EQUIPMENT ENERGY
EFFICIENCY PROGRAM

PRODUCT PROFILE

Gas Ducted Heaters

Prepared for the Equipment Energy Efficiency Program

January 2011

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

Prepared by EnergyConsult.

This Report is available at
www.energyrating.gov.au

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Executive Summary

This report provides a Product Profile for residential gas ducted heaters, explores options available for improving the energy efficiency of the new heaters which are sold, and seeks stakeholder input and feedback on those options. Gas ducted heaters, also referred to as central heating systems, are a type of gas heater and can be used to heat a whole house either alone or supplemented with other types of heating such as reverse cycle air-conditioning (heat pumps) and space (or room) heaters.

Energy consumed by appliances is a major source of energy demand and greenhouse gas emissions in Australia and New Zealand, and heating accounts for a large proportion of residential energy use in both countries. Both governments have recognised the substantial reductions in energy use which can be made by improving the efficiency of domestic products.

Gas ducted heaters (central heaters) are one of a range of products identified in the Equipment Energy Efficiency (E3) Work Plan for further investigation, based on their energy savings potential. The E3 Programme develops, amongst other things, the regulations for minimum energy performance standards (MEPS) and energy labelling for appliances and equipment. These aim to improve the energy efficiency of various energy using products sold on the Australian and New Zealand markets. MEPS and/or labelling already apply to a range of electrical products, for example domestic refrigerators and air conditioners.

This Product Profile provides an overview of the market in Australia and New Zealand for gas ducted heaters – i.e. what products are available, what their efficiencies are, major suppliers, and the current level of understanding about the sales and installed stock. It considers if technical improvements are possible with minimal disruptions to business, and reasons why more efficient models aren't dominating the market. A variety of different policy options that could be used to improve products such as these are explored. We make recommendations for further policy investigation to achieve energy savings and greenhouse gas reductions.

Further data is required for a more robust analysis of the policy options, in particular for the New Zealand market, and readers are asked to supply this where they have it. Readers are also asked for feedback on the assumptions and data in particular, as well as the potential impact of different policy options on the gas ducted heater industry.

Note that this document does not pose policy but rather it indicates a variety of options for feedback from industry, and for the governments in Australia and New Zealand to consider. Minimum Energy Performance Standards (MEPS) and mandatory labelling are included in the short list of possible options, along with voluntary measures. Any proposals for regulation will need to have further analysis and public consultation through a Regulatory Impact Statement.

The problem

In Australia, the energy consumption from gas ducted heaters is expected to increase from 60 PJ in 2010 to 80 PJ p.a. in 2025. Gas ducted heaters are estimated to currently produce around 3,800 kt CO_2-e of greenhouse emissions, and without market intervention this is expected to grow to 5,000 kt CO_2-e in 2025. This is largely due to the increasing stock of gas ducted heaters; over the last decade, the stock has increased at an annual growth rate of approximately 3% p.a. They now occupy 15.6% of Australian homes and consume two thirds of the energy used in residential heating by gas.

The Australian situation contrasts significantly with the situation in New Zealand, where gas heating is being displaced by reverse cycle air conditioners (heat pumps) and gas ducted heaters are used in only around 1% of New Zealand homes. Their energy use is projected to decline from 1.2 PJ in 2010 to 1 PJ by 2025, and their greenhouse emissions to decline from 64 kt CO_2-e in 2010 to around 52 kt CO_2-e in 2025, due to declining sales.

In Australia these heaters are already regulated for basic efficiency (as well as safety) under the standard AS4556 and are required to display a gas energy rating label. However, gas energy labelling is an Australian industry-led scheme and for labelling to be enforceable in New Zealand a compatible trans-Tasman scheme would need to be investigated. In addition, the method of test contained in AS4556 was developed around two decades ago, and would also need to be updated to reflect changing technology and the wider range of efficient models now available on the market.

Why hasn't the demand for efficient gas ducted heaters increased significantly? While there is some evidence that energy labelling of gas ducted heaters in Australia has led to an increase in energy efficiency over the last decade or so, there are a number of market failures which mean that the average efficiency of units sold is likely to be suboptimal. One of the key factors is that for the majority of sales, the end user does not choose the unit. Around 75% of sales are directed to builders for the new home and renovation/retrofit market, who have little incentive/instructions to purchase a higher efficiency product if it has a higher up front cost. Even if they were inclined to investigate more efficient models, the calculations to determine the price difference versus the payback time are very complex. The majority of end-users are never provided with enough information to properly evaluate the benefits of investing in the higher efficiency gas ducted heaters. This is especially the case in New Zealand where there is no formal energy labelling scheme for gas ducted heaters.

Possible policy options

A range of policy options have been explored in this Product Profile: MEPS, mandatory energy labelling, voluntary or endorsement labelling, and incentives. The analysis presented in this profile suggests that the most cost effective approach to increase the average efficiency of gas ducted heaters sold would be to implement a trans-Tasman MEPS at a higher level than is currently required in Australia, complemented by mandatory energy labelling. This could deliver cost effective energy savings to consumers - i.e. where any higher up front cost of a more efficient appliance would be more than paid off by the energy savings over the lifetime of that unit, as well as delivering significant greenhouse abatement.

Because of the significant split incentive in the gas ducted heater market – affecting around 75% of sales (i.e. products are purchased by someone other than the householder or bill payer) – energy labelling alone would not greatly transform the market. Regulation with MEPS would be expected to achieve greater savings without the consumer needing to perform the savings calculations. However labelling would assist consumers involved in the purchase decision to identify more efficient models, provide a competitive incentive for manufacturers to bring more efficient models onto the market, and facilitate any government incentives. The current Australian test method (AS4556) would need to be reviewed, and possibly revised, to form a sound basis for a government regulated labelling program covering this product class.

Possible benefits of the policy options

There are currently around 50,000 gas ducted heaters sold each year, and the market is made up of 2, 3, 4 and 5 star heaters, based on the 1 to 6 star energy labelling scale in operation in Australia. More than 50% of models available in the market are estimated to be low efficiency (2 or 3 star rating) which means that improving the efficiency of these less efficient heaters would considerably improve the average efficiency of new ducted heaters sold.

While the New Zealand market is small (around 1,000 sales per year), many of the New Zealand suppliers are already marketing the same products in Australia, so implementation costs for testing, registering and labelling products would be minimal, if any. (Readers are asked to identify if they sell New-Zealand specific stock, as this may incur test costs if MEPS and/or labelling were to be implemented.)

Also, where possible to reduce trade barriers, it is desirable to align regulations between Australia and New Zealand, so it is timely to investigate extending the Australian labelling regulations to New Zealand in some form. New Zealand industry has indicated a preference for labelling to be aligned with Australia, and to help drive competition between major retailers/suppliers.

The provision of easily accessible comparable information on gas ducted heaters would increase the effectiveness of the gas labelling programme. Buyers could compare the heat output, gas input and energy efficiency (star rating) of various types of heaters. The Energyrating website (www.energyrating.gov.au) performs this function for regulated electrical products such as fridges and freezers and this function could be extended to gas appliances in a similar manner. The trans-Tasman efficiency programme therefore has the basis to support a government labelling scheme at minimal cost, if this policy option is deemed cost-effective in subsequent analysis.

While MEPS and labelling are familiar to industry and government, analysis of these and alternative policy options will be needed to identify which combination would achieve the greatest benefits with realistically minimal costs to industry.

Where to from here

CONSULTATION ON THIS PRODUCT PROFILE

Readers are asked to comment on a number of aspects in this document, particularly market data and modelling assumptions, to assist with the formulation of a preferred policy option in future. While we welcome comments on all aspects of the Product Profile, comment of the questions in the breakout box below would be of particular assistance.

Written comments should be sent via e-mail, and should be received by Thursday 31 March, 2011. Comments can be sent to:

Australia

Gas ducted heater profile

energyrating@climatechange.gov.au

New Zealand

The gas ducted heater advisor

Energy Efficiency & Conservation Authority

regs@eeca.govt.nz

AFTER CONSULTATION ON THE PRODUCT PROFILE

The evidence in this Product Profile will be reviewed and supplemented in light of any written submissions made by stakeholders and/or issues raised at stakeholder meetings.

Decisions will be made on whether to proceed with a proposal for gas ducted heaters (to improve their energy efficiency) and what the preferred options should be.

If the preferred options involve regulation (e.g. MEPS and/or labelling) a regulatory impact statement (RIS) will be prepared to analyse the costs, benefits, and other impacts of the proposal. Consultation will be undertaken with stakeholders prior to any final decisions being made.

Final decisions on policy will be made by the Ministerial Council on Energy in Australia and by the New Zealand Cabinet.

Gas Ducted Heater Product Profile – Key Questions

Do you agree with the market data presented for Australia and New Zealand? In particular, do you agree with the estimates of current and projected stock and sales of gas ducted heaters? Are there any products that are only sold in New Zealand?

Do you agree with the breakdown of gas ducted heater sales between the new build, renovation and replacement market segments? Do you think that the breakdown is the same in New Zealand as in Australia?

Do you agree with the breakdown of sales between low efficiency (1 to 2 star), medium efficiency (3 to 4 star) and high efficiency (5 or more stars) models? Is the New Zealand market similar to the Australian market in this sense? Are the operating hours accurately estimated for New Zealand?

Do you agree with the breakdown between gas ducted heaters fuelled by natural gas and LPG in the Australian and New Zealand markets?

Is the use of an average Heat Load Reduction factor of 0.5 in the modelling a reasonable assumption?

Do you agree that split incentives and information failures are limiting the uptake of higher efficiency gas ducted heaters in the Australian and New Zealand markets? Are you aware of other market failures which impact on the sale of gas ducted heaters?

What do you think would be the best way for governments to facilitate an increase in the average energy efficiency of gas ducted heaters sold?

Do you think that there is a case for MEPS for gas ducted heaters and implementing a government regulated trans-Tasman MEPS?

Do you think that there is a case for mandatory energy labelling of gas ducted heaters as part of a trans-Tasman government program?

What impact do you think implementing more stringent trans-Tasman MEPS and energy labelling for gas ducted heaters would have on the gas ducted heating industry?

Do you think that the current Australian standard AS4556 could be used as the basis of a government regulated MEPS and/or labelling program? Do you think this standard needs to be made more robust before it can support government regulated MEPS and labelling?

What additional costs do you think this would place on industry compared to the current situation? What impact do you think it would have on competition and consumer choice?

Introduction

Background to project

Energy consumed in the operation of equipment and appliances is a major source of energy demand and greenhouse gas emissions within the Australian and New Zealand residential, commercial and industrial sectors. The Australian and New Zealand governments have recognised the substantial contribution that improving energy efficiency can make to climate change abatement, reducing energy costs, and a achieving a more secure supply of energy.

This report provides a Product Profile for residential gas ducted heaters, that is, a technology and market assessment of residential gas ducted heaters in Australia and New Zealand. It is intended to initiate discussion with industry on the potential inclusion of gas ducted heaters in the Equipment Energy Efficiency (E3) program, to review energy efficiency and energy consumption trends for gas ducted heaters under business-as-usual and identify scope for improvement, and to investigate options to help improve the efficiency of gas ducted heaters. Two standard E3 program measures which have been used for a number of other key domestic appliances are Minimum Energy Efficiency Standards (MEPS) and a mandatory government-led energy efficiency labelling scheme.

History of Government & Industry Activities for Gas Heaters

Minimum energy performance standards (MEPS) and energy labelling were developed by the Australian Gas Association on behalf of the gas industry, and have been a required part of the gas certification scheme for gas ducted heaters in Australia since the early 1980s. However, the levels and basis for the MEPS and labelling have not been updated. Certification is, in turn, a required part of state by state gas safety schemes in most Australian jurisdictions. Similar requirements do not apply in New Zealand.

A national program under which governments regulate the energy efficiency of appliances and equipment has been in place in Australia since 1992 and is now called the Equipment Energy Efficiency (E3) program. The current program is a joint initiative of the Australian Commonwealth, State & Territory governments and the New Zealand Government, and operates as a trans-Tasman program.

Since the late 1990's, governments have worked with the gas appliance industry on approaches to increasing the energy efficiency of gas appliances sold. In 2002, a number of Australian government agencies commissioned a review of the gas appliance labelling and MEPS scheme to explore options for enhancing the effectiveness of the scheme at driving energy efficiency improvements. This study, conducted by Mark Ellis et al, 2002, made recommendations to review the energy labelling categories and the MEPS levels for space heaters, including gas ducted heaters, as heaters were 'bunching up' towards the top of the labelling categories and easily exceeding MEPS levels. This was followed by the discussion paper *Driving Energy Efficiency Improvements to Domestic Gas Appliances* (July 2003) published by the E3 Program, which identified key priorities and proposed a time table for reviewing test methods, standards, MEPS and labelling for gas heaters.

In December 2004 the Ministerial Council on Energy approved the *Switched on Gas* strategy which spelt out a ten year strategy for improving gas appliance and equipment efficiency through government regulated standards. The *Switched on Gas* strategy commits governments to formally take over the energy efficiency regulation of key gas appliances and equipment, with gas water heaters and gas ducted heaters being the highest priority items. Gas water heaters will be the first product regulated under this new scheme, with MEPS scheduled to commence no earlier than February 2011 in Australia and April 2011 in New Zealand.

Sustainability Victoria is currently managing the development of new test standards, MEPS and labelling for gas ducted heaters on behalf of the Equipment Energy Efficiency (E3) Committee, with an initial focus on a testing program to review the existing energy performance test standard for gas ducted heaters and identify ways in which it can be improved.

Policy Context for improving the efficiency of products

AUSTRALIA

Australia's greenhouse abatement and climate change policies have evolved steadily since the release of the **National Greenhouse Strategy** in 1997. They started with information programs, moved to regulated energy efficiency standards and labelling, and programs to promote the uptake of renewable energy.

On 11 March 2008, Australia's ratification of the Kyoto Protocol was officially recognised by the United Nations Framework Convention on Climate Change (UNCCC). Under Kyoto, Australia is obliged to limit its greenhouse gas emissions in 2008 – 2012 to 108% of 1990 emission levels. Beyond Kyoto, Australia has committed to reducing it's greenhouse emissions by at least 5% compared to 2000 levels by 2020.

In October 2008, the Council of Australian Governments (COAG) agreed to develop the National Strategy on Energy Efficiency (NSEE), This strategy establishes a cooperative plan to deliver a range of energy efficiency measures across all Australian jurisdictions.

The finalisation of the NSEE was announced through a COAG Communiqué in July 2009 which noted the importance of dealing with climate change through energy efficiency:

> *For the first time, Australian Governments have agreed a comprehensive 10-year strategy to accelerate energy efficiency improvements for householders and businesses across all sectors of the economy. Accelerating energy efficiency is a key plank in the strategy to combat climate change, reduce the cost of emissions abatement and improve the productivity of the economy*

The strategy is wide-ranging in scope and includes a suite of measures to strengthen energy efficiency standards for appliances, equipment, buildings and vehicles. A number of measures under the strategy will also provide Australians with better information and training to assist them in making informed choices to improve their energy efficiency.

All Australian jurisdictions have also signed a National Partnership Agreement on Energy Efficiency to deliver a nationally-consistent approach to energy efficiency through a range of energy efficiency initiatives, including nationally-consistent energy efficiency standards for appliances and equipment and a process to enable industry to adjust to increasingly stringent standards over time.

NEW ZEALAND

Energy-using products and appliances have an important influence on New Zealand's overall energy use. Improving the energy efficiency of products available on the New Zealand market will significantly reduce the energy these products consume, with consequent reductions in national energy demand and end-user energy costs. The Energy Efficiency (Energy Using Products) Regulations 2002 are provided for under s 36(1) of the Energy Efficiency and Conservation Act 2000. They are administered by the Ministry of Economic Development, (enforced by the Energy Efficiency and Conservation Authority) and allow the implementation of MEPS and energy labelling for scheduled appliances.

These energy and related cost savings provide the following benefits to New Zealand:

National benefits

- Increased economic growth – through improved productivity and international competitiveness of New Zealand businesses
- Enhanced security of energy supply - from reduced energy demand

- Deferring the need to build more expensive energy supply infrastructure and reducing peak demand - with consequent reductions in costs and environmental impacts
- Reducing the absolute amount of renewable electricity required for New Zealand to achieve its target of 90% renewable electricity generation by 2025
- Reducing greenhouse gas emissions - consistent with New Zealand's medium and long term reduction targets
- Reducing national health costs and improved overall wellbeing of New Zealanders – by making energy services more affordable.

Benefits directly to end-users:

- Lowering costs of energy services to householders – which improves their ability to afford higher quality lifestyles and/or make energy cost savings
- Energy users who are better informed about their energy related choices are more capable of managing the impact of future energy prices, which will incorporate a price on greenhouse gas emissions.

The New Zealand Energy Strategy (NZES) and its companion document, New Zealand Energy Efficiency and Conservation Strategy (NZEECS) are currently being revised. The final strategies are expected to include a focus on energy efficient equipment to achieve the benefits mentioned above.

Energy efficiency and the response to climate change

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

More recently New Zealand adopted a provisional and conditional emission reduction target of 10-20% below 1990 levels in 2020 which complements a longer term target of reducing net emissions to 50% below 1990 levels by 2050.

Measures that reduce energy-related greenhouse gas emissions make an important contribution to meeting these targets. Implementing energy efficiency is widely regarded to be amongst the most cost beneficial ways to reduce greenhouse gas emissions.

Revised New Zealand Emissions Trading Scheme (NZETS) legislation was passed in November 2009. It forms the centrepiece of New Zealand's response to climate change by introducing a market price on greenhouse gases. The equipment energy efficiency programme is one of a raft of measures which complement emissions pricing.

Minimum energy performance standards and labelling act to reduce energy costs which will include a price on greenhouse gas emissions.

Product Description

This report is concerned with gas-fuelled ducted heating products used in residential applications. These products are defined and described below.

Gas Ducted Heaters

Gas ducted heaters (GDH) are often called 'central heating systems' as they can be used to heat a whole house, rather than 'space heaters' which are used to heat an area or single room.

Air is heated by a gas furnace and the warm air (generally heated to 50° to 60°C, but sometimes up to around 80°C) is blown through insulated flexible ducts to be discharged through air outlets (supply air registers) into nominated rooms. Colder air is drawn back to the return air grille where it may pass through a filter to collect dust before being returned to the gas furnace and reheated. A central heating system can be installed to heat either the whole house, part of a house or a number of selected zones using motorized dampers.

The main types of gas furnace used in gas ducted heating systems are as follows and are illustrated in Figure 1:

- Indoor-only units commonly referred to as internal heaters, which are generally installed in the roof space;
- Outdoor-only units that have weather proof enclosures suitable for locating outdoors, commonly referred to by industry as 'external units or heaters'; and
- Multipurpose heaters with enclosures suitable for installation indoors or outdoors.

