13,761 MJ/year). Any heater returning a test result of 28,900 MJ/year, or more, is assigned 1 star.

- The rating scale provides for up to 6 stars, in equal step reductions of 2,023 MJ/year. 2,023 MJ/year is 7% of reference level, so that 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 raises overall task efficiency of 73.26%).
- 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.

External GWH
External appliances account for 80% of the entries in the (truncated) list of certified appliances, split about 50:50 between storage and instantaneous models. The simple average[6] of their star ratings is 4.4 stars, with GsWH and GiWH averaging 3.7 stars and 5.1 stars respectively. Eighty-one per cent of the GiWH are 5 stars or more, but only 24% of the GsWH – see figure 1.1.

Most certifications since 2000 have been at 5 stars or better, but with the recent exception of two storage models that were registered in 2006 with 4.1 and 4.2 stars.

Significant 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 pilot ignition. The elimination of the pilot light, which ignites the burner on demand but burns continuously itself, offers is a significant energy saving. It can be replaced with electronic ignition or by a self contained device for gas ignition (examples are a device that uses the flow of water to generate a spark on demand and also battery ignition).

Internal GWH
Internal appliances account for 20% of the certifications, also split about 50:50 between storage and instantaneous models. The simple average of their star ratings is 4.3 stars, with mains pressure GsWH and GiWH averaging 3.4 stars and 5.1 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.

Three of the 14 internal appliances have 5 stars, all being GiWH. Another 4 internal appliances have 4-4.5 stars, all GiWH. All GsWH of the mains pressure type have less than 4 stars and 80% are less than 3.5 stars.

Product suppliers
Storage water heaters are bulky items that are manufactured in Australia, and all but one of the GsWH certifications are from the three suppliers with a readily identified presence in the market – Rheem, Dux and Aquamax. The remaining certification is for a small Perth-based company that seems not to have a significance presence in the market.

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

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. A major Japanese supplier, Tagaki, has certifications dating from 2006 and is now marketing products under several brand names.

There are also smaller 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.

Finally, Primo-Tech is a new entrant to the GiWH market. It has manufacturing facilities in Perth and expects its first significant sales in 2007.

There are 11 suppliers overall, 3 supplying GsWH only, 6 supplying GiWH only, and 2 supplying both. They range from large multinational companies to small and medium-sized businesses.

1.3 Sales projections for GWH

Baseline scenario for penetration of gas water heaters
The main elements of our baseline scenario are as follows:

- It is assumed that every household has a hot water system.
- It is assumed that the number of GWH fuelled with bottled LPG remains constant at 185,000, which is about 2.3% of Australian households at the present time and declines to 2% in 2020. This is consistent with returns from ABS surveys of energy and appliance use over the last 10 years[7].
- It is assumed that the proportion of Australian households using GWH fuelled by mains gas ('mains GWH penetration' hereafter) will increase from 35.4% in 2005 to 40.1% in 2020. This is slower than the historical trend indicated by ABS surveys – see figure 1.3.

The increase in mains GWH penetration is due mainly to an increase the proportion of households connected to mains gas, which is projected to rise from 46% to 52.5% over the period to 2020. This is consistent with regulator[8] projections for the growth in residential customers in the period to 2011, but assumes continued growth at that rate in the decade to 2020. This projection is also reported in figure 1.3.

Historically, the proportion of mains gas customers with GWH has also tended to rise, adding a second element to the rise in GWH penetration. Over the period to 2020, however, the proportion of gas customers with GWH is projected to remain constant at around of 77%. Increases in most jurisdictions are offset by Victoria's 5 star building regulations, which strongly favour the installation of gas-boosted solar systems where new dwellings have access to gas[9].

Figure 1.4 reports the resulting projection for total GWH penetration (both bottled and mains), increasing from 38% to 42% of households in the period from 2005 to 2020.

[7] ABS Cat 4602.0 *Environmental Issues*, 1994, 1999, 2002 & 2005.
[8] We refer here to the competition regulators in the various jurisdictions. They determine tariff structures for distribution networks and, in the process, publish projections for residential customer numbers and gas usage. See appendix B for further details.
[9] Appendices A and B provide supporting material. Appendix A documents policy measures favouring gas connections and installation of gas appliances. Appendix B provides a review of regulator projections for distribution networks, including projections for the growth in residential connections to mains gas.

FIGURE 1.3 GAS AND GWH PENETRATION OF AUSTRALIAN HOUSEHOLDS, PROJECTED TO 2020 (MAINS GAS ONLY)

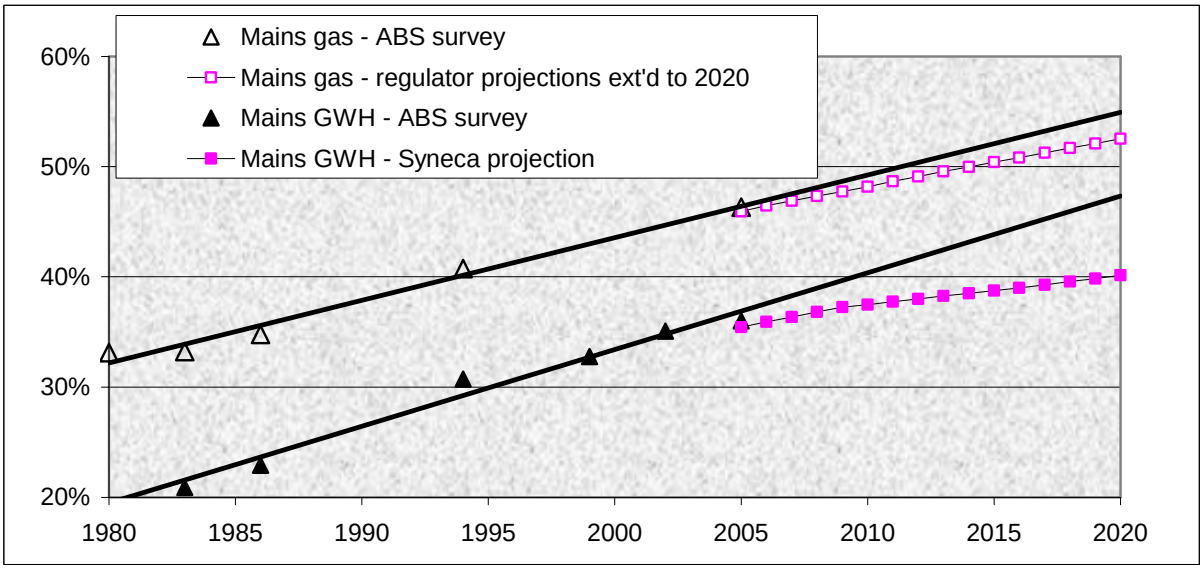
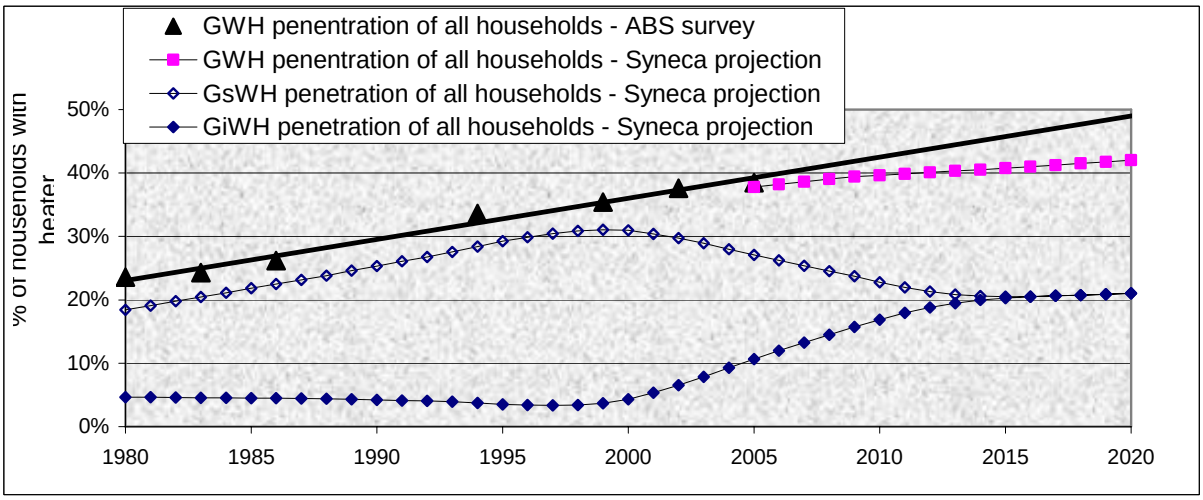


FIGURE 1.4 ESTIMATES OF GWH MARKET PENETRATION, PROJECTED TO 2020 (TOTAL OF BOTTLED AND MAINS GAS)



Changing mix of installed GsWH and GiWH

It is certain that GiWH penetration of all households has increased over recent years, and probable that GsWH penetration has started to fall. BIS Shrapnel reports that its 2006 survey put GsWH and GiWH penetration at 25% and 20% respectively (BIS Shrapnel 2006). However, examination of import data suggests that GiWH penetration is only about 11%. (All GiWH are imported and, while imports have increased rapidly in recent years, they don't account for 20% of the installed stock.) Accordingly, our baseline puts GsWH and GiWH penetration, in 2005, at 27% and 11% respectively.

It seems certain that GiWH penetration will increase further and that GsWH penetration will fall, but there is uncertainty about the timing and extent of the changes. Our baseline scenario is that, by 2015, GsWH and GiWH will each have 50% of the installed stock of GWH. This means that both converge on a market penetration of 20% in 2015 and then grow in line with projected penetration for GWH, reaching 21% in 2020 (= 50% of 42%) – see figure 1.4.

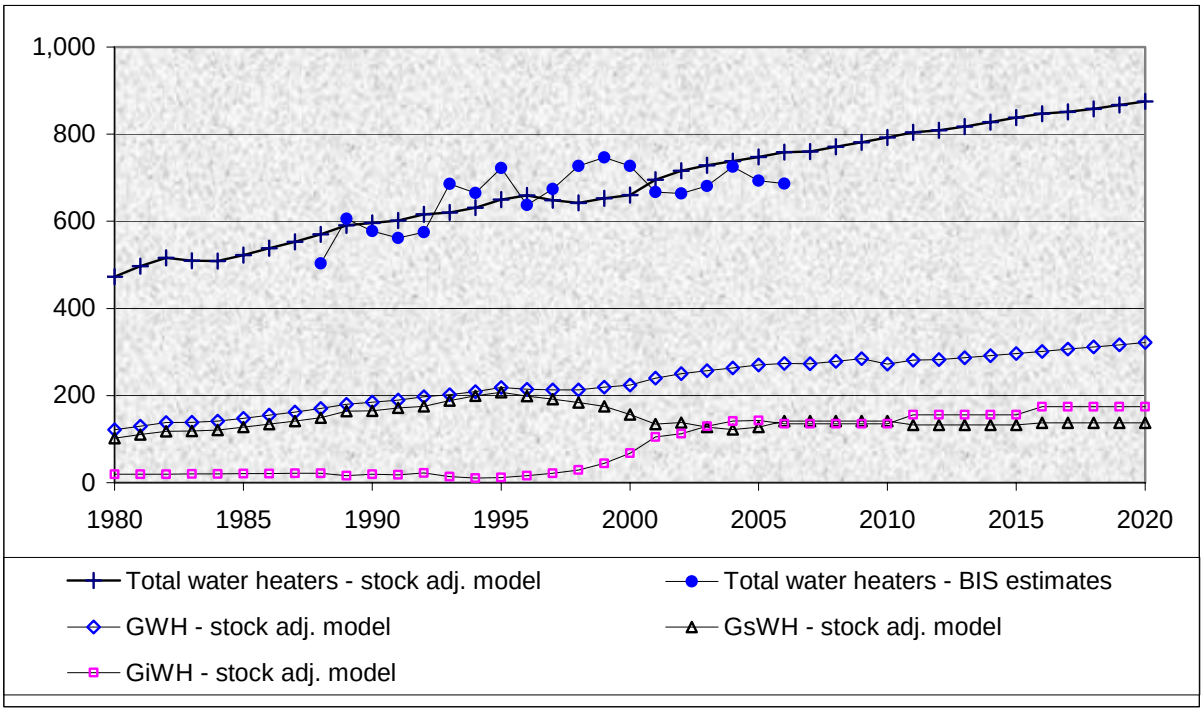
Baseline scenario for sales of GsWH and GiWH

Information about sales of water heaters is available from several sources. A series for all water heaters, including non-gas types, can be extracted from the periodic product reviews published by BIS Shrapnel. As noted already, sales of GiWH can be estimated from import data. Major suppliers have provided industry-wide information that they collect in collaboration with the ABS, combining trade data with a survey of heater manufacturers in Australia. It provides a breakdown by type but was not collected prior to 2002/03. Finally, estimates have been provided in various studies that have been published since the early 1990s.

The baseline scenarios presented in figure 1.5 are based on these sources. We used simple stock-adjustment models[10] to maintain consistency between the penetration scenarios and the available sales information. (Note that projected sales for GsWH and GiWH have been averaged over 5 year periods, suppressing year-to-year variations[11].) The main elements of the baseline scenario are as follows:

- Total sales of water heaters are expected to average 770,000/year in the 5 years to 2010, and to increase by 11.3% to 860,000/year in the 5 years to 2020. The cumulative tally of sales over the period 2010-20 is 9.2 million.
- The GWH share of total sales is projected to increase marginally, from 36.1% in 2005 to 36.7% in 2020. The cumulative tally of sales over the period 2010-20 is 3.3 million.
- Sales are split 45:55 between GsWH and GiWH over the period 2010-20. This is not enough to maintain the market penetration of GsWH, which falls. It is more than enough to maintain the market penetration of GiWH, which rises.

FIGURE 1.5 WATER HEATER SALES: 1980 TO 2020



[10] In a stock-adjustment model, annual sales are set equal to the increase in the stock of heaters over the relevant year plus an estimate of the number of heaters that need to be replaced. The increase in stock depends on population growth and changes in market penetration. Replacement demand is set to a constant fraction of stock.

[11] Historical fluctuations are repeated as replacement cycles over the projection period, imparting a sense of precise calculation that is unrealistic with simple stock adjustment models.

Mix of external and internal GWH
The vast majority of GWH sales will be for externally installed units. 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 hundreds or several thousands per year. Total sales are about 7,000 per 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.

Uncertainties
The key projections, which are for GWH market penetration of households and the mix of GsWH and GiWH, are necessarily uncertain. Our underlying assumption is that GWH are in a good competitive position relative to electric water heaters. Consider that:

- The greenhouse advantage of GWH over electric hot water systems (HWS) is set to become more important in the market, reflecting their superior greenhouse performance.
- GsWH have lower running costs in the three states with relatively cheap natural gas and relatively expensive electricity – Victoria[12], SA and WA.
- GiWH extend this running cost advantage to other states.

The exploitation of this advantage is impeded by inertia in replacement decisions, with many consumers taking the simplest option of replacing like with like. Where conversions occur, however, gas is strongly favoured: very few people convert to an electric heater from some alternate system[13]. This suggests that market forces will continue to favour gas in replacement decisions, but working slowly through the minority of replacements where conversion is actively considered.

The other major source of uncertainty is the impact of solar hot water systems on sales of GWH. We have assumed that GWH will not be an option for new Victorian dwellings after 2009, and that gas-boosted solar will be required instead. The market for GWH would be further reduced if there were broader support for solar hot water systems.

