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SWITCHING ON

BENEFITS OF HOUSEHOLD ELECTRIFICATION IN AUSTRALIA

Monash University recognises that its Australian campuses are located on the unceded lands of the people of the Kulin Nations, and pays its respects to their Elders, past and present.

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CONTENTS

KEY FINDINGS

ELECTRIFICATION CUTS ENERGY BILLS

Electrifying Australia's entire residential sector would save households $4.9 billion annually. Using 2021 Australian census data, this equates to around $450 per household every year.

These savings come from four primary sources. Firstly, gas network connection fees cost Australian households $1.3 billion per year before a single molecule of gas is consumed.

Additionally, electrifying hot water systems would save $2.1 billion, heating would save $1.2 billion and cooking would save $341 million annually.

GAS IS BECOMING INCREASINGLY EXPENSIVE

On average, wholesale gas prices increased by 234% between 2012/13 and 2022/23, compared to 137% for electricity.

The cost of gas is also rising almost twice as fast as electricity. Since 2012, gas prices have increased by an average of 6.37% per annum compared to 3.77% for electricity.

ELECTRIC APPLIANCES ARE MORE EFFICIENT

A modern split system is three times more efficient at warming a home than a gas heater. Similarly, induction cooktops boil water almost twice as fast as their gas counterparts.

This increased efficiency can help save money too. For example, a gas hot water system costs three times as much to operate as one run by a heat pump.

ELECTRIC APPLIANCES ARE SAFER AND HEALTHIER

Gas stoves can generate unsafe levels of indoor air pollution, with fine particle emissions ($PM_{2.5}$) released at particularly high rates. Due to their small size, these particles can end up in our lungs and bloodstream.

Additionally, homes with gas stoves typically have nitrogen dioxide (NO_2) concentrations significantly higher than those with electric stoves. This can have a variety of respiratory effects, especially for children and those with existing conditions like asthma.

Up to 12% of childhood asthma cases in Australian children aged 14 years and under can be attributed to the presence of gas cooking in the home. This is comparable to living with a cigarette smoker.

ELECTRIFICATION BENEFITS LOW INCOME HOUSEHOLDS

Lower income households face greater exposure to the health risks of residential gas use. This is because low income earners are more likely to live in smaller homes with older gas appliances and inadequate ventilation. These homes also typically have a higher density of occupants.

Electrifying low income households helps save energy. In the ACT, electrification has helped low income households reduce energy use by 6,104MJ per quarter – equivalent to almost 3,000 washing machine cycles.

ELECTRIFICATION IS A JOB CREATOR

Around 18,500 workers are already employed full-time in the rooftop solar industry. Electrification of Australia's entire residential gas appliance stock would create around 20,000 full-time jobs over a 10 year period.

KEY TERMS

CARBON DIOXIDE EQUIVALENT (CO_2e)

A standardised measure that compares the global warming potential of various greenhouse gases to CO_2.

EMPLOYMENT FACTOR

A measure assessing the work required to complete a task or project as a fraction of a full working year.

ENERGY POVERTY

A condition where individuals or communities struggle to access affordable and reliable energy services for basic needs, including to create a safe indoor temperature.

FULL ELECTRIFICATION

The transition of all non-electric household appliances – such as gas hot water systems, cooktops and heating – to electric replacements.

GIGAWATT (GW)

A unit of power equal to one billion watts, typically used to describe large-scale power plants or national energy capacities.

JOB-YEAR

The total work output of a single person working full time for a year.

KILOWATT HOUR (KWH)

A unit of energy representing the consumption of one kilowatt of power for one hour.

LOWER INCOME HOUSEHOLDS/ECONOMICALLY DISADVANTAGED POPULATIONS

'Lower income' households and populations in this report are those with incomes in the lowest 40th percentiles of equivalised disposable household income.

MEGAWATT (MW)

A unit of power equal to one million watts, commonly used to measure the capacity of energy generation systems.

MEGAWATT HOUR (MWh)

A unit of energy equivalent to the consumption or production of one megawatt of power for one hour.

NATIONAL ENERGY BILL

The total cost incurred by all energy users in Australia from energy consumption.

NITROGEN DIOXIDE (NO_2)

A gas emitted during the process of gas combustion that contributes to air pollution and can act as a respiratory irritant.

PETAJOULE (PJ)

One petajoule is 10^{15} joules (1 million billion) or 278 gigawatt hours. Equivalent to the energy used by 19,000 homes in a year.

SOLAR PV

Solar photovoltaic technology, also known as solar panels or solar systems, that converts sunlight directly into electricity.

SPLIT SYSTEM

A heat pump air conditioning system, often called an air conditioner or split system in Australia.

TOTAL NATIONAL EMISSIONS

The combined amount of greenhouse gases released into the atmosphere by Australia in a year.

WHOLESALE GAS PRICES

The price of natural gas purchased from the wholesale market by gas retailers.

CHAPTER ONE
INTRODUCTION

Rising gas prices, widespread coverage about the benefits of ‘electrifying everything’, and an increased desire to drive down emissions, have sparked a wave of interest in household electrification across Australia. A range of government programs supporting the switch from gas to highly efficient electric alternatives have also emerged. Together, these factors have created a narrative around the critical role electrification has to play in reducing emissions, improving health and cutting living costs in the long term.

Australia has access to the technology and skill base required for electrification. A focused skills and training program would help expand the number of people working in the sector, and ensure a rapid transition from gas to electric. Alongside workforce expansion, effective communication about the benefits of the transition would help inform the public and facilitate effective government policy.

This report brings together existing research and literature to provide a snapshot of residential electrification across Australia now and into the future. It presents the benefits of residential electrification, including: lowering bills, creating jobs, reducing associated health risks and achieving social equity. The suite of government policies and programs aiming to help households electrify is also summarised. The aim here is to showcase the actions governments are currently taking, and to determine what more can be done to incentivise electrification for Australian households.

The report is structured as follows:

Chapter 1 presents an overview of residential gas usage and the potential for electrification in Australia.

Chapter 2 highlights the potential financial and health co-benefits of residential electrification, along with achieving equity for vulnerable groups within the community.

Chapter 3 discusses job opportunities through electrification of the residential sector.

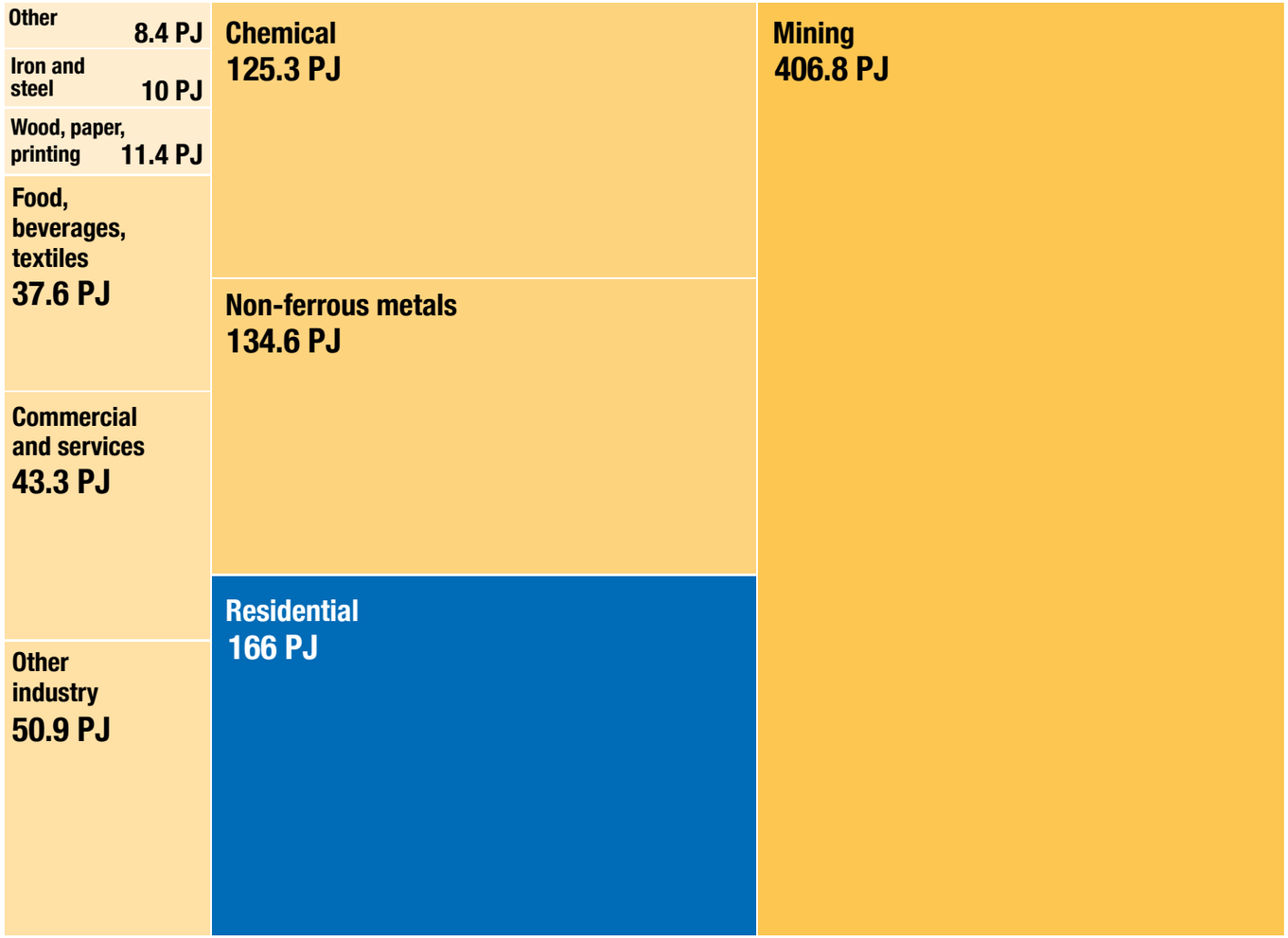
Chapter 4 summarises current policies in place across state and federal levels. The results highlight where action is being taken and where more focus is required.

1.1 OVERVIEW OF RESIDENTIAL GAS USAGE AND ELECTRIFICATION

Australian households are highly reliant on gas. In 2020-21, households burned through 165.8 petajoules (PJ) of gas, four times the amount used in the entire food, beverages and textiles sector, and significantly greater than the usage of other industrial sectors such as iron and steel manufacturing (Figure 1).[1]

In fact, more than a sixth of Australia's total gas use occurs in the residential sector. In emissions, this equates to 8.5 million tonnes of carbon dioxide equivalent (CO_2e)[2] every year[3] – the same as flying from Melbourne to London and back almost one and a half million times.[4]

Figure 1: Residential gas use compared to industry gas consumption



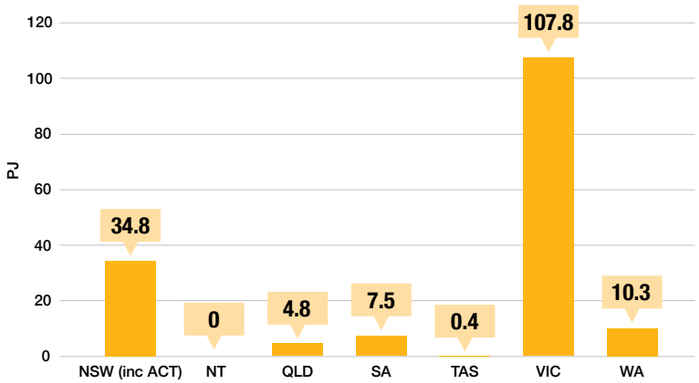
Source: Australian Energy Statistics 2022, Table H3

Residential gas usage by state

Residential gas consumption is not equally distributed across the country. In fact, it is highly concentrated in Victoria, with households consuming almost twice as much gas (107.8PJ) as all other households in Australia combined (57.7PJ) (Figure 2).[5]

Victoria's high residential gas consumption is due to the legacy of the Gippsland Basin oil and gas province[6] – the location of the first oil field discovery in Australia. Intensive development since 1965[7] has resulted in an expansive gas network across Melbourne, which, coupled with the state's colder winters and high rates of gas-fired space heating, continues to underpin high residential gas use today.

Figure 2: Residential gas use by state



Source: Australian Energy Statistics 2022, Table F

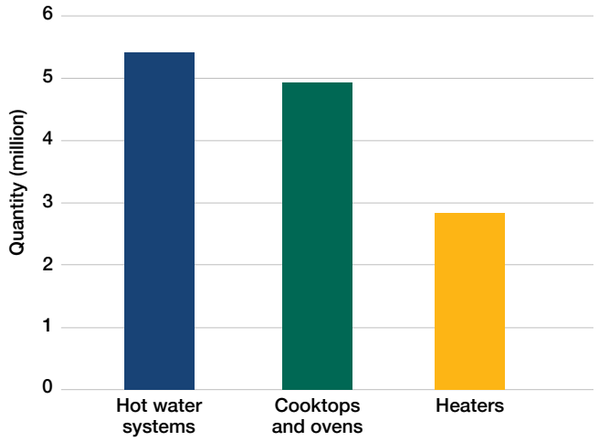
Gas use in Australian households

Gas is used in the residential sector for three main activities – heating homes, heating water, and cooking (Figure 3).

It is predominantly used for space heating, which accounts for 57% (95PJ) of consumption. This is driven by homes in colder regions such as Victoria, the ACT and, to a lesser degree, Tasmania, where, despite the notably cold climate, the residential gas network is not extensive. In these cooler areas, households with gas heating consume approximately three times as much gas as those without.[8] Water heating consumes another third of residential gas usage (59PJ), with cooking (9PJ) and other appliances (3PJ) accounting for the remainder.