The main components found in the gas furnace for a GDH are listed below, and Figure 2 provides a cut-away illustration of a 5 star internal gas ducted heater:

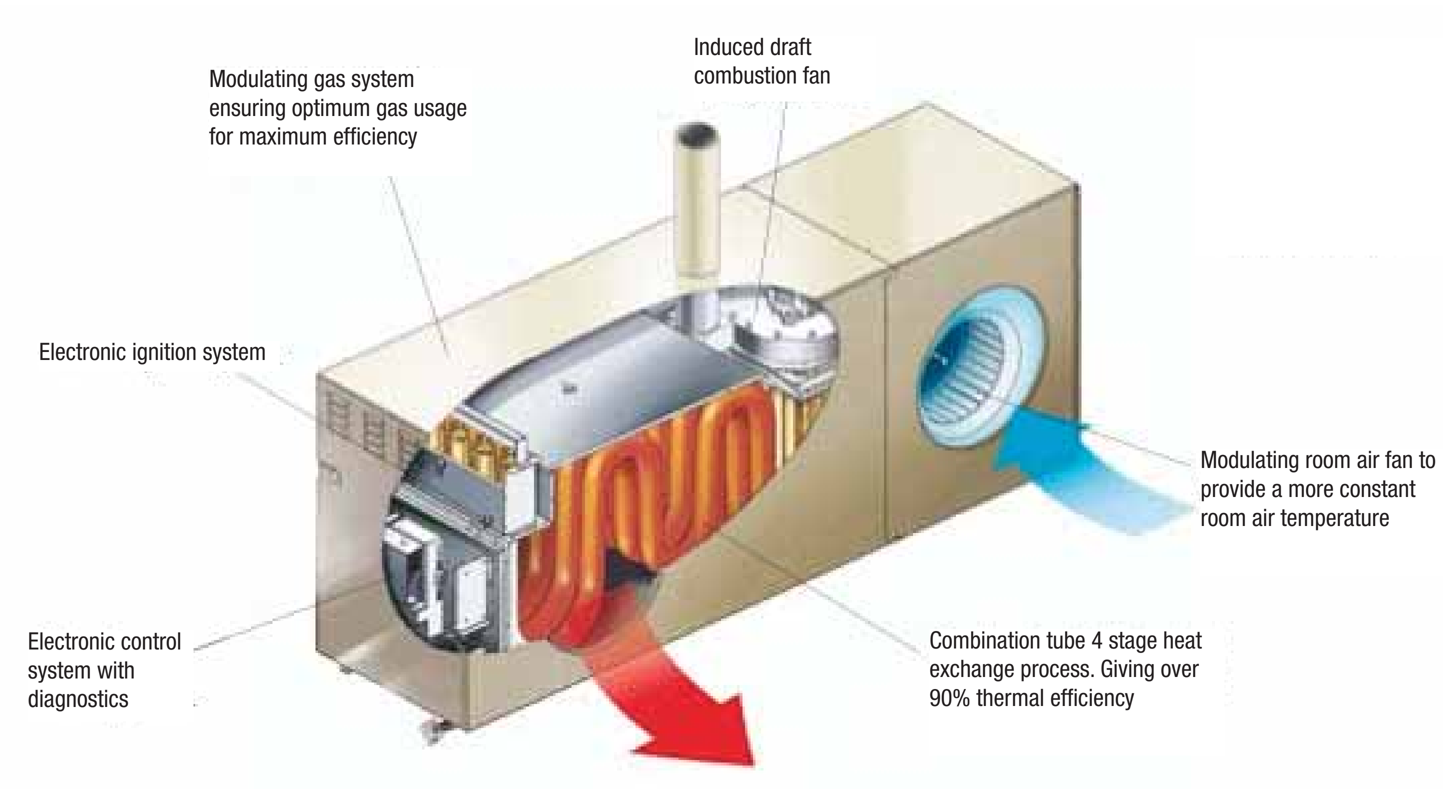
- Cabinet, insulated with aluminium foil and insulation material;
- Heat exchanger (primary and possibly a secondary condensing heat exchanger);
- Main blower;
- Gas control valves and burners (single stage, dual stage for high and low fire and variable control);
- Spark ignition or solid state spark ignition (early models had pilot lights and though some are still in service, they are no longer available for sale), and
- Control board to control temperatures, gas, air purge and the main blower with inputs for add-on air conditioning and accessories such as humidifier, zoning and electrostatic air filters.

Figure 1: Internal GDH and External GDH *(Source: Brivis)*

Internal GDH

External GDH

Figure 2: Main Components of a High Efficiency GDH furnace *(Source: Climate Technologies)*



GAS DUCTED HEATER EFFICIENCIES

In Australia the furnaces of GDH are required to have their energy performance tested, and to carry a gas energy rating label as detailed in the Australian Standard AS4556 which indicates efficiency on a scale from 1 to 6 stars. Many of the heaters sold in New Zealand are sourced from Australian suppliers and also carry the energy rating label in a voluntary capacity. Industry historically classifies GDH's into the following efficiency categories:

- Standard efficiency (natural draught combustion process heater), which corresponds to a 1 to 2 star rating;
- Mid efficiency heaters (fan assisted combustion process heaters), which corresponds to a 3 to 4 star rating;
- High efficiency heaters (fan assisted process heater with a 'condensing heat exchanger'), which corresponds to a 5 star rating.

Mid efficiency heaters are traditionally designed to extract only sensible heat[1] from the combustion gases generated by their burner/heat exchanger systems. This mode of heat transfer is commonly referred to as a 'dry' or 'non-recuperative' process, and typically provides fuel conversion efficiencies of no more than about 85%. A high efficiency condensing heater has a more efficient heat exchanger designed to recover the energy contained in the heated exhaust gases. This heat is normally lost to the atmosphere when the exhaust gases are discharged through the flue. A condensing heater captures a large proportion of this heat through the use of a secondary heat exchanger which exhaust gases pass through before being discharged, potentially raising the overall heat exchanger thermal efficiency to around 90% to 95%[2].

The primary and secondary condensing heat exchangers in high efficiency heaters are sometimes referred as 'dry' and 'wet' heat exchangers respectively. Secondary condensing heat exchangers capture heat in the hot exhaust gases, thereby cooling the exhaust gases, which results in a lower flue temperature (less than 70°C). As a side effect some vaporized combustion by-products are converted to condensate or moisture. This is why high efficiency heaters require the installation of a condensate drain and good practice for internally installed heaters is to add a condensate drain tray under the heater as a precautionary measure in the event that the primary condensate drain is blocked. Condensing heaters or medium efficiency heaters with long flue runs are typically installed with 'double skin' flues to avoid potential damage from condensate leaks.

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1 Sensible heat is defined as the potential energy in the form of thermal energy, or heat delivered during gas combustion, and refers to the heat that is added or removed from the air and dry bulb temperature changes without water vapour content change. Latent heat refers to the energy released or absorbed due to a change of state such as vapour condensing.

2 This is a nominal efficiency range and performance levels can vary depending on the test method.

DUCT WORK, ACCESSORIES AND ZONING

Homes can be ducted for heating the whole house, part of a house or selective zones where a system can heat all or parts of the house with the use of motorized dampers. These ducting arrangements can be installed under the floor, which is generally for 'heating only' installations or through the ceiling when there is not underfloor access and/or both heating and air conditioning (cooling) is intended to run through the same ducts. Figure 3 provides a schematic of a duct layout for an internal GDH installed in the roof space of a single storey home.

Figure 4 provides examples of the various components of a gas ducted heating system. When the furnace and ductwork are located in the ceiling, air is commonly supplied to rooms through down jets (see Figure 4) that direct warm air downwards to improve air mixing and minimize heat stratification when in heating mode. External furnaces are commonly used in under floor ducting configurations where the heater is located on the side of the house and blows hot air through ducts that run under the floor to discharge air via floor registers connected to 'floor boots' (see Figure 4).

The ductwork usually consists of insulated flexible duct offered in different thermal ratings (R-values); connectors that come in a variety of configurations (insulated or un-insulated, with multiple 'take offs') commonly referred to as 'branch take offs' or Y-pieces and a return air filter. (See Figure 4.)

A thermostat (sensor and controller) is required to control the supply of warm air from the GDH, and in the case of programmable thermostats switches the heater on/off and controls temperature according a time schedule (see Figure 4). Standard ducted systems work by heating zones in the house to the desired temperature based on one active thermostat (although some systems allow upstairs or downstairs control using a slave thermostat). Zoning systems allow the occupant to decide to supply air into zoned areas by switching zones off.

The furnace of a basic GDH system has a single gas burner rate and a single fan speed, and is controlled by a furnace management controller. In these systems a simple thermostat can be used to switch the gas burner off when the thermostat has reached its set temperature and switch the gas burner on again once the room has cooled a certain amount. The furnaces of many modern GDH systems have a number of gas burner rates and multi-speed fans, and in this case more sophisticated furnace controls are required. These systems can scale back both the gas burner and fan rate as the thermostat temperature approaches it's set point, thereby maintaining tighter temperature control. They are commonly connected to a programmable thermostat that controls room temperature to a time schedule.

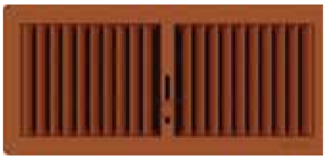
Zone controls can be integrated with the programmable thermostat and networked with the heater and cooling device or stand alone to control the zone dampers. A common simple zone configuration is three zones (living, common and bedrooms) achieved with two zone damper motors (see Figure 4) and a zone switch. More sophisticated zone systems use variable zone motor dampers (see Figure 4) to achieve desired temperatures in nominated areas or rooms.

Figure 3: Schematic of Duct Layout for Internal GDH in the Roof Space of a Single Storey Home

(Source: Climate Technologies)

Figure 4: Components of a Gas Ducted Heating System

Supply air register 'down jet'



Supply air floor register

Insulated flexible duct

Un-insulated 'branch tack off'

Insulated 'Y piece'

Return air with 'egg crate grill'

Programmable thermostat

Zone motor damper

Variable zone motor damper and BTO

Floor Boot

GAS DUCTED HEATING SYSTEM OVERALL EFFICIENCY

While energy efficiency standards for gas ducted heaters apply only to the gas furnace, it is important to remember that the furnace is part of an overall system which includes the furnace, ducting, thermostat and other components, as well as the building fabric of the house which the unit is heating. While building and installation standards can, and in some jurisdictions are, being used to increase the thermal efficiency of new homes and set minimum limits on the thermal efficiency of ductwork, many gas furnaces will be installed as replacement units into an existing home/system.

Any minimum energy efficiency performance requirements for the gas furnace should ensure that the furnace is relatively efficient and will operate efficiently as part of the overall heating system. A number of studies have been undertaken since 2000 which shed some light on the requirements of gas furnaces operating as part of an efficient system.

Warm air losses from duct work, thermal losses through duct walls and the drawing in of colder external air to the house through leakage will all undermine the efficiency of a GDH system. A recent Victorian field study (G. Palmer, 2008) indicated heat losses through duct work can range from 26% to 58% for older systems, and 10%-18% for retrofitted systems. This work suggests that gas furnaces with higher outlet air temperatures (greater heat losses through the walls of the ductwork) or which can operate under high back pressures (greater heat losses through hot air leakage) – under all or some operating conditions – will tend to lead to higher energy losses in the ductwork and lower overall system efficiencies.

Another significant issue affecting the overall system effectiveness is correct sizing of the GDH. A study into the heating requirements in Victorian homes (EES, 2001) found that standard industry practice is to size units as if the houses to be heated are relatively inefficient (eg 2 star homes or the average energy efficiency of new homes constructed at the time of this study). As new homes in almost all areas of Australia are required to meet 5 star requirements[3], or equivalent, then this sizing approach results in heaters

3 This requirement is to be raised to 6 stars by May 2011.

being sized at roughly twice the capacity that these homes actually require. This increases both the capital cost to the owners, in terms of buying over sized heaters, and potentially leads to increased operating costs. It also suggests that the heaters will spend a lot of their operating time running at a low duty cycle. This gap between real requirements and industry practice is expected to increase as the efficiency requirements of new houses improve.

Both the duct losses and over-sizing have implications for the type of gas ducted heaters that should be encouraged through any energy performance standards:

- models which have high outlet air temperatures and can operate at high back pressures will tend to increase duct losses;
- models which are oversized for their heating task will tend to operate at a low duty cycle (basic models) or will reduce their burner rate/fan speed and operate at a lower heat output – in this case it is important that they operate efficiently over their whole operating range, not just when operating at their maximum burner rate.

The impact of the gas furnace performance on the overall efficiency of gas ducted heating systems should be taken into account as part of the review of GDH test standards and energy performance requirements.

Australia Historical Background

'Town gas' (manufactured gas) was first used in Australia for lighting prior to the discovery of natural gas. The Australian Gas Light Company provided gas for the first public lighting in Sydney in 1841. In Melbourne, gas was first used for shop lighting in 1849, and for public use on New Year's Day 1856. The other major capital cities followed with the introduction of town gas lighting throughout the mid – late 1800's.

In the 1960's the first offshore discoveries of gas reserves and the subsequent building of major infrastructure to develop, produce and process the gas led to natural gas gradually replacing town gas in Australian towns and cities. In 1969, natural gas was introduced in Adelaide, Brisbane and Melbourne and arrived in Sydney at the end of 1976. Now natural gas is piped to major cities, regional towns, and a variety of commercial and industrial sites around Australia. The map in Figure 5 details the gas pipeline distribution throughout Australia and Victoria.

Natural Gas is primarily used in the home for space heating, cooking and water heating. Gas (natural and LPG/bottled gas) is the second most common source of residential energy and was used by 61% of households in Australia in 2008. In Victoria and Western Australia gas was used by 90% and 87% of households respectively (ABS 2008). The following table details the use of natural gas and LPG as a source of energy in Australian households.

Figure 5 Australian Natural Gas Network *(Source www.ena.asn.au)*

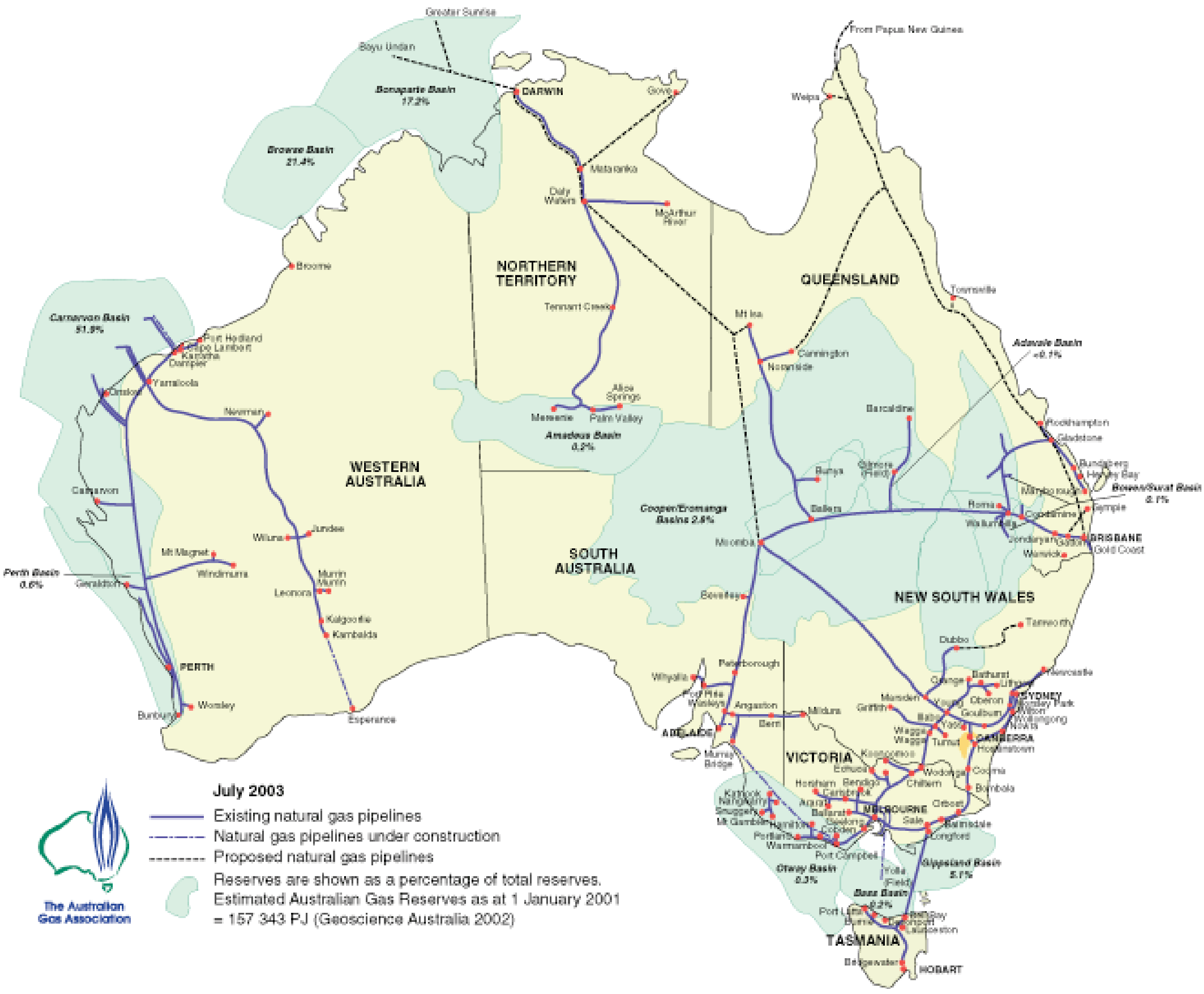


Table 1: Natural Gas & LPG as source of Energy in Households

	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
No ('000)									
Natural Gas	1,016.1	1,667.2	202.5	361.8	563.3	5.6	4.6	87.8	3,909.1
LPG	353.6	178.0	292.2	85.1	157.4	27.0	20.8	1.1	1,115.3
Proportion (%)									
Natural gas	37.5	81.1	12.5	55.9	68.1	2.8	7.6	68.4	47.4
LPG	13.1	8.7	18.1	13.2	19.0	13.4	34.1	0.9	13.5

Source: ABS 2008

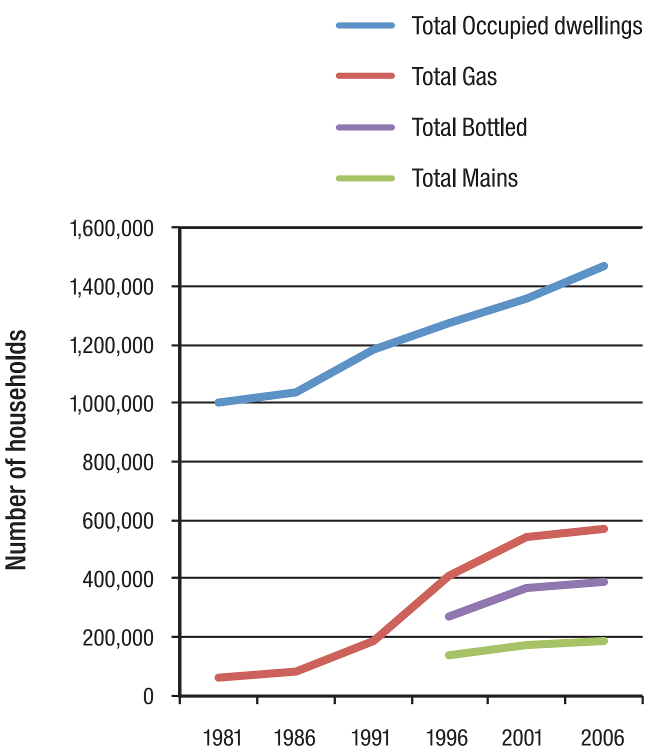
In all states of Australia, the gas regulator (e.g. Energy Safe Victoria) must 'accept' the safe design of a gas appliance before it can be legally supplied, sold or installed in that state. Acceptance for appliances typically used in residential and light commercial settings is generally through a certification scheme run by organisations such as the Australian Gas Association (AGA), SAI Global and IAPMO Oceania. Application is generally made direct to one of those certifying bodies and every gas appliance is required to have a 'data plate' affixed to it, showing certain essential details (type of gas, energy consumption, etc). That data plate will also show the Certificate Number.

Gas product certification is based upon an independent technical assessment of a sample product against relevant safety and performance standards (i.e., type-testing) and compliance with any other regulatory requirements. Gas ducted heaters certification is based on AS4556, and this includes requirements to meet minimum energy performance levels and to be tested and carry an energy rating label. The AGA publishes a *Directory of Certified Appliances and Components*, which lists the certification number, supplier, brand, model and relevant performance characteristics of the appliance, such as annual energy consumption figures (MJ/year) and the associated star ratings/shadings. All GDHs are currently listed in the AGA directory, however gas appliances can also be found on the SAI Global directory if certified by them.

