Are we still Cooking with Gas?

Report for the Consumer Advocacy Panel

ATA

November 2014

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Executive Summary

Background

The Consumer Advocacy Panel (CAP) approved a grant to the Alternative Technology Association (ATA) that focused on one of the consumer research priorities identified by consumer advocates and decision-makers at the Panel's strategic forum in August 2013.

The purposes of this research project were to understand and substantiate the impact, in particular on low income and vulnerable consumers, of anticipated retail gas price rises on households across the National Energy Market (NEM)[1], and to identify cost effective alternatives to gas appliances, if and where they may exist.

The new Liquefied National Gas (LNG) export market from Eastern Australia is pushing up retail prices for domestic gas, a situation expected to worsen in coming years with substantial impacts on the affordability of gas for households.

At the same time, electrical technology to heat air and water is increasingly efficient. While gas remains cheaper for each unit of energy supplied at the meter, an efficient electric space or water heater now uses only 1/7 to 1/5 of the metered energy that the most efficient equivalent gas appliance. As a result, efficient electric appliances for space and water heating have lower running costs than efficient gas appliances.

For cooking, electric induction cook tops are increasingly affordable, and provide similar amenity and higher safety than gas equivalents, such that they are preferred by many consumers.

These trends - higher retail gas prices and improved performance and price of efficient electrical technologies - are now established in Australia. While the efficiency of electric space and water heating appliances is continuing to improve, that of gas appliances is forever limited.

Approach

ATA's approach to this research involved estimating the up-front and running costs of efficient gas and electric appliances for space heating, water heating and cooking, over a ten year period, to provide economic comparisons that are broadly relevant to most households in the NEM.

The analysis was conducted across most gas pricing zones in the NEM, taking into account location-specific energy and maintenance costs, along with the impact of climate on heating loads and appliance performance, for six different housing types. These housing types account for differing sizes and construction of homes and with specific regard to public housing, new homes and homes using bottled gas.

New and existing homes were considered, both for single (electric only) and dual fuel (gas and electric) use. The analysis considered other key factors such as the impact of whether or not the existing gas appliances were near the end of their asset life, the of the order of appliance replacement relative to marginal costs of energy use and the impact of off-peak electricity pricing.

To account for uncertainty of future gas prices, a range of gas prices were considered.

[1] Victoria, South Australia, New South Wales, Australian Capital Territory, Tasmania and Queensland.

Findings: New Homes & Existing All-Electric Homes

Whether newly built or existing all-electric homes should connect to the gas network and install any number of gas appliances for economic reasons is dependent on one main factor; whilst a second factor may apply to a limited number of consumers:

- whether the household is able to install efficient electric appliances; and secondly
- whether the cost of gas appliances is heavily subsidised.

Finding 1: It is not cost effective to connect a new home to mains gas when efficient electric appliances are an option.

Finding 2: Connecting a new home to mains gas is cost effective when efficient electric appliances are not an option.

Finding 3: It is not cost effective to connect an existing all-electric home to mains gas when efficient electric appliances are an option.

Finding 4: Connecting an existing all-electric home to mains gas is cost effective when efficient electric appliances are not options.

Finding 5: Connecting an existing all-electric home to mains gas may be more cost effective when the cost of new appliances is heavily subsidised.

Findings: Existing Dual Fuel Homes

Whether dual-fuel homes should replace some or all of their gas appliances with efficient electric appliances for economic reasons is dependent on multiple factors. The main determinants are:

- the age or condition of the existing gas appliance;
- whether the replacement allows the customer to disconnect from the gas network;
- whether the household is able to install efficient electric appliances;
- whether the existing gas supply is mains or bottled gas;
- the marginal cost of gas on a declining block tariff;
- climate conditions; and
- the ratio of gas to electricity price.

Finding 6: It is significantly more cost effective to replace gas heaters with multiple reverse cycle air conditioners (RCACs) for space heating than with gas.

Finding 7: In warmer climate regions (including SA, QLD and some parts of NSW) switching all gas appliances to efficient electric and disconnecting from the gas network offers better economic returns than in cooler climates.

Finding 8: Heat pump hot water systems are more cost effective than gas hot water systems where the relative price of gas as compared with electricity is higher and/or where the climate is relatively warmer. Gas hot water systems remain more cost effective in most other locations.

Finding 9: Switching from gas to induction cook tops and electric ovens is typically only cost effective when avoiding a high fixed service to property charge as well as the gas usage charge.

Finding 10: Existing gas cook tops and ovens are more cost effective than efficient electric when the fixed charge is lower or not being avoided.

Finding 11: Customers in new gas zones pay more for gas than do customers in established zones.

Recommendations:

ATA's recommendations draw on the findings of this report as well as the broader context of developments in the National Energy Market in Australia.

In ATA's view, the single most urgent need is to mitigate the impacts of gas price rises on vulnerable and disadvantaged consumers. Recent increases to electricity prices have contributed to worsening levels of energy poverty in Australia, and increased gas prices are likely to exacerbate this

Recommendation 1: Improve energy concessions to address the cost of living impact of expected gas price increases on vulnerable and disadvantaged consumers.

Recommendation 2: Examine potential to control gas prices for vulnerable and disadvantaged consumers.

Recommendation 3: Provide better information for consumers regarding the real cost of purchasing and operating both gas and electric appliances.

Recommendation 4: Strengthen the regulatory oversight of the marketing of gas as cheaper and more efficient than electricity.

Recommendation 5: An urgent review of policy and programs that subsidise/support the expansion of gas networks is required.

Recommendation 6: Replace gas network expansion policies with programs that directly address energy affordability in regional areas.

Recommendation 7: Require gas network businesses to forecast disconnection of existing gas customers and analyse their competitive position against electricity.

Recommendation 8: Bring Public Housing energy policy in line with cost effective energy opportunities.

Recommendation 9: Provide support to landlords, and disadvantaged owner-occupiers, to replace less efficient and expensive-to-run gas appliances with more efficient appliances.

1.0 Introduction

The Consumer Advocacy Panel (CAP) approved a grant to the Alternative Technology Association (ATA) that focused on one of the consumer research priorities identified by consumer advocates and decision-makers at the Panel's strategic forum in August 2013.

The purpose of this research project was to understand and substantiate the impact, in particular on low income and vulnerable consumers, of anticipated retail gas price rises on households across the National Energy Market (NEM) and identify cost effective alternatives to gas appliances, if and where they may exist.

ATA's methodology for the research modelled six different household types, and compared the 10-year costs of installing gas or electric appliances in new homes replacing gas appliances with like-for-like gas appliances or efficient electric alternatives. Different replacement cases took into account whether the existing gas appliance/s were near the end of their asset life. The analysis was conducted across gas pricing zones and took into account the impact of different climate zones.

The ATA wishes to thank the CAP for supporting this important project.

1.1 Project Objectives

At the time of writing, little analysis has been made publically available that considers:

- the long term cost impacts of projected wholesale gas prices on small energy consumers in the National Energy Market; and
- the potential economic benefits of using high efficiency electrical appliances for traditional gas-fuelled end-use energy requirements (in particular space heating, water heating and cooking).

As such, the purpose of this research is to understand:

- which households are most cost effectively served by efficient gas appliances;
- which households are most cost effectively served by efficient electric appliances;
- if, and under what circumstances, a change in preference might occur;
- what the financial benefit is of choosing one fuel type over another.

In particular, it aims to understand the impact on vulnerable and disadvantaged consumers. With energy affordability decreasing in recent times as a result of growth in energy costs outpacing income growth, it is imperative that the most cost effective options in relation to household energy use are identified for these consumers.

In addition to understanding consumer impacts, the project also seeks to understand the future implications for energy market regulators, policy makers, rules and regulations.

1.2 Context

1.2.1 Energy Prices

The opening of Liquefied National Gas (LNG) export market from Eastern Australia is expected to drive up residential gas prices as domestic gas producers supply international export markets at a higher price on offer. This is already pushing up prices for domestic gas and is the catalyst for much public debate.

The recent 17+% increase in the regulated gas price for NSW residential consumers heralds the arrival of higher gas prices for residential consumers in the eastern states. While price forecasts differ, some suggest residential gas consumers will face real gas price increases of up to 50% within the next few years as a result of increased wholesale and network costs.

On the other hand, the Australian Energy Regulator's (AER's) recent draft price determination for NSW and the ACT electricity distribution businesses, along with various forecasts, indicates the stabilisation, and possible reduction, of electricity tariffs across Eastern Australia over the next few years.

Further, the Australian Energy Market Commission (AEMC) is considering changes to the National Energy Rules that would lead to reductions in volume-based charges in favour of fixed or kW demand-based charges for electricity, making it cheaper still to use in non-peak times (particularly for water heating).

1.2.2 Appliance Performance & Substitution

Space heating and water heating are the two most energy intensive activities that residential energy consumers use reticulated gas for, particularly in cold and temperate climates. Cooking is the third – and whilst the volume of gas used for cooking is much lower than for heating, consumers typically prefer the quality of gas cook tops over electric resistance cooking.

Electrical technology used to heat air and water is becoming increasingly efficient. Residential scale reverse cycle air-conditioners (for space heating) are reaching co-efficients of performance (CoP) of 5.0 and over – which means that for every 1 unit of energy input to the system, 5 units are generated to heat air. CoPs for the most efficient electric heat pumps (for water heating) now exceed 4.0.

Compared with the most efficient equivalent gas appliance that have a CoP of around 0.8 – 0.9, an efficient air-conditioner or electric water heater now uses 1/7th to 1/5th of the input energy for the same end use. While CoPs for electric appliances may continue to improve, gas appliances are forever limited to 0.9 at best.

In addition, induction cook tops, that offer high efficiency and similar (or greater) amenity to gas cook tops, have become increasingly affordable in recent years and continue to drop in price as they gain popularity as a mass market product.

Meaningfully comparing gas with electric appliance use is complex due to the variety of economic and other considerations that households are faced with in making such a decision, particularly for cooking and space heating. Naturally these considerations have fully informed ATA's assessment of what constitutes suitable electrical alternatives to gas appliances for most consumers.

1.2.3 Changing Economics

The two trends of higher retail gas prices and improved performance / lower price of efficient electrical technologies are now firmly established in Australia and are likely to continue.

Based on current price forecasts and appliance price and performance trends, are many cases where gas appliances are no longer the most affordable option for households for heating and cooking. This is a significant reversal of the rationale that has underpinned the last three to four decades of investment in reticulated gas connections and appliances for residential end-use energy needs.

1.2.4 Consumer Purchasing Behaviour

Approximately 7% of all Australian households replace their gas hot water systems each year, in keeping with a typical asset life of 10 to 15 years. Space heaters tend to have slightly longer asset lives. As such, every year at least 1 in 10 households buy a new space or water heater. When faced with this decision, according to industry data, the majority choose a 'like for like' replacement.

This common approach ignores the impact of running cost, determined by technology efficiency and future energy prices, on the total cost of purchasing, owning and operating the appliance over the life of the system. Hence, consumers often choose an appliance that costs more to run in the long term. This is particularly evident for hot water systems that have failed due to the urgency of reinstating hot water supply.

Where consumers do consider the longer term costs of gas and electric appliances, most ascribe to the conventional, yet out of date, view that gas is inherently the more affordable option.

1.2.5 Promotion of Gas

The view that gas continues to be the inherently more affordable option is perpetuated by marketing of gas supply and gas appliances as cheaper and more efficient than electric.

Feedback provided to ATA indicates that many financial counsellors and other front-line service providers are aware of increasing gas prices, but are not aware that electricity prices have begun to stabilise and efficient electric appliances are cheaper to own and run. The most common advice given to service users on appliance replacement includes:

- replace old gas appliances with more efficient versions of the same type, missing the opportunity to save money by fuel switching;
- replace old inefficient electric appliances with gas ones, missing the opportunity to save more money by instead installing efficient electric appliances; and
- connect homes to the gas network where it is available 'in the street', without regard for the performance or condition of existing appliances or the cost effectiveness of other alternatives.

Perhaps of greater concern, government incentives for infrastructure investment (particularly in Victoria) also reflect an increasingly outdated view that using gas will improve energy affordability for residential consumers.

1.3 Project Support

As part of the development of the model and the subsequent analysis, ATA were greatly assisted by a wide range of energy market and consumer coleagues and other stakeholders.

ATA worked closely with the Gas Advisory Group established through the National Energy Consumer Roundtable. In particular, the Consumer Action Law Centre (CALC), the Consumer Utilities Advocacy Centre (CUAC) and the Public Interest Advocacy Centre (PIAC) were instrumental in developing an research and advocacy strategy and hosting a Gas Masterclass for consumer organsiations.

St Vincent de Paul Society and Alviss Consulting were also of much assistance in the analysis surrounding gas and electricity tariffs, and feedback from members of the gas industry has been equally valuable in keeping our analysis and assumptions robust and realistic.

Other stakeholders that have made valuable contributions during the project include:

Name	Organisation	Name	Organisation
Alan Pears	RMIT	George Wilkenfeld	George Wilkenfeld & Assoc
Andrew Dillon	Energy Supply Assoc of Aust.	Dean Lombard	VIC Council of Social Services
Kieran Donoghue	Energy Supply Assoc of Aust.	Helen Scott	Ethnic Communities Council
Gavin Dufty	St Vincent de Paul	Martin Jones	CUAC
Dominic Eales	Energy professional	Nadine Lester	QLD Council of Social Service
Timothy Forcey	Melbourne Energy Institute	Oliver Derum	PIAC
Richard Keech	Beyond Zero Emissions	Gabrielle Kuiper	PIAC
May Mauseth	Alviss Consulting	Terry Williamson	The University of Adelaide
David Prins	Etrog Consulting Pty Ltd	Mike Dennis	ANU
Robyn Robinson	COTA	Nicholas Carrazzo	Project volunteer
Damian Sullivan	Brotherhood of St Laurence	Various	Multinet Gas
Matt Sullivan	Moreland Energy Foundation	Tosh Szatow	Energy for the People
Stacey Tabert	Brotherhood of St Laurence	Kath McLean	TAS Council of Social Services
Andrew Andraka	Worcester Polytechnic Institute (WPI)	Ian Maitland	Ethnic Communities Council
Jake Brown	WPI	Tony Wood	Grattan Institute
Ashleigh Collins	WPI	Cameron Chisholm	Grattan Institute
Andrew Klein	WPI	Various	Jemena Gas Networks
Seth Tuler	WPI	Ellen Wilden	Origin Energy
Peter Harvey	Project volunteer	Tony Siddons	Siddons Partnerships

It should be noted that the analysis and views presented in this report are not necessarily supported by all of the stakeholders noted in the table above.

ATA wishes to sincerely thank of all these individuals and organisations for their contributions to the project, and others who's involvement we have failed to note above.

2.0 Methodology

An objective of the research was to capture as many household types, locations, climate zones, replacement cases and gas and electricity pricing zones as required in order that the research provided useful guidance for the widest number of residential consumers.

For six different household types, we estimated the 10-year costs of replacing gas appliances with like-for-like gas appliances or efficient electric alternatives. Different replacement cases took into account whether the existing gas appliance was near the end of its asset life. The analysis was conducted across gas pricing zones and takes into account different climate zones.

In a residential setting, the primary use of reticulated (natural) gas or bottled (LP) gas occurs for any combination of the following end-use energy services:

- space heating (warming rooms and buildings);
- water heating; and
- cooking.

An individual consumer may be considering:

- switching one or two gas appliances with electric appliances, but retaining an existing reticulated gas connection or LPG gas system for any gas appliance/s that remain;
- a complete switch from gas to electric appliances, with subsequent:
    - disconnection from the reticulated gas network; or
    - termination of the use of LPG; or
- establishing a new connection to the reticulated gas network, and purchase of new gas appliances, for:
    - an existing home without mains gas; or
    - a newly built home.

Meaningfully comparing gas with electric appliance use is complex, particularly for cooking and space heating, due to the variety of economic and other considerations that households are faced with in making decisions.

These considerations have informed ATA's assessment of what constitutes suitable electrical alternatives to gas appliances for most consumers, as outlined below and explored in more detail in the appendices to this report.

2.1 Economic Variables

The economics of the gas and electric choices is sensitive to a wide range of interrelated factors, which include:

- whether or not an appliance is at or near the end of its asset life;
- whether the decision incurs the cost of a new connection or new fixed charges;
- whether the decision avoids the cost of existing fixed charges;
- current gas and electricity tariffs and tariff structures;
- forecast prices for electricity and gas;

- the annual input energy use of individual gas and/or electric appliances, which is itself influenced by:
  - building type, size and thermal performance;
  - the type and mix of existing appliances in the home;
  - climate zone (with particular reference to space and water heading loads and the performance of electric systems); and
  - consumer financial expectation, including the cost of capital and return on investment expectations for any individual consumer; and
  - consumer behaviour.

2.2 Household Scenarios

In with the above, ATA developed six 'Household Scenarios' that could be applied to each location modelled.

The scenarios considered a range of housing types and sizes, with differing characteristics in terms of gas and electric appliance use and overall energy use. The exception to this is the newly built home scenario (*Scenario 6: New Build*). As there are no existing appliances in place, a consumer is assumed to choose between installing either gas or electric appliances as the initial appliance investment.

The six Household Scenarios are outlined in Figure 2-1.

2.2.1 Replacing Gas Appliances in Existing Homes

Household Scenarios 1 to 5 consider cases where a decision to replace one or more existing gas appliance is made, either:

- at the point where it has failed, or is highly likely to require replacement within five years. In this case, replacing it with one appliance avoids the capital expense of another in the near to medium term, hence the up-front cost impact on the consumer will be the difference in capital cost between the two appliances; or
- while the existing appliance is still in good working order and unlikely to require replacement in the next five years. In this case, the decision does not lead to any avoided capital cost in the near to medium term and up-front cost to the consumer will be the full capital cost of the new appliance.

The options are either to:

1. replace the gas appliance/s with a new, efficient gas appliance (this is considered the *Business as Usual* (BAU) case; or
2. replace the gas appliance/s with an efficient electric appliance/s.

Under option 2, there is also the case where a consumer replaces all gas appliances with efficient electric, avoiding the need for an existing gas supply. In this case, the consumer:

- avoids the ongoing fixed charge incurred by maintaining a gas connection; and
- usually incurs a charge for temporary or permanent isolation of the gas supply to their home.

2.2.2 Connecting Existing All-Electric Homes to Gas

Household Scenarios 1 to 5 also consider the case where an established all-electric home has the option to connect to an existing gas network and install gas appliances. The available options are to:

1. connect one or more efficient gas appliances to the gas network, with or without some number of efficient electric appliances. In this case, the use of any one appliance avoids the capital expense of another, hence the up-front cost impact on the consumer will be the difference in capital cost between the two appliances; or

2. install efficient electric appliance/s and not connect to the gas network. Under this option, the consumer also avoids any ongoing fixed charge incurred by maintaining a gas connection.

In option 1 above, there is also an establishment cost to connect the home to the gas network in the street, including the installation of a gas meter. On the advice of gas network businesses and in order to be conservative, ATA have not attributed this cost to the householder, as businesses are likely to subsidise this cost as an incentive to the consumer to connect to the network.

2.2.3 Choosing Appliances for New Homes

Household Scenario 6: *New Home* considers the case where a new home is built and either:

1. connects one or more efficient gas appliances to the gas network, with or without some number of efficient electric appliances. In this case, the use of any one appliance avoids the capital expense of another, hence the up-front cost impact on the consumer will be the difference in capital cost between the two appliances; or

2. installs efficient electric appliance/s and does not connect to the gas network. Under this option, the consumer also avoids any ongoing fixed charge incurred by maintaining a gas connection.

2.3 Appliance Choice

The entire range of available gas, electric, solar and solid fuel appliances available for space heating, water heating, and cooking have been considered in our research.

In narrowing these down to which appliances to analyse, and to a shorter list of models for detailed economic analysis, we have considered the following questions of each type:

- Is it common and generally accepted by consumers in a given location?
- Is it available on the mass market and supported by mature supply chain?
- Is it energy efficient, relative to other appliances of the same fuel type?
- Is the purchase price in a realistic range for mass-market consumers?
- Is it acceptable for mass-market consumers with respect to quality, convenience and amenity?
- How is it comparable with equivalent appliances of different fuel types with respect to quality, convenience and amenity? In keeping with the context and intent of this research, this analysis considers the consumer experience of gas appliances to be the benchmark against which any electric equivalents should be compared. Appliances considered inferior to gas are therefore excluded.

- Is it widely accepted as safe to use in normal use?
- With respect to cost and performance characteristics, is it materially dissimilar to other appliance types analysed, such that we can't assume that the same conclusions can be drawn as for other appliances?

The application of these criteria to specifying gas or electric appliances, including their sizing, configuration and performance relevant to an individual location, are outlined in the relevant chapters and Appendices of this report.

Figure 2-1: Household Scenarios Modelled

	Scenario1 - Reference Home		Scenario2 - Small home		Scenario3 - Large home		Scenario4 - Public Housing		Scenario5 - LPG Home		Scenario6 - New build	
Description	*Considered typical of current housing stock*		*Considered typical of current small, detached and semi detached housing stock*		*Typical 10+ year old house on suburban fringe (3 star)*		*Concession eligible. Appliance profile aligned with DHS policy.*		*Supplied with 2*45 kg bottles*		*6 star build; Different CAPEX assumptions to Scenario 3*	
Gas usage tertile[1]	Med	-	Small	-	High	-	Med	-	Med	-	High	-
Gas services[2]	**BAU Case NG**	**All Elec**	**BAU Case NG**	**All Elec**	**BAU Case NG**	**All Elec**	**BAU Case NG**	**All Elec**	**BAU Case**	**Mainly Elec**	**Gas Option**	**Elec Alt**
Space heating	Ducted gas - Replace furnace. Sized to house[4]	New multiple RC/ACs. Sized to house	Ducted gas - Replacement furnace. Sized to house[4]	New multiple RC/ACs. Sized to house	Ducted gas - Replacement furnace. Sized to house[4]	New multiple RC/ACs. Sized to house	Two flued gas wall heaters. Sized to rooms	Two RC/ACs. Sized to rooms	LPG Heater for living room	RC/AC sized to room	Ducted gas. Sized to house[4]	Multiple RC/ACs. Sized to house
Hot water	Gas storage - New high efficiency med sized unit	Heat pump med	Gas instantaneous - New high efficiency unit	Heat pump small	Gas storage - New high efficiency large sized unit	Heat pump large	Gas instantaneous - New high efficiency unit	Heat pump med	Instantaneous LPG - new high efficiency medium unit	Heat pump med	Large gas storage - high efficiency unit	Heat pump large
Cooking[3]	Gas oven, cooktop 500MJ/Qtr	Elec oven, Induction cooktop	Gas oven, cooktop 250MJ/Qtr	Elec oven, Induction cooktop	Gas oven, cooktop 750MJ/Qtr	Elec oven, Induction cooktop	Gas oven, cooktop 500MJ/Qtr	Elec oven, Induction cooktop	LPG oven, cooktop 500MJ/Qtr	No change	Gas oven, cooktop 750MJ/Qtr	Elec oven, Induction cooktop

Notes:

1. Gas usage tertile - relative to state averages from CUAC's report. An indicative check.

2. Assumes satisfactory level of service over lifetime, whether elec or gas.

3. Cooking - additional sensitivity tests on ceramic/conduction & increased elec appliance use.

4. Household scenarios with ducted gas in Vic and ACT only. Otherwise multiple wall units.

Glossary

BAU - Business As Usual
LPG - Bottled gas
NG - Natural Gas

Glossary (cont.)

RC/AC - Reverse cycle air conditioning (heat pump tech)
Tertile - thirds

3.0 Results

Economic results for each Household Scenario are presented by gas pricing zone in the Results Tables in Appendix A. Locations modelled include:

- 13 Victorian gas zones;
- eight NSW zones;
- two South-East Queensland zones; and
- one zone each for:
  - South Australia (Adelaide)[2];
  - ACT (Canberra); and
  - Tasmania (Hobart).

Economic results include the following capital cost assumptions for each case:

Table 3-1: Capital Cost Assumptions by Replacement Case

No.	Replacement Case	Capital Cost Assumptions
1	Switching a gas appliance, within 5 years of end of life, staying on gas network	Gas & Electric
2	Switching a gas appliance, not within 5 years of end of life, staying on gas network	Electric Only
3	Switching one gas appliance, of any age, disconnecting from gas network	Electric Only
4	Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network	1 Gas & 2 Electric
5	New & existing homes, not currently gas connected, choosing efficient electric instead of gas	3 Gas & 3 Electric
6	All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex	1 Gas & 3 Electric

All economic results assume a discount rate of 5.5% - reflective of the cost of residential mortgages, considered an appropriate time cost of money for household investment.

Results are presented by appliance type (i.e. space heating, water heating, cooking) and replacement case for each Household Scenario. Net Present Value (NPV) over a ten year period.

Payback time of the efficient electric alternative/s to equivalent gas appliance/s based on discounted cash flows (as per above) are indicated as per below, along with ATA's advice.

[2] Although South Australia has five gas zones, there is very little tariff variation.

Cell Colour	Economic Result	ATA Advice
$NPV	A positive NPV with a payback time of five years or less.	Definitely choose efficient electric over gas: any extra up-front cost will be recouped through savings within five years.
$NPV	A positive NPV with a payback time of between six and ten years.	Consider choosing efficient electric over gas: any extra up-front cost will be recouped through savings within ten years.
- $NPV	A negative NPV over 10 years.	Choosing electricity over gas is unlikely to save any money: any extra up-front cost will not be recouped within ten years.

An example Results Table is provided here for context:

Table 3-2: Results Table – Greater Sydney Gas Zone

Gas Zone: Jemena/AGL Greater Sydney				**Electricity Zone: Ausgrid**		
Example Location: Hurstville, 2220, NSW				**Climate Zone: Balanced Moderate Demand**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,345	$1,166	$1,284	$1,847	$1,688	$2,114
Hot Water	$342	-$471	$519	-$123	$2,195	$740
Cooking	-$259	-$102	-$348	-$259	n/a	-$348
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,455	-$1,034	-$2,116	-$1,153	$72	n/a
Hot Water	-$1,158	-$1,671	-$1,281	-$1,323	$636	n/a
Cooking	-$2,059	-$1,902	-$2,148	-$2,059	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$936	$1,256	$320	$1,163	n/a	n/a
Hot Water	$1,416	$596	$1,429	$1,177	n/a	n/a
Cooking	-$236	-$286	-$185	-$236	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,954	$1,623	$1,988	$2,381	n/a	n/a
Hot Water+ Cooking	$1,134	-$36	$1,497	$595	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$6,416	$4,868	$7,029	$6,378	$6,838	$7,519
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$96	-$293	-$833	-$33	$3,888	-$493

** Assumes full CAPEX on both electric and gas sides.*

3.1 Sensitivity of Results to Gas Price Forecasts

Sensitivity analysis was undertaken to test the results against a range of forecast gas prices for Victoria and NSW. ATA adopted low and high ranges for the purposes of comparison against the 'medium' price trajectories used in the Results Tables in Appendix A.

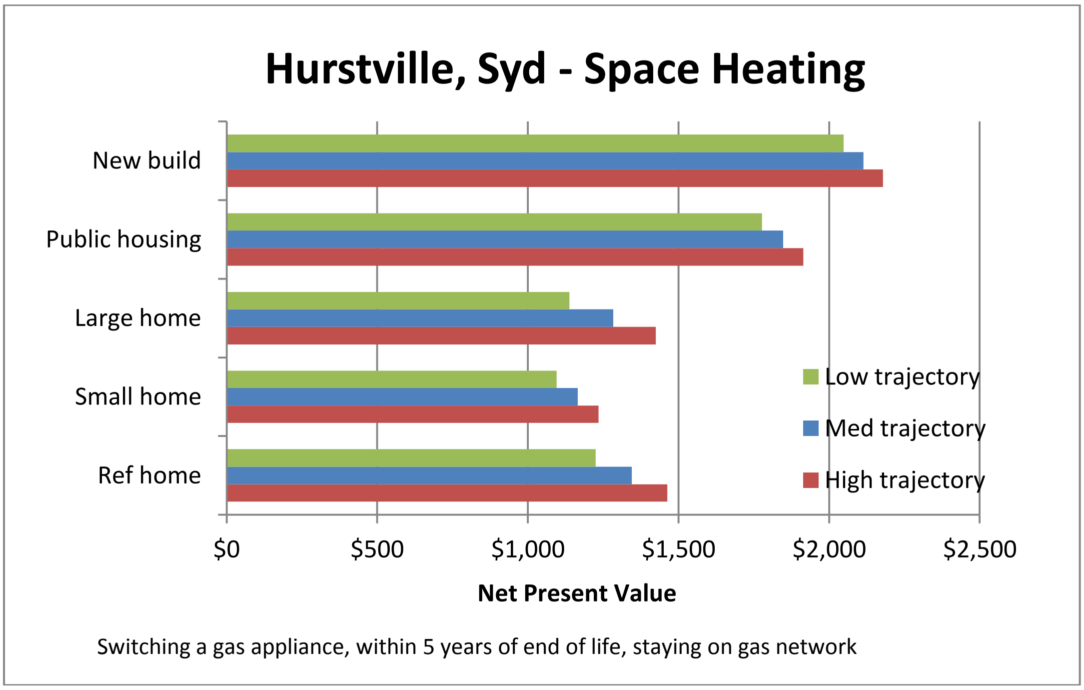
Refer to Appendix E for the low (medium) and high gas price trajectories used.

