Efficient heating and cooling in Adelaide homes

An analysis of energy bills and emissions

renew.

Prepared for South Australian Council of Social Services

Renew policy team
Prepared by: Rob McLeod and Sam Cope
Cover image: House designed by Paul Hendy, TS4 Living; photography by Shane Harris, Arch Imagery

Project funded by South Australian Council of Social Services

Renew Australia
552 Victoria St, North Melbourne VIC 3051
Wurundjeri Country

www.renew.org.au

Contents

1. Introduction

This report provides an analysis of the household energy bills and carbon emissions associated with heating and cooling an Adelaide home under a range of scenarios.

By comparing different choices of heating and cooling devices as well as thermal efficiency, we have assessed the impacts for Adelaide households of replacing inefficient appliances and conducting energy efficiency retrofits.

We have furthermore assessed the impact of rising energy prices by comparing the costs paid by households in each energy scenario from early 2022 to June 2023 and July 2023, before and after the 23.9% increase in Default Market Offer tariffs set to occur on July 1, 2023.

Using Renew's *Sunulator* energy simulation platform, we modelled the energy use, bills, and carbon emissions from heating and cooling a sample home in Adelaide. *Sunulator* simulates the operation of heating and other appliances, using local climate files to create half-hourly consumption data over a year. The tool allows for detailed configuration of appliances, thermal efficiency and solar generation. Our analysis combines detailed energy consumption data with local retail tariffs and carbon emissions factors.

Additionally, we modelled the NatHERS thermal efficiency rating of the sample Adelaide home using real floor plans and FirstRate5 energy modelling software. This detailed analysis allowed Renew to assess the impacts of measures such as insulation, draught sealing, and window covering on the home's efficiency, energy bills and greenhouse gas emissions.

These findings are available to assist policy makers in understanding the impacts of improving home energy performance and the impacts of rising energy prices on households. The findings are particularly relevant for policies on retrofits for low-income households and social housing; and minimum energy standards for rental homes, which face particular barriers to improved home energy efficiency.

2. Scenarios

This analysis was conducted using actual floor plans for existing Adelaide homes. These floor plans were selected as representative of common designs for existing homes in Adelaide. We selected one 2-bedroom duplex and one 3-bedroom detached home.

We modelled the costs of heating and cooling homes across six scenarios:

	HEATING	COOLING	NATHERS RATING (2BR DUPLEX)	NATHERS RATING (3BR DETACHED)
Scenario 1: gas heater	Gas	None	1.1 Stars	1.4 Stars
Scenario 2: inefficient portable heater	Inefficient panel electric	None	1.1 Stars	1.4 Stars
Scenario 3: Reverse cycle air conditioner	Efficient RCAC	Efficient RCAC	1.1 Stars	1.4 Stars
Scenario 4: Reverse cycle air conditioner and ceiling insulation	Efficient RCAC	Efficient RCAC	2.9 Stars	4.1 Stars
Scenario 5: Reverse cycle air conditioner and draught sealing	Efficient RCAC	Efficient RCAC	3.1 Stars	4.4 Stars
Scenario 6: Reverse cycle air conditioner, draught sealing and blinds	Efficient RCAC	Efficient RCAC	3.2 Stars	4.6 Stars

Our baseline scenario assumed that these homes had not been subject to energy efficiency standards or a retrofit, and as such did not include insulation. This basic level of thermal efficiency was modelled for scenarios 1 to 3, while scenarios 4 to 6 included improvements to thermal efficiency. We used FirstRate5 energy modelling software to calculate the expected NatHERS star rating for each home when energy efficiency features were added.

Scenario 1 is the only scenario we modelled that uses gas for heating.

Scenarios 1 and 2 provide heating only and provide no mechanical cooling option in hot weather.

Scenarios 3, 4, 5 and 6 use a reverse cycle air conditioner for both heating and cooling.

3. Assumptions

3.1. Energy use

We assume in this modelling that only one area of a home is heated and cooled, at a size of 50m^2. This assumption is made because it is more likely to reflect the appliance use of Adelaide residents on low incomes. This a relatively small space to be heated or cooled and as such the cost savings presented from greater energy efficiency are conservative. (In particular, heating and cooling costs for the larger 3-bedroom home may increase relative to the smaller 2-bedroom home if all rooms are heated and cooled.)

Our cost modelling includes the energy used for heating and cooling only. The overall energy use and bills of a home also include other appliances and fees and as such are higher than the figures presented in our analysis. (Depending on climate, efficiency and household behaviour, heating and cooling typically account for around 40-60% of a home's energy use.)

The scenarios in our analysis are assumed not to have onsite solar panels or battery storage. Solar panels would reduce the cost and emissions associated with electric heating and cooling by powering appliances with electricity generated onsite.

We made representative assumptions about the size and efficiency of the appliances. Reverse cycle air conditioners were modelled at a power of 6kW heating and 5.5 kW cooling and were assumed to have moderately high efficiency levels (heating Coefficient of Performance 4.4; cooling Energy Efficiency Ratio 4). The inefficient electric heater modelled in Scenario 2 is assumed to be a plug-in 2,400W panel heater (Coefficient of Performance 1). We have assumed the heater in scenario 2 to have a thermostat; we note that a heater running without thermostat would have higher energy usage and bills. Gas heating was assumed to have a heat output equivalent to 6kW and a Coefficient of Performance of 0.7.

Renew's energy modelling software *Sunulator* simulates household heating and cooling loads using local climate data. We applied an ideal indoor temperature of 22 degrees Celsius, with thermostat settings requiring heating to turn on when indoor temperatures fall below approximately 19 degrees, and cooling to turn on when indoor temperatures rise above approximately 27 degrees. These settings are approximate and include seasonal variation.

3.2. Tariffs

We assumed flat tariffs when calculating costs. We included only the charges for energy use and did not include daily connection fees. In practice, this approach assumes that households replacing their heating and cooling would remain connected to both gas and electricity networks. Removing all gas appliances (including heating, hot water and cooking) allows households to avoid daily gas connection charges, significantly improving the bill savings of all-electric homes.

Our analysis seeks to compare the costs paid by households in each scenario in the following dates:

- January 2022
- June 2023
- July 2023

These dates correlate with the 2021/22, 2022/23, and 2023/24 financial years and associated tariff regulations. Prices in January 2022 were prior to significant global energy price increases following Russia's invasion of Ukraine and other

factors. From 1 July, 2022, AEMO Default Market Offer (DMO) for SA Power Networks rose by 7.2% from 2021-22 prices. From July 1, 2023, the DMO will increase by a further 23.9% from 2022-23 prices.

