Consultation Regulation Impact Statement: Heat Pump Water Heaters

Air-Source Heat Pump Water Heaters in Australia and New Zealand

July 2013

A joint initiative of Australian, State and Territory and New Zealand Governments

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Background

This consultation Regulation Impact Statement (RIS) document examines the potential impacts, costs and benefits of implementing options to increase the energy efficiency of Heat Pump Water Heaters (HPWH). The options focus on the HPWH market with consideration of consumer behaviour and the strategy to improve the energy efficiency of the whole water heater market.

In both Australia and New Zealand, water heating accounts for the second largest segment of household energy use, after space heating. Heat pump water heaters as a group are relatively energy efficient, applying refrigeration technology to extract heat energy from the air and transfer it to a tank of water. The key advantage of this technology over the commonly used electric resistance technology is that HPWHs can supply the same amount of hot water while using about 60% less electricity. Even less efficient HPWH models should achieve energy savings over an Electric Storage Water Heater (ESWH) in most circumstances. However, there is a wide range of energy efficiencies between individual HPWH models, and testing has found that many models fall short of their claimed efficiency (E3 2012).

Market characteristics and consumer behaviour

Although HPWHs have been available in Australia and New Zealand for some time, their share of the residential water heating market was very low until a combination of government interventions (in particular financial incentives) and pricing changes led to a rising market share between 2007 and 2009. In Australia, HPWHs represented about 10% of water heater sales, but by 2011 – after the withdrawal of most rebates – this had dropped back to less than 3%.

Movements in sales in response to rebates changes show consumers are responsive to falls in net costs at the time of purchase. The BIS Shrapnel (2012) survey estimated capital costs for HPWHs are falling much faster than electric and solar water heater systems. Future sales could expand quickly if the cost of HPWHs continues to decline. In New Zealand, ESWHs dominate the market.

Current regulatory arrangements

There are no regulations that require the energy efficiency of HPWHs sold in Australia and New Zealand to be tested to a common standard, to carry labels indicating their energy efficiency or other key aspects of performance (e.g. noise), or to meet any minimum prescribed levels of energy efficiency or performance.

Suppliers can choose to register their models as eligible to create Small-scale Technology Certificates (STCs) under the *Renewable Energy (Electricity) Act 2000*, but this is not a mandatory requirement. This process estimates renewable energy contribution rather than direct energy efficiency, and does not use the rigorous product assessment process and compliance framework applied under energy labelling and Minimum Energy Performance Standards (MEPS).

The problem

Considering lower 'lifetime costs' are the key advantage of HPWHs to consumers over the dominant competing technology, ESWHs, it is reasonable to conclude that lower lifetime costs are a key preference for HPWH consumers. At the time of purchase the capital cost is clear, but the energy efficiency and hence relative lifetime energy cost of different models is not clear. There is a failure of information in the market. A large proportion of water heaters, including HPWHs, are purchased by builders or rental property owners, who are likely to be indifferent to running costs because those are paid by others. Therefore they are likely to prefer the cheapest model, even if they could be made aware that it has a higher lifetime cost.

In the case of HPWHs, the high contribution of ongoing energy costs to the lifetime costs of the appliance means that poorly informed decisions may be taken where information about energy costs is not available, or split incentives prevail. There is evidence which supports the case that these market failures occur in the HPWH market and are likely to have led to less than optimal purchasing decisions. As a consequence:

- Prospective consumers cannot be assured of getting a product that performs adequately in meeting their needs;
- Consumers who are motivated to do so are unable to reliably identify appliances with better energy efficiency (and avoid inefficient ones);
- There is limited market pressure on suppliers to improve product performance; and
- Energy use, costs and greenhouse gas emissions are higher than need be.

The capability for consumers to use consumer law to protect themselves from products they believe are not satisfactory is reduced when testing cannot be independently conducted and clear benchmarks are not available.

The objective of this RIS is to assess options to improve the energy efficiency of heat pump water heaters sold in Australia and New Zealand by addressing market failures related to information and split incentives that impact the heat pump water heater market, while ensuring key performance features are not adversely affected.

Options to address market failures

From a consumer perspective, it is critical that a HPWH is not only energy efficient, but first provides an adequate level of service (performance) to meet their needs. Proposals to increase the energy efficiency of HPWHs are considered together with key functional performance measures of hot water delivery, recharge rates and noise to ensure consumer satisfaction is not compromised.

A broad range of options were considered to assess whether they would address identified market failures, while remaining cognisant of the likelihood of the options improving the consumer choice process. After analysis, the following options were considered unlikely to lead to outcomes other than Business As Usual, if implemented alone:

- Consumer education campaign;
- Voluntary energy efficiency certification; and
- Dis-endorsement labelling.

The infrequent nature of water heater purchases limits the potential for a standalone consumer education campaign to impact purchase decisions. The costs of dis-endorsement labelling were estimated to be similar to a mandatory Climate Rating Label, with a smaller likelihood of resolving the information barriers. A dis-endorsement component was considered for inclusion in the proposed label to identify models that have not been tested for suitability in cold temperatures.

The following options were considered as more likely to alter consumer behaviour by addressing the market failures and were assessed to determine their impacts, costs and benefits:

- Mandatory testing, registration and public disclosure of energy efficiency and key performance information;
- Mandatory energy labelling (i.e. disclosing performance information on labels fixed to each product);
- Voluntary energy labelling; and
- A range of Minimum Energy Performance Standards (MEPS); combined with labelling or disclosure.

Mandatory labelling directly targets information to consumers and installers and is seen as the most direct option to address the information barriers identified. Voluntary application of energy labelling is likely to only provide information on higher performing models on the market, as presenting lower performance on a label is unlikely to provide a competitive advantage. Unless a voluntary labelling scheme has both high uptake and consumers trust the information it will only partially address information barriers. While information barriers are addressed through mandatory labelling, the split incentive issues will still exist. MEPS were explored as they provide the most direct instrument for improving energy efficiency when split incentives operate. As the identified problems are not completely addressed by either MEPS or mandatory labelling alone, a combination of the approaches was considered worth exploration.

Conclusions

A combination of MEPS and mandatory energy labelling provides the greatest net benefit and highest likelihood of altering consumer behaviour through addressing the identified market failures. The benefit-cost ratios of MEPS combined with mandatory labelling options are in a fairly narrow range of 2.1 to 2.3 in Australia and 1.4 to 1.9 in New Zealand under conservative modelling assumptions.

The most efficient proposal in terms of net benefits was MEPS Option C: Mandatory registration and disclosure proposed to take effect from 1 July 2014. The proposed MEPS level is equivalent to a 65% energy savings (compared with a standard ESWH) in Zone 3 for all models, plus an additional requirement to meet 60% energy savings in Zone 5 for models designated as suitable for cold climates. New Zealand would be designated as a cold climate (Zone 5). It is proposed that MEPS would take effect from 1 July 2015, and that mandatory labelling takes effect no sooner than 1 July 2015.

The proposal would enhance competition by providing consumers and installers access to reliable and consistent information on key performance features of HPWHs including energy efficiency, hot water delivery and noise, which is not presently available to them.

It is recommended that:

- Energy efficiency test standards be revised so that they are better able to support mandatory registration and compliance requirements, cold climate performance tests and noise testing;
- Once test procedures are finalised, the equivalence between the resulting energy efficiency metrics and recommended MEPS levels should be finalised, and requirements implemented through a GEMS determination;
- The tested energy efficiency, recharge rates, hot water delivery capability and noise levels of heat pump water heaters be registered with the GEMS regulator from 1 July 2014 in Australia;
- All HPWHs supplied from 1 July 2015 should meet a level of energy efficiency equivalent to MEPS level C;
- A form of mandatory energy labelling to indicate energy efficiency, hot water delivery, level of noise and suitability for cold climate performance should be developed and refined with the aid of consumer testing and market research;
- Energy labels should be fixed to all HPWHs supplied no sooner than 1 July 2015; and
- The label image should be included in all supplier brochures and advertising in Australia.

Consultation on this regulation impact statement

Readers are invited to comment on a number of aspects in this document, particularly market data and modelling assumptions, to assist with the formulation of preferred policy options. While we welcome comments on all aspects of the RIS, responses to the key questions below would be of particular assistance.

Following consultation on the RIS, additional consultation will also occur to discuss revisions to the test standards (once a draft is available), MEPS levels which will have been converted from percentage savings to coefficient of performance (COP) and climate rating label options that could be applied to HPWHs.

A discussion paper(s) will be made publicly available prior to the additional consultations to ensure interested stakeholders are well informed.

Written comments should be sent via e-mail, and should be received by 2 September 2013. Comments can be sent to:

Australia: Subject: Heat pump water heater Consultation RIS	**New Zealand:** Subject: Heat pump water heater Consultation RIS
energyrating@ret.gov.au	regs@eeca.govt.nz

Consultation questions

1. Do you believe consumers can currently make accurate comparisons of heat pump water heater energy efficiency, cold temperature performance, running costs and noise?
2. What do you think are the major factors that consumers consider when buying a heat pump water heater?
3. Do you think key heat pump water heater performance measures identified (in addition to energy efficiency) are important considerations for consumers i.e. recovery rate, noise, ability to operate in a range of climates?
4. Do you believe split incentives between plumbers-owners or builders-owners are impacting the heat pump water heater models being purchased?
5. Do you think there is a case for mandatory noise testing and declaration of noise levels?
6. If mandatory noise testing was introduced it is suggested that ISO 3741 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for

reverberation test rooms could be used. Do you have any concerns with using this standard? If yes please provide detail including solutions to address.

7. Can you provide improvements to the market data presented for Australia and New Zealand, and in particular, the estimates of current and projected sales of heat pump water heaters? Please provide data.
8. Do you think that there is a case for minimum energy performance standards (MEPS) and labelling of HPWHs?
9. Do you agree that the introduction of MEPS Option C and climate rating labelling would have a positive impact on the HPWH market in terms of energy efficiency and informing consumers? Please provide reasons.
10. Is MEPS Option C your preferred option? If not, please indicate the option you prefer. Please provide reasons.
11. Do you think that the proposed commencement dates provide sufficient lead time for implementation? Please provide reasons.
12. What impact do you think implementing these measures (MEPS and labelling) would have on competition, product costs and consumer choice? Please provide justification.
13. Do you think there is a case for the consistent physical energy labelling of all water heater technology types? Provide reasons.
14. Do you think there is a case for the mandatory physical labelling of heat pump water heaters with their performance? Provide reasons.
15. Do you think there is a case for the mandatory labelling of heat pump water heaters to be included in advertising material (e.g. catalogue, brochure and online material)? Provide reasons.
16. What are your views on the voluntary labelling option? Please provide justification.
17. Are there any issues to consider if product testing and registration was introduced and based on a revised AS/NZS 5125 including a new draw off test? Please provide detail.
18. Do you consider that there are any major technical or functional issues related to the proposals? If so, how should these be addressed?
19. Are there any additional measures to consider to increase the energy efficiency of heat pump water heaters?

Where data is provided as evidence for a claim (or to compliment the data presented in this document), please ensure that all this data can be verified (and provided to other stakeholders) to ensure all data is robust. All submissions may be published to ensure transparency.

1. Background

Australia and New Zealand have separate energy efficiency strategies; the National Strategy on Energy Efficiency (NSEE) in Australia and the New Zealand Energy Efficiency and Conservation Strategy (NZEECS). These strategies note the substantial reductions in energy use and greenhouse emissions that can be made by improving the efficiency of appliances, such as water heaters. The objective of the NZEECS for products is to improve consumer uptake of energy efficient products, including through robust economic analysis of energy labelling and Minimum Energy Performance Standards (MEPS), in partnership with Australia.

The Council of Australian Governments (COAG) agreed in 2010 to the NSEE which aims to accelerate energy efficiency efforts, streamline roles and responsibilities across levels of governments, and help households and businesses prepare for the introduction of a future carbon price. The Strategy was designed to substantially improve minimum standards for energy efficiency and accelerate the introduction of new technologies through improving regulatory processes and addressing the barriers to the uptake of new energy efficient products and technologies.

Improving the energy efficiency of water heaters is a key measure in the Strategy, with options to improve energy efficiency subject to a Regulation Impact Statement (RIS) process. Included were measures to increase the uptake of more energy efficient water heaters through considering minimum requirements for new technologies and to ensure consistent information is available for all water heaters on energy labels. Assessing options to improve energy efficiency information and provide minimum performance benchmarks for Heat Pump Water Heaters (HPWH) was a key element of the overall water heater measures, and the focus of this RIS.

Energy use in water heating

In both Australia and New Zealand, water heating accounts for the second largest segment of household energy use, after space heating. In Australia, about 45% of the energy used for water heating comes from electricity while in New Zealand, electricity supplies 80% of water heating energy. Electricity is the most greenhouse intensive form of delivered energy in Australia where it accounts for about 80% of the emissions from water heating while in New Zealand electricity is considerably less greenhouse intensive, as the majority is generated from renewable energy.[1]

Electricity can be used to heat water in many different ways, with different energy efficiencies and associated greenhouse gas emissions. The most common type is the relatively high energy using electric resistance technology, where the water is heated entirely by an immersed electric element. Electric Storage Water Heaters (ESWHs) have been subject to MEPS since 1999. Heat pump water heating is a more efficient technology that uses a relatively small amount of electricity to extract heat energy from the air.

Heat pump water heaters

HPWHs use refrigeration technology to extract heat from an ambient source and transfer it to a tank of water to supply household hot water. Heat pumps can be designed to extract heat from a range of renewable ambient heat sources including air, water or the earth. This consultation RIS deals only with 'air-source' HPWHs, as the sales of other types in Australia and New Zealand are negligible. Heat pumps have a key energy efficiency advantage over electric resistance technology in that they are capable of supplying the same amount of hot water with over 60% less electricity. Even a low energy efficiency HPWH model should achieve energy savings over an ESWH in most circumstances. However, the technology is still evolving and the actual energy efficiency varies widely from model to model. Appendix 1 gives additional information about HPWH technology.

[1] The average emissions intensity of electricity supply in Australia in 2010 was 295 kg CO_2-e/GJ, and natural gas 58 kg CO_2-e/GJ (GWA 2010). The average emissions intensity of electricity supply in New Zealand in 2010 was 38 kg CO_2-e/GJ, and natural gas 54 kg CO_2-e/GJ (EECA 2012).

HPWHs have the following advantages ESWH technology:

- They transfer more heat energy to the water than the electrical energy they use, providing financial savings over the lifetime of the appliance. A properly designed and installed HPWH should use about 60% less electricity in actual operation than an ESWH; and
- They can often be located in the same position, using the same electricity source as an external ESWH, so replacing an ESWH for a HPWH is relatively simple.

Their disadvantages include:

- Their capital costs are higher than ESWHs (BIS Shrapnel 2012);
- Their performance is strongly influenced by climate. In colder ambient air temperatures some models have significantly lower energy efficiency and slow rates of water heating;
- Their operation involves noise, since the heating process depends on the operation of moving parts (electric motors, compressors and fans); some models create excessive noise which may annoy owners or their neighbours;
- They are more complicated than ESWHs and can have issues with durability and reliability; and
- Some models can require connection to a more expensive continuous electricity tariff to operate effectively.

Water heater market

There are about 8.7 million private dwellings in Australia, of which 89% are occupied at any given time (ABS Census 2011). Virtually all houses and about 61% of apartments have their own water heaters and some homes have multiple water heaters. The remainder of apartments are served by central water heating systems (GWA 2010). This means there are about 8.2 million single residential water heaters in use in Australia. The number sold each year depends on the rate of dwelling construction and the rate of failure and retirement of old water heaters. GWA (2010) estimated that the total Australian market in 2010 was about 743,000 units, of which three quarters were replacements of a previous water heater.

Government interventions in the market

The HPWH market has been influenced by a range of historical and current market interventions in Australia and New Zealand (see Appendix 2). In Australia, government interventions have included financial incentives such as rebates and Small-scale Technology Certificates (STCs) and restrictions on the installation of greenhouse-intensive water heaters. In New Zealand the main market intervention was a rebate. These incentives aimed to increase the market share of low emission water heaters, including heat pump water heaters, and appear to have been quite effective in Australia with a rapid increase in the sale of HPWHs in the 2000s (Figure 1). In New Zealand, the influence of rebates was more muted (E3 2012).

Neither Australia nor New Zealand have mandatory MEPS or energy efficiency labelling for HPWHs. Systems that achieve over 50% energy savings are currently exempt from tank heat loss MEPS, however the soon to be released Electric Storage Water Heater Consultation RIS examines the potential to apply a lower tank heat loss MEPS to solar water heaters and HPWHs. The proposed MEPS levels have been designed to avoid material impact on current models, whilst ensuring that tank heat loss claims can be transparently verified.

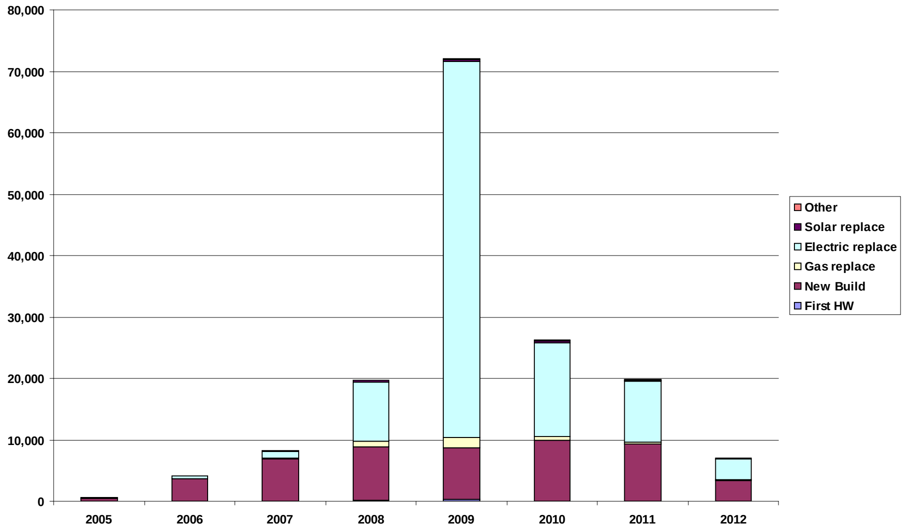
HPWH market trends

Although HPWHs were first introduced in the 1990s, they were considered a niche product and their sales remained very low until a combination of government interventions and price reductions led to a rising market share. Figure 1 indicates the number of residential size HPWHs for which STCs were registered with the Clean Energy Regulator (CER) in each calendar year. This data is a good proxy for the total Australian market, because STCs are registered for most HPWHs sold (albeit sometimes not until 12 months after installation). In 2009, HPWHs represented about 10% of Australian water heater sales, but by 2011 this had dropped back to less than 3%. The peak of the market in 2009 coincided with the maximum rebate values available to New South Wales (NSW) consumers. In that year, about 55% of all Australian HPWH installations were in NSW and 20% in Queensland (Qld). In other years, Qld accounts for the largest share of HPWH sales.

While the 2012 data is incomplete (covering only 9 months and with up to an additional delay of up to a year in registering STCs), they show the impact of the slowdown in construction following the end of stimulus measures after the global financial crisis. It is estimated that the current Australian market for HPWHs in a ‘normal’ year with construction rates back to the long term trend – with STCs available but without rebates – is about 20,000 units, representing about 3% of water heater sales (BIS Shrapnel 2012). The New Zealand Hot Water Association does not have firm sales data for HPWHs prior to 2010, but estimated sales were about 350 units in 2009 and 400 in 2010. It is estimated for this RIS, based on stakeholder consultation on the Product Profile, that the New Zealand market in 2012 is about 750 units (E3 2012).

Changes in sales in response to rebates changes show that consumers are responsive to falls in the net costs at the time of purchase. As rebates and financial incentives can bring forward potential future purchases and new home construction is likely to increase it is expected that the recent declining trend in sales will be temporary. The BIS Shrapnel (2012) survey estimated that capital costs for HPWHs are falling much faster than electric and solar water heater systems. Future sales could expand quickly if the relative cost of HPWHs continues to decline or new financial incentives are provided.

Figure 1 Residential size HPWH sales, Australia 2005 – 2012 (Proxy data, CER)



Consumer behaviour

Assessing influences on consumer behaviour including preferences, available options and the process that consumers follow when selecting a product are important considerations in policy that aims to alter consumer behaviour.

Consumer preferences

Traditional economic theory assumes that consumers make choices to maximise their satisfaction, otherwise known as utility. Consumer choices are assumed to be driven by preferences, constraints and prices. The most obvious considerations in the hot water market are:

- Perceived ability of the system to provide sufficient hot water;
- Capital costs and 'lifetime costs'; and
- Time to research a suitable system and importantly the time it will take to be installed.

As most water heaters are installed out of clear sight, it is unlikely that their appearance is a key purchasing consideration.

HPWH sales spiked in 2009, when rebate values were at their maximum, and fell away when rebates were reduced, despite the fact that household retail electricity prices in Australia continued to increase over this period (AER 2012). This suggests the impact of energy costs on water heater consumer behaviour was swamped by the impact of capital costs. For the majority of water heater consumers upfront cost appeared to be the main consideration in the purchase, and other preferences, such as reducing lifetime costs, had a lower impact.

Whilst capital costs were a dominant factor in consumer preferences of the total water heater market, HPWH consumer preferences are a little different as this technology has no clear advantages over the dominant cheaper ESWH technology except these systems provide lower lifetime costs. As there are no other clear advantages, it is reasonable to conclude that lower lifetime costs are a key preference for water heater buyers that have already chosen to purchase a HPWH over competing water heater technologies.

Consumer choice process

The process and influences that drive consumer behaviour, referred to in this document as the 'consumer choice process', are key to understanding the current market and measures that may positively alter consumer behaviour.

Water heaters are purchased in different ways from many household appliances as they are not regularly sold through retail stores, but rather acquired through agents such as plumbers and builders. This complicates consumer behaviour and creates a unique consumer choice process that needs to be considered. The market research company Artcraft Research reports:

> *Qualitative research has shown anecdotally that the purchase decision-making process for hot water systems (and air conditioners) is considerably different from the decision process for refrigerators. The decision regarding a refrigerator is fairly clear-cut and considered – there is usually time to decide (refrigerators tend to give warning of problems to come). People usually understand the appliance, a range of makes and models is readily available and able to be directly compared in showrooms, and energy usage parameters are simple as the appliance is on all the time. On the other hand, the decision regarding a water heater is often unexpected (water heaters rarely give warning of problems), hasty and ill-considered. The current study clearly identifies that the appliance installer (plumber and/or electrician) has a primary role to play in the water heater decision (Artcraft Research 2006).*

Most purchases of water heaters fit into two categories: emergency purchases to replace a suddenly failed system and those that are planned as part of renovations or new dwelling construction. Emergency purchases are often made quickly, and the time taken to restore hot water is often the key consideration in the purchase decision as identified by the speed of most installations. A consumer survey of the water heater market found that about a quarter of all water heater replacements are carried out within 24 hours, and the rest within a few days (BIS Shrapnel 2012). Planned purchases allow households more time to consider a range of systems and features in order to select one that best meets their needs. The restrictions surrounding the phase-out of greenhouse intensive water heaters in new homes in most jurisdictions have eliminated the option for consumers and builders to install an ESWH in new homes, resulting in increased installation of HPWHs and other low emission technology types.

Behavioural economics is essentially a series of tested observations of actual consumer behaviour that builds on traditional economic theory (OBPR 2012). Behavioural economics research provides some useful insights into actual consumer behaviour that is relevant to water heater consumers, including:

- Bias in preferences could lead consumers towards replacing a system with the same technology or brand, without consideration of alternatives. Specific evidence of a bias in consumer selection towards the status quo was evident in the BIS Shrapnel 2012 survey where 66% of ESWH heater buyers conducted no research at all on alternatives;
- Consumers may evaluate changes relative to their experience with the last water heater as a reference point, rather than objectively. A reference point was evident in ESWH consumers, where 52% claimed they installed a new ESWH as they were satisfied with their last model (BIS Shrapnel 2012);
- Aversion to loss could reduce consumer appetite to try alternative technology or brands. This may be one reason why only 7% of ESWH consumers considered HPWH technology (BIS Shrapnel 2012), even though it can provide a similar service with reduced lifetime costs in many instances; and
- Impacts of social norms may influence the consideration of environmental impacts.

Anticipation of the likely impact of options on the consumer choice process and preferences may help ensure the options positively influence consumer behaviour.

2. The Problem

The water heater market has been identified as subject to a range of market failures, including lack of information and split incentives, in which there is conflict between the interests of householders and intermediaries such as builders and plumbers who are influential in water heater choice (NSEE 2010; Artcraft Research 2006). Market failures result in sub-optimal purchasing decisions in some instances, and may reduce consumer satisfaction, also referred to as utility. In these circumstances, government intervention in the market has the potential to improve the overall welfare of the community if the intervention is aimed at correcting or reducing the impact of market failure.

Measures that impact energy prices (e.g. carbon pricing or time-of-use tariffs) do not directly address market failures of this kind, so sub-optimal outcomes are likely to continue to occur. Garnaut (2008) makes the point that regardless of a carbon price, the market's efficient adoption of established technologies and practices may not be efficient as it requires individuals to know:

- the options available;
- the approximate costs and benefits of the different options;
- how to deploy the options (including hiring experts); and
- the cost of investigating the options.

Garnaut argues that if the information barriers regarding efficiency levels are caused by market failures, a government may be able to intervene to improve the efficiency of the market. Time-of-use pricing could increase awareness of lifetime costs of appliances; however information barriers are likely to continue to impede consumer behaviour as the potential benefits of improved energy efficiency will remain inaccessible. As the HPWH market appears to be subject to market failures that seem to influence consumer behaviour in a material way, as detailed below, there appears to be a case to consider market intervention.

Market failures

Split incentives

A principal-agent issue can arise when the agent (landlord, plumber or builder) is unlikely to operate satisfactorily on behalf of the principal (buyer, tenant) due to 'split incentives' motivating the different parties. The split incentive is due to the fact that the ongoing energy costs of the water heater will be payable by the end-user rather than the adviser. Details of how these classes of split incentive apply in the water heater market include:

- **Builder/owner split incentive:** As the HPWH (or any other type of water heater) is a relatively minor part of a building or renovation project, and it may be selected before the buyer is known, the motivation and the opportunity for the ultimate occupant to influence the water heater selection will usually be limited. Typically the builder will be motivated to keep the purchase and installation costs low and will have no stake in the long term energy consumption costs the owner or user will bear. Considering that new builds constitute a large proportion of recent HPWH sales (Figure 1), there is potential for this split incentive to influence the consumer choice process.
- **Plumber/owner split incentive:** Many replacement water heaters are supplied by plumbers or purchased on advice provided by a plumber. Plumbers have an incentive to recommend and sell the HPWH which provide the greatest profit margin while requiring the least effort to install. Additionally, some plumbers may have a bias in the brands they recommend due to their commercial links (e.g. free or low cost training programs, or discount purchasing) with particular suppliers and manufacturers. In these situations the owner's interest to obtain an efficient and appropriately sized unit may not be met. This separation of the owner from the purchase of the heat pump water heater will be the case for many residential purchases.
- **Landlord/tenant split incentive:** A residential landlord has little incentive to purchase a HPWH in the first instance, and is likely to be motivated to minimise their capital outlay. Therefore this split incentive is only likely to operate within the HPWH market if they become the low capital cost option, as has occurred in the past for short periods due to rebates. The short term tenure of many rental properties also reduces tenants' consideration of energy costs (including water heating energy costs). The impact of this incentive was highlighted by the Australian Council of Social Service submission to the '*Reducing energy bills and improving*

efficiency' report – it argued that this problem has resulted in 'some of the most vulnerable households living in the most inefficient properties in Australia'.

These split incentive barriers are likely to apply to both the Australian and New Zealand markets. As HPWHs are not the lowest cost water heater option, split incentives are likely to be less of a factor in the HPWH market when compared to the ESWH market. However the commercial links between some plumbers and particular brands and significant numbers of installations in new homes still provide scope for split incentives to influence the selection of HPWH models. The potential for split incentives to influence consumer behaviour is exacerbated by the information barriers surrounding a lack of reliable information on ongoing energy costs that consumers can easily access.