ATA found that the results were not particularly sensitive to different gas price trajectories – whilst they changed the magnitude of the numbers; they largely did not change an uneconomic investment into an economic one (or vice versa), hence had little impact on the findings or advice.

As an example, in Hurstville (Sydney), switching to RCACs for space heating within five years of the end of gas appliance asset life and remaining connected to the gas network for other appliances was economic for households connected to mains gas under the medium trajectory for gas prices.

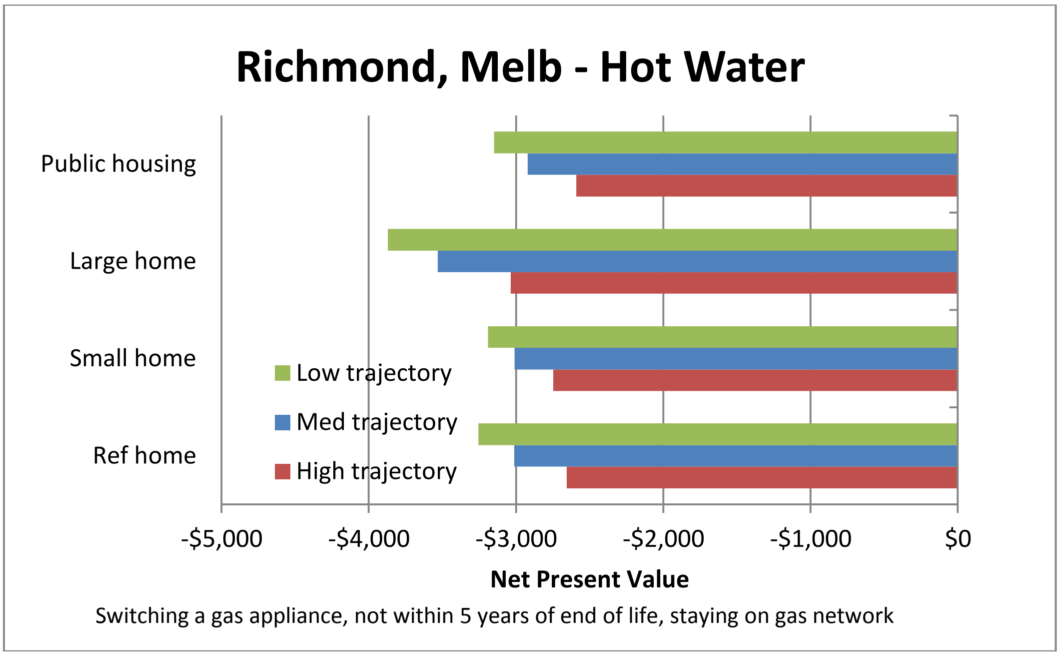
A high trajectory meant the economics of switching to RCAC became more compelling; whilst even under a low trajectory, the case remains strong. The chart below shows NPV variations over 10 years:

Figure 3-1: Sensitivity of NPV to Gas Price Forecasts, Hurstville, Space Heating



A second example was tested in Richmond (Melbourne, chosen for having very low gas prices) and considered replacing an existing gas hot water system before it was within five years of the end of its asset life. Switching was found to be uneconomic under the medium gas price trajectory and remained so even under the high price trajectory.

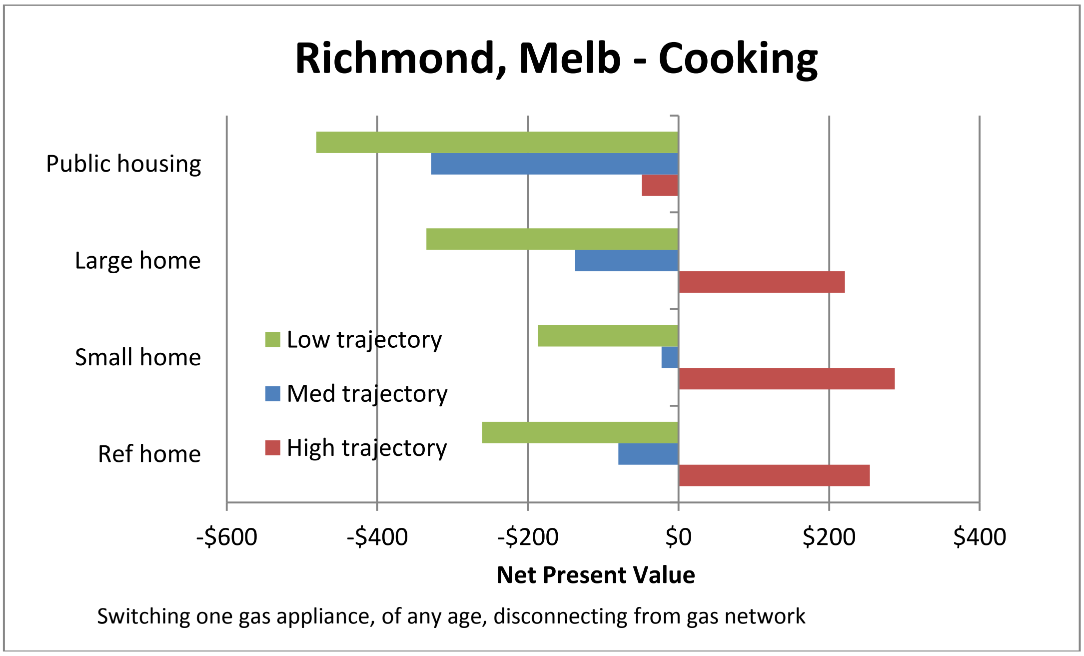
Figure 3-2: Sensitivity of NPV to Gas Price Forecasts, Richmond, Hot Water



In only a small number of gas zones and for a small number of household scenarios/replacement cases does the economic proposition for switching fuels change from negative to positive over 10 years on the basis of different gas price trajectories.

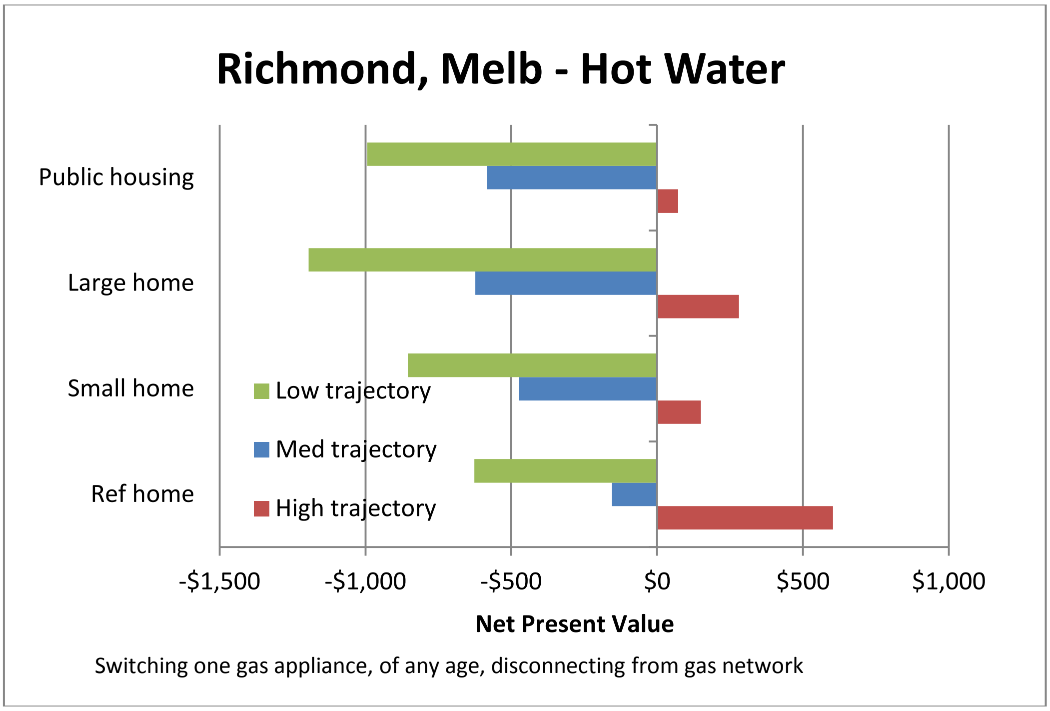
The first case was again in Richmond (Melbourne). Under a high price trajectory, it is economic for most household types to replace their gas cook top and oven with an efficient electric oven and induction cook top where it is the last gas appliance remaining. However under the medium price trajectory the economics are marginal at best; whilst under a low gas price trajectory, switching is uneconomic.

Figure 3-3: Sensitivity of NPV to Gas Price Forecasts, Richmond, Cooking



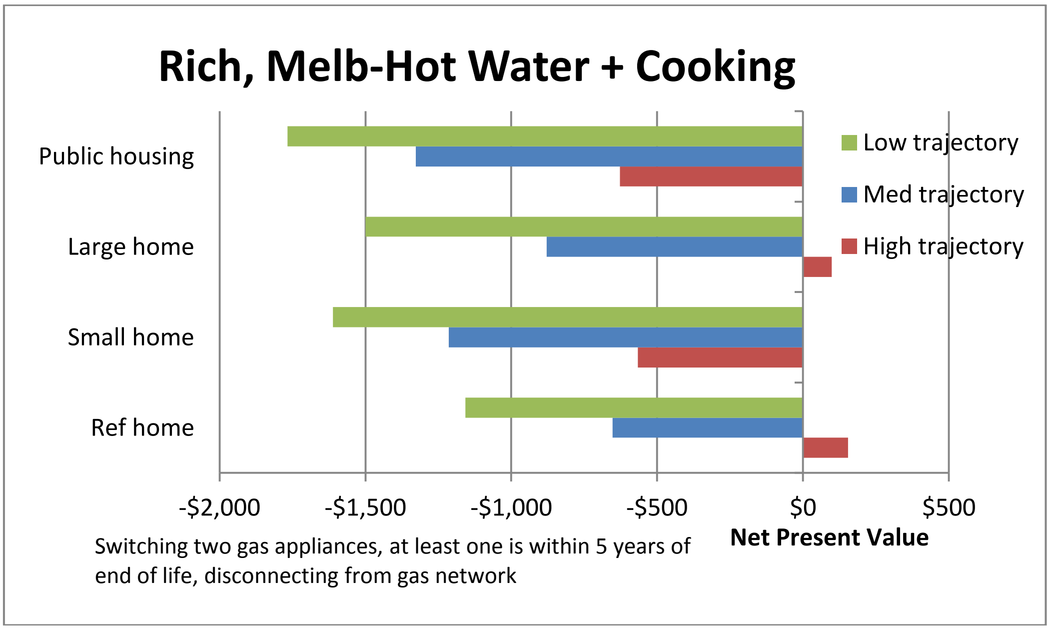
The second case involved hot water replacement (as the last appliance) in Richmond (Melbourne). As with cooking, under the high gas price trajectory switching is economic; whilst for the medium and low price trajectory it is not:

Figure 3-4: Sensitivity of NPV to Gas Price Forecasts, Richmond, Hot Water



Switching hot water and cooking together as the last two appliances on gas becomes economic under a high gas price trajectory; but remains uneconomic under both medium and low gas price trajectories:

Figure 3-5: Sensitivity of NPV to Gas Price Forecasts, Richmond, Hot Water + Cooking

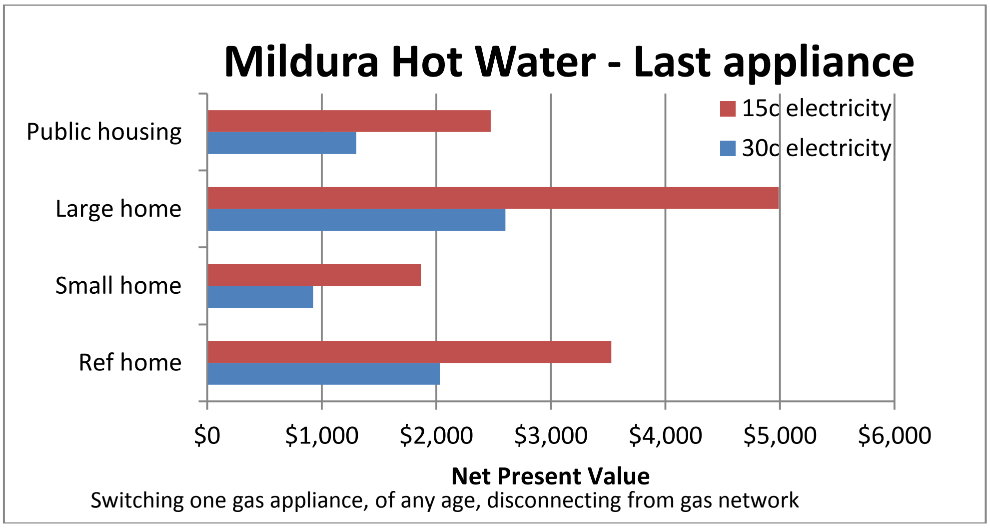


3.2 Sensitivity of Results to Availability of Off-Peak Tariffs

Some households (such as those in apartments) may not be able to install more efficient heat pump hot water systems. ATA analysed the sensitivity of using off-peak rates for electricity and/or electric resistance water heaters (on off-peak rates) to provide guidance for these consumers.

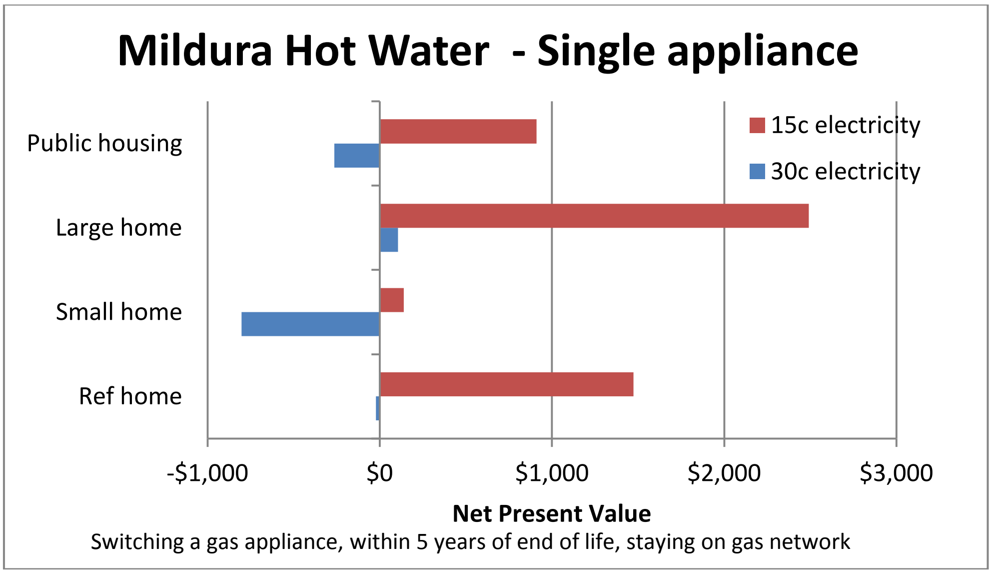
Currently, the availability of Time of Use, or 'flexible' pricing, with includes off peak rates, is limited: not all consumers can access these rates if they do not already, and a change of meter may be required to do so. The cost of a new meter has not specifically been considered. Where an economic case for switching already exists, the lower off-peak electricity rate makes the case even more compelling. An example of this is the case of an efficient electric hot water system in Mildura with disconnection from the gas network:

Figure 3-6: Sensitivity to availability of Off-Peak, Mildura, Hot Water, Last Appliance



Even without the avoided fixed costs of disconnecting from the gas network, switching to a heat pump hot water unit becomes economic in Mildura with 15c off-peak electricity if the household's current appliance is reaching end of life:

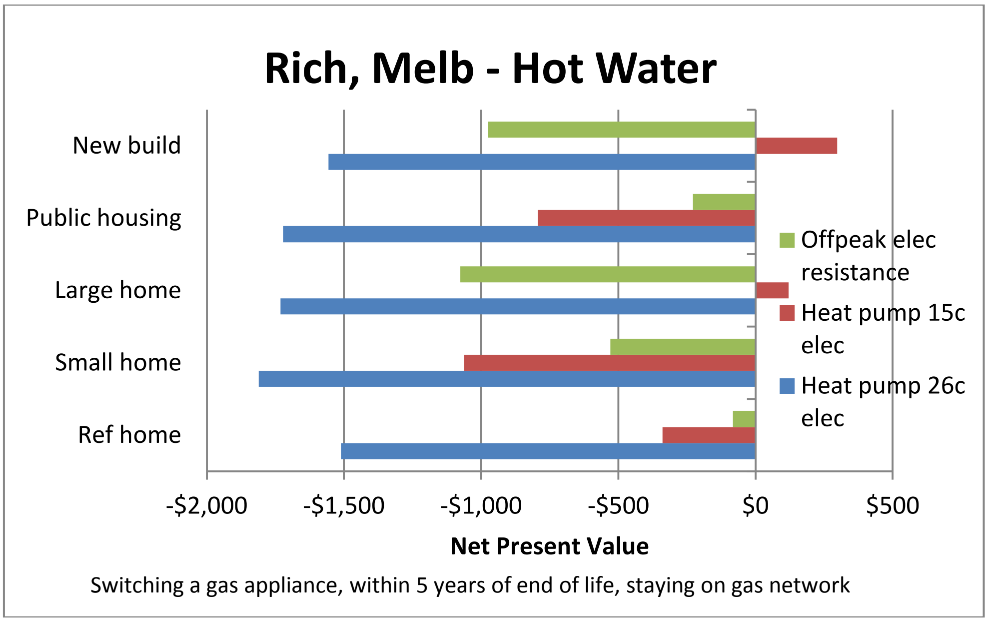
Figure 3-7: Sensitivity to availability of Off-Peak, Mildura, Hot Water, Single Appliance



Efficient electric hot water systems were largely found to be uneconomic in Richmond (Melbourne) when compared with efficient gas equivalent, however off-peak rates changes this finding for some households.

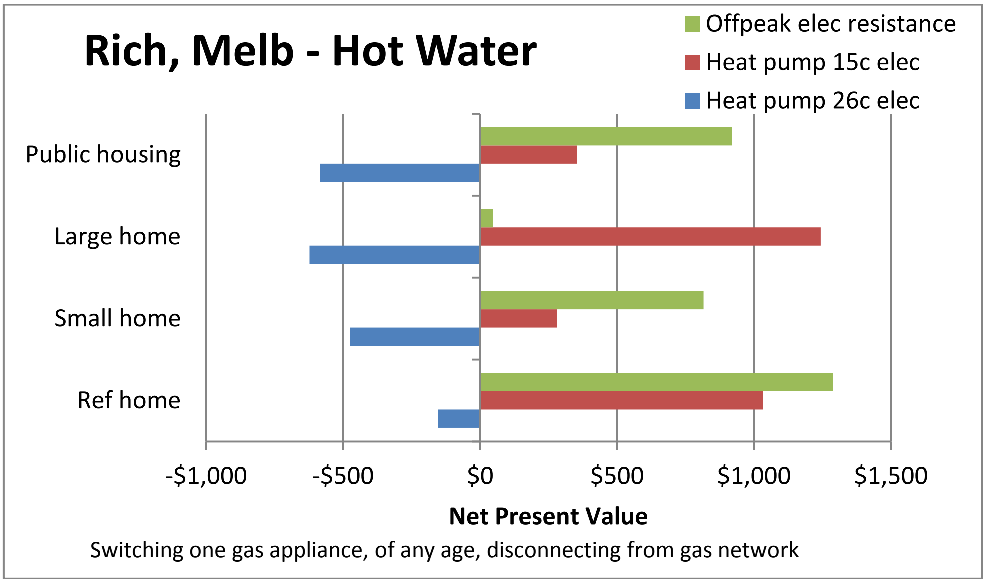
While staying connected to the gas network, efficient electric hot water systems are the economic option for households with larger loads with existing hot water systems approaching end of asset-life, if off-peak electricity rates can be accessed (assuming 15c/kWh):

Figure 3-8: Sensitivity to availability of Off-Peak, Richmond, Hot Water, Single Appliance



With disconnection from, or avoided connection to, the gas network, off-peak rates make a material difference, to the cost of operating a heat pump hot water system or even electric resistance hot water system (assuming CAPEX of $1,500 fully installed):

Figure 3-9: Sensitivity to availability of Off-Peak, Richmond, Hot Water, Last Appliance



3.3 Sensitivity to Gas Appliance Replacement Need

With reference to Replacement Case no. 6: *"All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex"*; the number of gas appliances approaching the end of their asset life did make a significant difference to these economic results across most zones.

The tabulated results for Replacement Case no. 6 assume that only one existing gas appliance is within five years of the end of its asset life; and yet all three gas appliances are switched to efficient electric. As such, only one gas appliance capex (assumed to be about $2,000) is avoided by the switch to electric.

Many of the results for Household Scenarios 1-3 and 6; for this replacement case; and across many gas zones; are close to negative $2,000 over 10 years.

If an individual household is in the situation of having a second gas appliance also within five years of the end of its asset life, it can reasonably be assumed that an additional $2,000 of gas appliance capex will be avoided by the switch to electric.

Under these circumstances, a total avoided gas capex of $4,000 would make many otherwise uneconomic investments in switching (particularly for Household Scenarios 1-3 and 6) economic – i.e. offering a positive NPV within or near 10 years.

An example of this is outlined below for one Victorian zone:

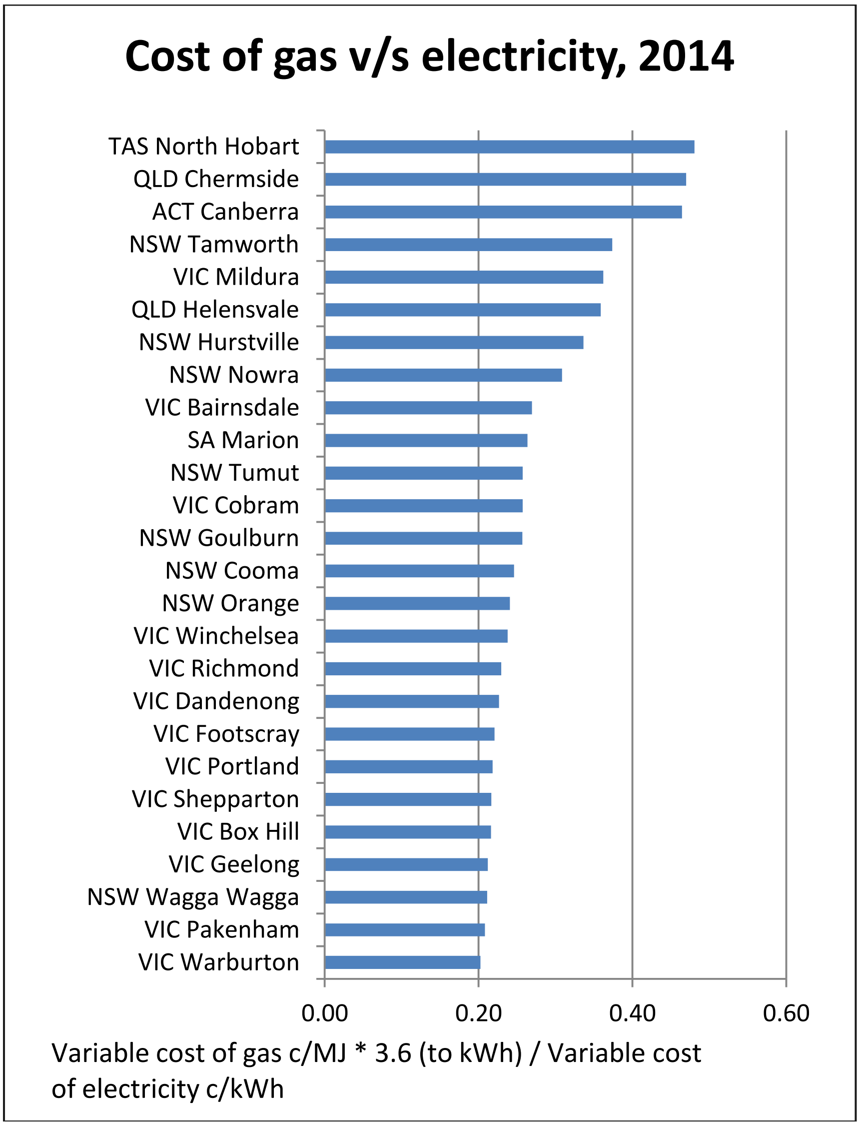
Table 3-3: Results Table – Winchelsea (Vic) Gas Zone

Gas Zone: SP Ausnet Adjoining West			**Electricity Zone: Powercor**			
Example Location: Winchelsea, 3241, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$1,540	-$1,696	-$1,367	-$4,263	$5,204	-$2,657
All gas appliances switched: two are within 5 years of end of asset life, avoiding $4,000 replacement capex.						
All Heating & Cooking	$460	$304	$633	-$2,263	$7,204	-$657

3.4 Relative Cost of Gas v Electricity

ATA found that the relative cost of gas versus electricity in each gas pricing zone was also important to the overall economics of the case for switching to/remaining on mains gas:

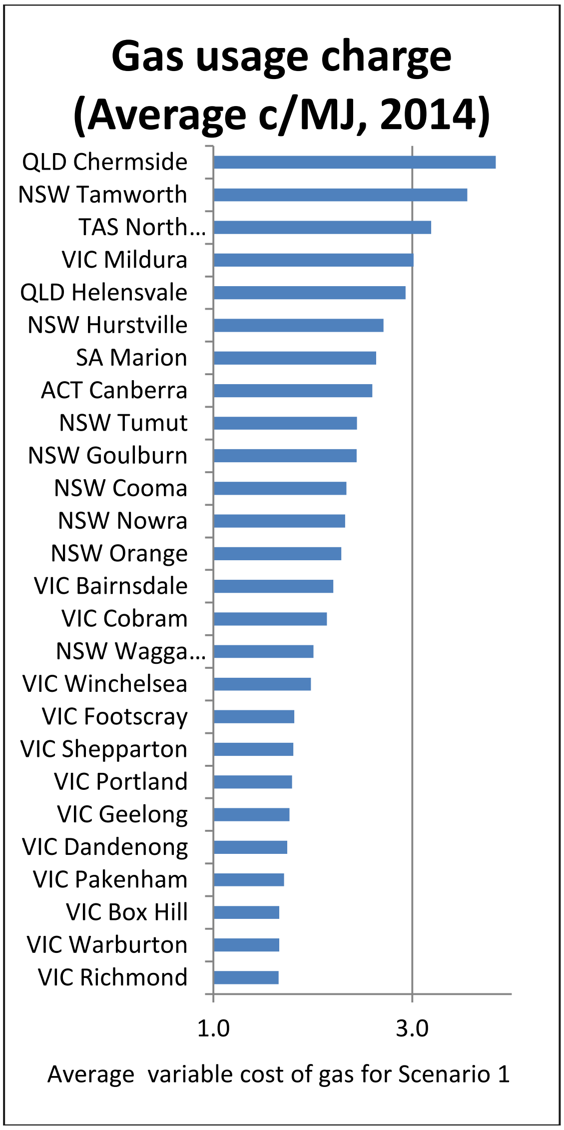
Figure 3-10: Relative Usage Cost of Gas v Electricity in each Gas Pricing Zone

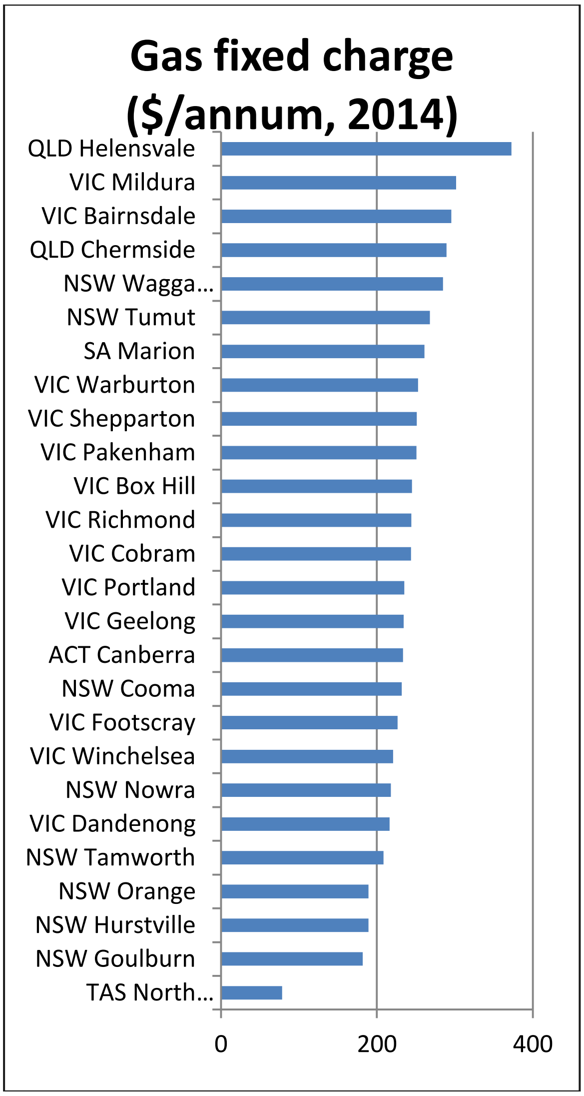


In the majority of Victorian gas zones, where switching was often uneconomic, gas costs approximately 1/5th to 1/4th the price of electricity on an equivalent energy basis. In parts of NSW and QLD however, where a significant number of economic switching cases were found, gas can be up to almost half the cost of electricity.