Approximately 13.2 million residential gas appliances in Australia[9] will need to be replaced to electrify the residential sector and work towards achieving net zero by 2050. Gas hot water systems are the largest appliance category, with 5.4 million units currently installed in households across the country. This is followed by gas cooktops and ovens (4.9 million) and gas heaters (2.8 million) (Figure 4).

Figure 4: Gas appliances in Australian households



Source: Residential Baseline Study 2021, The Australia Institute

Figure 3: Residential gas consumption by end use

Source: Residential Baseline Study and Australian Energy Statistics 2022

Electric technology alternatives

Fortunately, a variety of highly efficient, cost-competitive electric appliances are readily available to assist the transition. These primarily focus on the electrification of cooking, water heating, and space heating.

Induction cooktops – electrifying cooking:
Induction cooktops are a modern and efficient alternative to traditional gas or electric cooktops. Instead of an open flame or electric heating element, induction cooktops use a magnetic field to heat up pots and pans. The magnetic field heats the pan directly, which provides a faster, more precise, and safer cooking experience.

Hot water heat pump systems – electrifying hot water:
Hot water heat pumps, which use the same technology as split system air conditioners, are highly energy efficient. Heat pump systems generate three times as much heating energy in the water as a conventional gas-powered hot water system[10] and are suitable for all Australian climates. They can also be programmed to run using rooftop solar, further reducing costs.

Split system air conditioning – electrifying heating:
Australians are very familiar with the use of split system air conditioners for household cooling, however, they also offer the most efficient and safest heating option. A split system air conditioner produces warmth by absorbing heat from the outside air via an outdoor unit, which then travels to an indoor unit, heating the home. In contrast, gas heaters generate heat by burning gas. While this warms the air, it can also generate indoor air pollution and is far less efficient. Every unit of gas burned generates less than one unit of heat energy inside the home. In contrast, a split system converts a unit of energy into three or more units of heat energy.[11]

Induction cooktops beat gas for speed hands down. In Choice's speed test, top-performing induction cooktops boiled a litre of water in 2.37 minutes compared to four minutes or more for gas.[12]

Hot water heat pumps are cheaper to run than gas hot water systems. A good quality heat pump for a four person household will only cost $145-$175 a year (off-peak tariff) compared to $435-$635 for a gas system.[13]

Split systems will raise the temperature of a modern home by 1°C using 10kWh of energy, while a gas heater will only increase the temperature 0.3°C with the equivalent energy input.

CHAPTER TWO

FINANCIAL, HEALTH AND ENERGY BENEFITS OF HOUSEHOLD ELECTRIFICATION

This has been calculated by analysing the quantity of gas appliances in each state identified by the *Residential Baseline Study 2021*[14] alongside the number of residential gas connections per state identified by Energy Networks Australia. Numbers were then adjusted to account for state-specific cost savings per appliance – as found in the *Climate Council Switch and Save report*[15] – and avoided gas connection fees.

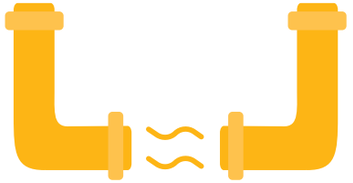
Our analysis uses current prices, and therefore potentially underestimates the true level of future savings from a program of full residential electrification. For example, gas prices are rising rapidly with annual price increases of 6.4% compared to 3.8% for electricity (see Rising gas prices).[16]

This means that, relative to electric appliances, gas appliances are becoming more expensive to run each year, and the savings from switching to electric might be even greater.

Additionally, electric appliances are more energy efficient than gas appliances (see Energy efficiency). This means households can perform the same tasks, like home heating or cooking, using less energy by electrifying. For example, by heating your home with a split system, the temperature will increase almost three times as much compared to using the same amount of energy in a gas heater.

Despite the associated upfront costs, electrifying the residential sector would ultimately slash the national energy bill, ease the cost of living, and reduce the inflationary pressures of gas expenditure.

FULLY ELECTRIFYING AUSTRALIA'S RESIDENTIAL SECTOR WOULD SAVE HOUSEHOLDERS $4.9 BILLION, APPROXIMATELY $450 PER HOUSEHOLD, EVERY YEAR, INCLUDING:



$1.3B

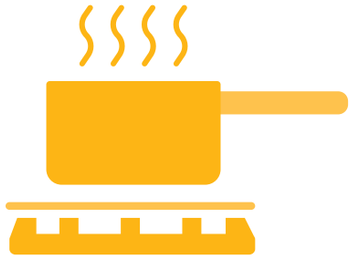
in avoided gas connection charges

$2.1B

through electrifying hot water

$1.2B

through electrifying heating



$341M

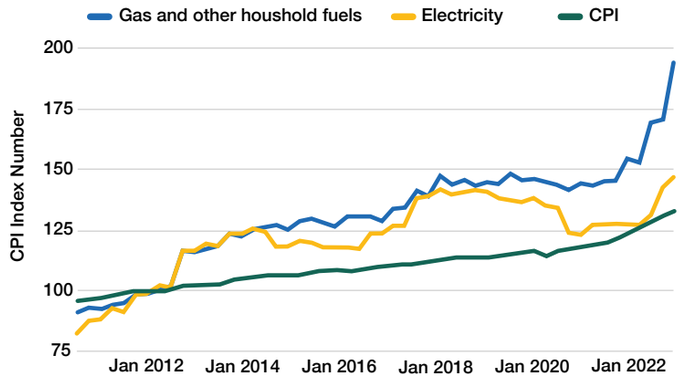
through electrifying cooking

2.1 FINANCIAL BENEFITS FOR HOUSEHOLDS

Rising gas prices

Gas is expensive, with the cost rising faster than the rate of inflation since 2012. On average, gas prices have been increasing by 6.37% per annum since 2012, compared to an average increase in electricity prices of 3.77% per annum (Figure 5). The inflation rate for gas has also consistently outpaced electricity for the past decade, including the most recent March quarter 2023, which saw gas prices rise 14.3% compared to 3% for electricity.[17]

Figure 5: Gas versus electricity price rises



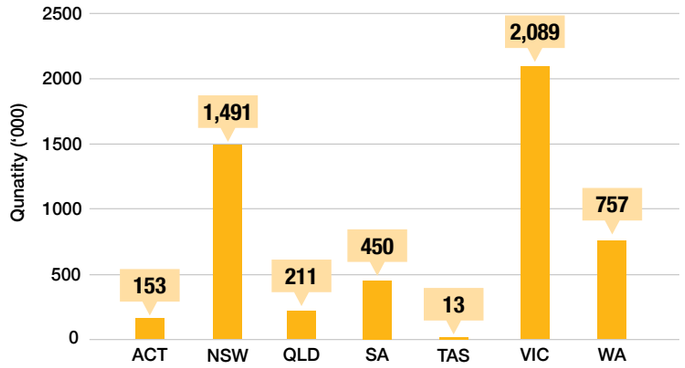
Source: ABC Consumer Price Index (CPI), 2023

While gas has historically been marketed as a "cheap" energy option, that is no longer true. Wholesale gas prices have increased by 234% on average between 2012/13 and 2022/23.[18] In comparison, electricity prices have increased by only 137% over the same period.[19]

Because electric appliances are more efficient (see Energy efficiency) they help to alleviate total economic and energy demand from the residential sector, increasing savings for household consumers. Though significant hurdles remain – such as upfront costs and access to reliable information – residential electrification is an increasingly smart economic and environmental move for households.

But the energy costs of appliances is only part of the story. A program to electrify the residential sector would also remove annual gas connection fees from household bills. Approximately 5.1 million homes are directly connected to the gas network in Australia,[20] with an additional 781,000 homes connected to bottled gas services.[21]

Figure 6: Residential gas connections by state



Source: Energy Networks Australia, 2021

By taking the average household connection fees per state from the Climate Council's *Smarter Energy Use* 2023 *report*[22] and pairing it with state-level data from Energy Network Australia on the quantity of residential gas connections,[23] we estimate Australian households spend $1.3 billion per annum before even a single molecule of gas is consumed.

Table 1: Annual gas connection supply charge cost

	Annual supply charge	Homes connected to gas ('000)	Annual cost ($)
ACT	$252	153	$38.6M
NSW	$229	1,491	$341.4M
NT*	N/A	N/A	N/A
QLD	$254	211	$53.6M
SA	$215	450	$96.8M
TAS	$215	13	$2.8M
VIC	$326	2,089	$681.0M
WA	$98	757	$74.2M
		TOTAL	**$1.3B**

*Since NT is not connected to a reticulated gas network, and therefore reliant on bottled gas, it is not subject to supply charges.

Source: Climate Council, 2023; Energy Networks Australia, 2021

Cutting energy costs

Studies have quantified the amount households can save in energy costs each year by replacing gas appliances with modern electric options, such as induction cooktops. This includes research by Rewiring Australia, which estimates that the average Australian household could save $5,000 a year by 2030 by electrifying everything in their house, replacing their car with an electric vehicle, and installing solar on their rooftop.[24]

Rewiring Australia has also undertaken state-specific reports that aimed to quantify the variations in annual savings for households in each state if full electrification occurs by 2030:

Rewiring Tasmania calculated savings of **$4,660**[25]

Rewiring Southern NSW calculated savings of **$4,570**[26]

Rewiring Greater Brisbane calculated savings of **$4,700**[27]

Rewiring Adelaide calculated savings of **$4,100**[28]

The research by Rewiring Australia has reshaped the debate on the role household electrification can play in reducing total national emissions. Importantly, this has paved the way for more in-depth research, such as the Climate Council's household electrification studies. Chief amongst these is the recent *Smarter Energy Use: How to cut energy bills and climate harm report*, which focuses solely on the electrification of cooking, heating and hot water in the home. The study found that electrification of these appliances could save a household between $336 and $1,311 per year (see Figure 7).[29] Further savings, like those noted in the Rewiring Australia reports, could be realised through electrifying personal transport and the installation of rooftop solar.

Household savings from electrification vary by state. This is due to a number of factors, namely regional variations in gas use, heating demand during winter, as well as gas prices and connection fees.

The Victorian Government's Gas Substitution Roadmap has estimated the costs and savings for Victorians of converting a gas-connected, solar-powered home to all-electric, finding a total average annual saving of $1,250.

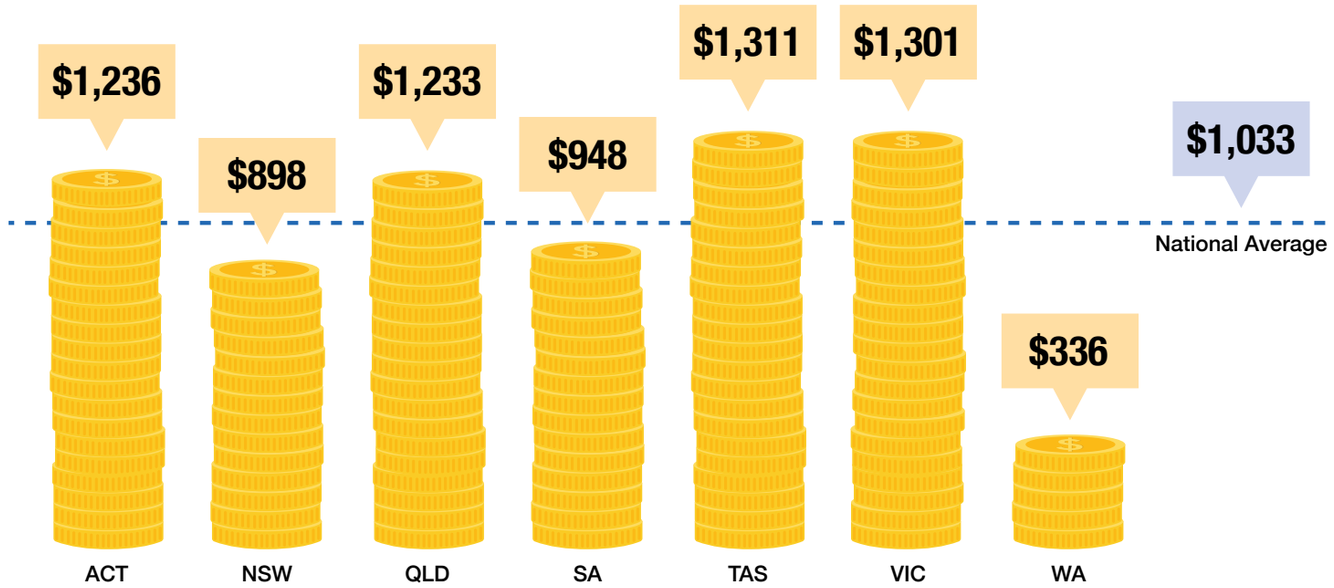
Replacing gas heating with electric split system heating was found to be the most cost-effective action a householder could make, delivering a saving of $570 per annum.

New research at the Australian National University (ANU) has validated these trends by conducting a study of energy use of more than 14,000 households in Canberra.

The study used quarterly billing data from 2015-2020, coupled with data from the ACT's *Energy Efficiency Improvement Scheme*, to determine the impact of replacing gas heaters and hot water systems with electric alternatives.

The findings identified large decreases in gas use alongside smaller increases in electricity consumption, with quarterly savings of $144 ($576 per annum) per household from electrifying heating.[30]

Figure 7: Household electrification cost saving by state (AUD)



Source: Climate Council (2023), Smarter Energy Use: How to cut energy bills and climate harm

National savings from electrification

Using these research findings, the average cost savings of electrifying appliances in each state can be calculated.

