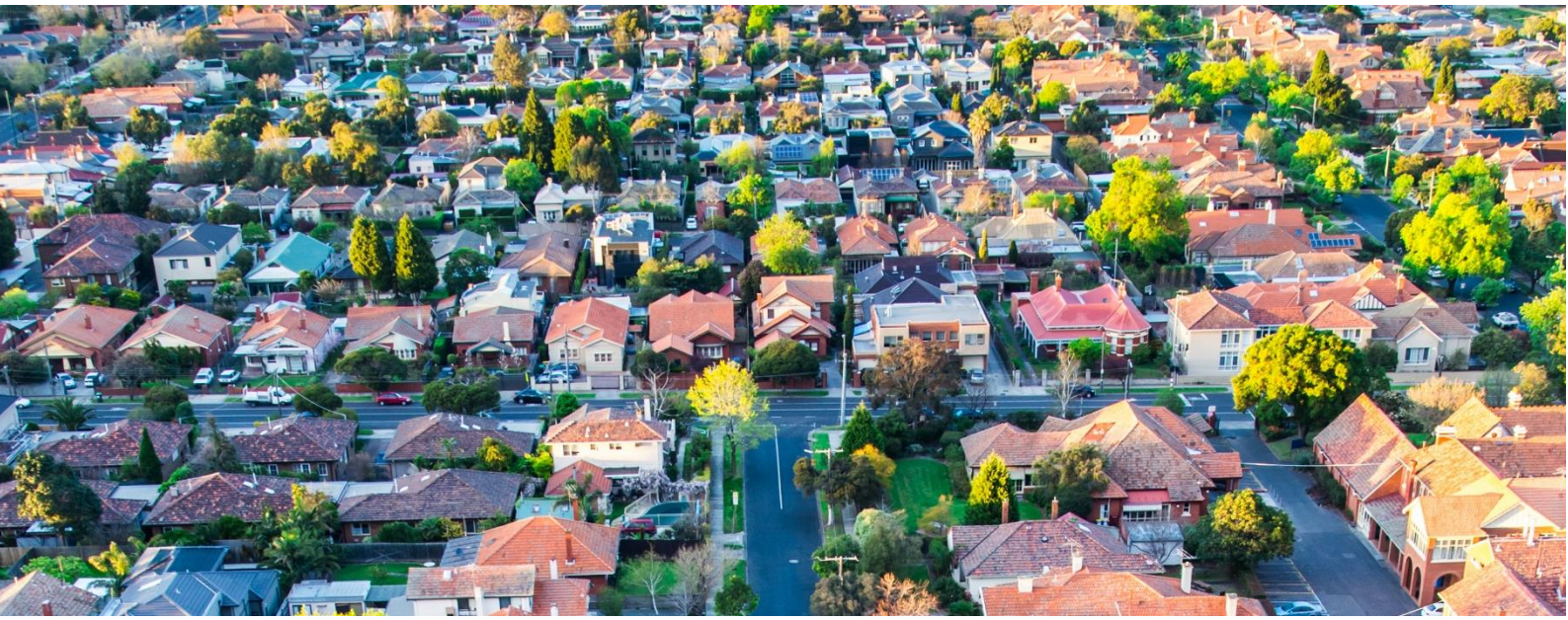
OCTOBER 2021

BRIEFING PAPER

Creating Victoria's first gas-free suburbs

Cleaner, cheaper power for new homes, and the regulations holding us back



New modelling of energy use, bills and upfront costs for 6-Star and 7-Star homes in Melbourne finds all-electric homes are significantly cheaper to run than homes that use gas for heating, cooking and hot water.

But while households would be better off without gas appliances, outdated Victorian planning regulations are forcing new housing developments to connect to the gas network.

These rules are hooking households onto an increasingly expensive fuel, putting pressure on gas supply and making it more difficult for Victoria to reach its legislated emissions reduction targets.

This briefing paper recommends well-overdue changes to the Victorian Planning Provisions and Plumbing Regulations, which would open the way for Melbourne's first gas-free suburbs, supplying new homes with a cleaner and cheaper source of energy, and leaving households better off financially.

KEY FINDINGS:

- For a 6-Star rated home without solar, choosing to be all-electric without a gas connection saves $735 per year on energy bills
- For a 7-Star rated home with solar and more efficient appliances, choosing to be all-electric without a gas connection saves $753 per year
- If energy bill savings are put into paying off a mortgage, an efficient all-electric home can reduce a home loan by two years
- All-electric homes also have lower emissions than homes with a gas connection
- Despite this, Victorian regulations are forcing many new homes to connect to the gas network, increasing household energy bills and emissions
- As a result, the Victorian gas network is expanding, tipping money into gas pipes that are likely to become stranded assets and creating pressure for environmentally destructive new gas supply projects

Contents

Acknowledgements

Lead authors: Rai Miralles and Rob McLeod

Editor: Greg Foyster

Modelling completed using Renew's Sunulator program.

Acknowledgement of Country

The head offices of Environment Victoria and Renew are located on Wurundjeri land, and the organisations work across many Aboriginal nations. We pay our respects to Aboriginal Elders past and present, recognise their continuing contribution to caring for Country, and acknowledge that sovereignty was never ceded.

About Environment Victoria

Environment Victoria is an independent charity, funded by donations. Established in 1969 as Victoria's peak environment group, Environment Victoria represents a community of 40 grassroots member groups and more than 150,000 individual supporters. Environment Victoria campaigns to solve the climate crisis and build a thriving, sustainable society that protects and values nature.

About Renew

Renew ('Alternative Technology Association Inc trading as Renew Australia) is a national, not-for-profit organisation that inspires, enables and advocates for people to live sustainably in their homes and communities. Established in 1980, Renew provides expert, independent advice on sustainable solutions for the home to households,

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

1. Victoria's gas problem

1.1 GAS USE IN VICTORIA

Victoria accounts for only one-quarter of the national population, but Victorian homes consume almost two-thirds of the gas burned in Australian homes.[1] This high gas use is driven by the relatively cold winters in Victoria, as well as a high rate of household gas connections. Eighty-three percent of Victorian households are connected to main gas, which amounts to 42% of Australia's household gas connections.[2]

On average, Victorian households consume almost three times more gas than households in NSW, the state with the highest overall residential gas consumption after Victoria.