1.4 BAU contribution to growth of greenhouse emissions

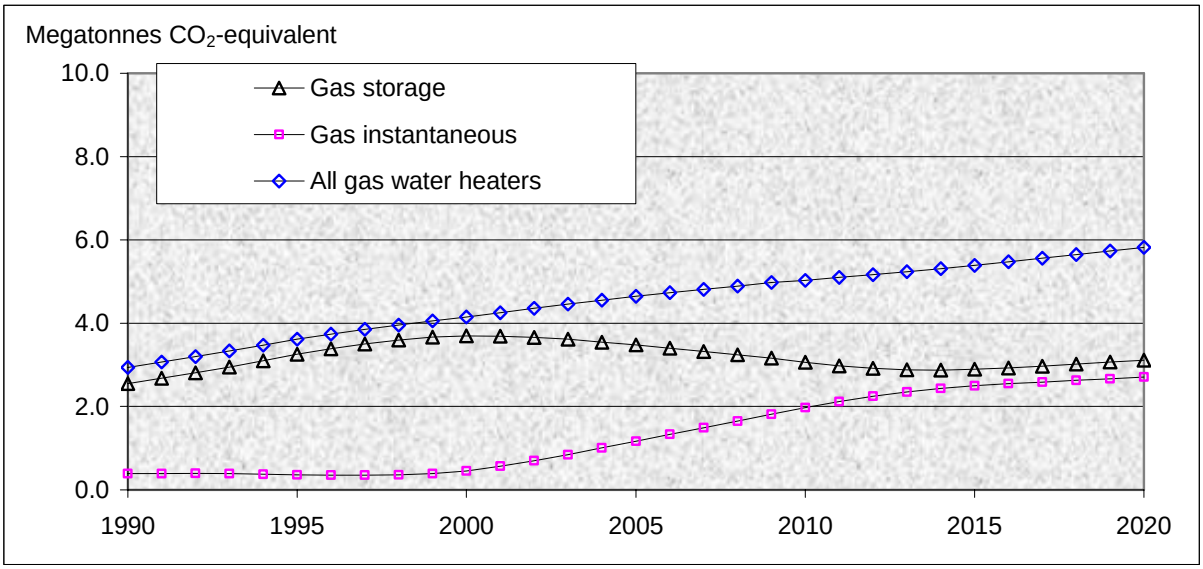
Figure 1.6 reports historical estimates and BAU (business as usual) projections of greenhouse gas emissions from the installed stock of GWH. This modelling indicates that emissions increased by 41% in the decade to 2000, will increase by 21% in the decade to 2010, and will increase by a further 16% in the decade to 2020.

In the first commitment period of the Kyoto Protocol (2008-12), this modelling indicates that:

[12] GWA (2005a) documents the competitive advantages of natural gas in Victoria.
[13] This pattern of behaviour is consistently documented by the consumer surveys conducted by BIS Shrapnel (BIS 2004 & 2006)

- Emissions will grow to 5.0 MT CO_2-e/year.
- GWH will account for 0.83% of Australia's total emissions, which are projected to reach 603 MT CO_2-e/year in 2010.
- GWH emissions will grow to 171% of their 1990 level, compared with a projected increase in total emissions to 109% of their 1990 level. 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.

FIGURE 1.6 GREENHOUSE GAS EMISSIONS FROM INSTALLED GWH: 1990 TO 2020



The drivers of emissions growth are population growth[14] and growing penetration, but offset by increases in the efficiency of new heaters. The increase in efficiency is the consequence of (a) efficiency gains in each of the major market segments, and (b) changes in market shares that favour the high efficiency segments. With respect to trends within market segments, the assumptions are based on examination of trends in the efficiency of newly-certified units, and are as follows.

- New GsWH with less than 5 stars: The average efficiency of new units rises from 3.0 stars in 1995 to 3.23 stars in 2007 and continues to improve at that rate, reaching 3.48 stars in 2020.
- New GsWH with at least 5 stars: New units are set at 5.05 stars in 2007 then improve at the same rate as units with less than 5 stars, reaching 5.3 stars in 2020.
- New GiWH with less than 5 stars: The average efficiency of new units rises from 4.0 stars in 1995 to 4.41 stars in 2007 and continues to improve at that rate, reaching 4.85 stars in 2020.
- New GiWH with at least 5 stars: New units are set at 5.32 stars in 2007 then improve at the same rate as units with less than 5 stars, reaching 5.76 stars in 2020.

The efficiency-enhancing changes in market share relate to the introduction of 5 star GsWH in the early 1990s and 5 star GiWH in the mid 1990s. Over recent years the effect has been to significantly reduce the market share of GWH with less than 5 stars – see figure 1.7. It now stands at about 35%.

[14] In 2010, the number of households is projected to be 142% of its 1990 level.

Figure 1.8 shows how these underlying trends in the efficiency and mix of products are expressed in the average efficiency of new and installed GWH. A plausible interpretation is that the mid to late 1990s saw sharp gains in the market share of 5 star GiWH which triggered a competitive response from suppliers of GsWH. Over time, these developments will drive up the average energy efficiency of the installed stock of GWH.

FIGURE 1.7 MARKET SHARE OF GWH WITH LESS THAN 5 STARS: BAU SCENARIO FOR 1990 TO 2020 (% OF GWH SALES) -

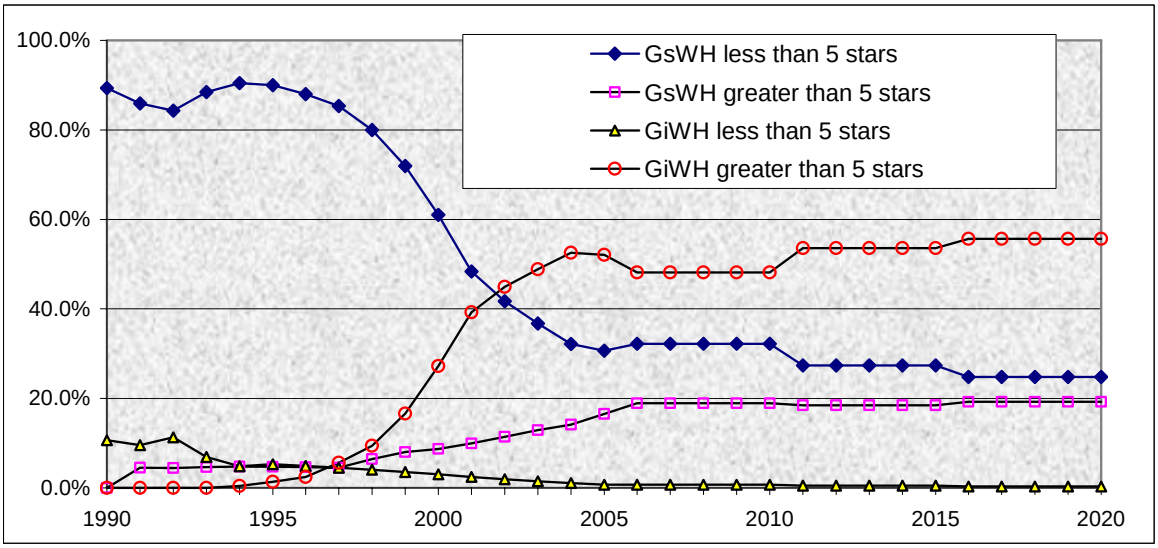
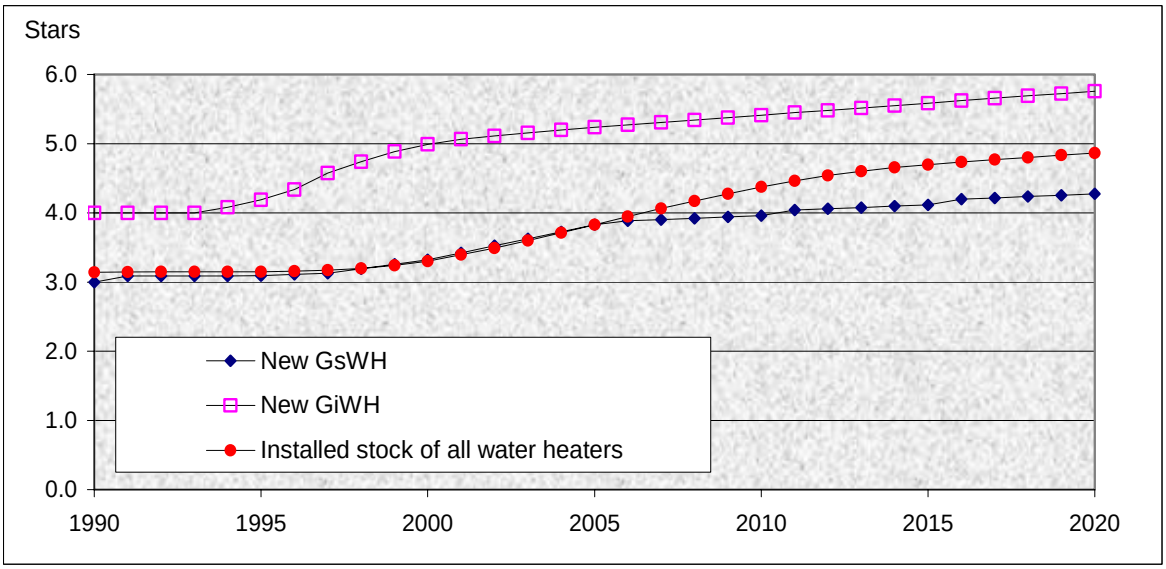


FIGURE 1.8 AVERAGE ENERGY STAR RATINGS FOR NEW AND INSTALLED GWH: BAU SCENARIO FOR 1990 TO 2020 (AVERAGE STAR RATINGS)



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.

An important consideration is that, for typical water heaters that will be affected by the regulation, the lifetime energy costs comprise about 74% of the total lifetime costs of the

heater[15]. The remaining 26% is the capital cost of the heater. Energy costs should therefore be a significant consideration in the purchase decision, given almost 3 times more weight than the capital cost. However, it is unlikely that many consumers give appropriate weight to energy costs and energy efficiency. Relevant considerations are that:

- 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. It is unreasonable to expect that many 'do the sums' in this way.
- The urgency of many heater replacements, which is reflected in the prominence of advertisements for 'same day' replacement services, means that it is difficult for consumers to give proper consideration to energy efficiency.
- Many purchase decisions are made by people do not pay the energy bills and thereby avoid the consequences of a poor decision. Builders or landlords are strongly motivated to minimise the purchase price. Owner-occupiers would also discount future energy savings heavily if they plan to sell or rent the dwelling at some time during the life of the heater.
- It is unusual for consumers to see the energy label prior to purchase. Water heaters are not 'shop floor' items and do not have the same consumer exposure as other types of household appliance.

The effectiveness of the gas labelling scheme has been the subject of recent research by the E3 Program (Artcraft 2006). Artcraft 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%.

This is in sharp contrast with the Energy Label for electrical appliances, and which is almost universally recognised. Ninety four per cent of Australian consumers recall the Energy Label unaided, rising to 96% when prompted, on a par with leading market brands and high profile celebrities. Eighty eight per cent of consumers say that they use the labelling information at some point in appliance selection processes.

These weaknesses are factored into our account of outlook under BAU conditions, as expressed in figures 1.7 and 1.8. Note in particular that:

- 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 5 stars is 25% in 2020, down from about 35% in 2005.
- The average efficiency of new GsWH is only 4.3 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.

Suppliers should examine this analysis of probable developments under BAU conditions, and argue the case for any alternative assessment of the probable future.

[15] 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% per 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.

2 Objectives of government action

2.1 Objective

The primary objective of all regulations proposed under the E3 Program is to reduce Australia and New Zealand's greenhouse gas emissions but subject to the constraint that, for individual measures, the incremental value of energy savings is not less than the incremental costs of the measure. This is a no-regrets policy.

2.2 Assessment criteria

The primary assessment criteria are that the measures deliver the maximum reduction in energy use and greenhouse emissions, but subject to the constraint that the average lifetime cost of appliances is reduced and the measures provide a net benefit.

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 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 options (3.3), and shortlists the options that are considered feasible (3.4). The shortlisted options 'go forward' to impact assessment in chapter 4.

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 currently 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 (to be published as a separate standard number) will be finalised in mid-2008, 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.

The E3 program is providing significant financial, technical and administrative support for the work, including funding for laboratory tests and analysis. E_3 intends that the new standard, particularly the energy test method, will provide a sound basis for the implementation of mandatory government regulated minimum energy performance standards.

3.2 Proposed regulation

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. In effect, these requirements impose a MEPS of almost 2 stars under AS4552-2005[16]. The core proposal is raise the MEPS to a level that is equivalent to 5 stars under AS4552-2005 from October 2008. The precise details cannot be known until the new standard is finalised, which means that the proposal is expressed as the intention to impose a MEPS that employs the new test method and standard for compliance purposes, and that the new MEPS will be broadly equivalent to 5 stars under the existing test and standard.

[16] Under AS4552-2000, the base MEPS requirement was 1 star for a standard storage unit. A maximum start-up energy for instantaneous systems is not specified in the standard, so in effect there is no real minimum star rating. An increase of the minimum permitted burner efficiency from 70% to 75% was introduced in the 2005 edition. 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.

Transition arrangements are proposed for two categories of GWH that have been or will be certified to the existing test and standard at any time before October 2008. This means that there are three categories for product for regulatory purposes. They are best defined in reverse order.

- Category 3: These are GWH that are certified to the existing standard on or after 1 July 2007. They can be imported or manufactured to October 2009 if they have energy ratings of at least 4.5 stars, and can continue to be imported or manufactured thereafter if they comply with the new standard, including the 5 star MEPS.
- Category 2: These are GWH that have been or will be certified to the existing standard on or before 30 June 2007, which would include all products listed in the April 2007 edition of the *AGA Directory*. They can be imported or manufactured to October 2010 if they have an energy rating of at least 4.5 stars, and can continue to be imported or manufactured thereafter if they comply with the new standard, including the 5 star MEPS.
- Category 1: These are GWH that are certified to the new standard, which will be available from mid 2008. It will be mandatory for new and renewed certifications from October 2008, and will impose MEPS of 5 stars. In the period from October 2008 to October 2010, the 5 star MEPS will apply to all products that are not in category 2 or category 3. From October 2010 the 5 star MEPS will apply to all products.

To repeat, the transitional relaxation of MEPS, to 4.5 stars, applies only to products that are registered to the existing standard. The intention is to allow for the fact, due to inaccuracies and ambiguities in the existing test method, suppliers are uncertain about which of their more efficient products will comply with new standard.

Exclusions
The following three 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.

The first two exclusions govern the labelling requirements of the existing standard and no consideration has been given to the testing requirements that may be appropriate for GWH that exceed 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 E3 Program will monitor product developments that have effect of using these thresholds to escape the MEPS requirements.

The E3 Program intends to review these exclusions at a later date, with a view to broadening the scope of the MEPS to include larger commercial and industrial appliances, central heating boilers, boilers that are use to provide both central heating and a hot water service, and appliances for mobile applications.

An issue for suppliers is whether these exclusions are reasonable, not only in terms of the broad intentions of the proposal but also in terms of specific technical thresholds that are proposed.

3.3 Alternative policy options

The BAU or ‘do nothing’ alternative is implicitly short-listed. It provides the base case against which all feasible options are compared. The remaining options 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 MEPS set at 4 stars

The MEPS could be set at 4 stars. Because the practical efficiency options are currently either 3 stars or 5 stars, the effect would be to upgrade the 3 stars segment to 4 stars, bridging about half of the existing efficiency gap between 3 stars and 5 stars.

An analysis of the option of a 4 star MEPS was included in a preliminary CBA that was circulated to suppliers in November 2006 (Syneca 2006). In that document, the impacts were simply assessed as proportional to the impacts of a 5 star MEPS – that is, delivering about half of the energy savings expected from a 5 star MEPS, at half the cost, and delivering half of the financial benefits. However, a proportional treatment of the main impacts is based on two questionable assumptions.

- First, it is assumed that the introduction of 4 star options would not encourage efficiency 'backsliding', expanding the market for 4 star units at the expense of the 5 star units. The associated potential for efficiency losses is a major concern for the E3 Program, seeming to put at risk the substantial market share that has already been established for 5 star products.
- Second, it is assumed that there are no additional costs associated with the introduction of a new range of 4 star products. This is unreasonable. The 5 star MEPS can be accommodated to significant degree by expanding the sales of existing 5 star models, whereas a 4 star MEPS would encourage suppliers to introduce new 4 star models.

In summary, it is noted that most suppliers have all but vacated the 4 star market and it is considered that it would be a backwards step to encourage redevelopment of that market, particularly given the option of building on recent growth in the 5 star market.

This is an important judgment that suppliers should critically assess.

3.3.2 Timing of the MEPS

The E3 Program intends to implement the proposals as soon as possible, given the constraints of program development, consultation processes and the need to give reasonable notice. The earliest date is October 2008 but may be deferred for 6 months if development and consultative work proceeds more slowly than is planned.

The sensitivity analysis in chapter 4 provides information about the impact of delays.

3.3.3 Alternative regulatory forms

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 the general experience of the E3 Program 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 cooperation 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 on a voluntary basis.