Information barriers

Considering lower lifetime costs are the key advantage of HPWHs to consumers over the dominant competing technology, ESWHs, it is reasonable to conclude that lower lifetime costs are a key preference for HPWH consumers. An informed HPWH consumer would ideally undertake research to inform themselves of the capital costs, expected service life and the projected running costs of models, then select the option with the lowest lifetime cost. Considering that HPWHs as a group are more energy efficient than ESWHs, there may be a perception amongst consumers that there will be sufficient benefit merely from selecting a HPWH, so there is no need to conduct further research to inform their purchase. This perception is further reinforced by the current lack of reliable comparative information on the energy efficiency and running costs of different HPWH models.

Lifetime costs of HPWHs comprise two main classes of cost: the capital cost of buying and installing the water heater and the ongoing energy costs to operate it. The capital cost is incurred up front and is easy to identify, while the energy cost is incurred progressively and is difficult to determine prior to purchase. For a typical HPWH purchase, the capital cost and ongoing energy costs are roughly equal (Section 4).

Ongoing energy costs reflect future hot water use and energy costs, which are uncertain and difficult for households to forecast. Such uncertainty can result in consumers focusing heavily on capital costs. Even where consumers have access to information, the complexity may result in poorly informed, sub-optimal decisions.

The information barriers caused by uncertainty surrounding ongoing energy costs and high certainty of capital costs, is likely to result in a purchase decision being made without appropriate knowledge or consideration of the ongoing energy costs.

Evidence of market failures

There is evidence which supports the case that market failures occur in the HPWH market and have led to less than optimal purchasing decisions.

Inconsistent information available to consumers

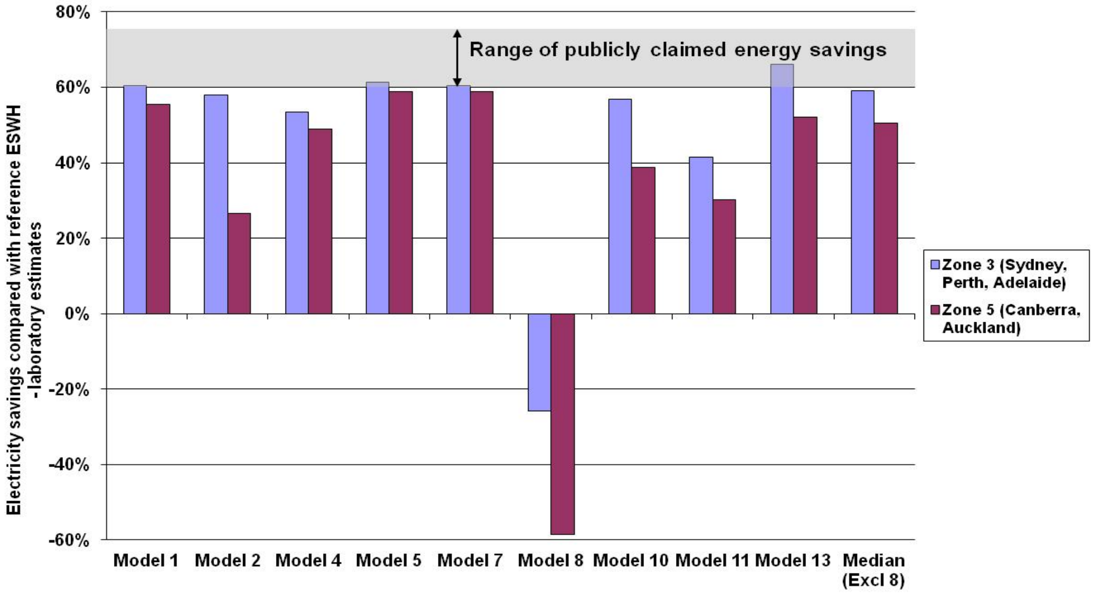
At present there is no mandatory requirement for manufacturers or suppliers to provide information on energy use or any other aspect of HPWH performance. There is a lack of consistent public information about key aspects of heat pump water heater performance, including energy efficiency, noise and the ability to perform under local climate conditions. What information is available is difficult to verify as it often requires extensive testing and modelling with the use of proprietary information.

The energy efficiency of HPWH technology is particularly sensitive to ambient air temperatures. The lower the temperature, the harder it is to heat water. Pitt & Sherry 2012 and the Product Profile on HPWHs (E3 2012) concluded that while there is a suitable range of HPWH models available in Australia to suit the broad range of electricity tariffs and climates, the required information is not available in the public domain to allow a consumer to select the appropriate model for their circumstances. Statements about other key performance features including noise levels and re-heat times, when provided, are published without explanation of the test method. In Australia, the only public information reported in a consistent format is the number of STCs that each HPWH model is eligible to create under the Commonwealth Renewable Energy Target Scheme. Most HPWH suppliers publish these values on their websites and in product brochures. As STCs provide an indication of the electricity displaced (or 'saved') by a HPWH, rather than its energy efficiency, this is not the most suitable measure to compare the energy efficiency of models.

Some manufacturers and suppliers also publish explicit indicators of energy efficiency, which are often given as 'coefficient of performance' (COP) values.[2] The published values are not presented consistently, and often the efficiency levels presented can only be achieved at the most optimal conditions, which are not representative of typical performance. This is rarely explained in manufacturers' literature.

During 2010-2011, three independent laboratories were commissioned by the Equipment Energy Efficiency Committee (E3) to test a total of 13 HPWH models representing approximately 90% of HPWH sales in Australia and New Zealand. Figure 2 presents the divergence between the independently commissioned energy savings estimates and the claimed savings by the manufacturers. The figure shows that while HPWHs generally use less energy than ESWHs, the range of energy savings claimed by manufacturers were higher than those from the independent tests. The overstating of energy savings by competitors is likely to reduce the potential sales benefits a manufacturer would gain through improved energy efficiency, unless their claims are also overstated.

Figure 2 Energy savings compared with electric resistance water heater reference model (E3 2012)



Note: After the completion of testing, Model 8 was found to operate with a manufacturing fault that compromised the tested performance of this model.

Performance issues

From a consumer's perspective, it is critical that a HPWH is not only energy efficient, but firstly also meets their performance expectations. A review of online forums and consumer reviews suggests that many consumers have found the HPWH they purchased was less efficient than expected and did not meet expectations in terms of performance, with criticisms relating to high levels of noise and insufficient hot water.[3] There have also been instances of state and territory housing bodies installing HPWHs and then replacing them with alternative water heating technologies due to client dissatisfaction.

The independent tests by E3 confirm that many models have performance issues, including relatively poor energy efficiency, especially at low temperatures, very long heat up times, and excessive noise (E3 2012). The range of performance issues identified through testing, combined with the lack of reliable information on these measures of performance further complicates the purchase decision. If buyers find the decision too difficult, they are more likely to rely on an agent, and exacerbate any principal-agent issues.

As a consequence of the lack of complete, consistent and reliable information on HPWH performance:

- Prospective buyers cannot be assured of getting a product that performs adequately in meeting their needs;

[2] For example, a COP of 3 means that 3 kWh of heat energy is transferred to the water for every 1 kWh of electricity used by the heat pump (referred to as 300% 'efficient'). Electric resistance water heaters would have a COP just below 1.0 (although with electric resistance technology this is usually described as near-100% 'efficiency').

[3] Whirlpool forum , Whirlpool forum and Product Review forum

- Consumers who are motivated to do so are unable to reliably identify appliances with better energy efficiency (and avoid inefficient ones); and
- There is limited market pressure on suppliers to improve product performance.

The capability for consumers to use consumer law to protect themselves from products they believe are not satisfactory is reduced when testing cannot not be independently conducted and clear benchmarks are not available.

Consumer behaviour

The BIS Shrapnel (2012) survey found the initial point of contact for 40% of buyers of replacement water heaters was a plumber, for 19% an energy retailer and 18% a hot water specialist. About three quarters of replacement water heaters are purchased through the first point of contact, so the influence of plumbers and installers is very high. This strong reliance on plumbers for advice results in a high potential for split incentive problems to influence the market. Although the BIS Shrapnel surveys were conducted in Australia, it is likely that consumers behave in a similar manner in New Zealand, considering the same market failures and purchasing dynamics are understood to apply.

Relationship between price and key performance features

A preliminary analysis of purchase prices of the nine models tested in Australia found no clear relationship between purchase price and energy efficiency, hot water delivery rates, cold temperature performance or noise (E3 2012). The models tested were widely available in both Australia and New Zealand. While this analysis was only preliminary, it does suggest that many of the key performance characteristics of HPWHs, including energy efficiency, are not directly influencing price, suggesting the possibility of market failure. If price and performance were found to be weakly related throughout the market, and this relationship did not improve with better information, the impacts of split incentives may be unintentionally muted.

A comparison of the relationship of energy efficiency and capital cost on sales cannot be presented without identifying individual brands, and would not be compatible with the confidentiality constraints surrounding the available data.

Potential energy savings from addressing market failures

Options to address the identified market failures may realise three categories of benefits:

1. HPWHs supplied to the market will have a higher average energy efficiency than without intervention;
2. Consumers will be able to identify and select the more energy efficient products on the market; and
3. Consumers will be better able to select an appropriate model for their level of household water use and climate, further reducing energy consumption and increasing welfare.[4]

Secondary benefits likely to result include:

a. Improved availability of information on performance of features beyond energy efficiency that may also impact consumer satisfaction (e.g. hot water delivery, durability, recharge rates and low noise); and
b. Potential small reductions in peak demand on the electricity grid.

Therefore measures to address HPWH market failures could provide benefits for individual householders and for the Australian and New Zealand economies.

If measures to address market failures also resulted in consumers that have decided to buy a HPWH then being able to purchase the correctly sized and climate suited model, the difference between a 50% reduction and a 60% reduction would be 400 kWh, or $56 per year in Australia and $100 in New Zealand. Similar savings would occur if the average efficiency of HPWHs was significantly improved as proposed in the options.

Further analysis is presented in Section 4: Impacts, Costs and Benefits.

[4] There is a separate proposal to mandate the presence of demand response interfaces on electric water heaters, which if adopted would take effect at about the same time as the proposed MEPS for HPWHs. If that occurs, the interface is likely to become the main method of controlling load and reducing peak demand from all electric water heaters, and the additional load reduction due to increasing eater heater energy efficiency would be small.

3. Objectives and Options

Objective

> **To improve the energy efficiency of heat pump water heaters sold in Australia and New Zealand by addressing market failures related to information and split incentives that impact the heat pump water heater market, while key performance features are ensured.**

Although there are already relatively energy efficient and well performing HPWHs on the market, consistent and reliable energy efficiency information is not available to enable consumers to select a model suited to their circumstances. There are also instances where less energy efficient models may be purchased as a result of split incentives. Through addressing the identified market failures, the proposed options are expected to increase the average energy efficiency of HPWHs installed, saving consumers money. The proposed options also ensure standardised measurement of key performance features, including hot water delivery, recovery rate and noise to avoid performance of these key features being compromised to improve energy efficiency.

The options focus on two approaches, either improving information to enable purchasers to make choices that suit to their requirements, and/or applying minimum standards for circumstances where split incentives occur.

A range of regulatory and non-regulatory options were considered when finalising the set of policy options to be assessed in detail through this RIS. Measure 2.2.4 of the National Strategy on Energy Efficiency specifically states that MEPS and mandatory labelling of all water heaters, including specifically HPWHs, would be considered through a full RIS process. While the Strategy was prescriptive on the consideration of these two options, the Product Profile assessed a range of options, and consultation with stakeholders was also used to refine policy options for this RIS. The options considered have been developed to address identified market failures, while remaining cognisant of the likelihood of improving the consumer choice process. More detail on the previous consultation is presented in Appendix 5. A detailed justification of the policy options considered and the options selected for impact assessment in this RIS is presented below.

Options considered

Options that have been considered and viewed as unlikely to resolve the identified market failures if implemented alone are:

- Consumer education campaign;
- Voluntary efficiency standards and certification; and
- Dis-endorsement labelling

Justification is presented below.

Consumer education campaign

Information about energy efficiency, greenhouse gas abatement and methods to reduce consumer energy costs has been provided by government agencies, community organisations and energy utilities for decades. For example, in Australia advice is available from the Department of Resources, Energy and Tourism website and in New Zealand from the Energy Wise website.

The infrequent nature of water heater purchases and the specific detailed information required for individual circumstances limits the ability of a broad consumer education campaign to address the identified market failures. General consumer education will continue to operate in Australia and New Zealand and is no different from Business As Usual (BAU).

Plumber training manuals and courses were developed and released by E3 in 2010 as part of the implementation of water heater elements in the NSEE. The training had a strong focus on informing plumbers of the range of water heating technologies and has been used by registered training organisations in a range of states and territories. These manuals are still publicly available (see Plumber Training Handbook) and are considered part of BAU.

Low level consumer education is seen as an important component of potential labelling and MEPS proposals as it is unlikely many of the agents (plumbers, electricians, plumbing supply stores) are aware of the requirements of supplying labelled appliances. Education for agents and relevant retailers is also likely to improve the interpretation of information provided on a label.

Voluntary efficiency standards and certification

Voluntary efficiency standards and certification rely on equipment suppliers being encouraged to meet certain minimum energy efficiency levels voluntarily. A voluntary scheme covering HPWHs has already been operating in Australia for over a decade and assumed to continue under BAU modelling. The *Renewable Energy (Electricity) Act 2000*, administered by the Clean Energy Regulator (CER), allows STCs to be created by all installations of eligible solar water heaters or HPWHs. Although it is voluntary to register a model for STCs, the commercial advantage to suppliers has resulted in nearly all HPWHs being registered.

This voluntary scheme overlaps the proposal to the extent that it covers many of the same products. However there are many significant differences. The CER scheme:

- is voluntary, and does not cover all HPWHs available in Australia;
- does not cover New Zealand;
- only disseminates information about STCs and gives no information about energy use and other key performance factors; and
- relies on performance modelling that requires proprietary information from the suppliers. The reliance on proprietary information makes it difficult to verify results independently. The proposed measures in this RIS ensure all key data must be verifiable by an independent laboratory without reference to the supplier.

Given that the existing market failures persist, even though this voluntary scheme has been in existence for over a decade, it is unlikely it will resolve the identified market failures in the future.

Dis-endorsement labelling:

A dis-endorsement labelling scheme would involve the registration of all models, and mandate dis-endorsement (or 'warning') labelling for models where the supplier did not perform an energy test, did not wish to declare the tested efficiency, or where the product performed below a specified level. As the existence of dis-endorsement labels on products could reasonably be expected to have a negative impact on consumer perceptions, the application of this sort of label alone may result in a perverse outcome. Consumers may negatively perceive all the models, including systems that were not dis-endorsed, resulting in switching to other water heating technologies. As a result, a dis-endorsement label would require an alternative endorsement label to reduce the risk of damaging the reputation of the technology.

Considering the potential large benefits of an endorsement label, and the comparative small cost of testing a system, it is likely that manufacturers would test most models to see if they achieve the endorsement label requirements. As a result, a dis-endorsement/endorsement label approach would involve similar compliance, administrative and testing costs as a mandatory energy efficiency label. While the costs of a dis-endorsement/endorsement label scheme would be similar to an energy efficiency label, the benefits are likely to be smaller. As a result this option was viewed as unsuited for further investigation.

An alternative dis-endorsement label option will be tested on consumer focus groups to test its suitability for inclusion into the proposed energy label. The aim of the dis-endorsement information would be to identify models that have not been tested to ensure suitability to perform in cold temperatures. While the poor performance of some models in cold climates has commonly been a problem for consumers (Section 2), the actual share of sales of HPWHs in colder areas is small. To reduce testing costs and to enable manufacturers the flexibility to develop models exclusively suited to warmer climates, the proposed label will include a form of dis-endorsement to identify models that have not been designed for operation in cold climates. The inclusion of a dis-endorsement component was seen as the best option to allow innovation for models suited exclusively to warm or cold climates, while ensuring consumers can assess if models are suited to their climate.

As there is the potential for dis-endorsement information to impact consumer perceptions towards all HPWHs, as outlined earlier, a range of forms of presenting dis-endorsement will be considered (e.g. a cross over the cold zone, zero stars, or text suggesting units are not tested as suitable for operation in frost conditions). The final selection of the type of dis-endorsement will be informed by testing alternate options on consumers and installers.

Options selected for further consideration

The options considered worth investigating are:

- No action (BAU);
- Mandatory testing, registration and public disclosure of energy efficiency and key performance information;
- Mandatory energy labelling (i.e. disclosing the above information on labels fixed to each product);
- Voluntary labelling program;
- Minimum Energy Performance Standards (MEPS); and
- MEPS combined with disclosure or labelling.

Business As Usual

The Business As Usual scenario assumes that there are no changes to policy. Under this scenario the HPWH market would continue to operate as it does now, with model energy efficiency improving at a relatively slow rate. There would be no legal requirement to provide comparable information on energy efficiency and no obligation on government or other independent parties to verify claims. As a result the extent and reliability of information available to consumers is unlikely to change, perpetuating existing market failures concerning information barriers and split incentives that will continue to impact consumer choice processes.

Mandatory registration and disclosure

Mandatory energy efficiency testing and registration of the results with the Regulator underpins all the options. In Australia, new regulations under the *Greenhouse and Energy Minimum Standards Act 2012 (GEMS 2012)* would require all HPWH models to be registered with the Regulator as a condition of lawful supply.[5] In New Zealand, registrations are required by regulation. The test results and the calculation of the required indicators and metrics submitted to the Regulator would be published on the Energy Rating website. This would significantly improve the reliability and comparability of the energy efficiency information available in the market. However, the technical nature of the information and the difficulties of accessing it at the right time in the water heater selection process are likely to constrain the ability of this option to resolve the range of information problems identified.

Knowing that performance information on their models will be publicly disclosed and can be compared with their competitors is likely to drive manufacturers to increase the energy efficiency of their products more rapidly than otherwise, even before consumers change their preferences. This 'anticipatory' market response has been observed at the introduction of energy labelling for other products (GWA 2011). Mandatory energy efficiency and performance disclosure should strengthen preference for more efficient models and so drive up the average energy efficiency of products, although the extent to which it can do so may vary according to whether it is combined with energy labelling and/or MEPS.

A system of mandatory registration and disclosure would require all HPWH models' energy efficiency to be tested in a consistent way. The Product Profile, and submissions received, supported the development of a revised physical test that is better suited to a mandatory registration system and associated compliance processes. A Working Group to develop a suitable test procedure has been established and a draft test developed.

The draft test procedure is expected to test all HPWHs for energy efficiency and hot water delivery at relatively warm temperatures. Products designated as suitable for cold climates will be required to be tested at an additional cold temperature point to ensure these systems deliver sufficient hot water with adequate energy efficiency in low temperatures. Products designated as suitable for cold climates will include both models suitable for low temperature operation without electric boosting and with electric boosting, defined as Class A and Class B systems in AS/NZS 5125. The required minimum COP for Class A and B may be different, to account for the fact that Class B HPWHs will be operating as electric resistance water heaters for some proportion of the time.

Key performance requirements

From a consumer perspective, it is critical that a HPWH is not only energy efficient, but first meets performance needs in other ways that may impact satisfaction with their choice. While energy efficiency benefits are the main subject of this RIS, it is important that products also provide an adequate hot water service. Other appliances regulated for energy efficiency have minimum performance requirements; for example, washing machines and dishwashers are tested to ensure they clean adequately. Without performance requirements for HPWHs, there is a risk that increases in energy efficiency will be achieved by compromising the ability of the product to deliver its

[5] S14 of the GEMS Act states that 'A supply of a GEMS product includes a supply of the product by way of sale, exchange, gift, lease, loan, hire or hire-purchase.'

intended service, reducing consumer satisfaction (utility). For example, greater apparent energy efficiency may be achieved with a slower heat up time or lower maximum temperature, increasing the likelihood a household will run out of hot water. More powerful compressors could heat water faster but may be noisy. The Product Profile thoroughly assessed the potential for unintended consequences in energy efficiency regulation of HPWHs and suggested energy efficiency testing and registration should include standard metrics for:

- Hot water delivery (the volume of hot water that can be drawn off at a useful temperature);
- Recharge rates (the volume of water that can be heated in a given time); and
- Noise.

It is therefore important that any proposals to increase the energy efficiency of HPWHs are implemented with key functional performance requirements to ensure any energy efficiency gains are not achieved by changing the models in a way that reduces consumer satisfaction. It is therefore important that measurements of hot water delivery, recharge rates and noise are implemented at the same time. Specifically *ISO 3741 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms*, will provide the basis for noise testing, while the energy efficiency test currently under development will provide measures of hot water delivery and recovery rates.

Mandatory energy labelling

Mandatory labelling is more likely to improve the consumer choice process through reducing information barriers than mandatory registration and disclosure alone, as the energy efficiency label is designed to communicate the information effectively at the point of sale or supply. This process assists consumer interpretation, but would impose the additional small cost of fixing a label to every unit produced. The high recognition rate of mandatory energy labels by consumers in Australia and New Zealand would also improve the likely impact of labelling HPWHs (Artcraft 2003).

At present physical energy labelling is applied in Australia to only gas water heaters under a certification scheme required by safety regulators. This scheme was initially introduced and administered by the Australian Gas Association (AGA).[6] Energy labelling of HPWHs will reveal the wide range in energy efficiencies and the influence of climate on performance at a point in the purchase process where it is likely to have some influence (at least on those buyers making their own selection rather than leaving it t0 an intermediary). It is also likely that some plumbers and builders will modify the range of options they offer consumers once it is clear that consumers may question their advice after sighting the information on the label.

Climate Rating Labelling

The energy efficiency test under development will provide a measure of energy efficiency of a HPWH while simulating the hot water use of a typical household over a day. In an actual installation, the air temperature and humidity will vary over the course of every day, and over the year as conditions change with the daily and seasonal variation of the climate.

The key features of the proposed energy label for heat pump water heaters are likely to include:

- A star rating to compare that model's climate energy efficiency with other HPWHs and possibly with water heaters of other types;
- Information to either endorse or dis-endorse the suitability of the HPWH for installation in a cold climate;
- Estimated annual electricity consumption; and
- Estimated noise level.

The proposed European Union (EU) water heater label for water heaters of all types, including HPWHs, presents an estimate of annual energy consumption for average, warm and cold climate zones (Appendix 2; European Commission: Energy labelling of water heaters PDF). The physical test procedure that underpins the proposed EU label is similar to the testing procedure that is being developed to underpin energy efficiency regulations in Australia and New Zealand.

Providing the market with a consistent measure for climate performance of all water heaters through a standardised label, as proposed to be deployed in the EU, would be likely to alter the consumer choice process through reducing the information barriers that have also been identified. A separate Equipment Energy Efficiency (E3) Program project to develop a consistent label for all water heaters, space heaters and domestic air conditioners will be finalised in 2013 to provide the label design for Australian and New Zealand HPWHs. The

[6] The Australian Gas Association product directory

suitability of applying the same principles used for the EU water heater label to the Australia and New Zealand markets will be investigated in the benefit-cost analysis below (Section 4).

Voluntary energy labelling

A voluntary energy labelling option could take several forms. One approach would be an industry-led scheme, which may not require government involvement with any aspect of the process. Another approach is where industry could voluntarily adopt the 'mandatory' labelling requirements developed by government, including being subject to compliance and enforcement activities. Both options would be directed at addressing the information barriers in the HPWHs market, by providing information to consumers and agents.

The extent to which a voluntary labelling option could achieve the objective of improving the energy efficiency of HPWHs (see p.13) would depend on various factors, not least: the level of uptake of a labelling scheme by current and future manufacturers; the level of trust placed in the labels by consumers; and the rigour of associated testing, compliance and enforcement activities. Voluntary labels could be expected to be adopted by higher performing models and avoided by lower performing models as presenting performance on a label is expected to only provide a commercial advantage for higher performers. Therefore a voluntary labelling scheme would be expected to provide a form of endorsement for higher performing models, but not necessarily improve information available on lower performing systems. A more particular issue for HPWHs is whether a voluntary would deal with climate suitability issues, noting that there appears to be limited commercial incentive to label models with poorer performance.

While a voluntary labelling option may be effective in partially addressing the government's objectives, it remains open to question whether the characteristics of the HPWH market, and the incentives on manufacturers, would lead to a suitable label with sufficient level of uptake, to provide a cost-effective intervention relative to other options. No such scheme has emerged to date and limited interest was shown by industry in voluntary labelling during the previous round of consultation on this proposal in the Product Profile. Moreover, irrespective of the level of uptake, we expect that most manufacturers will test their models against a common standard to determine if disclosing the model's performance would provide a commercial advantage. As testing is a major cost of labelling, the overall costs of a voluntary approach could be broadly similar to a mandatory regime, but the benefits would be less assured.

Minimum Energy Performance Standards (MEPS)

Mandatory registration and energy labelling address information failures but not split incentives. The most direct instrument for addressing the split incentive problems is MEPS.

The electric storage water heater market in the 1990s exhibited the same split incentive and information failures as are evident now for HPWHs. The dynamics of the market for this product and the purchase decision process at the time made it unlikely that energy labelling alone would be effective (GWA and LBL 1993). Therefore, MEPS was the only measure assessed as effective at the time. As a result, MEPS for electric storage water heaters were adopted in 1996 and took effect in 1999. The measure was effective and ESWH energy efficiency increased as predicted.[7]

MEPS would be effective in raising the average energy efficiency of HPWHs in the segments of the market where split incentives exist and mandatory information disclosure and labelling would have little effect.

In countries such as Switzerland, where energy labelling and incentives have had some impact on the water heater market (including encouraging the adoption of HPWHs), the market segments subject to split incentives have proven impervious to all measures other than MEPS (Kemna at al 2007). The EU has adopted MEPS as a key measure in its proposed water heater energy efficiency regulations to ensure that split incentive issues are addressed (EC 2013).

Combined MEPS and disclosure or mandatory labelling

MEPS would require a testing, registration and disclosure process. MEPS options can also be combined with a labelling program. As the identified market failures are not completely addressed by either MEPS or disclosure and labelling alone, a combination of the approaches may have advantages. The combined costs or benefits of MEPS and labelling are not simply additive. The increase in HPWH energy efficiency forced by MEPS reduces the scope for gains though labelling, and vice versa. Nevertheless, the combined impacts would be higher, which would have a greater impact on consumer behaviour, and as a result, on the market, than MEPS and information disclosure

[7] Before ESWH MEPS were implemented, no ESWH models reached the MEPS level and there was no BAU trend of increasing efficiency. After implementation, all products met the new MEPS level.

alone. There are also likely to be considerable efficiency in testing and registration costs if MEPS and labelling are implemented together.

Options Assessed

The analysis of impacts, costs and benefits includes detailed analysis the range of options outlined in Table 1.