Three quarters of gas used in Victorian homes is for space heating. Around one quarter goes to water heating, and a small fraction is used for cooking.[3] As a consequence, Victorian gas consumption is highly seasonal. The average demand on a cold winter day is about three times that on a summer day.[4]

1.2 GOVERNMENT POLICIES HAVE HOOKED HOUSEHOLDS ON GAS

Influenced by industry, successive Victorian governments have hooked Victorian homes on gas through decades of programs and regulations that have acted as a subsidy for the gas industry. These government policies locked households into using a polluting and increasingly expensive fuel.

Government programs to boost gas connections

Between 2011-2017, the Victorian Government spent about $100 million on the Energy for the Regions program. This program expanded the gas distribution network into rural Victoria, but at a massive cost to taxpayers (see Table 1 below).

Even under a 'best-case scenario' connecting every eligible household to the gas grid, the cost per household is staggering. Looking back, these households would have been better served by being supported to shift to all-electric appliances.

Table 1. Cost per Connection of Victoria's Energy for the Regions program

Town	Subsidy	Maximum New Connections	Cost per Connection
Huntly	$4.5 million	580	$7,758
Warburton	$7.88 million	500	$15,760
Avoca	$8.39 million	700	$11,985
Heathcote	$4.94 million	500	$9,880
Winchelsea	$4.16 million	600	$6,926

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

The gas network is still expanding

As a legacy of the public support for the gas industry, and due to clauses in the Victorian Planning Provisions and the Plumbing Regulations, gas connections are still increasing in Victoria and this is forecast to continue (Figure 1). More detail on these regulations is included in Chapter 3 from page 15.

Although there has been a gradual decline in average household consumption over the past years, Victorian homes remain the largest users of gas in the country, and these efficiency improvements have been offset by growing gas connections.

There are no current public subsidies to expand the gas network. However, despite the increasing cost of gas, the Victorian Government has used taxpayers' money until very recently to support the gas industry.

For example, between 2017 and 2020 the Victorian Government ran the $42.5 million Victorian Gas Program to support the search for new onshore gas fields. [5]

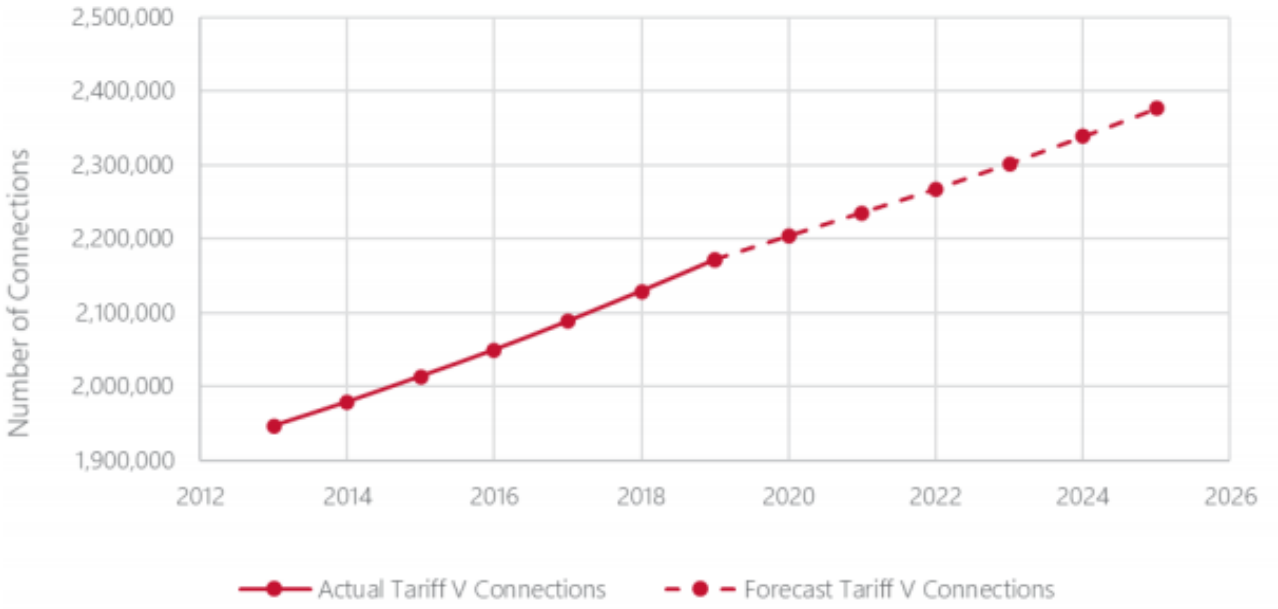


Figure 1. Historical and forecast DTS Tariff V connections, 2013-25. Source: AEMO (2021)

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

1.3 GAS IS COOKING THE PLANET

While the gas industry has promoted itself as a 'bridge fuel' in the transition to cleaner energy sources, independent research has questioned this framing and the future role of gas in our energy system.

The International Energy Agency's *Net Zero by 2050 Roadmap* recommends no new gas fields approved for development after 2021.[6] This is necessary to have a 50% chance of limiting global warming to 1.5 degrees by 2100.[7] The IEA's recommendation has massive implications and underpins the need to rapidly and deeply change the way jurisdictions such as Victoria produce and consume energy. In Victoria gas is responsible for 15.8% of greenhouse gas emissions.[8]

Gas is mostly composed of methane, which has a global warming potential 86 times higher than carbon dioxide over a 20-year period. This methane leaks throughout the gas production and supply chain, and research indicates that methane emissions have been underestimated globally[9] and may also be underestimated in Australia due to relying on emissions factors not direct measurement.[10]

The Intergovernmental Panel on Climate Change (IPCC) latest report, released in August, found the world has already warmed by 1.25 degrees Celsius since pre-industrial times. Methane, the main component of gas, is responsible for 0.5 degrees of the current warming.[11]

According to the IPCC's Regional Factsheet for Australasia, Australia is already experiencing increased heat extremes, sea level rise resulting in the retreat of shorelines, and decreased snowfall. Projected climate impacts for southern and eastern Australia include an increase in drought and lower rainfall.[12] The Victorian government estimates that, under a high emissions scenario, by 2050 Victoria may experience an average annual temperature increase of up to 2.4 degrees, longer fire seasons with double the number of high fire danger days, sea level rise and a decline in winter rainfall.[13]

In this context it is particularly worrisome to see that Victorian Planning Provisions and Plumbing Regulations still force Victorians to connect to the gas grid, supporting the expansion of a sector that has no clear path for decarbonisation, unlike electricity which is becoming cleaner by the year.