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, the E3 Program proposed that suppliers devise a voluntary program of retiring the least efficient water heaters, and offered assistance to work through the issues. The supplier response was such that the E3 Program formed a view that there would be no significant change on a voluntary basis.

3.3.4 Market-based instruments

It is highly probable that an emissions trading scheme will be introduced during the life of the proposed regulation, penalising greenhouse emissions and raising the price of gas fuels. The most recent strong pointer is the report of the Prime Ministerial Task Group on Emissions Trading (DPMC 2007), which recommends the introduction of a national emissions trading scheme. As noted by the Task Group, higher energy prices will encourage households to examine appliance choices more carefully and give greater weight to energy costs (DPMC 2007: page 133). However, the Task Group also says that *… emissions trading – globally or nationally – is not a panacea. Other market failures will persist. There will remain a role for governments in setting regulatory standards, supporting technological innovation and encouraging changes in household behaviour* (DPMC 2007: page 9).

The Task Group specifically endorses programs like the E3 Program, saying that … *There is a good case for continuing the development of well-designed and consistent regulated minimum energy standards for buildings and household appliances. Purchases of energy efficient products can have a large impact on aggregate emissions over time, and reduce the impact on household budgets of any rise in carbon prices* (DPMC 2007: page 135). The National Emissions Trading Taskforce (NETT), which reports to the Premiers and Chief Ministers of all Australian States & Territories, had previously come to the same conclusion (NETT 2006: section 13.3.2).

The underlying point is that, regardless of what is done to ensure that energy is priced to reflect all of its costs, including environmental costs, consumers may still misjudge the costs and benefits of energy efficiency. This is as true under a policy regime of carbon pricing as under a policy regime of no regrets.

3.3.5 Information and education

Information and education initiatives are standard operating procedure for the E3 Program, particularly in relation to its energy labelling program, and this aspect of market operation could be improved.

Importantly, there is already a labelling scheme for GWH, providing ratings from 1 to 6 stars. It is little known and understood by the public but it could be reformed to better reflect the range of product efficiencies that are now available, and it could be better promoted for increased effectiveness. Nevertheless, revival of the labelling scheme is not a feasible substitute for the proposal, for the following reasons:

- The E3 Program uses energy labelling to complement MEPS, not as a substitute for MEPS. They have different roles, one being to encourage development of high efficiency options, the other being to put a floor under low efficiency.
- Water heaters are not purchased from a shop floor or showroom where buyers can examine the appliance and take account of energy labels. Compared with whitegoods, energy labels for GWH would have a much lower impact on consumer choice.

- As discussed in chapter 1, buyers often don't have the time to make considered decisions, or the decision is made by builders or landlords who don't pay the energy bills.
- 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. There is no reasonable prospect that a revived labelling scheme would have a significant impact, and several years would be lost in testing a doubtful proposition.
- There is a risk that a revived labelling scheme will revise interest in the existing 4 star market, facilitating downgrades from 5 star products.

Reform of the existing labelling arrangements is one of the matters to be considered in conjunction with the development of a new energy test and revision of the existing standard. Labelling may be abandoned entirely or replaced with a much simpler arrangement that only models with near-exceptional performance to be described as 'high efficiency'.

3.4 Shortlist of feasible options

Based on the above discussion, the only feasible options are to accept the proposal or to maintain the *status quo*.

4 Impact analysis - Australia

This chapter reports an assessment of the impact of imposing a 5 star MEPS on gas water heaters. It deals with the expected contribution to greenhouse abatement (section 4.1). It then deals with each step in the process by which abatement is achieved, starting with the taxpayer-funded investment in program development (4.2), the compliance (red tape) costs incurred by business to responding to the program (4.3), the impacts on competition and trade (4.4), and the impacts on consumers (4.4). The chapter concludes with a summary statement of the net national impact and sensitivity analysis (4.6 and 4.7). Appendix C provides a breakdown of impacts by jurisdiction.

4.1 Contribution to greenhouse abatement

4.1.1 Timeframe for the analysis

The measures are assumed to apply fully during the 10 year period from 2011 to 2020, but with the first effects becoming apparent in 2008 and building through 2009 and 2010. Our market projections for this period have been reported in chapters 1 and 2 and can be summarised in three propositions, (a) Australian households will purchase 10.7 million new HWS over the period 2008 to 2020, (b) 3.8 million of these will be GWH and (c) 1.07 million will be GWH with less than 5 stars. Allowing for the phase-in period from 2008 to 2010, we estimate that 0.87 million GWH with less than 5 stars will be affected by the measures.

The estimate for total purchases is well-founded but the breakdown by type and efficiency is uncertain. We consider that the estimate of 0.87 million is a plausible inference from historical trends, existing market pressures, and known impediments to household take-up of energy efficient technologies. Suppliers should examine these estimates and argue the case for any alternative scenario that they consider more likely. The key graphical presentations are figures 1.4, 1.5 and 1.7.

Most GWH purchased in the period to 2020 will continue in use through the 2020s and some will survive into the late 2030s. On average, units that are purchased in 2020 with a 5 year warranty are assumed to retire in 2031 (11 year life) and units with a 10 year warranty are assumed to retire in 2035 (15 year life). Impact estimates are for the whole of the life of all units purchased in the period to 2020.

4.1.2 Greenhouse abatement

As discussed in chapter 1, the problem being addressed is that the greenhouse emissions associated with the use of GWH will grow to 5.0 MT CO_2-e/year (0.83% of Australia's emissions) in the first commitment period of the Kyoto Protocol (2008-12). They will increase by a further 15.7% in the period 2010 to 2020, to 5.8 MT CO_2-e/year.

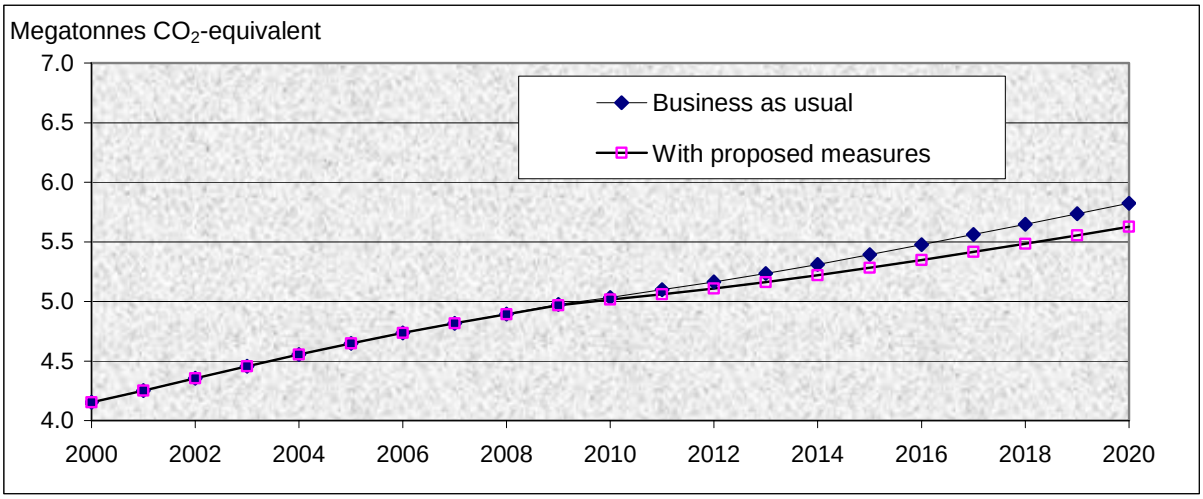
The proposed measures would be introduced during the first commitment period and have negligible impact on compliance with the Kyoto target. But the effects are cumulative, increasing as the stock of GWH is renewed over time and more of the installed stock comes within the scope of the measures – see figure 4.1. The impact of the measures is to:

- Reduce emissions growth for the period 2010-20 from 15.7% to 12.2%.
- Reduce 2020 emissions by 0.2 Mt CO_2-e. This is a 3.4% reduction in 2020 emissions, or 22% of the emissions abatement that would be needed to stabilise GWH emissions at the 2010 level.

- Deliver a 15% reduction in the emissions from the 0.87 million GWH that would otherwise have been sold with energy ratings of less than 5 stars.

Over the life of the more efficient units that are purchased in the period to 2020, the measures will contribute 2.3 Mt CO_2-e to emissions abatement.

FIGURE 4.1 IMPACT ON EMISSIONS GROWTH: 2000 TO 2020



4.2 Cost to the taxpayer

Table 4.1 provides estimates for the incremental cost of including GWH in the E3 Program, which is taxpayer funded. The E3 Program estimates that, in the period to implementation in 2008, 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 ongoing costs are for check-testing, maintenance of the product register, and the maintenance of stakeholder relationships. All of the 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.

We have high confidence in these estimates.

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

	Cumulative total to 2008 ($)	*Annually, beyond 2008 ($/year)*
Laboratory tests (store surveys to 2006 and combination of store surveys and compliance testing after 2006)	$150,000	$2,500
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**	**$10,000**

4.3 Business compliance costs

The Council of Australian Government (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[17], 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 cost increases of both a once-only and ongoing nature. All of 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 reasons for 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 the alter existing 5 star products to provide a range of 5 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 has 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 coordinate 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 presents our findings and is organised around 4 broad types of products – existing products that will comply with the 5 star 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 be require a more costly energy test (panel

[17] 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.

5). The total compliance cost for each category of product is obtained by multiplying the number of products by the average incremental permission cost.

TABLE 4.2 ESTIMATE OF INCREMENTAL BUSINESS COMPLIANCE COSTS

	Category of supplier			*Total*
	Large	*Intermediate*	*Small*	
1. Supplier characteristics				
Number of suppliers	3	3	5	11
Average products per supplier	16.0	4.3	1.0	
Total products	48	13	5	66
2. Re-testing & certification of 5 star 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	3	31
energy tests ($, permission cost)	45,000	52,000	18,000	115,000
certification ($, permission cost)	22,500	26,000	9,000	57,500
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	1.0	13.2
energy tests ($, permission cost)	14,400	5,200	3,000	22,600
certification ($, permission cost)	7,200	2,600	1,500	11,300
Present value				
energy tests ($, permission cost)	105,342	38,040	21,946	165,329
certification ($, permission cost)	52,671	19,020	10,973	82,664
6. Present value of all costs ($)				
Energy tests ($, permission cost)	322,842	90,040	39,946	452,829
Certification ($, permission cost)	142,671	45,020	19,973	207,664
Total	**465,513**	**135,060**	**59,919**	**660,493**

The following broad judgments are incorporated in table 4.2.

- For GsWH, it is assumed that two thirds of non-complying products are replaced by new products that would not otherwise have been introduced in the relevant timeframe. Of that 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 to the market.
- 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 $790,000 over the period to 2020. These outlays have a present value of $660,000. Our confidence in this estimate is medium. **<<Drafting note: This is a small increase on an earlier estimate and the new figure has yet to be included in the national summary tables.>>**

Note that table 4.2 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.

4.4 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; or
3. favouring products or suppliers in ways that are unrelated to the intention of the regulation, which is to increase energy efficiency.

Regarding the first matter, our baseline assessment of costs and benefits assumes that like-for-like replacements will not always be available for two types of GsWH: internal GsWH of the mains pressure type, and smaller GsWH with 90 litres of storage capacity. (See section 4.4 for the impact analysis for these consumers. They account for about 5% of sales.) This judgment may be pessimistic. 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 prior to implementation.

There are lesser risks affecting the replacement of three other types of water heater:

- Three 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 per 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.
- A small South Australian company manufactures an internal GsWH of the gravity feed type, currently rated at 4.4 stars. It services a small replacement market of several hundred per year. The manufacturer is concerned that the scope for increased efficiency is constrained by the difficulty of adding insulation to products that must be squeezed into ceiling spaces, but has indicated that 'it may be possible to do something.'

Our baseline assumption is that, for these three sub-markets, like-for-like replacements will be developed at reasonable cost.

Regarding the second matter, all but one of the 11 certified suppliers have a demonstrated capacity to supply products with 5 star ratings and seem not to be concerned about their continued viability in the market. The single exception is as small Perth-based manufacturer with a single certification for a 3 star GsWH. Their presence in the market is uncertain and the E3 Program will specifically solicit their response to the proposal. Subject to further submissions on this issue, it is considered that there will be no lessening in the quality of competition between suppliers.

Regarding the third matter, it is important that the proposed regulation is performance-based. It sets a threshold for minimum 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.

Implications for trading patterns

With minor exceptions[18], the situation is that GsWH are manufactured locally and GiWH are imported probably because of the bulky nature of storage units providing a transportation cost that GsWH purchasers have not been willing to pay. Since GsWH comprise the majority of GWH with less than 5 stars, some argue that the proposed regulation could shift demand towards imported GiWH affecting sales of locally manufactured GsWH.

Based on the information available, there may be some shift in this direction but it is difficult to quantify and may not be large because of the continuing high transportation costs associated with importing GsWH. Relevant considerations are that:

- 5 star GsWH are already available from all major suppliers, providing a large majority of households with the option of like-for-like replacement of storage units.
- 5 star storage units tend to be a little cheaper than 5 star instantaneous units which may limit the move to GiWH by the price conscious.

[18] The exceptions are all minor GiWH suppliers at the present time, specifically: two suppliers that assemble GiWH from imported components, and a recent entrant to the GiWH market with manufacturing facilities in Perth.

- The price of 5 star GsWH may fall or at least stabilise relative to GiWH, reflecting economies of scale in the production of such units and reduced scope for premium pricing in the absence of less efficient baseline products. Scope exists for 'regular' or 'basic' versions of 5 star GsWH to be developed, with fewer features and shorter warranties that are now only generally available at the 3 star level.
- In the replacement market, conversion from GsWH to GiWH is discouraged by the additional costs of installing a higher capacity gas line, power lines and new mountings. Plumber contacts suggest the additional cost is over $500 for standard conversions and higher in more difficult situations.

The above analysis suggests that the implications for changes between domestic production and import trade may not be large and probably could be benign. Suppliers are encouraged to comment on this assessment and to document any contrary views with supporting market data.

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, the adoption of performance-based regulation where possible.

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

- The E3 Program 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[19]. Either they are specific to local definitions of the heating task[20] (Europe) or they have yet to provide adequately for instantaneous designs (North America). It seems likely that Japan will adopt the revised Australian standards.
- 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 Agreement (TTMRA)

GWH are currently exempt from the TTMRA, which would otherwise provide that GWH that can be lawfully manufactured in or imported into either Australia or New Zealand may be lawfully sold in the other jurisdiction. The point of difference is that New Zealand has adopted a light-handed approach to the regulation of gas appliance safety that is unacceptable to Australian jurisdictions. Given the exemption, the proposed MEPS can be effectively implemented in Australia alone.

[19] 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).
[20] 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.

This proposal is part of the work program of the trans-Tasman Equipment Energy Efficiency Committee. It is intended that New Zealand will adopt the proposed measures at the same time as Australia.

In either case the proposal is not impeded by TTMRA.

4.5 Impact on consumers

This section deals separately with the impact on consumers in 6 market segments.

4.5.1 External GsWH with 135 or 170 litres of storage capacity

Incremental cost of water heater

External GsWH with 135 or 170 litres of storage capacity will account for about 95% of sales that will be affected by the measures, a total of 0.82 million units. The additional cost of these units has been estimated as follows:

- *Market segments:* Four market segments were distinguished, taking the 2 capacities (135L and 170L) and further splitting each type according to the warranty period – 5 years or 10 years.
- *Price of units with 5 year warranties under BAU conditions:* These prices were equated with prices reported in late 2006 editions of *Reed Construction Data*. The weighted average prices across the jurisdictions are $770 and $880/unit for 135L and 170L respectively.
- *Price of units with 10 year warranties under BAU conditions:* Based on examination of catalogue prices and price information provided by major plumbing supplier (Reece), the incremental cost of the extra 5 years of warranty was put at $110 and $120/unit for 135L and 170L respectively. For these units, therefore, the weighed average prices across the jurisdictions are $880 and $1,010/unit for 135L and 170L respectively.
- *Price increment for upgrading each market segment from 3.4 stars to 5.2 stars:* The energy efficiency of these units would need to increase by 15%. Based on a conservative interpretation of the available price information, we put the price increase also at 15% of the price of 3 star units with 10 year warranties. After adding GST, the baseline estimates of the incremental costs are as reported in table 4.3.
- *Weighted average price increment:* Market shares were assigned on the basis of information supplied by suppliers, indicating that the warranty split is 90%:10% in favour of 5 year warranties, and that the capacity split is 60%:40% in favour of 135L. This provides the basis for calculating a weighted average increase, which is the $157 that is also reported in table 4.3.