To determine the tariff used in our analysis, we researched the retail tariffs offered by three major providers in Adelaide (Origin, AGL, and Simply Energy) and calculated the average of the three providers. This research was conducted online in January 2022 and again in June 2023. These prices include consumer offers and are slightly lower than the Default Market Offer reference price (generally by 5-10%). In place of applying the reference price, to calculate tariffs from July 2023 onwards we have assumed an increase of 23.9% on June 2023 electricity prices; this increase is in line with the regulated increase but in practice may vary according to consumer offers or retailers. Gas prices are not subject to the same regulation mechanism and an exact increase is unknown at time of writing; to calculate the July 2023 cost used in this analysis we have conservatively assumed a 9% increase in line with national annual projections.

The retail offerings and average tariffs were as follows:

	AGL	SIMPLY ENERGY	ORIGIN	**AVERAGE**
Electricity per kWh: **January 2022**	$0.3185	$0.3315	$0.3019	**$0.3173**
Electricity per kWh: **June 2023**	$0.3654	$0.3598	$0.32171	**$0.3490**
Electricity per kWh: **July 2023**	N/A	N/A	N/A	**$0.4324***
Gas per MJ: **January 2022**	$0.03989	$0.0535	$0.0433	**$0.0456**
Gas per MJ: **June 2023**	$0.0523	$0.0471	$0.0564	**$0.0519**
Gas per MJ: **July 2023**	N/A	N/A	N/A	**$0.0566***

** projected*

Findings

3.3. Energy costs of heating and cooling

3.3.1. 2-bedroom duplex

The annual costs of heating and cooling in each scenario and year for the **2-bedroom duplex** are presented in the following tables:

2022 – 2BR UNIT	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1.361.48	N/A	N/A	**$1.361.48***
Scenario 2: inefficient portable heater	N/A	$831.55	N/A	**$831.55***
Scenario 3: Reverse cycle air conditioner	N/A	$385.66	$619.61	**$1,005.27**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$198.04	$135.50	**$333.55**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$194.57	$126.24	**$320.81**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$192.25	$121.61	**$313.86**

**no cooling provided in scenarios 1 and 2*

JUNE 2023 – 2BR UNIT	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1,550.12	N/A	N/A	**$1,550.12***
Scenario 2: inefficient portable heater	N/A	$914.55	N/A	**$914.55***
Scenario 3: Reverse cycle air conditioner	N/A	$424.16	$681.45	**$1,105.61**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$217.81	$149.03	**$366.84**

Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$213.99	$138.84	**$352.83**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$211.44	$133.74	**$345.18**

**no cooling provided in scenarios 1 and 2*

JULY 2023 – 2BR UNIT	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1,689.62	N/A	N/A	**$1,689.62 ***
Scenario 2: inefficient portable heater	N/A	$1,133.12	N/A	**$1,133.12 ***
Scenario 3: Reverse cycle air conditioner	N/A	$525.53	$844.32	**$1,369.85**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$269.87	$184.65	**$454.51**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$265.13	$172.02	**$437.15**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$261.98	$165.71	**$427.68**

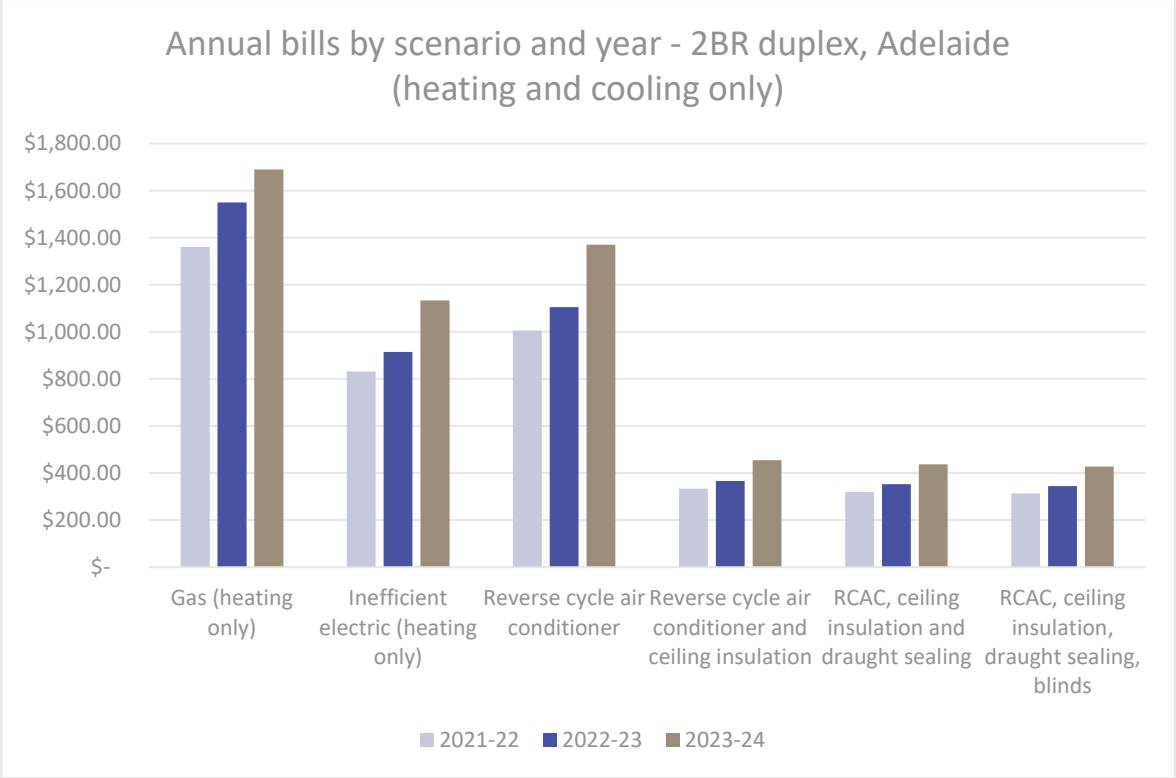
**no cooling provided in scenarios 1 and 2*

The **total bill annual bill cost** for each time period is as follows:

TOTAL ANNUAL BILLS – 2BR UNIT	21-22 TARIFFS	22-23 TARIFFS	23-24 TARIFFS
Scenario 1: gas heater	**$1.361.48***	**$1,550.12***	**$1,689.62 ***
Scenario 2: inefficient portable heater	**$831.55***	**$914.55***	**$1,133.12 ***
Scenario 3: Reverse cycle air conditioner	**$1,005.27**	**$1,105.61**	**$1,369.85**

Scenario 4: Reverse cycle air conditioner and ceiling insulation	**$333.55**	**$366.84**	**$454.51**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	**$320.81**	**$352.83**	**$437.15**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	**$313.86**	**$345.18**	**$427.68**