ATA also found a large relative difference between gas usage charges across the NEM; with little variation between gas fixed charges in most areas:

Figure 3-11: Gas Usage & Gas Fixed Charges across the NEM





4.0 Findings

4.1 New Homes & Existing All-Electric Homes

Whether newly built or existing all-electric homes should connect to the gas network and install any number of gas appliances for economic reasons is dependent on one main factor:

Whether the household is able to install efficient electric appliances:
Installing new gas appliances and connections can no longer compete with installing efficient electric alternatives in any case.

However, the ratio of gas prices to electricity prices is unlikely to grow high enough to make inefficient electric appliances (resistance based electric water heating, non-RCAC electric space heating) competitive with gas.

The exception to this is electric resistance water heaters used in the off-peak period, which, where competitively priced off-peak electricity is available, is competitive with gas in some cases today.

A second factor may apply to a limited number of consumers:

Whether the cost of gas appliances is heavily subsidised:
Some gas businesses may offer a substantial subsidy for homes to connect to the gas network.

Where *all* of the cost of connecting gas to the home and *most* of the cost of purchasing and installing new gas appliances is not borne directly by the householder, a new gas connection may be a more cost effective alternative to efficient electric appliances.

1. It is not cost effective to connect a new home to mains gas when efficient electric appliances are an option.

Connecting a new home to mains gas and installing any number of gas appliances is more costly in the long term than installing efficient electric appliances for space heating, water heating and cooking. This is the case in all National Energy Market states and territories[3].

This finding applies to most homes, with the exception being some in high density developments, as the limiting factor for efficient electric appliances in new homes is the capacity for external compressors to be installed for space and water heating.

2. Connecting a new home to mains gas is cost effective when efficient electric appliances are not an option.

Connecting a new home to mains gas and installing gas appliances is still less costly in the long term than installing inefficient electric appliances for space heating, water heating and cooking. This is the case in all National Energy Market states and territories.

[3] Victoria, NSW, ACT, Queensland, SA and Tasmania.

This finding applies to many homes in high density developments and some others where external compressors cannot be installed for space or water heating. The exception to this finding - homes where, in most locations, connecting to the gas network is not a cost effective option in any case - is homes that:

- have little or no space heating requirements; and
- have access to competitively priced off-peak electricity for water heating; and
- are able to install electric induction cook tops.

Homes should always be assessed on a case-by-case basis before installing gas and any benefit can be negated by gas not being available 'in the street', or the up-front cost of connecting to the gas mains being excessive.

3. It is not cost effective to connect an existing all-electric home to mains gas when efficient electric appliances are an option.

Connecting an existing home to mains gas and installing any number of gas appliances is more costly in the long term than installing efficient electric appliances for space heating, water heating and cooking. This is the case in all National Energy Market states and territories.
This finding applies to homes in low and medium density areas, and some in high density area, where external compressors can be installed for space and water heating.

Homes should always be assessed on a case-by-case basis before installing efficient electric appliances to determine if major rewiring that is required.

4. Connecting an existing all-electric home to mains gas is cost effective when efficient electric appliances are not options.

Connecting an existing home to mains gas is less costly in the long term than using electric appliances for space heating, water heating and cooking when efficient electric appliances cannot be installed cost effectively. Reasons for this may include:

- the cost of electrical work for new efficient electric appliances is excessive due extensive rewiring in older homes;
- external compressors cannot be installed for space heating with split systems; and/or
- external tanks or compressors cannot be installed for hot water.

In the situations where restrictions on external units are a limiting factor, gas ducted or hydroponic heating is also unlikely to be suitable either due to the requirement for an external heating unit, limiting the gas space heating option to wall mounted gas heaters.

Homes should always be assessed on a case-by-case basis before installing gas as any benefit can be negated by:

- gas not being available 'in the street', or the up-front cost of connecting to the gas mains being excessive;
- the cost of installing gas pipes and fittings in the home being excessive due to unfavourable access for plumbing or unsuitable housing design; or
- the installation of new gas appliances being complicated.

5. Connecting an existing all-electric home to mains gas may be more cost effective when the cost of new appliances is heavily subsidised.

Connecting an existing home to mains gas is may be less costly in the long term than using efficient electric appliances for space heating, water heating and cooking, where a substantial subsidy is offered to connect to the gas network, such that:

- the costs of connecting gas to the property; and
- some or all of the cost of reticulating gas throughout the home;

are not borne directly by the householder.

For example, if the distribution business does not charge for connecting gas to the premises and heavily subsidises the installation of new gas appliances (as may be the case in some Victorian gas extension zones), gas is likely to be the more cost effective option.

Homes should always be assessed on a case-by-case basis.

4.2 Existing Dual Fuel Homes

Whether dual-fuel homes should replace some or all of their appliances with efficient electric appliances for economic reasons is dependent on multiple factors.

The main determinants are:

The age or condition of the existing gas appliance:
Where an appliance is due for replacement immediately or in the next few years, replacing it with one appliance effectively avoids the capital expense of the other. In this case, the real capital cost to the consumer is the difference between the two. However where an existing appliance is in good working order and unlikely to fail in coming years, the full capital cost of the replacement is the real cost to the consumer.

Whether the replacement allows the customer to disconnect from the gas network:
In the case of mains supplied gas (as distinct from bottled gas) where there is only one gas appliance, replacing it with an electric appliance allows consumers to avoid the fixed charges associated with being connected to the gas network. In many cases this represents a further saving of around $200 per year.

Whether the household is able to install efficient electric appliances:
While RCAC space heating is - and heat pump water heating is becoming - competitive with gas equivalents, the ratio of gas prices to electricity prices is unlikely to grow high enough to make inefficient electric appliances (resistance based electric water heating and non-RCAC electric space heating) competitive with gas.

The exception to this is electric resistance water heaters used in the off-peak period, which, where competitively priced off-peak electricity is available, is competitive with gas in some cases today.

Whether the existing gas supply is mains or bottled gas:
Bottled gas is more expensive on a unit basis than mains gas, however for consumers with low gas requirements (for example, cooking only), the absence of fixed charges may negate this higher cost.

The marginal cost of gas on a declining block tariff

Most dual fuel households are on a declining block tariff for gas, meaning that higher consumption attracts a lower unit price (c/MJ). The marginal price of gas is therefore higher for homes that use less gas, and lower for homes that use more. As such, the economic case for replacing any one gas appliance is affected by the total energy consumption of all gas appliances in the home (including that to be replaced).

As a result, a consumer that uses more gas (for example, because they have three gas appliances) may save less from a single appliance replacement than a home that uses less gas (for example, with two gas appliances).

Climate

In warmer locations, less space heating is required, and some of the capital costs of RCAC are attributable to cooling requirements. In cold climates, RCAC and heat pump hot water systems do not run as efficiently as in warmer climates.

Ratio of gas to electricity price

In some locations, on an equivalent unit basis, the price of gas is 20-25% that of electricity. In these locations, gas remains competitive for some appliances. In other locations, gas ranges from 30-50% the price of electricity, and in these locations electrical appliances are economically more competitive.

6. It is significantly more cost effective to replace gas heaters with multiple reverse cycle air conditioners (RCACs) for space heating, in any case.

In each of the 26 gas zones modelled, ATA found positive NPVs over 10 years for switching space heating from gas to RCAC, where the existing gas heater is within five years of end of asset life. Some of these zones achieved less than five year payback.

In some zones (particularly in warmer climates), switching space heating from gas to RCAC achieved positive economic returns regardless of the age and condition of the gas heater.

Switching space heating and cooking as the middle and last appliance; or space heating on its own as the last appliance; and disconnecting from the gas network altogether, was also economic in the majority of gas zones and for the majority of Household Scenarios.

7. In warmer climate regions (including SA, QLD and some parts of NSW) switching all gas appliances to efficient electric and disconnecting offers better economic returns than in cooler climates.

This is primarily due to:

- better performance and lower heating requirements for efficient electric space and water heating appliances in warmer areas; and
- gas prices being relatively higher in warmer locations.

8. Heat pump hot water systems are more cost effective than gas hot water systems where the relative price of gas as compared with electricity is higher and/or where the climate is relatively warmer. Gas hot water systems remain more cost effective in most other locations.

Heat pumps use significantly less energy input to heat water, however where gas is cheap (e.g. in some parts of metropolitan and southern Victoria), the running costs in terms of utility bills are about the same. The higher capital cost associated with an efficient electric unit, as compared with gas hot water, favours gas water heating in these locations.

Efficient electric water heaters become an economic proposition in these areas if gas prices rise according to the high trajectory or if off-peak electricity is available.

9. Switching from gas to induction cook tops and electric ovens is cost effective when avoiding high fixed service to property charge.

10. Existing Gas cook tops and ovens are more cost effective than efficient electric when the fixed charge is lower or not being avoided.

Given its relatively small proportional energy use (as compared with space and water heating), capital costs associated with switching cooking from gas to efficient electric take longer to recover in energy savings.

However, where disconnecting a gas cook top and oven avoids paying fixed charges of over approximately $250 to access the gas network, replacing a gas cook top with electric induction is more cost effective. Where the fixed charge is below approximately $200, and the gas appliance does not need to be replaced, staying on gas is generally the more cost effective option.

11. Customers in new gas zones pay more for gas.

Of particular relevance to Victoria, is the finding that new gas customers located in areas that have only recently been connected to the gas network, pay higher tariffs.

In its 2013 report ‘Energy Retailers Comparative Performance Report - Pricing 2012-13’, the Victorian Essential Services Commission stated[4]:

> *“customers in newer gas distribution zones (for example, Envestra Mildura) paid notably more for gas than did customers in established areas.”*

This statement is consistent with the findings from the pricing analysis completed as part of this study.

4.3 Consumer Purchasing Behaviour

In order to better understand consumer purchasing behaviour, ATA conducted a brief survey of its members as part of this research project.

The survey posed the question:

> *“Have you disconnected from gas or replaced any of your gas appliances with efficient electric ones?”*

One in six respondents (16.5% of a sample of 151) answered in the affirmative.

[4] http://www.esc.vic.gov.au/getattachment/ca236fe9-c780-473e-9df2-0445e25c22c7/ddd.pdf - Page 83

Notably, respondents' fuel switching decisions have been made in the absence of any broader messaging to the effect that gas may be less cost effective: for the most part, these consumers have arrived at the decision through their own investigations and preferences.

Compared to the average or typical energy consumer, ATA members are generally more energy literate and engaged in the issues surrounding energy efficiency and pricing. Observed changes in behaviour among more energy literate consumers can be a useful predictor of future trends in the mass market.

ATA believe there are some key elements of this demographic in interpreting the relevance of these survey results to the mass market:

- These consumers are generally more financially and energy literate than the average: 40% estimate they save more than $100 per month per month through energy efficiency measures; whilst 38% of respondents estimate they save $50-100;
- Over 90% of survey respondents own their own home. This reflects an older and less urban demographic than average and is important to consider in the context of limitations to energy efficient choices available to those:
    - in rental and government housing; and/or
    - without ready access to capital;
- 'Financial considerations' were considered important or very important for 89% of respondents. This reflects that the majority of ATA members are actually of below average income, and support sustainability in the sense of maintaining a sustainable economy, society and environment. 'Environmental considerations' were 'very important' to 90% of respondents.

Should efficient electric appliances prove to perform better than gas, it is reasonable to assume that the change in behaviour observed across this group is representative of:

- the best long term outcomes for many consumers;
- future trends that can be expected in the mass market.

5.0 Recommendations

ATA's recommendations draw on the findings of this report as well as the broader context of developments in the National Energy Market in Australia.

In ATA's view, the single most urgent need is to mitigate the impacts of gas price rises on vulnerable and disadvantaged consumers. Recent increases to electricity prices have contributed to unprecedented levels of energy poverty in Australia.

Other priorities include improving consumer information regarding the economics of gas and electric appliances; bringing government energy and housing policy generally in line with the new economics of gas and electricity supply to homes; curtailing false and misleading marketing claims regarding gas appliances; and improving access to efficient appliances.

1. Improve energy concessions to address the cost of living impact of expected gas price increases on vulnerable and disadvantaged consumers.

The consumers facing the greatest cost of living impacts from gas price increases, and those least able to avoid those impacts, include:

- low income households in general;
- the unemployed;
- the aged, particularly pensioners with little or no superannuation;
- consumers with physical disability and/or medical needs; and
- other consumers who lack access to capital.

There is little or no consistency between states for energy concessions and in some states there are no concessions available for some disadvantaged consumers. Overall, there has been less focus on gas concessions compared to electricity – in part because gas use is less common, but also because gas has historically been a cheaper alternative.

Based on the findings of this report, ATA recommends that:

- nationally consistent energy concessions should be available for
  - low income households;
  - the unemployed;
  - the aged, particularly pensioners with little or no superannuation; and
  - consumers with physical disability and/or medical needs.
- energy concessions should be designed to provide further protection to consumers exposed to higher costs, rather than being a fixed amount or capped at a low level of consumption; and
- energy concessions should be consistent across all fuel types – this includes electricity, mains gas and bottled gas.

ATA and other consumer organisations have recently called on COAG and the AEMC to undertake a national review of concession frameworks. When such a review is undertaken, ATA suggest that it these recommendations be considered.

2. Examine potential to control gas prices for vulnerable and disadvantaged consumers.

Gas reservation policies and special tariffs are not favoured by some stakeholders and as a result there has been little or no genuine attempt by governments in the NEM to consider ways of managing the impacts of gas price increases on vulnerable and disadvantaged consumers through price controls.

There are a number of tools at the disposal of governments and businesses to effect price that can manage the impact of rising gas prices, and ATA recommend that these are investigated as part of a national review of concession frameworks noted above.

3. Provide better information for consumers regarding the cost of owning and operating gas and electric appliances.

The major finding of this study is that gas is no longer the cheapest fuel source for some residential activities in most locations.

As such, consumers need to be better informed of the real cost of purchasing and operating both gas and electric appliances in order that they can confidently make better decisions regarding those appliance choices that are in their long term interest.

The role of governments and industry here is to assist in the provision of accurate, targeted information and advice, that is easy to understand, and that assists consumers in making these choices over the medium to longer term.

4. Strengthen the regulatory oversight of the marketing of gas as cheaper and more efficient than electricity.

Questionable, and in some cases deceptive, claims about the affordability of gas are not limited to gas appliance sellers.

Through the process of research and analysis for this project, ATA has become aware of a prevalence of false, misleading and/or confusing statements, in particular proffered by some gas network and retail businesses, regarding the cost effectiveness of gas compared to electricity.

Examples of such statements found on just one gas business website include the following unqualified statements:

> *"Natural gas is far more cost effective and energy efficient than electricity when it comes to heating"*
>
> *"[Gas ducted heating] is a far more efficient and less obtrusive way to heat multiple rooms compared to operating several portable or wall-fixed heaters."*
>
> *"Natural gas is, in most states, far less expensive than electricity. The initial cost involved in buying a gas heater may be higher but the lower running costs will save you money in the long term."*
>
> *"Far more efficient than electric heating systems, Natural Gas solutions can save you money and provide a comfortable temperature more quickly"*
>
> [On gas being cheaper than electricity:] *"And those savings might only increase - experts have forecast that electricity rates will rise further as green taxes are levied on it."*
>
> *"These calculations are based on an average rate of 3¢ per MJ for the portable gas heater and, due to the larger consumption of ducted systems, 2¢ per MJ for the ducted gas heating. Compare that to an*

> *average cost of 30¢ per kWh for electricity and you can see that running a gas heater is far more cost effective"*
>
> *"Warning: You're losing money by not using a gas oven."*

ATA recommend that the ACCC and/or relevant jurisdictional departments of consumer affairs dedicate focus and resources to monitoring relevant marketing material in this area.

5. An urgent review of policy and programs that subsidise/support the expansion of gas networks is required.

In particular, the Victorian Government's $100M *Energy for the Regions* program has been established to roll out gas networks to regional areas and improve energy options to benefit regional consumers. While this program is likely to benefit some larger (non-residential) energy users, any future investment under this program is likely to lock small to medium consumers into higher energy costs and as such, fails to achieve the National Gas Objective, which states:

> *"promote efficient investment in, and efficient operation and use of natural gas services for the long term interest of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas."*

The current Victorian Government program fails this objective on at least two important counts:

- The infrastructure delivered under the program could not by any credible measure be considered an 'efficient investment'.

  In a number of towns reached by the program, each individual home to be connected is subsidised by taxpayers something in the order of $10,000 to bring the gas to the street or meter. This is in addition to many thousands of dollars per connection contributed by the gas network business to further incentivise both gas connection and gas appliance uptake. This gas network business incentive is ultimately a cost passed on to other gas consumers with an effective rate of interest of approximately 9%.

  Further costs to the householder and small business includes the cost of pipes, fittings and appliances, which can represent thousands of dollars per customer.

- For the above reasons, the program is clearly no longer in the 'long term interests of consumers', with particular reference to price.

  New consumers connecting to gas will not be served with the most cost effective energy supply and existing consumers will experience higher bills as they subsidise new connections. As noted above, once the new assets are built, the cost to finance and maintain them is recovered from all consumers.

6. Replace gas network expansion policies with programs that directly address energy affordability in regional areas.

The potential benefits achieved for households and other small to medium sized consumers by expanding gas networks to regional towns can be achieved by subsidising efficient electric appliances and basic building efficiency improvements, while saving taxpayers and consumers tens of millions of dollars.

Programs such as Victoria's *Energy for the Regions* could be replaced with a technology-agnostic energy efficiency and affordability program targeting regional areas. Noting that homes in regional areas and towns tend not to be high density, they do not experience restrictions to external compressor units for heating, being technology agnostic would naturally favour the installation of efficient electric technology, but still allow for efficient (e.g. five star) gas appliances wherever these are better suited.

The introduction of more cost reflective electricity pricing may impact consumers in regional areas due to the much higher costs to serve these consumers and subsidised efficient electric appliances would help manage those impacts.

The $10,000+ of tax-payer funds being spent on each connected home under the *Energy for the Regions* program could fund the fully installed cost of:

- multiple high-efficiency split system RCACs, along with some basic building efficiency improvements such as insulation or draft sealing; or
- a heat pump hot water system and induction cook top; along with some basic building efficiency improvements such as insulation or draft sealing.

In both the short and long term each householder, other energy consumers and all taxpayers would all be better off under such a program.

7. Require gas network businesses to forecast disconnection of existing gas customers and analyse their competitive position against electricity.

A plausible 10% shortfall in gas use below that forecast for the residential sector in the next five years could add similar percentage to the network charges for remaining household gas consumers, following a similar trend to what we have already seen in the electricity sector in recent years.

Yet gas network businesses are forecasting growth in the number of connections and demand on their networks over the same time. ATA recommends to COAG Energy Council and the AER to require gas network businesses to forecast disconnection of existing gas customers and analyse their competitive position against electricity. It may be appropriate to propose to the AEMC a change to the Rules to that effect.

8. Bring Public Housing energy policy in line with cost effective energy opportunities.

Currently there are two Victorian Department Human Services (DHS) policies that actively prevent public housing tenants from accessing the most cost effective energy sources:

- The use of efficient RCACs is effectively banned, except for tenants that require cooling for medical reasons. If a public housing tenant installs a RCAC system at their own expense, they are required to remove it and reinstate the site at the end of the tenancy.
- Gas is by default connected t all DHS homes for space and water heating, where it is available 'in the street'.

Noting the findings of this report, most consumers in public housing would be better able to afford to run efficient electric appliances than gas and in some cases, electric appliances are also cheaper up front.

ATA recommends that DHS revise the above policies accordingly.

9. Provide support to landlords, and disadvantaged owner occupiers, to replace less efficient and expensive-to-run appliances with more efficient appliances.

Assistance measures - such as and low/no interest loans, rebates, energy efficiency schemes - should be provided to disadvantaged consumers, taking into account the findings of this report with respect to distributional impacts.

These policies should be technology agnostic and designed in a way that achieves the reduction of the capital cost for the most cost effective technologies for those consumers who face the strongest capital cost barriers.

Considering that the Victorian Government has in the past year removed both the Winter Warmers grant for low income households and is determined to close the Victorian Energy Efficiency Target, much opportunity exists to support energy affordability for disadvantaged and vulnerable consumers.

6.0 Appendix A: Results Tables by Gas Zone

6.1 South Western Victoria

Gas Zone: SP AusNet West				**Electricity Zone: Jemena**		
Example Location: Portland, 3305, VIC				**Climate Zone: Heating Dominated**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,403	$1,109	$2,198	-$2	$2,771	$1,944
Hot Water	-$1,626	-$1,964	-$1,974	-$1,729	$2,550	-$1,728
Cooking	-$360	-$217	-$529	-$273	n/a	-$526
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,397	-$1,091	-$1,202	-$3,002	$1,271	n/a
Hot Water	-$3,126	-$3,164	-$3,774	-$2,929	$1,350	n/a
Cooking	-$2,160	-$2,017	-$2,329	-$2,073	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$811	$901	$1,335	-$1,340	n/a	n/a
Hot Water	-$946	-$1,176	-$1,279	-$1,262	n/a	n/a
Cooking	-$285	-$162	-$408	-$504	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,482	$1,095	$2,483	-$397	n/a	n/a
Hot Water+ Cooking	-$1,575	-$1,982	-$1,731	-$2,120	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,947	$2,796	$5,030	$1,178	$7,766	$4,130
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,472	-$2,273	-$2,738	-$4,691	$5,266	-$3,517

** Assumes full CAPEX on both electric and gas sides.*

6.2 Melbourne

Gas Zone: Envestra Central 2			Electricity Zone: CitiPower			
Example Location: Richmond, 3121, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$628	$514	$1,507	-$343	$2,925	$1,395
Hot Water	-$1,511	-$1,810	-$1,731	-$1,691	$2,904	-$1,556
Cooking	-$335	-$199	-$460	-$268	n/a	-$460
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$2,172	-$1,686	-$1,893	-$3,343	$1,111	n/a
Hot Water	-$3,011	-$3,010	-$3,531	-$2,891	$1,296	n/a
Cooking	-$2,135	-$1,999	-$2,260	-$2,068	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$622	$872	$981	-$1,136	n/a	n/a
Hot Water	-$155	-$475	-$623	-$579	n/a	n/a
Cooking	-$80	-$22	-$137	-$324	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,424	$1,132	$2,326	-$79	n/a	n/a
Hot Water+ Cooking	-$652	-$1,215	-$878	-$1,323	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,959	$2,958	$4,994	$1,494	$8,273	$4,276
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,461	-$2,112	-$2,776	-$4,376	$5,773	-$3,413

** Assumes full CAPEX on both electric and gas sides.*

6.3 Western Melbourne

Gas Zone: SP AusNet Central 2				Electricity Zone: Jemena		
Example Location: Footscray, 3011, VIC				**Climate Zone: Heating Dominated**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,390	$1,144	$2,171	$3	$2,771	$1,897
Hot Water	-$1,595	-$1,961	-$1,900	-$1,735	$2,550	-$1,687
Cooking	-$357	-$216	-$518	-$272	n/a	-$515
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,410	-$1,056	-$1,229	-$2,997	$970	n/a
Hot Water	-$3,095	-$3,161	-$3,700	-$2,935	$969	n/a
Cooking	-$2,157	-$2,016	-$2,318	-$2,072	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$846	$964	$1,365	-$1,269	n/a	n/a
Hot Water	-$876	-$1,151	-$1,149	-$1,198	n/a	n/a
Cooking	-$341	-$224	-$458	-$551	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,529	$1,165	$2,531	-$315	n/a	n/a
Hot Water+ Cooking	-$1,493	-$1,951	-$1,584	-$2,044	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$4,016	$2,862	$5,141	$1,249	$7,766	$4,222
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,403	-$2,206	-$2,628	-$4,620	$5,266	-$3,425

** Assumes full CAPEX on both electric and gas sides.*

6.4 Geelong

Gas Zone: SP AusNet Central 1 and SP AusNet Adjoining Central			Electricity Zone: Powercor			
Example Location: Geelong, 3220, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$871	$1,046	$1,063	-$64	$2,752	$1,457
Hot Water	-$1,756	-$2,014	-$2,263	-$1,748	$2,507	-$1,930
Cooking	-$374	-$223	-$567	-$279	n/a	-$563
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,929	-$1,154	-$2,337	-$3,064	$952	n/a
Hot Water	-$3,256	-$3,214	-$4,063	-$2,948	$929	n/a
Cooking	-$2,174	-$2,023	-$2,367	-$2,079	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$705	$1,076	$896	-$1,155	n/a	n/a
Hot Water	-$684	-$999	-$906	-$1,026	n/a	n/a
Cooking	-$271	-$158	-$383	-$490	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,397	$1,281	$2,075	-$192	n/a	n/a
Hot Water+ Cooking	-$1,292	-$1,795	-$1,327	-$1,863	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,698	$2,920	$4,281	$1,348	$7,704	$4,030
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,721	-$2,149	-$3,488	-$4,521	$5,204	-$3,618

** Assumes full CAPEX on both electric and gas sides.*

6.5 Southern Melbourne

Gas Zone: Envestra Central 1				Electricity Zone: SP AusNet		
Example Location: Pakenham, 3810, VIC				**Climate Zone: Heating Dominated**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$718	$523	$1,707	-$380	$2,772	$1,539
Hot Water	-$1,761	-$2,018	-$2,100	-$1,926	$2,552	-$1,968
Cooking	-$387	-$229	-$539	-$310	n/a	-$539
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$2,082	-$1,677	-$1,693	-$3,380	$970	n/a
Hot Water	-$3,261	-$3,218	-$3,900	-$3,126	$971	n/a
Cooking	-$2,187	-$2,029	-$2,339	-$2,110	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$581	$836	$1,015	-$1,249	n/a	n/a
Hot Water	-$555	-$706	-$1,161	-$904	n/a	n/a
Cooking	-$92	-$2	-$182	-$333	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,318	$1,064	$2,263	-$245	n/a	n/a
Hot Water+ Cooking	-$1,117	-$1,479	-$1,514	-$1,701	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,597	$2,685	$4,577	$1,543	$8,219	$4,253
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,824	-$2,386	-$3,193	-$4,777	$5,269	-$3,886

** Assumes full CAPEX on both electric and gas sides.*

6.6 Eastern Inner Melbourne

Gas Zone: Multinet Main 1			**Electricity Zone: United Energy**			
Example Location: Box Hill, 3128, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$457	$773	$595	-$200	$2,851	$1,155
Hot Water	-$1,741	-$1,958	-$2,169	-$1,731	$2,734	-$1,851
Cooking	-$357	-$210	-$525	-$276	n/a	-$521
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$2,343	-$1,427	-$2,805	-$3,200	$1,043	n/a
Hot Water	-$3,241	-$3,158	-$3,969	-$2,931	$1,139	n/a
Cooking	-$2,157	-$2,010	-$2,325	-$2,076	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$603	$1,070	$633	-$1,043	n/a	n/a
Hot Water	-$323	-$686	-$586	-$724	n/a	n/a
Cooking	-$122	-$37	-$208	-$362	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,350	$1,302	$1,894	-$34	n/a	n/a
Hot Water+ Cooking	-$877	-$1,454	-$924	-$1,515	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,644	$2,981	$4,144	$1,961	$8,480	$4,374
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,769	-$2,081	-$3,618	-$4,351	$5,530	-$3,583

** Assumes full CAPEX on both electric and gas sides.*

6.7 South Eastern Melbourne

Gas Zone: Multinet Main 2			Electricity Zone: United Energy			
Example Location: Dandenong, 3175, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$892	$920	$1,398	-$117	$2,851	$1,470
Hot Water	-$1,549	-$1,883	-$1,852	-$1,650	$2,734	-$1,608
Cooking	-$338	-$204	-$493	-$264	n/a	-$492
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,908	-$1,280	-$2,002	-$3,117	$1,043	n/a
Hot Water	-$3,049	-$3,083	-$3,652	-$2,850	$1,139	n/a
Cooking	-$2,138	-$2,004	-$2,293	-$2,064	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$648	$935	$943	-$1,197	n/a	n/a
Hot Water	-$515	-$892	-$747	-$886	n/a	n/a
Cooking	-$353	-$269	-$436	-$558	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,399	$1,169	$2,210	-$185	n/a	n/a
Hot Water+ Cooking	-$1,065	-$1,658	-$1,079	-$1,674	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,895	$2,924	$4,798	$1,889	$8,480	$4,540
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,518	-$2,139	-$2,964	-$4,424	$5,530	-$3,416

** Assumes full CAPEX on both electric and gas sides.*

6.8 Northern Victoria

Gas Zone: Envestra North			Electricity Zone: Powercor			
Example Location: Shepparton, 3630, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,407	$928	$2,866	-$324	$3,151	$3,619
Hot Water	-$1,840	-$2,155	-$2,166	-$2,042	$1,820	-$2,056
Cooking	-$370	-$223	-$517	-$292	n/a	-$517
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,393	-$1,272	-$534	-$3,324	$1,319	n/a
Hot Water	-$3,340	-$3,355	-$3,966	-$3,242	$291	n/a
Cooking	-$2,170	-$2,023	-$2,317	-$2,092	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$1,136	$1,099	$2,011	-$1,291	n/a	n/a
Hot Water	-$787	-$993	-$1,398	-$1,152	n/a	n/a
Cooking	-$106	-$7	-$204	-$350	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,857	$1,318	$3,233	-$302	n/a	n/a
Hot Water+ Cooking	-$1,367	-$1,774	-$1,776	-$1,963	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$4,076	$2,807	$5,521	$1,387	$7,866	$6,151
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,345	-$2,263	-$2,250	-$4,934	$4,916	-$1,987