Over the period to 2020, households would outlay an additional $129.6 million, being 0.82 million units with an incremental price of $157/unit. This is the undiscounted value, with a dollar spent in 2020 given the same weight as a dollar spent in 2008. The present value, after discounting at 7.5% per year, is $80.5 million.

The estimates reported in table 4.3 are based on evidence from Australian and US sources.

TABLE 4.3 ESTIMATE OF PRICE IMPACTS ($)

Storage capacity (litres)	*135*		*170*		*Weighted average*
Warranty period (years)	*5*	*10*	*5*	*10*	
	Unit price				
BAU price (3 stars)	770	890	880	1,010	826

WPM price (5 stars)	905	1,025	1,033	1,163	969
Incremental cost, ex GST	135	135	153	153	142
Incremental cost, inc GST	149	149	169	169	157
Weights	54%	6%	36%	4%	100%
Aggregate expense					
Total sales, 2009-2020 (million)	0.44	0.05	0.30	0.03	0.82
Incremental expense, inc GST ($million)					
Undiscounted value	66.4	7.4	50.2	5.6	129.6
Present value	41.3	4.6	31.2	3.5	80.5

Australian price comparisons

Catalogues and price lists were collected from appliance manufacturers, plumbing suppliers, energy retailers and on-line retailers, including outlets of a major plumbing supplier (Reece). Certain price differences can be reasonably attributed to a single appliance attribute, for example, differences in the price of models with the same capacity, same efficiency and from the same family of models, but with different warranty periods, or differences in the price of models with the same capacity, same warranty and from the same family of models, but with different efficiency. The price increments reported in table 4.3 - $149 to $169 for upgrading to 5 stars - are high relative to the average difference of $116 that was obtained from such price comparisons. The conservative bias is for two reasons.

First, the underlying comparisons returned highly variable results. In one instance, for example, 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 $203 for the same comparison. There were other oddities, such as the cost of upgrading from a 5 to 10 year warranty being greater for 135L models than for 170L models.

A second limitation is that, whereas models with 5 year warranties are generally available in both 3 and 5 star versions, allowing price comparisons, models with 5 year warranties are generally only available in 3 star versions. The only exception is one of the smaller suppliers who introduced a '5 year/5 star' model in 2005. It has been assumed that:

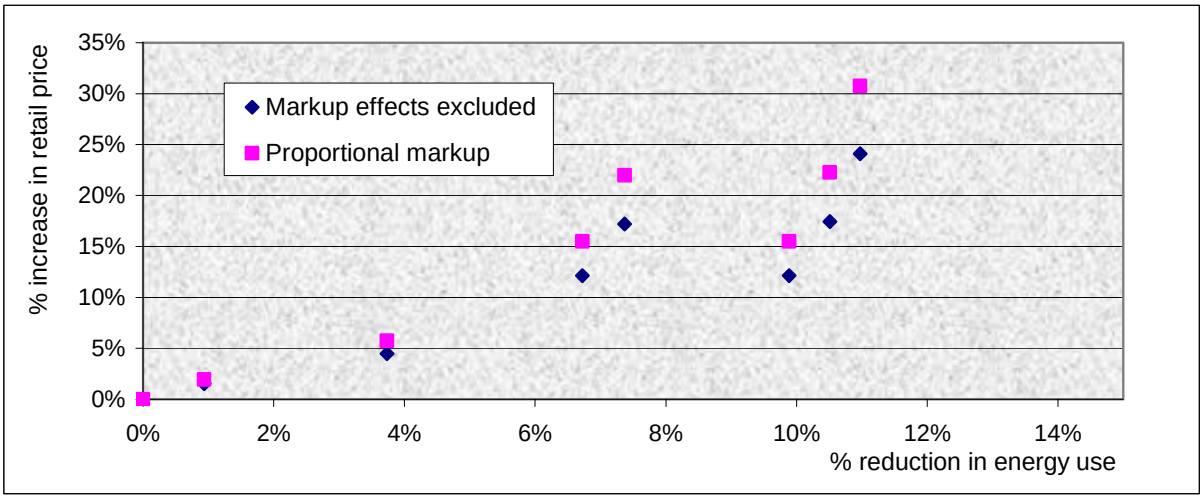
- suppliers will develop a range of '5 year/5 star' versions in response to higher MEPS; and
- the incremental price will be the same as for the corresponding models with 10 year warranties.

Impact of new energy conservation standards in the US

Figure 4.2 presents the results of analysis that the US Department of Energy published (DoE 1998) to inform the rule-making processes that led ultimately to an increase in the efficiency requirements of GsWH in the US, taking effect from January 2004. Depending on how mark-ups[21] are treated, the analysis indicates that an 11% reduction in energy use would be at the expense of a 24-31% increase in retail price. This suggests that the ratio of

[21] Markups are the additional cost of wholesale, retail and transport function that are often set as percentage mark-up on the base price. There is uncertainty about how the markups will be adjusted. At the extremes, the increase in the mark-up can be set proportional to the increase in the base price or excluded from consideration.

FIGURE 4.2 PROJECTED COST-EFFICIENCY RELATIONSHIP FOR THE US, FOR STANDARD 40 GALLON (150L) GAS STORAGE WATER HEATER



Source: DoE (1998) *Technical Support Document for Water Heaters*, Chapter 8, tables 8.4.25 and 8.4.26

percentage price increase (24-31%) to the percentage reduction in energy use (11%) is in the range 2.2 to 2.8. This is much higher than the ratio of 1.0 used to generate the baseline estimates reported in table 4.1, that is, a 15% reduction in energy use at the expense of a 15% increase in price.

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 in the US. 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 conservations standards.

It should also be noted that there was at least a 6 year delay between the cost analysis (pre-1998) and eventual implementation (2004).

Findings on incremental costs

We suspect that the estimates in table 4.3 will also be found to err on the high side. But there is uncertainty about this variable and suppliers are strongly encouraged to provide any alternative data and analysis.

Value of energy savings

Methods

We have estimated the energy savings that will be obtained by requiring these 0.82 million GsWH to be upgraded to 5 stars, based on the following assumptions:

- They are upgraded by 1.8 stars (from 3.4 to 5.2 stars on average), this being the expected difference between the average efficiencies of 3 star and 5 star appliances under BAU conditions. (Section 1.4 explains the BAU scenarios for average energy ratings.)
- The energy savings that are observed under test conditions are good estimates of the energy savings that accrue, on average, to households under actual operating conditions. Note the reference to the average household: the proposition is obviously not true for all households.

Energy savings has been valued at the marginal residential gas tariff, which varies considerably across the country. A weighted average has been calculated, taking account

of variations between jurisdictions, between metropolitan and regional consumers, and between small and large consumers. (Smaller consumers usually pay a higher marginal tariff than larger consumers.) There is also a small weight for LPG-fuelled heaters: LPG is about 3 times more expensive than mains gas. We estimated the national weighted average price at 1.38 cents/MJ in late 2006, including GST.

Future energy savings have been valued at a fixed price of 1.38 cents/MJ, as though the real cost of gas will remain constant, but have been discounted to the present at 7.5% per year. 'The present' is taken to be 2008, which is the proposed date of implementation.

Findings on value of energy savings

The installed stock of heaters affected by the measures will grow over the period to 2020, reaching 0.82 million in 2020. The full impact on energy use is therefore realised in 2020, and amounts to energy savings of 2.92 PJ per year, or 3.4% of the total energy consumed by GWH in 2020.

Annual savings grow in proportion to the number of GsWH affected by the measures until the maximum annual impact is realised in 2020, about $40 million per year. Over the entire period to the mid-2030s, when the last of the units purchased before 2020 is assumed to retire, the owners of the 0.82 million external GsWH will accrue financial savings of $476.8 million.

Financial gains become progressively less valuable as they are deferred further into the future. The E3 Program has adopted the general practice of discounting future values by 7.5% per year. On this basis, the present value of the savings is $208.6 million.

Net benefits for external GsWH with 135L and 170L storage capacity

The baseline assessment for households in this market segment is highly favourable.

- The incremental cost and benefits are $80.5 million and $208.6 respectively, in present value terms.
- The net benefits are $128.1 million and the benefit-cost ratio is 2.6.

4.5.2 External GsWH with 90 litres of storage capacity

The market for externally installed 90L GsWH is a niche market for replacement units and confined to smaller households and households in mild and warm climates, such as parts of Queensland. Sales are currently about 3,250/year and our baseline assumes that the proposed regulation would affect sales of 15,000 units in the period 2020. It is assumed that the market is declining and that suppliers will sell existing models up to October 2010, taking full advantage of the transition arrangements.

The subsequent difficulty for customers is that these appliances are currently available only in 3 star versions and suppliers may not invest in the design and production of 5 star versions, leaving them without a like-for-like replacement. Our baseline assessment assumes that they will upgrade to GsWH with storage capacity of 135L, with two consequences. First, existing price information (Reed Construction Data 2006) suggests that there would be an increase in the incremental cost of up to $100. Second, the 90L customer would not achieve all of the energy savings that may accrue to the average user of a 135L unit. This is because the replacement unit would be oversized relative to the user requirement, which means that excess water is kept hot in standby mode.

Our findings for this market segment have been obtained by making two adjustments to the analysis for GsWH with 135L and 170L storage, (a) adding $100 to the incremental cost of the appliance, taking it to $257/unit, and (b) reducing the energy savings by 33%. Using the energy rating formulas from the existing standard, the latter is commensurate with a 50% reduction in water use and seems a reasonable allowance for the smaller user. The impact on this market segment can then be stated as follows:

Impact on average customer

- Incremental cost of heater – $257
- Energy savings – 2,440 MJ/year
- Value of energy savings – $36.70/year
- Present value of energy savings – $298 (asset life of 13 years, discount rate of 7.5%)
- Net financial benefit – $41
- Benefit cost ratio – 1.2

Aggregate impact

- Additional sales of 5 star units to 2020 – 15,100
- Present value of incremental cost – $2,791,000
- Present value of energy savings – $3,201,000
- Net financial benefit – $410,000
- Benefit cost ratio – 1.2

On this figuring, there seems to be sufficient 'fat' in the benefit-cost analysis to protect this class of customer from significantly negative outcomes.

4.5.3 Internal GsWH

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.

Internal GsWH, gravity feed type
HWS Australia Pty Ltd is the sole supplier of these units and produces about 250 per 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 are 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

The E3 Program requests HWS Australia to assess the proposition that it can achieve 5 stars at an incremental cost that is not significantly more than $160/unit, including increases in both equipment and installation costs. The energy savings would then be delivered at zero net financial cost.

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 seems to be 4 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[22]. 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 price premium for an internal replacement with a 5 star ratine. 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?

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 of 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.

The E3 Program encourages suppliers of internal GsWH (both existing and possible new entrants) to consider whether 5 star versions of these products can be produced for a price that that is competitive and commercially viable compared with the more difficult and costly options that their customers would otherwise need to adopt.

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.

4.5.4 External GiWH

We have discussed the impact of the proposed regulation with all suppliers of external GiWH who are concerned that some of their products may not comply with the 5 star MEPS. We understand that the main issue is with two products that employ a continuously burning pilot light for ignition, currently have energy ratings of 3.9 and 4.2 stars, and would not be imported or manufactured after October 2008. Products with equivalent performance but hydro ignition and 4.5 stars will be available for the transition period, and with 5 stars from the end of the transition period. The incremental cost is expected to be about $60 per unit and the energy efficiency would improve by 0.5 stars during the transition period and by 1 star from the end of the transition period. The impact on this market can then be stated as follows:

Impact on average customer

- Incremental cost of heater – $60
- Energy savings – 1,012 MJ/year (transition), 2,023 MJ/year (full)
- Value of energy savings – $15.22/year (transition), $30.44/year (full)

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

- Present value of energy savings – $133/year (transition), $265/year (full)
- Net financial benefit – $73/year (transition), $205/year (full)
- Benefit cost ratio – 2.2 (transition), 4.4 (full)

Aggregate impact

- Additional sales of 5 star units to 2020 – 11,500 (assumes a declining market)
- Present value of incremental cost – $453,000
- Present value of energy savings – $1,764,000
- Net financial cost – $1,311,000
- Benefit cost ratio – 3.9

4.5.5 Internal GiWH

We have discussed the impact of the proposed regulation with all suppliers of internal GiWH with less than 5 stars. We understand that there is only one group of products on the market that may need to be upgraded and that upgrades are expected to be complete before the end of the transition period. There will be no significant impact on this market.

4.6 Baseline estimates of nationwide impacts

Table 4.4 summarises the findings that are reported in sections 4.2 to 4.5. The net present value is $128.8 million and the benefit-cost ratio is 2.5.

The cost-benefit ratio is best understood in terms of the shares of running cost and capital cost in the whole of life cost of a water heater. As discussed in section 1.5, a typical split is 74%: 26%, with energy costs having the larger share. This means that a 15% reduction in energy use will reduce the whole of life cost by about 11.1% (= 15% * 74%), and a 15% increase in the purchase price will increase the whole of life cost by about 3.9% (= 15% * 26%). This is the essence of the baseline estimate and suggests that the whole of life cost is reduced by 7.2% (= 11.1% - 3.9%) and that the benefit-cost ratio is about 2.8 (= 11.1% / 3.9%). This ratio is reduced to 2.5 as a result of various fixed costs of program development and higher costs of increasing efficiency in niche markets.

TABLE 4.4 SUMMARY STATEMENT OF NATIONWIDE IMPACTS

Number of GWH upgraded to 5 stars (million)	0.87
Energy use - PJ	-34.5
Greenhouse emissions (Mt CO_2-e)	-2.31
Undiscounted dollar amounts ($M)	
cost to the taxpayer	+0.41
business compliance costs	+0.79
incremental cost of heaters	+134.5
household expenditure on energy	-488.1
Present values ($M), discount rate = 7.5%	
cost to the taxpayer	+0.37
business compliance costs	+0.66
incremental cost of heaters	+83.9
household expenditure on energy	-213.7
Investment analysis	
total benefits ($M)	213.7
total costs ($M)	84.9
net present value ($M)	128.8
benefit-cost ratio	2.5

Given the assumptions underlying the baseline estimates, the proposals easily meet the criteria that measures should contribute significantly to greenhouse abatement without imposing a significant financial cost on the community.

4.7 Sensitivity analysis

The sensitivity analysis is organised under two headings, dealing separately with factors that alter the nationwide impacts and with factors that determine the impact on individual households. A particular outcome for the average household, at the national level, can hide considerable variation between households.

4.7.1 Sensitivity of nationwide estimates

Table 4.5 reports the sensitivity analysis and includes explanatory notes. It reflects our assessment that the most significant uncertainties relate to developments in the market share of GsWH with less than 3 stars, and the cost of upgrading these units to 5 stars.

Sensitivity analysis of the nationwide estimates indicates that the findings are robust. The benefit-cost ratio remains above 2.0 under reasonable alternative settings of the key variables.

4.7.2 Variable impact on individual households

Whatever the uncertainty about nationwide impacts, the impacts on individual households are certainly variable. Table 4.6 reports variations in the dominant market segment, which is for external GsWH with 135L or 170L of storage. Impacts in individual households are shown to depend on water consumption, the heating task and the price of energy. (Note that table 4.6 includes a restatement of the nationwide average, but with a benefit-cost ratio of 2.6. This is the outcome for a typical user in this market segment, ignoring the fixed costs of the program and the less favourable outcomes for minority market segments.)

Water consumption
Energy savings increase and decrease with the amount of water that is used, but not proportionally[23]. For example, a plausible outcome is that a 50% reduction relative to the test condition[24], would reduce energy savings by 33%. Conversely, a 50% increase in water use, to 300L/day, would increase energy savings by 33%. This estimate has been inferred from the formula used to calculate annual energy use for labelling purposes[25]. The impact is sensitive to this parameter but the assessment remains positive – see the third panel of table 4.6

Heating task
The heating task is the increase in temperature – from 'cold' to 'hot' – that the heater is required to deliver. It is set at 45^{o}C in the calculation of annual energy use that is employed for labelling purposes. For example, the heating task may be to raise the water temperature from 15^{o}C to 60^{o}C, or from 20^{o}C to 65^{o}C. However, the typical task varies with the climate, and some types of appliance allow users to vary the heating task by resetting the target temperature to a higher or lower level[26].