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

1.4 GAS EXPANSION CREATES PRESSURE FOR NEW GAS PROJECTS

Recently the Victorian Government has been taking steps to transition away from gas. The new Victorian Energy Upgrade (VEU) targets also included an update on the emissions factors of electricity and gas which mean that the VEU will no longer incentivise gas over electric appliances.

In addition, the Victorian state budget for 2020-21 included a commitment of $335 million over four years to replace 250,000 inefficient residential heaters, many of them gas, with efficient electric reverse-cycle air conditioners (also known as heat pumps). This Home Heating and Cooling Upgrade Program is aimed at low-income and vulnerable Victorians, providing rebates of $1000.[14]

These and other measures mean the Australian Energy Market Operator (AEMO) has forecast Victorian annual gas consumption to decrease by 12.7% over the next 5 years.[15]

Nevertheless, these efforts will be partially offset by the ongoing increase in residential and commercial connections. Any households and businesses added to the gas network will eventually need to transition away from gas as well.

And while it is encouraging to see Victoria's gas demand decrease, the reality is that our legacy gas fields are depleting at a faster pace. Any delay in the transition away from gas will increase the pressure for the development of new sources of gas supply in Victoria, such as Viva Energy's efforts to develop a gas import terminal near Geelong and Beach Energy's plan to drill for gas near the Twelve Apostles.

The Victorian Government has already committed to the development of a 'Gas Substitution Roadmap' but the pace is as important as the destination. A slow pace of substitution would increase pressure for new sources of gas supply, which would run for decades and make it more difficult for the state to reach interim emissions reduction targets.

	2017	2018	2019	2020	2021	2022	2023	2024	2025
DTS system consumption	201	192	196	201	197	195	192	189	187
DTS GPG consumption	15	10	20	7	3	2	2	2	1
Total DTS consumption	216	202	216	208	200	197	194	191	188
Non-DTS consumption	23	16	16	12	7	5	5	4	3
Total Victorian consumption	239	218	232	220	207	202	199	196	192

Figure 2 Victorian gas actual consumption and forecasts, 2025(PJ/y) Source: AEMO 2021

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

2. The benefits of all-electric homes

2.1 PREVIOUS STUDIES ON ALL-ELECTRIC HOMES VS DUAL-FUEL HOMES

Switching from gas to electricity poses uncertainties for some industries, such as steelmaking and manufacturers that use gas as a feedstock. But for the building sector the transition away from gas is straightforward. There is now ample evidence that all-electric buildings are cheaper to run, healthier for their inhabitants and better for the climate.[16]

Previous studies include:

- A 2015 study from the University of Melbourne found switching from using gas heating to a reverse cycler air conditioner saved up to $658/year for a large home in Melbourne.[17]
- A July 2018 report from ATA (now Renew) found owners will be between $9,000 – $16,000 better off over 10 years if they establish their new home as all-electric with a 5-kilowatt solar system rather than both gas and electric connections with no solar.[18]
- A November 2020 report from the Grattan Institute also found that households in Sydney, Melbourne, Brisbane, Adelaide, and Canberra that move into a new all-electric house with efficient appliances will save money compared to an equivalent dual-fuel house. (Table 5.2, page 45)[19]

Recently Renew conducted modelling on the costs and benefits of six energy efficiency scenarios for a medium sized home in four major cities. The results, discussed below, add to the findings of previous reports showing most households would be better off financially without a gas connection.

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

2.2 NEW MODELLING OF ENERGY COSTS FOR HOMES IN MELBOURNE

To find out just how much gas is costing a typical Melbourne household, Renew modelled the energy bills and upfront costs for dual fuel homes (with a gas connection) and all-electric homes (with no gas connection). We have used detailed energy use and tariff data to calculate bills and other costs for a medium-large 200m^2 detached home in Melbourne across a range of energy scenarios.

These calculations include the upfront cost of gas installation, regular gas account fees, and the cost of appliances. Choosing an all-electric home means cutting out the cost of gas connection and regular fees – which could be a significant saving for households. Furthermore, by using a reverse cycle air conditioner (heat pump) for heating and cooling and avoiding the costly installation of ducted gas heating, all-electric homes often reduce the upfront cost of appliances across a home.

Alongside the impact of choosing gas or all-electric, there are other factors that can influence household energy bills.

These include better thermal efficiency (measured with NatHERS star ratings) and installing efficient appliances and solar panels. We have modelled comparable scenarios for dual fuel and all-electric homes across two levels of efficiency to consider these impacts.

We modelled the costs and benefits of four scenarios:

1) A basic 6-Star dual fuel home (connected to gas), with basic appliances and no solar
2) A basic 6-Star all-electric home (not connected to gas), with basic appliances and no solar
3) An efficient 7-Star dual fuel home (connected to gas), with efficient appliances and solar
4) An efficient 7-Star all-electric home (not connected to gas), with efficient appliances and solar

A full summary of the features of each home is shown in the table below.

Table 2. Home features for energy cost modelling

	6-Star basic dual fuel	6-Star basic all-electric	7-Star efficient dual fuel with solar	7-Star efficient all-electric with solar
NatHERS rating	6	6	7	7
Hot water	Gas instantaneous	Heat pump	Gas instantaneous	Heat pump
Heating	Gas	Heat pump (basic)	Gas	Heat pump (efficient)
Cooling	Evaporative	Heat pump (basic)	Heat pump (efficient)	Heat pump (efficient)
Cooking	Gas	Induction	Gas	Induction
Other appliances	Electric	Electric	Electric	Electric
Solar	None	None	6.6 kW	6.6 kW

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

2.3 RESULTS OF ENERGY COST MODELLING

Energy bills

Our findings show that all-electric homes result in lower bills than comparable dual fuel homes. Choosing even a basic all-electric home was found to save $735 annually over a basic dual fuel home. Meanwhile, an efficient all-electric home with solar saved $1795 a year, cutting bills by 78% from a basic dual fuel home. Even when compared to an efficient dual fuel home with solar, the all-electric home still saved $753, cutting bills by 60%.