**no cooling provided in scenarios 1 and 2*



3.3.2. 3-bedroom detached house

The annual costs of heating and cooling in each scenario and year for the **3-bedroom detached house** are presented in the following tables:

2022 – 3BR HOUSE	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1,164.25	N/A	N/A	**$1,164.25***

Scenario 2: inefficient portable heater	N/A	$719.21	N/A	**$719.21***
Scenario 3: Reverse cycle air conditioner	N/A	$349.76	$452.83	**$802.59**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$198.04	$98.44	**$296.49**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$192.25	$96.13	**$288.38**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$185.30	$88.02	**$273.32**

**no cooling provided in scenarios 1 and 2*

JUNE 2023 – 3BR HOUSE	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1,325.55	N/A	N/A	**$1,325.55***
Scenario 2: inefficient portable heater	N/A	$790.99	N/A	$790.99 *
Scenario 3: Reverse cycle air conditioner	N/A	$384.67	$498.03	$882.70
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$217.81	$108.27	$326.08
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$211.44	$105.72	$317.16
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$203.80	$96.80	$300.60

**no cooling provided in scenarios 1 and 2*

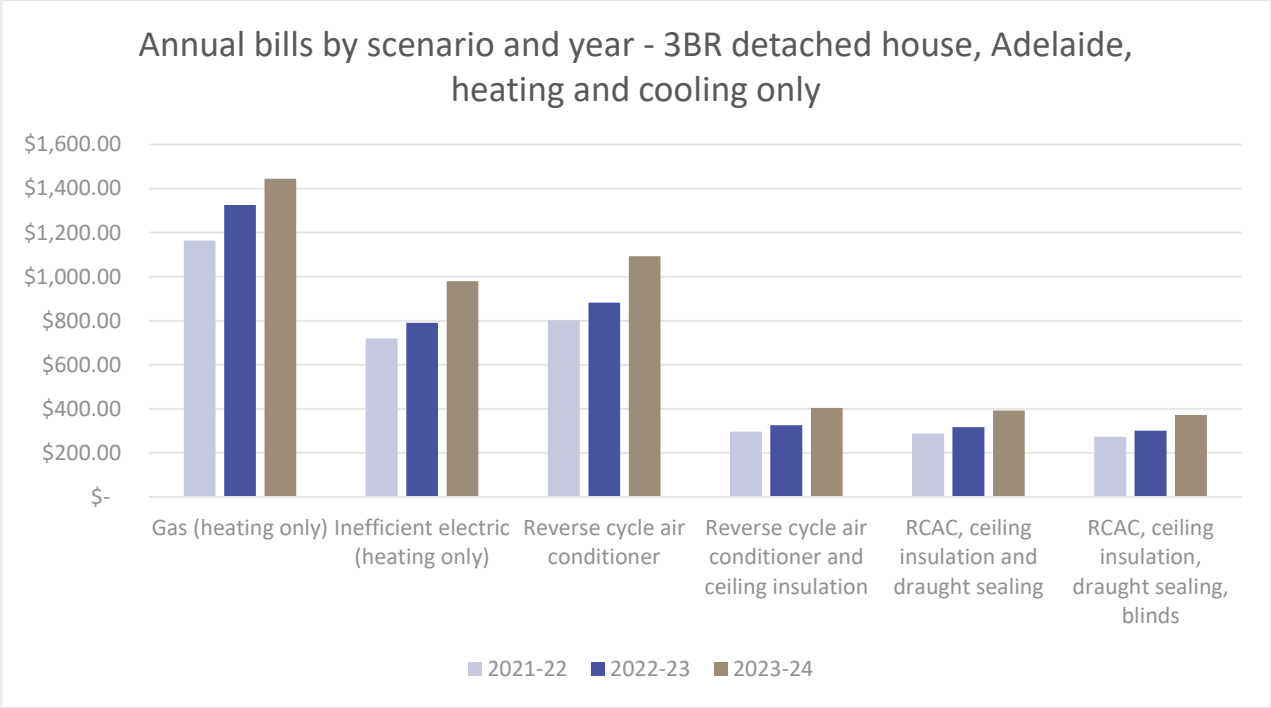
JULY 2023 – 3BR HOUSE	COST OF GAS HEATING	COST OF ELECTRIC HEATING	COST OF ELECTRIC COOLING	**TOTAL COST OF HEATING AND COOLING***
Scenario 1: gas heater	$1,444.85	N/A	N/A	**$1,444.85***
Scenario 2: inefficient portable heater	N/A	$980.04	N/A	$980.04 *
Scenario 3: Reverse cycle air conditioner	N/A	$476.61	$617.06	$1,093.67
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	$269.87	$134.14	$404.01
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	$261.98	$130.99	$392.96
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	$252.51	$119.94	$372.45

**no cooling provided in scenarios 1 and 2*

The **total bill annual bill cost** for each time period is as follows:

TOTAL ANNUAL BILLS – 3BR HOUSE	21-22 TARIFFS	22-23 TARIFFS	23-24 TARIFFS
Scenario 1: gas heater	**$1,164.25***	**$1,325.55***	**$1,444.85***
Scenario 2: inefficient portable heater	**$719.21***	$790.99 *	$980.04 *
Scenario 3: Reverse cycle air conditioner	**$802.59**	$882.70	$1,093.67
Scenario 4: Reverse cycle air conditioner and ceiling insulation	**$296.49**	$326.08	$404.01
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	**$288.38**	$317.16	$392.96
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	**$273.32**	$300.60	$372.45

no cooling provided in scenarios 1 and 2



3.4. Carbon emissions

We calculated the annual carbon emissions produced by the consumption of energy to heat and cool a home in each scenario.