[23] The less than proportionate impact is because there are fixed costs of maintaining the temperature of the stored water when the heater is not in active use, regardless of the amount of hot water that is drawn.
[24] The energy used by water heaters is measured under conditions where 200L of water are drawn daily. The 50% variation reported in table 4.6 is down to 100L/day and up to 300L/day.
[25] Specifically, the relationship is obtained by taking the baseline model used as a reference appliance for labelling purposes (with thermal efficiency of 70% and a maintenance rate of 1.14 MJ/day) and varying the daily rate of water use that is used in the formula for calculating annual energy consumption (part B51.7.4 of AS 4552-2005).
[26] The effect is to squeeze more hot water from a heater that is too small for the household's needs, or to reduce wastage from a heater that is too large.

TABLE 4.5 SENSITIVITY ANALYSIS OF THE NATIONWIDE IMPACTS

	Upgraded GWH (million)	*Energy use - PJ*	*Greenhouse abatement (Mt CO_2-e)*	*Total financial benefits ($M)*	*Total financial costs ($M)*	*Net present value ($M)*	*Benefit-cost ratio*
Baseline	0.87	-34.5	-2.31	213.7	84.9	128.8	2.52
Market share of GsWH with less than 5 stars The baseline assumption is that, at the end of the period under consideration, 0.87 million GWH with less than 5 stars will be affected by the measures, comprising 22.6% of GWH sold in the period 2008 to 2020. The alternative scenarios are that the measures affect 10% or 30% of GWH sales in the period to 2020, corresponding to 'low' and 'high' expectations for sales of GsWH with less than 5 stars.							
10% of GWH	0.38	-14.2	-0.95	84.0	34.9	49.1	2.41
30% of GWH	1.15	-46.3	-3.11	289.3	114.1	175.2	2.54
Price of energy or amount of energy saved The baseline assumes an average energy price is 1.38 cents/MJ and that, on average, the energy consumed under standard test conditions is a reasonable measure of the energy consumed under operating conditions. There is high confidence in the price but less confidence in the estimate of the energy savings, reflecting uncertainty about average water consumption and other factors. The downside test of -10% is a reasonable allowance.							
minus 10%	0.87	-34.5	-2.31	192.4	84.9	107.4	2.26
plus 10%	0.87	-34.5	-2.31	235.1	84.9	150.2	2.77
Incremental cost of 5 star GsWH The baseline assumption is that the percentage price increase is equal to the % increase in energy efficiency (15%) and is $157 for typical 135L and 170L units. We consider that this is a conservative assumption and have tested asymmetrically, up by 25% and down by 50%.							
plus 25%	0.87	-34.5	-2.31	213.7	105.1	108.7	2.03
minus 50%	0.87	-34.5	-2.31	213.7	44.7	169.1	4.78
Divergent trends in energy and capital costs The baseline assumptions are that the real prices of both energy and water heaters remain constant. An alternative scenario is that real energy costs increase as global warming is addressed, and that real manufacturing costs continue to decline.							
Energy costs up 1%/yr, heater costs down by 0.5%/yr.	0.87	-34.5	-2.31	236.3	80.3	156.0	2.94
One year delay The baseline assumption is that the measures will be implemented from October 2008.							
Implementation in Oct 2009	0.79	-31.2	-2.09	185.8	74.2	111.7	2.51
Discount rate The baseline discount rate is 7.5%							
0%	0.87	-34.5	-2.31	488.1	135.7	352.4	3.60
5%	0.87	-34.5	-2.31	276.1	98.3	177.8	2.81
10%	0.87	-34.5	-2.31	168.3	74.1	94.3	2.27

TABLE 4.6 SENSITIVE ANALYSIS OF IMPACTS ON INDIVIDUAL HOUSEHOLDS

	Capital cost ($)	*Whole of life energy cost ($)*	*Net effect ($)*	*Benefit cost ratio*
Nationwide average household, using externally installed 135L or 170L GsWH	+157	-406	-249	2.6
Water consumption				
water consumption reduced by 50%	+157	-272	-115	1.7
water consumption increased by 50%	+157	-540	-383	3.4
Heating task				
minus 10%	+157	-380	-223	2.4
plus 10%	+157	-432	-275	2.8
Price of energy				
LPG – 2.5 cents/MJ	+157	-734	-577	4.7
Natural gas				
NSW - 1.48 cents/MJ	+157	-435	-278	2.8
VIC – 1.0 cents/MJ	+157	-293	-136	1.9
QLD - 2.02 cents/MJ	+157	-592	-435	3.8
SA - 1.43 cents/MJ	+157	-420	-263	2.7
WA - 1.41 cents/MJ	+157	-413	-256	2.6
TAS - 1.53 cents/MJ	+157	-450	-293	2.9
NT - 1.43 cents/MJ	+157	-419	-262	2.7
ACT - 1.43 cents/MJ	+157	-420	-263	2.7

The base temperature of cold water is a further source of variation in the heating task. Based in data provided in the Australian standard for solar water heaters[27], there is a 10^{o}C difference in the average cold water temperatures of zone 1 (North and North East Australia) and zone 4 (Southern Victoria and Tasmania). Other sources of variation in the heating task are not well understood.

On this evidence, it is sensible to test in the range +/- 5^{o}C around the assumed figure of 45^{o}C. This has a less than proportional impact on energy savings and causes little variation in the benefit-cost ratio.

Regional variation in the price of energy

Marginal gas tariffs vary between states, resulting in considerable inter-state variation in the value of energy savings. Only in Victoria is the benefit-cost ratio lower than the Australian average. It has the cheapest gas and the least to gain.

The returns are positive for the average householder in all jurisdictions – see the last panel in table 4.6.

Minority market segments

Finally, suppliers are reminded that section 4.5 reported on a number of niche and declining markets, mainly for internal GWH, where the outcomes are less favourable and there is some uncertainty about the eventual availability of 5 star appliances. Our baseline estimates for average outcomes for customers in these market segments are:

- Internal GsWH, 90L storage: net financial benefit – $41: benefit-cost ratio – 1.2
- Internal GsWH, gravity feed type: net financial benefit – $0: benefit-cost ratio – 1.0
- Internal GsWH, mains pressure type: net financial benefit – $0: benefit-cost ratio – 1.0

[27] AS 3424-1994 *Solar water heaters – Domestic and heat pump – Calculation of energy consumption*

5 Impact analysis - New Zealand

This chapter reports the impact analysis for New Zealand. There are major differences between New Zealand and Australia that are not just a matter of relative size. Important differences are that the market share of GWH with less than 5 stars is much lower in New Zealand and a much higher proportion of the less efficient units are installed internally.

5.1 Market profile

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 over the period 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 2 units and 1% having three units. However not all systems were operational and many of the multiple installations were combinations 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 also relevant in the present context:

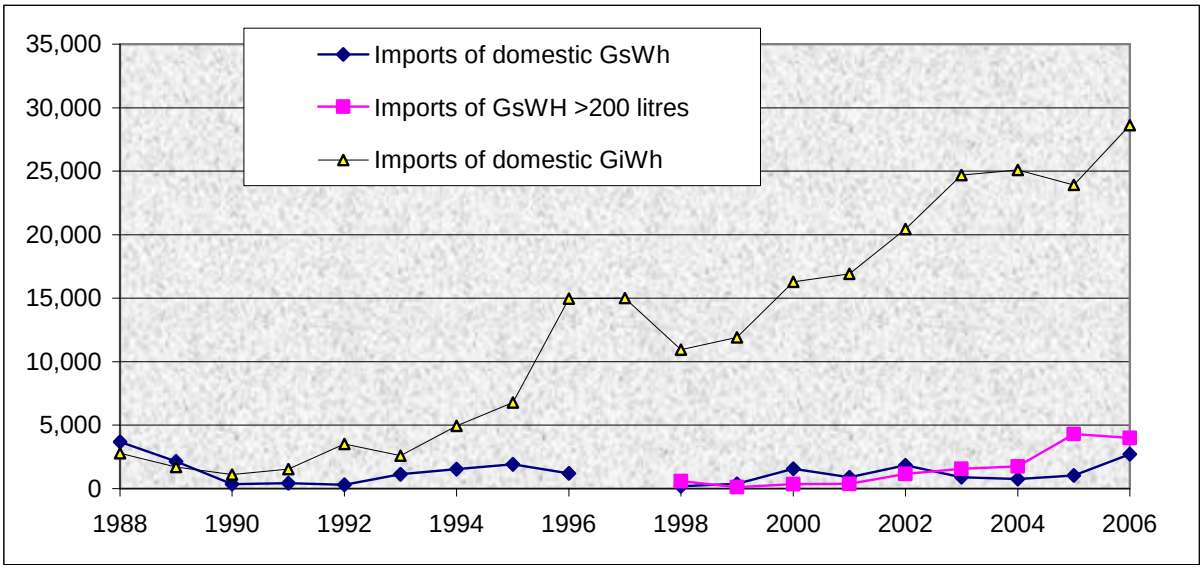
- Of households with hot water cylinders, including both gas and electric, 91% were installed internally and 80% were in a cupboard inside the house. All of the standing heat losses from internal cylinders contribute to house winter space heating and this was found to be considerable proportion in some 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 185 litres of storage. The sample includes only 2 units outside this range and 2 units where storage capacity could not be determined. The outliers comprised 1 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 185 litres of storage is 60:40 in favour of the smaller unit.
- 40% of the GsWH were low pressure units and correlate with the use of bottled gas. The combination of low pressure and installation in a cupboard is achieved by installing a feeder tank that in the roof 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% per year in the period 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 last 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 per year. This means that the import data tell the story – see figure 5.1. 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 currently installed in New Zealand homes. This represents market penetration of about 17%, somewhat higher than the 13% that HEEP recorded for the period 1995 to 2005.

FIGURE 5.1 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' prior to 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 5.2 presents our baseline projection for GWH penetration and sales. It envisages that penetration will continue to grow but at a decreasing rate and that penetration will increase from about 17% at the present time to about 27% in 2020. This is consistent with a modest further increase in sales, stabilising at 36,000 to 37,000 per year.

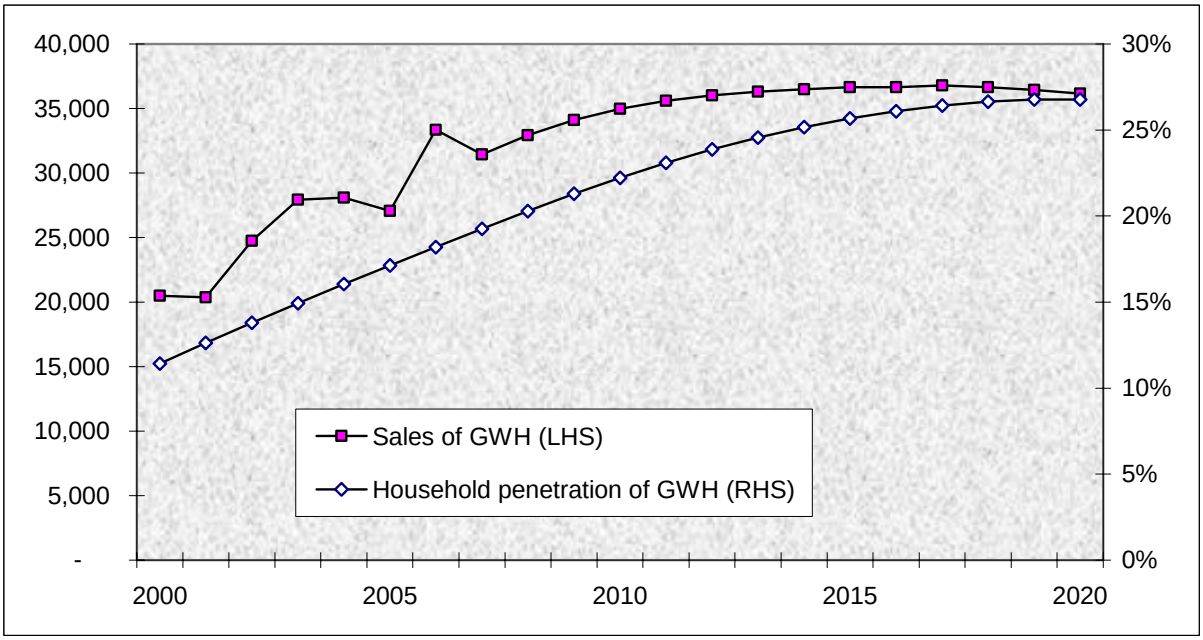
This projection may be conservative. New Zealand gas interests say that there is considerable scope to further increase mains gas take-up by households that already have access to gas, and that the residential market for LPG will grow at 10% per year (GANZ 2007: page 12). In a report on alternatives to augmentation of electricity supplies, SKM (2004: page 24) report that mains gas take-up by households with access to gas is 40% in Auckland and 70% in Wellington.

The outlook may become clearer when the New Zealand Government finalises its energy strategy. A draft strategy was published in December 2006 and is currently being finalised.

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 are projected to retain 50% of the market in 2020. An important difference between the two markets is that GsWH are manufactured on a much larger scale in Australia. GsWH are bulky items and suffer a significant cost disadvantage as imported goods. The GsWH that are manufactured in New Zealand – about 2,000 internal GsWH per year – remain strongly competitive in their niche market. It appears that only 10-20 internal GsWH are imported to New Zealand each year.

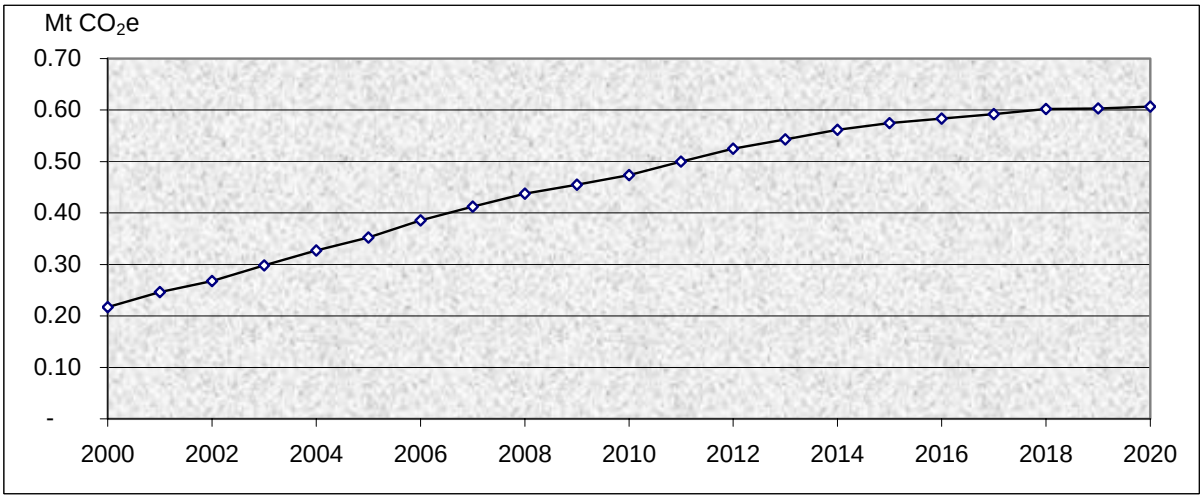
FIGURE 5.2 BASELINE PROJECTION FOR GWH PENETRATION AND SALES



5.2 Impact on greenhouse emissions

Figure 5.3 reports estimates of the expected increase in greenhouse emissions under BAU conditions. They increase by 118% in the decade to 2010 and by a further 28% in the decade to 2020. This is somewhat slower than the corresponding increases in the installed stock of GsWH – at 119% and 34% respectively – and reflects the improvements in average efficiency that are expected under BAU conditions.

FIGURE 5.3 BAU SCENARIO FOR GREENHOUSE EMISSIONS



Emissions are estimated to reach 0.47MT CO_2e in 2010, which is the mid-point of the first commitment period under the Kyoto Protocol. This is 0.6% of the forecast for total New Zealand emissions in 2010, which is 83.9Mt (Ministry for the Environment 2006: page 91).