Table 1 Summary of options

Option	Date of effect	Information Disclosure	MEPS based on performance in Zone 3 (Zone 3 includes Sydney, Perth, Adelaide)	MEPS based on performance in Zone 5 (Zone 5 includes Canberra)
Business As Usual (BAU)	N/A	N/A	N/A	N/A
Option 1: Registration only	2014	Registration only	N/A	N/A
Option 2: Labelling only*	2015	Climate Rating Label	N/A	N/A
MEPS Option A + Labelling (MEPS equivalent to existing claims)	2014	Climate Rating Label	60% saving – all models	50% saving if supplier designates model suitable for cold climates. Otherwise no requirement
MEPS Option B + Labelling	2015	Climate Rating Label	65% saving – all models	55% saving if supplier designates model suitable for cold climates. Otherwise no requirement
MEPS Option C + Labelling	2015	Climate Rating Label	65% saving – all models	60% saving if supplier designates model suitable for cold climates. Otherwise no requirement
MEPS Option D + Registration	2014	Registration only	60% saving – all models	50% saving – all models
MEPS Option E + Labelling**	2015	Climate Rating Label	Remove least efficient 20% of models according to Zone 3 rating	Remove least efficient 20% of models according to Zone 5 rating

**Mandatory labelling was modelled. This provides an estimate of the upper bound of potential impacts, costs and benefits of voluntary labelling*

***MEPS Option E was rejected; refer to Appendix 4 for justification.*

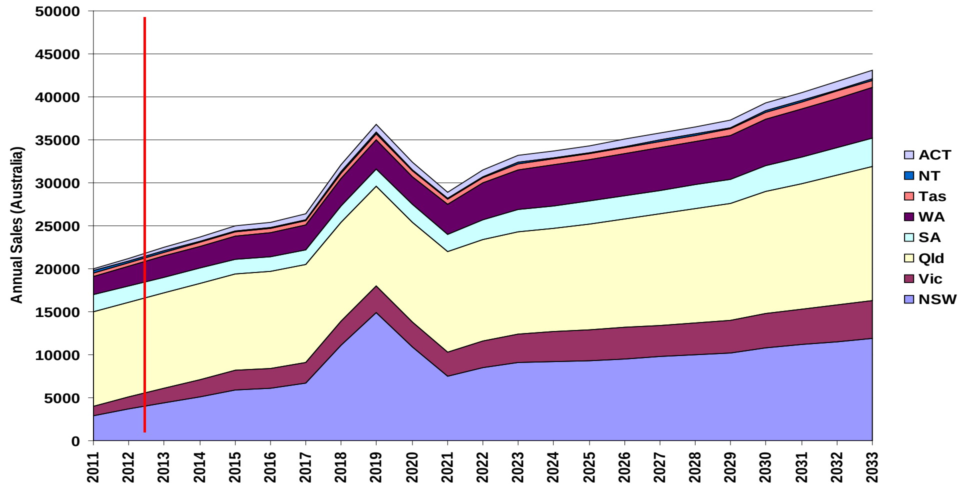
Further detailed discussion of the individual options assessed is presented in Appendix 3. Figure 10 in Appendix 2 provides a map of the relevant climate zones.

4. Impacts, Costs and Benefits

The potential options decided for further investigation were assessed through a benefit-cost analysis to determine the options that best improve the consumer choice process by addressing the identified market failures with the highest net benefit. Analysis focused on the primary benefit of energy cost savings for HPWH consumers with analysis over a 20 year timeframe using the best available datasets and conservative assumptions where uncertainty existed. Additional sensitivity analysis was conducted to assess the impacts of three assumptions (projection periods, discount rates, price-efficiency ratios) that were deemed to have a significant impact on benefit-cost analysis. A limited analysis of secondary benefits was undertaken. More detail on the benefit-cost modelling is presented in Appendix 3, while a brief summary of input data, scenarios and key assumptions is available in Appendix 4.

Data

Figure 3 Projected HPWH sales, Australia, 2011-2033



**Note the projected surge in sales around 2019 reflects the expectation that most of the HPWHs installed in 2009 will have reached the end of their service lives, and about half would be replaced with new HPWHs (E3 2012)*

The benefit-cost analysis of options is underpinned by data sources of relatively high quality, when compared with what is usually available to assess the merits of energy efficiency regulation of other appliances. The Clean Energy Regulator's database provided the details, including location and model details, for all HPWHs that received the financial incentive of STCs. The attraction of the financial incentive means that the great majority of installations claim STCs, so this dataset provides a good proxy for individual model sales, aggregated by year and location. Data from 2011 was used as the base year for projections because 2010 sales were inflated by the availability of rebates and the 2012 sales data were incomplete.

The sales projections for Australia in Figure 3 are based on current HPWH installation rates and projected building rates. New Zealand sales are projected to be about 750 in 2013, rising to 1,000 per year by 2033, based on New Zealand Hot Water Association estimates.

There is no adjustment for projected sales in the event that the proposed measures may increase capital costs, because:

1. Water heaters are a critical household service, and consumers will not forgo water heating even if capital prices increase;
2. Similar energy efficiency measures for competing water heater technologies are being considered, as outlined in the National Strategy on Energy Efficiency, for implementation over similar timeframes, so cost relativities are likely to remain roughly constant; and

3. The increased energy efficiency of HPWHs as a result of proposed energy efficiency measures is expected to increase the financial benefit of STCs, reducing the impacts on upfront cost.

The capital costs of HPWHs and the share connected to day rate and off-peak tariffs were obtained from BIS Shrapnel (2012). The energy price projections take into account current Australian Energy Regulator price determinations. The annual energy consumption of HPWHs for specific locations, hot water demands and tariffs were derived from Pitt & Sherry (2012). Further details of the data and assumptions that underpin this analysis are available in Appendix 3.

Sales-weighted energy efficiency

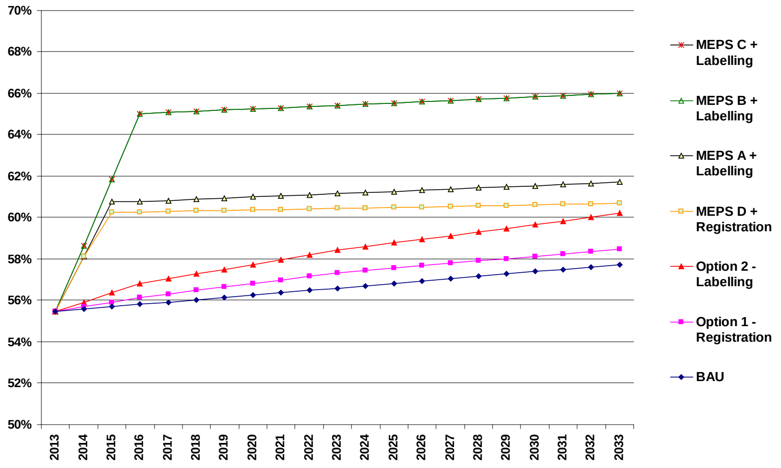
The energy efficiency of HPWHs in the Australian and New Zealand market in 2011 was assessed and determined by independently commissioned laboratory testing of models that represented 90% of Australian sales in 2011. Some of these models are also available in New Zealand. When combined with the proxy sales data in Figure 1, this enabled historical sales weighted energy efficiency trends to be estimated with a high level of confidence.

With the introduction of mandatory registration and information disclosure (Option 1), it is likely that some suppliers will improve the efficiency of their model range prior to having to make the information public to avoid negative impacts on brands. Some buyers will respond to this information by preferring more efficient models, so driving a further increase in sales-weighted efficiency. The supplier and consumer response to the mandatory physical labelling of products is projected to be somewhat greater.

The projected impacts of energy labelling and the various MEPS options on model energy efficiency are illustrated in Figure 4 (further details in Appendix 3). The BAU line trends slowly upwards at a constant slope. The sales-weighted energy efficiency of HPWHs is projected to increase at 0.2% per annum under BAU (as measured by the metric '% energy saving'). The mandatory registration and disclosure plus energy labelling trend lines diverge from BAU fairly smoothly – more steeply at first, as suppliers change their models, then more gradually as consumers make use of the information to change their preferences. Similar changes in sales-weighted energy efficiency were observed around the time of previous product energy label introductions for including air conditioners and refrigerators (E3 2011).

The MEPS trend lines of sales-weighted efficiency rise steeply, because suppliers would be required to ensure that every model met the MEPS level by mid-2014 (MEPS A and D) or mid-2015 (MEPS B and C). If there was no labelling, the sales-weighted average efficiency would change at relatively slow rate after MEPS introduction, but with labelling there would be a continuing incentive for both suppliers and consumers to seek further improvement.

Figure 4 Projected sales-weighted '% energy savings' compared with reference models (Zone 3)



Categories of costs and benefits

The primary benefit-cost analysis estimates the capital cost increase of HPWHs resulting from energy efficiency changes as well the 'program costs' associated with additional product testing, registration and government administration. These costs are compared to the benefit of lower average ongoing energy costs to HPWH users. Both cost increases and energy savings are compared with the BAU case. If the net present value of energy savings less cost increases is positive, the proposal is cost-effective. Secondary benefits are considered qualitatively.

This RIS quantifies the benefits and costs for a group (or 'cohort') of HPWHs installed in the 20 year period 2014 to 2033. As the average HPWH is estimated to remain in service for about 10 years, the energy benefits extend to cover the lifecycle of this group of HPWHs. The main aspects of the quantified benefit-cost analysis are summarised below. Full details are given in Appendix 3.

Costs

Two main categories of cost are taken into account: program costs incurred by the government from the cost of implementation of the GEMS program, and the increase in capital cost required to make products that are more energy efficient, quieter and better performing, on the assumption that such improvements require better quality components, more materials or greater skill and time to manufacture. This RIS assumes that any increases in product design, construction, testing and registration costs will be incurred by the manufacturers in the first instance and then passed on to suppliers and customers. Administrative costs to government are also included in program costs, although they will be borne by the taxpayer.

Testing and registration

The recent commissioned test program suggests that extra testing costs (beyond those already being incurred voluntarily) and registration fees will amount to $10,000 per model. Suppliers would be able to register via the Energy Rating website, using procedures that are well established for other products.

All models that remain on the market after the start of a mandatory program (whether registration only, labelling, MEPS or all of these) will need to be tested to the prescribed standards. There are about 80 HPWH models on the market at present.[8] It is assumed that there will be 70 HPWH models on the market at the time of implementation of the proposals in this RIS (some already on the market, some yet to be introduced). This means a total initial testing and registration cost of $0.7 M. It is assumed that 5 new models are introduced each year, so the ongoing testing cost to suppliers is $0.05 M per year.

Further information on the costs of testing and registration is available in Appendix 3.

Labelling

It is estimated that physical labelling, along with the provision of images of the labels in advertising and brochures, will add 50c to the retail price of each unit sold. At projected sales of about 24,000 units in FY 2015, the labelling costs in the first year of the program would be $ 0.012 M, rising annually with sales.

A voluntary labelling scheme was not specifically modelled due to a high level of uncertainty surrounding the likely level of voluntary uptake. The mandatory labelling option that was investigated provides a good estimate of the upper bounds of costs, benefits and B/C ratios of a voluntary scheme. The costs of a voluntary scheme would be similar to a mandatory labelling scheme as most manufacturers are expected to test their models to assess if presenting the performance on the label would provide a competitive advantage. The benefits would be dependent on the level of uptake of the label, quality of information provided and consumer trust of the information provided. It follows that unless there was complete uptake and high consumer trust in the information the net benefits and the benefit/cost ratios for voluntary labelling would also be lower.

Product redesign

Energy labelling enables suppliers to align the redesign of products to improve energy efficiency with the regular product development cycles, so costs can be minimised. However, the time available for redesigning models to meet a MEPS deadline is constrained, so costs will most likely be higher. Alternatively, some importers may need to source alternative models from other manufacturers in order to remain in the market. This would also incur costs for those businesses. An amount of $50,000 has been allowed for each model that would need to be redesigned or replaced. The estimated number of models needing replacement and hence the total costs to industry would depend on the stringency of the MEPS level (Appendix 3). This once-only cost is fixed for each model redesigned and is separate from the capital cost impacts of manufacturing more energy efficient units.

The supplier costs borne by manufacturers of models that are unique to New Zealand are calculated separately. As the average sales per model are lower than in Australia, the negative impact on overall cost-effectiveness is greater.

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[8] *Register of solar water heaters – Air Source Heat Pump models with capacity of up to 425 litres, V14* (CER 16 October 2012). 80 models are eligible to create STCs after 1 November 2012. An additional 322 registrations expired on 31 October 2012.

Government administration

The administrative costs to government can be gauged from the present E3 program allocations for water heating products. However, some fixed costs are shared with other regulated products (e.g. the maintenance of the website) while the variable costs should be lower due to the smaller size of the HPWH market.

Total government program costs are estimated to be $75,000 per annum in Australia. New Zealand administrative costs are estimated at NZ$10,000 per annum.

Capital cost impacts

Increasing the energy efficiency of HPWH designs in response to MEPS or energy labelling would require physical changes in their materials, components and construction. The relationship between the resulting increase in consumer price and increases in energy efficiency is expressed as a 'Price/Efficiency' (PE) ratio. A PE ratio of 100% means that if energy efficiency increases by 10%, price also increases by 10%. A PE ratio of 50% means that if energy efficiency increases by 10%, price increases by 5%.

Based on the assumptions used in RISs for other refrigeration products (see Appendix 3) the impact analysis assumes a PE ratio of 50%, which results in an estimated average increase in costs for all models sold of between $18 and $192 per unit sold. Although there is no capital cost impact on models that already meet the MEPS, there is a cost impact both for products that are manufactured to higher standards after redesign, and also due to changing consumer preference due to labelling (i.e. even without MEPS, if consumers preferred the more efficient of the existing models, the same PE ratio would apply).

This is a conservative assumption. The BIS Shrapnel 2012 survey noted a *decline i*n the average net costs of HPWHs to consumers of 25% between 2010 and 2012 even though a range of manufacturers have developed and released new models, with claimed design improvements, over the same period. A sensitivity analysis has also assessed the impact of both lower (20%) and higher (100%) PE ratios.

The economic impacts of the proposed measures on capital cost were assessed net of changes in STCs because they represent a cross-subsidy from electricity users to buyers of HPWHs.

Summary of costs

Table 2 summarises the costs for the option with the highest projected energy savings (MEPS C and labelling). The allocation of costs between consumers and industry is somewhat arbitrary. Suppliers will need to incur the manufacturing costs of producing more efficient appliances, but this cost is allocated to consumers. Ultimately, it is expected that all other 'industry' costs will also be recovered from consumers through higher product prices.

Table 2 Summary of costs, Australia and New Zealand, MEPS Option C plus labelling

	Australia (a)			New Zealand (b)		
	Year 1	Subsequent years	PV 2014-33	Year 1	Subsequent years	PV 2014-33
Consumers	$0	Varies	$81.9 m	$0	Varies	$4.2 m
Industry	$2.70 m	$ 0.06 m	$3.1 m	$0.25 m	$0.10 m	$ 0.4 m
Government	$0.08 m	$ 0.08 m	$ 0.6 m	$0.01 m	$0.01 m	$ 0.1m
Total	$2.78 m	Varies	$85.6 m	$ 0.26 m	Varies	$ 4.7 m

(a) $A values, PV at 7% discount rate (b) $NZ values, PV at 5% discount rate

Benefits

The primary benefits come from the reduction in the quantity (in GWh) and hence cost of electricity required for HPWH operation due to greater energy efficiency. The only other category of benefit that can be quantified with reasonable confidence is the reduction (in kt CO_2-e) in greenhouse gas emissions associated with electricity use. It is assumed that a price for greenhouse gas emissions will continue to be internalised in energy prices, so it is not necessary to assign a separate value to the potential benefits of emissions reductions.

The tariff-weighted price projections enable the calculation of the annual and lifetime electricity costs for all HPWHs installed up to 2033. The stream of energy expenditures can be expressed as a present value (PV) using a suitable discount rate. The base discount rate used for the Australian analyses is 7%, with sensitivity tests at 3% and 11%. The New Zealand analyses use a base discount rate of 5%, as required by EECA.

Total costs and benefits

Australia

The total costs and benefits of the measures for Australia, at a discount rate of 7% and PE ratio of 50%, are illustrated and summarised in Table 3 and Figure 5. Over the period 2014-33 benefit-cost (B/C) ratios vary from 1.8 to 2.3. The measures would be cost-effective under all combinations of assumptions and options (Appendix 3). The highest net benefits ($M 108.1) are projected to occur under the most stringent measure (MEPS C and labelling).

Figure 5 Costs and benefits of measures, HPWHs installed 2014-33, Australia (7% discount rate)

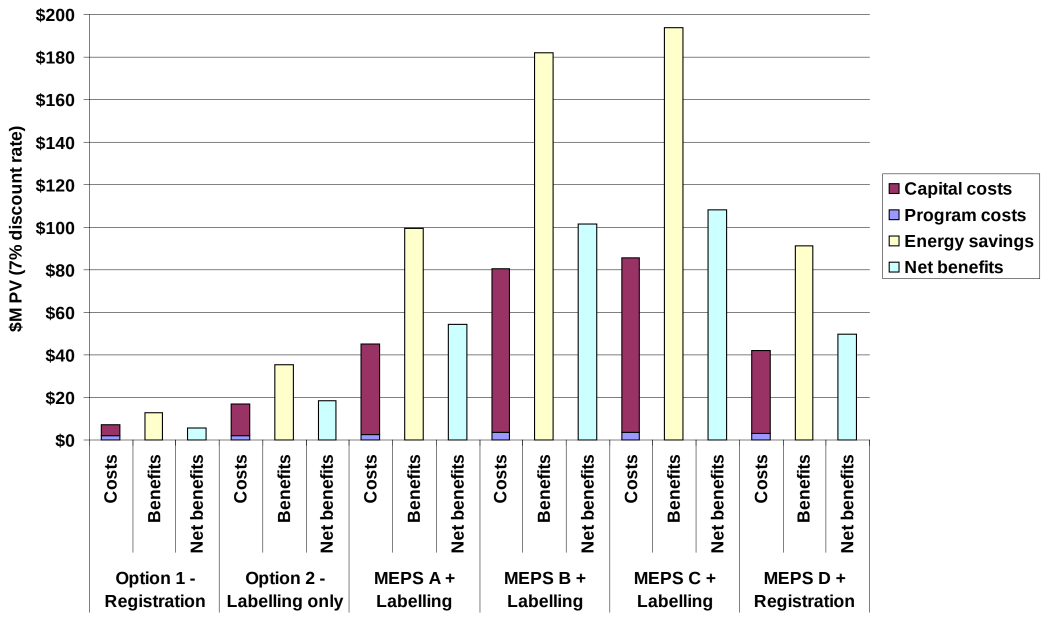


Table 3 Impacts, costs and benefits, HPWHs installed 2014-33, Australia (7% discount rate, 50% PE)

Measure	Program costs $M PV	Capital costs $M PV	Total cost $M PV	Energy savings $M PV	Net benefit $M NPV	Benefit/ Cost ratio	GWH saving	kt CO_2-e saving
Registration only	$1.8	$5.3	$7.1	$12.6	$5.5	1.8	127	94
Labelling only (a)	$1.9	$14.7	$16.7	$35.2	$18.5	2.1	359	264
MEPS A + labelling	$2.8	$42.4	$45.2	$99.3	$54.1	2.2	888	670
MEPS B + labelling	$3.5	$76.8	$80.3	$182.0	$101.8	2.3	1689	1275
MEPS C + labelling	$3.7	$81.9	$85.6	$193.6	$108.1	2.3	1795	1342
MEPS D + reg	$3.1	$37.0	$40.1	$87.1	$47.0	2.2	773	586

(a) Without accurate information on the likely uptake of a voluntary label scheme, it is not possible to model the likely net benefits of a voluntary application of labelling with any degree of certainty. Mandatory labelling has been modelled, which also provides an indication of costs, as well as an indication of the upper bound of net benefit and B/C ratios of voluntary labelling.

New Zealand

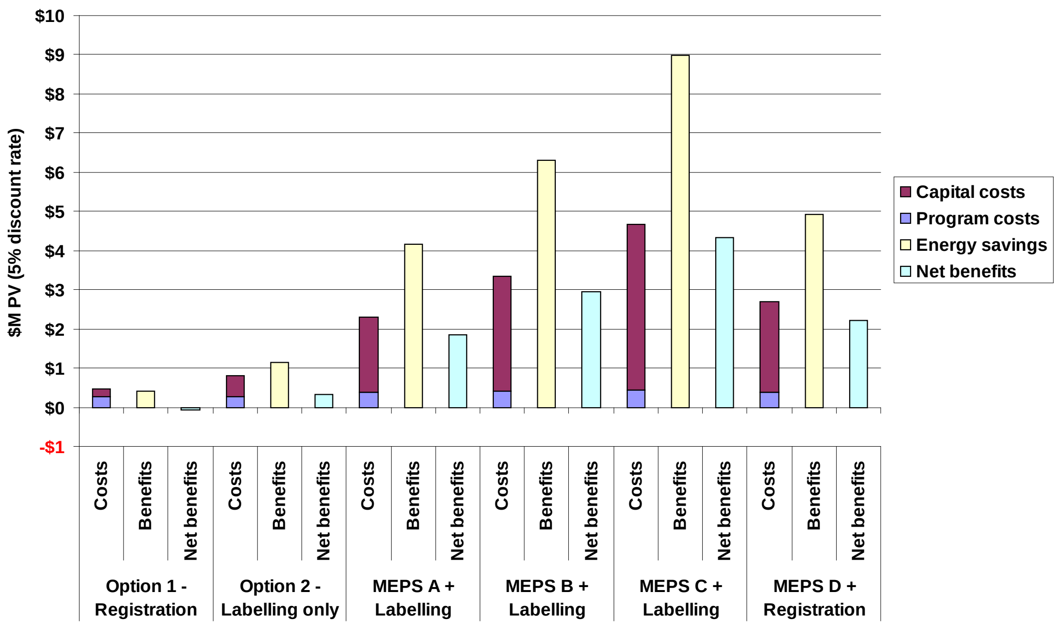
The total costs and benefits of the measures for New Zealand, at a discount rate of 5%, are summarised in Table 4 and Figure 6. The B/C ratio varies from 0.9 for Registration only (i.e. the costs slightly exceed the benefits) to 1.9. The highest net benefits ($M 4.3) are projected to occur under the most stringent measure (MEPS C) and labelling.

Table 4 Impacts, costs and benefits, HPWHs installed 2014-33, New Zealand (5% discount rate, 50% PE)

Measure	Program cost $M PV	Capital cost $M PV	Total cost $M PV	Energy savings $M PV	Net benefit (cost) $M NPV	Benefit/ Cost Ratio	GWH saving	kt CO_2-e saving
Registration only	$0.3	$0.2	$0.5	$0.4	($0.1)	0.9	3.4	0.5
Labelling only (a)	$0.3	$0.5	$0.8	$1.1	$0.3	1.4	9.7	1.3
MEPS A + labelling	$0.4	$1.9	$2.3	$4.2	$1.8	1.8	32.4	4.4
MEPS B + labelling	$0.4	$3.0	$3.4	$6.3	$2.9	1.9	50.1	6.9
MEPS C + labelling	$0.4	$4.2	$4.7	$9.0	$4.3	1.9	71.7	9.8
MEPS D + reg	$0.4	$2.3	$2.6	$4.8	$2.1	1.8	37.3	5.1

(a) Without accurate information on the likely uptake of a voluntary label scheme, it is not possible to model the likely net benefits of a voluntary application of labelling with any degree of certainty. Mandatory labelling has been modelled, which also provides an indication of costs, as well as an indication of the upper bound of net benefit and B/C ratios of voluntary labelling.

Figure 6 Costs and benefits of measures, HPWHs installed 2014-33, New Zealand (5% discount rate)



Sensitivity analysis

Sensitivity analysis was conducted to determine the impact of varying projection periods, discount rates and price-efficiency ratios. These variables were chosen for further investigation due to uncertainty surrounding suitable levels for analysis and their potential to have a material impact on the benefit-cost analysis.

The potential net benefits were lower under a 10 year projection period, with the B/C ratios falling slightly to the range 1.5 – 2.2, compared with 1.8 – 2.3 for the 20 year projection period (at 7% discount rate). For New Zealand, the B/C ratios are also slightly lower under the 10 year projection period: 0.7 – 1.8, compared with 0.9 – 1.8 over 20 years (at 5% discount rate).

The sensitivity of proposed options to discount rates of 3% and 11% were assessed for Australia. B/C ratios are higher at lower discount rates because the PV of future energy savings rises more than the PV of future increases in capital costs. At 50% PE ratio, all measures are cost-effective under all discount rates, with B/C ratios ranging from 1.8 – 2.3 for the 20 year projection and 1.5 – 2.2 for the 10 year projection. For New Zealand, at 50% PE, all options (other than registration) have a B/C ratio of 1.0 or more at discount rates of 5%, 3% and 8%.

The sensitivity of the benefit-cost ratios to PE ratios was also examined. Even under a PE ratio of 100%, all measures are still cost-effective for Australia (B/C ratios ranging from 1.0 to 1.2 at a discount rate of 7%). For New

Zealand, a 100% PE ratio would reduce the B/C ratios for the non-MEPS options below 1, but MEPS A, B and C would still achieve B/C ratios of 1.0.

The main conclusion of the sensitivity analysis is that under almost all scenarios and assumptions, the benefits are greater than the costs. Further detailed information on the sensitivity analysis is provided the Appendix 3.

Secondary benefits

The impact analysis has focused on the primary benefit of the direct financial savings to HPWH buyers/owners from the lower energy costs of more energy efficient models. Addressing information barriers and split incentives in the HPWH market is likely to also have secondary benefits that that are more difficult to cost, including:

- Increased performance of features beyond energy efficiency (e.g. improved hot water delivery, less noise, improved cold temperature performance);
- Potentially a small reduction in energy demand at peak periods due to increased energy efficiency;
- Emissions abatement at a low or negative cost; and
- Potential increased sales of HPWHs.

Energy use and emissions

The higher average energy efficiency of HPWHs resulting from the proposed options would reduce electricity use (Figure 7 and Figure 8), potentially resulting in minor reductions in the growth in the need for generation and network capacity. The value of these benefits was not analysed. They would be relatively minor while HPWH market share is small.[9]The total projected reduction in electricity use in Australia from each policy measure compared with BAU is shown in Figure 7. For example, for HPWHs installed over the period 2014-33, labelling alone reduces total HPWH electricity use by about 360 GWh, or 3.8% compared with BAU. The option with the highest impact (MEPS C + labelling) reduces HPWH electricity use by nearly 1,800 GWh, or 19.1% over the 20 year period. Figure 8 shows the corresponding impacts for New Zealand. Although the shapes are similar, the impacts for New Zealand are of course much smaller in magnitude, because the market is only 3.8% the size of the Australian market in 2013, declining to 2.5% in 2033.

The projected reduction in electricity use in the single year 2033, from MEPS C + labelling, would be about 365 GWh in Australia, and 3.9 GWh in New Zealand.

Impacts by jurisdiction

The impacts in each jurisdiction for the option with the highest projected energy savings (MEPS C + labelling) are indicated in Table 5.

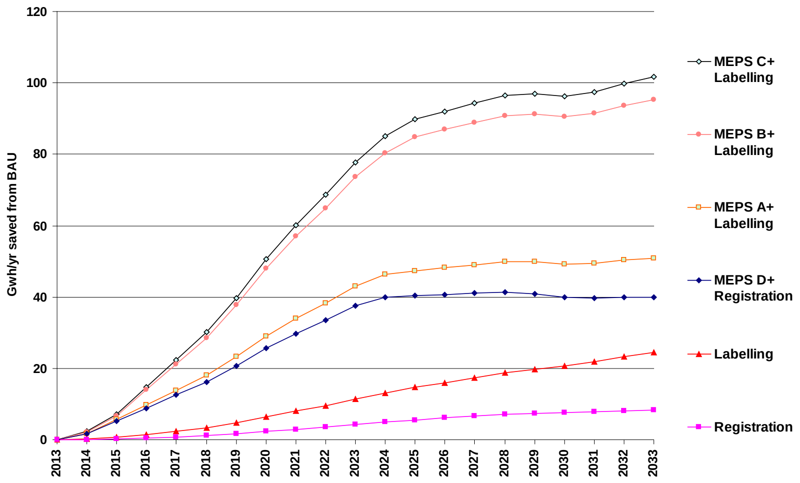
Table 5 Summary of projected impacts by jurisdiction, for period 2014-33, MEPS C + Labelling

	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Australia	New Zealand
Energy saved (GWh)	504	233	617	139	216	31	6	49	1795	72
Emissions saved (kt CO2-e)	408.7	145.7	511.3	67.2	157.7	7.1	4.2	40.5	1342	9.8
Total Benefit ($M PV)(a)	$50.0	$29.0	$62.1	$18.8	$26.4	$2.4	$0.7	$4.2	$193.6	$9.00
Total Cost ($M PV)(a)	$23.0	$11.3	$30.7	$5.9	$10.0	$1.9	$0.3	$2.4	$85.6	$4.30
B/C Ratio	2.2	2.6	2.0	3.2	2.6	1.3	1.9	1.8	2.3	1.9

(a)Present Value at discount rate of 7% in all jurisdictions except New Zealand, where discount rate of 5% is used.