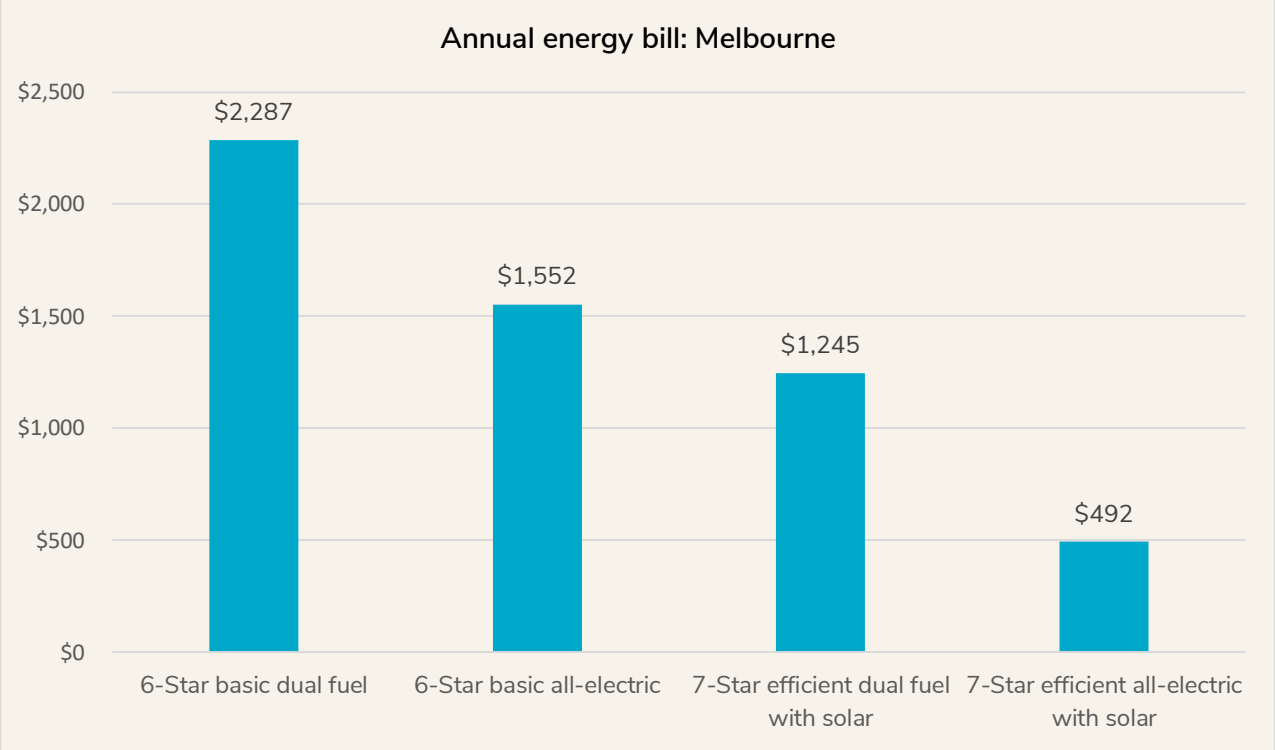


Figure 3. Annual energy bill savings

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

Net present value

Net present value (NPV) is a metric used to compare ongoing financial benefits or inflows with total investment costs. A discount rate is applied over a given period of time to ascertain the benefits. We have selected a conservative 2% discount rate over a 20-year time period. A NPV greater than zero indicates that an investment is beneficial. Our results use the basic dual fuel home as the baseline scenario against which others are compared.

We found that the choice to go all-electric was a good value investment. A basic all-electric home had a NPV of $16,671, while an efficient all-electric home with solar had a NPV of $25,482. Because the all-electric homes combined lower ongoing bills with lower upfront costs, the overall economic value of all-electric homes was found to be significantly higher than a dual fuel home with comparable energy efficiency. Lower upfront costs mean that even a basic all-electric home was found to have a higher investment value than an efficient dual fuel home.