These figures, coupled with the data insights from the *Residential Baseline Study 2021* into the quantity of gas appliances in Australia (see Table 6: Gas appliances by state and territory), enable us to calculate the projected annual cost savings from fully electrifying Australia's residential sector.[31]

We estimate that a program to electrify Australia's residential appliances would save householders $3.6 billion every year. Electrifying the nation's stock of gas hot water systems would deliver the greatest saving ($2.1 billion), due to the extensive use of gas hot water systems across the country.

A further $1.2 billion would be saved by electrifying heating, and $341.4 million from electrifying all gas cooktops and ovens.

Victoria would benefit the most from a program of full electrification, with the potential to cut total household energy expenditure in the state by $1.8 billion per annum, including an $870 million savings from electrifying heating in the state.

Table 2: Electrification savings by appliance type

	Electrifying gas heating	Electrifying gas hot water	Electrifying gas cooking
ACT	$590.00	$359.00	$20.00
NSW	$191.00	$464.00	$14.00
NT*	N/A	N/A	N/A
QLD	$183.00	$689.00	$107.00
SA	$271.00	$448.00	$15.00
TAS	$587.00	$465.00	$43.00
VIC	$531.50	$305.50	$160.50
WA	$184.00	$250.50	$1.90

*No gas usage cost data available for NT

Source: Calculated from Climate Council 2023, Victorian Gas Substitution Roadmap 2022, Energy Economics 2023

Table 3: Annual savings from total electrification

	Electrifying gas heating	Electrifying gas hot water	Electrifying gas cooking	Total
ACT	$61,103,940	$38,866,776	$1,604,165	$101.6M
NSW	$129,604,578	$599,941,328	$21,598,756	$751.1M
NT*	N/A	N/A	N/A	N/A
QLD	$3,886,737	$334,018,243	$105,171,762	$443.1M
SA	$29,198,353	$209,856,192	$5,756,585	$244.8M
TAS	$7,449,617	$9,316,740	$5,257,424	$22.0M
VIC	$870,802,691	$690,101,893	$201,067,734	$1.8B
WA	$53,513,824	$193,407,042	$982,568	$247.9M
Total	$1.2B	$2.1B	$341.4M	**$3.6B**

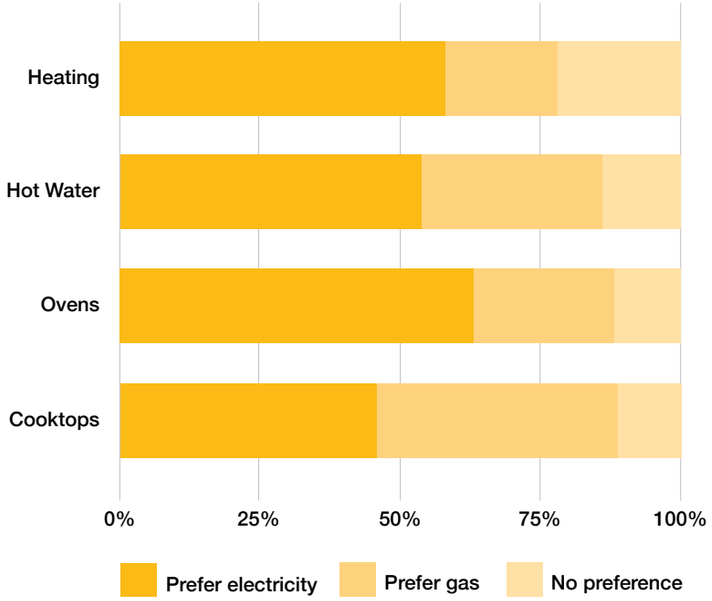
*No gas usage cost data available for NT

Table 3 values were calculated by multiplying state-specific values from Appendix A, Table 6 for heating, hot water and cooking, by state-specific values from Table 2 for each of these categories.

Source: Calculated using input data from Climate Council 2023, Victorian Gas Substitution Roadmap 2022, Energy Economics 2023, Residential Baseline Study 2021, and Australia Institute 2023

Traditional preferences for gas appliances seem to be changing. Research by SEC Newgate commissioned by the Australia Institute found that the majority of Australians prefer electric appliances. There is a clear preference for electrifying heating, hot water and ovens, with a more even split on preferences on cooktops, with a slight preference for electric over gas.

Figure 8: Australian electrification preferences



Source: The Australia Institute (2023), Community attitudes to home and car electrification

Overall, 55% felt positively about electrifying more homes, with 59% mentioning environmental reasons as a main driver of their opinion and almost one in five preferring electric for cheaper electricity bills and a healthier home.[32]

Complete residential electrification could save $4.9 billion.

Once marketed as a cheap source of energy, gas appliances are now costing households billions in energy costs every year. The cost of maintaining gas appliances will increase, with gas price inflation rising by more than 6% per annum,[33] driven by prevailing international pressures. In contrast, electricity price inflation is constrained by the growing market share of low cost renewable energy.[34]

Household electrification can play a key role in addressing the cost of living challenges for households, cutting the national energy bill by almost $5 billion per year and helping households to meet their same heating and cooking needs.

Energy efficiency

Electric appliances are far more efficient than gas appliances and therefore enable households to warm their homes and heat their water cost-effectively. Gas appliances work by burning fossil gas to produce heat. However, combustion also produces exhaust gas that is vented along with the heat energy it contains. Exhaust gas 'wastes' the energy and, in turn, reduces the energy efficiency of gas appliances.

In contrast, modern electric appliances are significantly more energy-efficient. This is, in part, because they do not produce wasteful exhaust gas, but also because appliances like heat pumps actually generate more heat energy than they consume (see Electric technology alternatives).

The significantly higher energy efficiency of split system heaters compared to gas heaters is underscored by the findings of the Healthy Homes Program in Victoria.

A study of household energy usage in the program found split systems increased indoor temperatures between 2.8 and 3.2 times more than gas heaters, using the same amount of energy (see Figure 9: Temperature increase from consuming 10kWh equivalent of gas or electric heating).[35]

Research from the much larger study published by ANU researchers in Energy Economics,[36] mentioned above, has found even greater efficiency improvements (see Cutting energy costs for study details). It found that households that upgraded to electric heating and hot water systems slashed their consumption of gas, but only moderately increased electricity usage.

Electric heating was between 388% to 542% more efficient than gas heating, and heat pump hot water was between 61% and 345% more efficient than the gas hot water systems.

The research found that low income households, referred to as 'priority households', achieved the highest energy efficiency improvements and benefited most from the program (see Table 4).

"The study finds evidence of large reductions in natural gas consumption and smaller increases in grid electricity consumption (measured in megajoules (MJ)) as a result of switching to new energy-efficient electric appliances under the EEIS."[37]

Table 4: Electric appliance efficiency improvement compared to gas

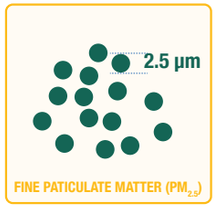
		Reduced gas use (MJ)	Increased electricity use (MJ)	Energy efficiency improvement
Low income households	Upgrade to reverse cycle air conditioning	7229.89	1125.75	542.23%
	Upgrade to hot water heat pump	4309.36	968.08	345.15%
All other households	Upgrade to reverse cycle air conditioning	6029.97	1235.26	388.15%
	Upgrade to hot water heat pump[38]	1795.64	1114.38	61.13%

Source: Hammerle, M. & Burke, P. (2022), Energy Economics

2.2 HEALTH BENEFITS OF RESIDENTIAL ELECTRIFICATION FOR HOUSEHOLDS

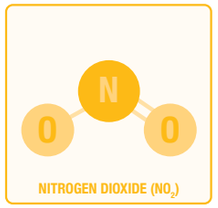
Shifting from gas to electricity offers substantial health benefits. The continued use of gas appliances poses serious concerns, particularly in regards to air quality, with Australians spending 90% or more of their time indoors.[39] Gas cookers and unflued gas heaters are two of the largest contributors to indoor air pollution,[40] and since homes have become better sealed from the outdoors, pollutants are being found at higher concentrations.[41]

The pollutants from the combustion of gas are associated with increased risks to health, including the following:



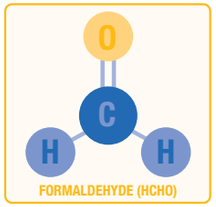
Fine particulate matter ($PM_{2.5}$)

Particulate matter that is less than 2.5µm in diameter, $PM_{2.5}$, is a particle emitted during gas combustion. The rate of $PM_{2.5}$ emissions are particularly high from gas-powered stoves. Due to their small size, these particles can end up deep in the respiratory system and cross the blood stream.[42] $PM_{2.5}$ exposure is one of the leading causes of mortality and morbidity globally,[43] and is associated with a range of health conditions including type 2 diabetes, lung and health conditions, impaired cognitive health and preterm birth rates.[44]



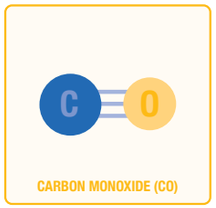
Nitrogen dioxide (NO_2)

NO_2 is a gas emitted during the process of gas combustion. It can act as an irritant when breathed in at high concentrations and may contribute to the development of asthma under longer exposure conditions,[45] especially for vulnerable people including children, the elderly, and those with lung conditions.[46]



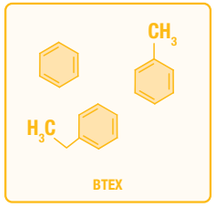
Formaldehyde (HCHO)

Formaldehyde is a gas released by flames in gas stoves, and is a respiratory irritant.[47] Under conditions of high exposure it has been found to cause a number of cancers.[48] A study by Roda et al identified identified an increased incidence of lower respiratory infections in infants exposed to formaldehyde in indoor environments.[49]



Carbon monoxide (CO)

CO is a flammable, poisonous gas that is odourless. CO poisoning is the leading cause of accidental poisoning worldwide,[50] and is produced from the incomplete combustion of fuels by cars, gas stovetops, heaters, and other appliances. CO reduces the oxygen-carrying capacity of blood and can negatively impact brain function under conditions of long-term exposure to low concentrations.[51] At high concentrations, this can cause unconsciousness and death.[52] CO poisoning deaths have been recorded in NSW, Victoria, South Australia, Western Australia, Queensland and New Zealand.[53] [54]



Benzene, toluene, ethylbenzene, and xylene (BTEX)

BTEX are volatile organic compounds known to impact human health.[55] Benzene is a carcinogen that the World Health Organization has advised has no safe levels of exposure for humans.[56] [57] Researchers from PSE Healthy Energy in California[58] found BTEX present in unburned natural gas from residential gas stoves, and that leakage from stoves and ovens can result in indoor benzene concentrations comparable to second-hand tobacco smoke.[59]

Health risks

Residential gas usage is more likely to affect vulnerable groups including children, people with pre-existing respiratory conditions, lower income households, and people of colour.[60] [61] [62]

In particular, a range of studies have examined the potential health impacts of gas usage in the home on children's asthma.

These include:

- A 2018 study by the Climate Council found that **up to 12% of the disease burden of childhood asthma in Australianchildren aged 14 years or less can be attributed to the presence of gas cooking in the home.**[63] The Climate Council estimates that this means a child living in a home with gas cooking faces a comparable asthma risk to a child living with cigarette smoking.[64]

- A meta-analysis by Lin et al on the effects of indoor NO_2 and gas cooking on respiratory issues estimated the risk of experiencing asthma symptoms increased by 42%, as well as a 24% greater chance of being diagnosed with asthma over the lifespan.[65]

- Research conducted by Gillespie-Bennett et al on the respiratory health impacts of NO_2 in children with asthma found that higher indoor NO_2 levels were associated with greater daily reports of lower and upper respiratory tract symptoms, more frequent coughing and wheezing, and more frequent ventolin use during the day.[66]

- A study by Kattan et al on the health effects of indoor NO_2 and passive smoking on children with asthma in urban settings found higher levels of indoor NO_2 are associated with increased asthma symptoms in nonatopic cases (asthma not triggered by allergens like pollen, pets, and dust mites).[67]

- A study by Yale's Center for Perinatal, Pediatric and Environmental Epidemiology on the effects of indoor NO_2 exposure on children with active asthma reported an increase in NO_2 exposure was associated with an increase in asthma severity. It also increased the frequency of wheezing, night symptoms and use of ventolin.[68]

- Asthma Australia's Guidelines note indoor exposure to NO_2 due to indoor gas stoves or heaters increases the risk of asthma symptoms, whereas replacing gas heaters with electric heating improves symptoms.[69]

Indoor air pollution

A review of evidence in the United States found that indoor air pollution from gas stoves often reaches levels that would be illegal outside the home.[70]

A comprehensive analysis was undertaken in Melbourne by a team of American researchers from PSE Healthy Energy & Stanford University, with results from the study still to be published (see Box 1).

The health risks of gas usage in the home are not sufficiently understood by the general public. The *2023 Essential Research national poll*[71] revealed the Australian community has a low awareness of the dangers of using gas in the home. Although 92% of respondents knew breathing in asbestos is extremely hazardous to health, and a similar proportion (90%) were aware of the health risks of smoking tobacco, **only 32% of respondents considered burning gas in the home for cooking or heating as harmful.**[72] The survey also found 60% of participants felt ambivalent and viewed burning gas in the home as benign.[73]

While Australia has outdoor air quality standards through the National Environment Protection Measure, currently no specific controls or frameworks exist for indoor air quality, except in workplaces.[74] Legislation regarding the regulation of indoor air quality is subject to the discretion of individual states and territories.[75] The Australian Standard AS1668[76] and the National Construction Code[77] specify ventilation system requirements. However, these requirements, which only apply to new buildings, only take air provision, rather than air quality, into consideration. The requirements are inconsistent with World Health Organization guidelines, and are not currently enforced.[78]

The Centre for Air Pollution, Energy and Health Research (CAR-CRE)[79] released a position paper calling for a national framework to develop standards for indoor air quality. The paper suggested this should be accompanied by policies that assist vulnerable populations.[80] For example, some European Union nations have begun to adopt specific measures to address concentration levels of certain pollutants, with others enforcing these via legislative acts.[81]

Actions for households

There are a number of steps that households can take to mitigate health risks associated with gas usage:

- Using an extractor fan, range hood or opening windows and doors. For example, a range hood covering the front burners of a cooktop with an airflow of at least 100 litres per second greatly reduces pollutant concentrations (using both a range hood and natural ventilation is the most effective method).[82] [83] [84]
- Purchasing an affordable portable induction top.[85]
- Purchasing an air purifier with a high-efficiency particulate air filter (HEPA) filter that removes indoor air pollutants.
- Installing a carbon monoxide monitor.
- Replacing gas appliances with electric alternatives.