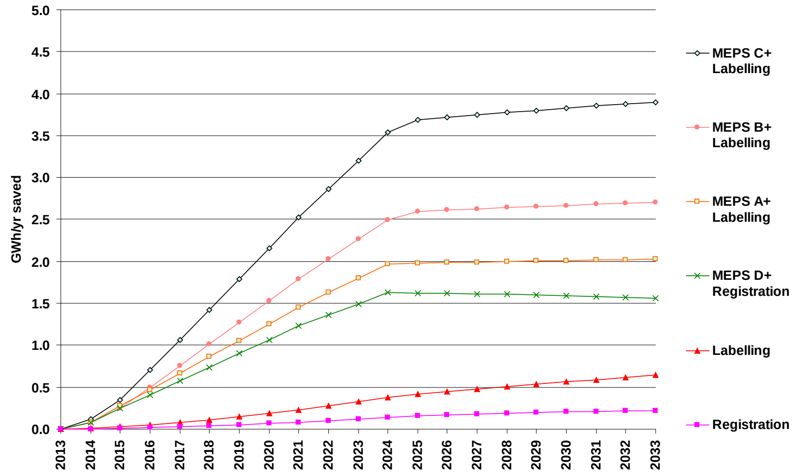
[9] There is a separate proposal to require all new electric water heaters sold after July 2014, including HPWHs, to have AS/NZS 4755 demand response interfaces. If that proposal is implemented, and there is a high use of the interface, the additional peak load management value of greater HPWH energy efficiency would be negligible.

Figure 7 Projected reductions in electricity consumption, HPWH installed 2014-2033, Australia



**Note that the savings for individual scenarios are not cumulative.*

Figure 8 Projected reductions in electricity consumption, HPWH installed 2014-2033, New Zealand



Note that the savings for individual scenarios are not cumulative.

Improved Performance

The energy efficiency testing that will underpin the proposed regulations requires other key measures of water heater performance, including hot water delivery, recovery rate and noise, to be measured on standard tests to ensure the energy efficiencies of models are compared on a level field. As noise is a commonly raised complaint with this technology, the standardisation of noise testing of HPWHs is likely to provide societal benefits by imposing less noise on neighbours. It is also likely that information on hot water delivery and recovery rates that will be provided as part of registering energy efficiency may result in models being designed that are more suited to consumer expectations.

Increased HPWH sales

Only about 3% of Australian homes currently have a HPWH, compared with more than 30% with an electric storage water heater (BIS Shrapnel 2012). In New Zealand, electric storage water heaters have a much greater share of the installed water heater market than in Australia, estimated at 77% based on 1996 Census data (Statistics New Zealand 1996) and a 2005 survey (BRANZ 2005). This indicates significant scope for HPWHs to increase market share in both Australia and New Zealand. If consumers are unaware of the energy efficiency benefits of HPWHs and associated lifetime cost savings compared with electric storage water heaters due to lack of information, they will forgo the possibility of energy savings of the order of 60 to 65%. If the proposed measures improve the consumer choice processes and lead to an increase in the market share of HPWHs, this will also increase the total benefit.

5. Market and Stakeholder Impacts

Industry

The Product Profile published in mid-2012 found 18 brands and about 80 separate models of HPWHs registered with the CER as eligible for STCs (E3 2012). As registration is voluntary this was not a complete list, and some brands have left the market and some have been added. Table 11 in Appendix 2 lists the suppliers and models in the market at the end of 2012.

Product testing, design and lead times

The HPWH markets in both Australia and New Zealand are quite diverse, with a range of product configurations, suppliers, brands, and countries of origin. The number of physically unique models is not known. Although 80 are listed with the CER, some suppliers sell the same models under different brands and some rebadge models obtained from other manufacturers. There are also some models in Australia that are not registered with the CER, and several in New Zealand, where STCs are not available.

If any of the options in this RIS were introduced, except voluntary labelling, all the models which suppliers intend to stay on the market after the implementation date (mid-2014 or mid-2015) would need to be tested to the appropriate standards. In a voluntary labelling scheme, manufacturers could avoid all testing costs by not participating. Irrespective of the level of uptake of a voluntary label, it is expected that the majority of models will be tested to assess if disclosing an individual model's performance would provide a competitive advantage. Testing could not begin until the revision of the standard is complete, which would be late-2013 at the earliest. If there are delays in the development of the standard, the implementation date may need to be changed to give a reasonable lead time.

It is estimated that about 70 models would need to be tested. There are at least four independent facilities in Australia and one in New Zealand with the capability to undertake the tests, in addition to the suppliers' own in-house testing facilities in Australia. It is also likely that overseas facilities in Asia and Europe, where similar HPWH test standards exist, could undertake testing. Therefore testing capacity should not be a problem.

The most stringent of the MEPS levels proposed for HPWHs require an energy saving of 22% compared with the average of models sold in 2011.

It is not unusual for a low number of models to achieve a new MEPS level when the level is first proposed. For example, only 25 to 30% of refrigerators and freezers on the market met the MEPS level when these were first proposed for those products, yet all met them by the time of implementation 3 years later (EES 2012). Independent testing of 13 commonly sold HPWH models suggests that only 1 model tested would achieve the most stringent MEPS option in conditions representing warmer climates (Zone 3) and no models would achieve the most stringent MEPS level in Climate Zone 5 conditions (Table 15).These estimates will be refined once the impacts of changes to the test standard, now underway, are analysed. The testing targeted models with high sales in 2010, so were typical of the range 4 to 5 years prior to the possible implementation of MEPS. A range of models with claimed efficiency significantly higher than the tested models were on the market in 2010, but were not tested. It is possible that the targeting of high sales models, with no testing of models that claimed high efficiency that were sold in low volumes in 2010, skewed the testing towards less efficient models.

Since testing was conducted, many of the models tested have been replaced. As energy efficiency improves through incremental product improvements under BAU, it is expected that many models will be available in mid-2015 that meet MEPS C, the most stringent level.

Testing of some recently released models, which are likely to still be on the market in mid-2015, is currently underway. The test results will provide an improved indication of the expected impacts of MEPS options on industry and consumers. If this testing finds the MEPS levels are likely to significantly impede competition by substantially constraining the availability of a range of models, or alternatively if the MEPS levels are found to not result in energy efficiency improvements, then alternative MEPS levels or implementation timeframes may be considered.

Plumbers, installers and builders

Plumbers, builders and hot water specialists are particularly influential advisers in the water heater purchase choice process. For project homes, the builder's influence is particularly strong as there is often no end user to consult. Intermediaries who wish to consult and assist buyers, for the first time, will be helped by the availability of reliable information on energy efficiency, hot water delivery performance, climate suitability and noise. Awareness that the buyer could also see this information will help counterbalance any tendency to recommend models on the basis of capital cost only, habit or commercial ties, rather than the optimal advice for the situation.

Physical energy labels will have a greater impact on plumbers and installers than restricting the disclosure to a website. They will rarely see the label prior to installation, but they will become aware of the existence of labelling and its likely impact on the consumer. Furthermore, the GEMS legislation allows the act of installation of a water heater by a plumber to constitute the point of 'supply' for energy labelling purposes.[10] This places a legal obligation on the installer to leave the energy label on the unit for the buyer to see. Plumbers will quickly learn that some buyers at least will take notice of labels. As a result, plumbers and installers are likely to take greater notice of energy efficiency as consumers will note this information on the label after installation and may complain if provided with a low efficiency product, or one not suited to their location. It would be necessary to inform plumbers and installers of these obligations through an information campaign if labelling becomes mandatory. The impact of labelling on the HPWH market would be larger if implemented on all water heaters as outlined in National Strategy on Energy Efficiency. Unless all manufacturers adopted a voluntary label and consumers trusted the information on the label, the impact of labelling on the advice agents or products they select would be reduced as individuals that wish to do so could simply avoid labelled models.

Although water heaters are often purchased in a way that does not allow the buyer to see the unit before it is installed, some buyers are nevertheless aware of water heater labels. Gas water heaters are the only water heater type currently labelled. A 2006 study, conducted some 17 years after the introduction of star rating labels for gas water heaters, found that 3 in 10 recent buyers of gas water heaters recalled the label (Artcraft Research 2006a). While this is much lower than for electrical products, it does indicate that labelling has some traction in the water heater market, and this provides a base for promotion to both installers and to buyers directly.

The implementation of MEPS is not likely to have a direct impact on plumbers, installers and builders, who may not even be aware that it is occurring. It could have some impact on sales if a higher price for HPWHs relative to other water heater technologies resulted in a change to market preference. This effect is likely to be negligible as similar mandatory energy efficiency requirements, with similar capital cost impacts, are being proposed for competing technologies.

Retailers and wholesalers

Retailers and wholesalers would be in similar positions to plumbers and installers. They may be unaware of information disclosure that is limited to a website, but if there is a requirement for physical labelling they would have to ensure that the products they supply are correctly labelled in accordance with the relevant determination under the *GEMS Act 2012*. As water heater suppliers tend to be allied to the hardware and plumbing industry rather than to the general retail sector where labelling is already common, it would be necessary to inform them of these obligations if labelling becomes mandatory.

All products supplied would have to be labelled by the specified implementation date. Allowing a lead time of a year or so would enable retailers and wholesalers to sell unlabelled products, and restock with labelled units, provided the manufacturers and importers made these available in time. It would also be possible for labels to be applied in the showroom or the warehouse, although this would be more costly and more liable to error.

Those water heater suppliers who want to enhance the level of advice and service they give to their customers – whether installers or end users – will be able to do so on the basis of the information disclosed or labelled. Even though only a small number of water heater buyers use retail outlets, there would be still be need for in-store staff training. Those suppliers who specialise in the lower efficiency end of the HPWH market may lose market share or have to discount to retain it.

The designation of some models as suitable for cold climates could allow retailers and wholesalers in individual warmer and colder areas to rationalise their model range, leading to some economies in stock holdings and

[10] It is possible that the only circumstance where the plumber or installer is *not* the supplier is in the case where a buyer selects the product, pays the wholesaler or retailer independently and then passes the unit to the plumber to install. In this case the retailer or wholesaler is the supplier, and bears the labelling obligations.

control. A voluntary labelling scheme not expected to fully resolve cold climate suitability issues as manufacturers of models with poor performance in cold conditions would not be expected to see a competitive advantage in voluntarily presenting this on a label. The implementation of MEPS is not likely to have a direct impact on wholesalers and retailers, who may not even be aware that it is occurring.

Consumers

Owner-occupier costs and benefits

While owner-occupiers directly bear the capital costs of water heater purchases as well as the energy costs, their engagement in the purchase process tends to be low, and most rely heavily on the advice of intermediaries (see Section 1). Disclosure of energy efficiency information on a government website will have some impact on a portion of the 35% of water heater consumers who research online (BIS Shrapnel 2012). The availability of trusted information may increase the size of the engaged consumer segment over time as awareness becomes more widespread. Those who use the Energy Rating website to research other appliances could be advised that this type of information is now available for HPWHs as well, so they will be more likely to consult the information when they need it. This process of education would be greatly enhanced if there was a requirement for a mandatory physical label as well as label images in catalogues, brochures and on supplier websites. Unless all manufacturers adopted a voluntary label and consumers trusted the information on the label, the likely level of benefits of a voluntary labelling scheme would be lower than the benefits of a mandatory labelling scheme.

Both MEPS and labelling options will benefit from key performance requirements, to ensure models improve energy efficiency without compromising other key features that are important for consumer satisfaction, such as being able to deliver enough hot water, or being suitably quiet. The standardised testing and disclosure of this additional information could enable these consumers to choose a more suitable system for their needs. This is likely to benefit consumers, although these secondary benefits are difficult to estimate and so have not been quantified.

It is likely that even non-users of the information would benefit from the introduction of mandatory labelling, because some suppliers will remove their lower performing products in order to avoid disclosing a low rating. This advantage is not likely to apply to voluntary labelling as manufacturers can select to not present this information on lower performing models. Some plumbers, builders and installers might also avoid lower rated models to avoid potential consumer complaints. MEPS would have a greater impact on consumers over the 20 year projection period, even if they were unaware that it had been introduced. The benefit-cost analysis in Section 4 demonstrates that as a group they would be better off, even under the most stringent of the MEPS regimes modelled.

STCs do not impact on total costs and benefits because they are transfer payments, and so have been excluded from the overall analysis. However, they will impact the out of pocket expenses of individual HPWH buyers. The number of STCs that HPWHs generate is likely to increase to some degree with improved average energy efficiency, so increasing the average financial benefit of STCs on product purchases. This will reduce the impact of capital cost increases resulting from energy efficiency improvements. Table 6 summarises the financial impacts of the proposal on HPWH buyers/owners, on the assumption that they receive half the additional STC value created by energy efficiency improvements that are higher than BAU.

Unlike the economic impacts, the cash impacts are calculated without discounting, because otherwise the present value in 2013 of the capital cost and lifetime energy cost of a water heater to be purchased by a consumer in 2033 would be negligible. The discounted present value of the program impacts would appear as a few dollars only, whereas the consumer in 2033 could face changes in both purchase price and energy costs of hundreds of dollars compared with BAU. Therefore the most appropriate way to make the comparison is to sum the total capital costs and the total lifetime running costs for the 650,000 units that are projected to be purchased between 2o14 and 2033. For the most stringent MEPS level (MEPS C) with labelling, the average net capital cost to consumers increases by $192, but the electricity cost falls by $827, leading to a lifetime cost reduction of $635. Even though the average consumer will benefit, there may be a few who are worse off because they are small users of hot water and do not recoup the additional capital costs imposed by the proposed measures.

Table 6 Cash impacts on HPWH buyers, 2014-33 (0.5 STC value, PE = 50%, undiscounted)

	Capital cost $/unit	Program cost $/unit	Total extra cost $/unit	Total extra cost %	Lifetime energy cost $	Saving in lifetime energy cost $	Total energy cost saving	Saving in total lifetime cost $	Reduction in lifetime cost $
BAU	$2,294	NA	NA	NA	$4,266	NA	NA	NA	NA
Registration only	$2,307	$4.8	$18	0.8%	$4,207	$59	1.4%	$41	1.0%
Labelling only	$2,330	$5.3	$42	1.8%	$4,100	$166	3.9%	$124	2.9%
MEPS A and labelling	$2,385	$6.9	$98	4.3%	$3,859	$407	9.5%	$309	7.3%
MEPS B and labelling	$2,465	$8.0	$180	7.8%	$3,491	$775	18.2%	$595	14.0%
MEPS C and labelling	$2,477	$8	$192	8.4%	$3,439	$827	19.4%	$635	14.9%
MEPS D and registration	$2,378	$8	$92	4.0%	$3,887	$379	8.9%	$287	6.7%

Sales 2014-2033 = 650,689 units

Rental property owners and tenants

Private rental property owners are usually resistant to paying more than the minimum to replace water heaters, because they cannot easily recover the additional capital costs of more efficient options, and it is the tenants who benefit from the lower running costs. This is one of the market failures identified in Section 2. For the present, this group is unlikely to prefer HPWHs in any case so long as lower cost options are available, so neither energy labelling nor MEPS is likely to have a significant impact. In the future, it is possible that cost differentials may decline to a point where rental owners are more likely to select a HPWH, as occurred in 2009 when Commonwealth and state rebate values were at their highest.

Public housing authorities are more likely to invest in energy efficient options because reducing utility cost pressures on their tenants is part of their corporate objectives. In the past some have had negative experiences with the performance and durability of HPWHs (E3 2012). The proposed measures should increase the confidence of public housing authorities to invest in HPWHs, because they would have access to reliable comparative information on energy efficiency, noise and other aspects of performance for the first time. Some experienced local authority property managers would also prefer to base their purchase decisions on consistent measures of energy efficiency (Ironbark 2012).

Government and standards

The proposals will impose costs on government to administer the program. These activities include:

- Administration of the program by government officials;
- Cost of maintaining a registration and approval capability;
- Random check testing to protect the integrity of the program;
- Cost of producing information for consumers, installers, industry and small business; and
- Consultant costs for standards development and program reviews.

The specific estimates of costs for Government were outlined in Section 4: Impacts, costs and benefits.

Regulators and governments

The Clean Energy Regulator scheme that provides HPWH buyers with the financial incentive of STCs overlaps the proposed measures to the extent that it covers many of the same products. It is likely that the Clean Energy Regulator scheme will benefit from the greater confidence in product performance statements that will come from mandatory testing, registration and compliance checking under the *GEMS Act 2012*.

Several regulations and energy efficiency programs operated by the Commonwealth, State, Territory and New Zealand governments use STC numbers as a proxy for energy efficiency of HPWHs, which as noted earlier is not always a fully accurate indicator, in the absence of direct, verifiable information on energy efficiency. These include:

- The few remaining rebate programs in Australia (most of these have been phased out);
- The National Construction Code (NCC) of Australia; and

- The Commonwealth's Local Government Energy Efficiency Program.[11]

The proposed energy efficiency regulations would provide a direct measure of energy efficiency that could be used by these programs in the future, providing several potential public policy benefits:

- MEPS compliance would indicate that a product meets the minimum accepted level of energy efficiency; and
- All HPWH models on the market would be covered– not just those registered for STCs.

Noise complaints by owners and neighbours are reasonably common[12]. It would be in the public interest to inform buyers of model noise levels.

Standards bodies

Implementation of the options relies on the availability of suitable standards for testing and labelling HPWHs. The range of current standards relevant to water heaters, and HPWHs in particular, are set out in Appendix 1.

The Department of Resources, Energy and Tourism has formed a working group to prepare a physical test suitable for mandatory energy efficiency registration and associated compliance testing procedures. These proposals would then be forwarded to Joint Technical Committee CS-28, Solar Water Heaters, which is responsible for relevant HPWH standards, for consideration. The working group was set up in late 2012 and the draft test procedure will be available for comment in mid-2013.

At present there is no standard covering the conversion of HPWH energy efficiency metrics into star ratings, or for presenting performance information on energy labels. This can be done in parallel with the work on the HPWH test development and a project has commenced to develop a consistent label for air conditioners, space heaters and all water heaters.

Competition

The HPWH market is relatively dynamic, judging by the rate at which suppliers and models enter and leave the market. This enhances competition and enables the market to respond more rapidly to regulatory requirements. As there is no reliable information available on the energy efficiency of HPWH models at present, the introduction of energy labelling would enhance competition as consumers and advisers will have more information to better compare products and make decisions on which product best meets their needs. It would give a commercial advantage to manufacturers and suppliers who offer models that are quieter, replenish hot water faster and are more energy efficient. The ability to designate models as suitable for cold climates would further increase competition in those markets. Unless all manufacturers adopted a voluntary label and consumers trusted the information on the label, the likely impact of voluntary labelling on competition would also be reduced.

The options would apply equally to fully imported and to locally manufactured and assembled products, so there is no trade discrimination. The same tests would apply to all systems, and a competent laboratory anywhere in the world would be able to carry out the test, once the standard is published. If there was a widely accepted international test standard there would be merit in considering it, but this is not yet the case (Appendix 1). As a result, international manufacturers supplying the Australian and New Zealand markets will have the same testing requirements as domestic manufacturers.

The competitive position of individual manufacturers or suppliers in relation to any given MEPS levels would depend on the number of their models that would need to be re-engineered or replaced. While the impacts on individual companies will be unknown until the test standard is finalised, there are believed to be some current models that can achieve all the proposed options, and it is likely that many existing models can be improved to meet the requirements. As detailed in impacts on industry section, testing is underway to provide an improved indication of the impacts of options on competition.

Local manufacturers may have advantages in terms of relatively large existing market share that allow the costs of redesign to be spread across more sales. Conversely, importers may have access to greater research and development capabilities in the country of manufacture, or can select more energy efficient models from their existing product range. However, local manufacturers also have access to a range of technologies, since most of the refrigeration components in locally assembled models are imported. Small manufacturers of poorer performing models are likely to be more impacted by the additional fixed costs of product re-design and testing as they have

[11]Local Government Energy Efficiency Program website

[12] About 15% of the HPWH reviews in one online forum mentioned noise (EnergyConsult 2011).

fewer sales to recover the costs. Smaller manufacturers of better performing models may recover the costs through the greater sales that may result from the comparative labelling of all HPWHs.

HPWHs as a group could be placed at a competitive disadvantage against other water heater types if the proposals resulted in a significant increase in price differentials, and if buyers did not value the energy efficiency advantages of HPWHs. However, the main competing technology, electric storage water heaters, is also the subject of proposals to raise MEPS. This is expected to result in comparable production cost increases, and without the price-cushioning effects of STCs which HPWHs enjoy. The effects on competition with other types of water heater could be positive if the resolution of information barriers results in consumers become more receptive to the energy efficiency advantages of HPWH technology.

Consultation process

There has already been one round of formal public consultation with industry and other stakeholders on key aspects of the proposals in this RIS. The Equipment Energy Efficiency (E3) Program Committee released a *Product Profile on Heat Pump Water Heaters* in late June 2012 (E3 2012). During the comment period, public information sessions were held in Canberra, Adelaide, Sydney, Brisbane and Wellington. Most of the parties attending these sessions also made written submissions. A summary of the previous consultation is provided in Appendix 5. This feedback has been taken into consideration in the development of the policy options and the development of a suitable standard test procedure.

There were 22 written submissions from a range of entities. The representation was fairly well balanced by country and by interest group (Table 7) except that there were no submissions from consumer groups.

Table 7 Submissions on Product Profile

Country of respondent	Manufacturer / importers	Research, design & test	Industry Association	Other	Total
Australia	7	3	1	3	14
New Zealand	4	3	1	-	8
Total	11	6	2	3	22

Mandatory product testing, registration and public access

Most submitters actively endorsed mandatory registration and access via a public website, and none opposed it. However, there were differences regarding the methods of testing (and modelling) for which results should be registered, given that these would also be used as the basis for MEPS and energy labelling.

None of the submissions from manufacturers or researchers supported the use of the standard AS/NZS 5125 in its current form. Clear support for a new physical test which includes a water draw down was provided by manufacturers and a process to develop this test commenced in December 2012.

MEPS and functional performance requirements

Most submitters actively endorsed MEPS and key performance requirements, and importantly none opposed it. All researchers and some manufacturers indicated that there were a number of poor performing models on the market, and that MEPS would remove those.

There was near universal support for noise testing and registration of the results, with one manufacturer suggesting an alternate test standard that would enable more suppliers to perform the tests. There were different views with regard to:

- The level of the MEPS; and
- If a mandatory maximum noise level should be implemented.

Energy labelling

Two submitters opposed physical labelling of products on the grounds that consumers, in their opinion, would not see it, and that the information was already available on websites. Of the other 20 submissions, all supported some form of physical labelling, mostly mandatory. Views on the content and the basis of labelling differed. Many indicated a preference for using a performance rating. Some submitters recognised that it would be impractical to include all possible metrics of interest on a label.

6. Conclusions and Recommendations

Market failures

Considering lower lifetime costs are the key advantage of HPWHs to consumers over the dominant competing technology, ESWHs, it is reasonable to conclude that lower lifetime costs are a key preference for HPWH consumers. An informed HPWH consumer would ideally consider the capital costs and the projected ongoing energy costs of alternatives, and select the option with the lowest combined lifetime cost. At the time of purchase, the capital cost is easy to identify, but the lifetime energy cost is not due to a failure of information in the market.

In the case of HPWHs, the high contribution of ongoing energy costs to the lifetime costs of the appliance means that poorly informed decisions may be taken where information about energy costs is not available. There is evidence which supports the case that these market failures exist in the HPWH market and are likely to have led to less than optimal purchasing decisions. As a consequence:

- Prospective consumers cannot be assured of getting a product that performs adequately in meeting their needs;
- Consumers who are motivated to are unable to reliably identify appliances with better energy efficiency (and avoid inefficient ones);
- There is limited market pressure on suppliers to improve product performance; and
- Energy use, costs and greenhouse gas emissions are higher than need be.

The capability for consumers to use consumer law to protect themselves from products they believe are not satisfactory is reduced, when testing cannot be independently conducted and clear benchmarks are not available.

In these circumstances government intervention in the market has the potential to increase the overall benefits for the community. Potential options were developed and assessed against the following objective:

> **To improve the energy efficiency of heat pump water heaters sold in Australia and New Zealand by addressing market failures related to information and split incentives that impact the heat pump water heater market, while key performance features are ensured.**

Options

A broad range of options were considered to assess whether they would address the identified market failures. The following options, if implemented alone, were deemed unlikely to lead to positive changes to the consumer choice process:

- Consumer education campaign;
- Voluntary energy efficiency certification; and
- Dis-endorsement labelling.

Consequently these options have not been further explored or analysed.

The following options were viewed as more likely to address the market failures, and improve the consumer choice process, were assessed to determine their impacts, costs and benefits:

- Mandatory testing and registration;
- Voluntary labelling;
- Mandatory energy labelling; and
- A range of MEPS combined with labelling or disclosure.

Summary of costs and benefits

As the distribution of model energy efficiencies and sales in 2011 (the base year for modelling) is known in detail, it is possible to project the energy impacts of the various fixed MEPS levels with reasonable confidence. The estimates of economic benefits of proposed measures come from the reduction in projected energy expenditure to deliver a comparable water heating service to the BAU case. The costs include:

- Energy testing and registration, beyond the level of such costs already being incurred;

- Physical labelling costs;
- Administrative costs;
- The fixed development costs needed to rapidly increase energy efficiency to achieve the MEPS; and
- The variable costs of manufacturing more energy efficient units.

The last of these elements accounts for 65 – 90% of the projected costs of the measures, so the cost-effectiveness is sensitive to manufacturing cost assumptions. As the introduction of MEPS for products using similar technologies (refrigerators and air conditioners) has resulted in no clear price increases, the assumptions in this RIS that cost increases at half the rate of energy efficiency (i.e. a PE ration of 50%) is conservative.

The projected total benefits and costs of the measures for Australia and New Zealand are summarised in Table 8 and Table 9. The B/C ratios of energy labelling and all the MEPS options are in a fairly narrow range of 2.1 to 2.3. The most stringent option (MEPS C and labelling) has the highest B/C ratio, and significantly higher net benefits. B/C ratios are higher at lower discount rates, because the PV of future energy expenditures rises more than the impact of higher capital costs. The measures would be cost-effective in Australia and New Zealand under nearly all combinations of assumptions, including extreme cases.

Table 8 Impacts, costs and benefits, HPWHs installed 2014-33, Australia (7% discount rate, 50% PE)

Measure	Program costs $M PV	Capital costs $M PV	Total cost $M PV	Energy savings $M PV	Net benefit $M NPV	Benefit/ Cost ratio	GWH saving	kt CO_2-e saving
Registration only	$1.8	$5.3	$7.1	$12.6	$5.5	1.8	127	94
Labelling only	$1.9	$14.7	$16.7	$35.2	$18.5	2.1	359	264
MEPS A + labelling	$2.8	$42.4	$45.2	$99.3	$54.1	2.2	888	670
MEPS B + labelling	$3.5	$76.8	$80.3	$182.0	$101.8	2.3	1689	1275
MEPS C + labelling	$3.7	$81.9	$85.6	$193.6	$108.1	2.3	1795	1342
MEPS D + registration	$3.1	$37.0	$40.1	$87.1	$47.0	2.2	773	586

Table 9 Impacts, costs and benefits, HPWHs installed 2014-33, New Zealand (5% discount rate, 50% PE)

Measure	Program cost $M PV	Capital cost $M PV	Total cost $M PV	Energy savings $M PV	Net benefit (cost) $M NPV	Benefit/ Cost Ratio	GWH saving	kt CO_2-e saving
Registration only	$0.3	$0.2	$0.5	$0.4	($0.1)	0.9	3.4	0.5
Labelling only	$0.3	$0.5	$0.8	$1.1	$0.3	1.4	9.7	1.3
MEPS A + labelling	$0.4	$1.9	$2.3	$4.2	$1.8	1.8	32.4	4.4
MEPS B + labelling	$0.4	$3.0	$3.4	$6.3	$2.9	1.9	50.1	6.9
MEPS C + labelling	$0.4	$4.2	$4.7	$9.0	$4.3	1.9	71.7	9.8
MEPS D + registration	$0.4	$2.3	$2.6	$4.8	$2.1	1.8	37.3	5.1

Impacts on stakeholders

The proposed measures would impact on HPWH manufacturers, importers, installers, wholesalers, retailers and consumers. While MEPS C had the greatest net benefit, it would also remove the largest proportion of models on the market. Some manufacturers and importers would need to adjust their model range to meet MEPS, but given sufficient lead time this should be achievable. The proposals would enhance competition, in that consumers and agents would have access to information that is not presently available to them. The measures would be non-discriminatory in that they would apply equally to both imported and locally manufactured products.