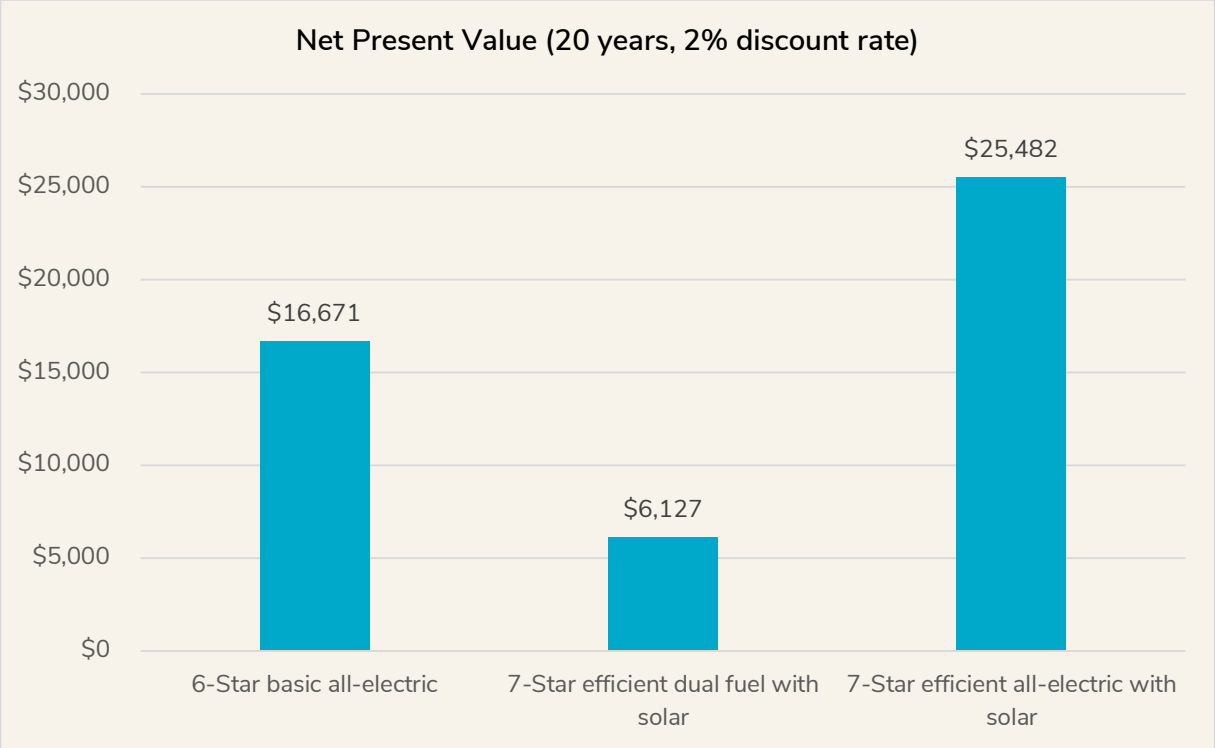


Figure 4. Net present value (20 years, 2% discount rate)

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

Monthly cash flow

By avoiding gas connection costs and replacing gas ducted heating with reverse cycle air conditioners (heat pump technology), the upfront cost of an all-electric home was found to be less than a dual fuel home by over $6000.

Using a basic 6-Star dual fuel home as our baseline comparison, we calculate how much of a financial impact each scenario will have on overall monthly household cash flow.

For each scenario, we calculate the expected monthly mortgage repayment, including any increased costs of higher energy efficiency standards and appliances. (We have conservatively assumed a 25-year loan term at a 5% interest rate.) We then calculate the expected monthly bills for each scenario, which differ according to energy efficiency and fuel choice. If these savings are higher than any additional costs of monthly mortgage repayments, then households are better off overall. For example, a borrower with mortgage repayments that are $20 per month higher than the baseline, but with energy bills that are $50 less than the baseline, is $30 per month better off from day one of their mortgage.

Once again, all-electric homes were found to leave households with more money in their pocket from day one. A household would be $91 a month better off choosing a basic all-electric home over a basic dual fuel home. Again, the biggest financial benefit was found for households choosing an efficient all-electric home with solar – enjoying savings of $137 a month. While making a dual fuel home more efficient was found to benefit households, the relatively high upfront costs of gas connections and appliance installation meant that even efficient dual fuel homes always led to worse overall cashflow than all-electric homes.

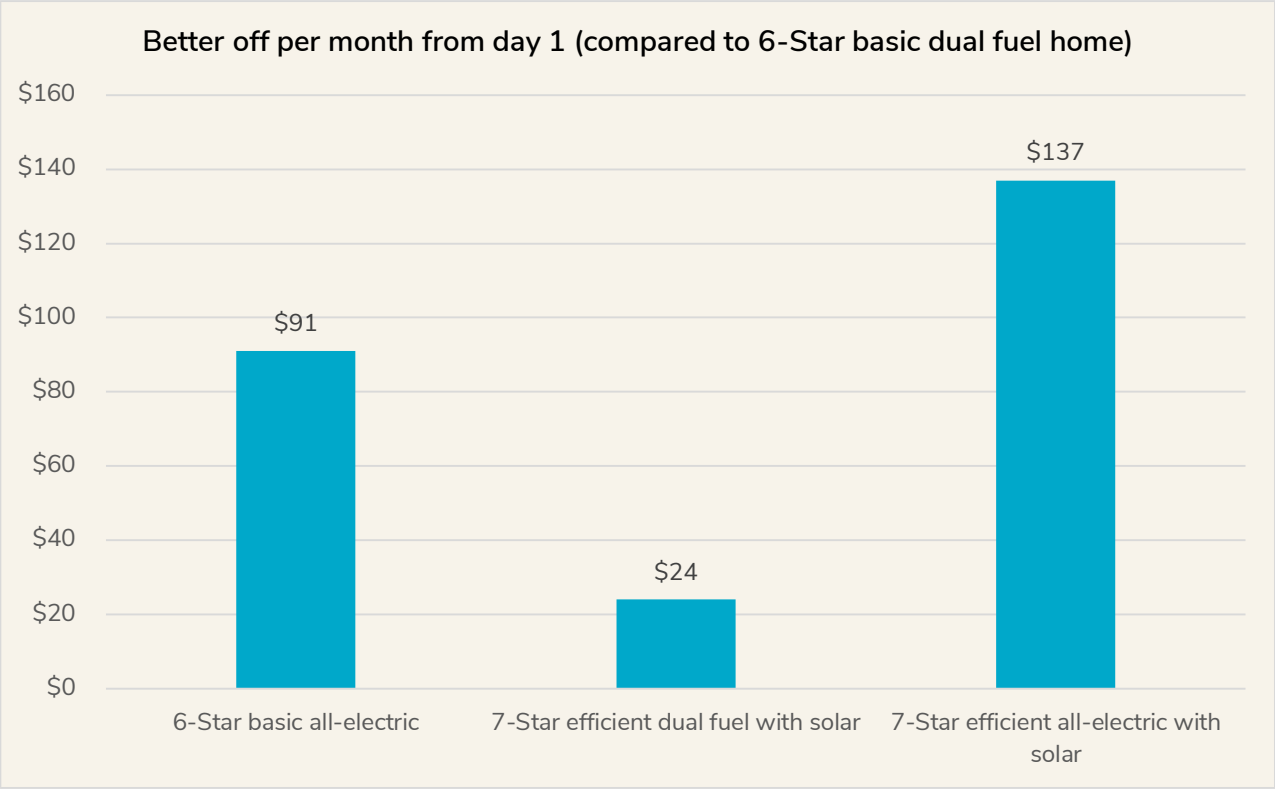


Figure 5. Monthly cash flow

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

Months saved off 25-year mortgage

This finding measures the impact on the life of a mortgage if a borrower uses their monthly savings to pay off their mortgage sooner. To find this, we assume that the additional monthly cash flow (the 'better off per month' figure above) is used as an additional monthly mortgage repayment amount. The effect of additional payments is that a mortgage is repaid sooner.