Ultimately, these options are not within the control of all Australians, particularly for renters and economically disadvantaged households. Changes to current government policy are required to provide Australian households with the resources and support necessary to transition their homes.

Box 1: Australia Kitchen Pollutants Study, PSE Healthy Energy & Stanford University[93]

2023 KITCHEN POLLUTANTS STUDY

The 2023 Kitchen Pollutants Study[86] aims to improve understanding of the links between human health, indoor air quality and residential gas use.

Researchers tested gas cooktops and ovens in Australian capital cities (see photo 1) to determine the chemical composition of unburnt residential gas, including the presence of toxic chemicals. The researchers also used advanced gas monitoring equipment (see photo 2) to test indoor pollution loads produced while cooking with a gas stove.

The team tested three different situations: in the kitchen with doors and windows closed; in the kitchen with doors open; and in the bedroom on the other side of the house. The full results of the study have not yet been published.

However, one sample from a Melbourne household found **the amount of nitrogen dioxide in an unventilated kitchen increased within 30 minutes to about five times higher than the Australian outdoor air quality standard**. While boiling a large pot of water, NO_2 levels in a kitchen with no ventilation peaked at six times the National Environment Protection Measure maximum concentration standard for NO_2.[87] With kitchen doors open, NO_2 levels still peaked above the outdoor air quality standard, while air quality in the bedroom sat comfortably below the standard.[88]

This study builds on similar research conducted by the PSE Healthy Energy and Stanford teams in California.[89]

Key findings from previous studies include:

- **Leakages from gas stoves and ovens, even while not in use, can result in indoor benzene concentrations comparable to second-hand tobacco smoke.** At a statewide level this would be **equivalent to annual benzene emissions from nearly 60,000 light-duty gasoline vehicles.**[90]

- Gas stovetops and ovens release methane emissions through leakages and incomplete combustion of gas, with **more than three-quarters of methane emissions measured originating when the appliance was not in use.** Using a 20-year timeframe for methane (given that methane has a much shorter atmospheric life than carbon dioxide), annual emissions from all gas stoves in American homes were estimated to have an environmental impact comparable to the annual carbon dioxide emissions of 500,000 cars.[91]

- Emissions from health-damaging nitrogen oxides (NO and NO_2) in Californian households were linearly related to the amount of natural gas burned. In addition, **households that have poor ventilation or do not use their stove top range hoods can surpass the American national outdoor standard of NO_2 within a few minutes of stove usage, especially in smaller kitchens.**[92]

Photo 1: Rob Jackson, Stanford University

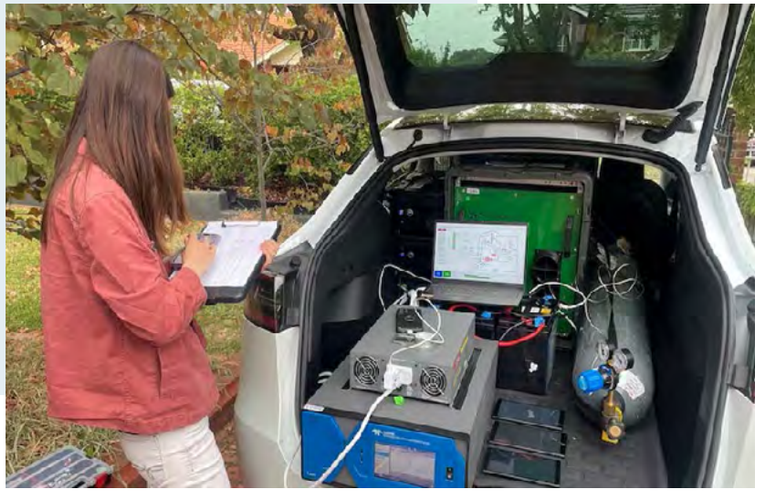


Photo 2: ABC News, Leonie Thorne

Photo 1 credit: Rob Jackson, Stanford University. Photo 2 credit: ABC News, Leonie Thorne.

2.3 BENEFITS OF ELECTRIFICATION FOR DISADVANTAGED HOUSEHOLDS

Lower income households are more exposed to the health impacts of residential gas cooking and heating. This is because they are more likely to live in smaller homes, have a greater number of people residing in the home, use older appliances, and have inadequate ventilation.[94] [95]

However, lower income households stand to benefit the most from the savings of switching to electric appliances (see 2.1 Financial benefits for households). This is partly due to the price of energy accounting for a greater percentage of their weekly expenditure.[96] For instance, recent research on electrifying households (see Table 4) found that converting homes from gas to electric heating reduced energy usage in priority low income households by 6,104MJ per quarter. This is compared to 4,795MJ for other households.[97]

Electrification enables low income households to heat spaces more efficiently by reducing overall energy use and costs (see Box 2). However, electrification is too often inaccessible to households that would benefit most. Barriers include the upfront costs of appliance installation and replacement, and a limited ability to make modifications in rental or social housing. This reflects an uneven distribution of opportunities to participate in Australia's energy transition.[98]

A number of states have policies to assist low income households with the electrification transition: the Sustainable Household Scheme[99] in the ACT, the Social Housing Energy Efficiency[100] upgrades program in Victoria, and the Solar for Low Income Households Rebate Swap[101] in NSW.

The provision of zero-interest loans and incentives may also help. This could cover the replacement of gas-powered appliances with electric alternatives, and purchasing equipment to support access to health co-benefits, such as a portable induction cooktop for renters and air purifiers with HEPA filters.

In addition, CAR-CRE has called for policies to make the replacement of gas appliances with electric equivalents mandatory in rental properties, as well as the adequate ventilation of new and existing buildings.[102]

Thermal comfort and energy poverty

Electrification is an efficient way to address health and wellbeing issues associated with thermal comfort. Australia's climate features cold winters, heatwaves, severe bushfires and hot summers.[103] Heat kills more Australians than any single natural disaster, with heatstroke being particularly dangerous in young children, the elderly, and people with underlying medical conditions.[104]

As part of the Digital Energy Futures project,[105] the Emerging Technologies Research Lab at Monash University assessed 72 households in NSW and Victoria on future energy use.[106] They found households are becoming more interested in managing their home's air quality and are adjusting heating and cooling practices (including changes as a result of COVID-19 lockdowns). Increasingly, air conditioners are being considered as essential, with more rooms and spaces in the home being heated and cooled.[107]

Research from the Digital Energy Futures project also suggests the increase in cost of living is more likely to result in households increasing their energy use, as they look to economise by cutting back on activities outside of the house.[108] With Australia's ageing population being increasingly cared for at home, respondents expect household efficiency to become even more important as they age.[109]

Energy poverty, which refers to when bills constitute a disproportionately high percentage of a household's income, poses challenges to creating a safe indoor temperature with adequate cooling during the summer months and sufficient warmth during winter months.[110]

Research conducted by Awaworyi Churchill and Smyth examined the relationship between energy poverty and health over a 13 year period.[111] Looking at 19,914 individuals, they found that energy poverty lowers general health.

A 2022 study by Fry et al found pensioners in Australia are more likely to experience energy poverty than self-funded retirees.[112]

A report by the Brotherhood of St. Laurence[113] found that between 2006 and 2020, 18–23% of households in Australia experienced at least one form of financial energy stress. In 2020, households reporting energy stress included the following:

- 41% those in the lowest 20% of incomes
- 35% renting public or community housing
- 24% in private rentals
- 27% where at least one member has a long-term health condition or disability.

The relationship between the health outcomes of vulnerable groups and energy poverty has been recognised in innovative policy initiatives overseas. For example, in the UK, GPs have begun a trial prescribing warmth to at-risk patients, with the aim to ease the impact of the cost of living crisis.[114]

The Warm Home Prescription pilot was trialled in Gloucestershire in 2022, allowing GPs to prescribe home heating for 28 patients on low incomes who were deemed to be at highest risk of being admitted to hospital during the colder months.[115] The program, funded by the government's housing support fund, is now being extended to 150 households in Gloucestershire and an additional 1,000 homes in Teesside and Aberdeen, following promising pilot results.[116]

In Australia, the peak body for renters, Better Renting, tracked temperature and humidity in 77 rental homes between December 2022 and February 2023 to assess the impact of these conditions on renters with substandard homes and increasing energy prices.[117] Table 5 shows key results from the study across jurisdictions, illustrating particular impacts in Queensland, Western Australia and the Northern Territory.

In these regions, renters spent more than 50% of their time at home in temperatures well above above 25°C – for global context, the World Health Organization's housing and health guidelines recommend a healthy temperature range inside homes of between 18°C and 22°C.[118] [119]

Table 5: Maximum temperature and time spent in different temperature ranges in rental properties studied

	Below 25°C	25-30°C	Above 30°C
ACT	83%	17%	0%
NSW	63%	36%	1%
NT	0%	78%	22%
QLD	19%	68%	13%
SA	60%	37%	4%
TAS	71%	23%	6%
VIC	77%	21%	2%
WA	37%	54%	9%
National	**55%**	**40%**	**5%**

Source: Barrett, B., Catania, L., Dignam, J. (2023), Sweaty and Stressed: Renting in an Australian Summer, Canberra: Better Renting

Research by Monash University has shown prolonged exposure to high temperatures above this range can lead to health impacts including respiratory disease, cardiovascular disease, and negative mental health impacts.[120] [121]

Qualitative data from Better Renting's study illustrated the severe impacts of these temperatures, with one renter in NSW stating:

> "*Everything about the efficiency of this house plus more has ruined my life and my mental health. I hate living here, crazy how much where you live affects your quality of life and every single aspect of it. I'm constantly sick*" (Melika, NSW).[122]

Similarly, in 2023 Jara-Baeza et al surveyed social housing residents' perception of indoor air quality in Melbourne.[123] The study found residents were least satisfied (33%) with the indoor temperature in summer, and that correlations were present between indoor air quality and the frequency of building-related health issues.

In 2019, University of Sydney researchers undertook qualitative research[124] on behalf of Mallee Family Care to explore the lived experience of residents facing extreme heat in Mildura's public housing. The results illustrated the impact of inadequate housing and cooling methods on residents' physical and mental health and social and economic wellbeing.[125]

Quotes from residents in the University of Sydney study highlighted these challenges:

"You can't function, it's that hot [sic]. And people get really miserable and really cranky too when the hot weather comes."

"Babies are constantly sick. You are constantly needing Nurofen, Panadol because they've got higher temperatures..."

"Concerned that it's gonna get even hotter… If this is what it's like in 2019, what is it gonna be like in the future?"

"I'm 65, what about when I'm 70…without [an] air conditioner I think it might be very hard for those in their 70's. [sic]"

There are certainly new promising policy initiatives, such as Victoria's minimum rental standard, which requires a fixed heater to be present in the main living space, or ACT's minimum standard for ceiling insulation in rentals. However, more needs to be done to ensure safe, equitable, healthy, and comfortable housing for all Australians.[126]

The Victorian Healthy Homes upgrade and research program run by Sustainability Victoria mentioned earlier (see Energy efficiency) provides an example of an effective, although small-scale, policy designed to assist disadvantaged households to improve the thermal comfort of their homes.