The most stringent of the MEPS levels proposed for HPWHs (65% in Zone 3) would require the equivalent of an average energy saving of 22%. This is comparable to the reduction required for other appliances that use similar refrigeration technology to HPWHs. For refrigerators and freezers, the reduction in average energy use required between 2009 and the 2015 MEPS is 20 to 25%. Changes to MEPS levels for small split system air conditioners required a 24% increase in energy efficiency over a 2 year period from 2004 to 2006. A further 20% increase in energy efficiency was then mandated through several MEPS changes over the 5 years from 2006 to 2011. As this would be the first application of MEPS to HPWHs the range of design opportunities should be wide, suggesting that even the most stringent of the proposed MEPS levels is technically feasible.

Consultations with the industry and with other stakeholders in 2012 indicated general support for mandatory product testing and registration, the introduction of MEPS and key performance requirements and mandatory labelling for HPWHs. There was lower support for voluntary labelling. At the same time, stakeholders were aware that changes to existing standards would be necessary to support these measures.

Conclusions

After consideration of the policy options it is concluded that there is a significant potential to increase energy efficiency and other aspects of performance in the HPWH market. A combination of MEPS and mandatory energy labelling provides the greatest net benefit and highest likelihood of addressing the identified market failures and improving the consumer choice process. The benefit-cost ratios of MEPS combined with mandatory labelling options are in a fairly narrow range of 2.1 to 2.3 in Australia and 1.4 to 1.9 in New Zealand under conservative modelling assumptions. The options would be cost-effective in nearly all jurisdictions under nearly all cases, even under extreme assumptions.

The most efficient proposal, in terms of net benefits, was the most stringent option, MEPS Option C - Mandatory registration and disclosure proposed to take effect from 1 July 2014. The proposed MEPS level is equivalent to a 65% energy savings (compared with a standard ESWH) in Zone 3 for all models, plus an additional requirement to meet 60% energy savings in Zone 5 for models designated as suitable for cold climates, proposed to take effect from 1 July 2015. It is proposed that mandatory labelling would take effect no sooner than 1 July 2015. While MEPS C has the greatest net benefit, it would require the highest number of current models to improve energy efficiency before implementation in mid-2015. It would require the equivalent of an average energy saving of about 13% compared with current claimed energy efficiency, although as many models overstate their energy efficiency the real improvement required would be about 22% compared with the 2011 market average. This is comparable to the rates of improvement that have been achieved by other appliances using refrigeration technology. The proposed measures would impact on HPWH manufacturers, importers, installers, wholesalers, retailers and consumers. The proposals would enhance competition by improving the consumer choice process through providing consumers access to reliable and consistent information on key performance features including energy efficiency, hot water delivery and noise, which is not presently available to them.

It is recommended that:

1. Energy efficiency test standards be revised so they are better able to support mandatory registration and compliance requirements, cold climate performance tests and noise testing;
2. Once test procedures are finalised, the equivalence between the resulting energy efficiency metrics and recommended MEPS levels should be established, and requirements implemented through a GEMS determination;
3. The tested energy efficiency, recharge rates, hot water delivery capacity and noise levels of heat pump water heaters be registered with the GEMS Regulator from 1 July 2014 in Australia;
4. All heat pump water heaters supplied from 1 July 2015 should meet a level of energy efficiency equivalent to MEPS level C;
5. A form of mandatory energy labelling to indicate climate impact on energy efficiency, hot water delivery, level of noise and suitability for cold climate performance should be developed and refined with the aid of consumers testing and market research; and
6. Energy labels should be fixed to all HPWHs supplied no sooner than 1 July 2015; and
7. The label image should be included in all supplier brochures and advertising in Australia.

7. Implementation and Review

Preparation

Revision of standards

The revision of the existing test standards for HPWHs is a prerequisite for the implementation of the proposed measures. There are four main tasks:

1. Revision of the energy efficiency test procedures and adoption of a noise test procedure;
2. Converting MEPS levels in the options to equivalent levels based on the revised physical test;
3. Development of a method of calculating energy efficiency metrics for labelling; and
4. Developing an energy efficiency label for HPWHs, in a form that is consistent with the energy labels for other climate zone-sensitive consumer products.

Work has begun on tasks 1 and 4, and the others depend on their completion. The draft test procedure is expected to test all HPWHs for energy efficiency and hot water delivery at relatively warm temperatures. Products designated as suitable for cold climates will be required to be tested at additional cold temperatures to ensure these systems deliver sufficient hot water with adequate energy efficiency in low temperatures. Products designated as suitable for cold climates will include both models suitable for low temperature operation without electric boosting and with electric boosting, defined as Class A and Class B systems in AS/NZS 5125. The required minimum coefficient of performance for Class A and B may be different, to account for the fact that Class B HPWHs will be operating as electric resistance water heaters for some proportion of the time.

Consultation will also occur on the test standards (task 1) and the converted MEPS levels (task 2) after the draft test standard is available for comment.

Development of Climate Rating Label

The energy label designs for HPWHs would be most influential if it is consistent with the energy label formats for other climate influenced products that are subject to mandatory energy labelling in Australia and New Zealand. At present, HPWH purchasers are not able to consider energy consumption in the purchase decision as is possible for consumers of refrigerators and air conditioners, for example, even though the annual energy use is likely to be far higher.

The presence of a consistent label should assist consumers who are familiar with energy labelling for other appliances to make the link with water heater energy efficiency and operating cost. This will be facilitated if the label has a familiar appearance. A rating scale that is common to HPWHs and other types of electric water heater would further emphasise the energy efficiency advantages of HPWHs as a product class, as well as allowing differentiation between HPWH models. The current 10-star scale (6 stars plus the option of up to 4 extra stars for 'super-efficient' products) should allow this degree of differentiation.

HPWHs perform differently in different climate zones, and consumers would benefit from a map that indicates this. Whether this should be part of the main label or supplementary information would need to be determined through consumer testing.

The European Union (EU) is currently developing a unified system of energy labelling for all types of water heater, incorporating maps of Europe to indicate performance in different climate zones (EU 2013; Appendix 2). Some elements of this approach could be adopted. A project to develop a suitable label that can be applied to HPWHs has commenced in early 2013 to enable Task 4 to be completed. Consultations on a proposed climate rating label are planned to take place in mid to late 2013.

Implementation

Implementation would be via a determination under the Commonwealth *Greenhouse and Energy Minimum Standards (GEMS) Act 2012*. The determination cannot be made until the required standards are finalised.

Notice of intention to implement the chosen measure will need to be given to the main stakeholders. While HPWH manufacturers and importers can be readily identified, it will also be necessary to inform plumbers and installers of their obligations.

Review of program effectiveness

Compliance monitoring

As with all other MEPS and energy labelling measures, if these options are adopted, E3 and the GEMS Regulator will need to monitor compliance at several points:

- Testing on selected models in independent laboratories to verify the registered performance claims; and
- Checking that models supplied are correctly labelled. This will require special surveys and store visits. E3 and the GEMS Regulator already undertake surveys of this kind for other labelled products, and the same process could be used for HPWHs. In New Zealand, the compliance surveys are undertaken by EECA.

Survey consumer impacts and product trends

Even with complete compliance, it could take some time before water heater buyers and the intermediaries who advise them are aware that comparative information is available. The E3 program uses various sources of information to track consumer awareness of labels over time, consumer intention to use the information in the purchase decision and the reports on actual use of the label by recent consumers.

Actual sales data also give an indication of program impact, since sales and energy efficiency of models can be tracked over time once a mandatory registration system is implemented, and compared with historical trends and with the projections in this RIS. In Australia, the GEMS Act, and in New Zealand the Energy Efficiency (Energy Using Products) Regulations 2002, empowers the regulators to collect data on the annual sales of every registered product. This improved data source will allow assessment of regulatory impact into the future.

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Appendix 1: Heat Pump Technology and Standards

Factors impacting energy efficiency

The theoretical maximum coefficient of performance (COP) of a heat pump depends on the properties of the refrigerant fluid. In practice, the COP will always be lower, because of tank heat loss, de-frosting cycles, and energy losses at the valve which controls the expansion of the refrigerant fluid, at the points of heat transfer in the evaporator and the compressor, and in the compressor motor and pump. For example, even a relatively efficient heat pump is typically only about half as efficient as the theoretical limit. Even so, it can still be two to three times as energy efficient as an electric resistance water heater.

The actual COP of the heat transfer process in any given HPWH will vary under different ambient temperature and humidity conditions. Even if those conditions are held constant in a test room, the COP will gradually fall as the unit heats up a tank of water from cold to the maximum operating temperature. The reducing COP is due to the lower temperature difference between the air source and the tank water temperature.

Heat pumps can be designed to operate at very low ambient temperatures – some refrigerant fluids can extract heat from the ambient environment at temperatures well below 0°C. However, if cold temperatures are accompanied by high humidity, the evaporator surfaces will 'frost' or ice up, and this will form an insulation barrier that inhibits heat transfer. To address this problem, some designs reverse the refrigerant flow from the stored hot water to the evaporator until the ice melts off; others incorporate de-icing resistance elements in the evaporator or in the water storage tank itself, so that the unit operates as an electric resistance water heater rather than as a heat pump while the frost conditions persist.

Some HPWHs lack defrosting capabilities, and so are unsuitable for use in frost-prone areas. Where defrosting capabilities are present they incur an energy penalty, which can be quantified if the unit is physically tested under frosting conditions, or estimated if its performance is modelled by computer simulation.

In common with all other storage water heaters, heat pump water heaters incur a standing heat loss. Even if no hot water is drawn off, heat will be lost from the stored water by conduction through the walls of the storage tank, and through the pipes that connect the tank to the refrigerant circuit and to the cold water inlet and hot water outlets. The better the insulation of the tank and the connecting pipes, the less the amount of energy needed to recover the heat loss.

The overall 'task efficiency' or 'task COP' of a water heater needs to take into account all categories of its electricity consumption and loss:

1. The electricity used by the refrigerant compressor motor and other auxiliaries (e.g. fans to increase air movement over condenser surfaces) in the process of heating the water;
2. The electricity used by the refrigerant compressor motor and other auxiliaries (e.g. a resistance element) to impart additional energy to the water to compensate for standing heat losses and water use; and
3. The additional energy used during defrosting and any other special operating cycles (e.g. regularly heating the water up to a level that kills Legionella bacteria).

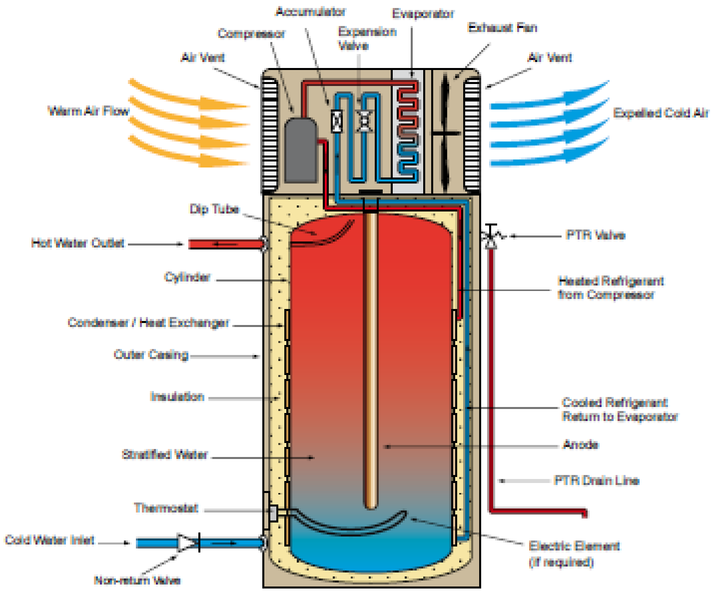
It is also common to express heat pump energy use in terms of the estimated reduction in electricity use compared with a 'reference' electric resistance water heater that could provide a similar level of service.

Product types

The main parts of a heat pump water heater are the evaporator unit (usually housing the evaporator, fan and compressor), the condenser that transfers heat to the water and the water storage tank itself. These can be physically configured in a number of ways, generally called integral, split and stand-alone.

Integral heat pump water heaters have all their parts housed in a single cabinet, with the evaporator unit commonly above the storage tank (Figure 9).

Figure 9 Integrated Heat Pump Water Heater (with wrap-around condenser)



The heat pump may be 'split' by separating the evaporator unit from the storage tank, and connecting them either by refrigerant flow and return lines or by hot water and cold return lines.

A 'stand-alone' heat pump water heater has the evaporator and the condenser in a self-contained unit that can be connected, by water lines, to any storage tank. Stand-alone heat pumps can be purchased separately and are commonly retrofitted to some types of existing electric resistance storage water heaters in New Zealand (although they are often marketed with a nominated tank as a package deal).

Estimating energy performance

At present the energy performance of a HPWH is estimated using a combination of physical tests and computer simulation. AS/NZS 5125 *Heat pump water heaters – product performance assessment* specifies physical testing in a climate controlled test room, at a range of five temperature and humidity conditions: Temperature Condition 1 (TC1) to Temperature Condition 4 (TC4) and a 'low temperature' (LT) test. The details of each test condition are in Table 8.

Table 10 AS/NZS 5125 Test Conditions (TCs)

Test Condition	Temperature range in test room	Relative humidity in test room	Water temperature at start of test
Low Temperature (LT)	0 – 2 C	>= 90%	< 10 C
TC 1	<10 C	80 – 90 %	< 10 C
TC 2	18 – 20 C	60 – 70 %	< 15 C
TC 3	20 – 35 C	30 – 40 %	< 25 C
TC 4	20 – 35 C	55 – 65 %	< 25 C

Under each test condition, the energy consumed and the water temperatures in the tank are recorded as the HPWH heats a tank of water from cold to the maximum temperature of the heating cycle. The LT test, which helps determine performance during frost conditions is applied only to products claiming to be suited to low temperature operation without the use of electric resistance boosting.

AS/NZS 4234 describes the use of the physical test results to calculate the annual delivered energy that would be used by a HPWH (or any other type of water heater) to perform a specified water heating task, when installed in any of standard climate zones, under various daily deliveries and draw off patterns. The annual electricity consumption of the HPWH is expressed in relation to that of a 'reference model' electric resistance water heater delivering the same water heating service in the same climate zone. The greater the percentage reduction compared with the reference, the higher the energy efficiency of the HPWH.

This calculation requires the use of a computer simulation program which meets the criteria in AS/NZS 4234. The best known of these is TRNSYS, although others may be used.[13] Proprietary information must be obtained from the manufacturer order to carry out the TRNSYS modelling.

Noise

The noise regulations developed and administered by local councils and state environment protection agencies vary considerably in their scope and application. Depending on how they are installed, HPWHs (especially in large numbers) could exceed the night-time tolerance in many suburbs.

As evident from internet fora (such as Consumer Forums), there are already problems with noise from space heating heat pumps (i.e. air conditioners) in New Zealand, which are generally larger than water heating systems. However, there is anecdotal evidence that HPWHs are perceived as noisy.

In New Zealand there appear to be no regulations specifically for heat pumps. International standards for determining sound levels of domestic appliances exist (e.g. ISO 3741: 2010; and ISO 13261-1).

Standards applicable to heat pump water heater energy consumption

Australian/New Zealand Standards

AS/NZS 2712: 2007 Solar and heat pump water heaters - design and construction plus appendices

Section 8 covers design and construction of solar water heater and HPWH with appendices; note the new addition of appendix H. This arose as an ad-hoc addition to the original solar water heater standard. The standard covers the evaluation of the overall system for integral systems and the heat pump itself for split/stand-alone systems.

AS/NZS 5125.1:2010 Heat pump water heaters – performance assessment

This standard covers the test conditions and test procedures for determining the energy performance characteristics of single circuit air-source heat pump water heaters. It does not apply to solar boosted heat pump water heaters.

AS/NZS 4234:2008 Heated water systems - calculation of energy consumption

This standard covers the computation from physical test results, proprietary information, known component properties and weather data of the expected annual performance of a range of water heaters including conventional solar and heat pump water heaters. The computation is based on a particular modelling software package, known as TRNSYS. This standard was originally formulated for solar water heaters and has to be modified to deal with HPWHs.

AS/NZS 4692.1:2005 Electric water heaters - energy consumption, performance and general requirements

Will supersede NZS 4602 at a date yet to be determined (see Preface to AS/NZS 4692).

AS/NZS 4692.2:2005 Electric water heaters - energy consumption, performance and general requirements: Amendments

Will supersede NZS 4602 at a date yet to be determined (see Preface to AS/NZS 4692).

AS/NZS 1056.4:1997 Storage water heaters - daily energy consumption calculations for electric types

This standard sets out a method for calculating the energy consumption of electric storage water heaters fitted with electric resistance elements. Exemptions within this standard result in the standard not applying to gas water heaters, solar water heaters, heat exchangers or heat pumps.

[13] TRaNsientSYstem Simulation (TRNSYS) is a public domain model originally developed by the University of Wisconsin. It is an algebraic and differential equation solver typically used to simulate performance of energy systems including water heaters, heating ventilation and cooling systems and renewable energy systems. Although other programs can be used, 'TRNSYS' will be used here to indicate all programs with the required capabilities.

AS/NZS 60335.2.40:2006 Household and similar electrical appliances - safety - particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

Australia specific Standards

AS 2984:1987 Solar water heaters - methods of test for thermal performance -outdoor test method

This standard describes the outdoor testing of solar and heat pump water heaters.

New Zealand specific Standards

These four standards cover the main features of heat pump water heaters. However installations may also be subject to a number of other regulatory requirements. For example hot water cylinders, including those used in heat pump water heaters, incorporated into new installations, must conform to the relevant national standards and regulations, domestic plumbing related to the systems must conform to the relevant national plumbing regulation and building codes, and electrical installation must conform to the relevant electrical regulations.

In New Zealand this includes the standards for hot water cylinder manufacture and installation:

NZS 4606:1989 Storage water heaters

Part 1 General requirements: This covers general construction and performance requirements for storage water heaters 6.5 l to 630 l other than those covered by NZS 4602. It also specifies allowable heat loss. This is based in part on AS 1056 part 1.

NZS 4305:1996 Energy efficiency – domestic type hot water systems

This standard sets out minimum energy efficiency requirements in terms of heat losses from domestic type hot water systems. It applies to all domestic type hot water systems irrespective of energy source and covers systems that may be found in residential, industrial and commercial buildings. Of particular note are section 2.1.1 and 2.1.2 which define values for heat loss from domestic sized cylinders.

Other Standards

EN 14511:2004 Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling

These are for air-water heat pumps but appear to be mainly designed for systems for space heating. Nonetheless they are quoted by some manufacturers. Results for 34 systems from WPZ indicate that tests are specified for water temperatures up to 55°C.

Although EN14511-2004 relates to air-source heat pumps for space heating and water chilling and heating, it is quoted by some Chinese manufacturers of air-source heat pump domestic water heaters (e.g. Sirac).

EN 255: 1997 Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors–heating mode–requirements for space heating and sanitary hot water units

This standard is for heat pumps for heating sanitary (domestic) hot water. Test results for 59 systems from WPZ indicate that tests are carried out with water temperatures up to 50°C.

Canada C745-00: 2000 Energy efficiency of electric storage tank water heaters and heat pump water heaters

This standard specifies the methods for determining the energy factor for electric storage tank water heaters and heat pump water heaters.

Appendix 2: Market Features

Government interventions in the HPWH market

The *Renewable Energy (Electricity) Act 2000*, administered by the Clean Energy Regulator (CER), allows Small-scale Technology Certificates (STCs) to be created by all installations of eligible solar water heaters or HPWHs, whether in new construction or as replacements in existing buildings. Although it is voluntary to register a model for STCs, the commercial advantage to suppliers has resulted in nearly all HPWHs being registered. While the number of STCs created by each installation depends on the model and the location, STCs contribute approximately $600 to $900 to the purchase of each HPWH (E3 2012).

Between 2004 and 2010 all Australian states and territories other than Tasmania and the Northern Territory (NT) introduced rules restricting the use of greenhouse intensive water heaters in new houses. These rules have largely eliminated electric resistance water heaters from the new house market in favour of HP, solar and gas water heaters. In 2013 the Queensland (QLD) Government repealed these rules.[14]

South Australia (SA) and QLD have had regulations restricting the replacement of electric resistance water heaters since 2008 and 2010 respectively. At the end of 2010, the Ministerial Council on Energy agreed to adopt measures to phase out greenhouse gas intensive water heaters for existing houses in all jurisdictions except Tasmania.[15] Since the 2010 MCE decision, no jurisdiction has implemented the phase-out, and in December 2012 the Queensland Government announced its intention to repeal its existing regulations in 2013. In jurisdictions where the phase-out proceeds, the water heater replacement market in houses would be restricted to HP, solar, natural gas and LPG water heaters.

The Commonwealth and several states and territories have in the past offered cash rebates for householders who replace an electric resistance water heater with a solar, heat pump and in some case a gas water heater. The value of rebates for HPWHs peaked in 2009, when $1,600 was available from the Commonwealth and up to $1,200 more from the NSW Government. The NSW rebate scheme finished at the end of 2011, the Commonwealth rebate scheme in June 2012, and the SA scheme is due to end in mid-2013.

In New Zealand, the Energy Efficiency and Conservation Authority (EECA) offered a $1,000 grant for HPWH installations during 2009, and $575 for installation between February 2011 and June 2012.

Manufacturers and importers

Table 11 provides list of identified suppliers and brands of HPWHs in Australia and New Zealand including information on country of production.

Table 11 HPWH suppliers and brands, Australia and New Zealand (CER)

Supplier	Heat pump brands	Available in:	Country of Manufacture or Assembly
Aquafire Industries Ltd	Aquafire	New Zealand	China
Aquatech (a)	Aquatech	Australia	Assembled in Australia
Atlantic Australasia	Atlantic	Australia	France
Azzurro	Azzurro Solar	New Zealand	China
Chromagen Pty Ltd	Chromagen	Australia	China
Conergy Australia (a)	Conergy	Australia	Germany
Econergy Limited	Econergy	New Zealand	Assembled in New Zealand
Efficient Heating N.Z. Limited	Exceed	New Zealand	China
Electrolux (a)	Kelvinator EcoKnight	Australia	China, Japan
GE Appliances Asia Ltd (a)	GE	Australia	USA

[14] Queensland Plumbing and Wastewater Code PDF

[15] Ministerial Council on Energy communique PDF

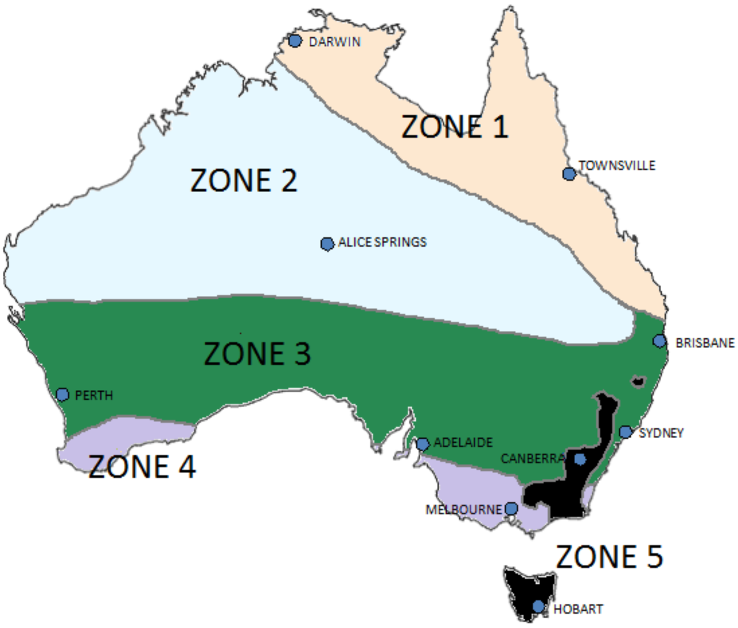
Supplier	Heat pump brands	Available in:	Country of Manufacture or Assembly
GWA Group Limited (a)	Dux , Ecosmart, Radiant	Australia	Mixture of imported and Australian manufactured components. Assembled in Australia
Hot Water Heat Pumps Ltd	Performance Plus	New Zealand	Assembled in New Zealand
Macon (a)	Macon	Australia	China
Midea (a)	Midea	Australia	China
Ochsner	Ochsner	Australia	Germany
Quantum Energy Limited (a)	Quantum, Airmax	Australia, New Zealand	China
Parex Industries Ltd	Stiebel Eltron	New Zealand	Germany, China
Rheem Australia Pty Ltd (a)	Rheem, Edwards, Everhot, Solahart, Accent Air, Aquamax, Vulcan	Australia	Mixture of imported and Australian manufactured components. Assembled in Australia
Rheem N.Z Ltd	Rheem	New Zealand	Mixture of imported and Australian manufactured components. Assembled in Australia
Rinnai (a)	Rinnai Hotflo	Australia	Australia, China, Japan
Sanden (a)	Sanden, Edson	Australia	Japan
Siddons Solarstream Pty Ltd (a)	Siddons Solarstream	Australia	Assembled in Australia
Solar Lord (a)	Solar Lord	Australia	China
Stiebel Eltron (a)	StiebelEltron	Australia	Germany
Sustainable Direct Solutions Pty Ltd	Taitronics	Australia	Thailand

(a) Some or all of product range registered with CER as eligible to create STCs after 31 October 2012.

Australian Climate Zones

Figure 10 details the five climate zones are defined in AS/NZS 4234:2011 Amendment 1. The map is based on the four solar irradiation zones, with an additional fifth zone defined based on Building Code of Australia (BCA) zones 7 and 8.

Figure 10 Australian climate zones as outlined in AS/NZS 4234:2010 Amendment 1



New Zealand Climate Zone

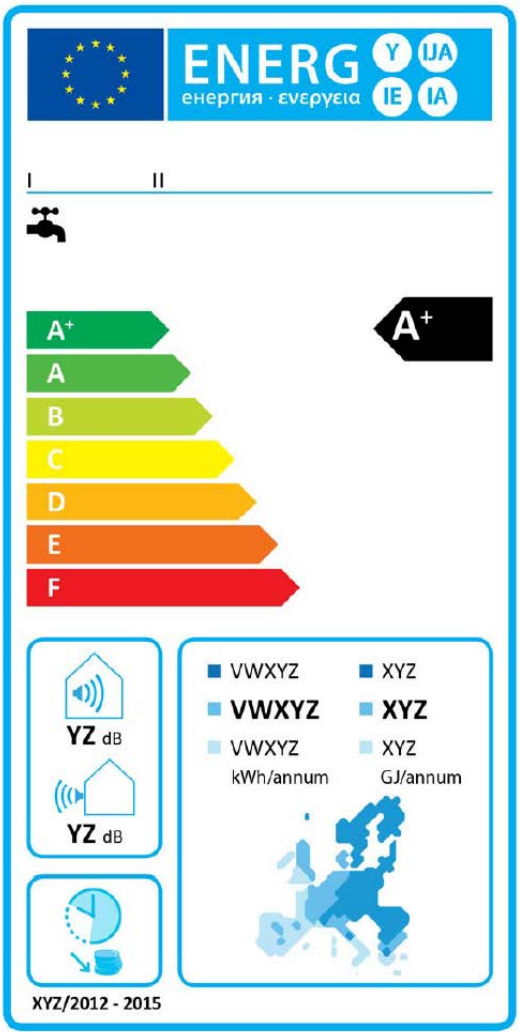
To ensure that HPWHs perform in winter conditions, the New Zealand climate zone is designated as Zone 5.