New Zealand Historical Background

The New Zealand Census data reports the type of fuel used to heat occupied dwellings and has been analysed by Environet Ltd (Environet 2009). They report that the number of occupied dwellings using gas for home heating has increased from 64,000 in 1981 to 574,000 in 2006, as shown in Figure 6. In 2006, around 389,000 households (68% of gas-heating households) reported using bottled gas for home heating compared with 186,000 (32%) households using mains gas (includes around 4,000 households with piped LPG). The proportion of occupied dwellings using gas heating increased from 6% in 1981 to 40% in 2001, levelling off to 39% in 2006. Results from a 2008 survey suggest that a much lower proportion of households now use gas for home heating, a change which is probably the result of poorer economic conditions causing many households (13%) to not heat their homes (Environet, 2009). There is also an increasing trend to use heat pumps in New Zealand, and this is expected to lead to a decline in the proportion of homes using gas heating in the future, as suggested by BRANZ, 2008.

Figure 6: Trends in Households Using Gas for Residential Heating in New Zealand



Source: Environet, 2009, derived from Statistics New Zealand (1981 to 2006)

In New Zealand, mains gas use is largely limited to the natural gas pipelines of the North Island (Environet 2009). Piped LPG is available in some cities of the North and South islands, although it is used by fewer households. Environet report an increase in mains gas use in Auckland, Wellington and the Waikato from 1996 to 2006. Mains gas is the predominant type of gas used in Wellington, Hamilton, Palmerston North, Whangarei and New Plymouth. Both mains and bottled gas are common in Auckland. In Auckland increases in mains gas use are most notable in Central Auckland, Manakau and on the North Shore.

In the South Island mains gas use is negligible because there is no access to piped natural gas. Trends in the south island are therefore dominated by bottled gas use which increased in most regions from 1996 to 2001 but did not change noticeably between 2001 and 2006. In Christchurch the number of houses with piped LPG has increased from around 500 in 1996 to around 1,800 in 2006.

In New Zealand gas ducted heaters must comply with Energy Safety Standard NZS 5262. Currently energy efficiency or labelling standards are not required, although many comply with the Australian standard AS4556 and display the Australian gas energy rating label as they are sourced from Australian-based suppliers.

Ducted Gas Heater Market

Annual sales of natural gas ducted gas heaters in Australia are currently steady at about 50,000 units. In comparison, in New Zealand the market is much smaller and industry sources suggest a current sales of around 1,000 units annually.

SUPPLIERS AND VALUE CHAIN

The key participants in the Australian and New Zealand gas ducted heater (GDH) markets are heater manufacturers/suppliers, dealers/major retailers, and builders. The major GDH manufacturers operate sales networks of specialist dealers and major retailers that sell their products into new and existing homes. The end use market is divided into large (national) builders; small to medium sized builders and consumers (existing home owners). Duct and accessory suppliers sell components to dealer networks that install systems either with their own staff or sub-contractors. The GDH value chain is illustrated in Figure 7 and each of the key participants is discussed in the sections that follow.

Australian Heater Manufacturer/Suppliers

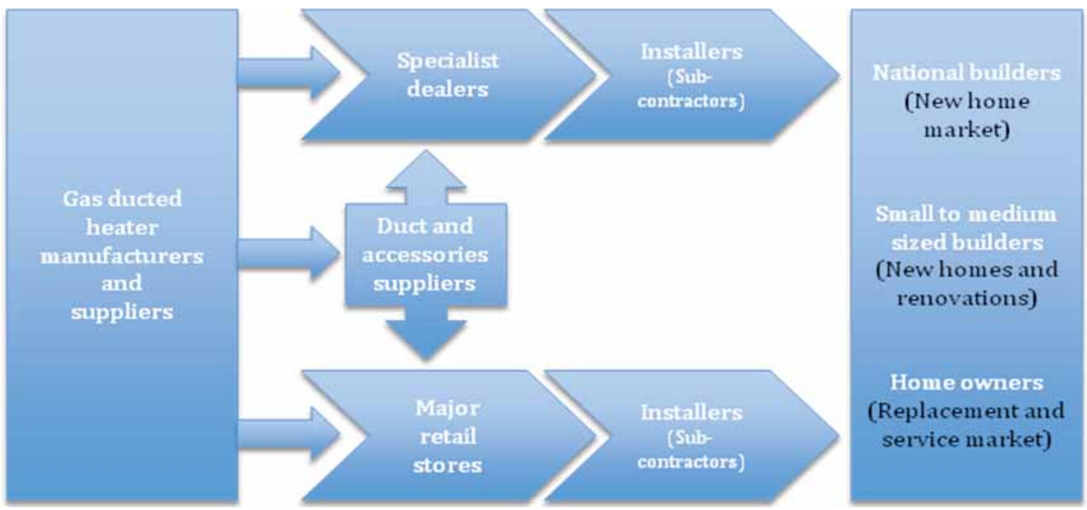
There are six suppliers of residential GDH in Australia offering over 90 base models ranging from 11.1 to 36.3 kW heat output, with most suppliers offering heaters in 20, 26 and 30 kW sizes. The heater manufacturer/suppliers are as follows:

- Carrier Air Conditioning (Brivis)
- Climate Technologies (Vulcan, Bonaire Vulcan, Pyrox, Bonaire Pyrox)
- Seeley International (Braemar)
- Heatcraft Australia (Lennox)
- Omega Climate Systems
- Eco Pacific (who commenced operating in 2006 after acquiring the former Stadt Industries business).

All residential gas ducted heaters are manufactured in Australia, except Lennox heaters which are imported from the USA and in some instances require manufacturing rework to meet local requirements. Suppliers of other types of heaters certified under AS 4556:2000 such as 'gas-electric' roof top packaged units and unit/duct heaters primarily used in commercial applications include:

- Heatcraft Australia (Lennox brand) who offers unit/duct heaters for warehouses and 'gas-electric' roof-top packaged units that provides heating with gas and cooling by a conventional air conditioning compressor operating on a vapour compression cycle;

Figure 7: Value Chain of the Gas Ducted Heater Market



- Aira who offer a range of unit and duct heaters for commercial and industrial building applications such as swimming pools, schools and industrial spaces;
- Celmec who offer a wide range of heating solutions including the Reznor range of unit/duct heaters and a gas-evaporative roof-top units;
- OEC Industrial who offer a range of unit heaters for agricultural-animal confinement buildings mostly used in the poultry industry in Australia.

There is one small specialty supplier, Motorhomes (Crossover car converters) that imports, modifies and offers air heaters for caravan and motor home use only.

Contractors, specialist dealers and major retailers

There are more than 300 small to medium sized contracting businesses that specialise in gas ducted heating in Australia. The major GDH manufacturers and suppliers operate sales networks of specialist dealers and major retailers that sell and install their products into new and existing homes. Specialist dealers generally offer a range of residential comfort products including air conditioning (refrigerated and evaporative), hydronic heating and service. Historically these businesses had their own installers, however most businesses now operate teams of sub-contractors that install their equipment including gas ducted heater installers (certified gas plumbers), duct fitters, refrigeration mechanics and electricians responsible for their area of expertise. The contracting market is broadly broken into the following types of businesses:

- **Specialist dealers** sometimes referred to by GDH suppliers as preferred dealers as they are offered dealer pricing discount structures and loyalty incentives to promote product sales. GDH suppliers often have pre-requisites to qualify as specialist dealers such as showrooms and sales volume targets to qualify for discounts. Specialist dealers generally service the existing home and small to medium sized builder markets. Some larger businesses operate as franchises with multiple showrooms or with allocated sales regions;
- **New home specialists** that have business processes, procedures and pricing discount structures suited to dealing with high volume or national builders;
- **Major retailers** who primarily deal with the general public in large retail show rooms, whose primary focus is to sell heating and air conditioning appliances such as wall mounted split system reverse cycle air conditioners. However some have branched out into ducted systems, traditionally the domain of specialist dealers.
- **Installers** that are smaller heating and cooling businesses or sub-contractors without show rooms that install equipment for specialist dealers, retailers or themselves and generally don't deal direct with major heater suppliers.

Table 2 provides a list of some of the major contracting businesses and retailers businesses selling GDHs in Australia.

Table 2: Suppliers of Gas Ducted Heaters

Name	Type	Web address	Location
Coldflow	Specialist dealer	www.coldflow.net.au	Melbourne metro
Conway Heating & Cooling		www.conwayheating.com.au	Melbourne metro
Pulbrook Air		www.pulbrookair.com.au	Melbourne metro
Weather World		www.weatherworld.com.au	Melbourne metro
Hallidays		www.hallidays.com.au	Melbourne metro
Dale Air		www.daleair.com.au	Melbourne metro
Heat Works		www.heatworks.com.au	South Australia
Mecair		www.mecair.com.au	South Australia
Climate Master		www.climatemaster.com.au	Canberra/Southern highlands
Dandy Air Supplies	New home specialist	Business by referral	Victoria
J&J Conditioning		www.jjair.com	Victoria
Mod Cons		Business by referral	Melbourne/Geelong
Dual Heating & Cooling		www.dualheating.com.au	Victoria
Origin shop	Retailer	www.originenergy.com.au	Southern Region
AGL Energy Shop		www.agl.com.au	Southern Region
Clive Peters		www.clivepeeters.com.au	Southern Region

Builders (new homes and renovations)

The large majority of new homes are constructed by high volume building groups commonly referred to as 'national builders' with several of them constructing more than a thousand new homes per annum in Victoria alone. The main national builders that operate in the southern region of Australia where gas ducted heaters are commonly used are:

- Henley Properties Group and Burbank Group
- Porter Davis Homes
- Delfin part of the Lend Lease Corporation
- Mirvac Group
- JG King Homes
- Simmons homes
- Metricon
- National Builders Group who is a contingent of smaller accredited builder members that have joined together.

Heating and cooling products installed in new homes vary depending on the type dwelling and its construction, fuel availability and climate. In the southern-eastern region of Australia where reticulated gas is provided, gas central heating systems with evaporative cooling is the most cost effective means for builders to heat and cool an entire house. This combination of products is the most common type of heating and cooling systems installed in new housing estates in metropolitan Melbourne.

Heating and cooling products installed in medium to high-density housing are different. Apartments favour reverse cycle air conditioning solutions, however small units with multiple rooms still favour GDH. For example gas ducted heating can be installed with supply air to 5 points in a new stand alone unit for less than $2,000 (excl. GST), which can cover the entire dwelling. However, if refrigerated air conditioning is required as well as heating, ducted or wall hung split systems become more attractive to builders. New luxury homes can have gas ducted heating, however split ducted (or bulk head) reverse cycle air conditioning systems or hydronic heating systems are becoming more popular in luxury homes in geographical regions traditionally dominated by gas ducted heating.

Duct and accessory suppliers

Duct and accessory suppliers are made up of regional and national wholesaling businesses that specialise in HVAC equipment and accessories such as duct, connectors such as 'branch take offs' and 'Y piece' connectors, supply air registers, return air grills/filters and general accessories required for installing heating and air conditioning equipment in residential and commercial applications. The main suppliers include:

- Polyair;
- Paltech;
- Advantage Air;
- Westaflex;
- Bradflow;
- Vic Air Supplies;
- Air Plus, and
- The Ventilation Warehouse

These suppliers generally offer equipment such as air conditioning and some have GDH to supply installers and small contracting businesses.

NEW ZEALAND MARKET

The New Zealand market for GDH is very small relative to the Australian market, and is estimated by suppliers, as indicated in discussion with the report authors, at around 1,000 units per annum over the last decade. The large majority of gas ducted heaters sold in New Zealand are imported from Australian manufacturers with an estimated 1% of commercial heaters, such as gas-electric roof top packaged and unit/duct heaters, imported from North America. Australian GDH manufactures operate through distributors or dealers, including:

- Warm Air (Brivis);
- Ducted Heating Supplies (Braemar);
- Energy Products (Braemar and Lennox);
- Complete Heat (Braemar), and
- Abergas with Happy Home outlets (Bonnaire Vulcan).

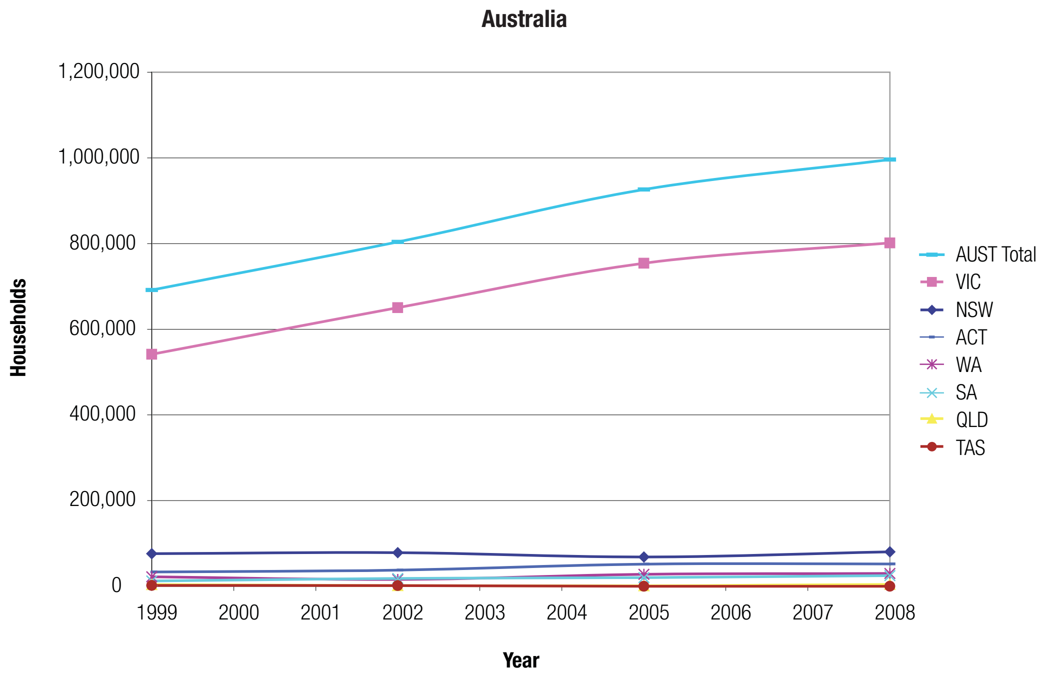
These constitute the main brands and suppliers to the New Zealand market. The existing installed stock of GDH in New Zealand is estimated to be around 18,000 heaters, as indicated by suppliers in discussion with the report authors.

CURRENT STOCK AND SALES

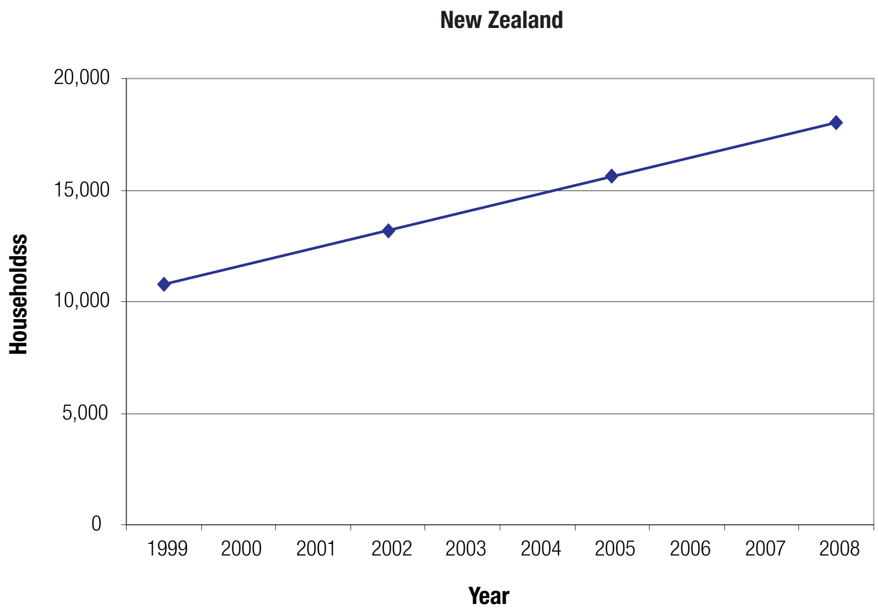
The number and proportion of Australian households who use gas ducted heaters as their main form of heating has grown from 15.1% in 2005 to 15.6% in 2008, according to data from ABS 4602 2008. This is a growth of 0.2% p.a. In comparison, the penetration of non-ducted gas heating has declined, from 27.4% in 2005 to 25.6% in 2008, suggesting the growth in GDH is at least partly at the expense of the market share of non-ducted heating. Over the past nine years from 1999, GDH stock numbers have grown by an average of approximately 3% p.a.

As the penetration of gas ducted heaters was 15.6% in 2008, this means that GDH account for about 39% of the total penetration of gas heaters and, as noted above, this proportion is growing.

Figure 8: Number of Households Using Ducted Gas Heating as Main Heating, 1999 – 2008



Source: ABS 4602 reports from 2002, 2005, 2008



Source: Estimates derived from industry sources

The growth in the use of gas ducted heating in Australia is mainly being driven by Victoria where the number of homes with ducted heating continues to grow, though possibly at a slightly lower rate since 2005. SA, WA and the ACT have also contributed to this growth.

The New Zealand stock numbers remain small. The estimated total number of households with ducted gas heaters, as their main heater, are shown in Table 3. With an estimated installed stock of only 18,000 units in 2008, they have a penetration only slightly above 1%.

These latest statistics and the sales data in the following section were used to develop the estimated stock and sales projections over the period 2000 to 2025. The estimated stock and sales of gas ducted heaters is shown in Figures 9 (Australia) and 10 (New Zealand) below. The stock of GDH is expected to continue growing in Australia, while in New Zealand it is expected to peak around 2012/13 and then decline, consistent with a shift away from gas heating towards the use of heat pumps (BRANZ, 2008).

Table 3: Number of Households with Ducted Gas Main Heating: 2002 - 2008

Year	NSW	VIC	QLD	SA	WA	TAS	ACT	AUST Total	NZ (approx)
1999	76,100	541,600	3,700	12,400	22,000	1,900	33,500	691,400	10,800
2002	78,400	650,200	1,700	18,100	16,000	1,400	37,500	803,600	13,200
2005	68,279	754,201	1,333	20,142	27,817	0	51,660	926,038	15,600
2008	80,391	801,600	4,324	24,793	29,810	20	52,203	995,920	18,000
% growth since 1999	5.6%	48%	16.9%	100%	35.5%	NA	55.8%	44%	66.7%

(Note: Derived ABS 4062 survey series and New Zealand estimated from industry sources)

There is limited information publicly available on the sales of gas ducted heaters and information on sales has primarily been obtained from industry sources. These suggest that sales of approximately 50,000 to 54,000 units p.a. in Australia and 1,000 units p.a. in New Zealand, and that the market is relatively steady at this level. Some industry participants suggest sales may increase in the next few years in Australia as older GDH cease functioning and are replaced.