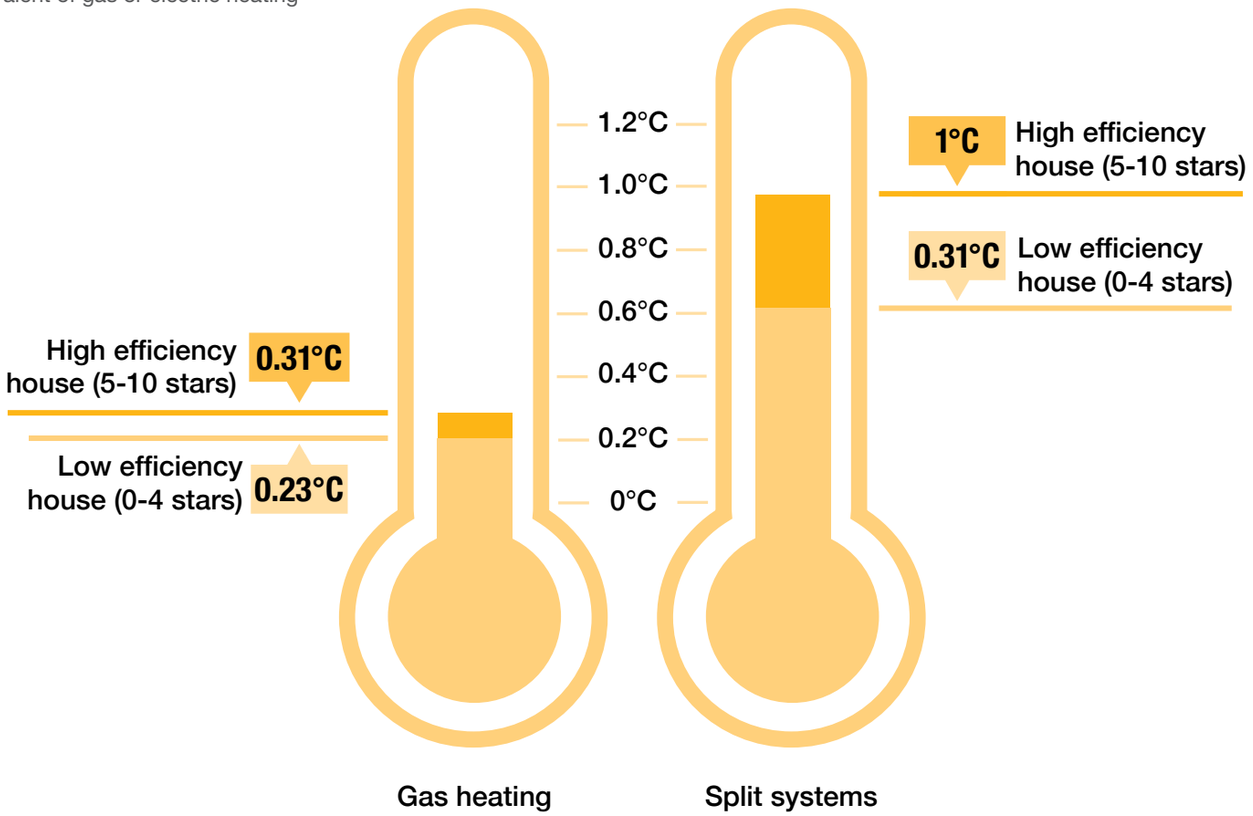
The Healthy Homes program delivered thermal comfort and energy efficiency upgrades to 1,000 homes of low income Victorians with a health or social care need, running over 3 years (2018 to 2020) across western Melbourne and the Goulburn Valley. The program was designed as a randomised controlled trial, with households receiving upgrades as part of either the intervention (upgraded before winter) or control (upgraded after winter) group. This allowed researchers to evaluate the difference in thermal comfort, energy use, healthcare utilisation, health, and quality of life between the two groups over winter.[127] [128]

A key finding of the program was a relationship between the type of energy being used (electric or gas) and indoor temperature. Evaluation of the program showed that using 10kWh equivalent of gas heating in households with low-efficiency appliances (0-4 star) increased the mean indoor temperature by 0.23°C and in high-efficiency households (5-10 star) by 0.31°C (see Figure 9). In comparison, using 10kWh of electricity to heat the home with a split system air conditioner increased average indoor temperatures by 0.64°C in low-efficiency households and 1°C in high-efficiency households.[129]

It is notable that electric heating raised the temperature three times higher than gas heating on a per kWh basis.

In addition, qualitative data from the Healthy Homes program illustrates how improved thermal comfort translates to improvements in quality of life for program participants as a result of electrification.

Figure 9: Temperature increase from consuming 10kWh equivalent of gas or electric heating



While the program intervention included a range of measures in addition to electrification (such as draught-sealing, curtains and blinds), the case study in Box 2 illustrates the mental and physical health, accessibility and quality of life benefits to a participating household from the installation of an electricity-powered reverse cycle split system.

Box 2: Healthy Homes Program Case Study – The mental & physical health, accessibility & quality of life benefits of a split system and improved thermal comfort[130]

HEALTHY HOMES PROGRAM CASE STUDY

Judy and Mark*, both in their late 60s, own their house in Melbourne's west. Judy has a long history of health problems. Oxygen deprivation at birth caused cerebral palsy, which has affected her legs and her balance, a situation compounded by a car accident in 2011.

> Judy: *"I have balance problems…I've got to walk with crutches or use my wheelchair depending on what kind of day I'm having."*

Impacts of the home upgrade

Their upgrade consisted of curtains and blinds, draught sealing and the installation of a split system. The window coverings have made a noticeable difference to the warmth of their house.

> Mark*: "You've got the shutter blind, in other rooms you've got the roller blind, and then you've got really thick block out drapes and it just creates that barrier so it keeps heat in or out."*
>
> Judy: *"The blinds are fantastic, the drapes in the bedrooms. Even the little guards on the doors…"*

"I was surprised at just how efficient they are…it's all been good."

To maximise the heating benefit, split systems are typically placed in the main living area as part of a Healthy Homes upgrade. Judy and Mark, however, had a special request. Their primary concern was being able to keep Judy warm during the lengthy wheelchair transfers in and out of the shower in the mornings.

> Judy: "*I was saying how cold I get in the mornings because my movements aren't as fast as you guys, and we said 'would it be possible to put a small split system in the bathroom?*"
>
> Mark: "*We had a little turbo heater, which really didn't do much*."
>
> Judy: "*And that used to eat up a lot of power, so to get the split system was just amazing. The morning is lovely, because we put it on and it's warm by the time I get in there for the shower. You just turn it on and they're so efficient.*"

Health benefits – physical and mental

Mark recognises that the upgrade is about more than just being warm and cosy.

> Mark: *"It helps us keep healthy."*
>
> Judy: "*I want to stay as independent as I possibly can. Staying warm is the best thing. If I get too cold all my muscles and tendons just stiffen up and I can't move.*"

The upgrades have made a big difference.

> Judy: "*We both suffer from asthma. If I get cold, I cough, and it's an asthma cough, and it's one of those coughs you can't get rid of unless you take Ventolin or something. If I'm warmer and in an environment where things can be closed up if it's cold, I don't get it anywhere near as much.*"

The health benefits of the upgrades, and the greater warmth they provide, are not limited to physical health. Judy has a history of anxiety and post-traumatic stress disorder.

> Judy: "*With my post-traumatic stress…if I don't feel good somewhere or something happens, I just want to come home because this place is my sanctuary. I feel within myself that if anything goes wrong it's not going to go wrong while I'm home. This has made it a lot more comfortable, a lot warmer, and a lot safer in my head, in my mind, because I feel like nothing can hurt me when I'm home."*
>
> *"My medical condition is better, I feel better. If my health is better, I feel better…so it's all linked."*

*Names have been changed.

CHAPTER THREE
JOB OPPORTUNITIES FROM RESIDENTIAL ELECTRIFICATION

To meet the growing demand of renewable energy, Australia needs a rapid increase in its workforce.

The national workforce required to deliver a program of full household electrification is significant. To meet the demand of residential electrification, Australia will need to focus on having enough workers. The Institute for Sustainable Futures (ISF) at the University of Technology Sydney (UTS) estimated that the national electrical workforce will need to grow significantly by 2030 to between 200,000 and 400,000 workers.[131]

3.1 JOB CREATION

Over a 10-year period, electrification of residential gas alone would create close to 20,000 full-time ongoing jobs across Australia, with the majority in Victoria and NSW.

This estimate focuses on electricians and plumbers, the workforce required to disconnect redundant gas appliances and associated infrastructure, and install new high-efficiency electric appliances. In addition, job creation is expected from the continued growth in residential rooftop solar and battery installations.

There will be increased demand for electrical workers from the construction of large-scale renewable energy projects, the significant upgrades required to the electricity grid, and a shift to industrial electrification.

Further down the supply chain, there is the opportunity to create jobs in the manufacturing sector. However, this will depend on the extent to which Australia fosters a domestic appliance manufacturing industry that can meet the demand for high-quality and competitively-priced electrical appliances.

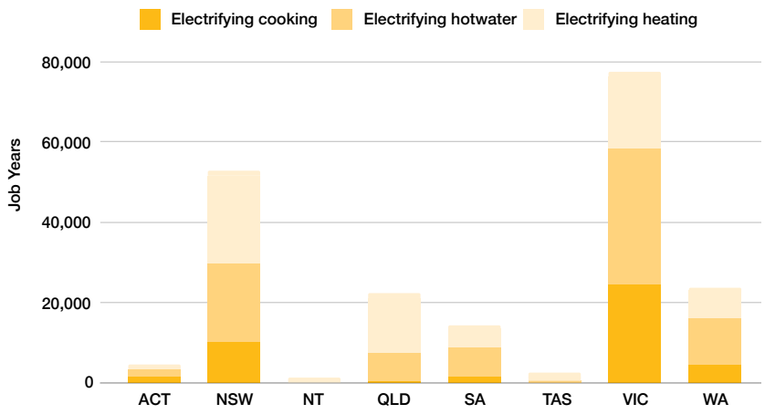
Appliance electrification

Complete electrification of the residential sector will involve replacing 13.2 million gas appliances in homes across Australia.

Research by the Institute for Sustainable Futures at UTS has established an employment factor (the time it takes to install an appliance as a fraction of the working year) of 0.015 job-years for each water heating system installed in Australia.[132] A job year is equivalent to one person working full time for the entire year.

This ratio was used to determine the direct job creation from replacing the nation's gas hot water systems. This excludes additional job creation that will occur from manufacturing and maintenance or electric appliances. The same employment factor was applied for the installation of split system air conditioners and induction cooktops, due to the similar installation work load as water heating systems.

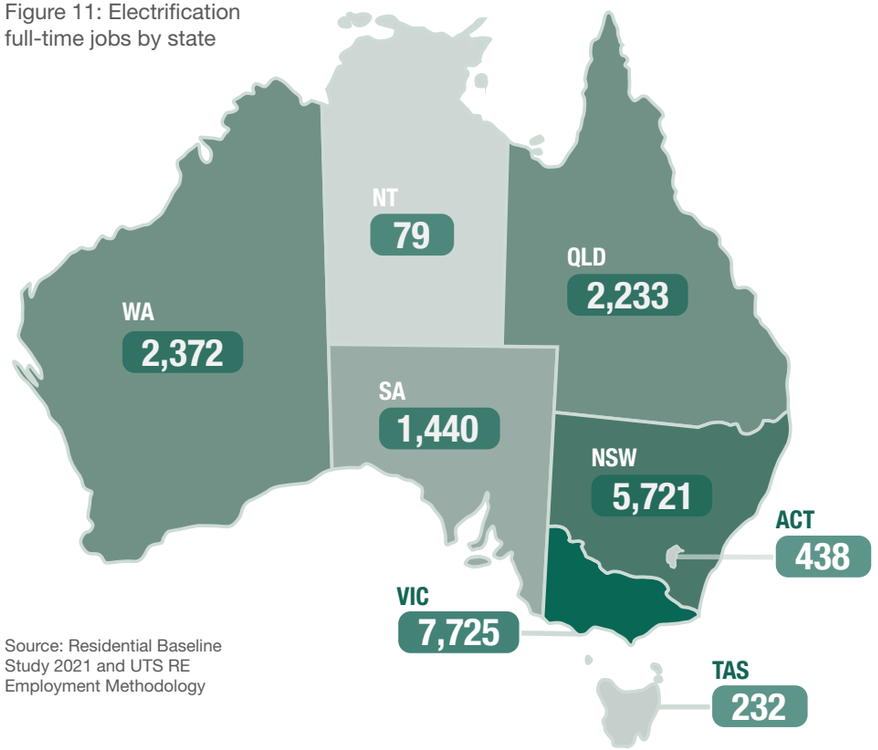
Figure 10: Residential electrification jobs by state



Source: Residential Baseline Study 2021 and UTS RE Employment Methodology

The number of job-years created from electrifying the residential sector were determined using two factors: insights from UTS, combined with the quantity of residential gas appliances in Australia from the 2021 Residential Baseline Study. The analysis shows that electrifying Australia's entire residential gas appliance stock is projected to create around 198 thousand job-years worth of work – that equates to around 20,000 full-time jobs over 10 years.

Figure 11: Electrification full-time jobs by state



Source: Residential Baseline Study 2021 and UTS RE Employment Methodology

Residential solar

The rooftop solar and battery industry will be a strong and growing employer as residential electrification accelerates. In Australia, one in three households features rooftop solar PV[133] and in 2018-19 there was a national rooftop solar workforce of 13,070.[134] The workforce is likely larger today, as households continue to break records with the amount of rooftop solar added each year. In 2021, 3.2GW of new solar systems were installed on 377,438 homes, compared to 1.5GW of new solar installed on 224,852 homes in 2018.[135] [136] The *Institute for Sustainable Futures' Renewable Energy Employment 2020 report* estimates that every megawatt (MW) of rooftop solar generates 5.8 job-years of work.[137] **This indicates that the rooftop solar industry now employs more than 18,500 full-time workers.**

Despite the 20GW of solar already installed on residential rooftops,[138] there is no foreseeable shortage of roof space for additional solar, with the Clean Energy Finance Corporation estimating that a further 179GW could be installed on Australia's rooftops.[139]

The residential battery storage installation sector is experiencing even faster growth. The *2023 Annual Australian Battery Market report* produced by industry analyst SunWiz found yearly growth of 55% for residential battery installations in 2022, with an additional 589MWh of capacity added within that year.[140] The Institute of Sustainable Futures calculates that every MWh of battery storage creates 5.6 job-years of work,[141] indicating that **the battery installation industry already employs more than 3,500 workers.**

3.2 SKILLS AND TRAINING

The growth in solar, battery, and residential electrification is creating new demand for workers. Those with electrical and plumbing skills are in high demand with the additional pressure from the electrification of industry, as well as large-scale renewable energy and transmission.

The demand for certain skills is expected to grow further. The National Skills Commission priority list shows national shortages of general plumbers, air conditioning and mechanical services plumbers, electrical engineers, general electricians, special class electricals and electronic equipment trades workers. The Commission found shortages are greatest among technicians and trade worker occupations, with only 54% of vacancies filled.[142]

Achieving the benefits of residential electrification for Australian homes will require training and expanding the workforce to address the shortages of today and the higher demand of tomorrow.

The 2023 announcement by the Australian Government of a Net Zero Authority with a remit to support workers and communities is a promising indication that there will be an increase in national coordination of critical skills and training.