We calculated the amount of time that would be taken off a 25-year home loan if this amount was repaid monthly as an additional payment.

All-electric homes cut years off a home loan. A basic all-electric home left households paying off their loan 15 months faster, while an efficient all-electric home cut the loan by a full two years.

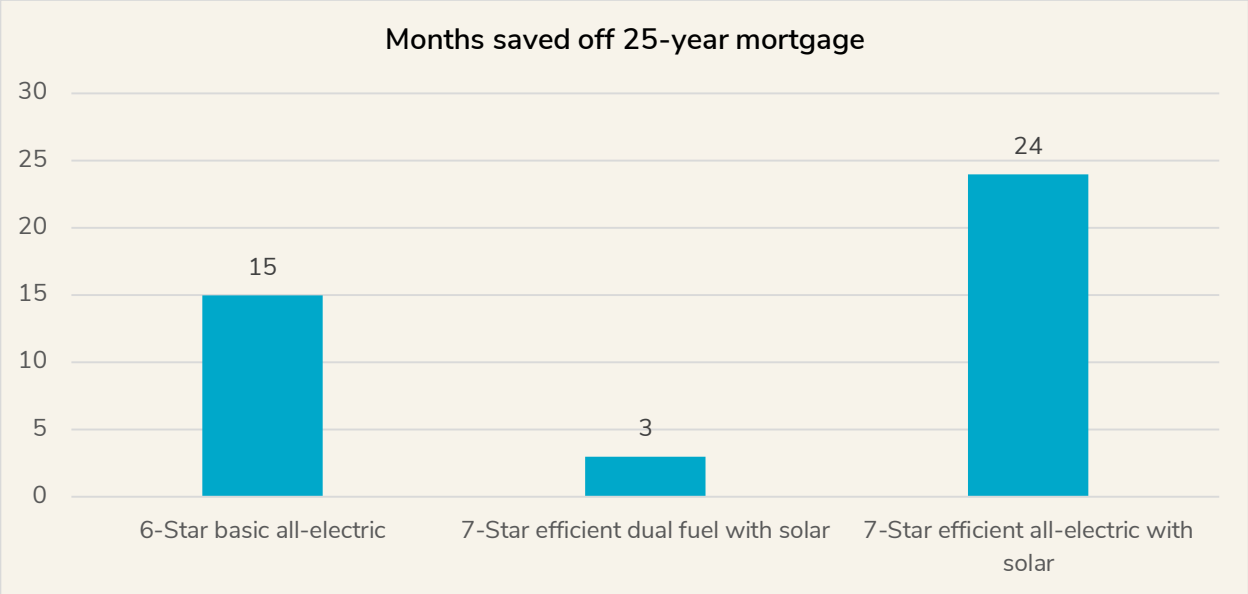


Figure 6. Months saved off mortgage

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

Carbon emissions

To determine the carbon emissions of homes in each scenario, we calculated the total gas and electricity required to power each home and applied government emissions factors to calculate total annual carbon emissions associated with energy use. To calculate the impact of having a home solar system, we assumed that energy generated onsite replaced energy purchased from the grid. We furthermore assumed that excess renewable energy generated onsite could be exported to the grid and reduced societal consumption.

The emissions impacts of the growth of distributed energy resources (DER) such as solar and the changing structure of the electricity grid have not been considered in this analysis but form an important policy context. Embedded carbon emissions are not considered as a part of this analysis.

We found that the optimal choice to reduce household carbon emissions was an efficient all-electric home with solar, which by exporting energy to the grid had net negative emissions of 3.1 tonnes a year. The basic all-electric home with no solar only slightly reduced overall emissions from a basic dual fuel home as it imported electricity entirely from the grid. This finding demonstrates that household solar and other decarbonisation of Victoria's electricity remains an important aspect of the energy transition. Importantly, through solar and other renewables, the emissions of the all-electric homes are expected to fall, while the emissions associated with gas consumed in the dual fuel scenarios are locked in.

These findings show that, even with the high amount of coal-fired power generation in the current electricity grid, an all-electric home is slightly better for emissions than a home with gas. Over the lifetime of the house and appliances, as more renewable energy enters the grid, the emissions from all-electric homes will drop further.

It should be noted that emissions factors used for this analysis likely significantly understate the impacts of methane and fugitive emissions from gas.[20]