Industry feedback suggests that the other Australian market characteristics and trends include:

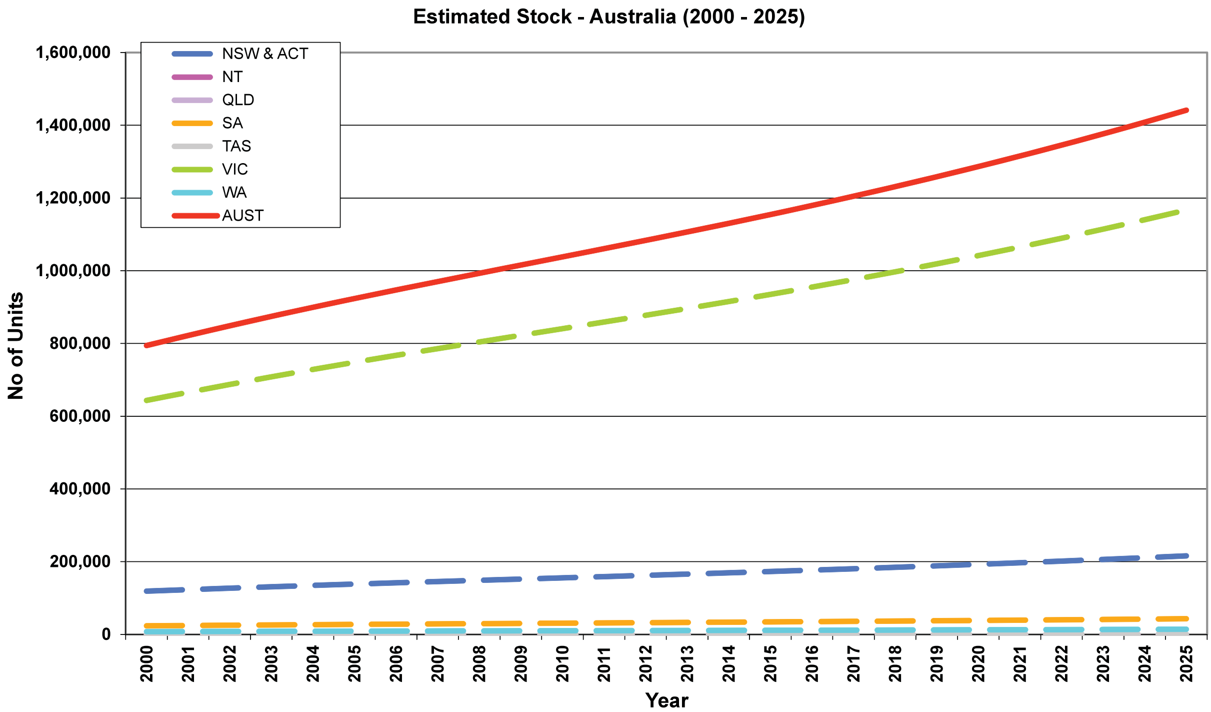
- New homes builder market segment is estimated to represent around 50% of sales, with home renovations making up 20% to 25%, and replacement of failed heaters in existing homes (25 to 30%) accounting for the balance;
- High efficiency condensing heaters have been available since the early 1990s, and the first generation models were the Lennox Pulse, Vulcan Powerhouse and Brivis HE. A number of high efficiency condensing heaters received 5 star certification in the late 1990s and have represented around 20% of sales by volume over the last decade. Over the last few years the market has seen more movement towards high efficiency heaters as consumers become more interested in choosing energy efficient appliances. Some brands have 30% of sales accounted for by high efficiency heaters. It is estimated that the proportion of high efficiency heaters in total GDH sales had grown to around 25% in 2008/09. In Australia, consumer selection of high efficiency models is facilitated by the energy labelling required under gas appliance certification.
- Over a decade ago standard efficiency heaters (1 to 2 stars) became largely obsolete, which left only mid and high efficiency heaters in the market. This technology transition has seen the development of more 4 star mid efficiency heaters with variable gas controls/blowers, and 3 tier product ranges simplistically marketed to consumers as good (2 or 3 stars); better (4 stars) and best (5 stars). Further investigation is needed to determine what proportion of sales are high, medium and low efficiency, and readers are asked to provide data if they have it.
- Internal heaters represent around 70% of heaters sold by volume in the Australian/New Zealand market and the remaining 30% are external heaters;
- Ducted heaters also vary on fuel source, either LPG or natural gas, and the proportion that operate on LPG is around 2% in Australia, based on ABS statistics for 2008. In New Zealand a higher percentage (68%) of gas heating uses LPG as a fuel source;
- Small quantities of GDH units can be found in rural pockets of Australia such as Broken Hill, Mildura, South of Perth, Toowoomba, Central Australia and parts of Tasmania that are connecting to natural gas;
- Around 80% of gas ducted heaters sold are in Australia are in Victoria, 10% in ACT, 5% in NSW and the balance in SA, NT, WA and Tasmania. At sales of around 1,000 units per year, New Zealand represents only around 2% of the trans-Tasman market in gas ducted heaters;
- New housing designs with 'low pitched' roofs have led to the re-emergence of 'up-flow' and 'down-flow' models. These models have a different physical shape and configuration so as to fit into more restrictive spaces. They were originally developed in North America for use in basements, voids and cupboards. In the 1970s and 80s Vulcan had a popular range of compact heater that was commonly used in cupboards and several suppliers with North American origins offered up-flow and down-flow heaters, and
- The growth in air conditioner sales has probably impacted on GDH sales, as ownership numbers of air conditioners have more than doubled in the last ten years and the vast majority of these sales are of reverse cycle units that can be used to supply space heating. Some factors contributing to this trend are:
  - Consumer demands for greater human comfort, especially cooling in Australia, and as an alternative heating source in New Zealand, has made reverse cycle air conditioners more popular;
  - The recent boom in new apartment construction, as reverse cycle air conditioners can be easy and cheaper to install than gas heating for apartments;
  - Declining prices of split ducted/wall mounted air conditioners;
  - Technological advancements, such as operation at lower ambient conditions and improved operational efficiencies of reverse cycle air conditioners, means they can effectively supply heating and cooling in a wider variety of climates and often at a lower unit running cost.

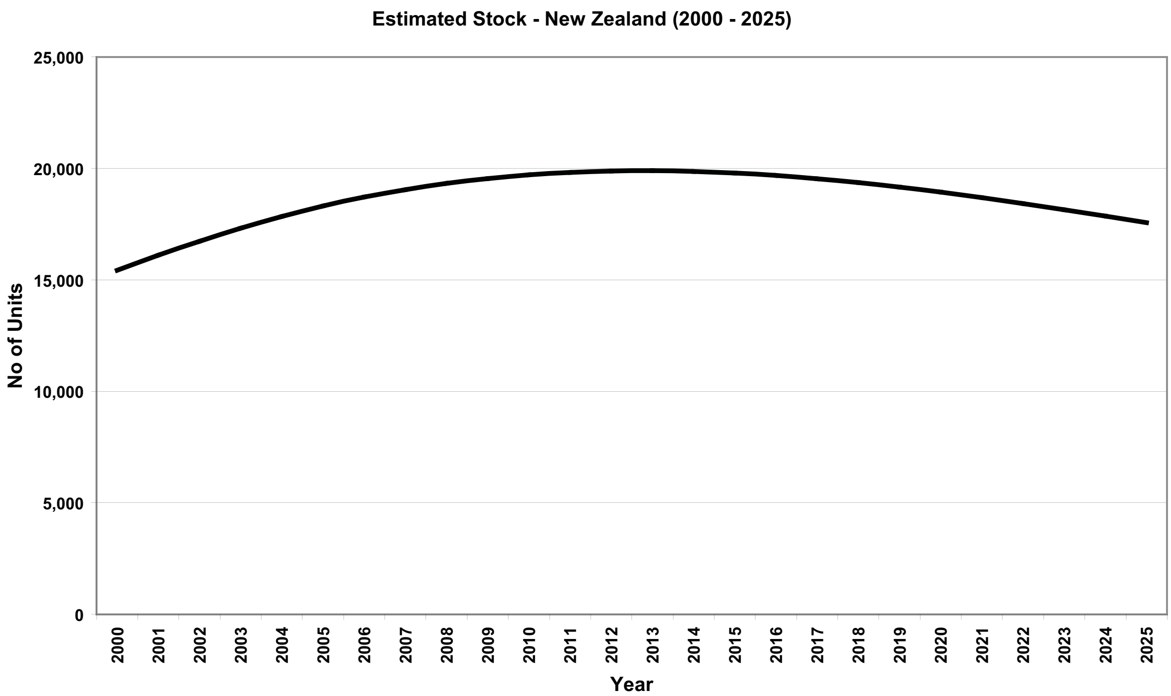
PROJECTED MARKET TRENDS

Based on the detailed stock numbers, sales and historical trends from ABS data and industry sources in Australia and New Zealand, a model was developed of the historical and projected stock and sales of ducted gas heaters in Australia and New Zealand. This model segments ducted gas heaters by country/state, and gas source (NG/LPG). The model accounts for the retirement of stock based on a logistic function representing the estimated useful life of gas ducted heaters. Some of the key assumptions include:

- The total stock of gas ducted heaters is continuing to grow in Australia (based on ABS and industry data), but is expected to decline in New Zealand;
- Sales of ducted gas heaters in Australia are presently slightly above 50,000 p.a. and are assumed to grow slightly at 2.5% p.a. from 2008, based on current trends;
- Sales in New Zealand are currently slightly over 1,000 p.a. but are likely to decline due to the growth of heat pumps (BRANZ 2008);

Figure 9: Estimated Stock of Gas Ducted Heaters 2000 - 2025

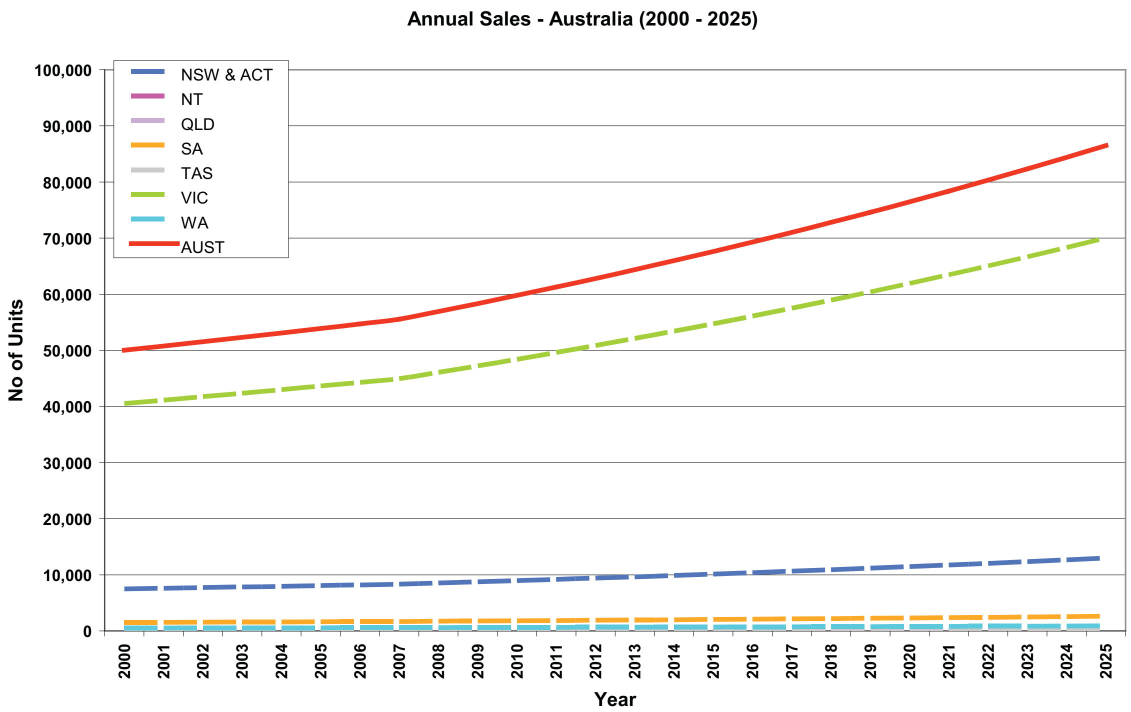


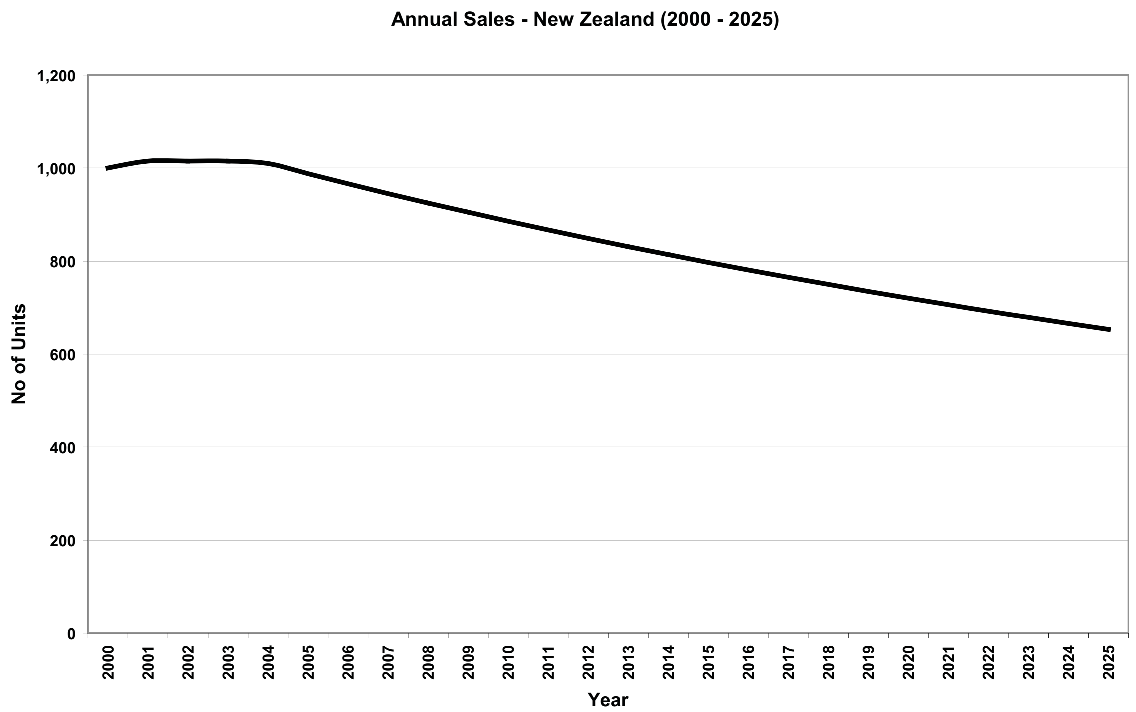


- The average life of gas ducted heaters is between 15 to 25 years, with the industry sources suggesting that about 50% of the heaters are replaced after 20 years;
- Australian state stock and sales shares are based on ABS data and industry source data by state.

The estimated historical and projected stock numbers of gas ducted heaters in both Australia and New Zealand are shown in Figure 9. LPG heaters represent around 2% of the total stock of ducted gas heaters in Australia, according to industry sources, and Victorian heaters represent 80% of the Australian stock. The overall Australian stock is projected to grow from approximately 990,000 units in 2008 to 1.4 M units in 2025. This stock growth is lower than forecasts in the EES 2008 and MAE 2002 reports, but the slower rate of observed growth over the last nine years indicated by the ABS survey results and feedback from industry sources, both suggest that a lower rate of growth is now more realistic.

Figure 10: Estimated Sales of Gas Ducted Heaters by State and Country - 2000 - 2025





In New Zealand, the market for LPG gas fuelled heaters is predicted to decline (BRANZ 2008), due to the increasing penetration of heat pumps. BRANZ forecasts that heat pump penetration will increase from 40% to 80% of households in Canterbury/Otago, and from 10 to 50% in Auckland over the period 2007 to 2020. This factor will most likely reduce GDH sales over the forecast period and reduce the overall stock.

The historical and forecast sales of ducted gas heaters in both Australia and New Zealand are shown in Figure 10. Estimated total sales are based on industry sources and estimates of the size of growth since 2000 and projected future growth post 2008, with sales growing at 2% p.a. in Australia. In New Zealand, forecast sales are expected to decline by about 1.5 to 3% pa.

Market Failures Regarding Energy Efficiency

GDH ENERGY EFFICIENCY MEASUREMENT

The efficiency of GDH models is currently assessed in a number of ways:- thermal efficiency, seasonal operating efficiency, and star rating. The star rating is the most comprehensive measure of their efficiency as it includes seasonal operating efficiency and makes allowance for their heat load reduction (or zoning) capability, which should mean this measure more accurately reflects the efficiency of the GDH unit in the 'real world'.

The AS 4556:2000 standard for Indirect Gas Fired Ducted Heaters, used as the basis of appliance certification in Australia, states regarding energy labelling:

> *'The annual energy consumption shall be calculated based upon the seasonal operating efficiency of the heating system, and a heating load for 600 hours. The star rating and red band shading shall be calculated to represent the seasonal operating efficiency of the heating system when subjected to both heavy load (75% duty) and light load (25% duty) operation. The operating efficiency is determined from the ratio of the heat delivered by the heater against the total energy consumed and includes a penalty for appliances incorporating any standby energy consumption, eg., continuously burning pilots.'*

The seasonal operating efficiency (SOE) determined from AS 4556:2000 is used to determine the base star rating allocation for the heater as follows:

> *'The number of stars allocated for the appliance operation (AS) is determined from the following equation. A maximum of 5 stars has been allowed for the appliance operation. The equation has been based on allocating 1 star to a 50% seasonal operating efficiency result and 5 stars to a 90% seasonal operating efficiency result, and linear interpolation between:*
>
> $AS = 0.1\,\eta_s - 4$
>
> *If AS > 5 then AS = 5; if AS < 0 then AS = 0.'*

In addition, up to one additional star can be granted depending on the heat load reduction (HLR) factor. The total star rating used on the energy rating label is then the sum of the AS and HLR.

> *'the **heat load reduction factor HLR** based on the manufacturer's recommended minimum number of warm air outlets which can be left open at any one time or the equation below (whichever yields the higher number), and the calculated maximum number of outlets nmax using the following equations.*
>
> *A maximum value of "1 star" has been allowed for heat load reduction factor.'*

The heat load reduction factor is a measure of the heater's ability to turn down its capacity to supply less duct outlet points. This heat load reduction measure of the standard is intended to encourage the use of two stage or variable gas control valves and variable speed fans in heater designs. However, while a larger HLR factor indicates the *potential* for energy saving by closing off outlets or activating any zoning capability this will not necessarily translate into an energy saving in practice as it relies on householders reducing the number of outlets in operation.

The efficiency calculations for both seasonal operating efficiency (SOE) and HLR factor are used to allocate a star rating of between 1 and 6 stars for the gas ducted heaters sold in Australia, and the star rating can be used as an approximate indicator of the seasonal operating efficiency of the GDH model.

The annual energy consumption is measured to communicate typical running performance based on a nominal 600 hours of heating at a typical heat load value of 0.2 $MJ/h/m^3$ and the performance of certified products currently available on the Australian market range from 188 to 125 MJ per m^3 per annum.

POTENTIAL FOR IMPROVED EFFICIENCY

The products presently in the Australian market display a wide range of efficiencies, with star ratings from 2.4 to 5.5, as previously discussed in Gas Ducted Heater Efficiencies (page 5). Assuming models obtain 0.5 stars on average for their heat load reduction capability, as discussed in Model Features and Assumptions (page 24), this implies the seasonal operating efficiencies range from 59% to 90%.

The 'best in class' GDHs with 'wet' heat exchanger technologies, could achieve heat exchanger nominal efficiencies above 95% and have heat load reduction factors up to 0.6 leaving minimal scope for significant product efficiency improvement. However, the mid-range efficiency GDH, those with 'dry' heat exchangers, still vary significantly in nominal efficiency from 70% to 85%. This suggests there is considerable scope to gain energy efficiency improvements if the market were to migrate from selling heaters in the lower end of the mid-range efficiency band to the higher end of the mid-range and above, or if the market was to move to selling the high efficiency 'wet' GDH units.

At present the market is made up of 2, 3, 4 and 5 star heaters. More than 50% of GDH models available in the market have low star ratings of 2 or 3 stars, 22% have a 4 star rating and 27% are high efficiency heaters with 5 star ratings, as illustrated in Figure 11 below. The estimated sales distribution of GDH units by star rating is shown in Figure 12; it shows that 5 star GDH make up 25% of sales and suggests there is considerable scope to improve the average efficiency of GDH sold. This breakdown assumes the Australian and New Zealand markets are similar, based on advice from Australian and New Zealand suppliers.

Given that it is cost effective to choose a 4 star unit over a 2 or 3 star unit, as discussed in Costs to Improve Efficiency (page 28), this suggests that there is considerable potential for the market to migrate to more efficient heaters and for the average efficiency of GDH's to be improved.