** Assumes full CAPEX on both electric and gas sides.*

6.9 Eastern Outer Melbourne

Gas Zone: Multinet Yarra Valley			**Electricity Zone: SP AusNet**			
Example Location: Warburton, 3799, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$227	$890	-$91	-$311	$3,177	$1,718
Hot Water	-$1,926	-$2,009	-$2,624	-$1,768	$2,552	-$2,373
Cooking	-$398	-$223	-$589	-$285	n/a	-$589
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$2,573	-$1,310	-$3,491	-$3,311	$1,344	n/a
Hot Water	-$3,426	-$3,209	-$4,424	-$2,968	$971	n/a
Cooking	-$2,198	-$2,023	-$2,389	-$2,085	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$674	$1,320	$560	-$1,019	n/a	n/a
Hot Water	-$239	-$614	-$472	-$638	n/a	n/a
Cooking	-$75	$19	-$169	-$324	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,403	$1,543	$1,796	-$22	n/a	n/a
Hot Water+ Cooking	-$809	-$1,390	-$837	-$1,442	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,494	$3,162	$3,559	$1,909	$8,624	$5,038
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,918	-$1,900	-$4,203	-$4,404	$5,674	-$2,918

** Assumes full CAPEX on both electric and gas sides.*

6.10 Eastern Victoria

Gas Zone: Envestra Bairnsdale			**Electricity Zone: SP AusNet**			
Example Location: Bairnsdale, 3875, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$2,595	$1,638	$4,389	$245	$2,772	$2,872
Hot Water	-$870	-$1,388	-$839	-$1,109	$2,552	-$689
Cooking	-$305	-$187	-$417	-$236	n/a	-$417
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$205	-$562	$989	-$2,755	$1,272	n/a
Hot Water	-$2,370	-$2,588	-$2,639	-$2,309	$1,352	n/a
Cooking	-$2,105	-$1,987	-$2,217	-$2,036	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,944	$2,399	$4,197	-$246	n/a	n/a
Hot Water	$832	$365	$604	$303	n/a	n/a
Cooking	$369	$410	$328	$52	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$3,780	$2,675	$5,592	$847	n/a	n/a
Hot Water+ Cooking	$368	-$359	$400	-$403	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$6,942	$4,922	$9,147	$3,354	$8,219	$7,474
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$521	-$148	$1,376	-$2,967	$5,269	-$664

** Assumes full CAPEX on both electric and gas sides.*

6.11 Inner Western Victoria

Gas Zone: SP Ausnet Adjoining West			Electricity Zone: Powercor			
Example Location: Winchelsea, 3241, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$2,118	$1,579	$3,215	$255	$2,752	$2,449
Hot Water	-$1,392	-$1,799	-$1,602	-$1,507	$2,507	-$1,395
Cooking	-$342	-$208	-$496	-$255	n/a	-$495
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$682	-$621	-$185	-$2,745	$1,252	n/a
Hot Water	-$2,892	-$2,999	-$3,402	-$2,707	$1,307	n/a
Cooking	-$2,142	-$2,008	-$2,296	-$2,055	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$1,493	$1,304	$2,305	-$1,129	n/a	n/a
Hot Water	-$752	-$1,081	-$956	-$1,085	n/a	n/a
Cooking	-$378	-$266	-$489	-$583	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$2,187	$1,510	$3,488	-$164	n/a	n/a
Hot Water+ Cooking	-$1,358	-$1,875	-$1,372	-$1,919	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$4,879	$3,372	$6,401	$2,055	$8,154	$5,440
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$1,540	-$1,696	-$1,367	-$4,263	$5,204	-$2,657

** Assumes full CAPEX on both electric and gas sides.*

6.12 Murray Valley

Gas Zone: Envestra Murray Valley			Electricity Zone: Powercor			
Example Location: Cobram, 3644, VIC			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$2,951	$1,764	$4,906	$355	$2,752	$3,136
Hot Water	-$1,209	-$1,815	-$1,205	-$1,571	$1,820	-$1,093
Cooking	-$297	-$190	-$404	-$227	n/a	-$404
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$151	-$436	$1,506	-$2,645	$1,252	n/a
Hot Water	-$2,709	-$3,015	-$3,005	-$2,771	$620	n/a
Cooking	-$2,097	-$1,990	-$2,204	-$2,027	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,115	$1,519	$3,472	-$1,002	n/a	n/a
Hot Water	-$743	-$1,059	-$1,038	-$1,121	n/a	n/a
Cooking	-$172	-$70	-$274	-$408	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$2,828	$1,734	$4,682	-$21	n/a	n/a
Hot Water+ Cooking	-$1,330	-$1,844	-$1,427	-$1,940	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$5,732	$3,586	$8,035	$2,139	$7,467	$6,142
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$689	-$1,484	$264	-$4,181	$4,517	-$1,996

** Assumes full CAPEX on both electric and gas sides.*

6.13 North Eastern Victoria

Gas Zone: Envestra Mildura				Electricity Zone: Powercor		
Example Location: Mildura, 3500, VIC				**Climate Zone: Balanced Moderate Demand**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$2,173	$2,097	$1,812	$2,241	$2,188	$2,397
Hot Water	$95	-$524	$282	-$81	$1,820	$862
Cooking	-$161	-$104	-$330	-$103	n/a	-$330
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$627	-$103	-$1,588	-$759	$688	n/a
Hot Water	-$1,405	-$1,724	-$1,518	-$1,281	$620	n/a
Cooking	-$1,961	-$1,904	-$2,130	-$1,903	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,883	$2,546	$2,422	$1,786	n/a	n/a
Hot Water	$2,032	$925	$2,603	$1,304	n/a	n/a
Cooking	$533	$517	$549	$201	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$3,833	$2,879	$3,988	$2,984	n/a	n/a
Hot Water+ Cooking	$1,681	$258	$2,569	$702	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$7,974	$6,025	$8,729	$6,492	$6,903	$9,192
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$1,554	$955	$958	$172	$3,953	$1,053

** Assumes full CAPEX on both electric and gas sides.*

6.14 Greater Sydney

Gas Zone: Jemena/AGL Greater Sydney			Electricity Zone: Ausgrid			
Example Location: Hurstville, 2220, NSW			**Climate Zone: Balanced Moderate Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,345	$1,166	$1,284	$1,847	$1,688	$2,114
Hot Water	$342	-$471	$519	-$123	$2,195	$740
Cooking	-$259	-$102	-$348	-$259	n/a	-$348
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,455	-$1,034	-$2,116	-$1,153	$72	n/a
Hot Water	-$1,158	-$1,671	-$1,281	-$1,323	$636	n/a
Cooking	-$2,059	-$1,902	-$2,148	-$2,059	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$936	$1,256	$320	$1,163	n/a	n/a
Hot Water	$1,416	$596	$1,429	$1,177	n/a	n/a
Cooking	-$236	-$286	-$185	-$236	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,954	$1,623	$1,988	$2,381	n/a	n/a
Hot Water+ Cooking	$1,134	-$36	$1,497	$595	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$6,416	$4,868	$7,029	$6,378	$6,838	$7,519
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$96	-$293	-$833	-$33	$3,888	-$493

** Assumes full CAPEX on both electric and gas sides.*

6.15 South Western NSW

Gas Zone: Envestra Wagga Wagga				Electricity Zone: Essential Energy		
Example Location: Wagga Wagga, 2650, NSW				**Climate Zone: Heating Dominated**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	-$459	-$370	-$1,243	$336	$2,580	-$193
Hot Water	-$1,646	-$2,098	-$1,891	-$2,154	$1,437	-$1,781
Cooking	-$378	-$231	-$526	-$378	n/a	-$526
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$3,259	-$2,570	-$4,643	-$2,664	$793	n/a
Hot Water	-$3,146	-$3,298	-$3,691	-$3,354	-$63	n/a
Cooking	-$2,178	-$2,031	-$2,326	-$2,178	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	-$732	-$43	-$2,116	-$137	n/a	n/a
Hot Water	-$619	-$771	-$1,164	-$827	n/a	n/a
Cooking	$348	$496	$201	$348	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	-$110	$127	-$1,042	$684	n/a	n/a
Hot Water+ Cooking	-$1,297	-$1,602	-$1,690	-$1,805	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$2,340	$1,675	$1,613	$2,626	$6,972	$2,323
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$4,056	-$3,371	-$6,133	-$3,670	$4,022	-$5,573

** Assumes full CAPEX on both electric and gas sides.*

6.16 South Eastern NSW

Gas Zone: Country Energy			Electricity Zone: Essential Energy			
Example Location: Tumut, 2720, NSW			**Climate Zone: Heating Dominated**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$425	$136	-$176	$842	$2,571	$338
Hot Water	-$2,139	-$2,102	-$1,454	-$2,637	$733	-$1,344
Cooking	-$325	-$204	-$447	-$325	n/a	-$447
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$2,375	-$2,064	-$3,576	-$2,158	$1,071	n/a
Hot Water	-$3,639	-$3,302	-$3,254	-$3,837	-$467	n/a
Cooking	-$2,125	-$2,004	-$2,247	-$2,125	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	-$294	$17	-$1,495	-$78	n/a	n/a
Hot Water	-$1,559	-$1,222	-$1,174	-$1,756	n/a	n/a
Cooking	-$45	$76	-$166	-$45	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$380	$213	-$342	$797	n/a	n/a
Hot Water+ Cooking	-$2,184	-$2,026	-$1,621	-$2,682	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$2,391	$1,810	$2,803	$2,310	$6,199	$2,977
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$4,059	-$3,290	-$4,996	-$4,040	$3,249	-$4,972

** Assumes full CAPEX on both electric and gas sides.*

6.17 Inland Cold NSW

Gas Zone: Jemena/AGL			**Electricity Zone: Essential Energy**			
Example Location: Orange, 2800, NSW			**Climate Zone: Heating dominated High Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,283	$582	$665	$1,250	$5,293	$781
Hot Water	-$1,657	-$1,551	-$1,221	-$2,140	$762	-$1,105
Cooking	-$362	-$153	-$501	-$362	n/a	-$501
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,517	-$1,618	-$2,735	-$1,750	$3,293	n/a
Hot Water	-$3,157	-$2,751	-$3,021	-$3,340	-$684	n/a
Cooking	-$2,162	-$1,953	-$2,301	-$2,162	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$1,094	$944	-$108	$850	n/a	n/a
Hot Water	-$413	-$236	-$191	-$605	n/a	n/a
Cooking	-$336	-$336	-$336	-$336	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$2,011	$1,261	$1,409	$1,967	n/a	n/a
Hot Water+ Cooking	-$796	-$918	-$274	-$1,288	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$4,424	$3,402	$4,638	$3,898	$9,010	$4,413
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,088	-$1,759	-$3,224	-$2,513	$6,060	-$3,599

** Assumes full CAPEX on both electric and gas sides.*

6.18 NSW Southern Highlands

Gas Zone: Actew AGL 1 1: Boorowa, Goulburn, Yass and Young				Electricity Zone: Essential Energy		
Example Location: Goulburn, 2580, NSW				**Climate Zone: Heating dominated High Demand**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$973	$652	$137	$1,164	$3,647	$587
Hot Water	-$1,910	-$1,785	-$1,311	-$2,281	$762	-$1,035
Cooking	-$326	-$186	-$453	-$309	n/a	-$452
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,827	-$1,548	-$3,263	-$1,836	$2,147	n/a
Hot Water	-$3,410	-$2,985	-$3,111	-$3,481	-$438	n/a
Cooking	-$2,126	-$1,986	-$2,253	-$2,109	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$750	$682	-$423	$588	n/a	n/a
Hot Water	-$811	-$784	-$249	-$1,017	n/a	n/a
Cooking	-$470	-$431	-$510	-$470	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,589	$960	$977	$1,626	n/a	n/a
Hot Water+ Cooking	-$1,273	-$1,506	-$450	-$1,779	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$3,781	$2,886	$4,124	$3,467	$7,304	$4,270
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$2,719	-$2,265	-$3,727	-$2,934	$4,354	-$3,766

** Assumes full CAPEX on both electric and gas sides.*

6.19 Southern NSW

Gas Zone: Country Energy 1: Cooma & Bombala			Electricity Zone: Essential Energy			
Example Location: Cooma, 2630, NSW			**Climate Zone: Heating dominated High Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$2,703	$1,336	$2,406	$2,041	$5,293	$1,634
Hot Water	-$2,070	-$2,063	-$1,358	-$2,569	$762	-$1,248
Cooking	-$317	-$200	-$435	-$317	n/a	-$435
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$97	-$864	-$994	-$959	$3,793	n/a
Hot Water	-$3,570	-$3,263	-$3,158	-$3,769	-$438	n/a
Cooking	-$2,117	-$2,000	-$2,235	-$2,117	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$1,896	$1,130	$1,000	$1,035	n/a	n/a
Hot Water	-$1,576	-$1,269	-$1,165	-$1,775	n/a	n/a
Cooking	-$124	-$6	-$241	-$124	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$2,579	$1,330	$2,165	$1,918	n/a	n/a
Hot Water+ Cooking	-$2,193	-$2,069	-$1,599	-$2,693	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$4,659	$2,967	$5,407	$3,499	$8,950	$4,295
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$1,791	-$2,133	-$2,393	-$2,851	$6,000	-$3,655

** Assumes full CAPEX on both electric and gas sides.*

6.20 NSW Northern Tablelands

Gas Zone: Country Energy Tamworth				Electricity Zone: Essential Energy		
Example Location: Tamworth, 2340, NSW				**Climate Zone: Balanced Moderate Demand**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$3,588	$2,406	$3,994	$3,116	$2,104	$3,495
Hot Water	$1,395	-$108	$2,567	$820	$1,752	$2,677
Cooking	-$94	-$88	-$100	-$94	n/a	-$100
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$788	$206	$594	$116	$604	n/a
Hot Water	-$105	-$1,308	$767	-$380	$552	n/a
Cooking	-$1,894	-$1,888	-$1,900	-$1,894	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,575	$1,993	$2,380	$1,903	n/a	n/a
Hot Water	$1,682	$479	$2,554	$1,407	n/a	n/a
Cooking	-$107	-$102	-$113	-$107	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$3,481	$2,305	$3,881	$3,009	n/a	n/a
Hot Water+ Cooking	$1,288	-$210	$2,455	$713	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$9,024	$5,895	$11,047	$7,977	$6,750	$10,208
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$2,576	$797	$3,248	$1,629	$3,800	$2,260

** Assumes full CAPEX on both electric and gas sides.*

6.21 South Coast NSW

Gas Zone: Actew AGL 1 3: Shoalhaven				Electricity Zone: Endeavour Energy		
Example Location: Nowra, 2541, NSW				Climate Zone: Balanced Moderate Demand		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$1,625	$1,297	$1,637	$2,005	$1,713	$2,269
Hot Water	-$128	-$1,137	$451	-$686	$2,356	$561
Cooking	-$182	-$132	-$232	-$182	n/a	-$232
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,175	-$903	-$1,763	-$995	$213	n/a
Hot Water	-$1,628	-$2,337	-$1,349	-$1,886	$1,156	n/a
Cooking	-$1,982	-$1,932	-$2,032	-$1,982	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$643	$916	$56	$823	n/a	n/a
Hot Water	$190	-$518	$469	-$67	n/a	n/a
Cooking	-$163	-$114	-$213	-$163	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$1,461	$1,183	$1,424	$1,841	n/a	n/a
Hot Water+ Cooking	-$292	-$1,251	$238	-$849	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$5,534	$3,797	$6,525	$5,356	$6,964	$6,853
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$967	-$1,354	-$1,325	-$1,045	$4,014	-$1,183

** Assumes full CAPEX on both electric and gas sides.*

6.22 Canberra

Gas Zone: ActewAGL			Electricity Zone: ActewAGL			
Example Location: Canberra, 2600, ACT			**Climate Zone: Heating dominated High Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$7,850	$4,588	$11,903	$2,521	$4,637	$6,746
Hot Water	$10	-$935	$1,320	-$560	$2,714	$1,430
Cooking	-$41	-$56	-$21	-$41	n/a	-$21
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$5,050	$2,388	$8,503	-$479	$3,137	n/a
Hot Water	-$1,490	-$2,135	-$480	-$1,760	$1,514	n/a
Cooking	-$1,841	-$1,856	-$1,821	-$1,841	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$7,089	$4,417	$10,542	$1,561	n/a	n/a
Hot Water	$561	-$114	$1,578	$291	n/a	n/a
Cooking	$56	$18	$95	$56	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$8,084	$4,773	$12,176	$2,755	n/a	n/a
Hot Water+ Cooking	$255	-$758	$1,611	-$315	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$12,270	$7,577	$18,111	$6,372	$10,307	$12,650
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$5,769	$2,426	$10,260	-$29	$7,357	$4,613

** Assumes full CAPEX on both electric and gas sides.*

6.23 Brisbane

Gas Zone: AGL North Brisbane & Ipswich			Electricity Zone: Energex			
Example Location: Chermside, 4032, QLD			**Climate Zone: Low Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$4,412	$3,317	$5,284	$4,024	$2,296	$5,072
Hot Water	$1,964	$498	$3,188	$1,411	$2,345	$3,324
Cooking	-$78	-$81	-$76	-$78	n/a	-$76
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$1,612	$1,117	$1,884	$1,024	$796	n/a
Hot Water	$464	-$702	$1,388	$211	$1,145	n/a
Cooking	-$1,878	-$1,881	-$1,876	-$1,878	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$4,133	$3,609	$4,420	$2,963	n/a	n/a
Hot Water	$3,224	$1,910	$4,256	$2,390	n/a	n/a
Cooking	$712	$543	$876	$159	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$5,389	$4,096	$6,440	$4,419	n/a	n/a
Hot Water+ Cooking	$3,180	$1,397	$4,676	$2,047	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$11,383	$8,222	$14,040	$9,862	$7,573	$13,488
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$4,957	$3,147	$6,264	$3,536	$4,623	$5,562

** Assumes full CAPEX on both electric and gas sides.*

6.24 Gold Coast

Gas Zone: Gold Coast areas, Toowoomba, Oakey			Electricity Zone: Energex			
Example Location: Helensvale, Gold Coast, 4212, QLD			**Climate Zone: Low Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$4,058	$3,114	$4,856	$3,821	$2,296	$4,906
Hot Water	$507	-$590	$1,190	-$35	$2,345	$1,307
Cooking	-$211	-$147	-$275	-$211	n/a	-$275
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$1,258	$914	$1,456	$821	$796	n/a
Hot Water	-$993	-$1,790	-$610	-$1,235	$1,145	n/a
Cooking	-$2,011	-$1,947	-$2,075	-$2,011	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$4,339	$3,985	$4,540	$3,892	n/a	n/a
Hot Water	$2,249	$1,363	$2,712	$2,000	n/a	n/a
Cooking	$1,156	$1,101	$1,211	$1,156	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$5,366	$4,357	$6,222	$5,119	n/a	n/a
Hot Water+ Cooking	$1,976	$735	$2,794	$1,427	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$9,923	$7,406	$11,869	$9,136	$7,535	$11,579
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$3,497	$2,330	$4,093	$2,810	$4,585	$3,653

** Assumes full CAPEX on both electric and gas sides.*

6.25 Toowoomba QLD

Gas Zone: Gold Coast areas, Toowoomba, Oakey			Electricity Zone: Say, Energex			
Example Location: Toowoomba, 4350, QLD			Climate Zone: Balanced Moderate Demand			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$4,941	$3,615	$5,909	$4,323	$2,957	$5,522
Hot Water	$507	-$600	$1,190	-$42	$2,345	$1,300
Cooking	-$211	-$147	-$275	-$211	n/a	-$275
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$2,141	$1,415	$2,509	$1,323	$1,457	n/a
Hot Water	-$993	-$1,800	-$610	-$1,242	$1,145	n/a
Cooking	-$2,011	-$1,947	-$2,075	-$2,011	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$5,224	$4,499	$5,592	$4,407	n/a	n/a
Hot Water	$2,249	$1,363	$2,712	$2,000	n/a	n/a
Cooking	$1,156	$1,101	$1,211	$1,156	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$6,251	$4,871	$7,274	$5,634	n/a	n/a
Hot Water+ Cooking	$1,976	$735	$2,794	$1,427	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$10,805	$7,908	$12,921	$9,639	$8,197	$12,194
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$4,379	$2,832	$5,145	$3,313	$5,247	$4,269

** Assumes full CAPEX on both electric and gas sides.*

6.26 Adelaide

Gas Zone: Envestra Adelaide				**Electricity Zone: SA Power Networks**		
Example Location: Marion, 5034, SA				**Climate Zone: Balanced Moderate Demand**		
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$863	$1,346	$687	$1,548	$2,050	$1,844
Hot Water	-$1,107	-$1,314	-$1,895	-$906	$1,190	-$1,597
Cooking	-$462	-$182	-$680	-$441	n/a	-$680
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	-$1,937	-$854	-$2,713	-$1,452	$550	n/a
Hot Water	-$2,607	-$2,514	-$3,695	-$2,106	-$10	n/a
Cooking	-$2,262	-$1,982	-$2,480	-$2,241	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,303	$2,548	$1,593	$2,458	n/a	n/a
Hot Water	$1,796	$884	$911	$2,070	n/a	n/a
Cooking	$246	$244	$247	$246	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$3,223	$2,867	$3,114	$3,578	n/a	n/a
Hot Water+ Cooking	$1,416	$203	$833	$1,390	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$6,040	$5,224	$5,494	$6,742	$6,202	$6,310
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	-$385	$149	-$2,281	$417	$3,252	-$1,615

** Assumes full CAPEX on both electric and gas sides.*

6.27 Hobart

Gas Zone: Tas Gas			**Electricity Zone: Tas Networks**			
Example Location: North Hobart, 7002, TAS			**Climate Zone: Heating dominated High Demand**			
Household Scenario	Ref home	Small home	Large home	Public housing	LPG home	New build
Switching a gas appliance, within 5 years of end of life, staying on gas network.						
Space Heating	$5,206	$2,855	$5,573	$3,561	$4,376	$3,326
Hot Water	$1,153	-$128	$2,212	$582	$2,806	$2,322
Cooking	-$6	-$44	$33	-$6	n/a	$33
Switching a gas appliance, not within 5 years of end of life, staying on gas network						
Space Heating	$2,406	$655	$2,173	$561	$2,876	n/a
Hot Water	-$347	-$1,328	$412	-$618	$1,606	n/a
Cooking	-$1,806	-$1,844	-$1,767	-$1,806	n/a	n/a
Switching one gas appliance, of any age, disconnecting from gas network						
Space Heating	$2,982	$1,232	$2,750	$1,137	n/a	n/a
Hot Water	$229	-$752	$988	-$42	n/a	n/a
Cooking	-$1,229	-$1,268	-$1,191	-$1,229	n/a	n/a
Switching two gas appliances, at least one is within 5 years of end of life, disconnecting from gas network						
Space Heating + Cooking	$3,977	$1,587	$4,383	$2,332	n/a	n/a
Hot Water+ Cooking	-$77	-$1,396	$1,021	-$648	n/a	n/a
New & existing homes, not currently gas connected, choosing efficient electric instead of gas*						
All Heating & Cooking	$9,239	$5,119	$11,155	$7,023	$10,076	$8,867
All gas appliances switched: one is within 5 years of end of asset life, avoiding $2,000 replacement capex.						
All Heating & Cooking	$2,829	$59	$3,395	$713	$7,126	$657

** Assumes full CAPEX on both electric and gas sides.*

7.0 Appendix B: Methodology – Space Heating

This Chapter outlines the methodology for calculating the annual and lifetime energy loads and costs of gas and electric appliances for space heating.

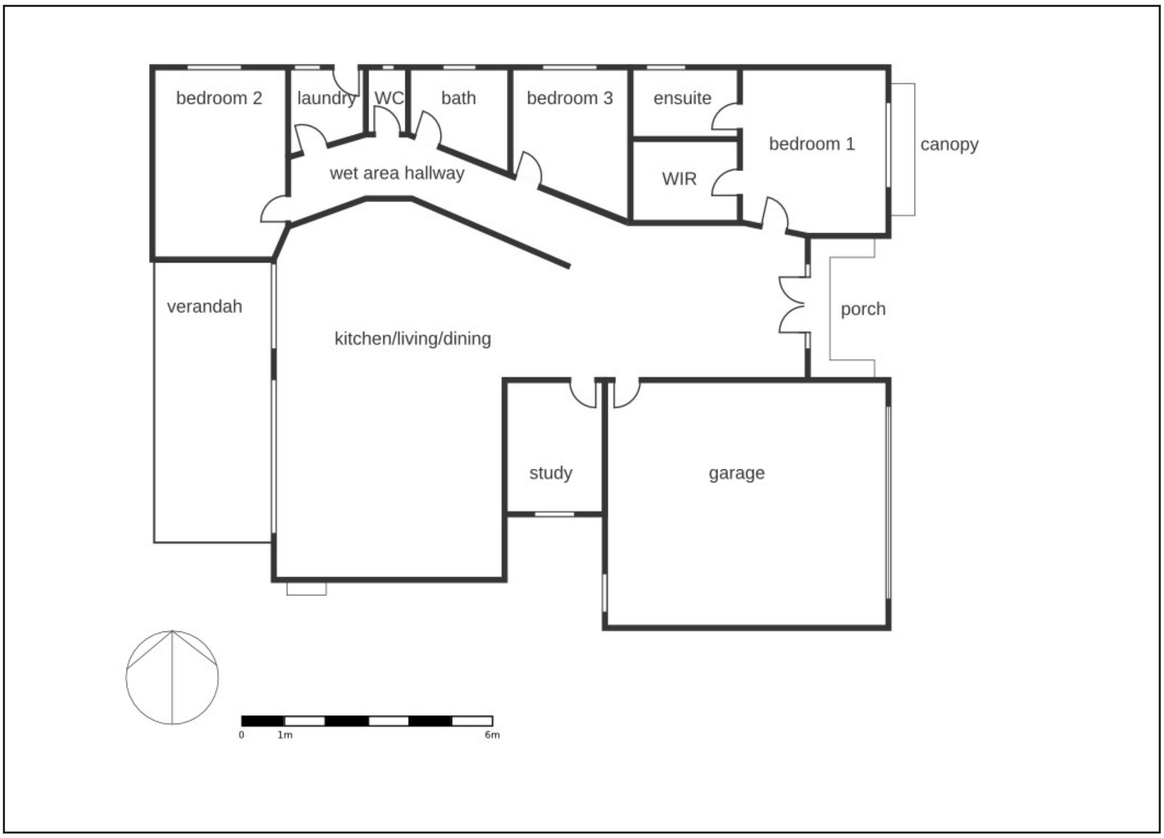
7.1 Determination of Heating Load

In order to understand the heating load requirements for different homes, ATA reviewed a range of research and analysis. This review identified that the heat load modelling recently undertaken by Beyond Zero Emissions (BZE) in their *Zero Carbon Australia Buildings Plan*[5] represented the most up-to-date and robust analysis of the characteristics of Australian housing stock that are of greatest relevance to this research.

Accordingly, ATA drew on this analysis in developing our Reference Household Scenario. ATA undertook further analysis to ensure that the modelled scenarios are broadly representative of Australian energy consumers.

BZE applied a single reference home as previously modelled by Energy Efficient Strategies (EES). The reference home was a three-bedroom, single-storey detached dwelling – with a number of variations based on orientation and building construction. The floor plan common to all variants is shown below:

Figure 7-1: Floor Plan, BZE Reference Home



[5] http://media.bze.org.au/bp/bp_appendix_7.pdf. Supporting model files and related resources are at: http://media.bze.org.au/bp/bp_appendix_7.zip

BZE developed six variants of the base model, corresponding to construction type as per the table below:

Table 7-1: Building Constructions, BZE Reference Home Model

House Type	Wall Construction	Floor Construction
1	Weatherboard	Timber
2	Weatherboard	Concrete Slab
3	Brick Veneer	Timber
4	Brick Veneer	Concrete Slab
5	Cavity Brick	Timber
6	Cavity Brick	Concrete Slab

The modelling previously completed by EES considered an uninsulated dwelling as a base case; and two other cases representing incremental improvements (identified as Modification levels 1 - 3 respectively). BZE added two further cases in their modelling for the Buildings Plan (Mod levels 4 and 5). The components of each modification level are outlined below:

Table 7-2: EES/BZE House Modification Levels

Mod Level	Modification Description	Comment
1	Baseline, uninsulated	
2	Mod Level 1 plus: - R2.5 insulation added to ceiling **This level is most broadly representative of current building stock*	
3	Mod Level 2 plus: - insulation added to walls to +R1.5 (except +R1.0 for brick cavity walls)	
4	Mod Level 3 plus: - ceiling to +R6.0, and walls to +R2.5 (except walls to +R1.5 for brick cavity)	
5DG	Mod Level 4 plus: - double glazing (ex garage) & ventilated downlights eliminated; - self-sealing exhaust fans, weather sealing & curtains / pelmets.	Relevant for cool climate
5SG	Mod Level 4 plus: - high-performance single glazing (ex garage); - ceiling fans in living areas & bedrooms; - ventilated downlights eliminated; - self-sealing exhaust fans, weather sealing & curtains / pelmets.	Relevant for warm climate

Modification Level 2 was considered by BZE as broadly representative of current housing stock.