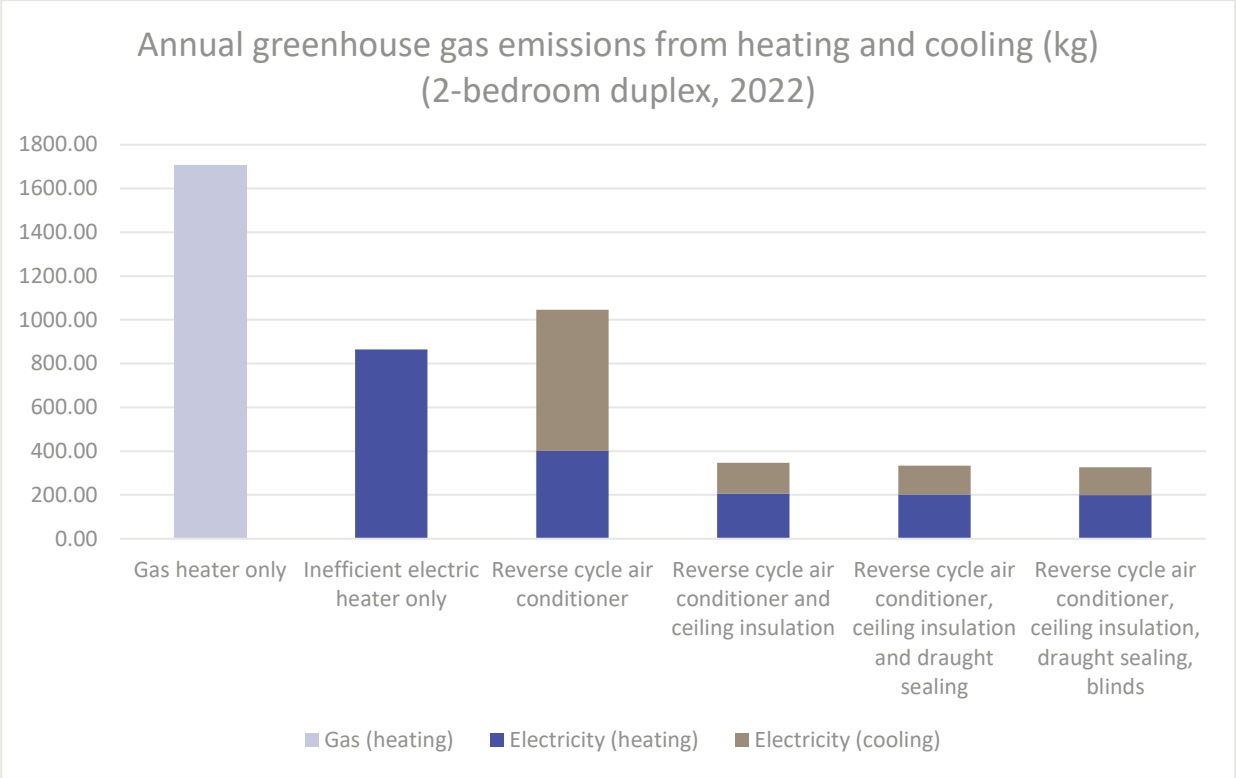
We applied the average emissions intensity of South Australian energy networks as calculated by the Australian government in the 2022 National Greenhouse Accounts Factors. These factors were 0.33 kg CO_2-E per kWh for electricity; and 57.07 kg CO_2-E per GJ for gas. As with the costs above, the emissions calculations are for heating and cooling only and do not include other household energy use.

Our findings for the sample 2-bedroom duplex were as follows:

SCENARIO	ANNUAL EMISSIONS FROM GAS (KG CO_2-E)	ANNUAL EMISSIONS FROM ELECTRIC HEATING (KG CO_2-E)	ANNUAL EMISSIONS FROM ELECTRIC COOLING (KG CO_2-E)	**TOTAL ANNUAL EMISSIONS FROM HEATING AND COOLING (KG CO_2-E)**
Scenario 1: gas heater	1703.94	N/A	N/A	**1703.94***
Scenario 2: inefficient portable heater	N/A	864.83	N/A	**864.83***
Scenario 3: Reverse cycle air conditioner	N/A	401.10	644.41	**1045.51**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	205.97	140.93	**346.90**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	202.36	131.29	**333.65**

Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	199.95	126.47	**326.42**

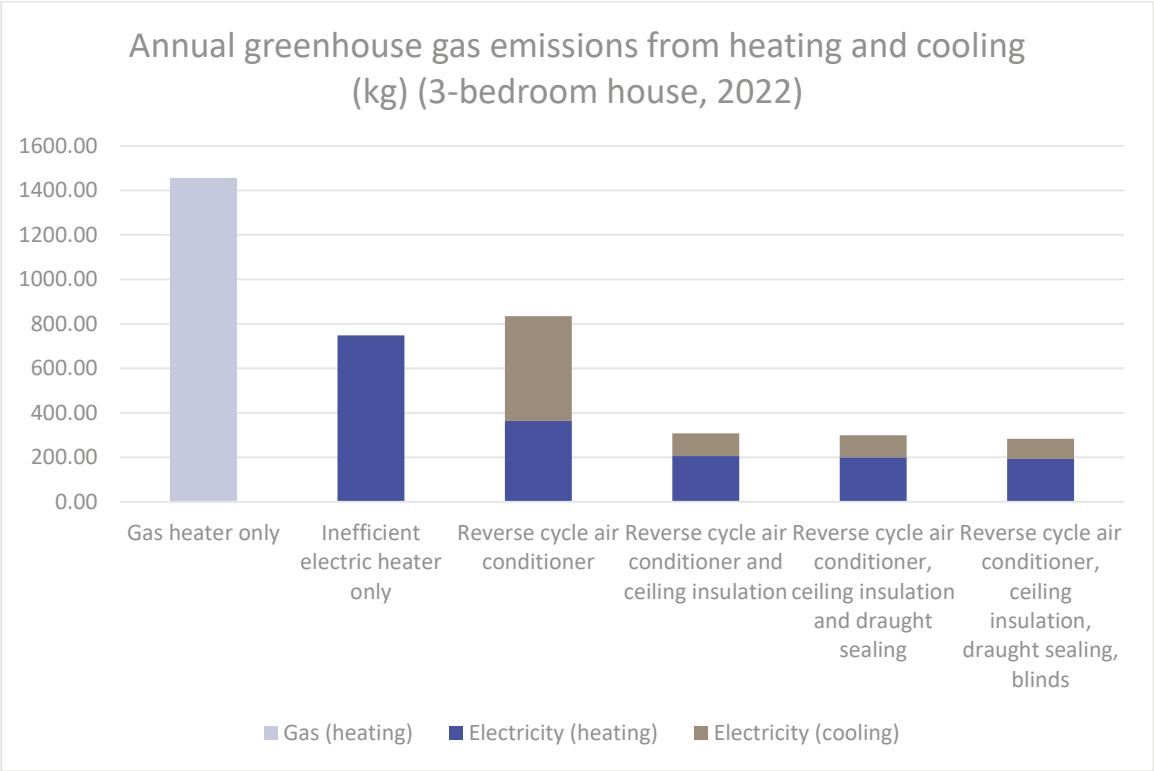
** no cooling provided in scenarios 1 and 2*



Our findings for the sample 3-bedroom detached house were as follows:

SCENARIO	ANNUAL EMISSIONS FROM GAS (KG CO_2-E)	ANNUAL EMISSIONS FROM ELECTRIC HEATING (KG CO_2-E)	ANNUAL EMISSIONS FROM ELECTRIC COOLING (KG CO_2-E)	**TOTAL ANNUAL EMISSIONS FROM HEATING AND COOLING (KG CO_2-E)**
Scenario 1: gas heater	1457.10	N/A	N/A	**1457.10***
Scenario 2: inefficient portable heater	N/A	747.99	N/A	**747.99***
Scenario 3: Reverse cycle air conditioner	N/A	363.76	470.96	**834.72**
Scenario 4: Reverse cycle air conditioner and ceiling insulation	N/A	205.97	102.38	**308.35**
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	N/A	199.95	99.97	**299.92**
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	N/A	192.72	91.54	**284.26**