Figure 11: Distribution of GDH Models by Star Rating

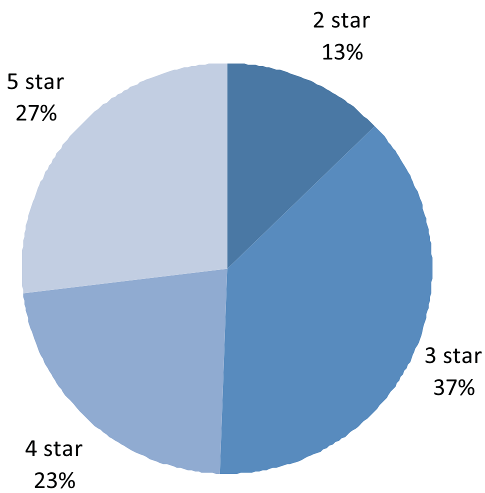
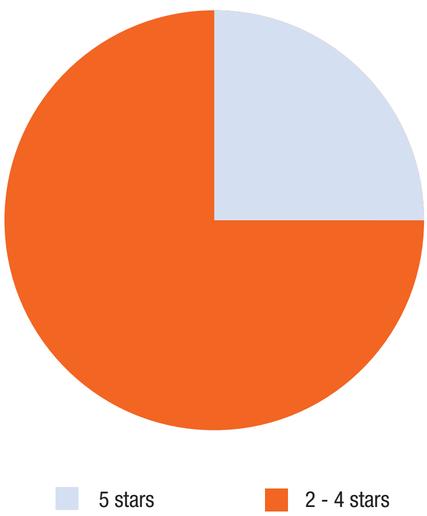


Figure 12: Estimated Distribution of GDH Sales by Star Rating



As it is cost effective for purchasers to choose more efficient GDH (see Costs to Improve Efficiency, page 28), this raises the question as to: why have not consumers migrated to purchasing more efficient GDH? The answer is that market failure has occurred, primarily because of builders dominating the purchase decisions in the market and a related split incentive problem.

BUILDERS MARKET AND SPLIT INCENTIVES

One of the key factors obstructing the take-up of the more efficient gas ducted heaters in the market is that for the majority of purchases the end-user, the householder, is not the agent choosing the GDH units. It is estimated that around 50% of GDH sales are directed towards the new home market, where the builder is the primary decision maker in the GDH purchase decision. There is little or no incentive for builders to purchase the more expensive high efficiency GDH, as the gains from lower operating costs flow to the home owner but the increased purchase costs are, at least initially, carried by the builders. This has caused a classic case of split incentive contributing to market failure.

As the residential building and construction industry is very price driven, where ducted gas heating is commonly installed in new homes the large majority of builder's select the least expensive whole home heating system, which is a low-end mid efficiency gas ducted heater. The complexity of communicating the benefits of a more expensive high efficiency heater to prospective homeowners – who often have a focus on upfront cost – also militates against this.

In Australia, the type and efficiency of heaters installed in new homes is not included in the required house energy rating, and so installing a high efficiency heater is not reflected in a higher rating. Even national Australian builders offering 6 and 7 star thermal rated homes in their product range may not offer high efficiency heaters. Prestige or boutique builders are more inclined to use high efficiency heaters as they find it easier to up-sell the long term benefits of high efficiency heaters to their clients.

An exception to this general trend is the Henley Property Group, which is leading other national builders in Australia on sustainability initiatives, by recently constructing a zero emission home in the Delfin Lend Lease Laurimar estate in Victoria and is installing 5 star heaters with zoning as a standard feature in the majority of their homes. The zoning capability specified in Henley homes provides whole house, living (common area), master bedroom and other bedroom zones using two zone motors.

Approximately 25% of GDH sales are for the renovation market which is mostly serviced by small to medium volume builders and owner-builders. In most instances where a builder is involved there is little incentive for them to up-sell to a high efficiency heater and they are similar to most high volume builders in tending to opt for the least cost option. However, when the owner is directly involved in the decision making process, such as an owner-builder, there is a greater likelihood that operating costs and high efficiency heaters will be considered. In Australia, the existence of an energy labelling scheme assists these consumers to choose a high efficiency GDH model.

Information was not available on the heating choices of the building market in New Zealand, but it is expected that similar decision making will also be restricting the uptake of high efficiency heaters in the new home market of New Zealand. The absence of mandatory energy labelling in New Zealand means that it is even more difficult for motivated builders/consumers to identify and understand the benefits of high efficiency models.

Around 20 to 25% of GDH purchases are for replacement units, and in this case greater consumer involvement would be expected. However, even in this situation the plumber or other gas ducted heater installer, may be the largest influence in the type of unit installed. This represents another form of split incentive.

MARKET FAILURE – INFORMATION PROVISION

Another factor which can contribute to market failure is if consumers do not have the information available or do not have the ability to process the information, in order to make an informed decision regarding their purchase. This is the situation with GDH as the majority of end-users are never provided with or do not see the information necessary for them to make an informed choice with regard to the efficiency of the GDH they will eventually own. This is partly due to the high proportion of purchases which are subject to some form of split incentive (see above), and partly due to the limitations of the current information provision measures.

In Australia, energy labelling is required on gas ducted heaters as part of the gas certification process, and is intended to enable consumers to identify the relative energy efficiency of models sold and estimate annual gas consumption and running costs. As many GDH units sold in New Zealand are sourced from Australian suppliers, these labels can also appear on products sold in New Zealand on a voluntary basis. The current Australian labelling is outlined in AS4556, and was developed initially by the Australian Gas Association on behalf of the gas industry. Australian and New Zealand governments were not involved in the development of the energy labelling scheme and are not in a position to enforce compliance. Unlike the electrical energy rating labels there is no check-testing program to identify models which do not meet their labelling claims[4].

The existence of the gas energy rating label in Australia has coincided with an increase in the number of 4 and 5 star models available on the Australian market since the mid-1990s, and with increased sales of these higher efficiency units. At the same time, the majority of lower efficiency (1 and 2 star) models have been withdrawn from the market. Data is not available to support a direct link between the gas energy rating labels and the increase in efficiency of gas ducted heaters sold, but anecdotal evidence suggests this has partly been a result of consumer demand and partly due to competitive pressures between manufacturers once the energy efficiency of their models was publicly disclosed.

However, market research conducted in 2005 across Australia and New Zealand indicated that only 15% of consumers have unprompted recall of the gas appliance label and only 20% can recall it when prompted (Artcraft Research, 2006), suggesting that most consumers have never or have rarely seen the gas energy rating label. This compares with an unprompted awareness for electrical energy rating labels of 94%. At 26%, the prompted awareness of the gas labels was highest in Victoria and in New Zealand was only 11%. Amongst the 20% of consumers who were aware of the gas label, only 40% correctly identified that gas ducted heaters were labelled, compared to 44% for gas room heaters and 46% for gas water heaters.

One reason for the lower awareness of the gas energy rating labels in New Zealand is that they are not mandatory, further reducing consumer access to energy efficiency data.

Even for the minority of cases where the end-user does make the decision regarding the GDH, the majority of consumers will not be in the position to make a fully informed choice, even where labelling exists. To make an informed choice the consumer would need access to the comparative energy consumption information of the products they are choosing between, they would need to understand this information and they would need to be able to make calculations on the lifetime operating costs of the different units. While it is relatively easy for consumers to compare energy ratings of different models, many consumers will not have the necessary skills to compare annual or lifetime running costs[5].

There is some evidence from Australia that energy labelling of gas ducted heaters can have an impact on the average efficiency of gas ducted heaters sold. However, the existence of the energy labelling cannot remove the issue that due to split incentives the majority of sales decisions are not made by end users, nor the lack of information and skills the consumer requires to make a fully informed decision.

Where a regulated energy labelling scheme exists it is important that the energy performance test on which the energy ratings are based is relatively accurate and repeatable, and that the energy ratings give a good indication of the relative energy consumption in actual use.

4 AS4556, including the energy labelling component, are reviewed in more detail in *Relevant Standards and Regulations* below (see page xx)

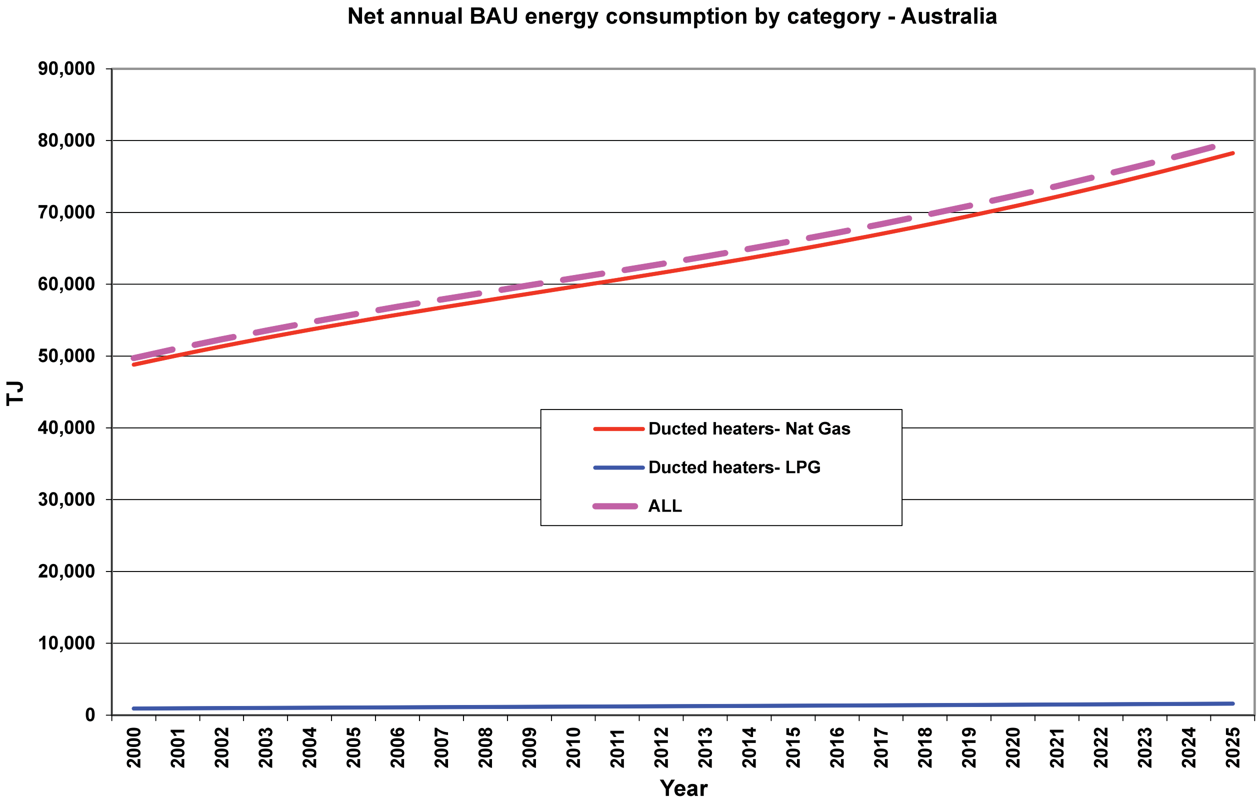
5 The comparative energy consumption information is not on the label. Annual energy consumption is based on 600 hours of operation – nominally in a Melbourne climate – and is given as MJ/m3/year. The consumer would need to know the volume of the home to be heated and the actual operating hours for their situation to accurately estimate annual running cost.

Gas Ducted Heaters

The historical and projected energy consumption by gas ducted heaters in Australia and New Zealand has been estimated using a stock/sales model that is combined with various appliance and usage attributes. The total estimated Australian annual energy consumption by gas ducted heaters is shown in Figure 13, with energy consumption estimated to grow from 49 PJ pa in 2000 to 80 PJ pa in 2025[6]. The increase in energy consumption is largely due to the increasing stock of gas ducted heaters.

The estimated energy consumption of GDH in New Zealand is shown in Figure 14 below. Total consumption is projected to grow from 1 PJ in 2000 to 1.2PJ over the period 2009 to 2012, and then decline to 1 PJ by 2025, due to a declining stock of gas ducted heaters.

Figure 13: Australian Annual Energy Consumption by Category 2000 - 2025



6 A comparison with previous estimates is provided in Appendix 1.

Figure 14: New Zealand Annual Energy Consumption by Category 2000 – 2025 *note the scale is in TJ for better separation of trend lines*

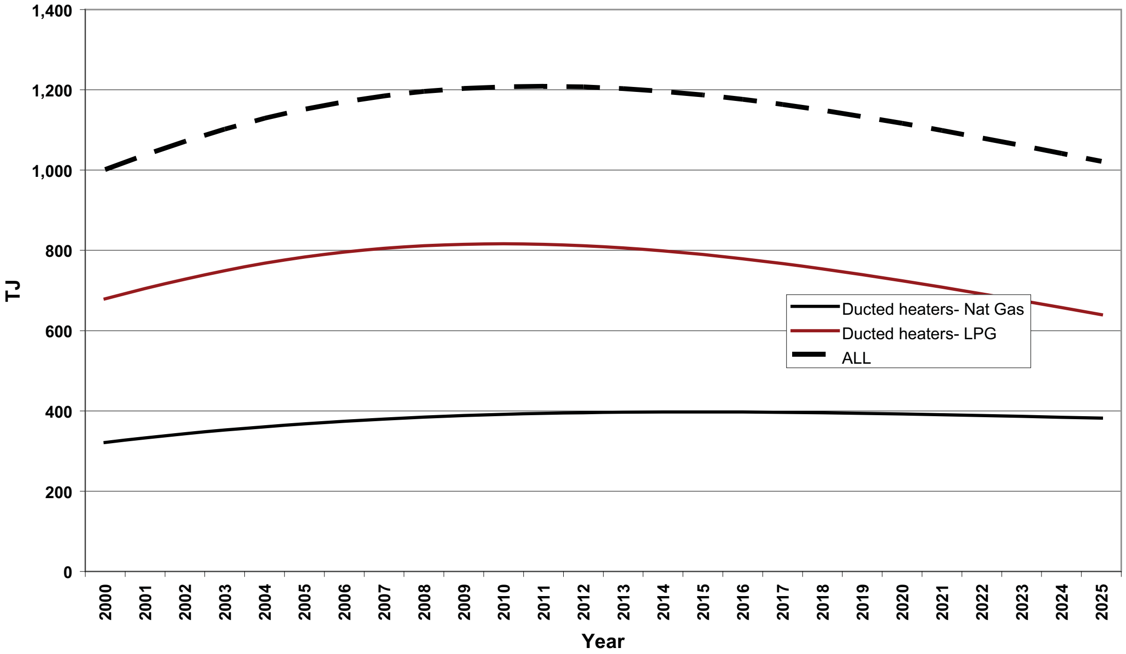


Table 4: Annual Energy Consumption by State 2000 – 2025 (TJ pa) NG and LPG Ducted Heaters

YEAR	NSW & ACT	NT	QLD	SA	TAS	VIC	WA	AUST	NZ
2000	7,481	0	0	820	0	41,214	216	49,732	**1,001**
2001	7,681	0	0	842	0	42,314	222	51,059	**1,038**
2002	7,872	0	0	863	0	43,367	228	52,329	**1,071**
2003	8,054	0	0	883	0	44,372	233	53,542	**1,102**
2004	8,228	0	0	902	0	45,331	238	54,699	**1,129**
2005	8,394	0	0	920	0	46,245	243	55,802	**1,152**
2006	8,552	0	0	938	2	47,118	247	56,857	**1,170**
2007	8,704	0	0	954	3	47,952	252	57,866	**1,185**
2008	8,854	0	0	971	5	48,777	256	58,863	**1,196**
2009	9,003	0	0	987	7	49,598	260	59,855	**1,203**
2010	9,149	0	0	1,003	10	50,407	265	60,834	**1,208**
2011	9,298	0	0	1,020	12	51,226	269	61,825	**1,209**
2012	9,449	0	0	1,036	15	52,060	273	62,834	**1,207**
2013	9,605	0	0	1,053	18	52,914	278	63,868	**1,203**
2014	9,764	0	0	1,071	22	53,795	282	64,934	**1,196**
2015	9,930	0	0	1,089	25	54,706	287	66,037	**1,187**
2016	10,102	0	0	1,108	29	55,654	292	67,184	**1,176**
2017	10,281	0	0	1,127	33	56,640	297	68,379	**1,163**
2018	10,467	0	0	1,148	37	57,667	303	69,622	**1,149**
2019	10,661	0	0	1,169	42	58,737	308	70,917	**1,133**
2020	10,864	0	0	1,191	46	59,851	314	72,267	**1,117**
2021	11,074	0	0	1,214	51	61,011	320	73,671	**1,099**
2022	11,293	0	0	1,238	57	62,216	327	75,131	**1,080**
2023	11,520	0	0	1,263	62	63,470	333	76,649	**1,061**
2024	11,757	0	0	1,289	68	64,772	340	78,225	**1,042**
2025	12,002	0	0	1,316	74	66,122	347	79,861	**1,022**

Table 4 shows that Victoria represents the vast majority of energy consumption attributed to gas ducted heaters in Australia, followed by New South Wales/ACT, Western Australia and South Australia.

Though GDH units differ in so far as they are internal or external units, the difference in the units does not affect their efficiency. GDH also differ in their fuel type, LPG versus natural gas, but again this does not affect their efficiency. Consequently information on these different types of categories is not presented in this report. The proportion of GDH that use LPG does not appear to have been surveyed, but the proportion of gas space heaters using LPG in Australia is estimated to be 2.9%. This supports the industry estimate of 2% of GHD using LPG (ABS 2008). In New Zealand, 68% of gas heaters are using LPG so it was assumed 68% of GDH are using LPG, as there is no other information available on their fuel usage.

The estimated greenhouse emissions by category from 2000 to 2025 are shown for Australia and New Zealand in Figure 15 and Figure 16. The Australian forecast is largely consistent with the MEA *et al* report in 2002. The MEA study estimated emissions of around 2.8 Mt CO_2-e in 2000, compared to the present study estimate of 3.2 Mt CO_2-e, to around 4.8 Mt CO_2-e in 2015, while this study estimated 4.2 Mt CO_2-e. The key difference is the slightly larger stock and sales forecasts used in the MEA study.