This projection incorporates our assessment of the relative importance and energy efficiency of products in various sub-markets. This is a little more difficult in New Zealand than in Australia, since the energy efficiency of GWH is neither regulated nor publicly disclosed in New Zealand. However suppliers are required to make a declaration that appliances comply with safety regulations and declared appliances are listed on the web site of Safety New Zealand. It is assumed that these declarations provide a comprehensive listing of products sold in New Zealand. Our assessment of energy efficiency was then informed by an exercise in matching New Zealand's declared products with the products listed in AGA's *Product Directory*, which provides the energy ratings. We also consulted with individual suppliers of unmatched products. We understand the situation as follows:

- External GsWH: 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 last 5 years and suppliers have indicated that less than 100 of these would have less than 5 stars. The baseline scenario is for the sale of 10,000 external GsWH in the period to 2020, 700 of which will be at less than 5 stars.
- Internal GsWH: The relatively few appliances that are imported from Australia – no more than 10-20 per year – have ratings of about 3 stars. The remainder are manufactured in New Zealand and have not been energy tested. But the supplier believes that they would also be rated at about 3 stars. The baseline scenario is for the sale of 15,000 of these units in the period to 2020.
- External GiWH: 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 has annual sales of about 200 units that are imported from China. They have not been energy tested. The baseline scenario is that 0.5% of total GiWH sales are of the external type with less than 5 stars, which is the same proportion as for Australia. This is about 700 units over the period to 2020.
- Internal GiWH: The major suppliers are the same for New Zealand and Australia, as is the product range. As for Australia, the baseline scenario is that normal processes of model renewal will remove the one product with less than 5 stars before the end of the transition period. There will be no significant impact on customers for these products.

In summary, the BAU scenario is that 16,400 GWH with less than 5 stars would be sold in the period to 2020, comprising 15,000 internal GsWH, 700 external GsWH and 700 external GiWH.

Impact of the proposed measures on greenhouse emissions
We estimate that the replacement of these 16,400 units with 5 star appliances would reduce total emissions over the period to 2020 by 0.07MT CO_2e, from 7.04MT to 6.97MT. This is a reduction of 1% and is commensurate with the small proportion of GWH sales that will be less than 5 stars.

5.3 Financial impact of the proposal

This section is organised to give an account of what is currently known about the financial impact of the proposed measures on the various sub-markets for products will less than 5 stars, then draw conclusions.

Business compliance costs
New Zealand does not require compliance with AS 4552 at the present time. However, inspection of the declared appliances list (Safety New Zealand web site) indicates that the vast majority of new products do comply with AS 4552 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 and a range of external GsWH that are currently imported to New Zealand from the Untied States. Neither of these products is sold in Australia or is certified in Australia.

This suggests that, with these two exceptions, the incremental business compliance costs for joint suppliers to the New Zealand and Australian markets would be minimal.

The New Zealand manufacturer would incur testing costs to demonstrate compliance with AS 4552 but may avoid the certification costs, depending on whether New Zealand adopts the certification regime that operates in Australia. The testing would probably need to be conducted in an Australian laboratory and, allowing for transport costs, the incremental costs would be about $NZ20,000.

The additional compliance costs may be prohibitive for the smaller importers, since the expense of $NZ20,000 would need to be recovered from sales that seem to be in the range 10-20 per year. Our research indicates that there may be one such importer of GsWH.

External GsWH imported from Australia
External GsWH with 5 star ratings are already sold in New Zealand and the effect of the proposal would be to shift 700 sales from the 3 star segment to the 5 star segment. This seems is financially attractive. The impact on this market segment can then be stated as follows:

Impact on average customer

- Incremental cost of appliance – $NZ350
- Energy savings – 3,860 MJ/year
- Value of energy savings – $NZ97/year
- Present value of energy savings – $NZ689 (asset life of 13 years, discount rate of 10%)
- Net financial benefit – $NZ339
- Benefit cost ratio – 1.97

Aggregate impact

- Additional sales of 5 star units to 2020 – 700 units
- Incremental compliance costs - nil
- Present value of incremental appliance cost – $NZ174,468
- Present value of energy savings – $NZ343,670
- Net financial benefit – $NZ169,202
- Benefit cost ratio – 1.97

This is essentially the calculation provided for the corresponding Australian case but adjusted for New Zealand prices. The incremental cost is that nominated by the major supplier of these products, which is Rheem NZ. The marginal gas tariff is that charged by Vector, which has prices that are comparable to the estimate of average NZ prices

published by the Ministry of Economic Development [28]. The discount rate is that prescribed by New Zealand Treasury, 10%.

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 pipework for water and gas that can add $NZ1,500-$NZ2,500 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 $NZ200 to the cost.
- The incremental cost of upgrading the local product would be quite high. Price differentials in the market for external GsWH suggest that the increase would be of the order of $NZ300-400, 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[29]. 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 $NZ20,000.

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
As discussed in chapter 4, there seems to be significant commercial incentives for Australian manufacturers to develop internal GsWH with 5 star ratings, largely because the alternative means of responding to a 5 star MEPS are unattractive. But it remains an uncertain prospect.

The very few sales to New Zealand, 10-20/year, would not influence the decision, which means that the consequences for New Zealand customers depend entirely on commercial decisions taken in Australia. 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.

External GiWH
External GiWH with 5 star ratings are already sold in New Zealand and the effect of the proposal would be to shift 700 sales from the 3 star segment to the 5 star segment. This is financially attractive. The impact on this market segment can then be stated as follows:

Impact on average customer

[28] http://www.med.govt.nz/upload/35306/20060301.pdf
[29] 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.

- Incremental cost of appliance – $NZ100
- Energy savings – 1,012 MJ/year (transition), 2,023 MJ/year (full)
- Value of energy savings – $NZ26.68/year (transition), $NZ53.33/year (full)
- Present value of energy savings – $NZ190/year (transition), $NZ379/year (full)
- Net financial benefit – $NZ155/year (transition), $NZ344/year (full)
- Benefit cost ratio – 1.9 (transition), 3.8 (full)

Aggregate impact

- Additional sales of 5 star units to 2020 – 700 units
- Incremental compliance costs - nil
- Present value of incremental appliance cost – $49,848
- Present value of energy savings – $146,841
- Net financial cost – $96,993
- Benefit cost ratio – 3.0

Again, this is essentially the calculation provided for the corresponding Australian case but adjusted for New Zealand prices. The distinction between the impacts during the transition period and after full implementation is because the replacement product will itself be upgraded as the measures are implemented.

Conclusion

The financial impact on New Zealand is the sum of (a) two small positive amounts associated with external GWH, with a combined net present value about $250,000, (b) a very small amount associated with internal GsWH imported from Australia, and possibly not much different from zero, and (c) a highly uncertain outcome associated with internal GsWH manufactured in New Zealand, but which may be significantly negative.

6 Consultation

This chapter explains the industry consultations relating to the broad strategies for improving the efficiency of gas appliances (section 6.1), and subsequent consultations relating specifically to MEPS for GWH (6.2)

6.1 Consultations relating to gas program strategy

For historical reasons, energy efficiency programs for gas appliances have always been administered by the industry body, AGA. Since 2002, however, AGO 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, SEAV, 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 release 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 programme 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 Consultations relating to MEPS for GWH

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, progress on the new test methods has been slower than expected and it is now appears that they cannot be finalised before mid 2008. This reassessment is in the light of a round-robin of tests that revealed unacceptable differences in the results from different laboratories. The standards committee had reviewed the issues at the time of writing (June 2007) and was awaiting the results of further laboratory investigations and new proposals that will be developed in the light of those results.

It was in this context that, at a GAMAA conference in Melbourne on 30th August 2006, the E3 Program proposed to suppliers that they voluntarily retire the least efficient water heaters from the market. The E3 Program subsequently commissioned a preliminary cost-benefit analysis of feasible measures to retire the least efficient units (Syneca 2006), and offered to provide funding for 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.

The E3 Program subsequently formulated the 5 star MEPS proposal and commissioned this cost-benefit analysis. Preliminary results were presented to an industry meeting on 14 May 2007 in the Melbourne offices of Standards Australia. There has since been significant further work to assess impacts on a number of niche and declining markets, mainly to replace GsWH that have been installed internally.

7 Conclusion and recommended option

7.1 Assessment

The primary assessment criteria are that the measures deliver the maximum reduction in energy use and greenhouse emissions, but subject to the constraint that the average lifetime cost of hot water services is not increased. Tables 7.1 and 7.2 report our assessment against these criteria and various secondary criteria, for Australia and New Zealand respectively.

TABLE 7.1 ASSESSMENT SUMMARY - AUSTRALIA

Objective	*Assessment*
Do the measures reduce greenhouse emissions?	It is expected that the measures will reduce greenhouse emissions by 2.3 Mt CO_2-e. This is the result of a 15% reduction in the energy consumed by 0.87 million GWH. These are the projected sales of the least efficient (3 & 4 star) of the current range of GWH, in the period 2009 to 2020.
Do the measures reduce the lifecycle cost of appliances?	The measures will deliver a significant reduction in the average lifecycle cost of these GWH. In present value terms, the lifecycle cost will be reduced by $128.8 million, comprising $213.7 million in energy savings, offset by equipment and program costs of $84.8 million. The benefit-cost ratio is 2.5.
Do the measures address market and regulatory failures?	The measures address significant failures in the market for GsWH. 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.
Does the option minimise negative impacts on product quality and function?	There are several issues of product quality and function. First, GsWH 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 (90L) GsWH or certain internally installed GsWH. The combined sales are currently about 5% of the market and declining. Subject to further submissions from suppliers, it is assumed that the financial impacts on these households will be neutral at worst.
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 machinery of Standards Australia that is familiar to industry, and the technical details are being developed in close consultation with industry, aiming to finalise in mid 2008.

TABLE 7.2 ASSESSMENT SUMMARY – NEW ZEALAND

Objective	*Assessment*
Do the measures reduce greenhouse emissions?	It is expected that the measures would reduce greenhouse emissions by 0.07 Mt CO_2-e. This is the result of a 15% reduction in the energy consumed by 16,400 GWH. These are the projected sales of the least efficient (3 & 4 star) of the current range of GWH, in the period 2009 to 2020.
Do the measures reduce the lifecycle cost of appliances?	The financial impact on New Zealand is uncertain. It may be significantly negative and, if positive, cannot be large. It is the sum of (a) two small positive amounts associated with external GWH, with a combined net present value about $250,000, (b) a very small amount associated with internal GsWH imported from Australia, and possibly not much different from zero, and (c) a highly uncertain outcome associated with internal GsWH manufactured in New Zealand, but which may be significantly negative. The latter account for 15,000 of the 16,400 GWH that would otherwise be sold with less than 5 stars.
Do the measures address market and regulatory failures?	The measures address significant failures in the market for GsWH. 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.
Does the option minimise negative impacts on product quality and function?	There one major issue of product quality and function, associated with internal GsWH manufactured in New Zealand. These can contribute significantly to space heating, raising the cost of space heating if replaced with external units.
Do the measures minimise adverse effects on suppliers?	The impacts on the New Zealand manufacturer of GWH are not yet fully understood.

7.2 Conclusions

We conclude that the proposed measures will meet the assessment criteria and that the E3 Program can proceed to develop the measures with a high degree of confidence that the objectives will be achieved.

7.3 Recommendations

It is recommended that the measures be developed expeditiously, aiming to publish revised methods of test in a new energy efficiency standard (replacing parts of AS 4552), two or three months before the measures are implemented in October 2008.

There should be early consideration of options to moderate impacts on customers in niche and declining markets who are currently without replacement options at the 5 star level.

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 time 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 3 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 on a case-by-case basis.

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 NT. Otherwise, however, the review process uses a parliamentary secretariat to raise issues and solicit public comment.

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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 of the order of $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	State variation to Building Code of Australia: Where gas is available, acceptable construction practice for new houses is to install: (a) 2.5 star GWH (b) heat pump or solar HWS achieving at least 22 RECs for 3+ bedrooms or 14 RECs for 1 or 2 bedrooms	None
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: REVIEW OF HISTORICAL TRENDS AND PROJECTIONS FOR GAS AND GWH PENETRATION

This review is based on the analysis of three sets of publications:

- Demand analyses that have been published by the competition regulators[30] in the various states. McLennan Magasanik Associates (MMA) undertook the analyses for Queensland, NSW, SA and ACT. That work is fairly current, having been completed in 2005 or 2006 and covers the period to 2010 or 2011.
- ABS Cat 4602.0 *Environmental issues*, 1994, 1999, 2002 and 2005. These provide survey-based estimates of household energy sources and types of water heater. The collections are not entirely consistent and we focused mainly on the 1994 and 2005 results.
- BIS Shrapnel's biennial review of the appliance market, *The Household Appliances Market in Australia*, 2004 and 2006.

There is considerable potential for statistical confusion. The following concepts have been employed where possible.

1. Network coverage – proportion of households with access to mains gas
2. Mains gas take-up – proportion of households with gas access that are gas customers
3. Mains gas penetration – proportion of households that are mains gas customers (= 1*2)
4. GWH penetration of mains gas customers – proportion of mains gas customers with GWH
5. Mains GWH penetration of all households – proportion of households with mains GWH (= 1*2*4)

Queensland

Penetration of mains gas and mains-fuelled GWH

There are four gas distribution networks in Queensland:

- Envestra reticulates Ipswich and the Brisbane suburbs north of the Brisbane River (Brisbane Region), plus Rockhampton and Gladstone (Northern Region). 90% of the network is in metropolitan Brisbane. Total residential connections in 2005 were 69,913.
- Australian Pipeline Trust reticulates the southern part of Brisbane, Gold Coast, Toowoomba and Oakey. Some NSW towns near the Queensland border, such as Tweed Heads, are also served by the network. Under cross-vesting arrangements between the jurisdictions, the Queensland regulator determines the access arrangements for the entire network. Total residential connections in 2005 were 61,517.
- The Dalby Town Council operates a network that currently serves about 2,500 natural and LPG consumers.
- The Roma Town Council operates a network the serves a total of 295 customers.

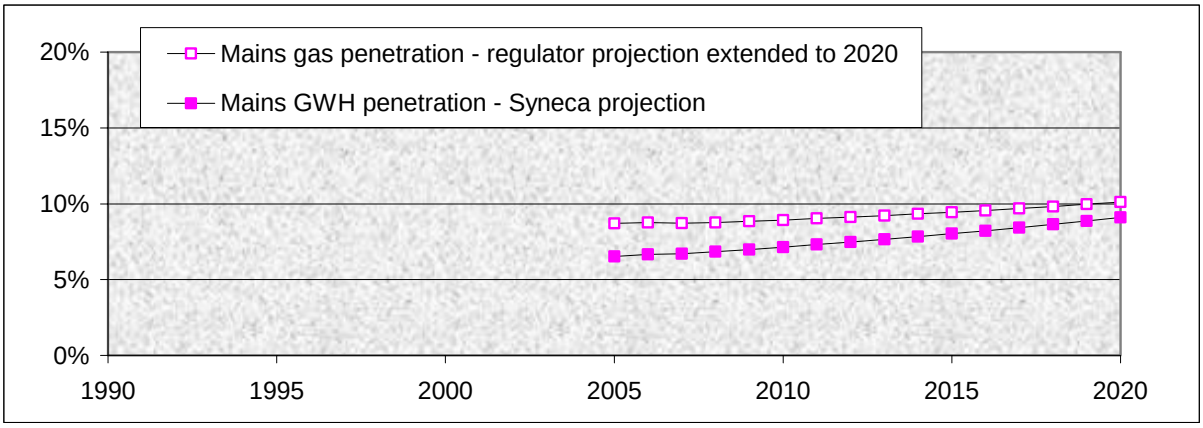
In 2005 these network companies reported a total of about 135,000 residential connections to Queensland's competition regulator, which is significantly lower than the ABS estimate of 189,400. We consider it is best to assume that there are significant errors in the ABS survey and to rely on the demand analyses published by the regulator, supplemented with

[30] Competition regulators determine network charges in the light of demand forecasts: higher demand improves the scale economies of network operations and reduces charges.

informal advice from the Queensland Department of Mines and Energy. These sources indicate that, in 2005, mains gas penetration is 9% in 2005 and GWH penetration of mains gas customers is 75%[31]. This means that mains GWH penetration of Queensland households is only about 6.5%.

Figure B.1 reports our baseline projection to 2020. There is a modest increase in mains gas penetration, to 10%, assuming that the rates of customer growth envisaged by the regulator in the period to 2011 are maintained to 2020. There is more rapid growth of mains GWH penetration, from 6.5% to 9%, assuming a significant increase in GWH penetration of mains gas customers.