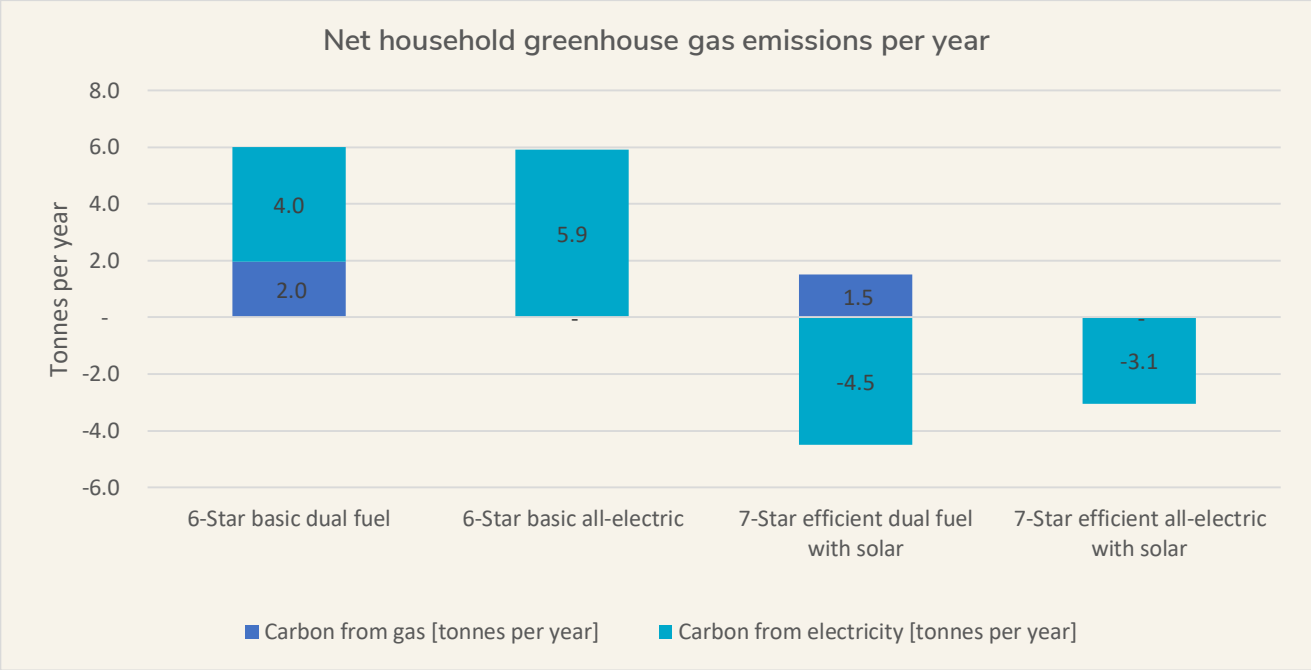


Figure 7. Net household GHG emissions

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

3. Regulations standing in the way

3.1 PLANNING PROVISIONS AND PLUMBING REGULATIONS

While the evidence points to all-electric homes being better for the environment and cheaper to run, one barrier has been outdated regulations that force new homes and businesses to connect to the gas network.

Infrastructure Victoria's 30 year strategy highlights this point. The strategy states that embedding long-term natural gas is incompatible with Victoria's 2050 net zero emissions target, and recommends that the Victorian Government update planning regulations to stop encouraging gas connections.[21]

The two regulations are:

- The Victorian Planning Provisions (VPP). The VPP is a set of standard, statewide planning provisions which ensure that planning schemes across Victoria are consistent. The VPP state that 'where available' residential developments must be connected to 'the satisfaction of the relevant gas supply agency'.[22] (Clause 56.09-2) Not abiding by these provisions could impact on the ability of a developer to procure a planning permit.
- Victorian Plumbing Regulations. These regulations state that if a gas supply is available for connection in a new building, new solar hot water heaters must be boosted by gas.[23] (Schedule 2, Clause 11 (4)) Heat pump water heaters are only allowed to be installed if they are not connected to the main electric supply.

These regulations should be changed as a matter of urgency to allow all-electric homes in new developments, and start saving households money.

3.2 ENCOURAGING GAS-FREE SUBURBS

Merely removing outdated regulations will not be enough to ensure a transition away from gas at the speed necessary to avoid destructive new supply projects and meet Victoria's emissions reduction targets. The Victorian Government should go further and require, or at least strongly encourage, new buildings to be all-electric. This is the most straightforward path towards carbon-neutral buildings.

Victoria would not be the first jurisdiction to take such a step in Australia. The ACT government has already announced it will trial a 'gas-free' suburb as part of efforts to reach net zero carbon emissions. The first stage will include 350 all-electric homes, which are expected to save $14,000 over the life of their appliances compared to dual fuel homes.

In Victoria some tentative steps have been taken with gas-free developments such as a 171-unit project in Brunswick planned to be built later this year. But these developments can be hard to replicate while existing regulations pressure developers to connect buildings to the gas network.

3.3 PROLONGING THE GAS NETWORK WITH HYDROGEN DOESN'T MAKE SENSE

Victoria has an extensive gas network. This has led some to advocate for replacing gas with hydrogen instead of electricity.

This approach ignores the fact that 90% of existing pipeline infrastructure would have to be decommissioned to prepare for a hydrogen network.[24] Further, hydrogen is an expensive fuel. According to a report commissioned by the Clean Energy Finance Corporation, hydrogen will not achieve cost parity with gas before 2050.[25]

Nevertheless, targeted adoption of hydrogen will likely be necessary for sectors where electrification proves unfeasible or too expensive, but not in households.

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

APPENDIX

Methodology and modelling of energy costs

We used Renew's simulation tool *Sunulator* to model household energy consumption and solar generation. *Sunulator* simulates the operation of heating and hot water appliances and energy production from solar PV systems on a daily basis, creating half-hourly consumption and generation data over a year to estimate how much solar generation will be consumed onsite versus exported. Updated climate data files are used to calculate heating and hot water requirements and solar generation across the range of locations.

The tool allows for detailed configuration of appliances, thermal efficiency and solar generation. Energy consumption of heating and hot water appliances is calculated from the gas or electricity input required to generate the same heat energy output. The electricity required for fans and controllers of gas heaters is added to base electricity consumption for dual fuel scenarios.

Unlike FirstRate and AccuRate, Sunulator doesn't simulate heat flows to model a building's thermal performance. Instead it mimics such modelling by simulating the operation of air conditioners and reconciling total annual energy consumption to the results published by NatHERS. In addition, there is a significant and growing number of real-world examples of higher efficiency, renewably-powered, all-electric homes and communities[26] that Renew can use to verify any modelling outputs. We are increasingly seeing real-world all-electric home examples perform better than predicted by Renew models, giving us greater confidence in these types of analyses.

We furthermore developed detailed cost profiles of home energy scenarios by calculating energy use alongside local energy tariffs, appliance costs and the upfront costs of thermal energy efficiency improvements during construction.
Scenarios

The total annual energy use and bills found for each scenario are as follows:

Scenario	6-Star basic dual fuel	6-star basic all-electric	7-star efficient dual fuel with solar	7-star efficient all-electric with solar
Average daily gas use (MJ)	96.9	0	74.6	0
Annual gas bill ($)	$1032	$0	$853	$0
Average daily electricity import (kWh)	11.06	16.19	6.70	8.10
Average daily electricity export (kWh)	0	0	19.02	16.47
Annual electricity bill ($)	$1,255	$1.552	$391	$492
Total annual energy bill	**$2,287**	**$1,552**	**$1,245**	**$492**
Annual bill savings from business as usual	-	*$735*	*$1,043*	*$1,795*
% bill savings from business as usual	-	*32%*	*46%*	*78%*

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

Data and assumptions:

A full range of assumptions and input data is available in Renew's report, "Households Better Off: lowering energy bills with the 2022 National Construction Code".[27]

Tariffs

Gas and electricity tariffs were sought from major retail providers. Flat tariffs were assumed. The following electricity and gas tariffs were applied:

Location	Electricity PRICE ($/kwH)	ELECTRICITY DAILY SUPPLY CHARGE	GAS PRICE ($/mj)	GAS DAILY SUPPLY CHARGE	ELECTRICITY FEED-IN TARIFF ($/kWH)
Melbourne	$0.1980	$1.05	$0.0220	$0.70	$0.08

We assumed heating and cooling use in line with assumptions made for government appliance cost calculators at www.energyrating.gov.au/calculator. In Melbourne this assumes 150 days of heating at 10 hours heating per day, and 90 days cooling at 6 hours cooling per day.