Figure 15: Annual Greenhouse Gas Emissions by Category, Australia 2000 – 2025 (kt CO_2-e)

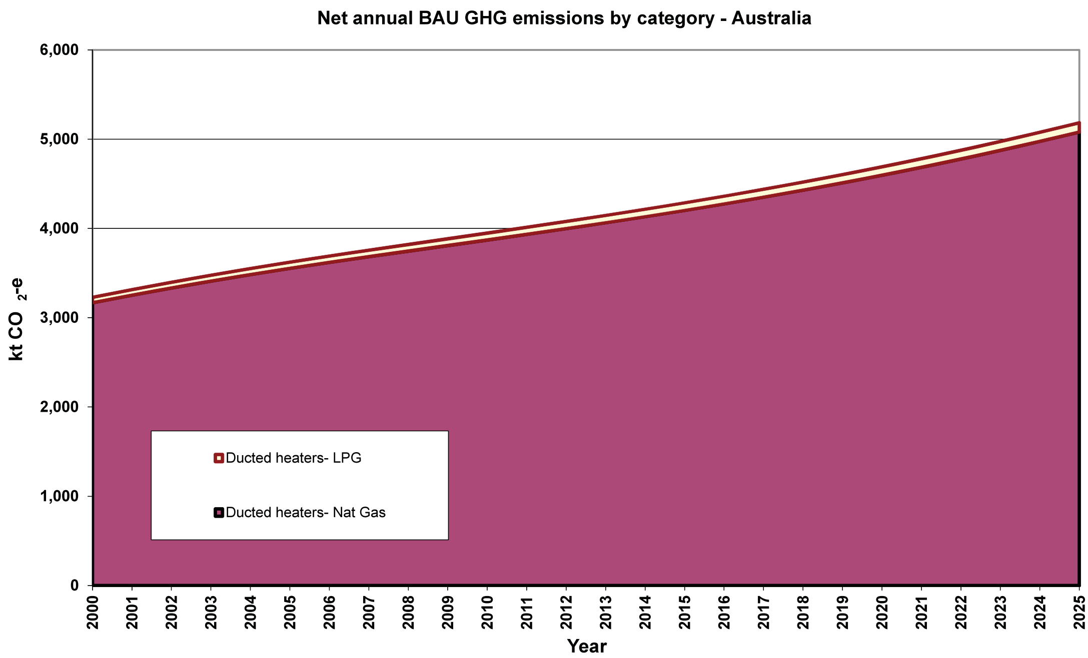
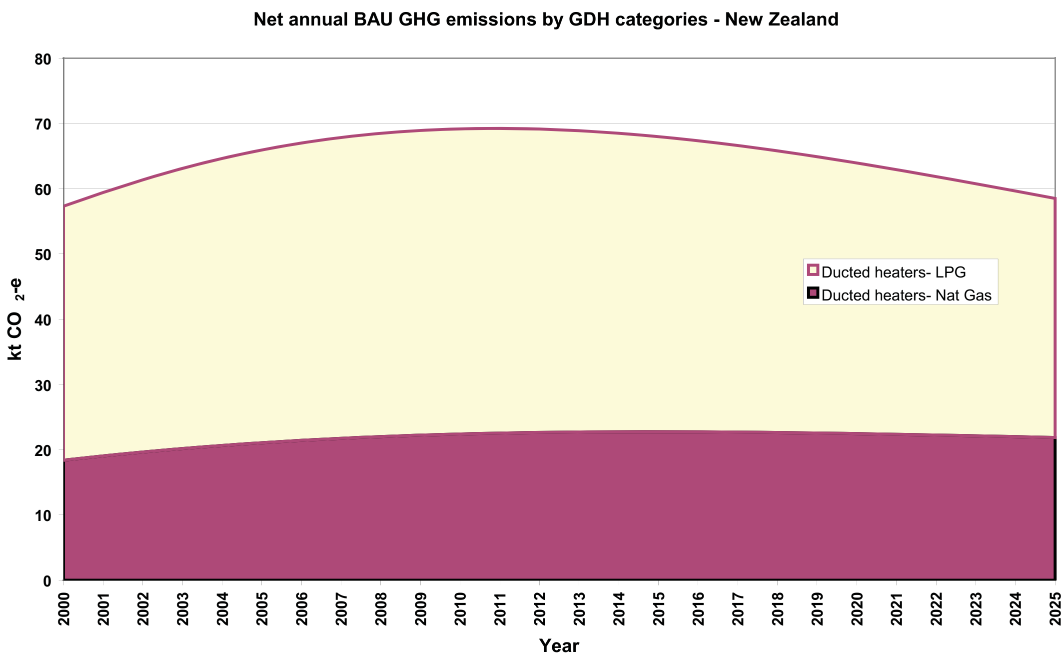


Figure 16: Annual Greenhouse Gas Emissions by Category, New Zealand 2000–2025 (kt CO_2-e)



MODEL FEATURES AND ASSUMPTIONS

To estimate energy consumption and greenhouse emission by state and heater category, a detailed model was developed utilising the stock and sales of gas ducted heaters, along with the energy efficiency, usage and heater output characteristics. The energy used by gas appliances is a function of average gas input, number of operating units and average number of hours of operation. In turn the greenhouse gas emissions are a function of energy consumption and emission factors for gas combustion.

The number of operating units is a function of existing stock, replacements and new sales. Estimates of stock and sales were made for all Australian states/territories and New Zealand, with summary results shown in the earlier sections. The stock and new sales were subjected to a 'survival function' that reflected the life span of the gas ducted heaters (assumed to be an average life of 20 years).

The average number of hours of operation for GDH in Australia was sourced from the input attributes of the EES 2008 study and is shown in Table 5. The New Zealand figure for operating hours is an estimate only, based on the assumption that the majority of ducted heating is installed in the North Island. Readers are asked to comment on these estimates.

The average heat output of gas ducted heaters was estimated from the sales weighted average heater output for mid-range and high-efficiency heaters from 2008 industry data. The average output was estimated at 72 MJ/hr.

Gas ducted heaters were assumed to have an average half life of 20 years, i.e., this is the point that 50% of the appliances would be discarded, and only 25% of the appliances remain after 25 years. A logistic survival function was utilised to retire the stock of appliances based on the age installed.

The greenhouse gas emission factors for natural gas ducted heaters are shown in Table 6, and are the same emission factors used for the calculation of emissions undertaken by the Equipment Energy Efficiency (E3) Program for Regulatory Impact Statements (RIS). To simplify the model, for Australian calculations the same emission factors were used for LPG, as less than 2% of the energy consumption of gas space heaters and decorative appliances was attributed to LPG. The emission factor used by the E3 Program for LPG is 59.9 kg CO_2-e/GJ, which is very close to the average emission factors for Natural Gas. Hence the GHG emissions from LPG fuelled appliances are slightly over estimated in the model results. For the New Zealand analysis, a weighted average between the emissions from LPG and distributed natural gas was used, again with the underlying E3 emission factors being used.

Table 6: GHG Emission Factors by State Natural Gas (kg CO_2-e/GJ)

State	Emission Factor (kg CO_2-e/GJ)
New South Wales & ACT	71.3
Northern Territory	53.6
Queensland	68.8
South Australia	73.8
Tasmania	60.0
Victoria	63.6
Western Australia	60.7
New Zealand	57.3

Source: *Equipment Energy Efficiency Program: RIS Household and Greenhouse Emission Factors, July 2009*

The brand weighted average star rating of gas ducted heaters was estimated by MEA (2002) to be 3.2 in 1999. From this the average seasonal operating efficiency (SOE) of heaters in 1999 was estimated as 67%, assuming an average Heat Load Reduction (HLR) factor of 0.5 stars was given to GDH models in 1999[7]. This allowance was made as initial research conducted by Sustainability Victoria on the HLR factor of 4 and 5 star GDH models shows a mean HLR factor of 0.7, suggesting it may be reasonable on to assume a HLR of 0.5 average over all models.

This study has used interviews of suppliers to determine the average GDH sales for the last 10 years. These estimates also include the share of the low, mid and high efficiency unit sales in each year. Based on industry sources, it is estimated that the sales weighted average star rating for 1999 to 2009 was 3.9 stars, which corresponds to a seasonal operating efficiency (SOE) of around 74% once HLR is taken into consideration. The average was felt to be relatively stable over this period.

Assuming that some margin of error exists, it has been estimated that BAU improvement of 0.2% BAU has occurred since 1999 and this was the trend used for MEPS impact modelling purposes.

Table 5: Average Annual Operating Hours by Appliance and State

Gas Appliance	NSW/ACT	NT	QLD	SA	TAS	VIC	WA	NZ
Gas Ducted Heaters	576	NA	130	316	1,200	588	250	600

**NSW/ACT hours are weighted according to estimated share of 2/3rd ACT and 1/3rd NSW*

[7] The base star rating (AS) for the average appliance is then 3.2 – 0.5 = 2.7 stars, and this can be linked directly to seasonal operating efficiency.

Testing and Efficiency Standards/Labelling

AUSTRALIA

The key standard affecting residential ducted gas heaters is ***AS 4556:2000, Indirect gas-fired ducted air-heaters***. This applies to new indirect gas-fired ducted air heaters, constructed totally from new materials and components, intended for use with natural gas (NG), town gas (TG), liquefied petroleum gas (LPG) and tempered liquefied petroleum gas (TLP) with gas consumption not exceeding 500 MJ/h. The standard provides minimum requirements for the safe design, performance and rational use of energy of indirect gas-fired ducted air heaters and sets out the method of test for gas energy labelling.

The standard defines the MEPS for gas ducted heaters as '*The thermal efficiency*[8] *of ducted air heaters shall not be less than 70%*'. It also describes the energy performance tests for determining the thermal efficiency of gas ducted heaters and the requirements for energy efficiency labelling. The energy rating used on the gas energy label is based largely on the seasonal operating efficiency (SOE) of the heaters - which is determined by the ratio of the useful heat delivered[9] by the heater against the total energy consumed, with electrical energy use and energy use in standby taken into consideration – but also takes into account the extent to which the heater can operate at lower air flow rates through a Heat Load Reduction factor, as previous discussed in GDH Energy Efficiency Measurement, page 18.

The energy performance test and calculation method for determining the GDH star rating and annual energy consumption prescribed under AS 4556:2000 will be reviewed as part of incorporating MEPS and energy labelling for gas ducted heaters into any government regulated scheme, as there are perceived and potentially real issues concerning its accuracy in allocating star ratings. It is important than any test used to underpin a regulatory regime is robust, accurate and repeatable, and there are concerns that the current test does not meet these requirements.

The current test method was established around two decades ago when gas ducted heating systems were much simpler, and many of the procedures have remained the same, as technology has advanced. The method is best suited to gas furnaces with a single burner rate and single fan speed which operate in either on mode or off mode based on feedback from a simple thermostat. Modern systems can have multiple gas rates, multiple fan speeds, sophisticated electronic feedback systems within the gas furnace and be controlled by intelligent thermostats. In addition to this, gas testing and measurement technology has improved since the test method was developed.

A number of stakeholders have offered some criticism and feedback regarding the current test method and labelling approach during consultation undertaken during the development of this Product Profile:

- The operational (Appliance Star) measure of the energy labelling standard promotes the development of heaters with seasonal operating efficiency (SOE) of only up to 90% (5 stars), however offers no star rating benefit for heaters with higher operating efficiencies (up to 95% is technically possible). This provides little incentive for manufacturers to bring super efficient models onto the market;
- The energy efficiency test comprises two 20 minute tests which aim to simulate operation at 75% load factor (15 minutes on and 5 minutes off) and 25% load factor (5 minutes on and 15 minutes off), but does not take into account typical performance characteristics of the residence. The test results are based on the heater running for either 5 minutes or 15 minutes, and heaters that start slowly, including those with heat exchangers with longer heat paths or with greater thermal mass, may take longer than 15 minutes to reflect their true operational performance;
- The recognition of the energy saving potential of 'zoning' (i.e. not heating un-occupied areas by closing off some outlet registers or a zone damper) through the 'heat load reduction factor' allows for a bonus of up to 1 star in the energy label determination (DEWHA 2006), but this may not accurately reflect the benefits of intelligent zoning systems that can independently control temperature or energy supplied to nominated zones of the home. On the flip side, realisation of this energy saving potential is reliant on consumer behaviour, and in some cases the heater may not react to zoning in a way which leads to energy savings. The current method of determining the heat load reduction factor only relates to air flow and does not account for possible rises in discharge air temperature or back pressure in response to outlets being closed – this could provide false credit to some systems, as increased outlet temperature and/or increased back pressure can both lead to increased losses in the ductwork; and
- The assumed heat load value of 0.2 MJ/h/m^3 used to calculate typical annual energy consumption is regarded as subjective and may overstate the energy consumption of GDH. The m^3 is supposed to represent the volume of a home, however the standard does not provide a definition or indicate if it represents the heated space or the whole home. In new, more efficient homes, heat

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8 This refers to the thermal efficiency of the heat exchanger alone and is measured via flue heat losses. The thermal efficiency is higher than the seasonal operating efficiency (SOE), which is a measure of the efficiency of the GDH to deliver useful heat over an operating cycle, and also takes into account electrical energy use and standby energy use..

9 In the energy performance test only hot air delivered above 40°C is considered to provide useful heat. Heater air delivered in the heat up and cool down phases of the heating cycle below this temperature is not included.

loads are much lower than when the energy labelling algorithms were developed, and this will mean that annual energy consumptions estimated from the labelling data could be double the actual energy consumption.

Other relevant, current Australian standards are as follows:

- **AS 5601:2004, Gas installations**, is a mandatory standard which sets out minimum requirements for consumer piping, fluing, ventilation and appliance installations that are associated with the use or intended use of fuel gases such as town gas, natural gas and liquefied petroleum gas.
- **AS 4426:1997, Thermal insulation of pipework ductwork and equipment selection, insulation and finish**. This standard is a mandatory standard that deals with the selection, installation and finish of thermal insulation for pipework, ductwork, tanks, vessels, and equipment in the temperature range -75°C to 800°C, but excludes manufactured pre-insulated equipment, structural insulation of buildings and cold stores, fireproofing structures, refractory linings of plant, airborne installations and all external underground mains.
- **AS 4254:1995, Ductwork for air-handling systems in buildings**, is a mandatory standard which specifies the requirements for performance, materials, construction (burn, collapse, pressure and static load tests) and installation of ductwork for air-handling systems in buildings. This standard covers subjects such as condensate removal required with condensing GDH and installation of flexible ductwork covering sealing and suspending.
- **Section J of the Building Code of Australia**, which applies to new dwellings or major renovations, prescribes minimum performance standards for ductwork and fittings for heating and cooling systems with a capacity of no more than 65kW (BCA, 2009). The minimum R-value for 'heating only' systems is 1.0 for most climate zones (except climate zone 8, typically Alpine regions and Canberra where an R-value of 1.5 is required) and 1.5 in 'combined heating and air conditioning' systems for most climate zones (except climate zones 2 and 5, which includes Brisbane, where a lower R-value of 1.0 is required).

NEW ZEALAND

No specific energy performance test standards are required for gas ducted heaters sold in New Zealand. As many of these units are sourced from Australian manufacturers, they will have been tested to AS4556:2000 and may also carry the energy rating label based on this standard in a voluntary capacity.

Regulations Impacting on Energy

AUSTRALIA

The energy efficiency requirements that impact on the energy performance of ducted gas heaters, are contained in the *AS 4556:2000, Indirect gas-fired ducted air-heaters* standard described above, but almost by default, as they are part of the certification required under AS 4556. Gas safety regulations which apply in most Australian jurisdictions require that gas ducted heaters are certified before they can be legally installed. To this extent, the MEPS and labelling requirements of AS 4556-2000 are effectively mandatory.

NEW ZEALAND

At this stage there are no controls relating to the energy efficiency of gas heating appliances. The Gas Regulations (1993) and standards and codes for the gas sector only apply to the safety of an appliance. There are no links between product safety and the energy efficiency of a product.

The New Zealand Building Code currently does not contain any provisions which impact on the energy efficiency of the gas ducted heater or the associated ductwork. However opportunities to include such provisions into the New Zealand legal framework are possible through amendments to the Building Code and the Energy Efficiency (Energy Using Products) Regulations 2002.

International Standards and Practices

- The large majority of GDHs manufactured, sold and installed globally are in North America. Small volumes of GDHs are sold by North American manufacturers into Europe (mostly Eastern Europe) and parts of northern China in luxury 'western style' homes. The dominance of the North American manufacturers means most overseas standards and policies on GDHs come from this region. They are as follows:
- **AFUE rating** is the performance measure used for GDHs (commonly referred to as furnaces) in North America, which provides a rating of the Annual Fuel Utilization Efficiency (AFUE) and is tested in accordance with test methods *ANSI/ASHRAE 103-2007, Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers* in the US and *CAN/CSA-P.2-07, Testing Method for Measuring the Annual Fuel Utilization Efficiency of Residential Gas-Fired Furnaces and Boilers* in Canada.
- **Minimum energy performance standards in the US** were recently amended by the Department of Energy under the 'final rule', Energy Conservation Program for Consumer Products; Energy Conservation Standards for Residential Furnaces and Boilers. The current energy conservation standards in the US are 78% AFUE for all residential furnaces and the proposed standards under the 'final rule', effective 19th November 2015 are 80% AFUE for non-weatherized (internal) furnaces and 81%

AFUE for weatherized (external) furnaces. The maximum technologically feasible levels of efficiency are discussed in the 'final rule', which concluded non-weatherized furnaces could achieve 96% AFUE and weatherized 83% AFUE (DOE 2007).

- Minimum energy performance standards in Canada are managed by Natural Resources Canada (NRC) under Energy Efficiency Regulations. The current minimum energy performance standard for residential GDH in Canada is 78% AFUE, however the Government of British Columbia responsible for the Ontario region implemented more stringent efficiency standards of 90% AFUE under its Energy Efficiency Act (building code) in January, 2008. NRC proposes to increase and harmonize the minimum performance levels to 90% AFUE for gas-fired furnaces with an input rate not exceeding 66 kW, effective 31st December 2009. There are no efficiency labelling requirements in Canada (NRC 2008).
- High efficiency measures and incentives in the US are managed by the Environmental Protection Agency and Department of Energy under the Energy Star program. Energy Star qualified gas furnaces have AFUE ratings of 85% and 90%, or greater. Federal tax credits are offered for home energy improvements for heaters placed in service from the 1st January 2009 to 31st December 2010. Rebates are offered based efficiency levels and high efficiency heaters with an AFUE ≥ 95% can claim 30% of the cost, up to $US 1,500.

North American heaters are often Air Conditioning, Heating, and Refrigeration Institute (AHRI) and CSA (Canadian Standards Association) certified. In 2008 the Gas Appliance Manufacturers Association (GAMA) merged with the Air Conditioning and Refrigeration Institute (ARI) to become AHRI and administers the heating, ventilation, air conditioning and commercial refrigeration (HVACR) industry's performance certification programs for equipment (heaters) and components that have been independently tested. The AHRI program independently verifies AFUE ratings of heaters with a heat input rate of less than 66kW.

Comparing efficiencies of heaters can be confusing, particularly when comparing values determined from different test methods. The flue loss efficiency of the heat exchanger efficiency is not to be confused with an AFUE rating. The AFUE rating measures heat exchanger efficiencies from flue losses, jacket losses, standby ventilation loads and sometimes use different heating values such as net versus gross heating values that can reflect differences of up to 10% in the percentage value. Other differences are that the AFUE tests steady state performance but the Australian test is based on a heating cycle, measuring dynamic performance, and the AFUE measures heat losses while the Australian test measures heat output. Consequently the AFUE percentage values cannot be compared to 'seasonal operational efficiencies' determined from the Australian test method AS 4556-2000.

Otherwise, the countries which are known to have voluntary or mandatory standards or energy labelling programs are listed below.

Table 7: International MEPS and Labelling of Gas Heating

	USA	Canada	Europe	UK
MEPS	Yes	Yes	Yes	Yes
Energy Label	Mandatory	Voluntary	No	No

Sales Weighted Average Efficiency

Accurate data is not available on the sales of ducted heaters by brand and model number, so it is not possible to determine a highly accurate sales weighted average efficiency. As previously mentioned, see page Model Features and Assumptions page 24, from a brand analysis by MEA 2002 and interviews with all major suppliers for this current study, the average seasonal operating efficiency was estimated as 67% in 1999 and 74% in 2009.

Range of Product Efficiency

The range of star rating by product model and gas input (MJ/hr) is shown in the following figure for ducted heaters. The heaters listed in the figure are based on the models that are currently certified in Australia, so some may not still be sold in the market, and does not capture New Zealand-specific models, if there are any.

There is quite a large spread of star ratings by model, which indicates that products with a wide range of efficiencies are available for most of the different sized heaters that are available in the market. Figure 17 shows the spread of star rating and heater capacity for current models certified under the AGA Directory (AGA 2009).

COSTS TO IMPROVE EFFICIENCY

Information on retail prices and installation costs were obtained in order to conduct an analysis to estimate the additional cost of technology to consumers when deciding between different efficiency heaters. The analysis included all major brands, which covers more than 90% of the market and compared internal heaters with a nominal heating capacity of 20 kW heat output. Table 8 provides a list of the models included in the review.