Given the thermal performance standards required for new homes in Australian states and territories (5 to 6 Stars), Modification Level 4 was considered by ATA as the most appropriate for Household Scenario 6: New Build.

BZE 's analysis modelled the heating load of the reference home for each construction type and for modification level. The residential building models were tested using the 'AccuRate' software package (version 1.1.4) across ten locales, selected as being collectively representative of most Australian locations.

Heat loads (MJ/m^2) for house Modification levels 2 and 4 across the representative Australian climate zones are described below:

Table 7-3: BZE Reference Home Heating Loads by Construction Type, Mod Level 2&4 (MJ/m^2)

Climate / Location	House Modification Level 2						House Modification Level 4					
	House Construction Type						House Construction Type					
	1	2	3	4	5	6	1	2	3	4	5	6
Balanced Moderate Demand												
Adelaide	167	130	135	111	106	98	68	63	63	61	49	55
Mascot	108	83	86	69	64	60	43	38	39	37	28	31
Cooling dominated – humid												
Darwin	0	0	0	0	0	0	0	0	0	0	0	0
Townsville	3.9	1.7	2.1	1	0.2	0.1	1	0	1	0	0	0
Heating Dominated												
Melbourne	257	211	222	192	188	178	113	118	107	116	93	111
Moorabbin	309	255	267	231	228	215	136	144	129	142	114	138
Tullamarine	330	275	285	249	243	230	148	156	141	153	124	148
Heating dominated High Demand												
Canberra	390	335	337	301	285	278	174	190	166	186	146	180
Orange	523	450	459	412	402	385	244	271	234	267	214	261
Low Demand												
Brisbane	54	37	38	27	22	19	19	13	17	12	9	8

From this heating load dataset for Modification levels 2 and 4, ATA used appropriate heating loads for each representative climate zone/location to apply to the six Household Scenarios.

For existing dwellings (Household Scenarios 1 - 5), ATA took the average heating load of all house construction types in a given location from the Modification level 2 results above.

The exceptions to this approach for existing dwellings were:

- the exclusion of weatherboard construction type for Adelaide – due to the lack of weatherboard dwellings in existence in this location (meaning the average was taken from construction types 3-6); and
- the exclusion of cavity brick construction type for Brisbane – for the same reason (meaning the average was from construction types 1-4).

For new dwellings (ATA's Household Scenario 6), ATA used either:

- the average heating load of all house construction types in a given location using the modelled results for BZE's Modification level 4 reference home; or
- the heating loads determined by the NatHERS rating system using the 6 star requirement.

NatHERS energy loads take into account both heating and cooling requirements; whilst the EES/BZE modification levels take into account heating requirement only.

As such, ATA utilised the NatHERS energy loads in heating dominated climates, whilst Modification Levels 2 & 4 were used for Balanced (similar heating and cooling loads) and Low Demand (low heating load) climate locations.

Table 7-4 below summarises the source data for heating loads by representative climate zone for the six ATA Household Scenarios[6]:

Table 7-4: ATA Selected Approaches to Determine Heating Loads

Climate Type	City	Scenario 1-5	Scenario 6: New Build
Balanced Moderate Demand	Adelaide	BZE Mod Level2 ex W'board	BZE Mod L4 ex W'board
Balanced Moderate Demand	Sydney	BZE Mod L2	BZE Mod L4
Heating Dominated	Tullamarine	BZE Mod L2	NatHERS 6 star
Heating Dominated	Melbourne	BZE Mod L2	NatHERS 6 star
Heating dom High Demand	Canberra	BZE Mod L2	NatHERS 6 star
Heating dom High Demand	Orange	BZE Mod L2	NatHERS 6 star
Low Demand	Brisbane	BZE Mod L2 ex brick	BZE Mod L4 ex brick

The selected approaches result in the following assumed space heating loads for each of the representative locations:

Table 7-5: Heating Load by Climate Location ($MJ/m^2/annum$)

Climate Type	City	Scenario 1-5	Scenario 6: New Build
Balanced Moderate Demand	Adelaide	112.8	56.8
Balanced Moderate Demand	Sydney	78.3	35.9
Heating Dominated	Tullamarine	268.8	197.0
Heating Dominated	Melbourne	242.4	114.0
Heating Dominated High Demand	Canberra	321.0	165.0
Heating Dominated High Demand	Orange	438.4	219.0
Low Demand	Brisbane	38.9	15.2

[6] The list of locations from **Table 7-3** does not show tropical zones that do require space heating (i.e. Darwin and Townsville); whilst Moorabbin, Melbourne RO and Tullamarine were consolidated into a single zone described as 'Melbourne'.

7.1.1 Application of Heating Load

The heating load for the most representative climate location in Table 7-5 above was then applied to each gas pricing zone, for each of the Household Scenarios.

When selecting heating loads for specific locations, ATA calculated heating degree days (using monthly Bureau of Meteorology data) for the locations in Table 7-5 above and correlated these with heating degree days for the specific location within the gas pricing zone.

7.1.2 Required Heating Area

The six Household Scenarios take into account a range of different house sizes and other attributes to be representative of most Australian homes. The heated area and maximum number of heated rooms for each scenario are outlined in the table below:

Table 7-6: No. of Rooms, Rooms Size & Total Heated Area, per Household Scenario

	Scenario 1: Reference Home	Scenario 2: Small House	Scenario 3: Large House	Scenario 4: Public Housing	Scenario 5: LPG House	Scenario 6: New Build (6 Star)
No. Rooms to be Heated	Up to 6	Up to 4	Up to 8	Up to 4	Up to 2	Up to 8
Total Heated Area (m^2)	**120**	**70**	**160**	**70**	**40**	**160**

The total heated area, heating loads per m^2 for each climate location and number of rooms provide the basis for the total heating loads and appropriate appliance configuration for each of the Household Scenarios.

7.2 Reverse Cycle Air Conditioners

Also called ‘split systems’ and in some locations ‘heat pumps’ (but not to be confused with heat pump water heating systems), reverse cycle air conditioners (RCACs) have become a common feature for heating and cooling in Australian homes.

RCACs provide convective heat, meaning they heat the air directly, and contain heat pumps, which use heat exchange and compression to provide space heating and cooling.

A heat exchanger is a piece of equipment built for heat transfer from one medium to another. In the case of RCAC in heating mode, the source medium (from which heat is being transferred) is the ambient air outside the building.

A compressor stores energy from the source in a fluid, turning it from a gas to a liquid. The fluid returns to a gaseous state on release of the heat. This process allows for temperatures to be reached that are higher than that of the source medium. Hence an RCAC can maintain a comfortable room temperature, even when the outside temperature is below freezing.

7.2.1 Performance

The amount of electrical energy input required to achieve and maintain a desired temperature varies with the temperature difference between the inside and outside air. The colder the outside temperature, the greater the electrical energy input required to achieve the same level of heat energy output from the system.

The ratio between the energy input (energy consumed by an appliance) and the heat energy output from the heat exchanger system is known as the Co-efficient of Performance (CoP). CoP is a measure of how efficiently the appliance converts electricity into heat. The CoP of an appliance is usually expressed as a number equal to the energy output (as heat transferred to the air inside a building) divided by the energy consumption (from electricity or gas consumed).

Efficient RCACs are reaching CoPs of 5.0 and over – which means that for every 1 unit of energy input to the system, 5 units are created to heat air.

Compared with the most efficient equivalent gas appliance that have a CoP of around 0.8 – 0.9, an efficient air-conditioner or electric water heater now uses 1/7th of the input energy for the same end use. While CoPs for electric appliances may continue to improve, gas appliances are forever limited to 0.9 at best.

7.2.2 RCAC Costs

Optimising the size and number of RCACs in a home is a three-way trade off between up-front cost, running cost and convenience or effectiveness. Generally speaking, small RCAC units operate with a higher CoP than larger systems and cost less per unit to purchase.

However, smaller systems are designed to heat smaller spaces. In inefficient buildings or during very cold weather an undersized system may not maintain a comfortable temperature and as such, two small RCAC units are required to heat the same space as one large unit.

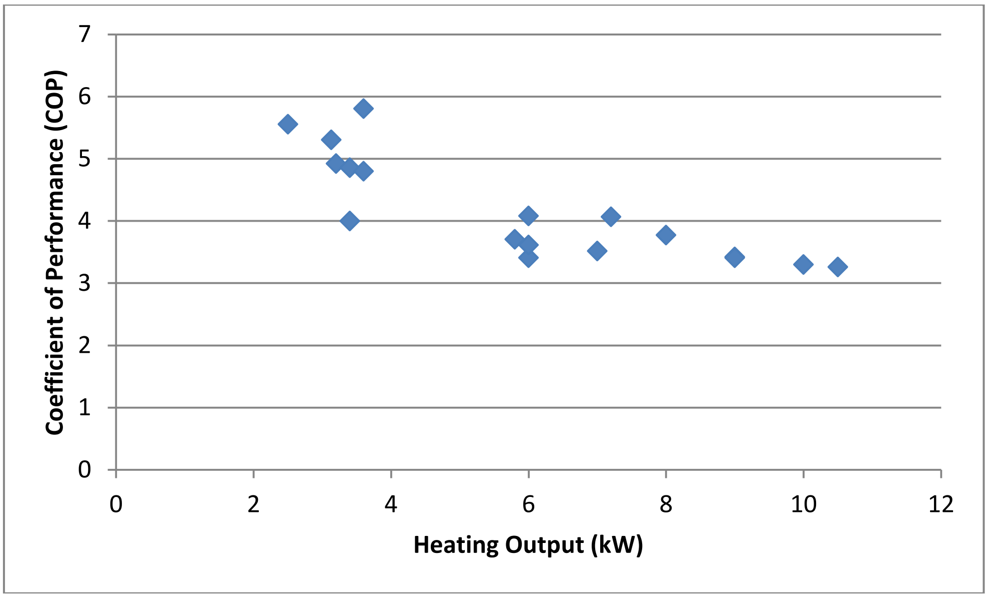
As a single unit is typically not effective at heating more than two rooms, multiple RCACs are required for whole-of-house heating, particularly if they are to be considered as a replacement for ducted heating systems.

In order to understand how best to size RCACs, ATA developed a sample of 18 different actual models currently available from the Australian Government's *Energy Rating* website[7]. Analysis of the dataset found that small and medium systems (2.5-3.5 kW nameplate capacity) have higher average CoPs; whilst a number of the more efficient larger-sized systems are not far behind.

Figure 7-2 below highlights how the CoP of these 18 RCAC systems varies with heating output:

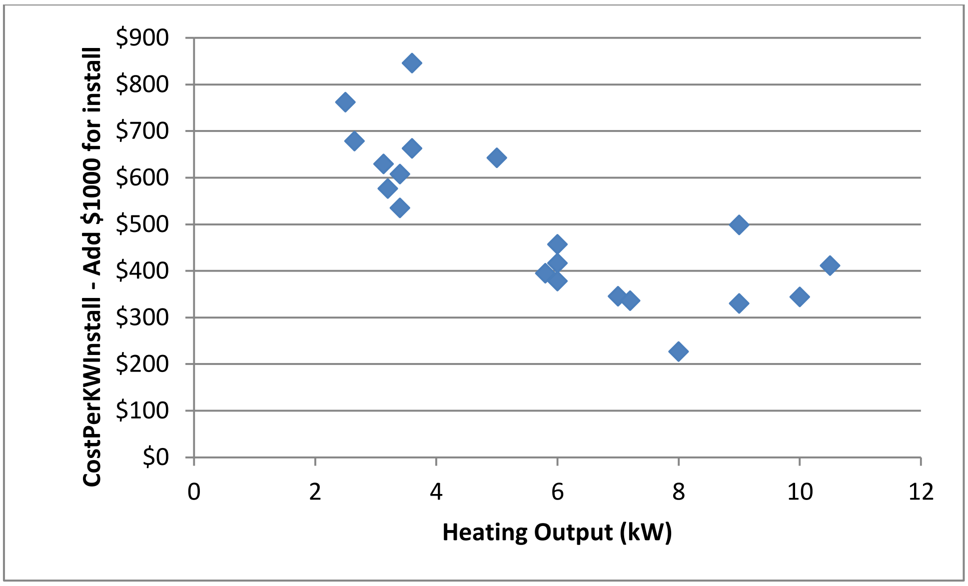
[7] Located at: http://reg.energyrating.gov.au/comparator/product_types/64/search/

Figure 7-2: Variation of Average CoP with kW Heat Output



The installation cost of RCAC varies little with system size[8]. Taking this into account, the cost per unit of nameplate heating capacity is markedly higher for smaller units that for larger units:

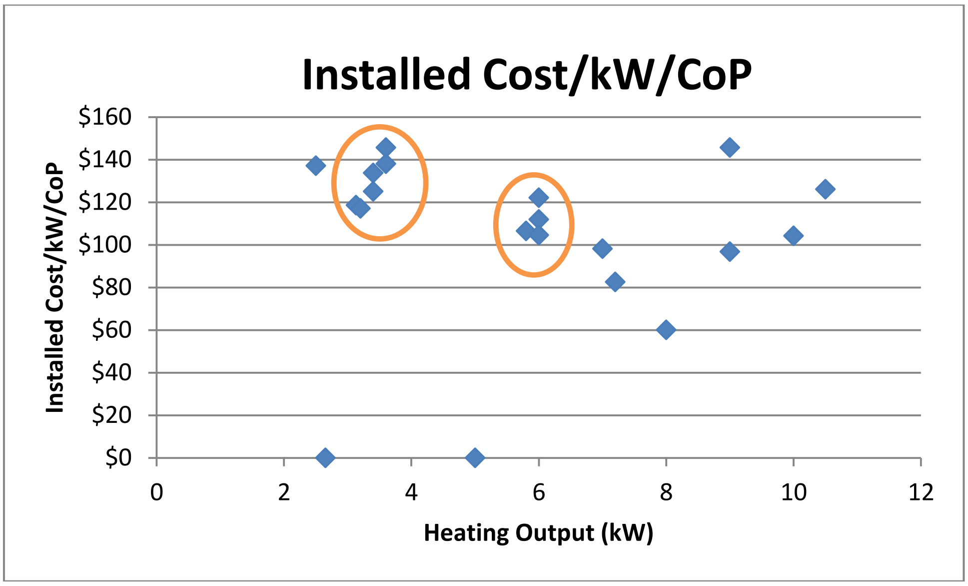
Figure 7-3: System Cost per kW (Retail + Installation Cost)



Though effectively more expensive, smaller systems perform more efficiently than larger systems. In order to choose optimally sized systems, ATA quantified the cost versus size versus efficiency trade-off by dividing the installed cost/kW by the CoP:

[8] Assuming same type of installation - i.e. ground level v first/second floor; similar cable and piping runs, etc.

Figure 7-4: Installed Cost per kW per CoP



This provided an installed system cost per kW adjusted according to its CoP – and ultimately an indication of a system's true value taking into account both its total cost (retail and installation) and its performance.

Of the 18 air con units in the figure above, 14 have an installed cost/kW/CoP of between (just under) $100 and $140. Two units are more expensive than $140/kW/CoP and two are significantly cheaper than $100.

Interestingly, one of the two most expensive systems is also a larger unit (i.e. 9.0kW).

The two cheapest models ($60 and $80/kW/CoP) are larger sized systems (i.e. 7.0kW and 8.0kW units). While these are more cost effective, in the interest of maintaining a conservative approach, credible analysis, we did not choose them for our modelling in case the lower price reflected temporary retail pricing strategies.

Ignoring those outliers, the analysis demonstrates that there is no significant difference in value of the remaining 14 units – irrespective of their size. At best, it could be argued that a slight value proposition exists in favour of larger systems.

7.2.3 RCAC Choice

Overall, ATA found a relatively level playing field between the real economic value of smaller and larger sized systems. This means cost assumptions regarding RCACs can be generalised on the basis of the heated floor area of a building, which is a key determinant of the overall installed heating capacity required.

The system specification for a home will be based on the best combination of systems with respect to heating requirements. For more open-plan homes, a smaller number of larger systems will be more appropriate. For a less open-plan home of the same floor area, the opposite will be preferable.

Due to the consistency of the true value across different sized systems, ATA's economic analysis is applicable to either.

Noting the above, ATA then selected two specific RCAC models – one small/medium, and one large – for the purposes of determining purchase price and performance for the modelling.

There are hundreds of models of RCACs available on the market. ATA expanded its existing RCAC sample from the Energy Rating website to capture a wider range of brands (35 small/medium [<3.6kW] and 28 large [>5.5kW]) as well as the existence of at least two of the higher performing models for each size range.

Within the sample, ATA found:

- a number of 6.0-7.0kW systems with a CoP of 4.0; and
- a number of 3.0-3.5kW systems with a CoP of between 5.0 and 6.0.

Those higher performing models, and their associated retail price[9], are outlined below:

Table 7-7: Higher Efficiency RC Air Cons, Large & Small

Model	Size (kW)	CoP	Price ($)
Medium to Large (6.0-7.0kW) Models			
Daikin FTXZ50N / RXZ50N	6.3	4.5	3369
Mitsubishi SRK50ZJX-S1 / SRC50ZJX-S	6	4.25	1420
Mitsubishi SRK50ZMXA-S / SRC50ZMXA-S	6	4.25	1450
Mitsubishi SRK60ZJX-S1 / SRC60ZJX-S	6.8	4	1568
Daikin FTXS60L	7	4	1976
LG UTN21WH/UU21WH	7	4	n/a
Fujitsu ASTG22KMCA/AOTG22KMCA	7.2	4	1419
Mitsubishi SRK60ZMXA-S / SRC60ZMXA-S	6.8	4	1716
Price chosen for modelling			***1600***

[9] Current retail price estimates were taken from:
http://www.woodpecker.com.au/woodpecker-products/daikin-ururu-sarara-split-system
http://appliancecentral.com.au/shop/index.php?route=product/product&product_id=380
http://www.getcool.com.au/d43/daikin-ftxs60l
http://www.webprice.com.au/online-store/daikin-ftxs60l-6-0kw-cooling-7-0kw-heating-split-system-air-conditioner?utm_source=myshopping&utm_medium=cpc&utm_campaign=Air+Conditioners&utm_term=Daikin+FTXS60L+6+0kW+Cooling+7+0kW+Heating+Split+System+Air+Cond
http://www.arrowairconditioning.com.au/DAIKIN-FTXS60L-Split-Inverter-Air-Conditioner-p/ftxs60l.htm
http://www.airconditioningsales.com.au/mitsubishi-air-conditioner-srk60zmxa-s.html
http://www.lawsonair.com.au/online-shop/all-product-categories/ururu-sarara-splits/daikin-ftxz50n-buy-online
http://www.airconditioningsales.com.au/mitsubishi-air-conditioner-srk50zma-s-1.html
http://appliancecentral.com.au/shop/index.php?route=product/product&product_id=368
http://www.airconditioning-online.com.au/mitsubishi-heavy-industries-SRK50ZMXA-S
http://www.lawsonair.com.au/online-shop/all-product-categories/ururu-sarara-splits/daikin-ftxz25n-buy-online

Small (3.0-4.0kW) Models			
Daikin FTXZ25N / RXZ25N	3.6	7	2045
LG K09AWN-NM12/K09AWN-UM12	3.2	6	874
Mitsubishi SRK25ZJX-S	3.13	5.5	1118
Mitsubishi SRK25ZMXA-S / SRC25ZMXA-S	3.13	5.5	964
Mitsubishi ELECTRIC MSZ-FB25VA	3.2	5	1245
Daikin FTXS25L / RXS25L	3.4	5	1103
Fujitsu ASTG09KMCA/AOTG09KMCA	3.2	5	810
Fujitsu ASTG09KUCA/AOTG09KUCA	3.2	5	870
Samsung Electronics AR09FSSSBWKN/AR09FSSSBWKX	3.2	5	836
Samsung Electronics AR09FSSSCURN/AR09FSSSCURX	3.2	5	795
Price chosen for modelling			***850***

Reflecting the selection criteria outlined in **Section 2.3**, and with particular emphasis on the appliance choice being representative of most commonly available models, the following systems were chosen for analysis:

- Large RCAC – the average price of the second and third most cost effective larger models (6.8kW Mitsubishi models SRK60ZJX-S1 and SRC60ZJX-S), excluding the cheapest Fujitsu ASTG22KMCA (to account for any potential limitations of consumer choice) – at **$1,600**;
- Small RCAC – the average price of the 6 most cost effective systems ranging between 3.1 and 3.2kW and CoP 5.0-5.5 – this being **$850**.

For the purposes of choosing a realistic CoP for the above units, ATA chose:

- Large RCAC: 4.0;
- Small RCAC: 4.5[10].

These figures represent de-rating below the collected sample to account for:

- performance deterioration over time;
- sub optimal installation, such as longer pipe runs in which more heat is lost within the system;
- homes with higher gas heating needs may be more common in cooler climates that the average test conditions of RCACs; and
- appliance choice may be limited for some consumers, particularly in regional areas.

In locations that experience the coldest temperatures, ATA further de-rated the CoP by 0.5 to account for lower performance in cold climates. Refer to **Section 7.2.6** for more detail on this.

[10] Arguably, an indicative efficient commonly-available small RCAC system could be assumed to have a CoP above 5.

7.2.4 Installation Cost

To account for variations in installation cost, ATA obtained a sample from a range of RCAC installers and retailers, which indicated the following results:

Table 7-8: Indicative Installation Costs, RC Air Cons

Complexity of Install	Installation Price ($)	Comments
Low	800	Uncomplicated, back to back, single storey.
Medium	1,200	Above plus at least one of following variations: More electrical work / upper storey / long pipe-run with lagging / complex header installation.
High	1,800	Above plus two or more of the above variations.

On the basis of the above, ATA chose to use an average installation cost of $1,000 per RC air con unit installed. The sample of data indicated that the majority of actual installations fall below this value.

Additionally, it would be reasonable to assume the cost of a high complexity installation will be a disincentive for most consumers to install one or more RCAC systems.

7.2.5 Maintenance

Due to a lack of reliable publically available data, ATA undertook a survey to gather information of maintenance costs for gas and electric heating and cooking appliances.

Participants included ATA members, newsletter recipients and the general public, accessed primarily through other stakeholder communications channels including the network of energy consumer advocates. Data from about 50 respondents was used to inform maintenance costs for space heating and cooking.

ATA asked questions relating to the type and age of the space heating appliance, length of tenure of the householder and the money they had spent on maintenance to date. After excluding outliers and adjusting for absent data, ATA used the annual average maintenance cost for each appliance as the input for the model:

Table 7-9: Annual Maintenance Cost Assumptions, Gas & RC Air Con

Heating	Min ($)	Max ($)	Average	Count	Zero Spend[11]	Zero Spend %
Gas Ducted	0	154	**63**	11	1	9%
Gas Wall/Space	0	80	**24**	11	5	45%
RC/AC			**27**	22	13	59%

[11] No maintenance required over whichever period is shorter of a. the period of tenure and b. the age of the appliance.

7.2.6 Asset Life

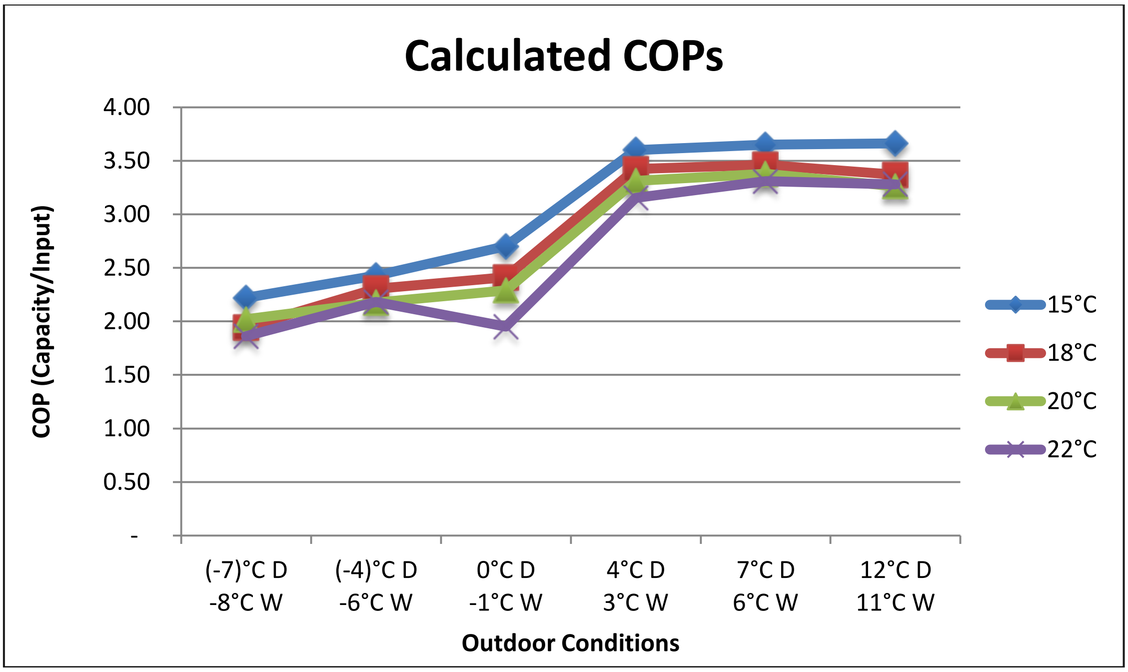
The asset life of RCACs varies with quality of construction, maintenance and usage. The National Association of Home Builders in consort with Bank of America produced a report in 2007 called 'Home Equity Study of Life Expectancy of Home Components'. It reports a 16 year average lifetime for RCACs. ATA assumed RCACs should last a minimum of 10 years and average 12 years.

7.2.7 CoP Penalties & Capex Sensitivity

As noted, the CoP of RCAC vary with ambient temperature conditions, and in colder climates they may not achieve the average annual CoP claimed by the manufacturer [12].

Figure 7-5 below indicates how CoP is affected by outdoor ambient air temperature and the required level of heating (the indoor air temperature maintained by the system is between 15^{0}C and 22^{0}C)[13]:

Figure 7-5: Variation of Average CoP by Outdoor Air Temperature



As can be seen, there is a marked drop in the CoP associated with RCAC when the ambient air temperature falls below four (4) degrees Celsius (^{0}C).

Above 4^{0}C and the CoP of a typical RC air con will stay within a range of between 3 and 4. Below 4^{0}C and the CoP falls away to below 2.5.

[12] Manufacturer-stated CoPs are based on ambient outdoor temperature of 7^{0}C determined by standard test conditions under AS/NZS 3823: http://www.airah.org.au/imis15_prod/Content_Files/EcoLibrium/2014/April14/04-14-Eco-006.pdf

[13] Manufacturer data

Taking this into account, ATA applied a CoP 'penalty'; a de-rating of the COP for locations where temperatures regularly fall below 4^{0}C throughout the highest heating seasons of the year. The penalty was assumed to be 0.5 CoP with the locations identified in the table below:

Table 7-10: CoP Penalty, by Location

Climate	Location	CoP Penalty
Heating Dominated	Tullamarine	- 0.5
Heating dominated High Demand	Canberra	- 0.5
Heating dominated High Demand	Orange	- 0.5

7.2.8 Attribution of Cooling Value to Capital Cost

RCAC also provides the benefit of cooling – indeed many consumers are more familiar with this function of RCAC than heating. In warmer climates, cooling is often the sole motivator for a consumer to purchase an RCAC.

To account for the different value placed by consumers on cooling in certain locations, ATA chose a portion, ranging from 0 to 100%, to reflect the capital value attributable to the heating function of RCAC for each location.

For example, where 50% is attributable, half of the capital cost of the RCAC is attributable to heating and included in the analysis, while the other half is attributed to cooling – a function that is not provided by equivalent gas fuelled appliances.

Where 100% is attributable, the RCAC is purchased for heating purposes and any cooling benefit is incidental. Where 0% is attributable, the RCAC is purchased for cooling purposes and any heating benefit is incidental.

To reflect the range of consumer motivations for appliance choice within each climate zone, ATA then applied a sensitivity value in order to understand the economic impact of the relative value placed by a consumer on heating versus cooling. These default and sensitivity values were as follows:

Table 7-11: Default Capex & Sensitivity for Heating, by Location

Climate	Location	Default Capex (Heating)	Capex Sensitivity (Heating)
Balanced Moderate Demand	Adelaide	50%	100%
Balanced Moderate Demand	Mascot	50%	100%
Cooling dominated - humid	Darwin	0%	
Cooling dominated - humid	Townsville	0%	
Heating Dominated	Melbourne	100%	0%
Heating dominated High Demand	Canberra	100%	0%
Heating dominated High Demand	Orange	100%	0%
Low Demand	Brisbane	0%	50%

7.2.9 RCAC Configuration & Sizing

ATA selected a specific number and size of RCAC units for each of the Household Scenarios. The choices were based on:

- floor area: 1kW of heating capacity per 10 m^2 of floor area is adequate for housing of the type selected throughout most of the study area.
- In high demand heating climates (Canberra and Orange), the standard industry advice is 1kW per 8.5m^2. In low demand heating climates (Brisbane), the industry advice is 1kW for each 16m2; and
- number of rooms: a single unit is typically not effective at heating more than two rooms.

ATA used these benchmarks[14] as a check that adequate RCACs for heating are installed for the households.