Currently there are a mix of initiatives at the state level, such as the $16 million Energising Tasmania Training Fund delivered by Skills Tasmania to develop an expanded energy sector workforce.[143] Other such initiatives include Queensland's $90 million investment in two SuperGrid Training Centre and Transmission Hubs as part of its Future Energy Workforce plan,[144] and Victoria's $220.5 million investment in trade and electrical skills announced in the 2023 state budget.[145]

CHAPTER FOUR
RESIDENTIAL ELECTRIFICATION POLICIES

As Australia endeavours to electrify its residential sector, the absence of a cohesive nationwide plan has resulted in a patchwork approach at the state and the federal level.

In order to address the significant challenges of residential electrification, this disjointed policy approach needs to be remedied at both levels of government.

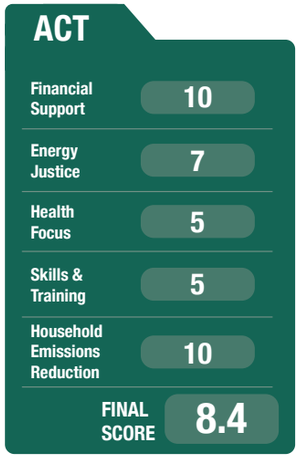
This chapter looks at the various policies enacted by the federal and state governments and scores them based solely on key policy aspects, such as electrification strategies, energy justice initiatives, focus on health, and more. By reviewing the policy landscape, this chapter provides an overview of the different approaches taken by governments to achieve residential electrification goals, and therein, where policy gaps lie.

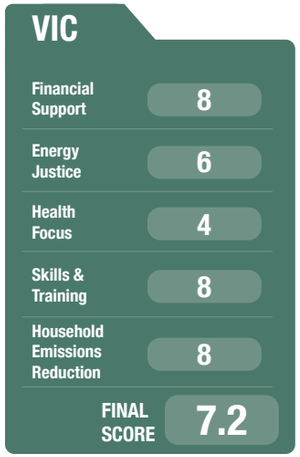
4.1 OVERVIEW OF RESIDENTIAL ELECTRIFICATION POLICIES

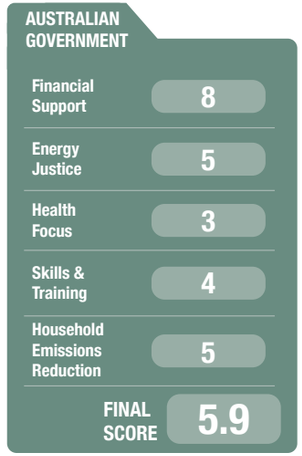
A nationally comprehensive plan to electrify the residential sector is yet to be established in Australia, leading to a variety of different approaches taken by states, territories and the Australian Government.

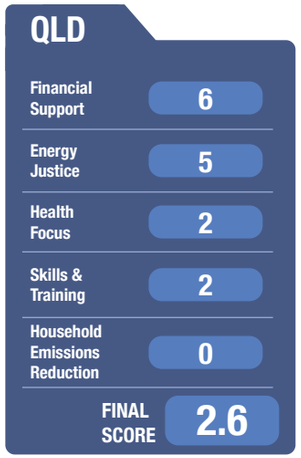
These scorecards provide the first snapshot of how Australia's states, territories and national government are performing as they attempt to electrify the residential sector.

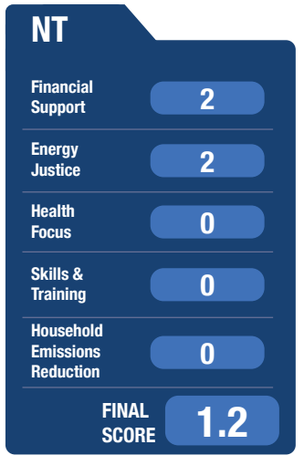
The scorecards rank governments on current policies and programs for electrification, energy justice, health, workforce skills and training, and emissions reduction.











Assessment of government policies

To evaluate the current residential electrification policies implemented by the Australian Government as well as in each state and territory, relevant policies and programs were scored against five criteria:

Financial support
Policies and programs providing financial support to incentivise residential electrification. This could include direct grants and subsidies, interest-free loans, certificate incentive schemes and other financing mechanisms.

Energy justice
Whether policies and programs exist that specifically focus on enabling access to residential electrification by reducing barriers or improving access for vulnerable groups. These groups include public housing residents, tenants, households with lower incomes, the elderly, and people experiencing a chronic illness.

Health
Policies and programs that have a primary focus on the health impacts of residential electrification, whether enabling health co-benefits or reducing exposure to negative health impacts.

Skills and training
Policies and programs that are designed to develop the workforce required to deliver residential electrification at scale, including the provision of targeted skills and training.

Household emissions reduction
The scale and ambition of policies that support electrification, with respect to the emissions reduction potential at a broad level. For example, this takes into account whether a program encourages households to install electric appliances exclusively, or whether it also incentivises gas appliance purchases.

To determine the overall score, weighting varied by criteria. 'Financial support' received a higher weighting due to the critical role financing plays in enabling rapid residential electrification. In contrast, the 'Health' and 'Skills and Training' criteria received less weight due to these areas being less developed within current electrification policy overall, and are not as strong a driver of electrification at this point in time. Only current policies and programs – including those recently announced but not yet implemented, such as those in the Federal and Victorian budgets – were considered as part of the assessment.

Key considerations in scoring the criteria included:

- **The breadth of policies**
  For example, with respect to financial support, ensuring a diverse mix of financial support provision via direct grants and subsidies, interest-free loans, certificate incentive schemes and other mechanisms.

- **The systemic versus narrow nature of interventions**
  For example, enacted policy changes compared to narrowly targeted rebate programs with short durations and limited funding.

- **Clarity and ambition of policy interventions**
  For example, establishing programs or strategies where supporting household electrification was a clear and intentional ambition and targeted outcome.

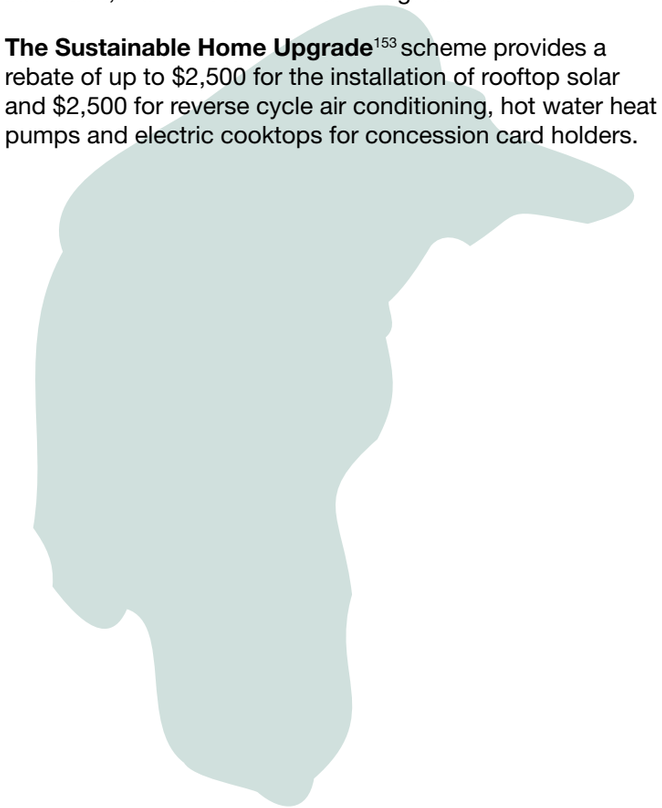
A number of stakeholders with expertise in residential electrification were also consulted to provide input on the current state of policy in Australian jurisdictions. These stakeholders include experts across social justice, health, and residential electrification.

AUSTRALIAN CAPITAL TERRITORY

The Australian Capital Territory has enacted a clear and comprehensive suite of policies.[146] These initiatives, which are part of the Powering Canberra plan,[147] are designed to expedite residential electrification. They encompass a gas phase-out date and provide incentives for households through the Energy Efficiency Improvement Scheme and the Sustainable Household Scheme.[148]

This policy mix addresses key barriers – including upfront costs and consumer knowledge – and aims to provide energy justice for both homeowners and renters with a clear goal to achieve net zero by 2045.

- **Energy Efficiency Improvement Scheme (EEIS)**[149] is a program to reduce greenhouse gas emissions and energy consumption by households. The scheme requires the ACT's largest energy retailer, ActewAGL, to offer discounts on energy-efficient electric appliance upgrades, including the replacement of gas appliances with electric. Households who live in public housing have received these appliances cost-free.
- **Clear information for residents**[150] is provided by the ACT in a simple-to-follow format for those seeking to electrify their home. Leading consumer advocacy group, Choice, provides a user-friendly tool which advises on high quality electric appliances and estimates cost savings.
- **The phase-out of gas connection** is underway in the ACT, with plans for a complete phase out of gas use by 2045 alongside proposed legislation to ban new gas connections from late 2023.[151]
- **The Sustainable Household Scheme**[152] provides zero-interest loans of up to $15,000 for households to install solar, batteries, high efficiency electric appliances, insulation, electric vehicles and chargers.
- **The Sustainable Home Upgrade**[153] scheme provides a rebate of up to $2,500 for the installation of rooftop solar and $2,500 for reverse cycle air conditioning, hot water heat pumps and electric cooktops for concession card holders.



ACT

Financial Support	10
Energy Justice	7
Health Focus	5
Skills & Training	5
Household Emissions Reduction	10
FINAL SCORE	8.4

VICTORIA

Victoria is highly reliant on gas, and therefore has much to gain from electrification policy. The government has announced an increase in skills and training funding for the electrification workforce in the 2023 Budget. Victoria's Gas Substitution Roadmap outlines a clear direction for the state, with measures such as the ban on gas connections for new homes from 2024 converting the roadmap's intent into policy practice.

Recent policies also support the phasing out of gas appliances and accelerating household electrification.

- **The Gas Substitution Roadmap**[154] is the first comprehensive policy document for Victoria that charts a path to electrify the residential sector. This is underpinned by programs which will enable greater household electrification. For example, electrification funding via Solar Victoria, removal of mandatory gas connections for new homes,[155] and a phase-out of incentives for all residential gas products by 2023[156] (including changes to the influential Victorian Energy Upgrades program).[157]
- **The All Electric Homes Scheme**[158] is a landmark change to Victoria's planning rules that phase out gas use by requiring new homes constructed from 1 January 2024 to be fully electric.
- **Solar Victoria**[159] provides rebates of up to $1,400 for solar panels, $1,000 for heat pump hot water systems, $2,950 for battery storage systems, and $3,000 for new zero-emissions vehicles. The program is targeted to benefit homeowners as well as renters and community housing providers, with dedicated streams for each. Solar Victoria also provides zero-interest loans.
- **Victorian Energy Upgrades** is a government energy efficiency program that provides discounts on energy-saving products. The program has supported households to upgrade appliances and equipment to reduce bills and emissions. The program has been adjusted in 2023 to support the electrification of households and remove support for gas.[160]
- **The Social Housing Energy Efficiency upgrades program**[161] provides $112 million to replace inefficient gas appliances with efficient split system air conditioners, hot water heat pumps, draught sealing, and insulation in social housing properties.
- **The removal of mandatory gas connection**[162] in 2022 means new properties are no longer required to be connected to the gas network.
- **The training the next generation of workers**[163] funding package announced in the 2023 Victorian budget includes:
    - $50 million TAFE Clean Energy Fund
    - $116 million to build six new Tech Schools
    - $16 million for two new clean energy worker training centres
    - $12 million SEC Centre of Training Excellence
    - $19 million for clean energy work experience
    - $7.5 million to introduce clean energy as a VCE Vocational Major.

VIC

Financial Support	8
Energy Justice	6
Health Focus	4
Skills & Training	8
Household Emissions Reduction	8
FINAL SCORE	7.2

NEW SOUTH WALES

The suite of New South Wales policies, including the Peak Demand Reduction Scheme and Energy Savings Scheme incentives, leaves the state in a good place to climb the ranks in the future. In particular, there is an opportunity to implement minor tweaks to existing funding programs so electric appliances are exclusively incentivised, as enacted in Victoria this year. Policies such as the Solar for Low Income Households Rebate Swap, which provides rooftop solar or energy upgrades to low income households in exchange for forgoing ten years of the Low Income Household Rebate, present an unnecessary trade-off that hampers electrification. Leading states are providing low income households with both energy cost relief and support to install solar and electric appliances.

NSW is also poised to improve its ranking if it adjusts existing programs to focus exclusively on electrification (as opposed to including eligibility for gas).