Figure 17: Star Rating by Model and Heating Output Capacity - Ducted Heaters

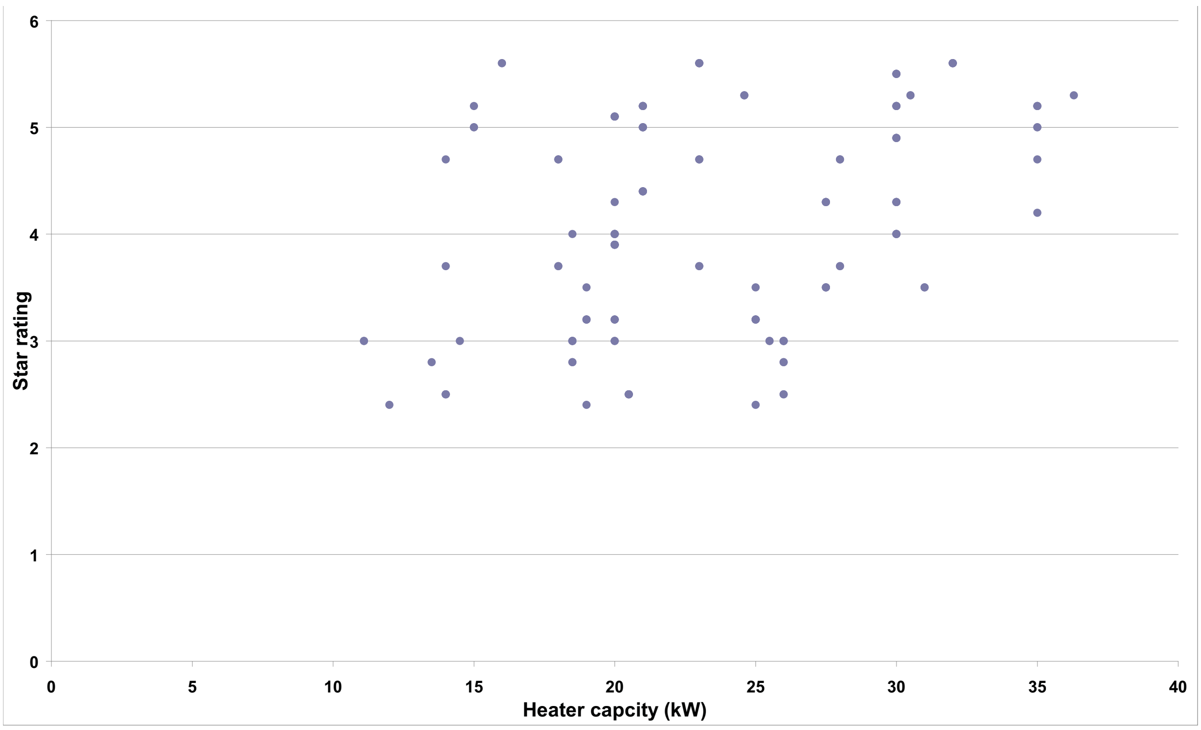
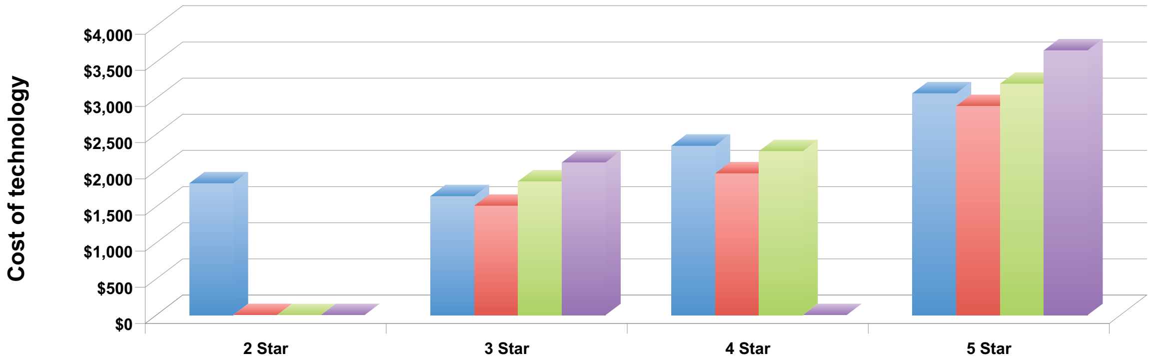


Table 8: Brands and Products Used In Study

	2 star	3 star	4 star	5 star
Brivis	Classic 20	2PE20	ME20i	HE20i
Vulcan	-	B3 20I	B4 20I	B5 21I
Braemar	-	TH320	TH420	TH523
Lennox	-	G34MQ3-080	-	G61MPVT-60C-090

Figure 18: Cost of Technology to Consumers



The analysis found 4 star heaters cost consumers an additional $400 on average compared to 3 star heaters and 5 star heaters cost an additional $1,400 versus 3 star heaters. Figure 18 provides a graphical illustration of the additional costs of technology for the major brands and the key assumptions in the analysis are listed below. The two star heater is slightly more expensive that the 3 star heaters, which is due to its different up flow configuration.

For the analysis the following assumptions in were made:

- Calculated prices are estimated consumer prices including GST
- Prices of all heaters include a programmable thermostat
- Prices based on preferred dealer discounts with 40% mark-up
- Nominal capacity of heaters is 20 kW (72 MJ/h) heat output, which corresponds to the heat output of the average new unit
- Additional cost to install a condensing heater (5 star) is $300, which includes the cost to run the condensate drain and allows for a drain tray and different flue arrangement.

Based on the $400 additional incremental costs to the consumer of choosing a 4 star heater compared to a 3 star heater, and the estimated annual energy cost savings of approx $95 pa for Victoria (which is the biggest Australian market for GDH) means the simple payback period for a 4 star heater is 4.2 years to the Victorian consumer. Over the 20 year life of the heater, the discounted (7.5%) savings would be approximately $1,000, providing a cost benefit ratio of 2.4 to the consumer. The results of this analysis for all states and New Zealand are presented below.

The result of the analysis shows that in almost all states/ territories, and in New Zealand, the benefits of installing a 4 Star GDH versus a 3 Star model produced benefits which exceed the costs. The only exception was in Queensland, where the benefit/cost ratio was 0.8 but even here a simple payback would be achieved long before the GDH need to be replaced.

Table 9: Estimated Benefits from Installing a 4 Star GDH Compared to 3 Star

State	Estimated Annual Energy Savings (MJ/yr)	Energy Cost Savings ($ pa)	Present Value Cost Savings (20yrs)	Benefit Cost Ratio	Simple Payback (yrs)	Estimated Life time GHG Reduction (t CO_2-e)
NSW/ACT	8,512	$144.70	$1,475	3.7	2.8	12.1
NT	NA					
QLD	1,920	$30.72	$313	0.8	13.0	2.6
SA	4,667	$60.67	$619	1.5	6.6	6.9
TAS	17,723	$265.85	$2,710	6.8	1.5	21.3
VIC	8,684	$95.53	$974	2.4	4.2	11.1
WA	3,692	$51.69	$527	1.3	7.7	4.5
NZ(NZ$)	8,862	$362.88	$3,699	9.2	1.1	9.3

There are range of potential policy options to improve the efficiency of gas ducted heaters, from increasing the mandatory Minimum Energy Performance Standards (MEPS) to providing consumers with more effective energy efficiency and energy use information. These options are explored below.

MEPS

There is potential for a significant (6%) reduction in the average energy consumption of gas ducted heaters sold by improving product efficiency through raising the MEPS on the furnaces of GDH from it's current level (a minimum thermal efficiency of 70%) to a seasonal operating efficiency of 75%, equivalent to around a 4 star rating on the current Australian labelling scheme.

The current MEPS are applicable to the furnaces of gas ducted heaters and specify the minimum thermal efficiency of 70%. There are two measures of efficiency used in the AS 4556-2000 for gas ducted heaters – thermal efficiency and seasonal operating efficiency. The thermal efficiency of the ducted heater is determined by analysing the flue products and calculating the heat content, according to methods defined in the AS 4556, and represents just the efficiency of the heat exchanger. The seasonal operating efficiency (SOE) used to determine the star rating and Annual Energy Consumption for the Energy Label is based on the useful heat output divided by total energy input over two heating cycles, and also takes into account gas and electricity consumption in standby mode, and electricity consumption during operation; the SOE is based on the average of efficiencies measured for a 75% duty cycle and a 25% duty cycle, based on a 20 minute heating cycle.

It is now over 25 years since the original industry-based MEPS levels were established and the spread of efficiency for ducted heaters is wide enough now to support an increase in the MEPS. In Australia the minimum star rating available is 2.4 Stars, meaning that all products on the market exceed the MEPS by a significant amount. Rather than MEPS based on the thermal efficiency of the heat exchanger, it would be more appropriate for any MEPS to be based on the seasonal operating efficiency, as this encourages the reduction of any standby energy consumption as well as reduced electricity consumption during operation. This is the general approach being applied to air conditioner labelling from April 2010, and proposed to apply to from April 2011 to air conditioner MEPS (in Australia-only at this stage)

A MEPS that was set at an SOE of 65% – corresponding to approximately a 3 star rating, assuming a HLR of 0.5 - could not be met by around 12% of the currently certified models from the market. The percentage of total GDH sales this would account for is not known for certain, but is likely to be in the order of 10-15%. Consequently introducing a MEPS at this level would have a minimal impact on the market and would see only a small increase in the sales-weighted average GDH efficiency.

Alternatively, a MEPS set at an SOE of 75% - corresponding approximately to a 4 star rating (assuming a HLR of 0.5) - could not be met by around 50% of the currently certified models on the market, but would have a much more significant impact on the sales-weighted average GDH efficiency. Although this level would affect an estimated 50% of models on the market, how many of these are actively still being sold, and what proportion of sales this represents, is yet to be determined.

Extending the MEPS to New Zealand would impose new costs on the local industry for products supplied solely to the New Zealand market. However, because GDH are already required to have their energy performance tested for the Australian market, and many of the products available in the New Zealand market are also sold in Australia, it is thought that any impact of a revised MEPS programme through E3 may have only a modest cost impact for manufacturers and suppliers. Readers are specifically requested whether they have different data from this assumption for the New Zealand market.

More consultation and analysis is needed to determine if MEPS is a feasible option for gas ducted heater efficiency, as opposed to other policy options, or no intervention at all, and to determine the impacts of any policy options for suppliers and manufacturers.

Possible impact of MEPS - a preliminary Cost-Benefit Analysis

Ideally to calculate the impact of the potential MEPS, detailed sales data by brand and model is available, so that a sales weighted average GDH efficiency before and after the MEPS can be calculated. As this was not possible an approximation of the sales weighted average GDH efficiency value was used based on the proportion of products registered with different star ratings and discussions with industry stakeholders. This resulted in an estimated average GDH seasonal operating efficiency of 74% under business as usual.

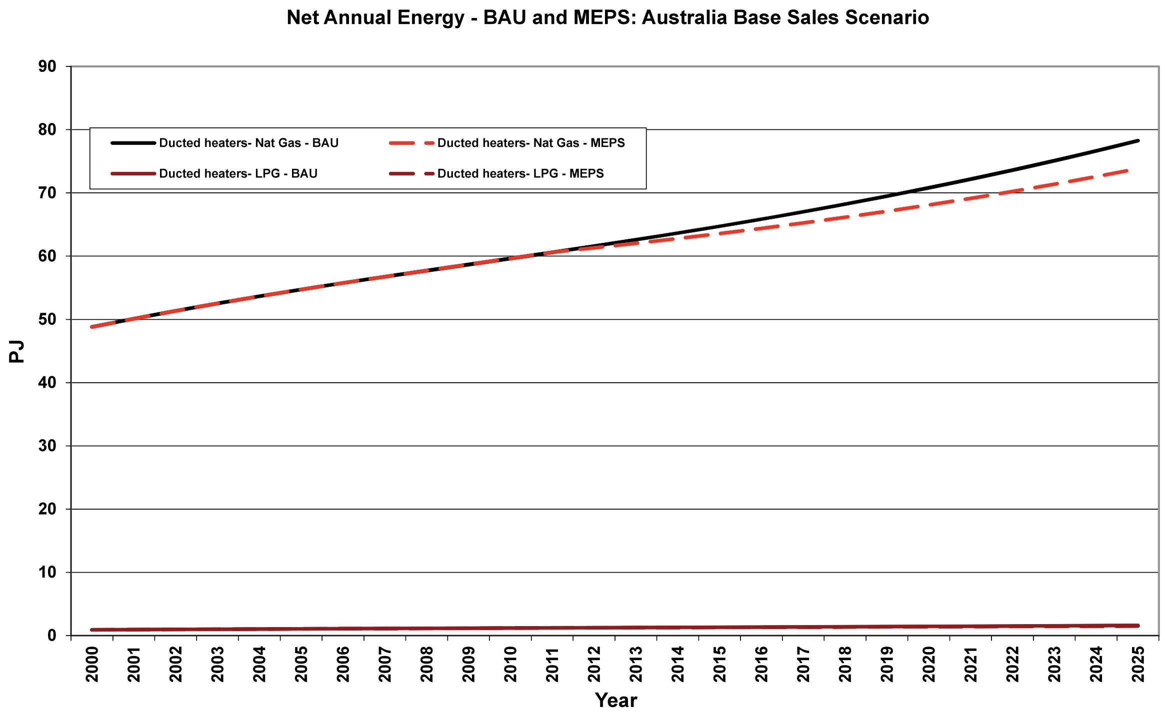
To test the potential impact of a trans-Tasman MEPS, the impact of a MEPS based on a seasonal operating efficiency of 75% was modelled. It is estimated this would raise the sales weighted average efficiency of GDH sold to 81%. This is probably a conservative estimation, as 2 to 3 star products probably make up a higher proportion of total current sales than has been assumed in calculating the pre-MEPS seasonal operating efficiency.

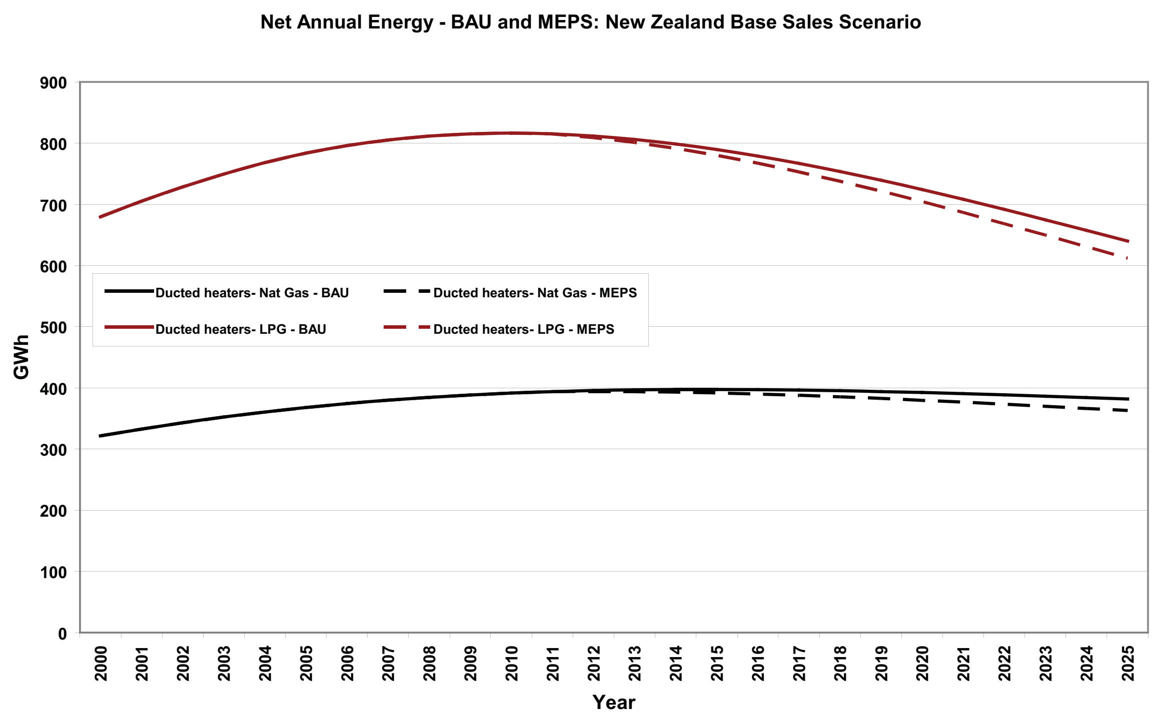
The potential impact of raising the level of the GDH MEPS in Australia from 2012 and extending this requirement to New Zealand was modelled. This analysis used the following assumptions:

- The new MEPS level would be set at 75% seasonal operating efficiency (SOE)

- The mean registered product SOE would rise to 81% if this MEPS was introduced, and this was used as an approximate indication of the sales weighted average efficiency for GDH
- The current 75% of sales of mid-efficiency heaters would continue to be drawn from the mid-efficiency range of heaters, but the sales would migrate from being a range of 2 to 4 star products to 4 star products only
- This would affect approximately 50% of GDH unit sales (the proportion of sales is not clear) costing an additional $400 per unit to move from a 2 or 3 star heater to a 4 star heater. Across all GDH sales therefore, the average additional cost of implementing MEPS at this level is estimated to be $200 per unit.

Figure 19: Estimated BAU and MEPS Energy Consumption 2000 – 2025

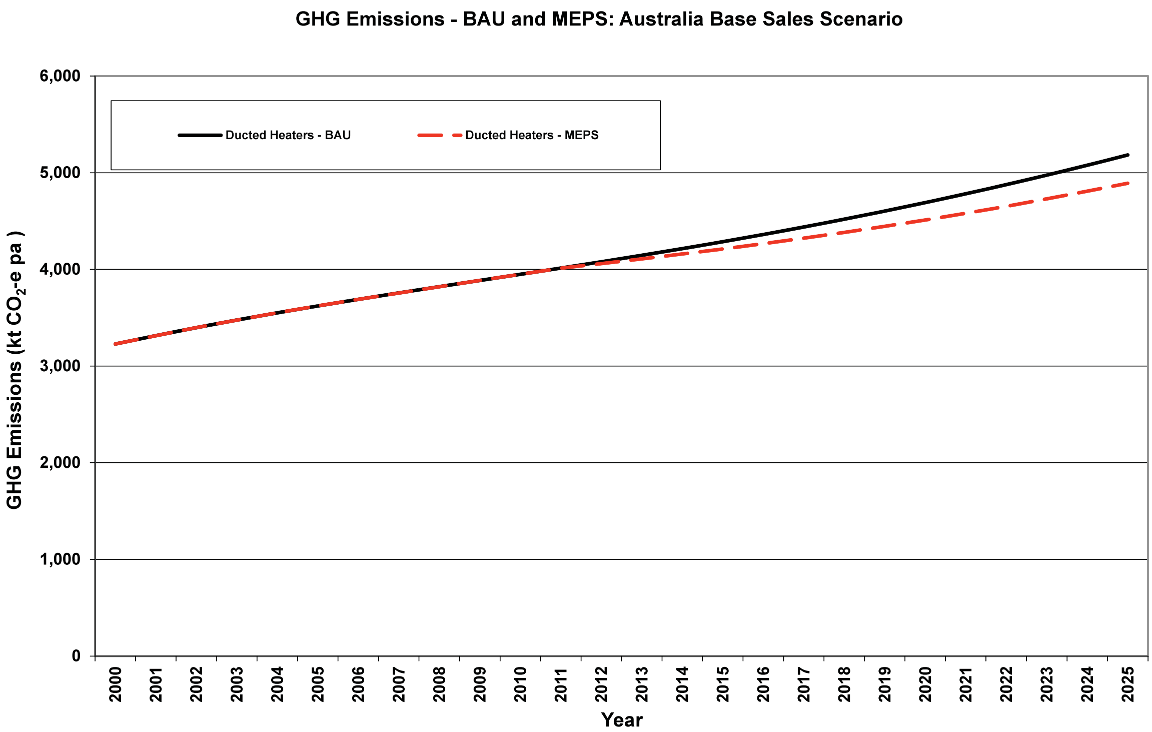


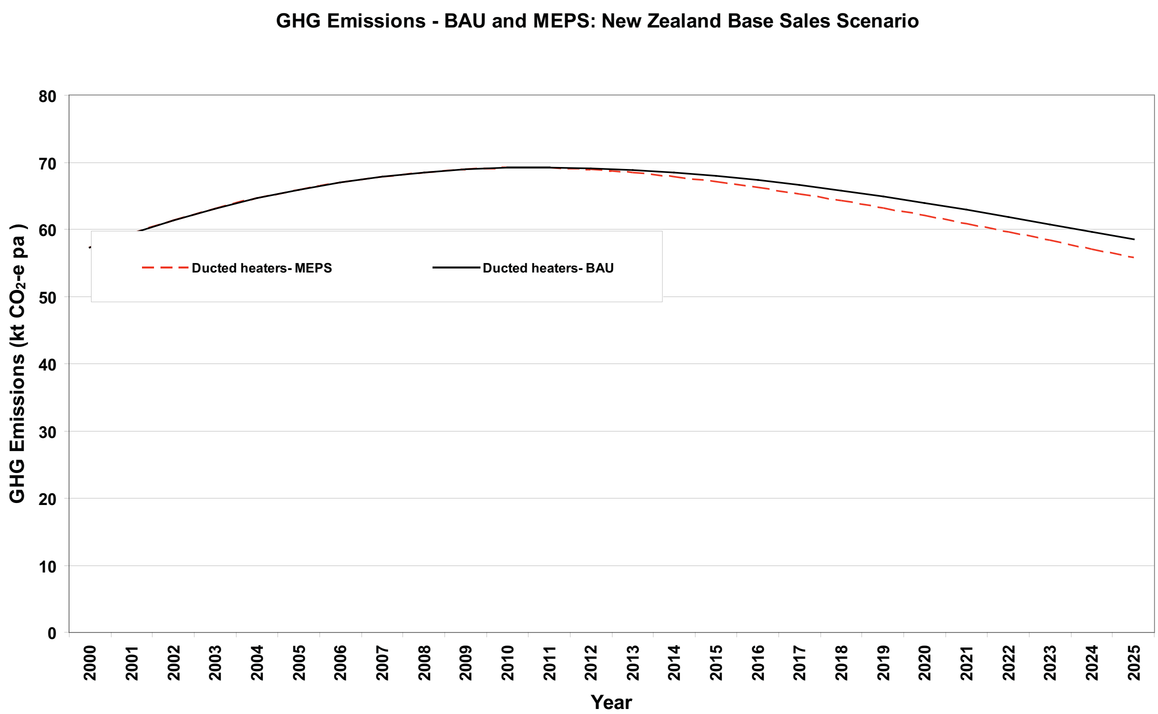


The potential savings from a MEPS introduced in 2012 would be approximately 4.5 PJ pa of gas for Australia by 2025 or a reduction of 5.6% of GDH energy consumption compared to BAU in 2025. The potential savings for New Zealand are 0.290 PJ pa by 2025. A basic cost benefit analysis indicates an Australian societal savings in 2025 of $58M NPV at a discount rate of 7.5%, and for New Zealand a saving of $14M NPV at a discount rate of 5%. Given the long average life of GDH's these savings would be even larger if a longer term perspective was taken.