** no cooling provided in scenarios 1 and 2*



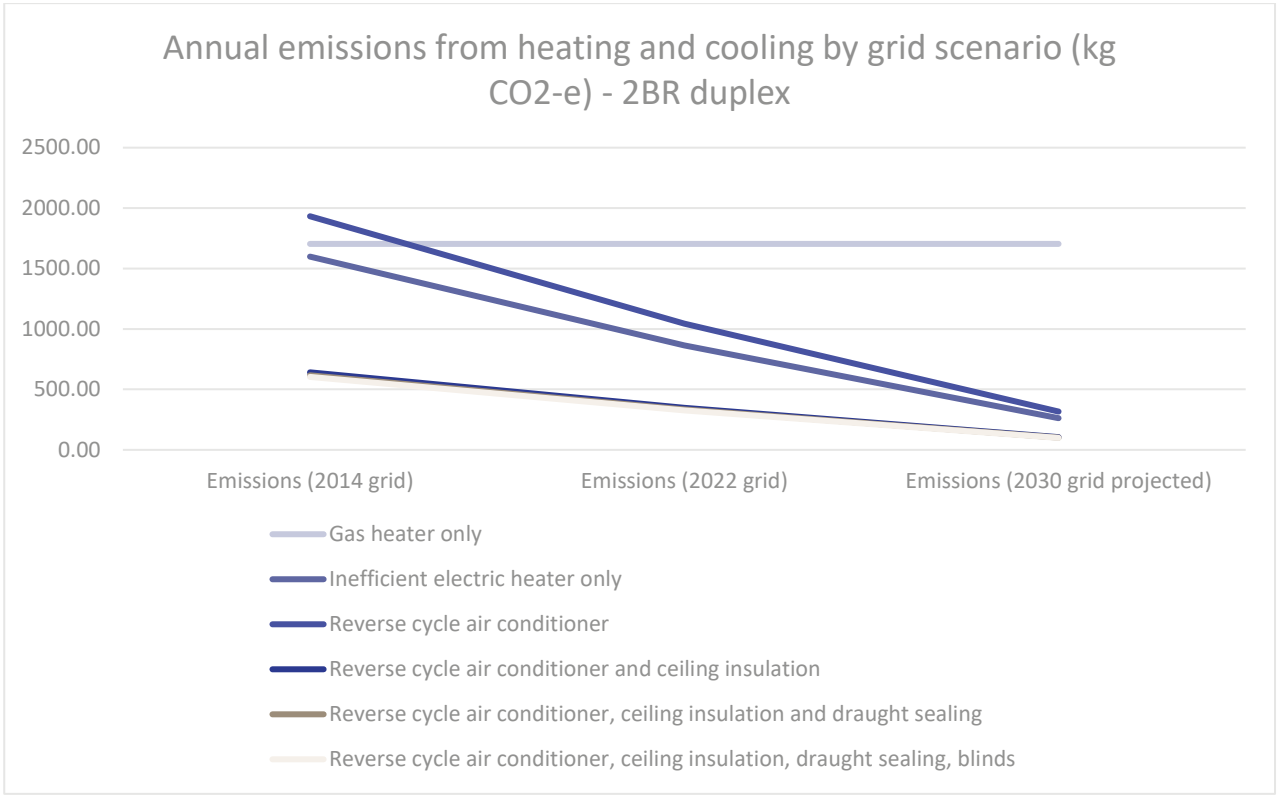
A key consideration when assessing the emissions impacts of appliances is that the emissions produced by gas will remain constant, whereas the emissions intensity of electricity is rapidly reducing as renewables replace fossil fuels in the electricity grid. South Australia has already transformed its energy system, achieving 60% renewables. AEMO forecasts the South Australia will reach 85% renewables by 2026 and the state is committed to 100% renewables by 2030.

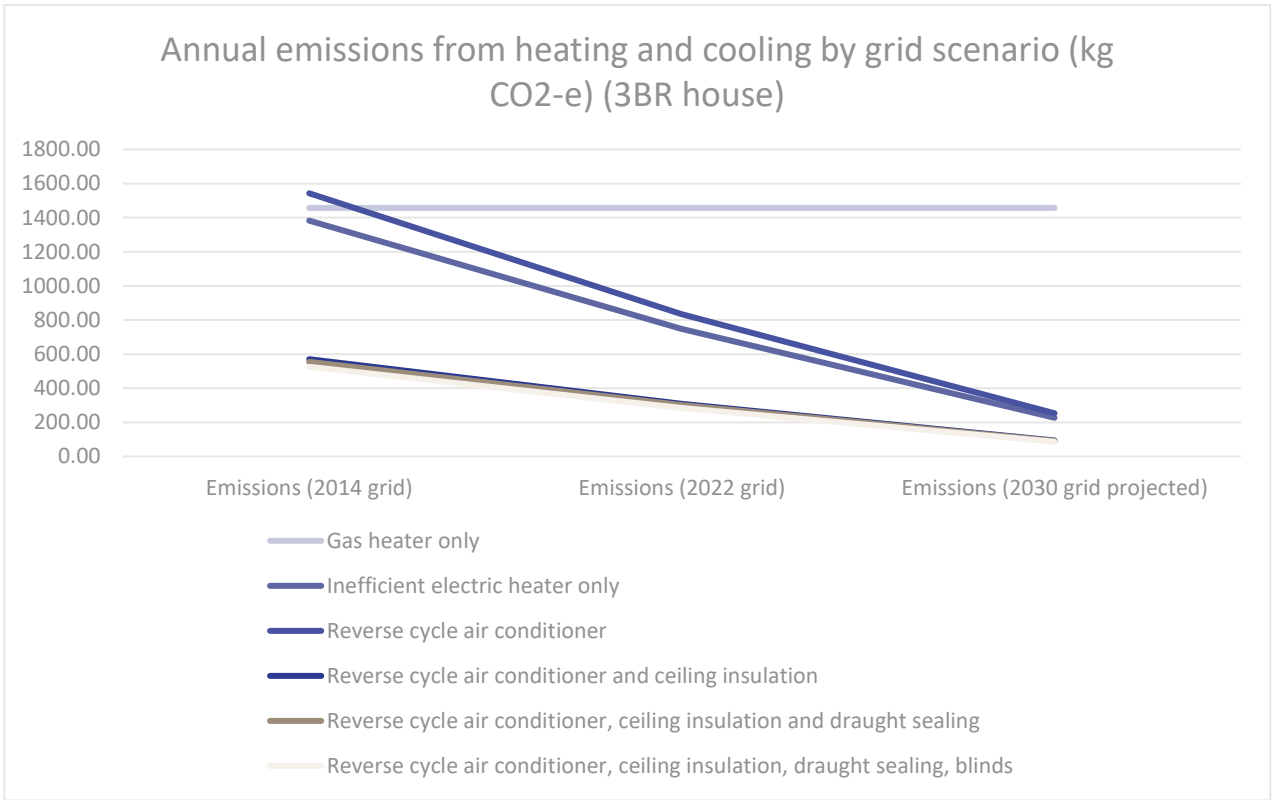
To account for the further decarbonisation of the electricity grid and how this relates to household appliance choice, we compared expected emissions for each home using three emissions intensity figures, based on Scope 2 and Scope 3 emissions factors from the National Greenhouse Accounts Factors:

YEAR	EMISSIONS
2014 South Australia electricity emissions intensity	0.61 kg CO_2-E per kWh
2022 South Australia electricity emissions intensity	0.33 kg CO_2-E per kWh
2030 South Australia electricity emissions intensity (projected)	0.10 kg CO_2-E per kWh

In each of these scenarios, the same emissions factors for gas were applied.

Our findings were as follows:


Annual emissions from heating and cooling by grid scenario (kg CO2-e) - 2BR duplex
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Emissions (2014 grid)
Emissions (2022 grid)
Emissions (2030 grid projected)
Gas heater only
Inefficient electric heater only
Reverse cycle air conditioner
Reverse cycle air conditioner and ceiling insulation
Reverse cycle air conditioner, ceiling insulation and draught sealing
Reverse cycle air conditioner, ceiling insulation, draught sealing, blinds


Annual emissions from heating and cooling by grid scenario (kg CO2-e) (3BR house)
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Emissions (2014 grid)
Emissions (2022 grid)
Emissions (2030 grid projected)
Gas heater only
Inefficient electric heater only
Reverse cycle air conditioner
Reverse cycle air conditioner and ceiling insulation
Reverse cycle air conditioner, ceiling insulation and draught sealing
Reverse cycle air conditioner, ceiling insulation, draught sealing, blinds

4. Costs of retrofits

While the above findings suggest that improvements to home energy efficiency and appliance choice reduce ongoing energy bills, households seeking to upgrade face an upfront cost to replace appliances or install thermal efficiency improvements.

To assess the upfront costs currently faced by Adelaide households, we have sought quotes from providers on the energy retrofit scenarios detailed in this report. These quotes and costs have been sourced in June 2023.

Prices quoted below do not include discounts, rebates or incentives through programs such as the Retailer Energy Productivity Scheme (REPS).

4.1. Quotes for services in Adelaide

4.1.1. Reverse Cycle Air Conditioner

Prices for RCAC units were sourced online from major retailers. We selected three popular models with specifications in line with the output and efficiency assumed in modelling savings (heating output 6kW at 4 Star efficiency rating; model names use cooling output which is less than heating output).

MODEL	COST
Samsung AR9500 Wind-Free Geo 5.0kW	$1699
Fujitsu 5kW ASTG18KMTC	$1678
Fujitsu 5kW Lifestyle Range KMTC	$1599
Average	**$1659**

4.1.2. Reverse Cycle Air Conditioner installation costs

We sought quotes from Adelaide providers to install RCAC units of similar size and specifications as the models listed above. We assumed that the installation was for a relatively straightforward back-to-back installation in a single-storey home. Installation costs would likely be higher for homes with more complex installation requirements (for example, double-storey homes or longer connections between indoor and outdoor components).

	COST
Quote 1	$748
Quote 2	$699
Quote 3	$700
Average	**$716**

4.1.3. Insulation

We sought quotes from Adelaide providers for installing R4 insulation in the scenario homes modelled in this report. Quotes were given for entire homes or on a per m^2 basis, which we have used to calculate total costs for the scenario 2BR and 3BR homes. Costs presented include materials and installation. We have assumed when requesting quotes that no significant complicating factors for installation are present in the home, which would increase installation costs.

One quote received was from a provider with a primary market outside of South Australia and was given including an additional cost of $842 for each installation for additional temporary safety structures and electrical safety check. These costs are being undertaken for installations under the incoming ACT minimum standards regulations. We have here included these costs in the cost benefit analysis, but note that this may overstate actual market costs for Adelaide homes.

2023	2BR DUPLEX (85M2)	3BR DETACHED (125M2)
Quote 1	$1,275	$1,1,750
Quote 2	$1,675	$2,300
Quote 3	$3,150*	$4,235*
Average	**$2,033**	**$2,762**

(* Including additional costs)

4.1.4. Draught sealing

The cost of draught sealing is typically low and the activity is usually conducted by residents. Costs can range from negligible (e.g. by using tape to seal cracks) to the cost of purpose-made products such as door seals or sealants. Limited services were found providing professional or tailored draught sealing services to Adelaide households. For the purposes of cost-benefit analysis, we have assumed a cost of $100 for materials/products for draught sealing.

Some households may face barriers to undertaking draught sealing. Draught sealing may be dangerous in homes with unflued gas heaters. Renters require permission from landlords for alterations, which may include some forms of draught sealing.

An emerging market for Residential Efficiency Scorecard assessments (a program created in Victoria that has been approved for national use under an expanded NatHERS In-Home rating scheme) may increase availability of tailored energy advice, including draught sealing. A full assessment (including draught sealing advice) is expected to cost $200-400, depending on home size and type.

4.1.5. Blinds/curtains

A large range of blinds and window coverings is available on the market, ranging from simple designs (vertical, roller blinds) with relatively limited thermal efficiency benefit, to heavy curtains and honeycomb blinds providing greater thermal benefits. We have selected popular brands from major retailers to provide indicative costs. Installation costs are not included in the below prices; we assume self-installation at zero cost.

Our scenarios assume that a 50m^2 area of each of the 2BR and 3BR homes is heated and cooled. As such, we assume the installation of window coverings in only the main living space in each home. Floor plans provided indicate only a small difference in window size between the two homes in the main living area, resulting in a relatively small price difference for window coverings across our two scenarios (and equal prices for non-fitted curtains). The window shapes of modelled homes have resulted in a wide variation of prices for fitted blinds, including lower prices for the modelled 3BR home in some quotes. It should be noted that if all windows in the home are to be covered, the 3BR home would experience a relatively higher increase in cost than the 2BR home.