Figure B.1 Gas and GWH penetration of Queensland households, projected to 2020 (mains gas only)



Mains gas take-up seems to be in the range 40%-50%, indicating that there is potential for gas penetration to increase at a faster rate, carrying mains GWH penetration with it. In new housing estates, MMA (2005a: page 15) reports that Envestra achieves 45% take-up; Allgas requires that the great majority of houses have gas cookers and water heaters. As noted in appendix A, take-up on new housing estates has been boosted by Queensland's new sustainable housing measures, and there is obviously an intention to increase take-up by established dwellings as electric HWS fall due for replacement. The 1994 ABS survey also asked questions about access to mains gas and take-up of mains gas, and the responses suggest that there is take-up by 30%-60% of households with access to mains gas. (The uncertainty is because a significant minority of respondents did not know whether they had access to gas.)

The projected increase in GWH penetration of mains gas customers, closing the gap between mains gas penetration and mains GWH penetration as projected in figure B.1, is based on the economics of gas connection in warm climates with no significant demand for gas-fuelled space heating. As explained in recent reports to the Queensland regulator (MMA 2005a & 2005b), the remaining uses are cooking and water heating, using 2 GJ/year and 9-15 GJ/year respectively, and it is difficult to justify connection for cooking only. MMA reports that:

> *Both Allgas and Envestra have stated that they try to restrict new residential customer connections to those where customers connect, at a minimum, both hot water and cooking gas appliances. Without connection to a hot water system the required returns for new connections are unlikely to be met.* (MMA 2005a: page 16)

[31] Informal advice from the Queensland Department of Mines and Energy is that there are **<<xxx>>** mains gas customers that use it only for cooking, out of a total of 135,000.

The Department of Mines and Energy has identified cooking-only customers as prime targets for installation of GWH, taking advantage of their low marginal cost of incremental gas usage.

Bottled LPG in Queensland
ABS surveys indicate that, while there is moderate growth in the use of LPG, the number of LPG-fuelled GWH is static at about 60,000. This is about 4% of households and, when combined with our estimate of mains GWH penetration, takes total GWH penetration to about 10.5% of Queensland households. This figure is considerably lower than the BIS Shrapnel estimate of 14% for total GWH penetration. This raises the possibility that the ABS has significantly underestimated the number of LPG-fuelled GWH. We have adopted the ABS estimate nevertheless and assume that the number of LPG-fuelled GWH remains static at 60,000.

Market segments
BIS Shrapnel estimate that market penetration is split 50:50 between GsWH and GiWH.

NSW and ACT
Penetration of mains gas and mains-fuelled GWH
Excluding networks that have been cross-vested to the Queensland or Victorian regulators, there are currently four distribution networks in NSW and the ACT

- AGL Gas Network (AGLGN) – Sydney, Wollongong, Newcastle and a number of regional centres in the Central West. Total residential connections in 2005 were 930,758.
- ActewAGL - Queanbeyan and the Shoalhaven. Total residential connections in 2005 were 98,551.
- Country Energy Gas - Wagga Wagga and surrounding areas, and South West Slopes. Total residential connections in 2005 were about 17,500.
- Central Ranges Pipeline Gas Network - This network is under construction and is eventually intended to cover the towns of Tamworth, Gunnedah, Mudgee, Dunedoo, Coolah, Gulgong, Quirindi, Werris Creek, Coonabarabran and Gilgandra. The Tamworth system (250 km of reticulation pipeline) will be complete by end 2007 but there are, as yet, no firm plans for the rest of the network. It is anticipated residential connections in Tamworth will eventually reach 7,500.

In 2005 these network companies reported a total of about 1,047,000 residential connections to the NSW and ACT regulators, which is somewhat higher than the ABS estimate of 996,500, and would be higher still if the cross-vested gas customers were included.

ABS surveys indicate that, in 1994, gas and GWH penetration in NSW and the ACT could be described as follows: network coverage was 50-55%: mains gas take-up was 50-55%; and GWH penetration of mains gas customers was 65%. The result was that 19% of all households had installed GWH. The latter figure increased to 25% in the period to 2005 and, while there is some uncertainty about the underlying drivers[32], the results of an IPART-commissioned survey (IPART 2004) suggest that the main factor has been an increase in gas take-up. Regarding the other two factors:

- There seems to have been little change in GWH penetration of mains gas customers. An IPART-commissioned survey (IPART 2004) found that 70% of NSW mains gas customers had installed GWH in 2003, compared with the ABS estimate of 67% in 1994.

[32] There is uncertainty because information about access to mains gas was not collected in the post-1994 ABS surveys.

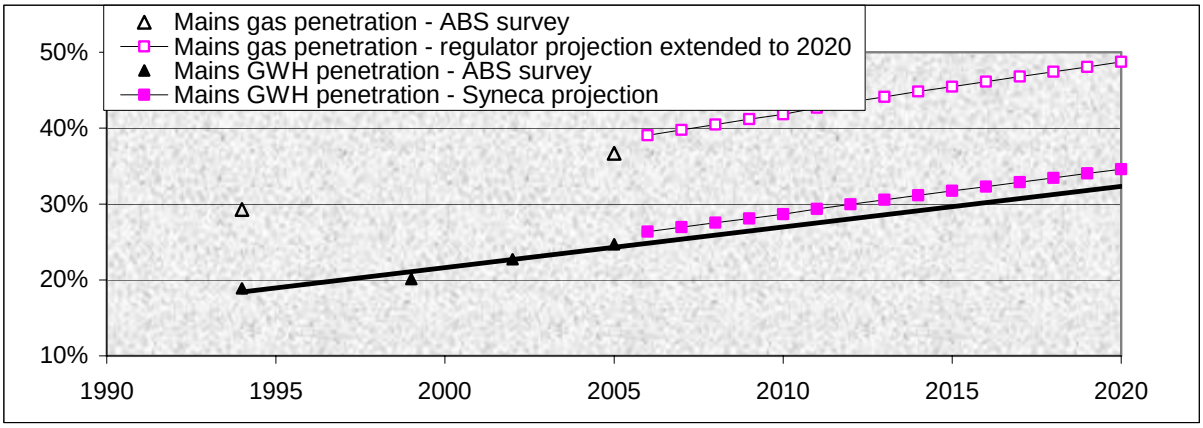
- While the gas network has been extended, it seems that network coverage did not change significantly. An obvious consideration is the amount of construction in coastal areas, outside the major urban areas with access to gas.

These averages hide considerable geographical variation within NSW and ACT. The 'Queensland model' is likely to apply in temperate coastal areas, that is, where the demand for gas-fired space heating is minimal and connection to gas makes little sense if GWH is not installed. Mains gas penetration tends to be relatively low in such circumstances but GWH penetration of mains gas customers can approach 100%. The growth of GWH penetration is then largely dictated by the growth of mains gas penetration.

Locations like Canberra and the Blue Mountains, with cold winters, present a different picture. They can have relatively high gas take-up, but relatively low GWH penetration of mains gas customers. In the ACT for example, network coverage was 90-95% in 2005; gas take-up was about 75%; and GWH penetration of mains gas customers was 60%. The result is that gas penetration of all households was only 42%, suggesting that there is considerable scope for increased GWH penetration in areas where gas is well established.

Figure B.2 reports our baseline projection to 2020. It assumes that mains gas penetration continues to grow strongly, carrying mains GWH penetration with it. There is also a small contribution from increasing GWH penetration of mains gas customers, rising from 67% in 2005 to 71% in 2020. The combined effect is to lift mains GWH penetration of all households from 26% to 35%. These projections are a continuation of the historical trends revealed by ABS surveys, but adjusted for the difference in the number of mains gas customers.

Figure B.2 Gas and GWH penetration of NSW and ACT households, projected to 2020 (mains gas only)



Bottled LPG in NSW and ACT

ABS surveys indicate that, while there is moderate growth in the use of LPG as a residential fuel, the number of LPG-fuelled GWH has been reasonably static, and now stands at about 1% of households. Our baseline assumption is that the number of LPG-fuelled GWH remains constant at 27,500, which is the average of the ABS survey estimates for 1994 and 2005.

The inclusion of LPG-fuelled GWH takes our estimate of total GWH penetration to about 27% of NSW and ACT households. The BIS Shrapnel estimate is a little higher, at 31%.

Market segments

BIS Shrapnel estimate that market penetration is split 55:45 between GsWH and GiWH.

Victoria

Penetration of mains gas and mains-fuelled GWH

Including networks that have been cross-vested to Victoria by the NSW regulator, there are currently three network operators in Victoria – Envestra, Multinet and SPI. Each has a share of the major metropolitan markets, Melbourne and Geelong. Envestra also reticulates the Eastern Rural and Central Rural. SPI also reticulates the Ballarat, Bendigo and Western Rural areas.
Total residential connections in 2005 were: Envestra, 494,025; Multinet, 618,000; SPI, 489,936. This is a total of about 1,582,000 residential connections, which is close the ABS estimate of 1,552,300, and may be closer still if cross-vested gas customers were excluded.

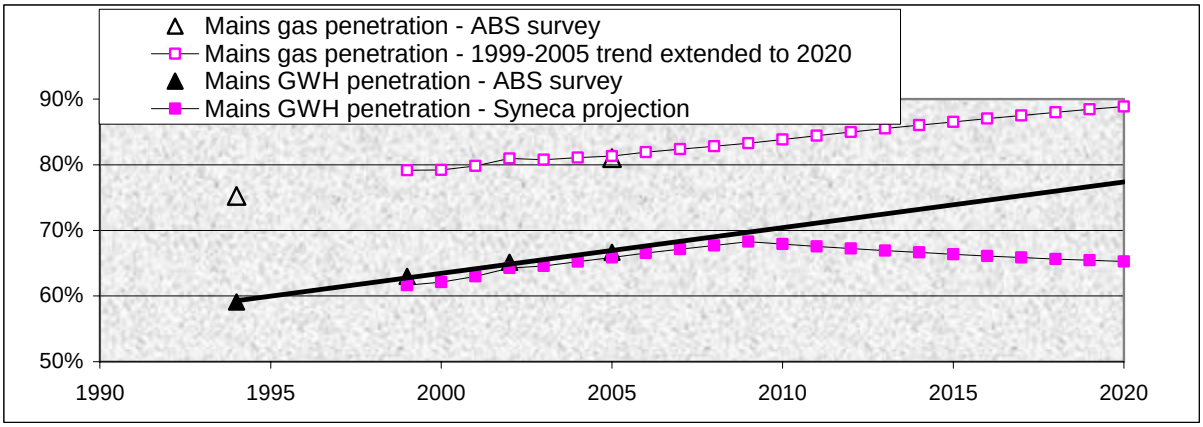
ABS survey estimates indicate that, in 1994, mains GWH penetration in Victoria could be described as follows: network coverage was 82%; mains gas take-up was 92%; and GWH penetration of mains gas customers was 79%. The result was that 59% of all households had installed mains GWH. The latter figure increased to 67% in the period to 2005 and seems to be the result of incremental gains on all margins. That is, there have been incremental increases in (a) network coverage, (b) mains gas take-up, and (c) GWH penetration of mains gas customers. Looking forward, relevant considerations are that:

- The existing projections for mains gas penetration are out of date, having been commissioned in 2002 for the regulatory period ending in 2007.
- A new review for 2008-2012 has been initiated but is not complete. However, we have historical data for 1999-2005 and rely on informal advice from the regulator that current trends should continue. Specifically, virtually all new dwellings are constructed in areas with gas access; virtually all of those dwellings are being connected to gas; and the Natural Gas Extension Program will continue to subsidise 'uneconomic' extensions to regional towns. This means that gas penetration will continue to grow, tending to carry mains GWH penetration with it.
- Victoria's 5 star building regulations currently require that new houses install either a rainwater tank or a gas-boosted solar hot water system. These regulations may be changed to require both a rainwater tank and a gas-boosted solar hot water system. The effect would be to significantly moderate the growth of mains GWH penetration, shifting incremental demand to gas-boosted solar.

Our approach to modelling the Victorian market is to first put aside the additional households that are expected to form in Victoria after 2009, which has the effect of assigning about 290,000 households to gas-boosted solar products and to alternative heating technologies where gas is not available. For the remainder, it is assumed that there is incremental growth of mains gas penetration (from 81% in 2005 to 88% in 2020) and incremental growth in GWH penetration of mains gas customers (from 81% in 2005 to 85% in 2020). This leaves GWH penetration of mains gas customers equal to the maximum figure that is currently observed in Australian jurisdictions (for South Australia).

The result is that mains GWH penetration of total Victorian households is little changed from 2005 to 2020, at about 66%, as shown in figure B.3.

Figure B.3 Gas and GWH penetration of Victorian households, projected to 2020 (mains gas only)



Bottled LPG in Victoria

ABS surveys indicate that, while there is moderate growth in the use of LPG as a residential fuel, the number of LPG-fuelled GWH has been reasonably static, and now stands at about 1.5% of households. Our baseline assumption is that the number of LPG-fuelled GWH remains constant at 28,500, which is the average of the ABS survey estimates for 1994 and 2005. The inclusion of LPG-fuelled GWH takes our estimate of total GWH penetration to about 68% of Victorian households. The BIS Shrapnel estimate is a little higher, at 71%.

Market segments

BIS Shrapnel estimate that market penetration is split 63:37 between GsWH and GiWH.

Tasmania

Penetration of mains gas and mains-fuelled GWH

Figure B.4 reports our baseline projection for mains gas and mains GWH penetration in Tasmania. The background to the mains gas projection is that:

- Powerco has a Development Agreement with the State Government of Tasmania to construct a gas distribution network in the state.
- A gas transmission pipeline is already in place from Victoria, across Bass Strait into Tasmania and down through the main population centres of the State to Hobart. Powerco's gas backbone network tees-off this transmission pipeline.
- The agreement with the State provides Powerco with the approval to distribute natural gas to Tasmania's major industrial, commercial and residential customers.
- The rollout to small business and residential customers commenced in 2006 and, at April 2007, 38,500 residential customers will have access to mains gas.
- Powerco recently signed its 2,000th customer, which is 1% of Tasmanian households.
- Powerco have a MoU with the Tasmanian government to make gas available to 100,000 dwellings and hope for take-up of 60%, or 60,000 customers.
- The baseline projection is that about half of this target is achieved by 2020. It is assumed that Tasmanian households connect to mains gas at the rate of 1% per year for 15 years.

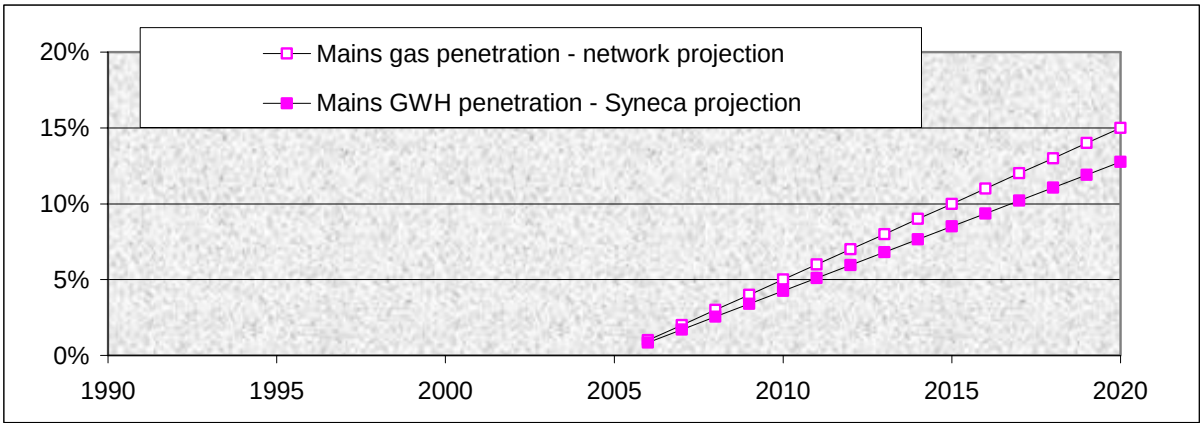
It has been assumed that mains GWH penetration of gas customers is 85%, equal to the maximum figure that is currently observed in Australian jurisdictions (South Australia). Importantly, the rollout strategy includes a cash incentive payment for new connections and even the minimum payment requires that the customer has a permanently connected

water heating unit with a minimum rating of 40 MJ/hr. Overall, Powerco will need to be satisfied the customer's annual usage will exceed 20 GJ.