European Union Climate Rating Label

The European Union has proposed the introduction of mandatory energy labelling for all types of water heaters. This proposal is currently under EU Regulatory Committee consideration. Should it be implemented, all water heater types would be required to display a label and provide other technical specifications on a printed brochure to accompany products.

The label design for heat pump water heaters (Figure 11) is similar to the newly mandated EU air conditioner label, and features ratings based on three European climate zones – moderate, warm and cool. In addition to the climate rating information, the label also indicates the overall efficiency rating of the appliance (based on the moderate zone), its hot water delivery load, an indoor and outdoor noise declaration, and suitability for the heat pump to operate on off-peak power. More information on the proposal can be found here: European Council for an Energy Efficient Economy website.

Figure 11 Proposed European heat pump water heater energy label (EU 2012)



Appendix 3: Benefit-cost Analysis

Options assessed in benefit-cost analysis

After consideration of both regulatory and non-regulatory options after consultation on the Product Profile, a range of labelling, registration and MEPS options were selected for further quantitative analysis. Analysis and discussion focused on the following combinations:

Labelling only: Mandatory testing (for energy efficiency, hot water delivery and recharge rate and noise) and registration of the information, from 1 July 2014. Mandatory labelling of climate performance, noise and suitability for installation in cold climate zones will take effect after a climate rating label is finalised, but no sooner than 1 July 2015.

MEPS Option A and labelling: Mandatory registration and disclosure to take effect from 1 July 2014. MEPS equivalent to current performance claims (60% 'energy savings' in the warmer climate Zone 3 for all models, plus an additional requirement to meet 50% energy savings in the colder climate Zone 5 for models designated as suitable for cold climates), to take effect from 1 July 2014. Mandatory labelling as above, to take effect no sooner than 1 July 2015.

MEPS Option B and labelling: Mandatory registration and disclosure, as above to take effect from 1 July 2014. MEPS equivalent to a 65% energy savings in Zone 3 for all models, plus an additional requirement to meet 55% energy savings in Zone 5 for models deemed as suitable for cold climates, to take effect from 1 July 2015. Mandatory labelling to take effect no sooner than 1 July 2015.

MEPS Option C and labelling: Mandatory registration and disclosure to take effect from 1 July 2014. MEPS equivalent to a 65% energy savings in Zone 3 for all models, plus an additional requirement to meet 60% energy savings in Zone 5 for models designated as suitable for cold climates, to take effect from 1 July 2015. Mandatory labelling to take effect no sooner than 1 July 2015.

MEPS Option D and registration: MEPS equivalent to a 60% energy savings in Zone 3 and 50% energy saving in Zone 5 for all models, to take effect from 1 July 2014. Mandatory registration to apply from 1 July 2014, but no labelling.

MEPS Option E and labelling: Mandatory registration and disclosure from 1 July 2014.MEPS levels to be set in mid-2014 to eliminate the least energy efficient 20% of models based on Zone 3 results, and the least energy efficient 20% of models based on Zone 5 results, to take effect from 1 July 2015. Mandatory labelling to take effect no sooner than 1 July 2015.

Labelling only

A voluntary labelling scheme was not specifically modelled due to a very high level of uncertainty surrounding the likely level of voluntary uptake. The mandatory labelling option that was investigated provides a good estimate of costs and benefits of a mandatory label, as well as providing the upper bounds of costs, benefits and B/C ratios of a voluntary scheme. As the costs of a voluntary scheme would be similar to a mandatory labelling scheme, but the benefits would be significantly smaller, it follows that the net benefits and the benefit/cost ratios would be lower.

Unless a voluntary label received very high coverage of available models and consumers trusted the information on the label, it would not be expected to resolve previously identified cold climate performance issues and would only allow consumers to partially compare the energy efficiency of the range of models.

MEPS Option A

Setting a MEPS level that corresponds to the *lowest* level of energy efficiency claimed by manufacturers would in effect add a mechanism for physical compliance testing to verify claims for the first time, while ensuring performance does not decline, as could happen if existing government interventions were changed or cheaper imported products became available. As this would ensure all manufacturers' claims are verified, it would provide consistent and verified information that could improve consumer confidence, and as a result it is likely to be supported by suppliers with above average levels of performance, referred to as MEPS Option A.

In MEPS Option A, all HPWH models sold from mid-2014 would have to comply. This is considered the earliest practicable implementation date for any measure, given the need to complete the regulation impact assessment process, finalise changes to the standards and allow reasonable lead time for manufacturers to comply.

Option A (as well as B and C) allows manufacturers to decide if they want their product to be labelled as cold suitable, which would require models to achieve an additional cold temperature MEPS level. MEPS A (and B and C) depends on a suitable labelling program to present the cold climate suitability information. Only those who chose to design products for cold climates would need to meet the cold climate MEPS. This option provides greater latitude to commercial and competitive forces, as opposed to option D where all models must perform well in all climates.

MEPS Option B and C

MEPS Options B and C would impose more stringent requirements than Option A, and manufacturers would be given an extra year to comply with regulations imposed from mid-2015.

Option B and C (as with A) allows manufacturers to decide if they want their product to be labelled as cold suitable, which would require models to achieve an additional cold temperature MEPS level. MEPS B and C (as with A) depend on a suitable labelling program to present the cold climate suitability information. This option provides greater latitude to commercial and competitive forces, as opposed to option D where all models must perform well in all climates.

MEPS Option D

There is a case for applying two separate metrics to HPWHs – one for the climate zone in which most are likely to be installed, and another for the zone which will place extreme demands on them. A HPWH is statistically most likely to be installed in Zone 3 (which includes Sydney, Adelaide and Perth), so a MEPS level corresponding to that Zone is appropriate. An additional requirement for all models to meet a MEPS level corresponding to cold temperatures (Zone 5 which includes Canberra and is representative of New Zealand, a) would ensure that consumers in colder areas, where performance is compromised, are also assured of a minimum level of performance.

This option would create greater costs on manufacturers and result in larger impact on competition as it would reduce the potential market separation offered in the other MEPS options. This proposal has one key advantage as it does not require a labelling program and still resolves the cold temperature performance issues.

MEPS Option E

If an absolute MEPS level is set in advance, as in MEPS Options A to D, suppliers would be assured that any product meeting that level could be lawfully sold up to any subsequent rise in the MEPS level (should that occur). MEPS Option E is significantly different in that the level would only be set a year in advance of MEPS applying, and would depend on an analysis that can only be made once all models have been tested and registered (around mid-2014). MEPS would then be set at a level that eliminates the 20% least energy efficient models then on the market. This would reduce the time manufacturers have to meet MEPS but would guarantee the number of models removed from the market.

This approach would in effect transfer the risk of selecting an effective MEPS level from governments (who have always borne it in the past) to the market. The projected impact of any given MEPS level depends on the expected difference between the product efficiency trend that would have occurred without market intervention (the 'BAU projection') and the level that is imposed on the market by that MEPS level. If the BAU rate of increase in energy efficiency is under-estimated, the MEPS impact is over-estimated. In that case, a higher MEPS level may well have been justified on the basis of impact and cost-effectiveness. There will always be some uncertainty whether this has occurred; because once MEPS are implemented the original BAU projection can never be tested. MEPS Option E would reduce this uncertainty, because a known number of models with a known level of performance would be impacted.

Interaction of mandatory labelling and MEPS

Although HPWHs are already tested in order to determine their eligibility to create STCs, there could be additional costs if extra energy or performance tests are required. Registration with the GEMS regulator would involve additional cost.

There would also be additional costs to suppliers who decide to redesign products to make them more energy efficient. Models are redesigned from time to time in any case, so if there is a timely signal to the industry that the commercial value of increasing energy efficiency metrics will increase (in comparison with, say, the value of maximising STC entitlements, which is a major driver of design at present), the additional design and reengineering costs may be moderate.

The benefits of registration and disclosure only can be estimated by comparing:

- The increase in model-weighted energy efficiency compared with BAU (i.e. how suppliers react); and
- The increase in sales-weighted energy efficiency compared with BAU (i.e. how consumers react).

The costs of climate labelling are higher than registration and disclosure only, however, disclosure through labelling of every unit produced, and the requirement to include the information in catalogues, brochures and internet advertising result in benefits that would most likely be higher than registration and disclosure alone, because:

- Suppliers might be expected to make more effort to increase efficiencies on the expectation of greater exposure of the information;
- Consumers would be more inclined to select more efficient products from those on offer; and
- There would be a better fit between the products selected, hot water demand and climate zones if consumers could identify the most suitable models, and this would lead to further increases in energy efficiency.

MEPS + disclosure option D1 would mean that by the target implementation date every model on the market would have to meet or exceed the specified MEPS level. The models that do so today would not have to be changed, but suppliers would have to make a choice regarding models that do not: drop them from the range without substituting another model, replace them with a model that just meets MEPS, or replace them with a model that is more energy efficient than MEPS. Projecting the impact of each MEPS level requires a judgement about which of these responses is most likely in each case. The more stringent the MEPS level the more likely that new models would just meet it rather than exceed it, so the 'overshoot' will be less.

Projecting impacts for MEPS Option E is the most difficult, because it requires two sets of assumptions: the energy efficiency distribution of the models on the market in mid-2014, when the MEPS level that eliminates the 20% least efficient models is determined, and then the responses of the suppliers of the eliminated models. This approach has one key benefit as it is allows a more direct estimate of the number of manufacturers and models that will be required to alter products.

It is however possible to envisage Option E could result in suppliers of poor-performing products making no model changes at all before the 20% selection process, because altering or removing models with poor efficiency prior to the setting of the MEPS level would most likely drive up the MEPS level (making subsequent compliance more difficult). This would result in BAU changes to energy efficiency being lower for that period that would have been the case. While this is possible, a similar situation exists for all markets that are being influenced by MEPS as the levels are normally set based on the level of efficiency of the worst performing models. As such, a manufacturer with a poor performing model could keep it on the market to influence future MEPS level, or wait until MEPS levels are defined before altering products, reducing the BAU energy efficiency level. While this is possible, it is unlikely that an individual manufacturer could alter the MEPS level by retaining poor performing models as there were over 80 models in the market in 2012, reducing the impact that one manufacturer can have. It is equally possible that not defining a MEPS level, but defining the market percentage to be removed, could result in manufacturers overshooting the required MEPS level to ensure their products pass, resulting in a higher average market efficiency.

Also, the combined impacts of disclosure and MEPS are not simply additive. The increase in HPWH energy efficiency forced by MEPS reduces the scope for gains though disclosure, and vice versa. Nevertheless the combined impacts would be higher with physical labelling, which would have a greater market impact than information disclosure alone.

Approach to the analysis

Projecting HPWH electricity use

The HPWH market in 2011 was selected as the starting point for projections, because it was more representative than 2009-10, when the market was inflated by the availability of rebates, and 2012 when the data set was incomplete and the market was deflated by the slow-down in building activity after the end of stimulus measures following the global financial crisis (Figure 1).

The CER data made available to the former DCCEE enabled a full analysis of the sales of all 19,972 HPWH units for which STCs were registered in 2011, by brand name, model and location of installation. The only adjustment was to the number of HPWHs sold in the ACT. As 2011 was an unusually low sales year (possibly due to growing consumer awareness of the poor cold-weather performance of some HPWH models), a 4-year average value was used. Sales in QLD were revised down in anticipation of the impact of the decision to remove phase-out requirements from new and existing buildings.

This adjustment took 2011 sales to exactly 20,000 units, which is the starting point for the HPWH market projections (Figure 12). It is assumed that FY 2013 returns to trend and then sales increase gradually, except for a spike around 2019, when the large number of HPWHs installed in 2009 will come to the end of their service life and need replacement. It is assumed that only half will be replaced by new HPWHs, largely due to the inertia of water heater consumers, who tend to replace like with like. The rest will revert to other types, because the substantial cash incentives that favoured HPWHs in 2009-10 will not be available.

Table 12 HPWH Sales by jurisdiction and Zone, 2011

	NSW	Vic	Qld	SA	WA	Tas	NT	ACT(Adj)	Total	Check
Zone 1			3488		130		183		3801	19.0%
Zone 2			41		694		81		816	4.1%
Zone 3	2866	244	7469	1904	1121				13604	68.0%
Zone 4		676		77	164				917	4.6%
Zone 5	52	205				362		243(a)	862	4.3%
	2918	1125	10998	1981	2109	362	264	243	20000	
	14.6%	5.6%	55.0%	9.9%	10.5%	1.8%	1.3%	1.2%	100.0%	

(a) Average of 4 year sales in ACT

Although there were 18 brands represented in the CER data, several of these were owned by the same companies (these are listed in E3 2012). After all re-brandings of the same basic models were taken into account, the 9 distinct models which were independently tested for the former DCCEE in late 2011 accounted for 18130 units (over 90% of all sales). An additional 4 units were tested in New Zealand in 2010.

The 'efficiencies' determined in those tests were expressed as a nominal % saving in electricity use compared with the corresponding reference electric storage water heater, calculated using AS/NZS 4234, in Zone 3 and Zone 5.[16] For brevity, this value is simply called the '% saving' value. The higher this value, the less energy used by the HPWH to deliver a set amount of hot water.

The sales-weighted average % saving values for each Zone were determined as follows:

- The Zone 3 value was used for HPWHs installed in Zones 1,2 and 3;
- The Zone 5 value was used for HPWHs installed in Zones 5;
- The mean of the Zone 3 and Zone 5 value was used for HPWHs installed in Zones 4.

This covered 92% of sales. The other 8% of sales were assigned generic efficiency levels as indicated in Table 13. Most were given the medium efficiency, but CO_2-refrigeration units were given a higher efficiency and products which are listed with a relatively lower number of STCs in the CER register were given a lower efficiency.

Table 13 Efficiency values assigned to untested models

	% saving in Z3	% saving in Z5
Generic lower efficiency	57%	46%
Generic medium efficiency	60%	48%
Generic higher efficiency	63%	50%

After all models were assigned a set of efficiency values the sales-weighted value in each of the 5 zones was automatically calculated from the number of each model sold.

[16] The % savings used are based on the Australian draw-off patterns. For the same models, the % savings values calculated using NZ draw-off patterns were significantly higher. For consistency, the Australian % savings were used for the NZ impact analysis as well.

One product scored very poorly in the laboratory tests, and after testing was completed the unit was found to be faulty. As the model accounted for a significant number of sales, its efficiency values had a noticeable effect on the sales-weighted average. The performance of that model was 'corrected' to match other models of the same brand, on the assumption that either the fault was random or, if endemic, the suppliers will correct it now that they have been made aware of it by the former DCCEE.

The results of the analysis are summarised in Table 14. If all units had been installed in Zone 3 the weighted average % savings value would have been 55.5%, and if all had been installed in Zone 5 the weighted average % savings value would have been 43.9%. However, many of the sales in colder zones were of models which performed better in those areas, so the actual weighted average was significantly higher – 51.3%. This suggests that there is already a degree of locational matching of HPWHs based on performance in the cold.

Table 14 Sales-weighted '% savings' value for HPWH units with STCs registered in 2011

Installed in	Units	% saving if installed in Zones 1, 2 or 3	% saving if installed in Zones 4 or 5
Zone 1	3,801	54.7%	43.1%
Zone 2	816	55.6%	49.2%
Zone 3	13,604	55.5%	43.3%
Zone 4	917	56.3%	51.3%
Zone 5	862	58.3%	50.8%
All units	20,000	55.5%	43.9%
Warm zones	18221	55.3%	
Cold zones	1779		51.3%

All 'efficiencies' based on TRNSYS modelling using Australian draw off in AS/NZS 4234.

The impacts of adopting MEPS level D can be simulated by:

- Identifying the models with '% savings' values in Zone 3 and Zone 5 that are lower than the MEPS level; and
- Replacing those models with notional units that just meet the MEPS level (this builds in a conservative bias because suppliers are more likely to replace sub-MEPS models with those that exceed MEPS rather than just meet it).

Table 15 indicates that 6 of the 12 model groups currently on the market would meet MEPS D, and these account for 30% of total sales. For MEPS A, as in MEPS D, all models would have to pass 60% saving in Zone 3, but the Zone 5 criterion only applies to those models which suppliers choose to designate as Suitable for Cold Climates (SCC). If the MEPS A criteria were applied to the current model range, there are 6 models that would meet a criterion of 50% saving in Zone 5, should suppliers choose to designate them SCC. This is the same number as would meet the MEPS D criterion for performance in Zone 5. However the one Zone 3 compliant model not capable of meeting the 50% saving in Zone 3 would presumably not be designated SCC and could still remain on the market in MEPS A, even though it would be eliminated in MEPS D. This model has a fractionally lower % savings value than the other models passing in Zone 3, so the energy saving impact of MEPS A would be slightly less than that of MEPS D, if today's model range is considered.

On the other hand, MEPS options A, B, C and E would be coupled with energy mandatory labelling, which would strengthen market demand for products optimised for either SCC or general use. This would enable suppliers to achieve a better fit between product design and locational marketing in future. Therefore it is assumed that MEPS A will achieve a *higher* level of savings compared with MEPS D over time. The margin is assumed to be 0.5% greater sales-weighted % saving in the warmer zones and 1.0% greater for colder zones.

The MEPS option is based on the efficiency distribution of models on the market that will only be revealed once all products are tested and registered. However, if the market remains largely unchanged from today's model range, the % savings levels that would eliminate about 20% of models are indicated in Table 15. These are significantly less stringent than MEPS option A, which corresponds to the level of efficiency currently claimed for HPWHs. Thus MEPS Option E runs the risk that it could legitimise a level of energy efficiency that is less than is currently being claimed. It can be rejected on that basis alone, and no further modelling of MEPS E has been undertaken.

Table 15 Models and sales (from 2010) passing at various MEPS levels

MEPS level Named in Table 1	Minimum % saving in Zone 3	Current Models passing in Zone 3	% of current sales passing in Zone 3	Minimum % saving in Zone 5	Current Models passing in Zone 5	% of current sales passing in Zones 4&5	Models Passing both Zone 3 & 5 % savings	Sales from 2010 passing both
	40%	12	100%	25%	12	100%	12	100%
	45%	11	84%	30%	11	95%	10	78%
	50%	11	84%	35%	10	85%	10	78%
MEPS E(a)	55%	10	76%	40%	9	50%	8	37%
	60%	7	33%	45%	9	69%	7	36%
MEPS A	60%	7	33%	50%	6	50%	6 (MEPS level D)	30%
	65%	1	1%	50%	6	50%	1	1%
MEPS B	65%	1	1%	55%	4	42%	0	0%
MEPS C	65%	1	1%	60%	0	0%	0	0%

Grey cells indicate mandatory MEPS requirement for all models. Yellow cells indicate requirement mandatory only for those models which the supplier chooses to designate as Suitable for Cold Climates. (a) MEPS level E was selected on the basis that it eliminated close to 20% of current models on both the Zone 3 and the Zone 5 criterion.

This analytical method allows the calculation of the change in sales-weighted efficiency of HPWHs that would occur if each of the specified MEPS regimes were adopted. In many cases the resulting average is slightly higher than the MEPS level, because some of the models on the market already exceed that level. Comparing Table 16 with Table 14 shows that if MEPS A were adopted, the sales-weighted efficiency of HPWHs sold in 2011 would have increased from 55.5% to 60.3% (measured on their performance in Zone 3) or from 51.3% to 52.3% (measured on their performance in Zone 5). Table 16 outlines the estimated sales weighted %savings of models in individual climate zones for the range of MEPS options assessed. The table shows that the actual market efficiency is expected to be above the MEPS level given current models having higher efficiency than the proposed MEPS levels.

Table 16 Sales-weighted '% savings' if all HPWH units passed MEPS

	MEPS A		MEPS B		MEPS C		MEPS D	
Installed in	Z3 saving	Z5 saving	Z3 saving	Z5 saving	Z3 saving	Z5 saving	Z3 saving	Z5 saving
Zone 1	60.2%	52.0%	65.0%	55.6%	65.0%	60.0%	60.7%	53.0%
Zone 2	60.3%	54.1%	65.0%	56.8%	65.0%	60.0%	60.8%	55.1%
Zone 3	60.3%	52.1%	65.0%	55.8%	65.0%	60.0%	60.8%	53.1%
Zone 4	60.5%	53.4%	65.0%	56.4%	65.0%	60.0%	61.0%	54.4%
Zone 5	60.9%	54.4%	65.0%	56.9%	65.0%	60.0%	61.4%	55.4%
All units	60.3%	52.3%	65.0%	55.9%	65.0%	60.0%	60.8%(a)	53.3%(b)

(a) Assume 0.5% margin over MEPS A (b) Assume 1.0% margin over MEPS A due to greater freedom for suppliers to match product characteristics to climate zones.

The model allocates the projected HPWH sales in to each of 9 regions (the 8 Australian jurisdictions and to NZ) and to climate zones within each regions, in the ratios recorded in 2011 (Table 12). For NZ, 750 sales are assumed for 2011, progressively rising to 1,000 in 2033, with 80% of sales in NZ Zone 4 and 20% in NZ Zone 5.

The annual electricity required to deliver hot water in each zone using the appropriate 'reference' storage water heater was taken from the Pitt & Sherry report *Running Costs and Operational Performance of Residential Heat Pump Water Heaters*(September 2012). Pitt & Sherry calculates values for three deliveries in each zone – low, medium and high.

Previous research has indicated that the average household demand for hot water has been falling over time as household size declines and the efficiency of water-using appliances and fittings increases (GWA 2010). This is simulated by assuming that 80% of households in each area in 2011 have 'medium' hot water demand and 20% have 'low' demand, and by 2033 70% have medium and 30% have low demand. These assumptions result on the trends in the 'reference' electricity demand for water heating indicated in Figure 13. The energy used by HPWHs installed new in each Zone in each year is then calculated by multiplying the reference electric water heating value for that zone by the '% savings' values for HPWHs sold new that year.

Figure 12 Projected HPWH sales, Australia, 2011-2033

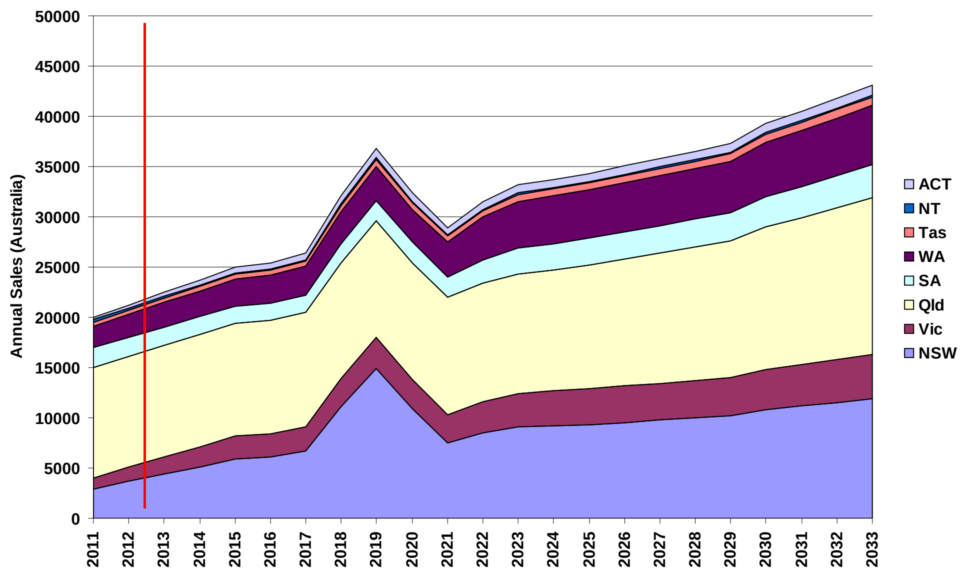
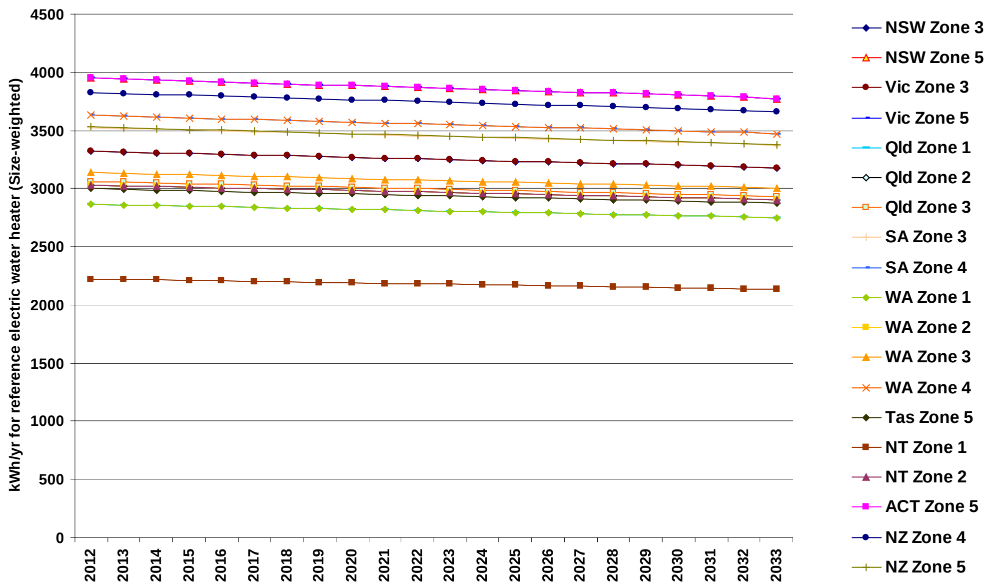


Figure 13 Electricity use by reference electric water heating in each State and Zone, 2012-33



Projecting impacts of measures

Sales-weighted energy efficiency

The sales-weighted energy efficiency of HPWHs can be projected to increase even in the BAU scenario, without any new policy measures. This is evident from the registers of HPWH models eligible to create STCs, published from time to time by the CER. After allowing for the changes in the AS/NZS standards which underlie the calculation of the number of STCs, the average number of STCs for newer models is significantly higher than for older models re-registered under the latest methodology. While energy efficiency and STCs are not always directly related, part of the change in STC generation numbers is likely to be a result of improvement to energy efficiency. It is therefore assumed that without new measures, the sales-weighted % savings value will increase by 0.2% per annum.

The introduction of mandatory registration and information disclosure (Option 1) will have an immediate impact on suppliers, who will try to improve the efficiency of their model range prior to having to make the information public. Similar step changes in energy efficiency have been observed prior to previous label introductions, including air conditioners and refrigerators (E3 2011). This is projected to lead to a 0.4% per year increase in sales-weighted % savings, for the 3 year period to 2013-15. After this consumer preference for the more efficient of the available models drives the increase in % savings further, at 0.3% per year initially then falling to 0.2% per year after 2023 – the same rate of change as the BAU.

The supplier and consumer responses to the mandatory physical labelling of products and other related advertising and brochures are projected to be somewhat greater (Table 17). When energy labelling is combined with MEPS, however, the label impact is diminished, because MEPS will drive a step-change increase in sales-weighted efficiency, so reducing the scope for further savings in the market. In essence, a moderate MEPS will bring forward some of the longer-term savings that might be achieved by labelling alone. The increase in HPWH energy efficiency forced by MEPS reduces the scope for gains though labelling, and vice versa. Nevertheless the combined impacts would be higher, which would have a greater market impact than MEPS and information disclosure alone.