- **The Energy Savings Scheme (ESS)**, NSW' largest energy efficiency program, is due to run until 2050. This scheme provides households (as well as businesses, which are beyond the scope of this report) with financial incentives to improve the energy efficiency of their appliances. The ESS sets an energy savings target for electricity retailers and large users, who then meet their target by creating or purchasing energy savings certificates (ESCs) for eligible activities, such as the purchase of a more energy-efficient appliance.[164]

- **The Peak Demand Reduction Scheme (PDRS)** aims to reduce energy demand during peak hours by setting a peak demand reduction target for electricity retailers and large users. Similar to the ESS, retailers and large users create or buy peak reduction certificates (PRCs) for eligible activities to meet their targets. This results in reduced energy usage during peak demand periods, such as replacing an existing hot water boiler or water heater with an air source heat pump water heater system.[165]

- **The Solar for Low Income Households Rebate Swap** helps eligible low income households to install a free three kilowatt solar system to reduce their electricity bills.[166] To meet the criteria to receive the solar system, households must also agree to a number of conditions, including to stop receiving the Low Income Household Rebate for 10 years.[167] An alternative for households (that are not suitable for solar) is available in the form of a rebate swap for energy upgrades valued up to $4,000.[168]

- **The Empowering Homes Solar scheme** was initially intended to offer no-interest loans of up to $9,000 for a solar battery system; and up to $14,000 per solar and storage system to owner-occupiers with an annual household income below $180,000 for up to 300,000 households. It experienced delays as a pilot program in a small number of local government areas and closed on 31 July 2022.[169]

- **The Community electrification pilot scheme,** worth $8 million, provides funding to trial decarbonising across local urban, regional and remote communities in NSW. One of the goals of the program is to identify cost-effective ways to upgrade existing homes with electric and energy-efficient appliances and technologies, via a competitive process to partner with the private sector.[170]

- **The Regional Community Energy Fund** provided grants to community energy projects that create innovative and/or dispatchable renewable energy and realise benefits for local communities. The first funding round awarded approximately $15.4 million to seven projects, which will collectively unlock nearly 17.2MW in electricity generation and up to 17.9MW/39.3MWh of energy storage and leverage approximately $36 million in private investment. The Government has not yet confirmed whether a second round of funding will occur.[171]

NSW

Financial Support	7
Energy Justice	5
Health Focus	2
Skills & Training	4
Household Emissions Reduction	4
FINAL SCORE	5.2

TASMANIA

Tasmania's Renewable Energy Action Plan[172] includes a range of policies to increase renewable energy generation, grow the economy and jobs, and ensure reliable, secure and affordable energy for Tasmanian customers. However, the overarching focus is on industry development.

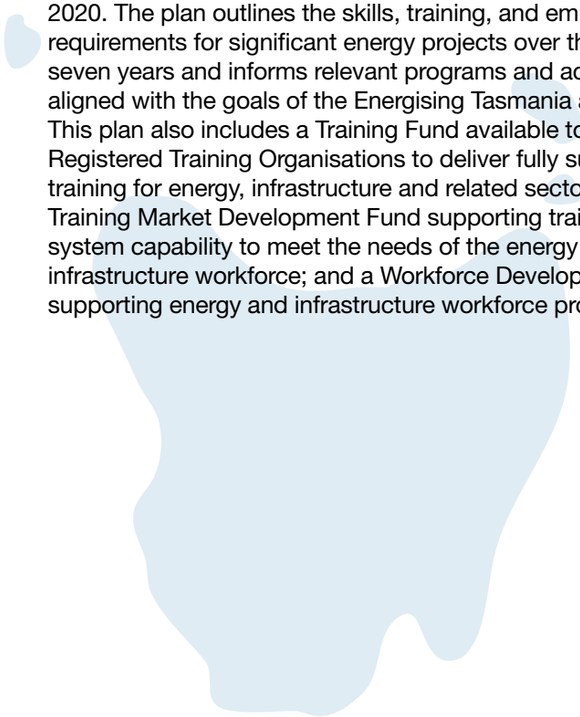
- **The Energy Saver Loan and Subsidy Program**,[173] run in partnership with Aurora Energy and No Interest Loans (NILS) Tasmania, assists low income households to reduce their electricity bills and enable them to purchase energy-efficient products. The Tasmanian Government is providing an additional $1 million to expand the provisions of no-interest loans to 2023–24, enabling further loans to be provided to Healthcare Card recipients. The NILS program provides a subsidy of up to 50% toward the cost of purchasing new energy-efficient appliances, in conjunction with the no-interest loans scheme.

- **Public housing heating and energy efficiency initiatives** target cost of living pressures for public housing tenants through the provision of $15 million to increase energy efficiency, decrease operating costs and reduce power bills for Housing Tasmania tenants via programs to:

    - Finish substituting energy efficient heat pumps for inefficient direct electric heating and gas heating in all public housing stock.
    - Substitute ageing standard electric hot water systems for new heat pump hot water cylinders in public housing stock, targeting the oldest systems first in approximately 1,200 public housing properties.[174]

- **The Energy Customer Empowerment Blueprint** aims to empower Tasmanian customers to manage their energy needs by increasing understanding of their day-to-day energy usage patterns, thereby reducing bills through altered energy behaviours and choices. The four-year plan will include the monitoring of the rollout of advanced electrical meters across Tasmania to ensure a smooth transition.[175]

- **Energising Tasmania**, established in 2019, serves as the foundation for Tasmania's energy sector workforce. As part of this initiative, the Workforce Development Plan for the Tasmanian Energy Sector (Stage 1) was created in December 2020. The plan outlines the skills, training, and employment requirements for significant energy projects over the next seven years and informs relevant programs and activities aligned with the goals of the Energising Tasmania agenda. This plan also includes a Training Fund available to Endorsed Registered Training Organisations to deliver fully subsidised training for energy, infrastructure and related sectors; a Training Market Development Fund supporting training system capability to meet the needs of the energy and infrastructure workforce; and a Workforce Development Fund supporting energy and infrastructure workforce projects.[176]



TAS

Financial Support	5
Energy Justice	5
Health Focus	2
Skills & Training	5
Household Emissions Reduction	4
FINAL SCORE	4.5

SOUTH AUSTRALIA

Despite the high level of renewable energy generation in South Australia's local grid, the state provides some support for greater household electrification through the Retailer Energy Productivity Scheme. However, while the scheme provides incentives for electric appliances, it also incentivises the installation of gas appliances, an issue that could be fixed with a simple regulatory change like that enacted in Victoria.

Housing South Australia's Virtual Power Plant program to install solar and batteries on 4,100 of its properties is a promising initiative, even if expanding the policy to support a far greater number of properties is required to lift South Australia up the rankings. The City of Adelaide's Sustainability Incentives Scheme, which offers rebates to residents for the installation of sustainable technologies in their home, could be expanded to the whole state.[177]

- **The Retailer Energy Productivity Scheme (REPS)** provides incentives for South Australian households and businesses to save energy. To do so, the Minister for Energy and Mining sets energy productivity targets (EPTs) for electricity and gas retailers. And, to achieve these targets, retailers under the Scheme offer incentives to households and businesses to achieve energy productivity through actions such as installing energy efficient lighting, water-efficient shower heads, or saving on water heating costs.[178] [179]
- **Solar PV and batteries for public housing residents** will lead to 4,100 Housing South Australia properties receiving solar PV and batteries to save money on their power bills.[180]
- **A Home Battery Scheme** was launched in October 2018 to offer up to $6,000 on eligible systems, but was decreased to a $2,000 maximum subsidy and ultimately closed under a new state government.[181] [182]

SA	
Financial Support	6
Energy Justice	5
Health Focus	2
Skills & Training	2
Household Emissions Reduction	0
FINAL SCORE	3.8

QUEENSLAND

While Queensland has the highest rate of household solar installation in the nation, the state currently lacks a plan to electrify household appliances, as well as programs to ensure that low income households share the benefits.

The Energy and Jobs plan will tangentially assist households through the expansion of community batteries that will enable greater solar uptake; but it does not provide any direction for the electrification of gas appliances. The Future Energy Workforce plan's $90 million commitment for two new training centres is the most significant national skills investment program identified. While industry focused, the plan should help address broader electrical skill shortages across the sector.

- **Queensland's Energy and Jobs Plan**[183] includes a $500 million investment in the deployment of large scale and community batteries. The expansion will enable higher rates of rooftop solar installation. However, there are no open support programs to assist homeowners to reduce the cost of installing electric appliances, battery or solar.
- **Queensland's Zero Emission Vehicle Strategy** provides rebates of $6,000 for the purchase of new electric vehicles[184] for eligible households.
- **The Solar for Remote Communities program**[185] is part of the $3.6 million Decarbonising Remote Communities program and has resulted in 1,139kW of solar installed in remote communities. A further $10 million provided as part of the Queensland Microgrid Pilot Fund[186] will support the replacement of diesel generators with stand-alone renewable generation and storage.
- **Interest-free loans for solar and storage**[187] and the **Solar for Rentals trial**[188] are two closed Queensland programs that, if still funded and operational, would have lifted the state's score.

QLD

Financial Support	6
Energy Justice	5
Health Focus	2
Skills & Training	2
Household Emissions Reduction	0
FINAL SCORE	2.6

WESTERN AUSTRALIA

Western Australia currently lacks a dedicated plan for residential electrification, although its Energy Transition Strategy[189] outlines the path to a renewable energy power system. However, small scale programs, such as the Household Energy Efficiency Scheme and Smart Energy for Social Housing, are promising and provide a template for expansion.

The complete electrification of the town of Esperance this year and decommissioning of the local gas distributor offer key lessons and insights for other states exploring the complete electrification of townships proximal to existing gas networks.

- **The Electrification plan of Esperance**, despite the lack of a clear program, has delivered a notable initiative with full electrification. The Western Australian Government committed $10.5 million to shut down the gas network and replace the gas appliances of 379 customers with energy-efficient electric replacements[190] in 2023.
- **The Smart Energy for Social Housing plan**[191] encompasses $6 million worth of solar panels installed on 500 social housing properties in Western Australia, cutting tenant energy bills by 20%.
- **Battery Storage Systems for regional towns** involves a $31 million project that is enabling an additional 10MW of rooftop solar to be installed on regional households by improving grid stability. The changes will help regional households connect solar systems and cut average bills by $1,275.[192]
- **The Household Energy Efficiency Scheme** is a $13 million program to improve energy efficiency in 10,000 low income households.[193]

WA

Financial Support	2
Energy Justice	4
Health Focus	2
Skills & Training	0
Household Emissions Reduction	3
FINAL SCORE	2.4

NORTHERN TERRITORY

The absence of a reticulated residential gas network, combined with a warm climate, means that the Northern Territory has very low gas usage. As a result, this analysis has focused on the aspects of household electrification within the Northern Territory's control, such as solar installation rates, remote community electricity sources and energy efficiency support.

Despite being the sunniest region in Australia,[194] the Northern Territory has a low renewable energy uptake, with less than 10% of current electricity supply generated from renewable sources, with a rooftop solar installation rate half that of neighbouring Western Australia and Queensland despite a similar climate.

The low score is further exacerbated by the absence of any program or policy intent to improve household energy efficiency in the Northern Territory, nor to increase the installation of rooftop solar.

Finally, the high reliance upon diesel generators for power supply in remote communities, and limited interest in replacing them with renewables and storage, has also contributed to a low score.

- **The Home and Business Battery Scheme**[195] offers grants of $450 per kWh of capacity up to a cap of $6,000 for household battery systems.
- **The Electric Vehicle Charger Grants Scheme**[196] provides grants of up to $1,000 for the installation of an EV charger at a residential property.

NT	
Financial Support	2
Energy Justice	2
Health Focus	0
Skills & Training	0
Household Emissions Reduction	0
FINAL SCORE	1.2

AUSTRALIAN GOVERNMENT

The Australian Government has recently announced a $1.6 billion Energy Savings Package to support households (including social housing) to electrify and undertake energy efficiency upgrades.

The package design should complement existing federal programs that subsidise electrification and set minimum standards. However, the current federal housing strategy, the *Trajectory for Low Energy Buildings*[197] policy document is still focused exclusively on energy efficiency, with no mention of gas or the role of electrification.

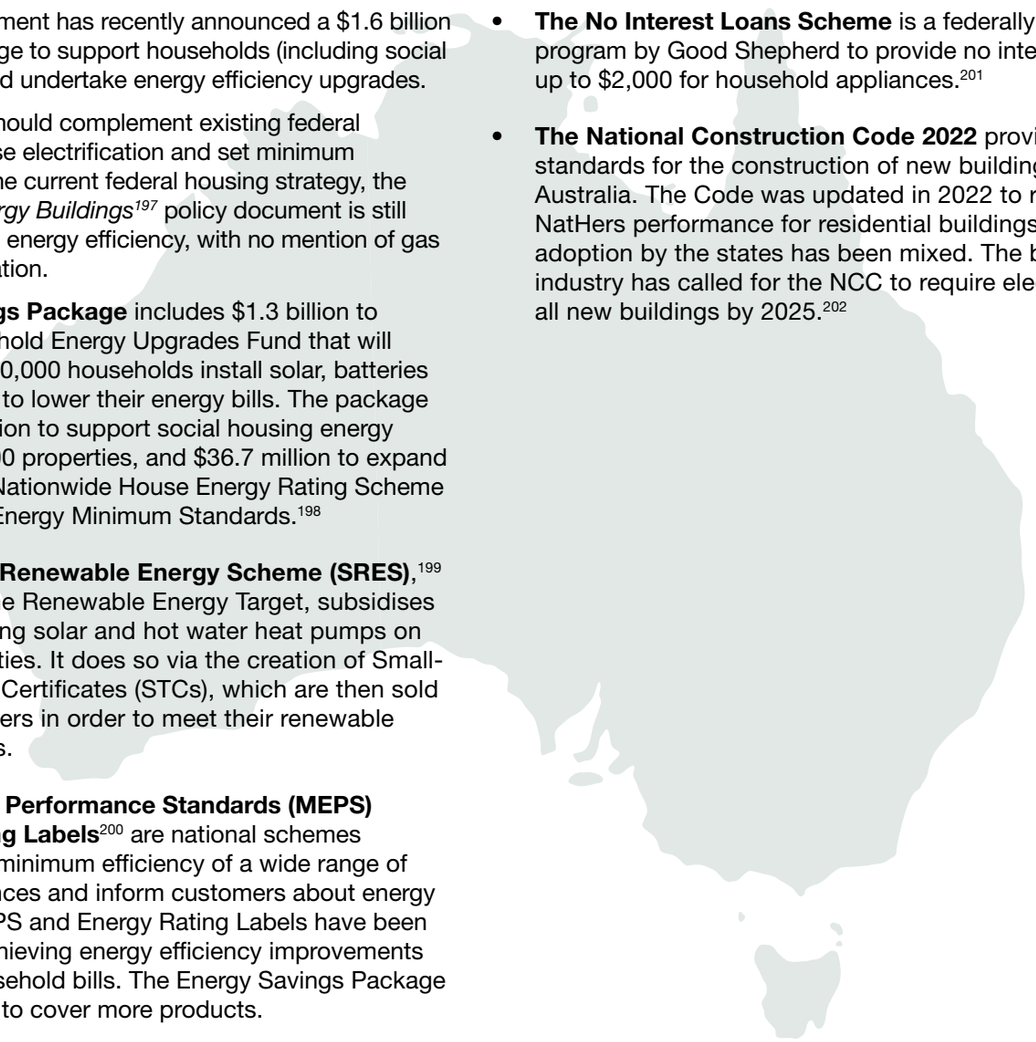
- **An Energy Savings Package** includes $1.3 billion to establish a Household Energy Upgrades Fund that will help more than 110,000 households install solar, batteries and electrification to lower their energy bills. The package includes $300 million to support social housing energy upgrades to 60,000 properties, and $36.7 million to expand and upgrade the Nationwide House Energy Rating Scheme and Greenhouse Energy Minimum Standards.[198]

- **The Small-scale Renewable Energy Scheme (SRES)**,[199] which is part of the Renewable Energy Target, subsidises the cost of installing solar and hot water heat pumps on residential properties. It does so via the creation of Small-scale Technology Certificates (STCs), which are then sold to electricity retailers in order to meet their renewable energy obligations.