Bottled LPG in Tasmania
Our baseline assumption is that the number of LPG-fuelled GWH remains constant at 1,900, which is the average of the ABS survey estimates for 1994 and 2005.

Market segments
The network company has advised that almost 100% of the installations mains GWH are GiWH. This may reflect the profile of early adopters, who probably tend to be the more wealthy members of the community.

Figure B.4 Gas and GWH penetration of Tasmanian households, projected to 2020 (mains gas only)



South Australia
Penetration of mains gas and mains-fuelled GWH
Envestra is the only network operator in SA, serving Adelaide, Barossa Valley, Peterborough, Port Pirie, Mount Gambier and Murray Bridge. Total residential connections in 2005 were 348,844. The ABS survey estimate was 365,500.

ABS survey estimates indicate that, in 1994, mains GWH penetration in SA could be described as follows: network coverage was about 69%; mains gas take-up was 77%; and GWH penetration of mains gas customers was 86%. The result was that 46% of all households had installed mains GWH. The latter figure increased to 57% in the period to 2005 and seems to be the result of an uncertain mix of gains in network coverage and mains gas take-up. There was no increase in GWH penetration of mains gas customers. The latter figure was 86% in 1994 and 85% in 2005.

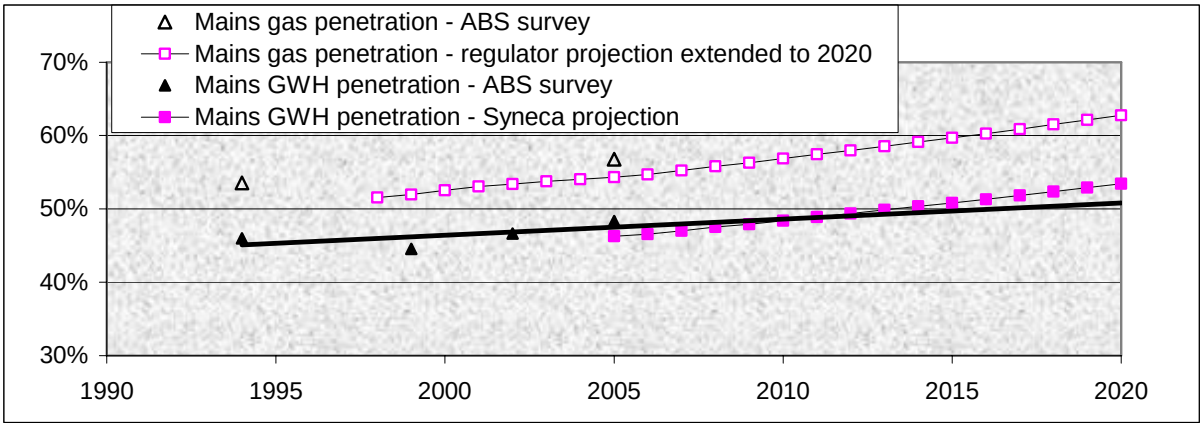
Figure B.5 reports our baseline projection to 2020. We assume that, for mains gas penetration, the projected growth to 2011 continues at the same rate to 2020. This delivers continuing gains in mains gas penetration, carrying mains GWH penetration with it. But there is no increase in GWH penetration of mains gas customers: SA already has Australia's highest GWH penetration of mains gas customers – 85%. The effect is to lift GWH penetration of all households from 46% to 53%, which is slightly faster growth than the historical trend suggested by ABS surveys.

Bottled LPG in SA
ABS surveys indicate that, while there is significant growth in the use of LPG as a residential fuel, the number of LPG-fuelled GWH has been static, and now stands at about 2.5% of households. Our baseline assumption is that the number of LPG-fuelled GWH remains constant at 15,500, which is the average of the ABS survey estimates for 1994 and 2005.

The inclusion of LPG-fuelled GWH takes our estimate of total GWH penetration to about 49% of SA households. The BIS Shrapnel estimate is much higher, at 63%.

Market segments
BIS Shrapnel estimate that market penetration is split 44:56 between GsWH and GiWH.

Figure B.5 Gas and GWH penetration of SA households, projected to 2020 (mains gas only)



Western Australia
Penetration of mains gas and mains-fuelled GWH
Alinta operates the major network in WA, serving Geraldton, Perth, Mundurah, Bunbury and Busselton. Total residential connections in 2005 were 517,005. There are several smaller networks with a total of about 10,000 residential customers, taking total mains customers to about 527,000. The ABS survey estimate was 530,500.

ABS survey estimates indicate that, in 1994, mains GWH penetration in WA could be described as follows: network coverage was about 70%; mains gas take-up was 73%; and GWH penetration of mains gas customers was 79%. The result was that 41% of all households had installed mains GWH. The latter figure increased to 54% in the period to 2005 and seems to be the result of an uncertain mix of gains in network coverage and mains gas take-up. The ABS survey records no increase in GWH penetration of mains gas customers. It was 79% in 1994 and 80% in 2005.

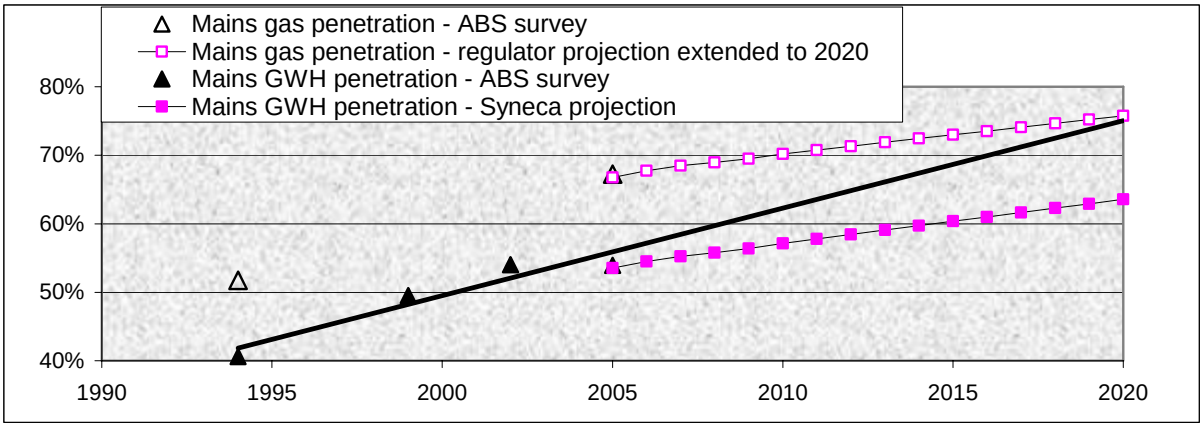
Figure B.6 reports our baseline projection to 2020. We assume that, for mains gas penetration, the projected growth to 2009 continues at the same rate to 2020. This delivers continuing gains in mains gas penetration, carrying mains GWH penetration with it. There is also a significant increase in GWH penetration of mains gas customers, from 80% to 85%, equal to SA. The effect is to lift GWH penetration of all households from 54% to 64%, which is considerably slower than the historical trend suggested by ABS surveys.

Bottled LPG in WA
ABS surveys indicate that there was little growth in the use of LPG as a residential fuel. The number of LPG-fuelled GWH has been static, and now stands at about 6.2% of households. Our baseline assumption is that the number of LPG-fuelled GWH remains constant at 48,700, which is the average of the ABS survey estimates for 1994 and 2005.

The inclusion of LPG-fuelled GWH takes our estimate of total GWH penetration to about 60% of SA households. The BIS Shrapnel estimate is somewhat higher, at 70%.

Market segments
BIS Shrapnel estimate that market penetration is split 50:50 between GsWH and GiWH.

Figure B.6 Gas and GWH penetration of WA households, projected to 2020 (mains gas only)



Northern Territory

The ABS surveys have returned estimates of between one and three thousand GWH in the Northern Territory. Our baseline assumption is that there will be a fixed stock of 2,000 GWh throughout the projection period.

APPENDIX C: BREAKDOWN OF IMPACTS BY JURISDICTION

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	11.902	23.801	3.690	5.961	8.761	0.049	0.025	0.960	55.149
2001	11.861	23.720	3.678	5.941	8.731	0.049	0.025	0.957	54.961
2002	11.780	23.558	3.653	5.900	8.671	0.049	0.024	0.950	54.584
2003	11.629	23.257	3.606	5.825	8.560	0.048	0.024	0.938	53.888
2004	11.406	22.811	3.537	5.713	8.396	0.047	0.024	0.920	52.853
2005	11.192	22.382	3.470	5.605	8.238	0.046	0.023	0.903	51.861
2006	10.954	21.906	3.397	5.486	8.063	0.045	0.023	0.884	50.758
2007	10.690	21.379	3.315	5.354	7.869	0.044	0.022	0.862	49.535
2008	10.430	20.858	3.234	5.224	7.677	0.043	0.022	0.841	48.329
2009	10.178	20.354	3.156	5.097	7.492	0.042	0.021	0.821	47.161
2010	9.849	19.697	3.054	4.933	7.250	0.041	0.020	0.794	45.639
2011	9.584	19.166	2.972	4.800	7.054	0.040	0.020	0.773	44.407
2012	9.390	18.778	2.911	4.703	6.912	0.039	0.019	0.757	43.509
2013	9.277	18.552	2.876	4.646	6.828	0.038	0.019	0.748	42.985
2014	9.249	18.497	2.868	4.632	6.808	0.038	0.019	0.746	42.859
2015	9.309	18.617	2.887	4.663	6.852	0.039	0.019	0.751	43.137
2016	9.411	18.820	2.918	4.713	6.927	0.039	0.019	0.759	43.607
2017	9.563	19.124	2.965	4.790	7.039	0.040	0.020	0.771	44.312
2018	9.716	19.430	3.013	4.866	7.151	0.040	0.020	0.784	45.019
2019	9.869	19.736	3.060	4.943	7.264	0.041	0.020	0.796	45.729
2020	10.022	20.043	3.108	5.020	7.377	0.041	0.021	0.808	46.441
WPM energy use (PJ, GsWH only)									
2000	11.902	23.801	3.690	5.961	8.761	0.049	0.025	0.960	55.149
2001	11.861	23.720	3.678	5.941	8.731	0.049	0.025	0.957	54.961
2002	11.780	23.558	3.653	5.900	8.671	0.049	0.024	0.950	54.584
2003	11.629	23.257	3.606	5.825	8.560	0.048	0.024	0.938	53.888
2004	11.406	22.811	3.537	5.713	8.396	0.047	0.024	0.920	52.853
2005	11.192	22.382	3.470	5.605	8.238	0.046	0.023	0.903	51.861
2006	10.954	21.906	3.397	5.486	8.063	0.045	0.023	0.884	50.758
2007	10.690	21.379	3.315	5.354	7.869	0.044	0.022	0.862	49.535
2008	10.422	20.842	3.231	5.220	7.671	0.043	0.022	0.841	48.291
2009	10.153	20.304	3.148	5.085	7.473	0.042	0.021	0.819	47.046
2010	9.791	19.581	3.036	4.904	7.207	0.041	0.020	0.790	45.370
2011	9.466	18.931	2.935	4.741	6.968	0.039	0.020	0.764	43.863
2012	9.213	18.424	2.857	4.614	6.781	0.038	0.019	0.743	42.689
2013	9.040	18.079	2.803	4.528	6.654	0.037	0.019	0.729	41.890
2014	8.954	17.906	2.776	4.484	6.591	0.037	0.019	0.722	41.488
2015	8.954	17.907	2.776	4.485	6.591	0.037	0.019	0.722	41.491
2016	8.996	17.991	2.789	4.506	6.622	0.037	0.019	0.726	41.685
2017	9.089	18.176	2.818	4.552	6.690	0.038	0.019	0.733	42.115
2018	9.182	18.362	2.847	4.599	6.759	0.038	0.019	0.741	42.546
2019	9.283	18.564	2.878	4.649	6.833	0.038	0.019	0.749	43.014
2020	9.392	18.782	2.912	4.704	6.913	0.039	0.019	0.758	43.520
Energy savings (GJ)									
2000-07	0	0	0	0	0	0	0	0	0
2008	8,284	16,567	2,569	4,149	6,098	34	17	668	38,387
2009	24,853	49,702	7,706	12,447	18,294	103	51	2,005	115,162
2010	57,990	115,971	17,981	29,044	42,686	240	120	4,678	268,710
2011	117,446	234,875	36,417	58,822	86,450	486	243	9,474	544,214
2012	176,903	353,778	54,853	88,601	130,215	732	366	14,269	819,717

2013	236,359	472,681	73,289	118,379	173,980	979	489	19,065	1,095,221
2014	295,815	591,585	91,725	148,157	217,745	1,225	612	23,861	1,370,725
2015	355,271	710,488	110,161	177,935	261,509	1,471	735	28,657	1,646,228
2016	414,766	829,469	128,609	207,733	305,302	1,717	859	33,456	1,921,911
2017	474,261	948,449	147,057	237,530	349,096	1,964	982	38,255	2,197,593
2018	533,756	1,067,430	165,504	267,328	392,889	2,210	1,105	43,054	2,473,276
2019	585,795	1,171,500	181,640	293,391	431,194	2,425	1,213	47,252	2,714,410
2020	630,378	1,260,659	195,465	315,721	464,011	2,610	1,305	50,848	2,920,996
Emissions abatement (t CO2-e)									
2000-07	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	591	1,054	177	306	370	2	1	48	2,574
2010	1,772	3,161	530	919	1,110	6	3	143	7,723
2011	4,135	7,376	1,237	2,143	2,591	14	6	334	18,021
2012	8,374	14,938	2,506	4,341	5,248	29	13	675	36,498
2013	12,613	22,500	3,774	6,539	7,904	44	20	1,017	54,974
2014	16,852	30,063	5,042	8,736	10,561	59	26	1,359	73,451
2015	21,092	37,625	6,311	10,934	13,217	73	33	1,701	91,927
2016	25,331	45,187	7,579	13,132	15,874	88	39	2,043	110,404
2017	29,573	52,754	8,848	15,331	18,532	103	46	2,385	128,893
2018	33,815	60,321	10,117	17,530	21,190	118	53	2,728	147,381
2019	38,057	67,889	11,387	19,729	23,848	133	59	3,070	165,870
2020	41,767	74,507	12,497	21,652	26,173	146	65	3,369	182,041
Value of energy savings ($'000)									
2000-07	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	129	172	60	62	97	1	0	10	531
2010	388	517	179	187	290	2	1	29	1,593
2011	905	1,207	417	437	677	4	2	67	3,716
2012	1,833	2,444	844	885	1,372	8	4	136	7,526
2013	2,761	3,682	1,271	1,333	2,067	12	6	205	11,336
2014	3,689	4,919	1,698	1,781	2,761	16	8	274	15,146
2015	4,616	6,157	2,125	2,229	3,456	20	10	343	18,956
2016	5,544	7,394	2,552	2,677	4,150	24	12	412	22,766
2017	6,473	8,633	2,979	3,125	4,846	28	14	480	26,579
2018	7,401	9,871	3,407	3,574	5,541	32	16	549	30,391
2019	8,330	11,109	3,834	4,022	6,236	36	18	618	34,204
2020	9,142	12,192	4,208	4,414	6,844	40	20	679	37,538
Additional appliance cost ($'000)									
2000-07	0	0	0	0	0	0	0	0	0
2008	355	710	110	178	261	1	1	29	1,645
2009	710	1,420	220	356	523	3	1	57	3,290
2010	1,420	2,839	440	711	1,045	6	3	115	6,579
2011	2,547	5,095	790	1,276	1,875	11	5	205	11,804
2012	2,547	5,095	790	1,276	1,875	11	5	205	11,804
2013	2,547	5,095	790	1,276	1,875	11	5	205	11,804
2014	2,547	5,095	790	1,276	1,875	11	5	205	11,804
2015	2,547	5,095	790	1,276	1,875	11	5	205	11,804
2016	2,549	5,098	790	1,277	1,876	11	5	206	11,812
2017	2,549	5,098	790	1,277	1,876	11	5	206	11,812
2018	2,549	5,098	790	1,277	1,876	11	5	206	11,812
2019	2,549	5,098	790	1,277	1,876	11	5	206	11,812
2020	2,549	5,098	790	1,277	1,876	11	5	206	11,812