SCENARIO	WINDOWS IN LIVING SPACE
2BR Duplex	2 windows (1500mm x 1210mm)
3BR Detached	2 windows: 1000mm x 1500mm; 1500mm x 1200mm

Prices sourced were as follows:

WINDOW COVERING TYPE	BRAND/MODEL	2BR SCENARIO COST	3BR SCENARIO COST
Roller blind	Titan Snow White Blockout	$241.20	$228.60
Heavy curtain	ALESUND blockout eyelet panel	$138	$138
Honeycomb blind	Duolight Cotton Pleated	$436.50	$379.50

Our modelling of the benefits to thermal efficiency provided by blinds uses FirstRate5 software, which does not distinguish between different blind types. In order to conduct a cost-benefit analysis of blind installation in the following section, we have assumed an average of the three selected options. In practice, the thermal savings from honeycomb blinds are likely to be somewhat higher than the modelled bill savings, but with a higher upfront cost.

4.2. Rebates and programs

4.2.1. Retailer Energy Productivity Scheme (REPS)

The primary rebate and incentive program active in South Australia is the Retailer Energy Productivity Scheme (REPS). The program sets energy productivity targets to be met by electricity and gas retailers. These retailers in turn have flexibility to design and offer incentive programs to customers, which may include financial support or rebates for specific retrofit activities listed in this report. The program focuses on low-income households.

Commercial confidentiality requirements mean that data on costs or rebate amounts from obliged retailers under the scheme are not disclosed. The 2021 REPS annual report indicates that the program delivered 383 ceiling insulation 'activities' and 2,794 reverse cycle air conditioner 'activities' during the year.[1] Further detailed analysis on the average savings to households through the REPS program may be of value to policy makers.

Some providers approached for quotes indicated that rebates through this program may be available to some customers, subject to income status and work undertaken; others were not registered or associated with activities under the program. Rebates or discounts through the REPS program are not included in costs listed in this report.

4.2.2. Comparison with interstate models

Models for rebates and support for home energy productivity provide useful policy context for this analysis.

Victoria

- Solar Homes Program – until June 2023 the Home Heating and Cooling Upgrades provides direct rebates of $1,000 to replace gas heaters with reverse cycle air conditioners for renters and low-income homeowners. New applications closed in December 2022.
- Victorian Energy Upgrades program provides further cost reduction. Program has removed all incentives for gas appliances and introduced incentives for replacing gas appliances with efficient electric appliances.
- Cumulative impact of programs meets majority of upfront cost of installing reverse cycle air conditioner for eligible households; ending of Home Heating and Cooling Upgrades program likely to affect costs

[1] https://www.escosa.sa.gov.au/ArticleDocuments/21892/20220627-REPS-AnnualReport2021.pdf.aspx?Embed=Y

NSW

- Low-income energy rebate for concession holders can access 10 years of concession payments as upfront payment to upgrade appliances, including heating and cooling
- Up to $4000 upfront access for upgrades

ACT

- Home Energy Support program soon to include rebates up to $5,000 for solar and energy efficiency retrofits for Australian Government Pensioner Concession Card or Department of Veterans' Affairs Gold Card holders
- $2,500 available for reverse cycle air conditioners, insulation and heat pump hot water
- No-interest loans also available through program
- From 2023, insulation has been mandated as a minimum standard for rental homes, subject to phase-in periods concluding in 2026. Homes with no insulation or insulation less than R2 standard are required to install R5 insulation; homes with existing R2 or above insulation are not required to upgrade.

Cost benefit analysis

We calculated the total cost of the upgrades in each of the scenarios detailed in this report in order to conduct a cost-benefit analysis.

The cost-benefit analysis compares the upfront cost of retrofits with the ongoing bill savings, as detailed in Sections 3 and 4 of this report. Our approach calculates a 'payback period' for each upgrade – that is, the number of years in which the ongoing energy bill savings of more efficient homes add up to the amount of the upfront costs.

We have conducted a separate cost benefit analysis using tariffs from each of 2021-22, 2022-23, and 2023-24 as presented in Section 3 of this report. Each analysis assumes the same costs for retrofits using June 2023 quotes. We have conducted an analysis for each tariff rate in order to allow for a comparison of the payback periods and therefore the impact of rising energy bills on returns for efficiency retrofits.

The possible use of cooling impacts on the findings of our analysis. Homes with only a gas heater or an inefficient panel electric heater (scenarios 1 and 2) have no access to cooling. Installing a reverse cycle air conditioner will reduce the ongoing cost of heating, however it will also provide the option of summer cooling. To account for this, our cost-benefit analysis includes a calculation of the years to pay back upfront costs both with cooling *included* and cooling *excluded*.

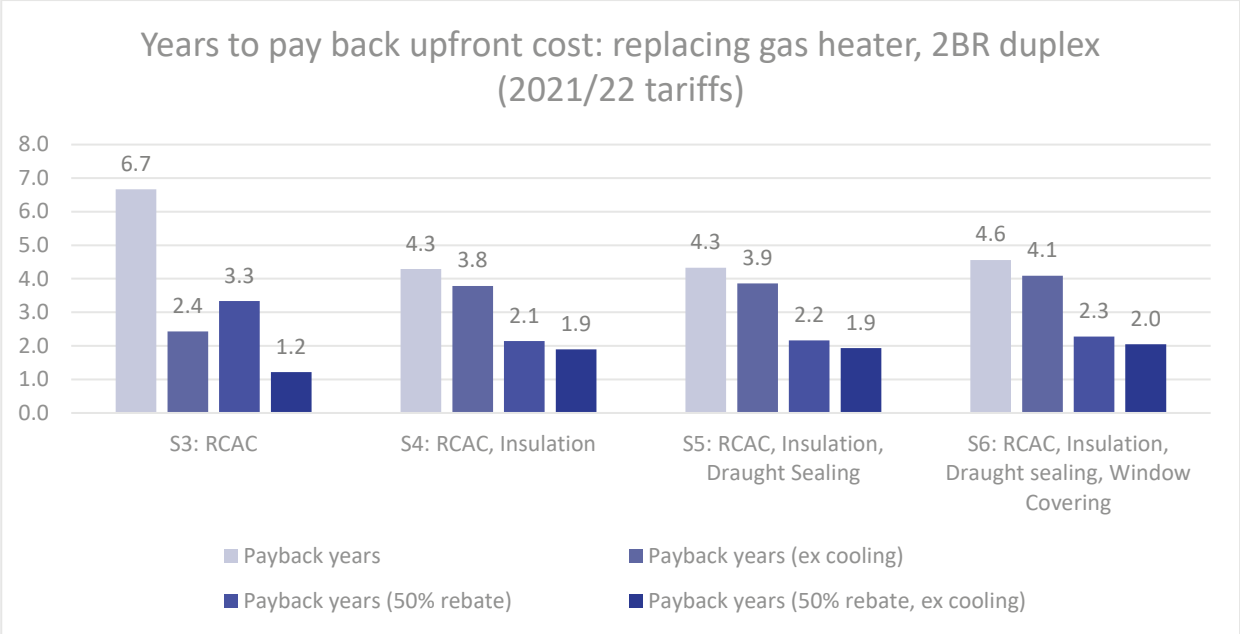
A consideration of our analysis is the impacts of potential rebates or other financial support for households. In this analysis, we calculate the impacts on years to pay back upfront costs of a potential 50% rebate on the cost of upgrades. This provides an indication of the potential impacts of government policy or other incentives on households. Meanwhile, the payback period findings assume no interest paid on the cost of initial upgrades.