- **Minimum Energy Performance Standards (MEPS) and Energy Rating Labels**[200] are national schemes that mandate the minimum efficiency of a wide range of household appliances and inform customers about energy performance. MEPS and Energy Rating Labels have been instrumental in achieving energy efficiency improvements and reducing household bills. The Energy Savings Package will update MEPS to cover more products.

- **The No Interest Loans Scheme** is a federally funded program by Good Shepherd to provide no interest loans of up to $2,000 for household appliances.[201]

- **The National Construction Code 2022** provides model standards for the construction of new buildings in Australia. The Code was updated in 2022 to require 7 Star NatHers performance for residential buildings. However, adoption by the states has been mixed. The building industry has called for the NCC to require electrification of all new buildings by 2025.[202]



AUSTRALIAN GOVERNMENT

Financial Support	8
Energy Justice	5
Health Focus	3
Skills & Training	4
Household Emissions Reduction	5
FINAL SCORE	5.9

4.2 KEY CHALLENGES

The challenges of household electrification in Australia are multifaceted, encompassing various economic, social and structural factors.

In a time where the cost of living is skyrocketing, many consumers are facing significant barriers to residential electrification,[203] mainly due to high upfront costs, ownership and control barriers, and lack of available financing options.[204] Additionally, a study[205] by RMIT University found that eligibility criteria for energy assistance programs may currently exclude those that need it most, namely some vulnerable households. This includes those with an income that is just above the welfare threshold and those who have voluntarily disconnected their electricity due to financial hardship.

A more concerted focus on supporting these households would be necessary to improve residential electrification. This includes providing greater direct financial assistance to support households to electrify, install solar, and improve thermal performance by adding insulation, for example.

The low energy efficiency of Australia's existing housing stock should also be considered when talking about the challenges for residential electrification. While energy efficiency standards for new buildings and households have been improving, in many cases existing housing stock is not so well off. Of the over 10 million homes in Australia, approximately 60% were built prior to 1995.[206] Houses built prior to this time typically only have an average House Energy Rating of 1.5 out of 10.

This is not good news for states such as Victoria who already face an uphill battle when electrifying households as their reliance on gas far outpaces their neighbours.

This leads to a host of challenges, the most significant of which includes the sheer volume of household gas usage, the number of gas-connected homes, and quantity of appliances that need to be replaced.

Investment will play a major role in successfully exiting the gas network, which, if well timed, would lead to earlier network investments in areas of low population growth and increased transmission investment from the federal and state governments.

Remote communities pose a significant challenge to some states. Across Australia, there are approximately 100,000 Aboriginal and Torres Strait Islander people living in remote regions which often experience extreme weather conditions and significant infrastructural challenges when it comes to residential electrification.

For these communities, electrifying the residential sector in the Northern Territory, Western Australia and Queensland presents specific policy and infrastructural challenges due to their unique characteristics and geographical factors.

Many remote households in the Northern Territory, Western Australia and Queensland run on pre-paid smart meters and consumers do not have the same regulated protections against energy disconnection as their urban counterparts.[207]

Poor building standards are another major issue. For example, the Northern Territory building code has much more rigorous requirements for buildings and households in urban areas compared to rural areas.[208] This discrepancy results in buildings that lack basic characteristics such as passive cooling design, structural integrity, and insulation, further exacerbating energy poverty in the region. This is amplified by the fact that a significant proportion are living in rental housing and thus are unable to enact the changes that would benefit them without approval from their landlords.

Consumer knowledge also remains a major hurdle to overcome. This includes raising awareness on how to improve energy efficiency in homes. The lack of visual presentations and the use of technical language make it difficult for communities to comprehend the benefits and feasibility of renewable energy solutions, further limiting access to information and understanding amongst consumers. However, care should be taken to avoid making consumers feel like they are being 'patronised' or 'talked down to'.[209]

Administrative capacity and governance present another significant challenge in states like Western Australia. First Nations corporations responsible for governance and administration often face limited resources and competing priorities, which affects their ability to investigate and pursue renewable energy and electrification projects effectively.[210]

Electrification policies would benefit by addressing the specific needs and circumstances of these communities including off-grid solutions, microgrids, as well as the integration of more sustainable energy options such as solar.

4.3 SUMMARY AND POLICY GAPS

Overall, there is significant scope for improvement on most criteria by all government jurisdictions, as showcased in the policy summary below. There is still notable improvement required on health, skills and energy justice metrics to ensure that electrification ambitions can be delivered, and that the most vulnerable benefit.

The most striking gaps across all levels of government include a limited focus on:

- **Building workforce capability** to implement mass residential electrification in Australia at the required scale, by addressing the workforce shortages.
- **Policy that prioritises the health co-benefits** of residential electrification.
- **Justice-focused policy** to reduce barriers or improve access to residential electrification.

In terms of workforce training, a comprehensive national approach would be beneficial to train new workers and address current shortages of electricians and plumbers in every state and territory. A national approach could build on the investment Victoria has made in the 2023 State Budget.

As for health, a national indoor air quality framework to develop enforceable standards for indoor air quality is required, along with policies that ensure vulnerable populations gain access to these standards.

In regards to justice, comprehensive actions to share the benefits of electrification include:

- Expansion of electrification upgrades to all social housing stock. The recent federal commitment to upgrade 60,000 homes is a start, but is a fraction of the total stock of 440,000 dwellings.[211]
- Expanding access to zero-interest loans for electrification upgrades will reduce upgrade barriers for 492,000 households that are asset rich but income poor.[212]
- Mandating the publication of a home's ratings at the point of sale and rent could provide clear information about household energy performance and enable buyers and renters to make informed choices.[213]
- Establishing minimum energy efficiency and electrification standards for rental properties in order to provide energy justice for renters,[214] as well as introducing a phase-in date for electric appliance replacement standards in rental properties. For example, New Zealand's healthy homes standards, implemented in 2019, provides a template Australia can adapt to include electrification outcomes.[215]
- Lifting the National Construction Code and all state codes to require electrification of all new buildings by 2025 would ensure all new building stock is future-proof and avoid the expense of future electrification retrofits.
- Conducting behaviour change campaigns can provide households with access to up-to-date, easy-to-understand information about their energy choices. This includes energy efficiency measures, cost differentials by energy and device type, benefits of peak demand management, and steps to electrify the home if feasible for consumers.
- Improving housewide energy performance through energy efficiency upgrades in conjunction with incentivising appliance switching from gas to electric will optimise benefits. Well-insulated homes will heat more efficiently and conserve warmth for longer, assisting in both energy savings for consumers and demand of the energy system.[216]
- In addition, while it is beyond the primary focus of this report, reforming electricity concessions to meet the needs of people would improve energy justice. Implementing complementary measures to support the effectiveness of energy concessions is also crucial. Currently, many people who require financial support to afford their energy bills are unable to access it due to eligibility restrictions or accessibility barriers.[217]

In addition, gas use is still incentivised in many policies and programs. For example, building certification schemes and energy efficiency credit programs often include incentive support for gas appliances. Phasing out all incentives for gas from existing programs, which Victoria has done this year, is necessary to avoid subsidising and motivating the installation of new gas appliances.

Finally, identifying the role of household electrification in reducing emissions and cutting household energy expenditure is required nationally, so as to ensure coherent policy packages are developed that advance rapid deployment.

CONCLUSION

This report presents the benefits of residential electrification. It showcases the actions governments are currently taking, and highlights additional efforts that could further support the electrification of Australian households.

Currently, Australian households are highly reliant on gas, mostly for space heating, heating water, and cooking. With gas prices rising at almost double the rate of electricity, efficient electric alternatives could save each household between $336 and $1,311 per year after installation. The potential health impacts associated with particulate matter and noxious gases emitted by gas cookers and unflued gas heaters would also be reduced by electrification. A program to complete electrification of residential gas over 10 years would on its own create almost 20,000 full-time jobs (mostly in Victoria and NSW), with additional job opportunities and energy cost savings associated with aligned rooftop solar and battery storage industries.

However, there are several barriers associated with electrification. There are job shortages in critical trades, and segments of the population may not have the financial capacity for the upfront costs for removal of gas connections and replacement of appliances. Not owning one's home also limits capacity for electrification. At the larger scale, the traditional centralised electricity network and extreme weather exposure also pose infrastructural connectivity challenges for more remote communities.

A diverse range of policies and programs are in place across Australia's states and territories to promote environmentally and economically sustainable energy production and use; despite this, gas use is still incentivised in many policies and programs. Governments face various challenges relating to household electrification. The key policy gaps identified include a limited focus on building workforce capability, consideration of health-related benefits associated with residential electrification, and a need for justice-focused policy that reduces barriers and improves access to residential electrification.

The findings of this report are of great interest to the Australian public, and will only become increasingly more so. This is reflected, for example, in the Senate's recently announced inquiry into residential electrification, with a report due for publication in late 2024. Australia's energy sector is undergoing significant change, driven by market and policy shifts. Australian consumers need to be informed and prepared to make the most of future changes that emphasise economic, health and community benefits.

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APPENDIX A
DATA TABLES

Table 6: Gas appliances by state and territory

		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	TOTAL
Cooking	**Cooktops***	48,672	934,593	26,578	596,018	232,371	74,023	760,006	314,539	**2,986,799**
	Ovens**	17,523	337,140	9,583	214,779	83,887	26,724	273,678	113,313	**1,076,628**
	Uprights**	14,014	271,036	7,682	172,116	67,515	21,518	219,075	90,653	**863,609**
Heating	**LPG gas non-ducted**	5,074	97,194	261	11,910	7,811	1,912	12,288	9,380	**145,830**
	Mains gas ducted	71,744	79,560	0	614	35,273	997	1,194,378	27,684	**1,410,250**
	Mains gas non-ducted	26,748	501,804	0	8,715	64,659	9,782	431,721	253,772	**1,297,201**
Hot water	**Gas instant (LPG) Hot water**	387	69,745	3,875	154,989	34,140	6,346	61,961	56,029	**387,472**
	Gas instant (mains) hot water	62,609	686,958	1,465	136,638	235,715	5,310	1,093,536	381,810	**2,604,041**
	Gas storage (LPG) hot water	236	42,547	2,364	94,550	20,530	3,931	37,314	34,903	**236,375**
	Gas storage (mains) hot water	43,796	482,382	1,009	96,455	172,605	3,648	787,383	274,260	**1,861,538**
	Solar gas hot water	1,236	11,345	64	2,155	5,439	801	278,732	25,082	**324,854**
	Total	**292,038**	**3,514,303**	**52,881**	**1,488,940**	**959,944**	**154,993**	**5,150,071**	**1,581,426**	**13,194,597**

Source: Residential Baseline Study 2021; Community Attitudes to Home and Car Electrification, 2023, The Australia Institute. *Assuming 43% of stock in Residential Baseline Study are gas (See Community Attitudes).
** Assuming 21% of stock in Residential Baseline Study are gas (See Community Attitudes)

Table 7: Residential gas use data table

Gas use by State (PJ)	NSW (inc ACT)	VIC	QLD	WA	SA	TAS	NT
2020-2021 (Residential - natural gas use)	34.8	107.8	4.8	10.3	7.5	0.4	0

Source: Australian Energy Statistics 2022

Table 8: Residential gas consumption by end use table

Gas use in households adjusted for Australian Energy Statistics 2022	PJ (AES 2022)	%
Space heating	94.6	57%
Hot water heating	58.8	35%
Cooking	9.1	5%
Other appliances	3.3	2%
Total	**165.8**	

Source: Total residential gas use from Australian Energy Statistics 2022, attribution to end use derived from Residential Baseline Study 2021

Table 9: Gas and electricity whole price increases

	GAS	ELECTRICITY
	Average wholesale gas price ($/GJ)	Average volume weighted price ($/MWh)
2012-13	5.18	62
2013-14	4.19	55.6
2014-15	3.28	41.6
2015-16	5.11	66.4
2016-17	8.61	92
2017-18	7.85	91.2
2018-19	9.55	103
2019-20	6.48	69.6
2020-21	6.04	57.4
2021-22	16.28	128.2
2022-23 (YTD)	17.29	147.2
2012/13 - 2022/23 % change	**234%**	**137%**

Source: Australian Energy Regulator[218] [219]