Table 7-12: Number & Size of Air Con Units, by Household Scenario

	Scenario 1: Reference Home	Scenario 2: Small House	Scenario 3: Large House	Scenario 4: Public Housing	Scenario 5: LPG House	Scenario 6: New Build (6 Star)
Total Heated Area (m^2)	**120**	**70**	**160**	**70**	**40**	**160**
No. Rooms to be Heated	Up to 6	Up to 4	Up to 8	Up to 4	Up to 2	Up to 8
No. 7.0kW Systems	1	1	2	1	1	2
No. 3.0kW Systems	2	1	2	1	-	2

7.2.10 Zoning

ATA's analysis accounts for the relative operating time of different RCACs to reflect how multiple units are typically used within a home.

In typical home, RCAC used for heating living areas are likely to be operational for the majority of the heating time required. However, given the potential for zoning[15], ATA assumed:

- a primary, large heating unit will be operating during all heating hours;
- any second large unit (if present) is in operation 90% of heating hours; and
- small units, more likely to be used in bedroom and other non-living areas, are in operation for 50% of heating hours.

To account for this, ATA adjusted the operational time and energy use for relevant RCACs accordingly.

[14] http://www.elgas.com.au/blog/476-gas-heater-sizing-facts
[15] Space heating or cooling only of areas that require temperature control.

7.2.11 Electricity Use per Climate Zone per Household Scenario

Taking into account the approach and assumptions described in this section, the following annual electricity consumption figures were calculated for RCACs across the climate zones and Household Scenarios:

Table 7-13: Annual RC Air Con Energy Use by Climate Location & Household Scenario, kWh

Climate	Location	Scenario 1: Reference Home	Scenario 2: Small House	Scenario 3: Large House	Scenario 4: Public Housing	Scenario 5: LPG House	Scenario 6: New Build (6 Star)
Balanced Moderate Demand	Adelaide	703	418	873	418	313	440
Balanced Moderate Demand	Sydney	488	290	607	290	218	278
Heating Dominated	Melbourne	1,429	849	1,776	849	637	1,429
Heating Dominated	Tullamarine	1,899	1,133	2,368	1,133	853	1,735
Heating dominated High Demand	Canberra	2,267	1,353	2,828	1,353	1,019	1,454
Heating dominated High Demand	Orange	3,096	1,848	3,862	1,848	1,392	1,929
Low Demand	Brisbane	242	144	301	144	108	117

7.3 Energy Use – Gas

To ensure consistency in the analysis, the approach to identifying annual fuel consumption for gas ducted and wall furnace space heaters drew on much of the underlying logic developed for electric RCAC where relevant.

The most relevant heating load was used from **Table 7-5** and applied to the heated area of each home.

The burner efficiency, for both gas ducted and wall furnace systems, was determined and applied to each Household Scenario. These estimates drew from previous work done by Energy Consult[16] and BZE. The assumed burner efficiencies are:

- 80% for ducted heating systems (Household Scenarios 1, 2, 3 and 6);
- 70% for wall furnace systems (Household Scenarios 4 and 5).

[16] EnergyConsult. (2012). Product Profile: Gas Space & Decorative (Fuel Effect) Heaters: Equipment Energy Efficiency Program.

The 2012 Energy Consult report showed that the sales were clustered around 25MJ-30MJ gas wall furnaces with 67%-70% efficiency. ATA also accounted for heat losses through the ducting system for Household Scenarios where ducted systems were modelled (Household Scenarios 1, 2, 3 and 6 in Victoria and the ACT).

Old, poorly maintained ducting systems can incur heat loss of up to 50%, due to leaks, obstructions and poor insulation of ducts and fittings; whilst new ducting is in the range of 15 to 20% (the higher end of that range applying to larger homes with longer duct systems)[17].

Noting the above, the assumed ducting losses are:

- 20% for brand new ducting (Household Scenario 6);
- 25% for existing ducting in small and medium sized homes (Household Scenarios 1 & 2); and
- 30% for existing ducting in larger homes (Household Scenario 3).

These figures assume the ducting in existing systems is in good repair.

Ducted gas heating is common only in Victoria and the ACT (41-42% of households[18]). For climate zones outside these states, the ATA assumed multiple gas wall units for all household scenarios. Less than 2% of households in NSW rely primarily on gas ducted heating and it is not known whether these households cluster into the very cold climates.

In the interests of making conservative assumptions for this report, the ATA has assumed gas wall units across NSW. In a few instances, the best match for heating demand for a gas zone outside Victoria or the ACT was determined by the ATA to be Melbourne or Canberra. (For example, Tasmania has a comparable heating load to Canberra and Wagga Wagga has a comparable heating load to Melbourne.) Consequently another series of heating loads with gas wall units for all household scenarios was calculated.

The electricity use associated with the fan in both gas ducted and wall furnace heating systems was also included. ATA gathered the average annual operating hours by gas appliance and state defined by Energy Consult[9], reviewed the power and energy associated with gas fan use from a range of sources including Whirlpool forums as well as ATA internal sources, to indicate typical fan motor rated capacity and running time to estimate electrical energy consumption.

ATA did not analyse thermostat or controller loads. As well as being minor, these are common to both gas ducted and RCAC systems and therefore can be considered to cancel out for the purpose of comparing one system type with another.

The above approach led to the following gas appliance fuel use estimates in each of the climate zones and for each of the Household Scenarios:

[17] Pears, A. (2013). 'Winter comfort, Not just a heater choice', ReNew 127 & 128.
Palmer (2008). 'Field study on gas ducted heating systems in Victoria', RMIT thesis, September 2008.

[18] Australian Bureau of Statistics, 4602.0.55.001 Environmental Issues: Energy Use and Conservation - More Tables, March 2011, Table 8.

Table 7-14: Annual Gas Appliance Energy Use by Climate Location & Household Scenario

Climate	Location		Scenario 1: Reference Home	Scenario 2: Small House	Scenario 3: Large House	Scenario 4: Public Housing	Scenario 5: LPG House	Scenario 6: New Build (6 Star)
Balanced Moderate Demand	Adelaide	MJ pa	15,497	8,893	18,784	8,906	6,477	9,404
		kWh pa	38	24	46	24	16	46
Balanced Moderate Demand	Sydney	MJ pa	10,767	6,179	13,050	6,187	4,500	5,946
		kWh pa	69	43	84	43	29	84
Heating Dominated	Melbourne	MJ pa	45,853	26,748	65,505	18,110	13,171	32,571
		kWh pa	235	176	353	44	29	353
Heating Dominated	Tullamarine	MJ pa	53,760	31,360	76,800	21,232	15,442	56,286
		kWh pa	235	176	353	44	29	353
Heating dominated High Demand	Canberra	MJ pa	64,193	37,446	91,705	25,353	18,438	47,143
		kWh pa	230	173	346	43	29	346
Heating dominated High Demand	Orange	MJ pa	60,252	34,576	73,030	34,626	25,183	36,291
		kWh pa	69	43	84	43	29	84
Low Demand	Brisbane	MJ pa	5,340	3,064	6,472	3,069	2,232	2,511
		kWh pa	16	10	19	10	7	19
Heating Dominated	Melbourne (Gas wall units)	MJ pa	31,609	18,110	38,195	18,110	13,171	18,992
		kWh pa	71	44	85	44	29	85
Heating dominated High Demand	Canberra (Gas wall units)	MJ pa	44,252	25,353	53,471	25,353	18,438	27,488
		kWh pa	69	43	84	43	29	84

7.3.1 Gas Capital & Installation Costs

As with RCACs, ATA reviewed an online sample[19] of 17 gas wall furnaces and flued convection space heaters; as well as five gas ducted heaters, in order to understand appropriate capital costs for the modelling.

Indicative installation costs were drawn by many of the same suppliers, as well as direct discussions with gas installers in Victoria, WA and online. With regards to installation assumptions, it should be noted that for ducted systems (relevant to Household Scenarios 1-3), only the cost associated with burner replacement is used in the analysis in the context of understanding capital cost of replacement gas heating systems – as these homes will already have ducts in place.

This analysis led to the following capital and installation cost inputs for gas heaters:

Table 7-15: Capital & Installation Cost Assumptions, Gas Heaters

Scenario	Replace GDH Furnace	Replace GDH Furnace (MJ)	Wall Units (No.)	Purchase Price ($)	Installation Cost ($)	Total ($)
1 – Reference Home	1	80		2,100	700	2,800
2 – Small Home	1	50		1,600	600	2,200
3 - Large Home	1	120		2,600	800	3,400
4 - Public Housing			2	2,400	600	3,000
5 - LPG House			1	1,200	300	1,500
6 - New Build						4,000

7.3.2 Asset Life

Energy Consult profiled gas ducted heaters in 2011 and gas wall heaters in 2012 for the Equipment Energy Efficiency (E3) program with the same results for both: i.e. expected asset lives of 15 to 25 years. Industry sources suggest that about 50% of heaters are replaced within 20 years.

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[19] Current retail price estimates were taken from:
http://www.billyguyatts.com.au/braemar-eco-superstar-wf25-wall-furnace-090061.html
http://www.gstore.com.au/heating-cooling/gas-space-heaters
http://www.gascentral.com.au/collections/space-heaters/products/braemar-wall-furnace
http://www.elgas.com.au/appliances/gas-heaters-gas-fireplaces-gas-log-fires/flued-gas-heaters/braemer-sh18-space-heater-price
http://www.wonders.com.au/page/gas_space_heating.html
http://www.appliancewarehouse.com.au/showProduct.aspx?SEName=rinnai-energysaver-561ft-natural-gas-heater-free-flue-kit&ProductID=5613
http://forums.whirlpool.net.au/archive/1697698
http://www.ductedheatingandcooling.com.au/heating/braemar-ducted-heating/braemar-th-56-star-series/
http://forums.whirlpool.net.au/archive/1908792
http://forums.whirlpool.net.au/archive/2256975

7.4 Other Heating Types Considered

Comparing gas and electric space heating options on a solely economic basis is more complicated than for hot water or cooking.

There are a large range of appliances and configurations available, and non-financial considerations often play a greater role in the decisions a consumer makes than for cooking or water heating.

7.4.1 Hydronic Heating

Hydronic heating, where water is heated centrally and piped to wall-mounted or in-floor heat exchangers to heat space by convection and radiation, is considered the most comfortable form of heating by many consumers.

As there is no forced ventilation, hydronic heating is quieter and less irritating than fan-forced heating from ducted or split systems. Hydronic heating systems tend to cost much more upfront than other fan-forced heating options, but are often significantly cheaper to run.

Some consumers prefer other types of heating as hydronic systems take longer to achieve a comfortable air temperature, or they find hydronic heating panels intrusive.

Hydronic heating was not specifically modelled in our analysis, for a number of reasons:

- Known outcome: For consumers that choose hydronic heating, gas can be assumed to be the most cost effective fuel source for hydronic heating at this stage.
- Lack of efficient electric equivalent: While heat –pump hydronic heating systems are increasingly available, there is not yet a mature market for these, and there has been insufficient use of efficient heat pumps from which to draw enough information about cost and performance.
- Higher costs: Due to higher capital costs, hydronic is the most expensive fixed-appliance heating option over the longer term, even taking into account the lower running costs.
- Consumer priorities: The main motivations for installing hydronic heating are not economic.
- Less common: Due to the cost, hydronic heating is less common than gas ducted heating (the other centralised heating option) and so the findings would be less relevant to the majority of consumers (particularly those more likely to be highly impacted by costs.)

Some of these reasons are explored herein.

Health & Safety

Due to the absence of airborne dust and changes to humidity caused by fan-forced heating, hydronic heating has little or no impact on respiratory health. By comparison, ducted heating systems are known to cause and aggravate health (particularly respiratory) issues. Some people choose hydronic heating for this reason alone.

There is also a risk of minor contact burns from wall mounted hydronic panels, pipes and fittings, however they are generally not hot enough to cause severe burns or start fires.

Consideration of Fuel Options

Hydronic heating can be fuelled by main gas, electricity, or solid fuel. Gas is generally the fuel source of choice for those with access to it.

Electric heat-pumps are a viable source of heat for hydronic systems, however due to the impact on performance of colder weather (when heaters are used more) they are unlikely to be able to compete with gas on a cost basis in the same way they do as a water heating appliance (which is used all year round, including summer when heat pumps perform better).

Additionally, a single electric heat pump is unable to meet a high residential space heating load, requiring multiple units (or alternately large and expensive storage tanks) to replace a gas boiler for bigger systems.

The recent advent of 'bolt on' type heat pumps may change this, as may smarter control systems that allow for a combination of gas and electric heating, where the heat pump supplies most of the heat load for most of the heating season (from water heated during the off-peak period) and gas is used as backup on colder days. These technologies are not yet available though as a mass-market option for hydronic heating systems.

Recommendations

While we have not analysed hydronic systems in detail, our advice for consumers considering hydronic heating is:

- If your primary motivation for hydronic heating is to save money, be aware that hydronic heating is not the most cost effective option for heating your home. The long term savings through lower running costs are insufficient to justify the additional up-front cost when compared to efficient gas or electric appliances. However hydronic heating offers other non-financial benefits.

- At this time, the most cost effective source of fuel for most hydronic heating systems, taking into account the long term costs, is mains gas.

- There are cases when it may be worth considering a heat pump instead of gas to fuel a hydronic system today, such as:

    - high additional up-front cost for gas: if for example you are not already connected to the gas network, or if your gas line needs to be upgraded to supply a new gas system, the capital cost of a new gas hydronic system may be higher than the cost of an efficient electric one with multiple electric heat pumps; and

    - additional fixed charges for gas: if space heating will be your only gas load, and your fixed charges for gas are high, the additional fixed cost may make a new gas hydronic system more expensive option than efficient electric;

- Gas is likely to remain more cost effective for hydronic systems, but if in the future electric heat pumps do become competitive, it is likely that a gas boiler can be replaced or supplemented with an electric heat pump at that time. Therefore there is little risk that a consumer installing a gas hydronic system today will have a stranded asset in the future.

ATA recommend that this analysis is revisited if and when there is a mature market for heat pump powered hydronic heating; or if there is an unanticipated change in the cost of a particular hydronic heating technology.

7.4.2 Radiant Heaters

Radiant heaters, fuelled by gas or electricity and available as fixed or plug-in appliances, are an efficient way to heat because they heat the surface (such as skin or clothes) directly without heating the air in between.

Although common, they are excluded from our analysis as radiant heat is broadly agreed to be lower quality and is not popular for whole-of-home heating. Electric radiant heaters are common in bathrooms, however there are no commonly used gas equivalents; therefore analysis of fuel switching for heating bathrooms is not relevant.

7.4.3 Unflued Heaters

Unflued gas heaters can be fixed or plug-in appliances and are common in some states where their use is not restricted for safety reasons.

They have been excluded from this analysis however as they can be considered unsafe, to the extent that they are banned in public housing in Victoria.

In general terms however, the findings regarding the use of flued gas wall heaters can be loosely applied to unflued heaters, noting that unflued heaters:

- have a lower capital cost than flued heaters; and
- when used safely, may have higher running costs. Due to the lack of flue losses, unflued gas heaters are more efficient at converting gas to end-use heat, however they are dangerous to use in unventilated rooms and some heat is lost from the space in ventilation – hence they may be no more efficient than flued heaters when used safely.

7.4.4 Fan-forced Plug-in Electric Heaters

Fan forced electric plug- in heaters are readily available and are commonly used. Some can heat a small space quickly.

These heaters are known to be highly inefficient and usually the most expensive heaters to run, and so are not recommended for regular whole-of-home heating. Accordingly are excluded from our economic analysis.

7.4.5 Non Fan-forced Plug-in Electric Heaters

Plug in electric heaters that deliver heat with a combination of radiant and non-fan-forced convection (such as oil filled heaters or panel type heaters) are available in many forms and are commonly used today. They are more efficient the fan-forced plug in electric heaters.

They are excluded from our analysis as they are not as cost effective as gas or efficient electric for regular whole-of-home heating expected by typical consumers. Additionally they may take longer to bring a room up to optimal temperature, and are less convenient as an option for whole-of-home heating.

However, where heating is infrequently required - for example in energy efficient buildings, infrequently heated rooms, milder climes or for consumers who are simply more tolerant to cold - plug in non-fan-forced electric heaters are in some cases more cost effective than fixed heating appliances (gas or electric), due to the low capital cost.

Infrequently used plug in electric heaters may displace the need for one or more heating units in homes with fixed non-centralised heating systems (such as electric split systems or gas wall furnaces), reducing the up-front costs and, where used effectively, the longer term costs as well.

While we expect that some consumers will choose to do this, we have not separately analysed this scenario due to the complexity in analysing this choice, and the higher degree of energy literacy and attention to behaviour required by for those consumers to make an informed choice.

From a strictly economic perspective, it could be assumed that where consumers would be better off choosing a plug-in heater because it is cheaper in the long run than a fixed electric heater, this would not alter the case for them to use electricity rather than gas.

7.4.6 Ornamental Heaters

Ornamental heaters, for example those that give the appearance of having a visible flickering flame, can be fuelled by gas or electricity and be fixed or plug-in appliances. There are a variety of types available.

While their price and performance does vary considerably, they have been excluded from specific analysis because:

- many are already accounted for by other heater types (e.g. unflued gas, radiant electric);
- some (though not all) are highly inefficient;
- most (though not all) cost more than the 'non-ornamental' equivalents; and
- consumers are less motivated by economics to choose these heaters over others.

Further, the electric equivalents do not offer the same aesthetic performance as gas ornamental heaters, suggesting electric cannot be considered a viable like-for-like replacement for a gas ornamental heater.

7.4.7 Wood Heaters

There are many types of solid fuel heaters. Most burn wood – some with very high efficiency, others (such as open fires) with very low efficiency.

For many consumers in rural areas with access to low- or no-cost wood fuel, wood heaters are common. They are certainly a viable alternative to electric and gas fuelled heating, and can be the most cost-effective source of space heating. Some wood-fuelled heaters use can also heat water and be used for cooking.

ATA did not analyse wood heaters for space heating because:

- New wood heaters is restricted in many (mainly urban) areas due to the health impacts of wood smoke;
- In rural areas where wood heating is generally not restricted, mains gas is less common;
- Many consumers with wood heating also use other heating sources in any case;
- It is difficult to generalise about the costs of wood heating. High performance wood heaters cost more to purchase, but cheaper heaters are more common. Fuel may be free, but the cost of time and transport to acquire and prepare the fuel would need to be considered to allow an accurate comparison with to gas or electricity;
- most importantly, wood heating requires more effort and sophistication than gas or electric alternatives that operate 'at the flick of a switch' and maintain a constant temperature with minimal intervention. Wood heating requires a higher level of competency to use effectively and safely;
- Noting the above, wood cannot be considered to be a 'like-with- like' substitute for gas or electricity;
- Heating with wood carries a higher risk of burns and fires.

Wood heating is nonetheless a viable and safe alternative to gas or electric heating for consumers with suitable competency, and is hence is the heater of choice for many consumers.

For rural consumers with access to low- or no-cost wood fuel, and who place a low value on the time taken to gather and prepare wood fuel and manage use of the heater, wood heating will generally be a cheaper option than gas and electricity.

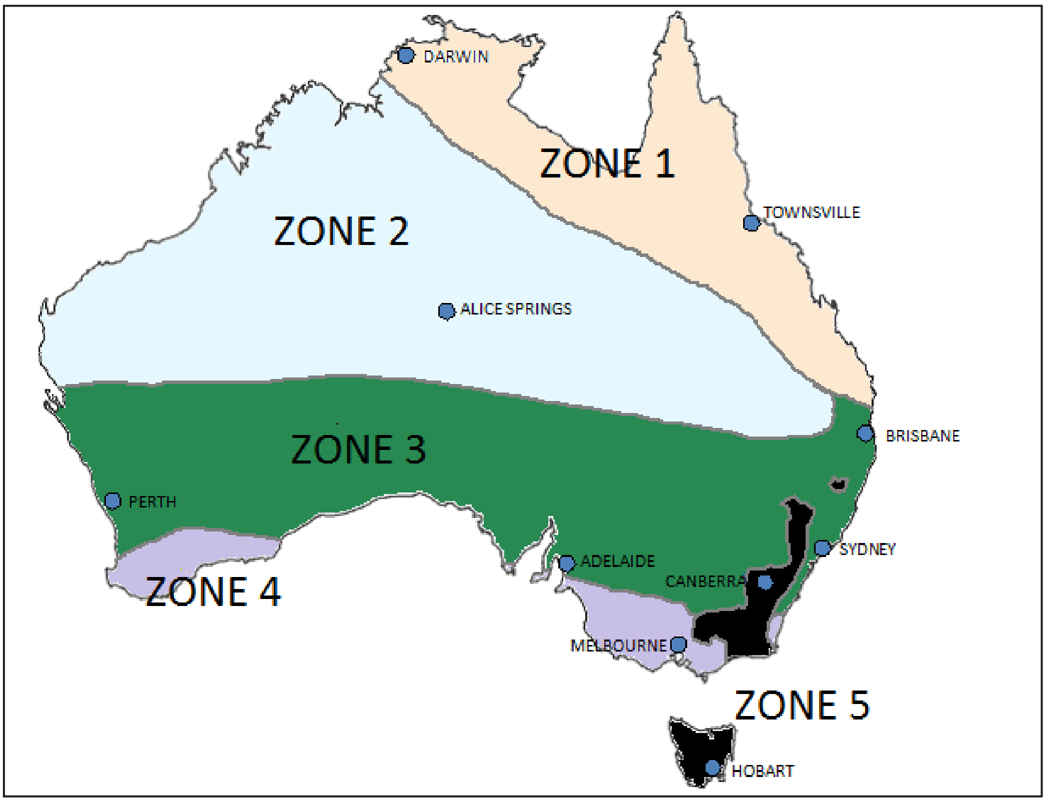
8.0 Appendix C: Methodology – Water Heating

8.1 Annual Energy Use: Gas

In order to understand the potential economic value of replacing existing gas water heaters with electric heat pump alternatives, ATA first needed to consider the annual energy use of gas water heaters.

Input energy usage of gas storage and gas instantaneous hot water systems was informed by a report done by Energy Consult (EC) for Sustainability Victoria in 2009[20]. EC modelled the annual input energy of both storage and instantaneous systems within Zones 3 & 4 of the Australian water heating climate zones:

Figure 8-1: Australian Water Heating Climate Zones



Given its task to advise a Victorian agency, EC's report categorised Zone 3 as 'northern Victoria. In reality, Zone 3 extends through New South Wales and up to (and including) Brisbane – and is therefore of high relevance to this project.

Gas instantaneous systems use both input gas and input electricity, whilst storage systems use only input gas. EC's annual gas and electricity usage of medium (providing 200 litres of hot water per day) and small (120 litres per day) systems in Zones 3 & 4 are as follows:

[20] Energy Consult, 2009 *'Estimated Hot Water System Running Costs in Victoria'*: http://solarthermalworld.org/content/estimated-hot-water-system-running-costs-victoria-2010

Table 8-1: Annual Gas Consumption, Medium Gas Systems providing 200L/Day

Medium Households (200 Litres/day)	Northern Vic/NSW/Brisbane (Zone 3)		Southern Vic (Zone 4)	
	Electricity kWh pa	Gas MJ pa	Electricity kWh pa	Gas MJ pa
Gas storage (3 stars)	0	22680	0	24720
Gas storage (5 stars)	0	19170	0	20980
Gas instantaneous (3 stars)	71	22400	71	24710
Gas instantaneous (5 stars)	71	18700	71	20620

Table 8-2: Annual Gas Consumption, Small Gas Systems providing 120L/Day

Small Households (120 Litres/day)	Northern Vic/NSW/Brisbane (Zone 3)		Southern Vic (Zone 4)	
	Electricity kWh pa	Gas MJ pa	Electricity kWh pa	Gas MJ pa
Gas storage (3 stars)	0	16410	0	17930
Gas storage (5 stars)	0	13180	0	14520
Gas instantaneous (3 stars)	67	13420	67	14970
Gas instantaneous (5 stars)	67	11220	67	12520

8.2 Annual Energy Use: Electric

The most up-to-date independent research on the input electrical energy requirements of heat pump hot water systems was conducted by Pitt & Sherry (2012)[21].

P&S tested nine different models of electric hot water systems, including five resistance and four efficient heat pump systems, for comparative purposes. Small, medium and large models were tested, in 10 different Australian locations (and therefore climatic conditions) and under different hot water loads, in order to understand annual electricity usage.

Table 8-3 below contains the annual electricity usage of the four heat pump systems, compared with comparatively sized resistance systems, for the six locations of relevance to this study:

[21] Pitt & Sherry, 2012 *'Running Costs and Operational Performance of Residential Heat Pump Water Heaters'*: http://www.pittsh.com.au/assets/files/CE%20Showcase/Residential_heat_pump_water_heaters.pdf

Table 8-3: Annual Electricity Consumption (kWh), Resistance & Heat Pump Systems

City	Vol L/day	HP Model 1	MedElecResist	HP Model3	SmallElecResist	HP Model 7	HP Model 9	LgElecResist
Brisbane	136	1053	2009	792	2192	897	876	2088
Brisbane	264	1697	3322	1297	3538	1376	1374	3398
Brisbane	384	2278	4850	1786	4807	1811	1819	4661
Sydney	136	1204	2165	887	2360	1049	983	2249
Sydney	264	1940	3610	1467	3838	1590	1543	3690
Sydney	384	2597	4989	2013	5223	2075	2039	5070
Canberra	136	1084	2549	1139	2774	1517	2287	2639
Canberra	264	2761	4298	1867	4552	2279	2005	4382
Canberra	384	too small	5958	2504	6212	too small	2636	6046
Adelaide	136	1340	2290	963	2494	1184	1068	2377
Adelaide	264	2119	3833	1592	4068	1771	1669	3915
Adelaide	384	2831	5303	2168	5544	2335	2203	5383
Melbourne	136	1401	2353	1001	2562	1206	1112	2441
Melbourne	264	2228	3948	1663	4183	1827	1744	4030
Melbourne	384	2972	5464	2266	5710	2374	2296	5546
Hobart	136	1595	1974	1098	2721	1373	1231	2592
Hobart	264	2556	3256	1828	4465	2082	1932	4301
Hobart	384	3370	4454	2469	6093	2720	2545	5924

The annual electricity use figures for the medium-sized Model 1 system were consistently higher than for the larger sized systems (i.e. Models 7 & 9), except where Model 1 provided 136 litres of hot water per day. As such, Model 1 was considered unreliable and subsequently excluded from further analysis.

Model 3 was a smaller sized system. The annual energy use figures for Model 3 for delivering 136 litres per day is directly comparable to the required heat pump system for the **Small House - Scenario 2**, and was subsequently used for this household scenario.

The large Models 7 & 9, tested to deliver 384 litres per day, was directly comparable to the required heat pump system for the **Large House - Scenario 3**. The average of the annual usage figures for Models 7 & 9 was subsequently used for this Household Scenario.

8.3 Synthesis

The P&S and EC analyses used different daily hot water loads to understand annual energy usage for each system type, as follows:

Table 8-4: Assumed Daily Hot Water Loads, P&S & EC

	Daily Hot Water Load (Litres per day)		
	Small	Medium	Large
Pitt & Sherry – heat pumps	136	264	384
Energy Consult – gas storage & instant.	120	200	N/A

In order to directly compare gas and electric systems for the same daily hot water load, ATA:

- converted the annual gas usage for the small EC gas storage and instantaneous systems (i.e. annual MJ at 120L/day hot water load) into an equivalent annual gas usage for providing 136L/day[22];
- averaged the annual electricity usage of the P&S medium sized Models (7 & 9), at both 136L/day and 264L/day, in order to calculate annual heat pump electricity usage for a 200L/day system – which is directly comparable to the medium sized EC gas systems (and the average of 136L & 264L). This is also directly comparable to the required heat pump system for the **Reference House - Scenario 1**, and was subsequently used for this modelling scenario;
- used the task efficiency of the 5 star gas storage system providing 200L/day (i.e. 66% from Wilkenfeld 2007) and applied a 10% efficiency gain for providing the larger daily volume of 384 Litres. (As the storage losses will be averaged across more hot water, the system should be more efficient at this level of hot water demand) This resulted in a task efficiency of 72.7% being applied to this system size).

These conversions provided the following annual energy usage figures, for the modelled gas storage (5 stars), gas instantaneous (5 stars) and heat pump systems, for the three daily hot water loads and for the relevant modelled house scenarios:

Table 8-5: Annual Gas & Electricity Consumption, ATA Modelled Hot Water Systems

City	Household Size	Hot Water Load	Gas Storage (5 stars)	Gas Instantaneous (5 stars)		Heat Pump
		L/day	MJ pa	kWh pa	MJ pa	kWh pa
Brisbane	Small	136	N/A	68	12716	792
Brisbane	Medium	200	19170	71	18700	1131
Brisbane	Large	384	27788	N/A	N/A	1815
Sydney	Small	136	N/A	68	12716	887
Sydney	Medium	200	19170	71	18700	1291

[22] ATA calculated the increased energy use by a straight line method that increased energy use commensurate with the increase in hot water load.