Figure 19 and Figure 20 show the estimated BAU and MEPS impact for both energy consumption and GHG emission, if the MEPS was implemented in 2012.

Figure 20: Estimated BAU and MEPS GHG Emissions 2000 – 2025





ENERGY LABELLING

Energy labelling already applies to gas ducted heaters sold in Australia. The Energy Label has not been redesigned since it was introduced in the 1990's for GDH. Consumer research undertaken in 2005 across Australia and New Zealand found only a low consumer awareness of gas energy rating labels, and this awareness was lowest for gas ducted heaters, especially in New Zealand (ArtCraft Research 2006).

Current government thinking is that any government regulated energy labelling scheme for GDH would use a label design format similar to the electrical energy rating labels. It would also be likely to involve the use of half star ratings, rather than the continuous rating band that is used for the current Australian labels. Consideration would also be given to the way in which the information in the Comparative Energy Consumption box – currently expressed in MJ/m3/yr – was provided, as this is particularly difficult for consumers to understand.

While consumer awareness and use of the energy rating labels on gas ducted heaters is known to be low, there could still be significant consumer benefits from such a labelling scheme, if combined with MEPS. In addition to enabling motivated consumers to compare the energy efficiency and energy use of different models available on the market, the existence of publicly disclosed energy ratings generates a competitive incentive for manufacturers to improve the efficiency of their product offerings – this is likely to have been a reason why most manufacturers now carry a 5-Star model in their product range, and have largely eliminated 1 and 2 star models from their range. Also, there are a number of schemes operating which provide a financial incentive for installing a high efficiency gas ducted heaters, and use the rating schemes as the basis for identifying the high efficiency models. For example, the replacement of an existing gas ducted heater with a 5 Star gas ducted heater is one of the eligible measures under the Victorian Energy Efficiency Target (VEET) Scheme[10]. The existence of comparative rating schemes is a pre-requisite of such incentive schemes. In addition, the "Warm Up New Zealand: Heat Smart" program (which subsidises the installation of clean heating devices) only funds flued gas Space heaters (tested to the Standard AS 4553) that have an energy rating of 4-star or more.

The current spread of star ratings for the GDH appears to be sufficient to allow consumers a reasonable choice of more efficient models, see Figure 17, however the absence of 1 or 2 star units has decreased the value of the label for GDH as there is less of a star rating spread – currently there is a 4 star spread and this would be reduced to 2. If a mandatory energy rating label was introduced, it is likely that the appropriateness of the Heat Load Reduction factor in the calculation of the star ratings would also be reviewed. Removing the Heat Load Reduction factor in the star rating calculations would probably scale back the rating of most heaters and may mean that at least initially there would be a sufficient spread of efficiencies /star ratings. Removing the artificial limit of a maximum of 5 stars allocated on the basis of the seasonal operating efficiency (SOE) would also reward those products which had very high operating efficiencies.

Currently the AGA Certified Product Directory (eg, AGA 2009) is the only complete source of comparative performance information on gas heaters. It is presented as a 200+ page Adobe PDF file which lists the heaters according to their category (AS 4556, etc) and is republished periodically throughout the year with appropriate changes (new models or changes to the registration status). The Directory lists the product supplier name, model name/numbers, certification number/date, Annual Energy Consumption, Star Rating/degrees shading and gas type (LPG, TLP, Town Gas, NG). The Directory is not suitable for consumers to compare products, and it does not list the output (kW) of the heater.

The gas labelling programme could be made more effective through the use of a more recognisable label - like the well-known energy rating label used for electrical products, and through making comparative information on gas ducted heaters more accessible to consumers. A web enabled searchable database could allow consumers to search and compare gas ducted heaters by category, output (kW), gas consumption (MJ/hr), Star Rating and Annual Energy Consumption. This is the function of the current Energyrating website for all electrical products covered by MEPS and/or labelling, and soon, gas water heaters. So the machinery and platform to administer this comparative information is already in place, and for minimal cost to government or tax payers, could accommodate further products.

However, the biggest difficulty with the effectiveness of the energy labelling scheme is that the end-user households are in most cases not involved in the GDH unit purchase. Consequently, due to the split incentive issues with builder purchases already mentioned, the energy label will have minimal or no impact for the majority of purchases. The energy labelling scheme will continue to have value for the minority of purchases conducted by the home owners, but it will never be as effective as an increased MEPS at market transformation.

A shift to government regulated energy labelling for gas ducted heaters under the E3 Program would have the benefit of extending mandatory energy labelling to New Zealand, enabling energy efficiency to be a selling point in both the Australian and New Zealand markets, would help to drive further competition between suppliers and align Australian and New Zealand provisions. It would require a detailed review of the test method used as the basis of labelling as this would need to be both robust and repeatable to support a check testing and compliance regime. It is also likely to require that the design format for the gas label be aligned with that of the electrical rating label.

As with trans-Tasman MEPS, the shift to mandatory labelling is considered likely to impose only modest additional costs on suppliers and manufacturers, as the majority of products are already tested and labelled under the existing Australian

10 For further information see: http://www.esc.vic.gov.au/public/VEET/

scheme. (Readers are asked to comment on this.) The costs associated with re-testing to an improved test method may be substantial, and will require further investigation. Labelling alone would still incur test costs but would be expected to have a lower greenhouse abatement impact. MEPS and labelling combined would be expected to have a larger impact than simply MEPS alone as it would 'push' the low end of the market and facilitate consumer 'pull' for the high end of the market.

VOLUNTARY OR ENDORSEMENT LABELLING

An alternative or addition to mandatory energy labelling would be voluntary energy labelling and/or the use of endorsement labelling such as ENERGY STAR.

In the absence of any action from government, the current Australian gas energy labelling scheme will continue, as it is required as part of gas appliance certification. This labelling scheme is already used on a voluntary basis in New Zealand. The main disadvantage of voluntary labelling schemes is that it is generally only the high efficiency products which are labelled and while it would make it easier for consumers to identify these products they would not be able to compare the performance and benefits with the lower efficiency products. Also, voluntary schemes are generally not supported by as robust a compliance and enforcement regime, which can reduce consumer confidence in voluntary labels.

The New Zealand government runs an active compliance programme of enforcement and promotion for the US ENERGY STAR scheme for a number of electrical appliances. In special cases, New Zealand has been given permission to develop their own or specifications, based on a MEPS standard where the US standard is fundamentally different or unsuitable.[11]. ENERGY STAR applies to gas ducted heaters in the North American market, but the test method used as the basis for this scheme is different to the Australian test method and is most relevant to heaters which are operated on a continuous (24/7) basis. Gas ducted heater use in Australia and New Zealand is intermittent (eg only when required) and the US test is not considered to be appropriate for this mode of operation. An active promotion, compliance and enforcement regime is required to ensure the ENEGRY STAR endorsement is used correctly, to maintain the relationship with the US programme. An ENERGY STAR specification for gas ducted heaters may be possible for the New Zealand market initially, based on a MEPS standard, but further investigation is needed. It is easier to run the programme where an existing standard can be used as a basis. The programme relies on industry partners actively promoting the endorsement mark and using it in the correct manner.

This could be valuable adjunct to a mandatory labelling scheme.

[11] For further information see: http://www.eeca.govt.nz/standards-and-ratings/energy-star

Voluntary and endorsement labelling schemes are likely to only apply to the highest efficiency models on the market. They suffer from the same limitations as a mandatory labelling scheme – in that around 75% of the market is covered by a split incentive (where the appliance is purchased by someone who isn't the householder or bill payer).

FINANCIAL INCENTIVES

Governments could provide financial incentives to encourage consumers to purchase high efficiency appliances. As noted above, one current example of this is the Victorian Energy Efficiency Target Scheme, a "white certificate" scheme which allocates tradeable certificates to the replacement of existing gas ducted heaters with 5 Star models[12]. However, a prerequisite for such schemes is some form of energy performance labelling, so governments can have confidence that they are rewarding the better performing products on the market.

Data collected from the Australian market suggests that a government funded rebate scheme could be quite costly. The cost differential between a 4 star heater and a 3 star heater is $400 and between a 5 star heater and a 3 star heater is $1,400, and only 25% of current annual sales of 50,000 units are estimated to be 5 star models. Shifting say 10,000 sales of low (2 and 3 star) efficiency heaters to the 4 star level with a $200 rebate would cost $2 million per annum, or a total cost of $20 million over a 10 year period[13]. Shifting a greater percentage of sales to the 5 star level would cost even more. It would be difficult for governments to justify this high outlay given that there are many different types of appliances which might benefit from such an incentive. Also, the analysis undertaken for this report indicates that in most jurisdictions there is already an economic benefit to consumers from purchasing at least a 4 star model without any government incentive.

It is relevant to note that under a financial incentive scheme the taxpayer bears some of the cost of purchasing a higher efficiency heater, but the financial benefit of the energy savings goes only to the household receiving the incentive. In the case of a MEPS regime, the household bears the additional cost but also receives the financial benefit.

A Victorian study (Palmer 2008) also suggests that significant savings could be achieved by replacing old degraded ductwork with good quality new ductwork. The Palmer study of 10 houses found that an average thermal efficiency of existing ductwork was around 65%, and that this increased to 85% after a good quality retrofit. This means that energy savings of around 25% could be achieved through upgrading

[12] To date, this has driven little activity in the GDH market. A mid sized 5 Star heater will generate around 10 certificates but the current certificate price is fairly low (around $15). The VEET "rebate" of around $150 is not currently large enough to overcome the somewhat higher cost of 5 Star models.

[13] Offering an incentive for just 4 star heaters may have the perverse outcome of reducing sales of 5 star units. Differential incentives would have to be offered for both 4 and 5 star heaters to overcome this.

old ductwork. With an average efficiency of 61%, ductwork which was older than 15 years was found to have the worst performance; this was largely because the type of ductwork installed during this period in Victoria was particularly prone to degradation. Ductwork less than 15 years old had an average efficiency of 76%. This study suggests that government incentives to upgrade old ductwork could yield significant savings. However, the cost of retrofitting ductwork is quite high (around $1,200) and quite a large incentive would be required. This might be considered in jurisdictions such as Victoria which have a large installed base of ductwork that is over 15 to 20 years old, and where energy consumption by ducted systems is high.

Summary of Policy Options

While there is some evidence from the Australian market that the energy efficiency of the average gas ducted heater sold has increased since the early 1990s – most probably due to the impact of energy labelling that stimulated supplier competition – the current market average efficiency (3.9 stars, corresponding to a seasonal operating efficiency of around 74%) is less than optimal from a consumer perspective and is leading to greater energy costs, energy consumption, and greenhouse emissions than are necessary. Increasing the average efficiency of GDH units would be cost effective for the large majority of consumers and would also significantly reduce energy use and greenhouse gas emissions.

Due to split incentives applying to around 75% of the GDH market, and the energy and greenhouse implications of using inefficient gas ducted heating, some form of market intervention appears to be the most appropriate and cost effective approach to raise the energy efficiency of GDH in Australia and New Zealand. (Cost-effective meaning the energy savings cost less than the increased up front purchase price over the lifetime of the heater.)

An energy efficiency labelling scheme already exists – mandatory in Australia but voluntary in New Zealand - but has a reduced impact on the market as most sales are not directly to the home owner. A MEPS already exists for GDH sold in Australia but this is set at a low level and has not been revisited for fifteen years, despite improvements in GDH technology. All models on the market currently exceed this MEPS by a considerable margin.

At first glance, the most effective approach to increasing the energy efficiency of the average GDH sold in Australia and New Zealand could be to address the split incentive market failure, by investigating a minimum energy performance standard (MEPS) based on the existing Australian standard. A useful measure might be the seasonal operating efficiency (SOE) of the GDH, rather than simply the thermal efficiency of the heat exchanger.

Mandatory energy labelling could also be useful as it would provide a competitive incentive to manufacturers to innovate and bring even more efficient GDH onto the market. Because many of the products on the New Zealand and Australian market are already tested to the Australian standard, additional costs are thought to be minimal at this stage, but further investigation into labelling is needed.

Both the labelling scheme and the test method may need to be revised to support a MEPS or labelling scheme in order to ensure that testing was robust, accurate and repeatable. The basis on which the star ratings are allocated would also need to be reviewed, to ensure that units with the highest operating efficiency were recognised and that the star ratings provided a fair comparison of in-use performance.

Conclusions and Reccomendations

The conclusions of this Product Profile are:

- Gas ducted heaters are used in 15.6% of Australian homes and consume two thirds of the energy used in residential heating by gas. In comparison, gas ducted heaters are used in only around 1% of New Zealand homes. While the market in Australia is expected to continue to grow, the New Zealand market is expected to decline due to an increasing market share for heat pumps.
- Gas ducted heaters presently are estimated under the BAU scenario to produce around 3,800 kt CO_2e in Australia, growing to 5,000 kt CO_2e in 2025, while New Zealand would produce 64 kt CO_2e in 2010, declining to around 52 kt CO_2e in 2025 due to declining GDH sales.
- There is potential for a significant (6%) reduction in the average energy consumption of gas ducted heaters sold by improving product efficiency through raising the MEPS on the furnaces of GDH from it's current level (a minimum thermal efficiency of 70%) to a seasonal operating efficiency of 75%, equivalent to around a 4 star rating on the current Australian labelling scheme.
- If MEPS turned out to be a favoured policy option, the cost of increasing MEPS from its current level to a minimum seasonal operating efficiency of 75% could be relatively low, an average of less than $200 per unit sold. For households in Australia this would give an average annual saving of around $40 per year and an average pay back of around 5 years; in New Zealand this would give an annual average saving of close to $200 per year and an average payback of around 1 year (due to the higher cost of gas and greater use of LPG). This would mean that the additional cost would be fully recovered within the typical 20 year life of a GDH system.
- A basic cost benefit analysis indicates that introducing a MEPS based on a seasonal operating efficiency of 75% could result in Australian societal savings in over the period 2012 to 2025 of $58M NPV at a discount rate of 7.5%, and for New Zealand societal savings of $14M NPV at a discount rate of 5%. The potential energy savings would be approximately 4.5 PJ pa of gas for Australia by 2025 or a reduction of 5.6% of GDH energy consumption compared to BAU in 2025. The potential savings for New Zealand are 0.290 PJ pa by 2025.
- While the nationwide energy savings potential for gas ducted heating is relatively low in New Zealand (due to its low market share) aligning standards with Australia could nonetheless benefit New Zealand by reducing business compliance costs, providing benefits to individual consumers, and providing protection against poor quality products being dumped on the New Zealand market (we welcome stakeholder feedback on the likelihood of this). Aligned standards would also help Australia and New Zealand to uphold the principles of the Australia New Zealand Closer Economic Relations Trade Agreement (ANZCERTA).
- The existing Australian energy labelling scheme would need to be reviewed, and potentially revised, and become government controlled scheme under the E3 Program.

It is recommended that:

- Further and more detailed information be collected on the gas ducted heater markets in Australia and New Zealand, to enable the E3 Committee to make more accurate estimates of the likely impact from establishing trans-Tasman MEPS and labelling, and to help determine where levels could be set. Industry feedback on this Product Profile is encouraged, and will be valuable.
- The E3 Committee conduct further investigation into the case for government-regulated, trans-Tasman MEPS and energy labelling for gas ducted heaters, subject to:
  - **the outcomes of consultation on this product profile, and**
  - **approval from the Energy Efficiency Working Group to proceed to a regulatory impact statement (RIS) which will set out recommended options and assess their impacts**
- Further industry consultation be undertaken when a RIS is available.

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The estimated energy consumption by gas ducted heaters has been reported by EES (2008) in the *Energy Use in the Australian Residential Sector, 1986-2020*, as ranging from 35 PJ pa to 56 PJ pa over the period 2000 to 2008, with the overall energy consumption forecast to grow in Australia to 95 PJ pa in 2020. In 2008 GDH are estimated to use about twice the energy compared to gas space heaters, despite there being only 60% the number of GDH compared to gas space heaters, a result of the GDH being used to heat the whole of houses rather than specific areas, and their greater use in colder climates.

In comparison, the present study has estimated the historical and projected energy consumption by gas ducted heaters using a stock/sales model that is combined with various appliance and usage attributes. The results of the present study have been compared to the output of the EES 2008 study and found to be of a similar order of magnitude but to differ in the detail. The present study and EES study both estimated current, 2008, gas energy consumption at around 52-56 PJ pa. However, the EES study forecast future consumption as growing much more rapidly to 95 PJ pa in 2020, while the present study estimated growth to 71 PJ pa.

The main difference in the approaches which seems to be causing the differences in the energy consumption estimates appear to be the underlying stock numbers used for the modelling. For the present study, considerable industry sourced data on sales and stocks were made available that EES would not have been able to access, plus ABS 2006-2008 stock survey data was available. This additional information suggested a much lower rate of growth over the last few years and into the future than was assumed for the EES study, or the MAE 2002 study. It is estimated that annual sales growth of around 7% p.a. would be required to meet the projected EES energy consumption shown for 2020. This difference explains the main variation in the values of total energy consumption estimated by the present study compared to the EES 2008 report, as shown in later figures and tables. Other differences in projections may be explained by EES using a more complex model of energy demand linked to the thermal load of houses, which was based on the nature and size of the houses, but the difference in annual sale growth of GDH units is likely to be the key cause of the difference in the projections of the EES and present study.

Figure 21: Residential Heating Energy Consumption in Australia 1986 – 2020 (EES 2008)