Appliance and upfront costs

We assumed 7-Star homes to have an additional build cost of $1,938 over equivalent 6-Star homes, based on ABCB figures.

Cooling

We modelled evaporative and heat pump cooling options (with heat pump units being used for heating as well as cooling in the all-electric scenarios). We assumed non-ducted heat pump systems, requiring one large unit in the living area and three smaller units in bedrooms. Based on online research and previous Renew research, we selected the following models:

type	model	heat kw	cool kw	Price	install cost	total price
Heat pump (large)	Mitsubishi Heavy Industries SRK63ZRA-W	7.1	6.3	$1,569	$800	$2,369
Heat pump (small)	Mitsubishi Heavy Industries SRK20ZSXA-W	2.7	2	$1,190	$650	$1,840
Evaporative	Promina P46			$2,630	$2,000	$4,630

One installation cost was included for full-house installation of evaporative cooling, while we included an installation cost for each heat pump unit (a total of four units). As such, the total cost for cooling capital expenditure in scenarios with evaporative cooling was $4,630, while for homes with heat pump cooling total capital expenditure was $7,889.

Heating

Ducted gas heating was assumed. Based on industry interviews, we modelled the Brivis CC320I 7 OTL, with a purchase price of $3,000 and an installation price of $6,000, for a total capital expenditure of $9,000. All-electric homes use heat pump RCAC units for both heating and cooling.

Gas connection

We assumed a cost to connect the newly constructed home to the gas network, including pipes and meter, at $1,500. This cost was included for all dual-fuel scenarios but not included for all-electric scenarios.

Hot water

The following options were included:

Type	model	price	installation	total
Instantaneous gas	Infinity 26	$1,395	$600	$1,995
Heat pump	Stiebel Eltron 302L	$3,700	$1,000	$4,700 ($3,512) *

* An STC discount of $1,188 was applied to the heat pump hot water option, resulting in a total cost of $3,512.

Cooking

Based on online research of common models, we assumed a gas cooktop to have a purchase cost of $500 and an installation cost of $170, for a total expenditure of $670. We assumed an induction cooktop to have a purchase cost of $750 and an installation cost of $250, for a total expenditure of $1,000.

The baseline cost of a mortgage was based on the average loan amount for a newly built home in Melbourne in May 2021 of $518,397.

Carbon emissions

Emissions intensity metrics from the National Greenhouse Accounts Factors[28] were used to calculate the carbon emissions in each scenario. It should be noted that these figures likely significantly understate the impacts of methane and fugitive emissions from gas. The emissions intensity applied was an addition of Scope 2 and Scope 3 emissions, as follows:

Location	Electricity emissions factor (kg co2-e / kwh)	Gas emissions factor (kg co2-e / gj)
Melbourne	1.00	55.5

For more information please contact Media Advisor Greg Foyster
g.foyster@environmentvictoria.org.au | 0410879031

ENDNOTES

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[2] https://www.abs.gov.au/ausstats/abs@.nsf/mf/4602.0.55.001

[3] https://grattan.edu.au/wp-content/uploads/2020/11/Flame-out-Grattan-report.pdf Table 5.1, page 43. Figures are: space heating 74%, water heating 24%, cooking 2%.

[4] https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/vgpr/2021/2021-victorian-gas-planning-report.pdf?la=en and https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/1716/2544/4975/Victorias_Gas_Substitution_Roadmap_Consultation_Paper.pdf

[5] https://earthresources.vic.gov.au/projects/victorian-gas-program

[6] https://www.iea.org/reports/net-zero-by-2050

[7] https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

[8] https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/1716/2544/4975/Victorias_Gas_Substitution_Roadmap_Consultation_Paper.pdf (Including both fugitive emissions and emissions associated with the combustion of gas.)

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[10] https://www.climatecollege.unimelb.edu.au/files/site1/images/20161026%20Review%20of%20Methane%20Emissions.pdf

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[14] https://www.premier.vic.gov.au/helping-vulnerable-victorians-stay-warm-and-cool-less

[15] https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/vgpr/2021/2021-victorian-gas-planning-report.pdf?la=en

[16] https://renew.org.au/wp-content/projects/CAP_Gas_Research_Final_Report_251114_v2.0.pdf

and https://www.climatecouncil.org.au/wp-content/uploads/2021/05/Kicking-the-Gas-Habit-How-Gas-is-Harming-our-Health.pdf

[17] https://energy.unimelb.edu.au/__data/assets/pdf_file/0007/1993309/switching-off-gas-an-examination-of-declining-gas-demand-in-eastern-australia.pdf

[18] https://renew.org.au/research/all-electric-solar-homes-save-thousands-over-gas-report/

[19] https://grattan.edu.au/wp-content/uploads/2020/11/Flame-out-Grattan-report.pdf

[20] https://ieefa.org/wp-content/uploads/2020/03/Is-the-Gas-Industry-Facing-its-Volkswagen-Moment_March-2020.pdf

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[22] Victorian Planning Provisions (2021f) Clause 56.09-2 https://planning-schemes.api.delwp.vic.gov.au/__data/assets/pdf_file/0007/481723/VPPs_All_Clauses.pdf?_ga=2.197397423.1245469641.1632196286-1549056072.1611021851

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[28] https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf

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