Table 17 Projection parameters – BAU and energy labelling impacts

	BAU annual Increase	Option 1 – Information disclosure only				Option 2 – Physical labelling			
		Suppliers 2013-2015	Consumers 2016-2023	Consumers 2024-2033	Option 1 Combined with MEPS	Suppliers 2013-2015	Consumers 2016-2023	Consumers 2024-2033	Option 2 Combined with MEPS
Zone 1	0.20%	0.40%	0.30%	0.20%	0.04%	0.80%	0.40%	0.30%	0.09%
Zone 2	0.20%	0.40%	0.30%	0.20%	0.04%	0.80%	0.40%	0.30%	0.09%
Zone 3	0.20%	0.40%	0.30%	0.20%	0.04%	0.80%	0.40%	0.30%	0.09%
Zone 4	0.20%	0.40%	0.30%	0.20%	0.04%	0.80%	0.40%	0.30%	0.09%
Zone 5	0.20%	0.40%	0.30%	0.20%	0.04%	0.80%	0.40%	0.30%	0.09%

The combined projected impacts of MEPS and mandatory energy labelling are illustrated in Figure 14 and Figure 15, for HPWHs sold in Zones 3 and 5 respectively. The BAU trend line at the bottom trends upwards at a constant slope. The energy labelling trend lines diverge from it fairly smoothly – more steeply at first, as suppliers change their models, then more gradually as consumers make use of the information to change their preferences.

The MEPS trends lines rise steeply, because suppliers would be required to ensure that every model met the MEPS level by mid-2014 (MEPS A, D) or mid-2015 (MEPS B, C, D). If there were no labelling the sales-weighted average would remain effectively unchanged, but with mandatory labelling there would be a continuing incentive for both suppliers and consumers. Therefore the trend line of efficiency would continue to rise under the influence of labelling after the initial impact of MEPS, but at a slower rate than through labelling alone.

Energy use and emissions

The total annual energy consumption under BAU and each policy measure of HPWHs sold between 2013 and 2033 in each Australian jurisdiction and in New Zealand has been modelled by combining the sales projections (Figure 12), the electricity consumption of the reference electric water heaters (Figure 13) and the sales-weighted % saving values (Figure 14 and Figure 15).

The total projected HPWH electricity use in Australia for the range of options considered is shown in Figure 16. Figure 19 compares the electricity use under each policy measure with the BAU case, to show the energy impact of each measure. For example, mandatory labelling alone reduces total electricity use over the period 2013-33 by about 360 GWh, or 3.8% compared with BAU. The option with the highest impact (MEPS C + labelling) reduces electricity use by nearly 1,800 GWh, or 19.1%.

Figure 18 and Figure 19 show the corresponding electricity use and impacts for New Zealand. Although the shapes are similar, the impacts for New Zealand are of course much smaller in magnitude, because the market is only 3.8% the size of the Australian market in 2013, declining to 2.5% in 2033.

Figure 14 Projected sales-weighted % savings, HPWHs sold in Zone 3

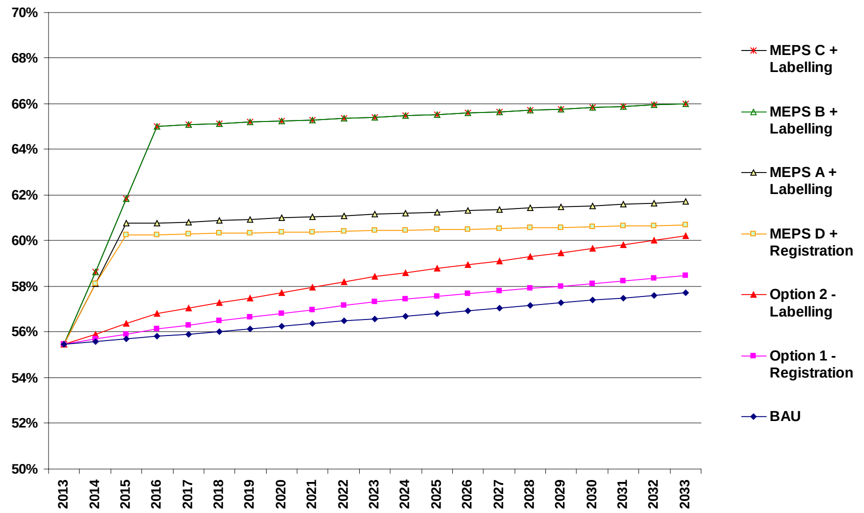


Figure 15 Projected sales-weighted % savings, HPWHs sold in Zone 5

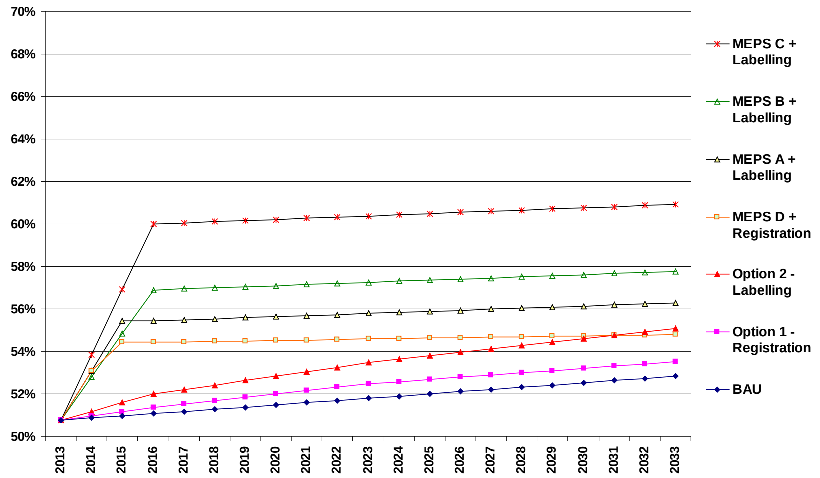


Figure 16 Projected electricity consumption, HPWHs installed 2013-2033, Australia

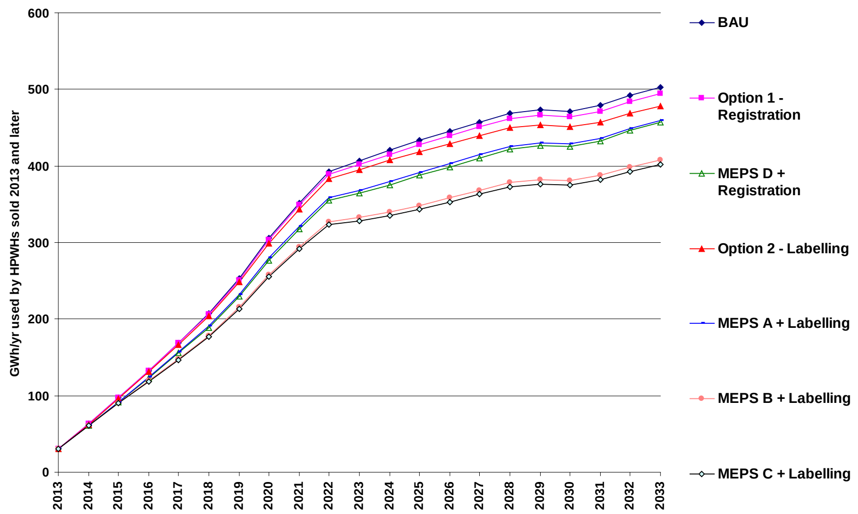


Figure 17 Electricity saved by various measures, HPWHs installed 2013-2033, Australia

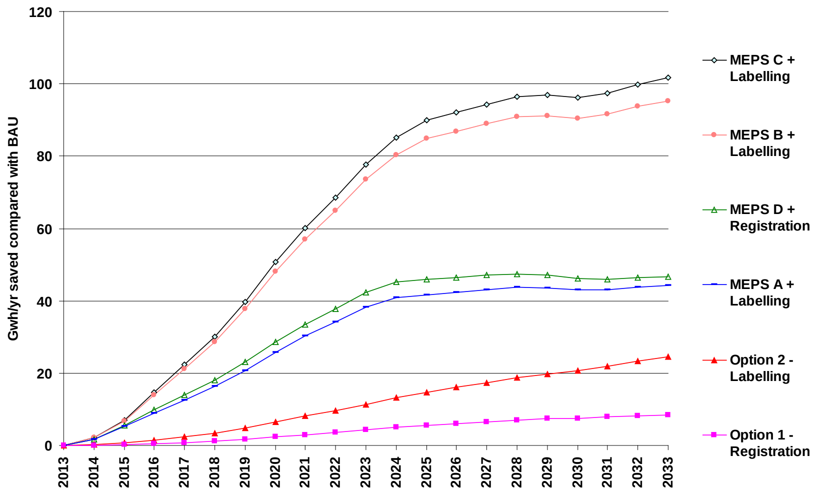


Figure 18 Projected electricity consumption, HPWHs installed 2013-2033, New Zealand

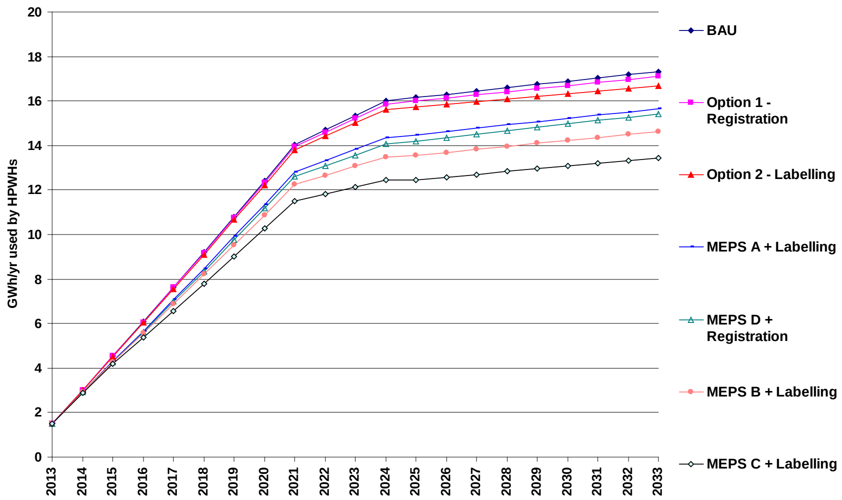


Figure 19 Electricity saved by various measures, HPWHs installed 2013-2033, New Zealand

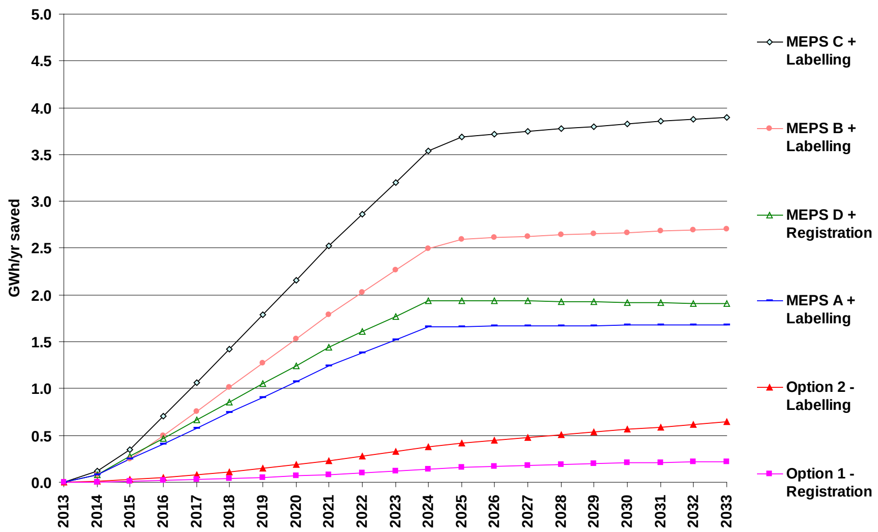


Figure 20 Emissions intensity projections, Australia

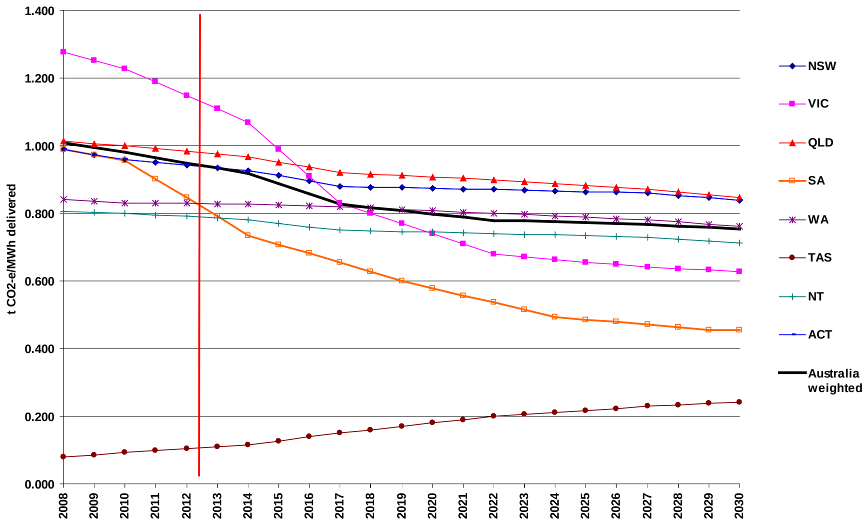


Figure 21 Projected emissions reductions compared with BAU, Australia

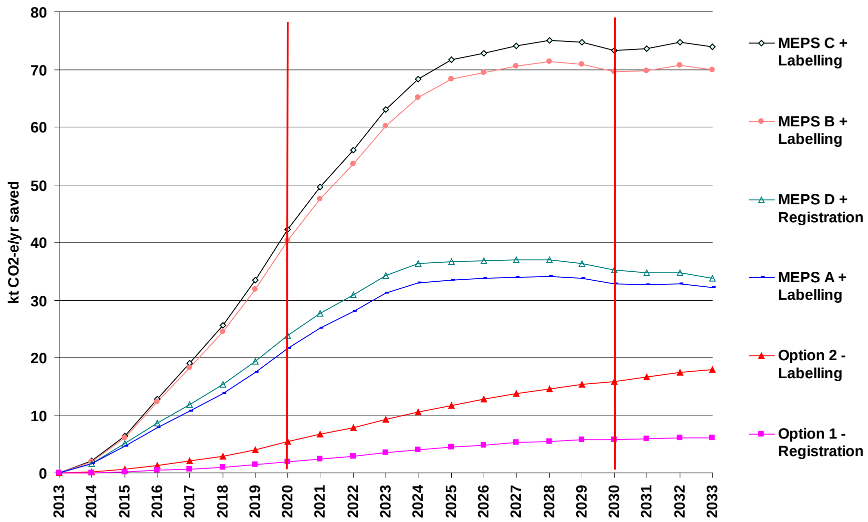
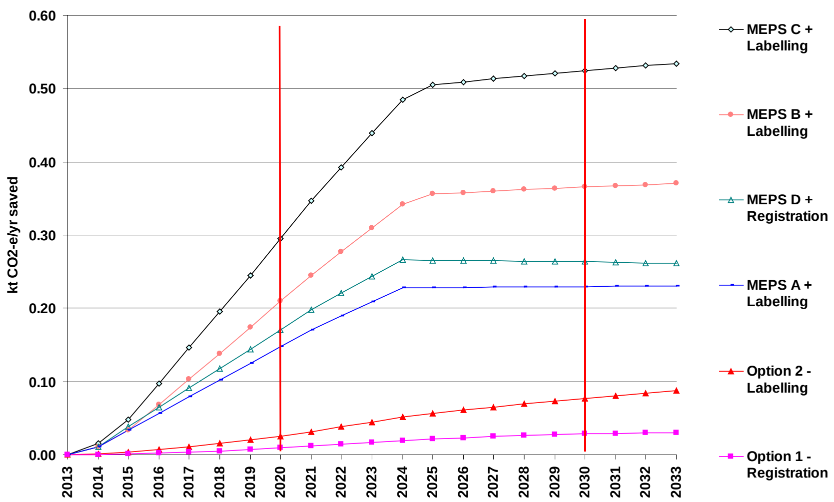


Figure 22 Projected emissions reductions compared with BAU, New Zealand



The emissions related to electricity use are calculated using the emissions intensity projections first developed for GWA (2010), and updated to take into account the fall in SA emissions-intensity due to the more rapid than expected development of wind power (Figure 20). The reductions in emissions are shown in Figure 21. For the cohort of HPWHs installed between 2014 and 2033, mandatory energy labelling alone reduces emissions by a cumulative 264 kt CO_2-e, or 3.7% compared with BAU. The option with the highest impact (MEPS C and label) reduces emissions by a cumulative 1,342 kt CO_2-e, or 18.9% compared with BAU. The emissions reductions below BAU due to mandatory labelling alone are 5 and 16 kt CO_2-e in the years 2020 and 2030 respectively. Those from MEPS C and labelling are 42 and 73 kt CO_2-e in 2020 and 2030 respectively.

The emission-intensity for New Zealand is projected to be a constant 0.137 kt CO2-e/kWh delivered (E3 2012). Coupled with the low sales of HPWHs, this means that the greenhouse impacts of measures are low (Figure 22).

Costs and benefits

The primary benefits of the proposal come from the projected reduction in the electricity use of HPWHs that will be purchased after the measures come into effect, compared with the BAU case, in which no policy measures change.

This RIS quantifies the reduction in energy use for a group (or 'cohort') of HPWHs installed in the 10 and 20 year periods from FY 2014 to FY 2023 and FY2033.The benefit-cost calculations take account of any increases in the capital costs of HPWHs that may occur due to the measures, as well as the lifetime energy costs for all HPWHs installed during this period. This means that for HPWHs installed in 2033, the stream of energy costs goes up to FY 2042. The 20 year results were deemed most suitable for water heaters as the full impact of measures was not reflected in the 10 year results, largely due to the slower turnover of the existing stock for water heaters due to their service life exceeding 10 years.

It is assumed that the measures do not significantly affect the size of the HPWH market compared with the BAU case. However, there could be a reduction in market size if the measures increase the relative price of HPWHs in comparison with other options and ongoing energy costs are not considered. However, as alternative water heaters (including electric storage water heaters) are likely to be subject to similar policy measures, this factor is likely to be minor.

On the other hand, the demand for HPWHs could increase because the options aim to address the identified market failures and non-price factors which inhibit take-up of HPWHs at present: noise and the poor performance of some models in cold climates. Mandatory testing and registration would disclose the performance of each model in colder as well as warmer climate zones, so consumers and intermediaries such as plumbers would have clear guidance on product selection. MEPS would set minimum performance requirements in the key zones (3 and 5). The testing and disclosure of noise levels would give a market advantage to quieter models and may increase sales. However, the potential increase in the HPWH market share due to these factors is not taken into account.

The measures should also enable a better fit between HPWH model selection and household hot water demands. At present the only public information available is the number of STCs that each model can create. The more STCs the greater the potential *reduction* in capital cost, but the absolute capital cost may still be inflated if consumers choose models that are unnecessarily large for their needs simply to maximise the discount. Furthermore, the larger models will often have higher heat losses and may be operating at a less efficient part of their performance curve for more of the time, so their running costs may be higher. If the proposed measures create market drivers for suppliers to increase energy efficiency rather than maximise STC numbers and allow consumers to better select an appropriately sized model, this could further reduce energy use compared with BAU.

The measures should also improve the utility of HPWHs with respect to recovery rates, since these would also be disclosed on a website and/or physically labelled on products.

However, the only class of benefits that can be quantified with reasonable confidence is the amount of electricity savings in the HPWH market, the monetary value of those savings and the related reduction in greenhouse gas emissions. It is assumed that the costs for greenhouse gas emissions will continue to be internalised in energy prices, as they have been since mid-2012, so it is not necessary to assign a separate value to emissions reductions. The main aspects of the quantified benefit-cost analysis are summarised below.

Energy costs and cohorts

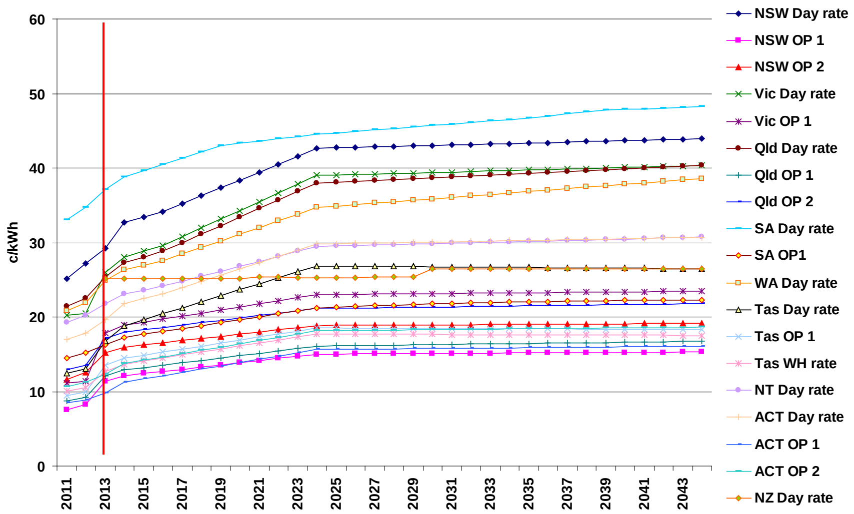
The value of energy used by HPWHs depends on the projected trends in electricity tariffs in each jurisdiction, and the share of HPWHs connected to each tariff. The projections in Figure 23 are based on those in GWA (2010), calibrated to actual FY 2013 prices. The share of HPWHs connected to continuous and off-peak (OP) tariffs is taken from energy retailer information and from BIS Shrapnel (2012). The highest rates of connection to off-peak tariffs are in NSW and Qld, where it is assumed that 60% of HPWHs will be connected to either restricted hours or extended hours OP tariffs based on BIS Shrapnel 2012 survey results. The tariff-weighted price projections enable the calculation of annual and lifetime electricity costs for all HPWHs installed up to 2033. The stream of energy expenditures can be expressed as a present value (PV) using a suitable discount rate. The discount rate used for most analyses is 7%, with sensitivity tests at 3% and 11%.

At a discount rate of 7%, energy represents about half the lifetime cost of owning a HPWH, and capital cost (purchase plus installation) the other half (this includes STC values, without which capital costs to consumer would be about 40% higher). Consumers incur the entire capital cost when the water heater is installed, but pay for energy progressively over the service life of the water heater (which for HPWHs is assumed to be 10 years – see GWA 2010). The NPV of the stream of future capital expenditures for HPWH purchases can be calculated using discounted cash flow analysis, in the same way as the future energy expenditures.

NPVs are calculated for two groups (or 'cohorts') of HPWHs:

- Those installed in the 10 year period from FY 2014to FY 2023. The NPV calculation includes the capital costs incurred over this period and the lifetime energy costs for all HPWHs installed during this period. This means that for HPWHs installed in 2023 the stream of energy costs goes up to FY 2032; and
- Those installed in the 20 year period from FY 2014 to FY 2033. The NPV calculation includes the capital costs incurred over this period and the lifetime energy costs for all HPWHs installed during this period. This means that for HPWHs installed in 2033 the stream of energy costs goes up to FY 2042.

Figure 23 Projected electricity tariffs by jurisdiction (constant 2012 prices)



Capital costs

Purchase price and STCs

The reported mean price of HPWHs in 2012 (including installation) was about $2,230 (BIS Shrapnel 2012).[17] Although this was based on a relatively small sample and should be viewed with caution, it is a reasonable basis for capital cost projections since it is the changes that bear on the benefit-cost analysis rather than the absolute values. The price is net and would include the value of STCs but not cash rebates, which had dropped to negligible levels in mid-2011.

Table 18 indicates the sales-weighted average number of STCs created by the HPWHs installed in each Zone in 2011. Between April 2010 and February 2012, the annualised moving average market price of STCs ranged from $27 to $37.[18] Assuming an average value of $35 would mean that the cost to buyers would have been reduced by

[17]Excluding a significant ratio of installations that appear to have been replacements under warranty.
[18]*Ecogeneration* magazine.

about $800 to nearly $1,000, depending on the zone. However the pre-STC capital cost of HPWHs installed in colder zones would have been higher, since they would have incorporated anti-frost capabilities and higher performance. The estimated pre-STC prices, STC impacts and net price to users are summarised in Table 18.

Table 18 Estimated capital costs of HPWHs, 2013

	No-STC price	Average STCs	STC value (a)	Net price to user
Zone 1	$2,800	23.0	$804	$1,996
Zone 2	$3,000	21.8	$764	$2,236
Zone 3	$3,200	27.0	$943	$2,257
Zone 4	$3,400	28.1	$985	$2,415
Zone 5	$3,700	26.3	$921	$2,779
Sales-weighted	$3,155	26.1	$912	$2,243

(a) Assuming an effective value to buyers of $35 per STC

Capital cost impacts of proposed measures

Increasing the energy efficiency of HPWH designs in response to MEPS or energy labelling would require physical changes in their design and construction. The costs of redesign would be fixed for each model, irrespective of the number sold (see next section), but increases in material costs and quality would be incurred for each unit sold. It is assumed that both categories of cost are added to consumer prices.

The relationship between increases in consumer price and increases in energy efficiency is expressed as a 'Price/Efficiency' (PE) ratio. A PE ratio of 100% means that if energy efficiency increases by 10% price also increases by 10%. A PE ratio of 50% means that if energy efficiency increases by 10% price increases by 5%. The following PE ratios have been estimated for other regulation impact analyses of other appliances that also use refrigeration technology:

- RIS for refrigerator and freezer MEPS, 2005:Average 24%, range 15% to 40%, depending on product category (EES 2009);
- RIS for changing refrigerator and freezer energy tests: Average 34%, range 10% to 90% depending on product category (EES 2009); and
- RIS for air conditioner MEPS 2011: 4-6 kW split units: 58% in the first year, declining by 5%p.a. (EnergyConsult 2010).

Retrospective analysis following the implementation of MEPS and labelling for refrigerators, freezers and air conditioners concluded that 'there is no evidence that the real price of appliances increased at all as a result of the rise in energy efficiency' (E3 2011).

The BIS Shrapnel 2012 survey noted a decline in the average net price of HPWHs to consumers of 25% between 2010 and 2012 and the energy efficiency of models improved (as seen by increased average STCs models generated which is a proxy of efficiency). This decline in net out of pocket expenses occurred at a time when the level of financial rebates declined. The rate of price decline of HPWHs was far greater than the declines of other competing water heater technologies. The increasing number of relatively cheap imported models from Asia could further reduce average prices of HPWHs in the medium term. The modelling has taken the conservative assumption that prices will not continue to decline. Stable prices is conservative as the PE ratio is calculated as a precent change to capital costs, so an assumed higher capital cost results in a higher assumption of capital cost impacts of energy efficiency measures. Considering the rapid decline in recent prices corresponding with an increase in average energy efficiency, the future capital price assumptions can be viewed as conservative. The impact of a PE ratio of 50% and 100% is also calculated for information.

Any increases in capital costs to consumers could be offset by increases in the number and total value of STCs created. However, this effect is difficult to predict, because it is possible that the STC market will respond to the creation of additional STCs from more efficient HPWHs by a weakening of STC prices, or suppliers who factor STCs into point of sale discounts may retain a share of any increase in STC values. A range of 'STC value impacts' on consumer prices is modelled, from 0% (no impact) to 100% (full impact, and assuming a linear relationship between energy efficiency increases and STC creation).

The economic impact of the proposed measures on capital cost needs to be assessed net of changes in STC values (i.e. an STC value impact of 0), because STCs represent a cross-subsidy from one group (all electricity users) to consumers of HPWHs and other eligible small-scale technologies. However, the existence of STCs means that the financial ('cash') impacts of the proposed measures on HPWH consumers will diverge from the actual capital cost impacts, so STC values need to be taken into account for that purpose. The most likely STC value impact factor has been deemed to be about 50% for the analysis, although impacts of 0 and 100% are also tested.

Program costs

Program costs are those incurred due to the establishment of a measure, whether or not the measure results in increases in energy efficiency. This RIS assumes that any increases in product design, construction, testing and registration costs will be incurred by the manufacturers in the first instances and then passed on to customers. Administrative costs to government are also included in program costs, although they will be borne by the taxpayer.