Sydney	Large	384	27788	N/A	N/A	2057
Canberra	Small	136	N/A	68	14189	1139
Canberra	Medium	200	20980	71	20620	2022
Canberra	Large	384	30249	N/A	N/A	2636
Adelaide	Small	136	N/A	68	12716	963
Adelaide	Medium	200	19170	71	18700	1423
Adelaide	Large	384	27788	N/A	N/A	2269
Melbourne	Small	136	N/A	68	14189	1001
Melbourne	Medium	200	20980	71	20620	1472
Melbourne	Large	384	30249	N/A	N/A	2335
Hobart	Small	136	N/A	68	14189	1098
Hobart	Medium	200	20980	71	20620	1655
Hobart	Large	384	30249	N/A	N/A	2633

8.3.1 Gas Capex & Opex

For new, 5 star gas storage and instantaneous systems, ATA reviewed a sample of a range of system prices available on four different online supplier websites[23] comprising 16 gas storage models and 12 gas instantaneous models in total.

ATA also reviewed installation costs, for 'like-for-like' gas hot water system replacements with Bunnings and with a number of individual hot water suppliers. This data review provided the following purchase and installation costs for the two types of gas hot water systems per Household Scenario:

Table 8-6: Gas Hot Water Purchase & Installation Costs by Household Scenario

Household Scenario	Appliance Type / Size	Purchase Price ($)	Installation Cost ($)	Total Upfront Cost ($)
Scenario 1 - Reference Home	Storage Med	1,200	300	1,500
Scenario 2 - Small House	Instant	900	300	1,200
Scenario 3 - Large Home	Storage Large	1,500	300	1,800
Scenario 4 - Public Housing	Instant	900	300	1,200
Scenario 5 - LPG House	Instant	900	300	1,200
Scenario 6 - New Build	Storage Large	1,500	300	1,800

For Victoria, ATA assumed no discount to the purchase price on the basis of the VEET scheme, as this is due to end in 2015.

[23] http://www.gstore.com.au/hot-water.html
http://www.elgas.com.au/appliances/gas-hot-water-heaters
http://www.bunnings.com.au/hotwater-gas-unit
http://www.hotwaterprofessionals.com.au/

8.3.2 Heat Pump Capex

For new heat pump hot water systems, ATA reviewed a sample of a range of system prices available on two online supplier websites[24] as well as from previous reviews by both BZE and Choice[25]. ATA reviewed 16 heat pump models from these sites in total.

ATA also reviewed installation costs for heat pump systems from the same sites (where available), as well as using information (labour time) from one manufacturer and another supplier (EcoShop).

This data review provided the following purchase and installation costs for the two types of gas hot water systems per Household Scenario:

Table 8-7: Heat Pump Hot Water Purchase & Installation Costs by Household Scenario

Household Scenario	Heat Pump Size	Purchase Price ($)	Installation Cost ($)	Total Upfront Cost ($)
Scenario 1 - Reference Home	Med	4080	600	$4,680
Scenario 2 - Small House	Small	3980	600	$4,580
Scenario 3 - Large Home	Large	4190	600	$4,790
Scenario 4 - Public Housing[26]	Med	4080	600	$4,680
Scenario 5 - LPG House	Med	4080	600	$4,680
Scenario 6 - New Build	Med	4080	600	$6,080

For Victoria, ATA assumed no discount to the purchase price on the basis of the VEET scheme, as this is due to end in 2015. For other jurisdictions, no energy efficiency scheme incentives were assumed either.

Given current status of the Renewable Energy Target (and particularly the SRES), ATA assumed the current purchase price, including the discount associated with STCs for heat pumps, remains. The number of STCs varies by heat pump size and climate zone, but at $34 per certificate reduce out of pocket expenses by $1,000-$1,200.

8.3.3 Maintenance

For both gas and electric hot water, maintenance is a significant factor during appliance asset life.

For both gas and heat pump technologies, periodic routine servicing is assumed to reach the intended asset life and maintain good performance. In regards to heat pump maintenance, the Australian Government's Department of Industry[27] states:

[24] http://www.enter-shop.com.au
www.energymatters.com.au

[25] BZE (2013)
Choice (2008), Heat Pump Buyers Guide

[26] The SA Government's Solar Hot Water Rebate Scheme offers a $500 rebate to low income households. ATA included this for the concession-eligible Household Scenario 4 for Adelaide.

> "Talk to your installer about having your water heater regularly inspected and serviced, checking the integrity of the refrigeration system and replacing the pressure relief valves where required. Refer to manufacturer's instructions and installer's advice on when your system should be inspected and serviced."
>
> "Most tanks have a sacrificial anode (a metal rod that protects the metal hot water tank by attracting corrosion) that a licensed service person needs to replace approximately every five years."

For gas hot water, ATA assumed $30 per annum for anode replacement every 5 years (i.e. approx. $150 anode replacement cost). For heat pumps, enquiries with manufacturers and installers conversations suggested servicing and re-gassing should occur at least every five years, and costing in the order of $150-$200 per service. Accordingly $40 per annum for re-gassing was assumed.

While some suppliers and plumbers recommend more frequent routine scheduled maintenance, there is no evidence to suggest that the benefits of doing so outweigh the costs over the longer term.

8.3.4 Asset Life

The asset life of a water heater typically ranges from 10-15 years, 'depending on the material and lining of storage vessels, and on water pressure and quality)'.[28]

After reviewing the literature and consulting with industry, Wilkenfeld (2010)[29] concluded that gas instantaneous (12 years) would last a little longer than gas storage (10 years). Heat pump electric storage also average about 10 years. Accordingly, ATA have assumed asset lives of:

- gas instantaneous (12-15 years);
- gas storage (10-12 years);
- heat pump (10 years).

8.4 Electric Resistance Water Heaters

ATA also modelled the performance of electric resistance water heaters supplied by cheaper off-peak electricity in two Victorian locations – Richmond (Melbourne) and Mildura – to provide guidance to those consumers who may not be able to install heat pumps (e.g. due to space or building configuration constraints – such as an apartment block) but can access cheaper off-peak rates for electricity.

To understand the case for electric resistance systems, ATA modelled an off-peak tariff of 15c per kWh.

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27 'Heat Pump Water Heater Guide for Households', 2013, p9: http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Water_Heating/Heat_Pump_Water_Heaters/HeatPumpWaterHeaterGuide_toWeb.pdf

28 George Wilkenfeld and Associates, "Specifying the Performance of Water Heaters for New Houses in the Building Code of Australia" December 2007.

29 George Wilkenfeld and Associates, "Regulation Impact Statement: for Decision Phasing Out Greenhouse-Intensive Water Heaters in Australian Homes" Prepared for the National Framework for Energy Efficiency by George Wilkenfeld and Associates with National Institute of Economic and Industry Research, 15 November 2010.

9.0 Appendix D: Methodology – Cooking

While different in a number of ways, gas and electric induction cook tops are considered to be of similar enough quality to be interchangeable for the purposes of this research. While each has its clear pros and cons in terms of the user experience, electric induction cook tops are considered to be at least as user-friendly as gas cook tops in most respects, and have some advantages over gas.

Gas cook tops remain the appliance of choice for consumers over electric resistance (non-induction) cook tops; yet electric induction cook tops are overwhelmingly preferred over gas by consumers who are familiar with both gas and induction. This is reflected in the fact that many consumers with access to gas still choose electric induction in spite of it being (until recently) the more expensive option.

9.1 Energy Use

ATA found very little useful information available on the typical energy consumption of gas or induction cook tops. Of the literature that does exist, it does generally agree that gas use for cooking is a very small proportionate part of a household’s overall annual gas bill.

According to the NSW Independent Pricing and Regulatory Tribunal (IPART)[30], household use of gas for cooking is around 500 MJ per quarter. This estimate agreed closely with the findings of ClimateWorks Australia in their '*Low Carbon Lifestyles*’ reports (2012) that assumed 1552 MJ per annum throughout Australia.

Taking the figure of 2000 MJ per annum, ATA apportioned this between gas cook top use and gas oven use (60/40) and considered high and low usage levels for sensitivity (high: 3,000 MJ pa; low: 1,000 MJ pa). ATA converted the MJ/pa figure into electricity (kWh/pa) for induction and ceramic-based cook tops and ovens and applied an efficiency factor at the point of use for each cooking appliance type:

Table 9-1: Energy Use & Efficiency of Gas and Electric Cooking Appliances

Type	Energy input	Energy input	Efficiency at point of use	Energy Output
Cook top	*MJ/pa*	*kWh/pa*	*%*	*MJ/pa*
Natural Gas	1,200	333	40%	480
Induction	600	167	80%	480
Ceramic	667	185	72%	480
LPG	691	192	70%	480
Oven				
Natural Gas	800	222	7%	56

30 http://www.ipart.nsw.gov.au/Home/For_Consumers/Compare_Energy_Offers/Typical_household_energy_use

Electric	400	111	14%	56
LPG	560	156	10%	56
Total				
Natural Gas	2,000	556		
Electric Induction	1,000	278		
Electric Ceramic	1,067	296		

The efficiency factors were referenced from a variety of sources as per the table below:

Table 9-2: Point of Use Efficiency Factors of Gas and Electric Cooking Appliances

Type	Power Source	%	Reference
Oven	Elec	14%	BZE 2013
Oven	Natural gas	7%	BZE 2013
Oven	Natural gas	5.2-5.3%	US DoC
Oven	Elec	9.3-9.6%	US DoC
Oven	LPG Gas	21%	Ehow
Oven	LPG Gas	10%	Gas company (www.alliantgas.com)
Cook top	Natural gas	40-45%	Choice 2013
Cook top	Elec -Ceramic Radiant	65-85%	Choice 2013
Cook top	Elec - Induction	85-90%	Choice 2013
Cook top	Elec -Ceramic Radiant	79%	BZE 2013
Cook top	Natural gas	40%	UBC students citing US DoE
Cook top	Elec - Radiant	71%	UBC students citing US DoE
Cook top	Elec - Induction	84%	UBC students citing US DoE
Cook top	Elec - Radiant	57%	Wuppertal 2013
Cook top	Elec - Induction	80%	Wuppertal 2013
Cook top	LPG - kitchen - cold start	76%	Aprovecho (test results)
Cook top	LPG - kitchen - simmer	63%	Aprovecho (test results)
Cook top	"Trad electric"	60%	Alan Pears
Cook top	LPG standard cook tops	40%	Gas company (www.alliantgas.com)
Cook top	Natural gas	Approx. 30%	US DoC
Cook top	Elec	77-82%	US DoC

9.2 Capital Costs

As with RCACs and heat pumps, ATA reviewed an online sample[31] of 34 gas cook tops and ovens; and 32 electric cook tops and ovens, in order to understand appropriate capital and installation costs for the modelling. As a result of this analysis, the following capital and installations costs were chosen as model inputs:

Table 9-3: Capital & Installation Cost Assumptions, Gas & Induction Cooking

	Purchase Price ($)	Installation Cost ($)
Gas:		
Cook Top	400	170
Oven	1,000	230
Electric:		
Oven	500	150
Induction Cook Top	700	250
Ceramic Cook Top	450	150

9.3 Asset Life

The US benchmarking study (National Association of Home Builders/ Bank of America) indicate that gas ovens and cook tops are among the longest lived of home appliances. It reports that gas ovens typically last 10-18 years and gas (cooking) ranges 15-17 years. The same source reports the lifespan of electric ranges at 13 years.

31 Current retail price and installation cost estimates were taken from:
http://www.ebay.com.au/itm/like/111257445502?clk_rvr_id=666054824171&crlp=1_262691&mt_id=641&mid=428969&sdc_id=1405318213z521353z51073b0a574zzz&fitem=111257445502&linkin_id=8080378&kw={query}&crdt=0&sortbid=35
http://www.electroseconds.com.au/browse-products/cooking-appliances/gas-cooktops/
http://www.buysmarte.com.au/
http://www.getprice.com.au/6-gas-kitchen-cooktops-gpc115t1376t2378.htm
http://www.whitfordshomeappliances.com.au/
http://www.wyz.com.au/Install.aspx
http://www.aus-appliances.com.au/emilia-sec64gwi-gas-cooktop-with-wok-burner.html
http://www.appliancesonline.com.au/600mm60cm-emilia-gas-wall-oven-emf61mvi/
http://www.frog.net.au/gas_cook_tops.html
http://www.2ndsworld.com.au/oven-cooktop-rangehood-stove/oven/gas-oven/
http://www.stancash.com.au/
http://www.pricepirate.com.au/
http://www.billyguyatts.com.au/westinghouse-single-oven-gor474wlp.html
http://www.handycrew.com.au/wp/cooking/
http://www.wyz.com.au/Install.aspx
http://www.theelectricdiscounter.com.au/Cooking-Appliances/Gas-Or-Electric-Wall-Ovens
http://www.harveynorman.com.au/
http://www.bunnings.com.au/our-range/kitchen/appliances/ovens-cooktops
http://forums.whirlpool.net.au/archive/1278748
http://forums.whirlpool.net.au/archive/1781669

As a relatively new technology, the lifespan of induction is somewhat unknown; however some models (such as LG[32]) come with a 10 year warranty, suggesting manufacturer confidence in similar life spans to gas equivalents.

9.4 Maintenance Costs

In order to obtain realistic estimates of ongoing maintenance costs, ATA undertook a survey of ATA members and members of the public accessed through other stakeholders. ATA used this survey of 49 respondents to inform maintenance costs for space heating and cooking.

Given that induction cooking is relatively new, ATA did not receive enough responses back for this cooking appliance, suggesting a zero maintenance cost. In order to be conservative, ATA used the average maintenance cost for gas cook tops would also apply to induction cook top maintenance.

Table 9-4: Maintenance Cost Assumptions, Gas & Induction Cooking

Cooking	Min ($)	Max ($)	Average	Count	Zero Spend	Zero Spend %
Gas Cook top	0	43	**2**	25	16	64%
Gas Oven	0	64	**14**	15	5	33%
Induction Cook top	0	0	**0**	4	3	75%
Electric Oven	0	70	**11**	7	3	43%

9.5 Non-Economic Considerations

The majority of consumers who are in a position to choose between gas and electric induction for cooking will be used to cooking with gas, and have little or no experience cooking with electric induction. Consumers are naturally reluctant to change behaviour. It is unsurprising then that the (qualitative) feedback ATA has received in researching consumer preferences suggests that:

- many consumers who have no experience with electric induction are reluctant to move away from gas and some are sceptical that induction might offer a comparable experience;
- consumers who have limited experience with induction and more experience with gas report mixed preferences, with some preferring gas and others induction;
- consumers who are familiar with both gas and induction overwhelmingly tend to prefer induction.

Learning to cook with electric induction is not difficult. Most people who are experienced with gas or electric resistance cook tops could be expected to become confident with induction cooking within a few weeks.

Naturally, for some consumers, the desire to cook with gas will be stronger than the desire to save money over the longer term. Regardless of whether and how they use other gas appliances, these consumers are likely to stay connected to the gas network, or use bottled gas, for the purpose of cooking.

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[32] http://www.lg.com/au/built-in-appliances/lg-KA68030F-cooktop

9.5.1 Utensils & Appliances

Gas cook tops are more versatile than induction in terms of use with different cookware. The most often noted disadvantage of induction cooking is that it only works with flat-bottomed ferrous (e.g. steel) utensils. For a consumer moving from gas cooking to induction, this means:

- existing non-ferrous (e.g. aluminium) cookware cannot be used. This will require additional up front expense for some consumers, however as steel is the cooking material of choice for a large majority of consumers, many will not have to invest significantly in new cookware, if at all;
- wok cooking in particular is compromised, as round-bottomed woks cannot be used with standard induction cook tops. There are numerous ways of addressing this, including:
  - using a flat-bottomed wok (sub-optimal for wok purists);
  - using a plug-in curved electric resistance hob (also sub-optimal for wok purists);
  - for occasional use, using a portable bottled gas hob; or
  - for more frequent use, choosing an induction cook top with a curved induction hob for woks (available on higher-end induction cook tops but are expected to become more common on middle-range cook tops).

Plug in electric cooking appliances, such as microwave ovens, rice cookers and plug in electric pans, are also a typical feature in most households and it is reasonable to assume a typical consumer will purchase such an appliance in addition to a new electric induction cook top.

To account for utensil and appliance changes required to ensure a similar or higher level of convenience and amenity, ATA's analysis assumed that the average consumer will incur some up-front expense in relation to upgrading appliances and/or cookware of $400.

9.5.2 Health & Safety

Electric induction cooking is considerably safer than gas on a number of fronts. Some consumers, including households with young children or mobility and health issues, choose induction over gas for reasons of safety alone, including:

- no flame, eliminating the risk of burns and fire starts from flame contact;
- as there is no conduction of heat through an element, the cook top surface is seldom hot to touch so there is little chance of injury through burns, even on a high setting;
- no carbon monoxide emissions, which can be a risk to life and health;
- no risk of gas leaks, which can be a risk to life and property; and
- the fact that induction cook tops often have additional safety features (e.g. timers, sensors).

9.5.3 Convenience

There are a range of factors to consider in terms of user convenience and both induction and gas come with pros and cons.

Generally speaking, induction cook tops are constructed with a single glass top that is significantly easier to clean than gas burners. Induction cooking however is more effective when the cooking utensil is placed centrally over the hob – whereas gas burners are more forgiving in this regard.

9.5.4 Ovens

Many consumers opt for electric ovens even where gas is available, due to better temperature regulation, electronic controls and other features. As such, electric and gas ovens have been considered more or less interchangeable for the purposes of this analysis.

9.5.5 Electric Resistance Cook Tops

Electric resistance cooking is widely agreed to be inferior compared to gas as it:

- is slow to heat up and transfer heat to appliances;
- stays hot long after use; and
- is harder to control temperature.

Users report better performance from ceramic type plates than electric coil type or solid metal elements, but most still consider these inferior to gas and induction. To ensure the findings of this study remain relevant to average consumers, electric resistance cook tops have not been considered a suitable replacement for gas and excluded from analysis.

10.0 Appendix E: Methodology – Energy Prices

ATA's analysis has been structured by gas pricing zone – with relevant electricity prices available within those gas zones used for modelling electric alternatives.

ATA was greatly assisted by St Vincent de Paul (StVdP) in the review and selection of relevant gas and electricity tariffs for the modelling. StVdP has developed and manages the ongoing *Tariff Tracker* project[33], which provides analysis and monitoring of retail gas and electricity prices across a range of de-regulated price jurisdictions.

Obtaining representative gas and electricity prices is a significant task – within any one jurisdiction, there can be many gas and electricity pricing zones (e.g. Victoria has 17). And within those zones there exists both standing offers[34] and market offers[35] – some of which are not transparent through retail comparator websites.

On the advice of StVdP, ATA tried to simplify the pricing analysis where possible by using only standard offers; or an average of the 'big three' (i.e. Origin, AGL and Energy Australia). ATA used the cheapest of the big three for the selection of gas tariffs.

ATA set a date for the gas and electricity pricing analysis of January 2014 – however adjusted these for the repeal of the carbon tax (July, 2014). In Victoria, prices typically change every six months, whilst in other jurisdictions prices change on an annual basis (in July). ATA took scheduled price rises into account beyond 1 Jan 2014.

10.1 Gas Prices

The selection of gas tariffs differed in approach by jurisdiction, given the availability of information and jurisdiction-specific pricing issues:

- In Victoria – all standing offer gas tariffs are gazetted[36] and ATA was able to draw on these for tariff selection;
- In NSW – gas tariffs are not gazetted. ATA therefore sourced NSW gas tariffs from the StVdP *Tariff Tracker* tool;
- In SA – only Origin Energy in SA has standing offers, and so these were utilised. ATA also found that retail gas prices in South Australia did not differ significantly across gas zones. Ultimately, an average retail price was used and applied to the Adelaide-based (Marion) pricing zone contained in this report;

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33 http://www.vinnies.org.au/page/Our_Impact/Incomes_Support_Cost_of_Living/Energy/

34 Standing offer contracts are basic electricity and gas contracts with terms and conditions that are prescribed by law and designed to protect your rights. In some states and territories, the government remains responsible for control of the energy prices customers see on their bills. For example, in QLD, NSW, ACT & Tas, you can ask for a contract with a regulated electricity price where the price is set by government. Regulated prices for gas are only available in NSW. In VIC & SA, there are no regulated offers or tariffs (for electricity or gas), which means that energy retailers set all of their own prices: http://www.aer.gov.au/retail-markets

35 Market offers are electricity and gas contracts that include minimum terms and conditions prescribed by law. The terms and conditions of market retail contracts generally vary from standing offer contracts.

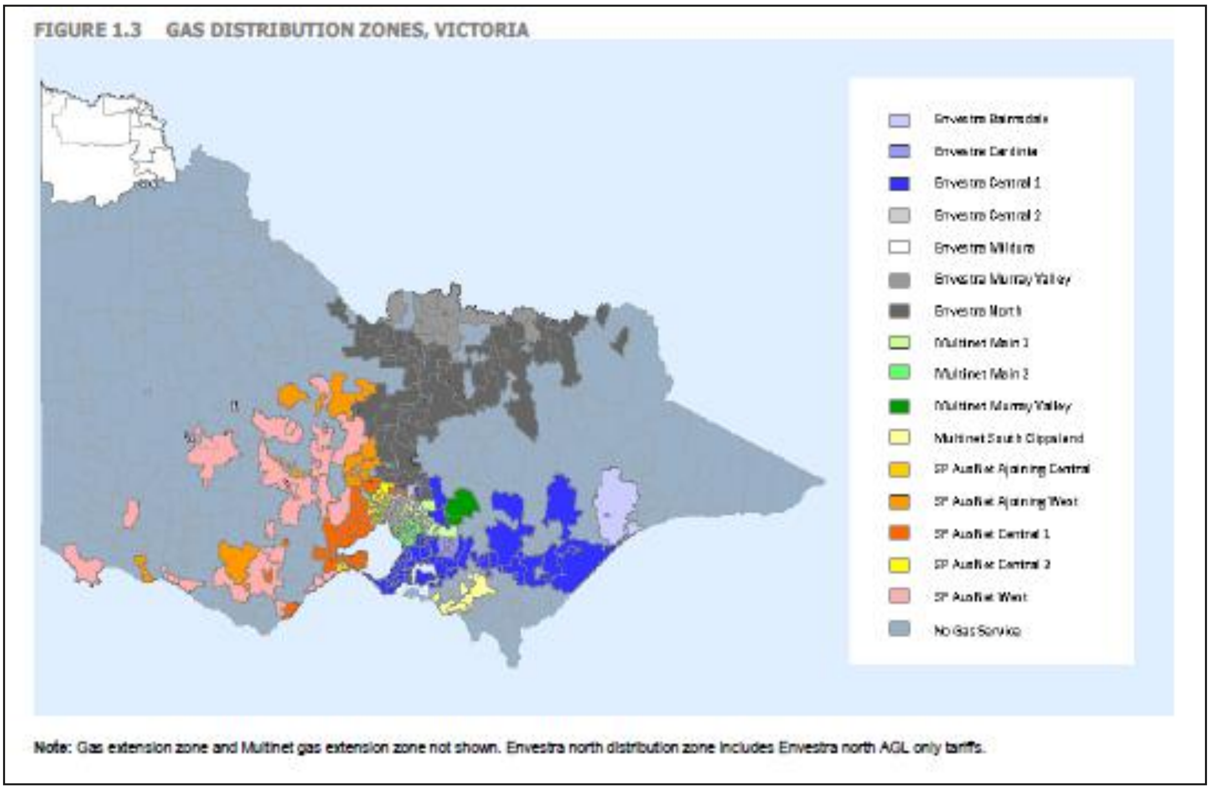
36 http://www.gazette.vic.gov.au

- In QLD – only two gas retailers exist in QLD. ATA used the listed prices of the two retailer's websites[37];
- In the ACT – only one gas retailer has standing offers in the ACT. ATA used prices from the retailer's website[38]; and
- In TAS – two retailers split Tasmanian market share 50/50. ATA used Tariff 31 for the purposes of the modelling.

10.1.1 Victoria

The most challenging jurisdiction in regards to gas pricing is Victoria. Victoria has a high reliance on residential gas use overall and has 17 different gas distribution zones, as per Figure 10-1 below.

Figure 10-1: Victorian Gas Distribution Zones



The AER regulates the prices for the distributor responsible for each zone. These network costs reflect the longer term cost of transporting gas to energy consumers throughout Victoria and vary from place to place accordingly, which is a the main reason retailers charge different prices for the same product across the state.

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37 http://www.originenergy.com.au/priceguide/?_qf_p2_display=true&ga_vs=http%3A%2F%2Fwww.originenergy.com.au%2F46%2FElectricity-and-gas&at=resi; and http://www.agl.com.au/~/media/AGL/Residential/Documents/Plans%20and%20Pricing/2013/July/QLD%20Gas%20Notice%20for%201July2013.pdf

38 http://www.actewagl.com.au/

Customer bills comprise of:

- A volume-based consumption cost—which varies with the amount of energy consumed and when the energy is consumed (peak and off-peak seasons);
- a fixed supply charge; and
- any additional retail charges as allowed under the Energy Retail Code.

Retail prices in Victoria are not regulated. The cost to the consumer indirectly includes the distribution charges paid by the retailer to the local gas network business on behalf of the retailer.

In order to find the cheapest gas tariffs available in Victoria, ATA:

- used CUAC's 'tertiles of gas usage' by state (AGL customer data)[39]; and
- applied those consumption levels in the StVdP *Tariff Tracker* (standing offer workbooks). The tool covers the eight largest and most established Victorian gas zones;

This produced estimated gas bills (in annual $) by gas zone by retailer.

ATA found that there were three gas zones in which AGL had cheaper prices across all gas consumption levels than its major competitors. In three other zones, AGL is cheaper except when only taking into account the lowest tertile of consumption. In one zone, Origin was cheaper across a greater number of tertiles.

As such, on the basis of price, ATA chose to use AGL in all Victorian pricing zones as the default retailer. Subsequent modelling analysing gas use for Household Scenarios 1-6 proved AGL cheaper in gas zone. The exceptions found were Multinet Yarra Valley (Energy Australia used) and Envestra Mildura (Origin used).

10.1.2 Price Forecasts: Gas

Price forecasting is an inherently complex exercise and not one that ATA sought to conduct any primary investigations into as part of this project. Instead, ATA drew on existing price forecasts available in the public domain.

In its recent consumer gas report[40], CUAC undertook a review of publicly available forecasts of gas prices by jurisdiction. In broad terms, the CUAC analysis supports a general assumption of a doubling of wholesale gas prices by 2020.

Wholesale gas prices represent approximately 20-25% of retail gas prices in most jurisdictions. As such, the projection above implies a retail price increase of in the order of 20-25% (real) by 2020.

As mentioned, ATA adjusted the 1 January 2014 prices to account for carbon tax repeal; whilst also allowing for other jurisdiction-based pricing decisions (e.g. IPART's 17% increase in July 2014).

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[39] CUAC (2013) *Making the Gas Connection*, Consumer Utilities Advocacy Centre, Melbourne: http://cuac.org.au/index.php?Itemid=30&option=com_docman&limitstart=5 Table 3, Page 9.

[40] CUAC (2013) *Making the Gas Connection*, Consumer Utilities Advocacy Centre, Melbourne: http://cuac.org.au/index.php?Itemid=30&option=com_docman&limitstart=5

Taking the above into account, ATA assumed gas price growth in all jurisdictions over the period 2014-2018; with prices remaining stable beyond this period. The figure and table below outline the gas price forecasts used in the modelling:

Figure 10-2: Assumed Gas Price Trajectory, Index by Jurisdiction

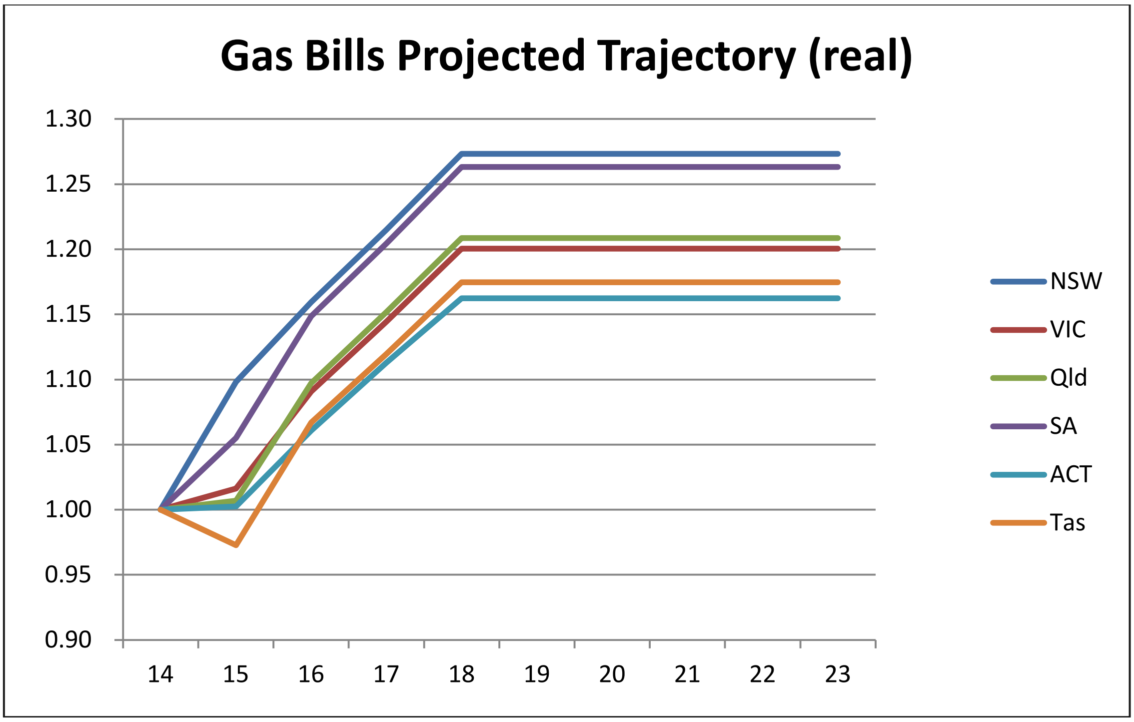


Table 10-1: Assumed Gas Price Trajectory, Index by Jurisdiction

Year	NSW	VIC	QLD	SA	ACT	TAS
2014	1.00	1.00	1.00	1.00	1.00	1.00
2015	1.10	1.02	1.01	1.06	1.00	0.97
2016	1.16	1.09	1.10	1.15	1.06	1.07
2017	1.21	1.14	1.15	1.20	1.11	1.12
2018	1.27	1.20	1.21	1.26	1.16	1.17
2019	1.27	1.20	1.21	1.26	1.16	1.17
2020	1.27	1.20	1.21	1.26	1.16	1.17
2021	1.27	1.20	1.21	1.26	1.16	1.17
2022	1.27	1.20	1.21	1.26	1.16	1.17
2023	1.27	1.20	1.21	1.26	1.16	1.17
2033	1.27	1.20	1.21	1.26	1.16	1.17
By 2020	27%	20%	21%	26%	16%	17%

Of interest, the residential gas price forecasts witnessed by the ATA failed to consider the impact on consumer bills in the likely event that infrastructure costs are recovered from a diminishing customer base using less gas in response to higher prices.

As an example, a potentially realistic 10% shortfall in gas use below that forecast for the residential sector over the next five years could add a further 10% to the network charges for remaining residential consumers.

Should gas increasingly become a discretionary fuel, the question remains as to whether gas network businesses will need to re-price upwards from a diminishing customer base – and potentially one that is increasingly comprised of vulnerable and disadvantaged consumers.

10.2 Electricity Prices

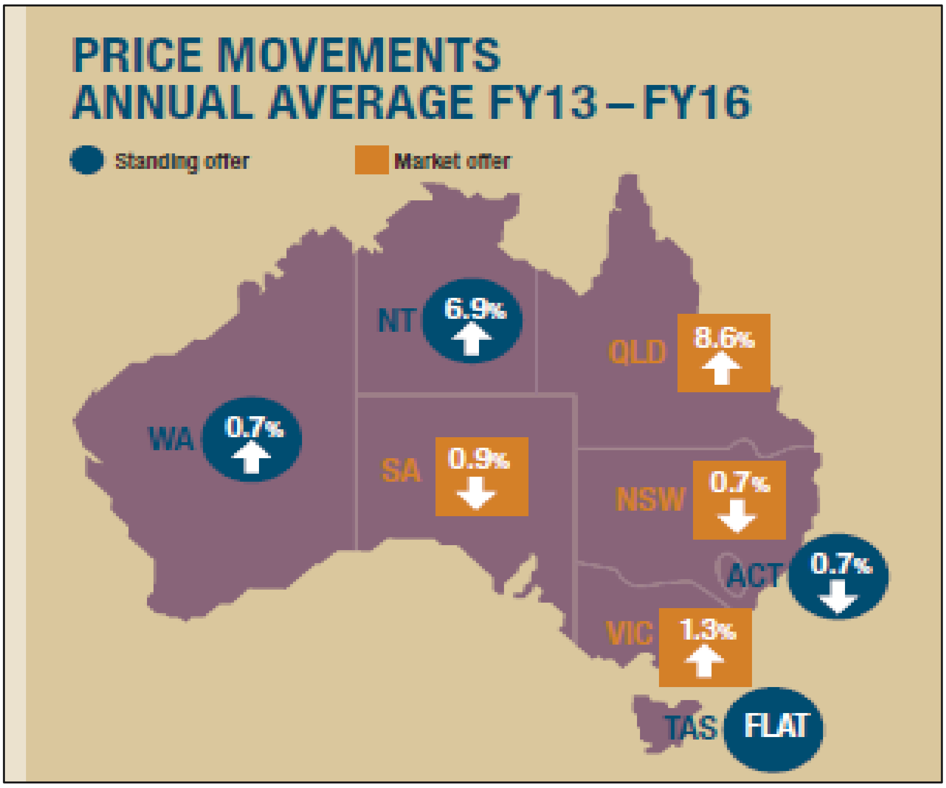
As mentioned, on the advice of StVdP, ATA tried to simplify the pricing analysis where possible by using only standard offers; or an average of the 'big three' (i.e. Origin, AGL and Energy Australia).

In Victoria, ATA found that for electricity, single rate tariffs were cheaper than all two-rate and ToU tariffs[41]. This justified using single rate tariffs within the model.

10.2.1 Price Forecasts: Electricity

ATA utilised the latest electricity price projections compiled by the AEMC[42] as part of their Market Review of 2013 Residential Electricity Price Trends. These forecasts are outlined in the infographic below:

Figure 10-3: AEMC Residential Electricity Price Trends, Dec 2013



41 Essential Services Commission 2013, *Energy retailers comparative performance report—pricing 2012-13*, December 2013 P31

42 http://www.aemc.gov.au/market-reviews/completed/retail-electricity-price-trends-2013.html

As mentioned, ATA adjusted the 1 January 2014 electricity prices to account for carbon tax repeal. Taking the above into account, the figure and table below outline the electricity price forecasts used in the modelling:

Figure 10-4: Assumed Electricity Price Trajectory, Index by Jurisdiction

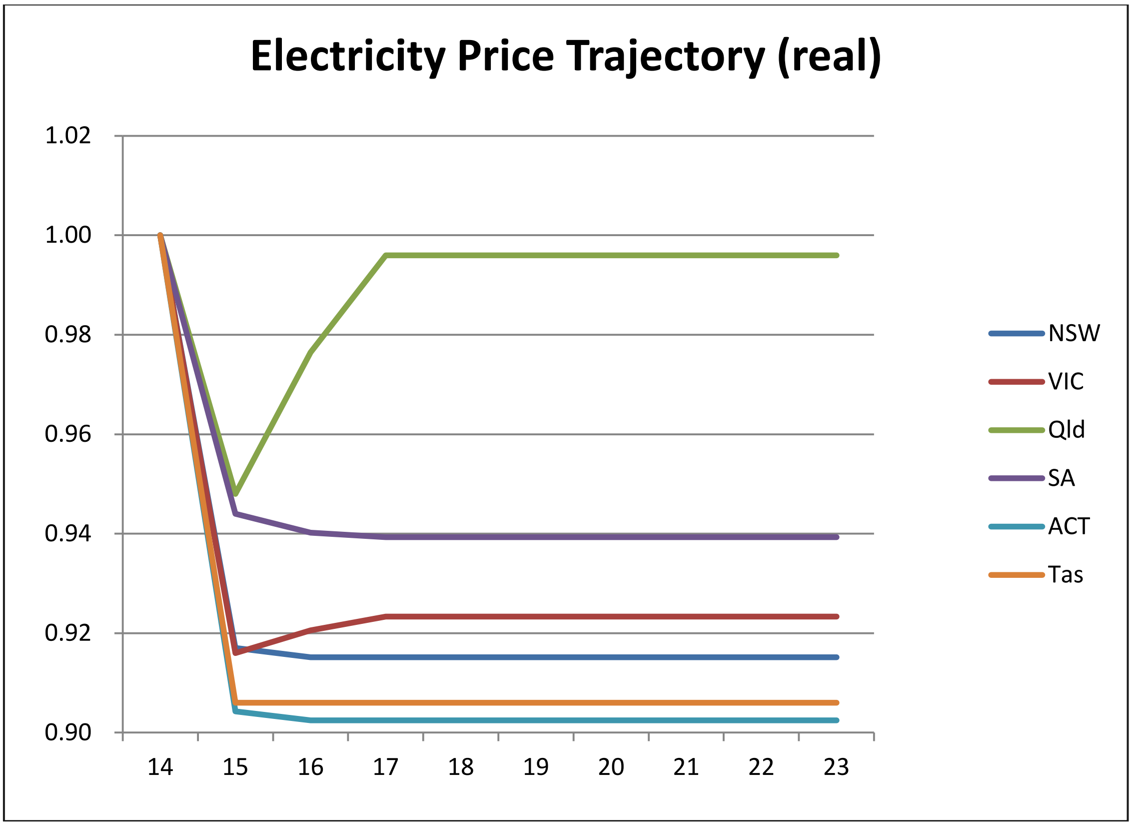


Table 10-2: Assumed Electricity Price Trajectory, Index by Jurisdiction

Year	NSW	VIC	QLD	SA	ACT	TAS
2014	1.00	1.00	1.00	1.00	1.00	1.00
2015	0.92	0.92	0.95	0.94	0.90	0.906
2016	0.92	0.92	0.98	0.94	0.90	0.906
2017	0.92	0.92	1.00	0.94	0.90	0.906
2018	0.92	0.92	1.00	0.94	0.90	0.906
2019	0.92	0.92	1.00	0.94	0.90	0.906
2020	0.92	0.92	1.00	0.94	0.90	0.906
2021	0.92	0.92	1.00	0.94	0.90	0.906
2022	0.92	0.92	1.00	0.94	0.90	0.906
2023	0.92	0.92	1.00	0.94	0.90	0.906
2033	0.92	0.92	1.00	0.94	0.90	0.906

10.3 Price Forecast Sensitivity

ATA also conducted sensitivity analysis on gas prices for Victoria and NSW – adopting low and high ranges for the purposes of comparison against the 'medium' price trajectories outlined in the gas price trajectories above. This analysis was carried out in order to understand the underlying strength of economic results.

For Victoria, ATA assumed the following high and low trajectories for the sensitivity analysis:

Figure 10-5: Low, Medium & High Gas Price Index Trajectories, Victoria

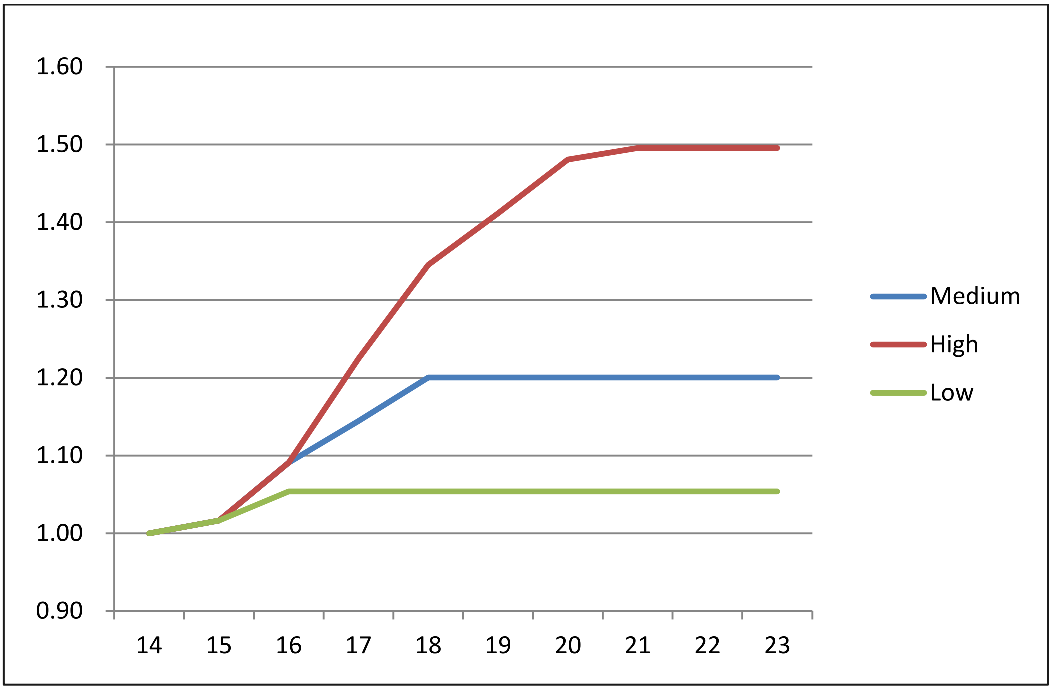


Table 10-3: Low, Medium & High Gas Price Index Trajectories, Victoria

Year	Medium	High	Low
2014	1.00	1.00	1.00
2015	1.02	1.02	1.02
2016	1.09	1.09	1.05
2017	1.14	1.22	1.05
2018	1.20	1.35	1.05
2019	1.20	1.41	1.05
2020	1.20	1.48	1.05
By 2020	20%	48%	5%

For NSW, ATA assumed the following high and low trajectories for the sensitivity analysis:

Figure 10-6: Low, Medium & High Gas Price Index Trajectories, NSW

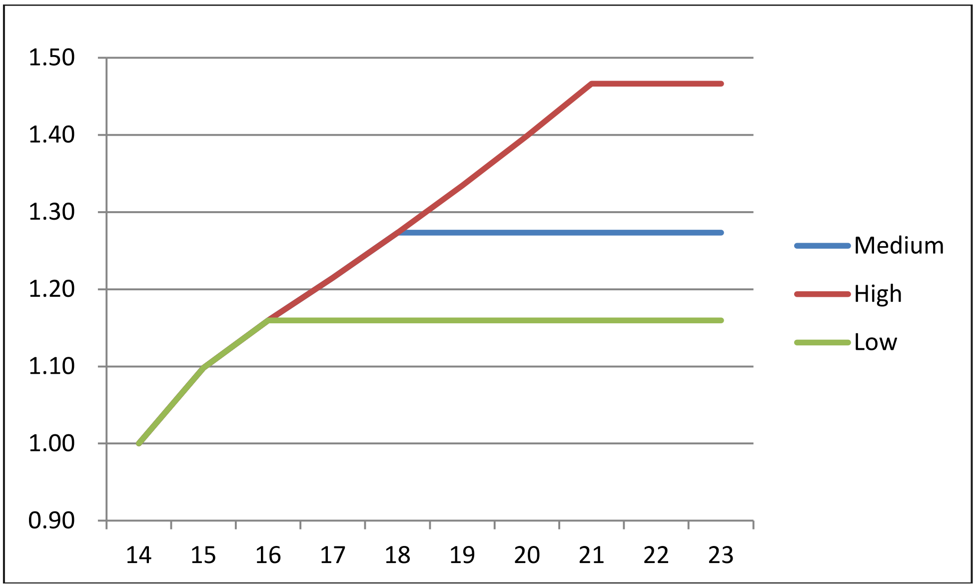


Table 10-4: Low, Medium & High Gas Price Index Trajectories, NSW

Year	Medium	High	Low
2014	1.00	1.00	1.00
2015	1.10	1.10	1.10
2016	1.16	1.16	1.16
2017	1.21	1.21	1.16
2018	1.27	1.27	1.16
2019	1.27	1.33	1.16
2020	1.27	1.40	1.16
2021	1.27	1.47	1.16
By 2021	27%	47%	16%

10.4 LPG

LPG wholesale prices in Australia are set with reference to the international benchmark of Saudi Aramco Contract Price and vary from month to month. Retail prices for bottled gas of LPG vary from location to location based on a number of factors including degree of market competition, transport costs and number of existing customers.

ATA consulted with Origin Energy in order to try and understand relevant price ranges for LPG in September 2014. The prices listed below were quoted to ATA and are presented on the basis of rental per 45kg cylinder per year:

Table 10-5: LPG Bottle Rental & Refill Prices, by Location

Location	Delivered from	Bottle Rental ($)	Refill Price - Low ($)	Refill Price - High ($)
Victoria	Dandenong	35	115	145
	Shepparton	35	102	141
Tasmania	Hobart	35 / 21[43]	99	159
	Devonport	35 / 21	99	159
	Launceston	35 / 21	99	159
SA	Metro	39.50	99	135
	South Coast	39.50	105	140
	Riverina	39.50	105	140
NSW	Sydney	39	101	140
	Lightning Ridge	39	134	157
	Wagga Wagga	39	117	137
QLD	Brisbane	37.50	110	148
	North QLD	37.50		156
	Remote Inland	37.50		172

ATA assumed:

- The current Origin Energy rental annual fees by state of $70-79 for two cylinders;; and
- $110 refill for a 45 kg cylinder (which comes to 5c/MJ).
- A flat outlook for LPG prices, which appear to be in line with Treasury forecasts of long run terms of trade[44].

[43] Discount to pensioners.
[44] Bureau of Resources and Energy Economics forecasts oil prices to be down 1.8%-3.6% by the end of 2014. In May 2014 Treasury forecast long term terms of trade. Beyond 2023 they project real oil prices to be flat (rising with inflation). Before that, Treasury used 'Consensus Economics' projections (based in London). Tidbits on the Consensus Economics website to Jan 2015 show Brent projections are flat.

10.5 Concessions

Household Scenario 4 (Public Housing) involves the consideration of low income and concession eligible consumers. Concessions vary by jurisdiction in regards to both their amount and application[45].

Medical and seniors concessions were also considered, using original sources only (mainly government websites). However given their potential complexity and the level at which the model was pitched, ATA ignored medical concessions (typically relating to emergency or life support situations).

ATA found that seniors concessions were typically the same amount and structure as low income concessions. As such, for the majority of locations, the relevant low income concession was used.

In QLD no income-based concessions exist. For this jurisdiction, ATA utilised the seniors concession as the input to the model.

Finally, South Australia's low income concession is fuel agnostic – i.e. an eligible consumer can obtain a rebate of $215 for either gas or electricity. As such, the SA concession did not alter the economic results for Scenario 4 in this jurisdiction. However the SA Government does have a $500 rebate for heat pumps under its Solar Hot Water Rebate Scheme. This was included in the concession-eligible Household Scenario 4 for Adelaide.

Table 10-6: Concessions Model Inputs by State

State	Low Income		Seniors	
	Gas	Electricity	Gas	Electricity
NSW	None	$225 pa for 2013/14 ($235 pa in July 2014). Additional rebate for families $125 pa for 2013/14 ($150 pa in July 2014).	Same conc as low income	
VIC	17.5% discount in Winter (1/5-31/10) > $62.4	17.5% for bills >$171.6 pa. If bills >$2763 pa an excess energy concession application must be made	Same conc as low income	
QLD	None	None	Capped at $67.61	Capped at $320.97
SA	Energy concession cap $215: Electricity or LNG or LPG	Energy concession cap $215. Electricity or LNG or LPG	Same conc as low income	

45 Income based concessions were consolidated from:
AEMC, 2013 Residential Electricity Price Trends report, 13 December 2013;
ATA, The Benefits of Solar Water Heaters on Energy Concessions Budgets, March 2013;
May Mauseth Johnston, Alviss Consulting Pty Ltd (for St Vincent de Paul), 'The Relative Value of Energy Concessions 2009-2012 Part 1', Jan 2013;
May Mauseth Johnston, Alviss Consulting Pty Ltd (for St Vincent de Paul), 'The Relative Value of Energy Concessions 2009-2012 Part 2', March 2013.

TAS	None	Approx. $458.84 per year. Rebate increases in line with electricity price increases	$56 a year paid in two $26 instalments (not gas specific?) Stringent cash assets test.	Same conc as low income
ACT	None	Energy + utility concession. ($406.15 max combined off energy retailer)	Same conc as low income	

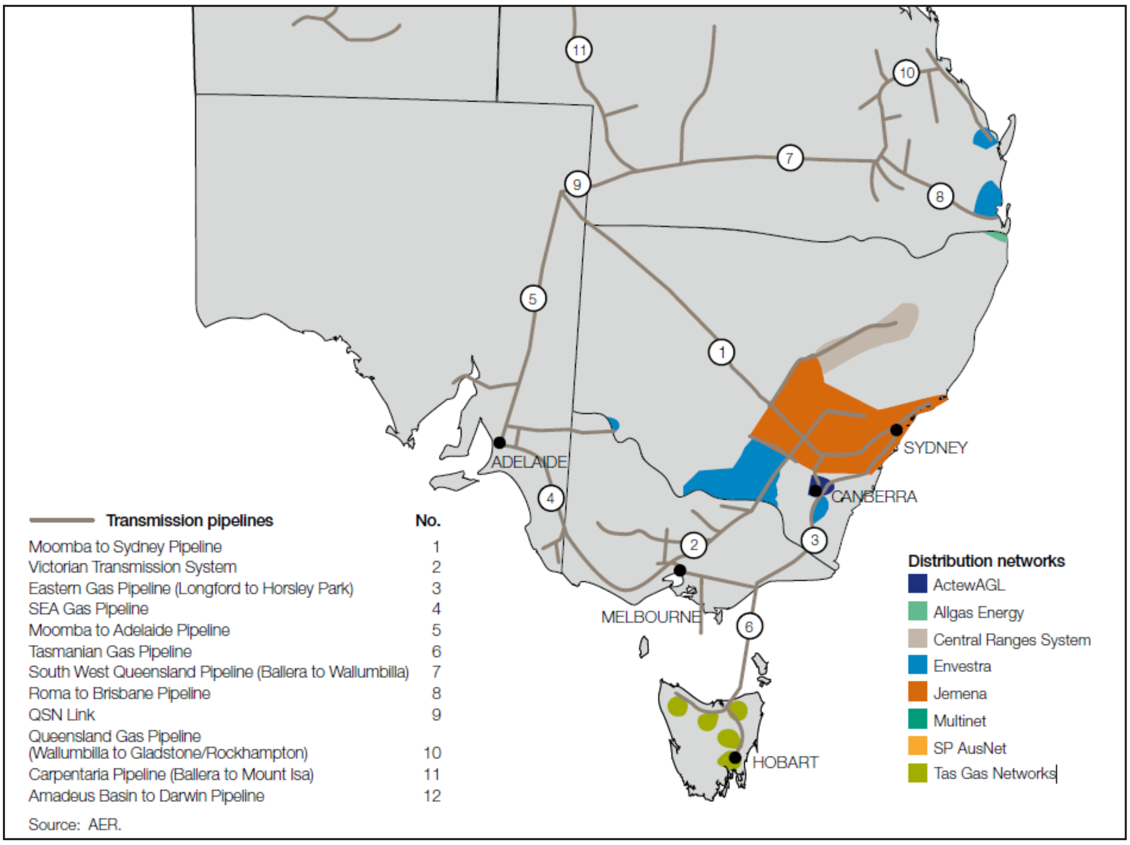
10.6 Connection & Disconnection Costs

The cost to disconnect from the reticulated gas network, on either a temporary or permanent basis, is also a relevant consideration.

ATA found that the existence of both temporary and permanent disconnection fees were relatively common. Temporary disconnection fees were levied on a once off basis and were mostly less than $100, however this varied by distributor. Permanent disconnection fees typically involved complete decommissioning of meters.

The following figure is a map of the relevant gas distribution networks and pipelines in the eastern states of Australia:

Figure 10-7: Eastern States Gas Distribution Networks & Pipelines[46]



46 Australian Energy Regulator (2013), 'State of the Energy Market 2013', Melbourne

ATA assumed that households with existing gas connections choosing to disconnect from gas would do so paying the relevant temporary disconnection charge in their distribution network. ATA found the following connection and disconnection charges in different jurisdictions and networks:

Table 10-7: Connection & Disconnection Charges by Location & Distributor

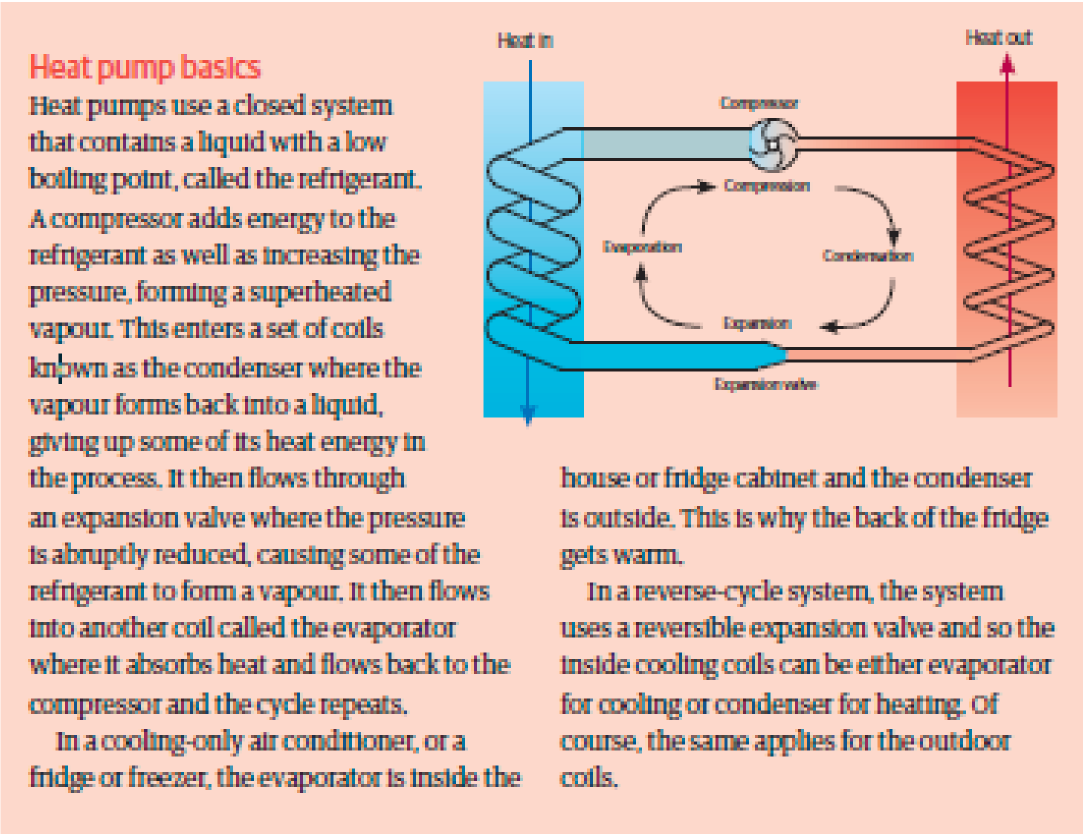
State	Source	Service	Fee (inc GST)
VIC	Multinet	Meter Turn On/ or Reconnect	44.13
VIC	Multinet	Meter removal - various	62.55
VIC	Envestra	Disconnection	70.40
VIC	Envestra	Meter Removal	103.40
VIC	SP Ausnet	Disconnection - locks and plugs at meter install	59.61
NSW	Jemena	Temporary disconnection	161.55
NSW	Jemena	Permanent disconnection	482.77
NSW	Jemena	Decommissioning & meter removal	1,124.29
NSW	Envestra	Disconnection service (not business)	45.77
NSW	ActewAGL	Disconnection Fee	150.78
QLD	All gas	Disconnection fee	61.38
QLD	Envestra	Disconnection fee	75.90
SA	Envestra	Disconnection service	74.80
Tas	TAsGas	Connection fee - at least 20GJ pa	300.00
Tas	TAsGas	Disconnection service	60.00

Connection costs are relevant for Household Scenario 6 (New Home). ATA found that these:

- existed up to $200 for Victoria; and
- in Tasmania, were $300 for an anticipated household load of up to 20GJ/pa; whilst above this level, Tas Gas charged $1,500 for a new connection;
- in the ACT, a small fee ($36) is levied by the retailer for new connections; and
- in NSW, Queensland and South Australia, no connection fee was found.

11.0 Appendix F: Glossary

Co-efficient of performance (CoP):	A measure of the heating efficiency of heat pump systems. This is a ratio of the heat moved to the electrical energy input.
Outdoor unit:	A complete heat pump reverse cycling air-conditioner system comprises an air handling unit and an outdoor unit (and a remote control). In heating mode, the outdoor unit could be called a compressor. These units are usually in separate locations (hence the term 'split-systems'). Sometimes one compressor can manage several air handling units.
Efficient electric appliances:	Heat pumps for water heating, AC split systems for space heating, and induction cook tops.
Electric appliances:	Resistant electric water heating, electric systems other than AC split systems for space heating, and resistance cook tops.
Heat pump:	Process explained in ReNew 120:



Heat pump basics

Heat pumps use a closed system that contains a liquid with a low boiling point, called the refrigerant. A compressor adds energy to the refrigerant as well as increasing the pressure, forming a superheated vapour. This enters a set of coils known as the condenser where the vapour forms back into a liquid, giving up some of its heat energy in the process. It then flows through an expansion valve where the pressure is abruptly reduced, causing some of the refrigerant to form a vapour. It then flows into another coil called the evaporator where it absorbs heat and flows back to the compressor and the cycle repeats.

In a cooling-only air conditioner, or a fridge or freezer, the evaporator is inside the house or fridge cabinet and the condenser is outside. This is why the back of the fridge gets warm.

In a reverse-cycle system, the system uses a reversible expansion valve and so the inside cooling coils can be either evaporator for cooling or condenser for heating. Of course, the same applies for the outdoor coils.

Inefficient electric appliances:	Resistant electric water heating, electric systems other than AC split systems for space heating, and resistance cook tops.
Mains gas:	A distributed reticulated gas system in the National Energy Market.

Physical CoP (for heat pump HW): There is an Australian Standard for testing and establishing the performance of heat pump hot water systems, AS/NZS 5125:

"The COP values given are usually in the range 3.5 to 4.5, values which can only be achieved at the temperature and humidity conditions which are the most favourable for HPWH performance." Commonwealth of Australia (2012a)

Task CoP (for heat pump HW): Annual energy imparted to the hot water load divided by the annual electricity supplied to the water heater:

"The Task COPs of HPWH models calculated using AS/NZS 4234 modelling results are significantly lower than the physical COPs measured at the AS/NZS 5125 Test Conditions." Commonwealth of Australia (2012a)

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