Testing and registration

The initial cost of testing is assumed to be borne by the HPWH manufacturers, either locally or overseas. At present the cost of a full cycle of HPWH tests in Australia is about $13,000. The cost of noise tests is estimated to be about $3,000. The actual costs which mandatory energy efficiency and noise testing will impose are likely to be significantly lower, because:

- Manufacturers already test all models to determine their eligibility to create STCs, so much of the testing costs will be incurred anyway; and
- For initial registration tests, manufacturers do not have to use accredited independent laboratories in Australia, but are free to use overseas or in-house laboratories where costs are significantly lower.

It is estimated that *extra* testing costs and registration fees will amount to$10,000 per model. Registration will be via the Energy Rating website, using procedures that are well established for other products. All models that remain on the market after the start of a mandatory program (whether labelling, MEPS or both) will need to be tested to the prescribed standard. There are about 80 HPWH models on the market at present.[19] It is assumed that there will be 70 HPWH models on the market at the time of implementation of the proposals in this RIS (some already on the market, some yet to be introduced). This means a total initial testing and registration cost of $ 0.7M, as indicated in Table 19. It is estimated that 5 new models are introduced each year from 2015, so the ongoing testing cost to suppliers is $0.05 M per year.

Labelling and product redesign

It is estimated that physical labelling, along with the provision of images of the labels in advertising and brochures, will add 50c to the retail price of each unit sold. This cost is incurred for Option 2 but not Option 1, where only disclosure of information is required. At projected sales of about 24,000 units in FY 2015, the labelling costs in the first year of the program would be $ 0.012 M, rising annually with sales.

Disclosure and labelling on their own would create a commercial incentive for suppliers to increase the energy efficiency of their products, but the rate of product redesign is up to them. If they fit in with the regular product development cycles the costs can be minimised. However, the time available for redesigning models to meet a MEPS deadline is constrained, so costs will most likely be higher. Alternatively, some importers may need to source alternative models from other manufacturers in order to remain in the market. This would also incur costs for those businesses.

An amount of $50,000 has been allowed for each model that would need to be redesigned or replaced. The estimated number of models needing replacement and hence the total costs to industry would depend on the stringency of the MEPS level (Table 19).

Administrative costs

The administrative costs to government can be gauged from the present E3 program allocations for water heating products, but they were assumed to be lower for HPWHs due to the smaller market. They are estimated as follows:

[19] *Register of solar water heaters – Air Source Heat Pump models with capacity of up to 425 litres, V14* (CER 16 October 2012). 80 models are eligible to create STCs after 1 November 2012. An additional 322 registrations expired on 31 October 2012.

- Salary and overheads for officials administering the program: $40,000 per year;
- Check testing, research and other costs underpinning the program: $25,000 per year, half of it borne by the Commonwealth and the other half by other jurisdictions in proportion to their population, in accordance with long-standing cost-sharing arrangements for E3 activities; and
- Printing and promotional activities at $10,000 per year.

Hence total government program costs are estimated to be $75,000 per annum in Australia. New Zealand administrative costs are estimated at NZ$10,000 per annum, in addition to the supplier costs borne by manufacturers of models that are unique to New Zealand.

Table 19 Estimated Program Costs

Cost	Options	Number of models (a)	Cost per model	2014 cost $M, Aust
Energy test	All	70 (5)	$10,000	0.70
Product redesign or replacement	MEPS A	20 (2)	$50,000	1.00
	MEPS B	35 (3)	$50,000	1.75
	MEPS C	40 (4)	$50,000	2.00
	MEPS D	30 (3)	$50,000	1.50

(a) Figures in parentheses are estimated number of additional models unique to New Zealand

Summary of costs

Table 20 summarises the costs for the option with the highest projected energy savings (MEPS C + labelling). The allocation of costs between consumers and industry is somewhat arbitrary. Suppliers will need to incur the manufacturing costs of producing more efficient appliances, but this cost is allocated to consumers. Ultimately, it is expected that all other 'industry' costs will also be recovered from consumers through higher product prices.

Table 20 Summary of costs, Australia and New Zealand, MEPS Option C plus mandatory labelling

	Australia (a)			New Zealand (b)		
	Year 1	Subsequent years	PV 2014-33	Year 1	Subsequent years	PV 2014-33
Consumers	$0	Varies	$81.9 m	$0	Varies	$4.2 m
Industry	$2.70 m	$ 0.06 m	$3.1 m	$0.25 m	$0.10 m	$ 0.4 m
Government	$0.08 m	$ 0.08 m	$ 0.6 m	$0.01 m	$0.01 m	$ 0.1m
Total	$2.78 m	Varies	$85.6 m	$ 0.26 m	Varies	$ 4.7 m

(a) $A values, PV at 7% discount rate (b) $NZ values, PV at 5% discount rate

Projected costs and benefits

Australia and New Zealand

The following diagrams summarise the NPV of costs, benefits, net benefits (i.e. benefits less costs) and the ratio of benefits to costs under a range of combinations:

- For the BAU and for all the labelling and MEPS options;
- Under discount rates of 7%, 3% and 10%;
- Under PE ratios of 0%, 20% and 50%; and
- For the cohort of HPWHs installed between 2014 and 2023, and for the cohort installed 2014-2033.

The difference between BAU and any selected policy option will give the economic benefits and costs. For these comparisons the STC value impact is set at 0, because STCs represent a transfer payment between groups of consumers. However, STC values of 50% and 100% are also modelled, to indicate the financial impact of the measures on HPWH consumers.

Almost every option tested returns a significant net benefit, with B/C ratios well above 1 and in some cases above 10. The few exceptions are where the PE ratio is set to 100%, well above the assumed level of below 50%. Even in those cases the net loss is very low, and the B/C ratio is still close to 1.

Some unlikely combinations could bring double financial benefits to consumers. If they benefitted by a full $35 for each STC created, if extra STCs were created in direct proportion to the rise in HPWH efficiency and PE ratios were

(20%), then the increase in total STC values would exceed the sum of efficiency-related rises in prices as well as the program costs. As both after-STC net capital costs and energy costs would fall, the payback time is effectively zero and B/C ratios are infinite (these cells are marked 'INF'). However, this is a financial not an economic gain, since others pay for the STCs.

The B/C ratios for the main options vary with discount rates and with PE ratios, as illustrated in Figure 24 and Figure 25, for 7%, 3% and 11% discount rates. The time profile of the projection makes very little difference: the B/C ratios for a 20 year cohort (Figure 25) are only slightly higher than the corresponding ratios for a 10 year cohort (Figure 24). Figure 26 and Figure 27illustrate the B/C ratios for New Zealand, 5%, 3% and 8% discount rates.

Figure 24 Benefit/Cost ratios, Australia, HPWHs installed 2014-2023 (No STC value)

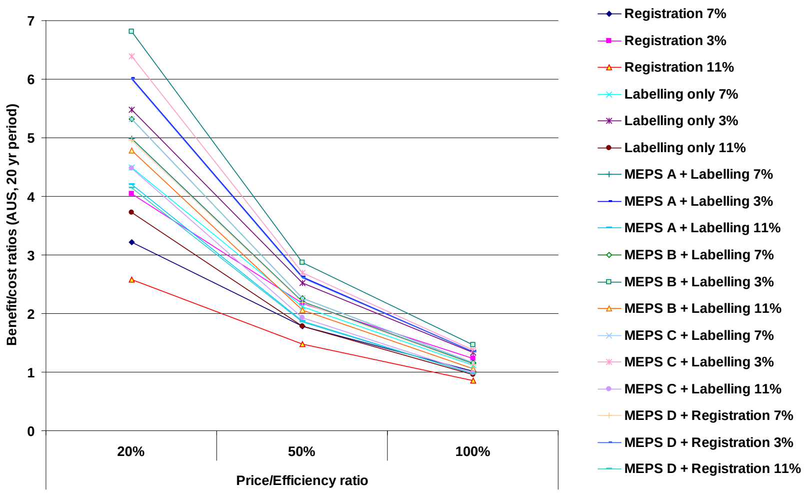


Figure 25 Benefit/Cost ratios, Australia, HPWHs installed 2014-2033 (No STC value)

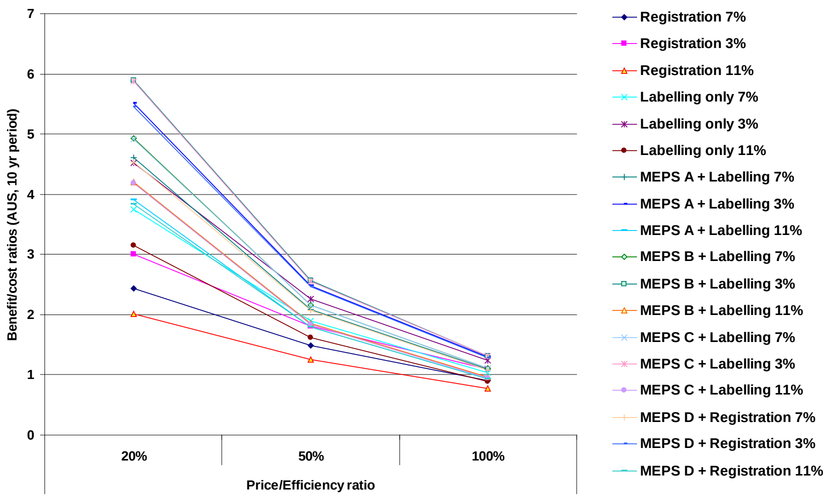


Figure 26 Benefit/Cost ratios, New Zealand, HPWHs installed 2014-2023 (No STC value)

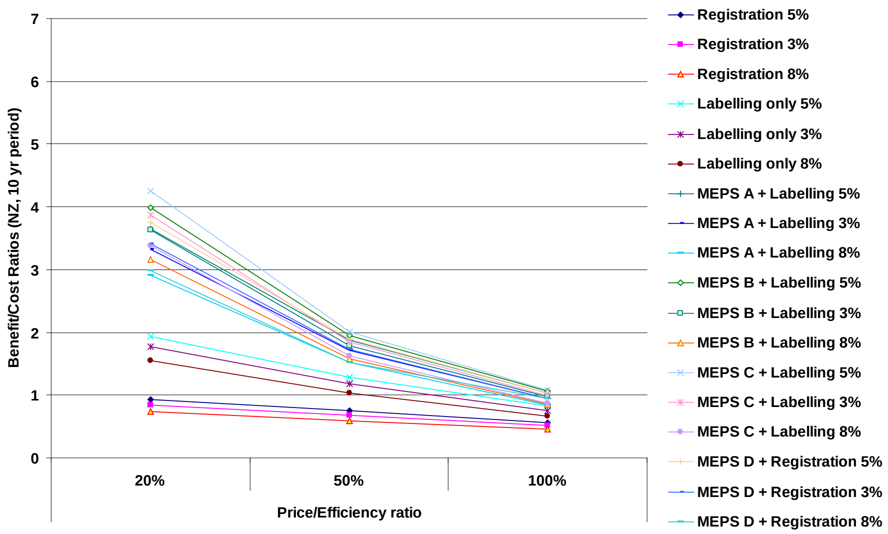
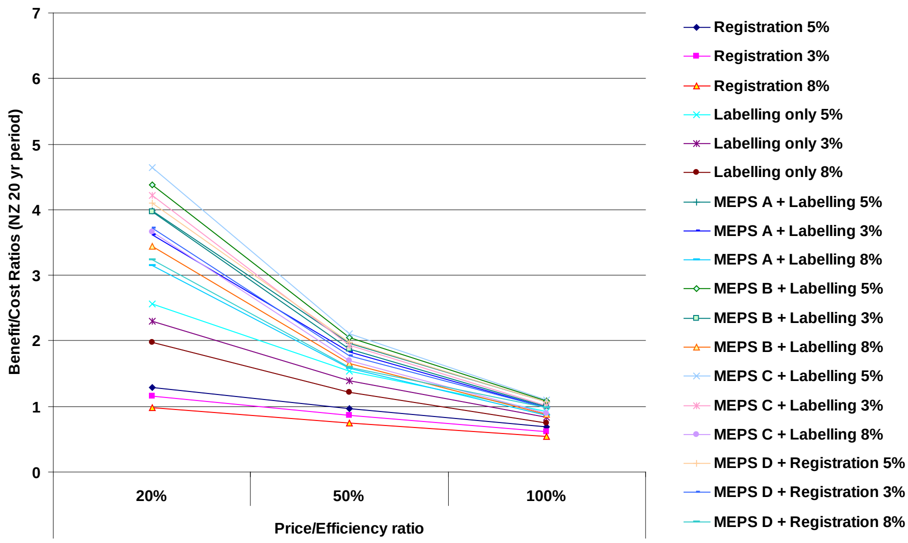


Figure 27 Benefit/Cost ratios, New Zealand, HPWHs installed 2014-2033 (No STC value)



Appendix 4: Benefit-cost analysis summary

Regulation scenarios	• Option 1 = Testing, Registration and disclosure only • Option 2 = Testing, Registration and mandatory label • Option A = MEPS 60% Z3 for all; 50% Z5 for models designated suitable for cold climate, 2014 • Option B = MEPS 65% Z3 for all,55% Z5, for models designated suitable for cold climate, 2015 • Option C = MEPS 65% Z3 for all, 50% Z5 for models designated suitable for cold climate, 2015 • Option D = MEPS 60% Z3 and 50% Z5 for all models, 2014 • Options A-D are also modelled for both MEPS and disclosure and MEPS and labels. • Option E = MEPS to be determined after disclosure commences (2014) and then set to eliminate least efficient 20% of models, 2015. This option was rejected and not modelled as it runs the risk of legitimising a level of energy efficiency below the level that all models currently claim.
Sales	• Aus: 20,000 in 2011 based STC registrations, increasing in line with ABS housing construction projections and water heater replacements – total sales estimates to reach ~43,000 by 2033. (Lower projection than in Product Profile due to QLD decision to abolish regulations to phase-out electric resistance water heaters, announced December 2012).2019 spike in sales a result of 2009 high sales being replaced (50% with HPWHs). • NZ: 750 in 2011 increasing to 1000 by 2033(estimate).
Projection periods	• 10 year (cohort of units installed 2014-2023) • Cohort modelling refers to tracking the energy use of the appliances installed during the cohort period up until the end of their lifetimes (10 years lifecycle assumed)
Efficiency	• 9 models were tested for energy efficiency (representing over 90% of total sales in 2010) • Market weighted efficiency calculated with STC registration data by model. • BAU energy efficiency trend increase of 0.2% per annum assumed • Mandatory labelling assumed to result in efficiency increase of 0.8% pa (2013-15), 0.4% (2016-2023), 0.3% pa (2024-33).
Capital costs	• BIS Shrapnel 2012 survey estimated average HPWH price after STCs of $2,230 (adjusted to remove systems which cost <$1000, and were probably replaced under warranty). Models sold in colder temperature zones assumed more efficient to cost more than the average. • STC price effects estimated from average STCs created (from CER reports) and average spot price over period ($35 average). Impacts of STCs are not included in benefit-cost analysis because STCs represent transfer payments. • STCs are included in assessment of impact on consumer prices.
Energy consumption	• Reference hot water energy use estimates correspond to those calculated by Pitt& Sherry for small and medium households in each climate zone. • Share of HPWHs installed in 2013 small (20%), medium (80%) and in 2033 small (30%); medium (70%) – i.e. declining average hot water use over time • State tariffs at end 2012 surveyed by GWA, 60% of HPWHs installed in NSW and Qld are connected to off-peak or restricted hours tariffs, 40% to continuous, based on BIS Shrapnel 2012 survey responses. Tariff shares in other jurisdictions vary – not all offer restricted hours tariffs. • Tariff projection series taken from Decision RIS for Phase-out of greenhouse intensive water heaters (GWA 2010) which were derived from 2008 Treasury modelling of impacts of carbon price. Values at start of series were adjusted to actual tariffs at end 2012.
GHG emissions	• State energy intensity projections taken from Decision RIS for Phase-out of greenhouse intensive water heaters (GWA 2010) which were derived from 2008 Treasury modelling of impacts of carbon price. SA series adjusted down to reflect rapid increase in wind energy production.

Registration Admin costs	• Admin costs assumed to be covered 50% by registration fees and 50% by government, based on agreed GEMS registration fees.
Industry costs	• $50,000 cost for each new model or model re-design. • $10,000 testing costs estimated based on E3 testing of HPWHs.
Sensitivity Analysis	NPV: • Australia 7% discount rate, with sensitivity tests at 3% and 11%. • New Zealand 5% discount rate, with sensitivity analysis to 3% and 8%. Price/Efficiency ratios: • 50% assumed most likely, with sensitivity tests at 20% and 100%. STCs • Increases in number and value of STCs generated by more energy efficient HPWHs have no impact on benefit-cost analysis, but do affect financial impact on HPWH consumers, who are assumed to receive 50% of nominal additional value, with sensitivity test at 0 and 100%. Projection Period • 20 year (cohort of units installed 2014-2033) with sensitivity test at 10 year.
Key Assumptions	• Increase in HPWH energy efficiency expressed as increase in '% energy savings' compared with reference electric water heater. Final metric likely to be Seasonal Coefficient of Performance (SCOP), which is to be defined in the revision of AS/NZS 5125. The actual SCOP levels which correspond to the MEPS levels in the RIS will not be certain until the test standards are complete. • Rebound (take back) assumed to be zero; i.e. it is assumed that people do not use more hot water as a result of having lower electricity bills. In any case, the slightly higher capital cost of a more energy efficient HPWH would have a countervailing influence on household budgets.

Conservative nature of other key assumptions

1. Sales assumption:
    i. Even though measures are designed to resolve market failures (information and split incentives), modelling assumes the resolution of the market failures does not increase market share of HPWHs. If the measures did result in increasing diversion of sales from ESWHs to HPWHs, the financial and GHG benefits would increase. The measures are not likely to result in a shift away from HPWHs to ESWHs as higher MEPS levels are expected to be implemented for ESWHs at the same time, so maintaining the cost differentials.
    ii. Assumes that the trend of declining capital cost of HPWHs relative to competing electrically power appliances does not increase sales. In fact, the increasing number of STCs created as a by-product of the measure should narrow the cost disadvantage against ESWHs and so increase HWPH market share.
    iii. Assumes that cheaper imports do not arrive even though more imported models are now available
    iv. STC applications are assumed to cover 100% of sales. Larger systems (>425L), such as those installed as central systems in apartments, are not eligible for STCs and some manufacturers have domestic models that are not registered to generate STCs. In addition, there are likely to be some installs where the owner just does not claim the STCs, even when eligible.
    v. No new future financial incentives for HPWH such as rebates are included.
    vi. Assumes no expansion of the phase-out (even though some jurisdictions are considering expansion/implementation) but does include recent changes in QLD.
2. MEPS scenario assumes that models below the MEPS level are replaced with models with the minimum efficiency level required to meet MEPS. It is likely that in reality some models will be developed that exceed MEPS. Some models may also be withdrawn so the cost of industry adaptation may be overstated.
3. Average hot water loads are assumed to continue to decline due to increasing water use efficiency and falling household sizes. Both of these trends may have reached their limits, so if hot water use remains constant or increases, the energy savings would be greater.
4. The Price/Efficiency (PE) ratio of 50% (with sensitivity tests at 20% and 100%) is likely to be on the high side when considered in tandem with the assumed no decline in future capital costs. Analyses of actual price trends following MEPS increases for refrigerators, freezers and air conditioners found no evidence that prices had increased at all (i.e. the PE ratio appeared very low).

Appendix 5: Previous Consultation

There has already been one round of formal public consultation with industry and other stakeholders on key aspects of the proposals in this RIS. The Equipment Energy Efficiency (E3) Committee released a *Product Profile on Heat Pump Water Heaters* in late June 2012 (E3 2012). The Product Profile contained the following recommendations:

1. *Establish a system of mandatory product testing and registration, based on AS/NZS 5125, as well as noise testing to ISO 3741. As HPWH suppliers already conduct physical tests to AS/NZS 5125 and governments already maintain registers of other appliances, the additional costs should be relatively minor in comparison with the potential public benefits.*
2. *Introduce MEPS and functional performance requirements, including addressing cold temperature performance and noise issues, with proposed notification of the requirements no later than mid-2013 and requirements to take effect by mid-2014. There are likely to be significant benefits from ensuring that all models are fit-for-purpose and achieve MEPS.*
3. *Enable public access to the registered data, with models identified. This will provide potential purchasers, competing suppliers and regulators with an overview of the range of products and performance levels on the market.*
4. *Develop energy labelling standards, either as a mandatory requirement or initially for voluntary use by suppliers.*
5. *Develop a roadmap of potential future increases in minimum performance criteria.*

The Product Profile also sought responses to 14 key questions. Written submissions were invited up to 10 August 2012. During the comment period, public information sessions were held in Canberra, Adelaide, Sydney, Brisbane and Wellington. Most of the parties attending these sessions also made written submissions.

There were 22 written submissions, from a range of entities. The representation was fairly well balanced by country, and by interest group – manufacturers/importers, researchers and industry associations (Table 7). There was one submission from a regulator, one from a welfare-based non-governmental organisation and one from the supplier of a thermal insulating enclosure for water heaters. There were no submissions from consumer groups.

Table 21 Submissions on Product Profile

Country of respondent	Manufacturer / importers	Research, design & test	Industry Association	Other	Total
Australia	7	3	1	3	14
New Zealand	4	3	1	-	8
Total	11	6	2	3	22

The responses to recommendations were as follows:

1. Establish mandatory product testing and registration

Most submitters actively endorsed this recommendation, and none opposed it. However, there were differences regarding the methods of testing (and modelling) for which results should be registered, given that these would also be used as the basis for MEPS and energy labelling. These differences are described in the following sections. One manufacturer cautioned against an additional registration fee.

2. Introduce MEPS and functional performance requirements

Most submitters actively endorsed this recommendation, and none opposed it. All researchers and some manufacturers indicated that there were a number of poor performing models on the market, and that MEPS should remove those. However, there were differences with regard to the proposed method of test for energy efficiency.

Among the manufacturers:

- 7 supported the use of a modified AS/NZS 5125 as the basis for MEPS, with all of these indicating that a physical draw off test/s was the key modification required;
- 1 did not oppose the use of AS/NZS 5125 as is;
- 1 supported the use of the '% reduction in energy use compared with a reference electric water heater' calculated using AS/NZS 4234 as the MEPS metric, with the addition of a draw off test to AS/NZS 5125 to verify the TRNSYS modelling; and
- 2 offered no opinion on this issue.

Among the researchers:

- 4 supported the use of the '% reduction in energy use compared with a reference electric water heater' calculated using AS/NZS 4234 as the MEPS metric; and
- 2 supported the use of a modified AS/NZS 5125 as the basis for MEPS.

Among the other parties:

- 3 supported the use of a modified AS/NZS 5125 as the basis for MEPS, with all of these indicating that a physical draw off test/s was the key modification required;
- 1 did not oppose the use of AS/NZS 5125 as is; and
- 1 offered no opinion on this issue.

There was near universal support for noise testing and registration of the results, with one manufacturer adding the caveat that suppliers should be able to perform the tests.

There were different views with regard to:

- The level of the MEPS metric: a few submissions suggested that a level of efficiency corresponding to a '60% reduction in electricity use compared with an electric water heater,' i.e. the current threshold for determining eligibility for STCs, would be suitable. One suggested a metric of '50% reduction' for Climate Zone 5. Both of these proposals formed policy options that are considered in the RIS; and
- Noise: no manufacturer advocated a mandatory maximum noise level, although several other submissions did so.

None of the submissions from manufacturers or researchers supported the metrics proposed in the Product Profile (i.e. time-weighted COP and litres/hr heated from 45C to cut-off, all based on current AS/NZS 5125 tests). The main objection was that, while these metrics are reasonably indicative of performance for integrated and multi-pass stand-alone models, they are not appropriate for single-pass stand-alone systems where the hot water in the tank is stratified (the current AS/NZS 5125 test actively prevents stratification). Most submissions suggested that energy efficiency and recovery rates were the key metrics, but that they should be determined using a revised AS/NZS 5125 that incorporates physical draw-off rather than under the current AS/NZS 5125. This feedback has been taken into consideration in the development of the policy options and the development of a suitable standard test procedure.

3. Enable public access to the registered data

Most submitters actively supported, and none opposed, the placing of the registered data for HPWHs on a public website. However, one manufacturer requested that only selected data be made available, and in a way that encouraged consumers to use it 'correctly'. Other submissions only supported public disclosure in a context where it would be required for other water heaters types as well.

4. Develop energy labelling

Two submitters opposed physical labelling of products on the grounds that consumers would not see it so it would be pointless, and/or that the information was already available on websites. Of the other 20 submissions, all supported some form of physical labelling, mostly mandatory. One industry association proposed that the form of the label should be developed by the water heater industry and that its use should be voluntary.

Views on the content and the basis of labelling differed widely. Where submitters indicate a preferred basis for energy efficiency claims made on the label, most indicated a preference for using a climate energy efficiency rating or a metric derived from AS/NZS 4234 (e.g. '% reduction in energy use compared with a reference electric water heater') or a derived seasonal COP value. Even those who advocated the use of (modified) AS/NZS 5125 tests as the basis for MEPS suggested that the efficiency information on labels should be derived in some other way.

Some submitters advocated that the method of presentation of energy and efficiency data should be comparable with:

- Electric storage water heaters only; or
- All electric water heater types, including solar; or
- All water heater types, including gas.

Various ways of expressing efficiency, energy use and/or running cost were proposed, including:

- COP;
- % efficiency;
- % reduction in energy use compared with reference electric water heater;
- Number of STCs for which the model is eligible;
- Annual kWh consumption under 'standard' conditions;
- Annual $ energy cost;
- kg CO2-e/MJ; and
- Lifetime energy cost (capital plus energy).

A range of visual devices and indicators was also proposed:

- Energy Star (recognising that this would be available to all models that meet some performance threshold, and would give no additional comparative information); or
- Continuous band star ratings as used on other energy labels; or
- Maps of climate zones.

There were many other aspects of performance suggested for inclusion in labelling:

- Suitability (or unsuitability) for installation in specific climate zones or frost-prone areas;
- Categorisation as A, B or C with regard to low-temperature operation;
- Suitability for operation with different tariff classes;
- Noise level;
- Whether the model has a resistance element;
- kW heating capacity;
- Hot water deliver capability;
- Litres/hour recovery rate; and
- Heat up time.

Some submitters recognised that it would be impractical to include all possible metrics of interest on a label (especially for metrics that varied by climate zone) and it may be necessary to link the label to information on the public register or to a website that allowed for calculations.

5. Develop a roadmap of potential future increases in MEPS

There were several comments from manufacturers regarding this recommendation. Two manufacturers advocated a forward program of rising MEPS, but most suggested that government should concentrate on establishing the initial benchmark, and were cautious about future changes to it, stating that future changes should

- Only be considered if there is a change in technology;
- Only be considered after consultations with the industry;
- Only be implemented after a reasonable lead time; and
- Be guaranteed to remain stable for a reasonable number of years.

Some researchers advocated that the roadmap should cover all water heaters.

6. Other Matters Raised

Many submissions proposed changes to the key standards. Most of the comments were directed at AS/NZS 5125. They included:

- Proposals for draw-off, delivery and recovery rate tests;
- Suggestions for changes to the test that would better capture the performance of single-pass, stratified configurations;
- Proposals for tests to check performance estimates derived from AS/NZS 4234; and
- Monitoring energy use in Legionella control routine.

One researcher proposed adding or changing maintenance and durability criteria for AS/NZS 2712 or AS/NZS 5125, including:

- Monitoring compressor loading in relation to manufacturer's safe operating criteria;
- Inspection of product materials, fastenings and construction;
- Assessment of accessibility of key components for maintenance; and
- Removal of requirements for double wall heat exchangers.

Other matters raised by submitters included:

- The need for more field monitoring of HPWH performance;
- The need for a general information campaign to inform both consumers and installers on the selection and sizing of HPWHs. Info campaign for consumers & installers;
- Preventing boosted HPWHs from reverting to permanent operation as a resistance water heater if HP fails; and
- Ensuring that testing regime accommodates possible technology developments, e.g. integration of solar with HPWHs, or units that may supply both space heating/cooling and water heating.

Equipment Energy Efficiency

Consultation Regulation Impact Statement:

Heat Pump Water Heaters

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