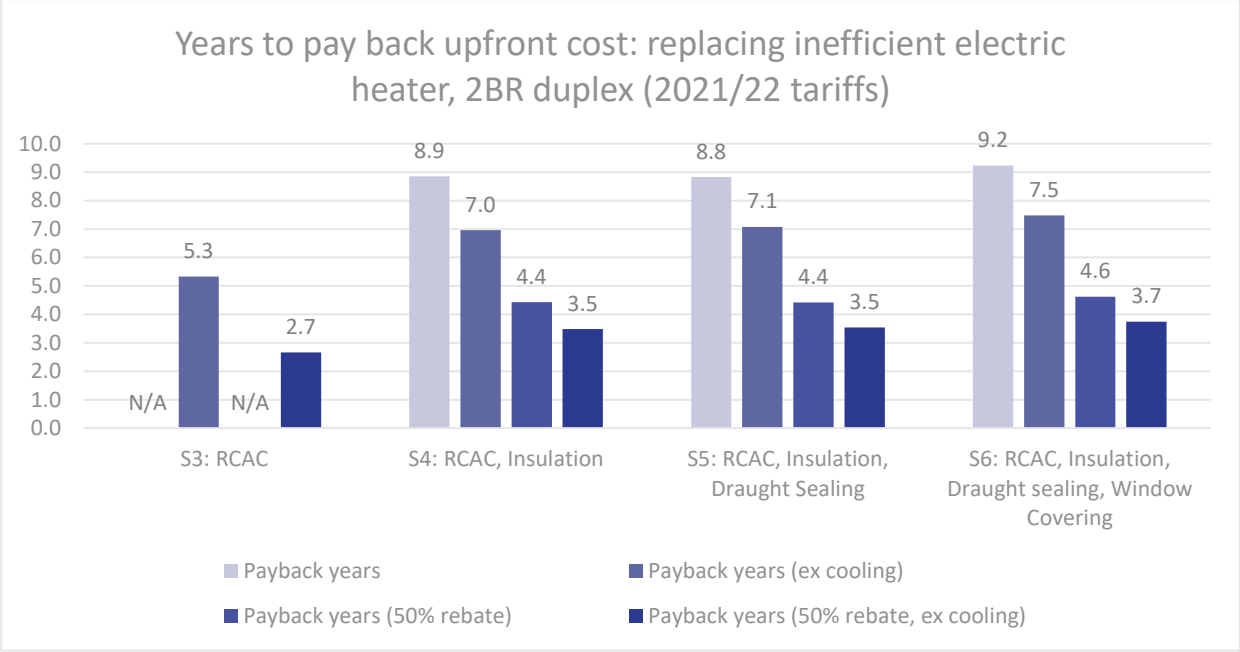
4.2.3. Results: 2BR duplex

The total costs of retrofits and yearly savings for the **2BR duplex** were as follows:

2BR DUPLEX, 2021/22 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)
Scenario 3: Reverse cycle air conditioner	$2375	$356.21	$975.82	- $173.72	$445.89
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$4408	$1027.93	$1163.44	$498	$633.51
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$4508	$1040.67	$1166.91	$510.74	$636.98
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$4780	$1047.62	$1169.23	$517.69	$639.30

Assuming 2021/22 tariffs, the years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:

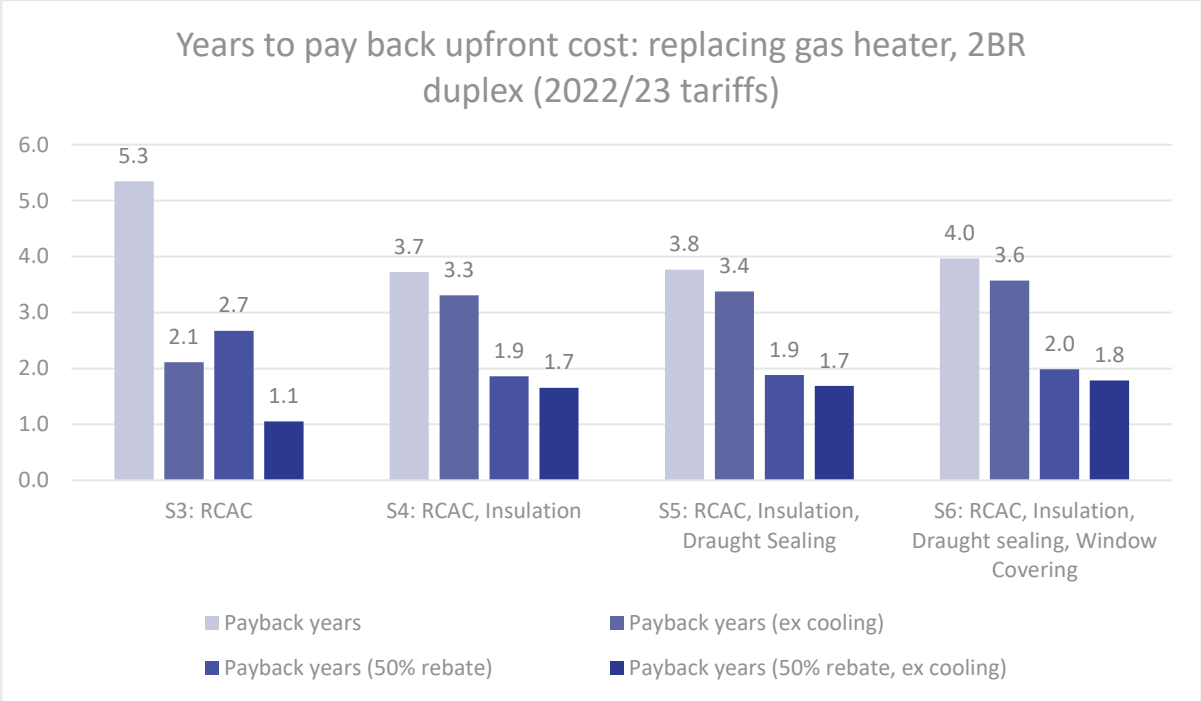


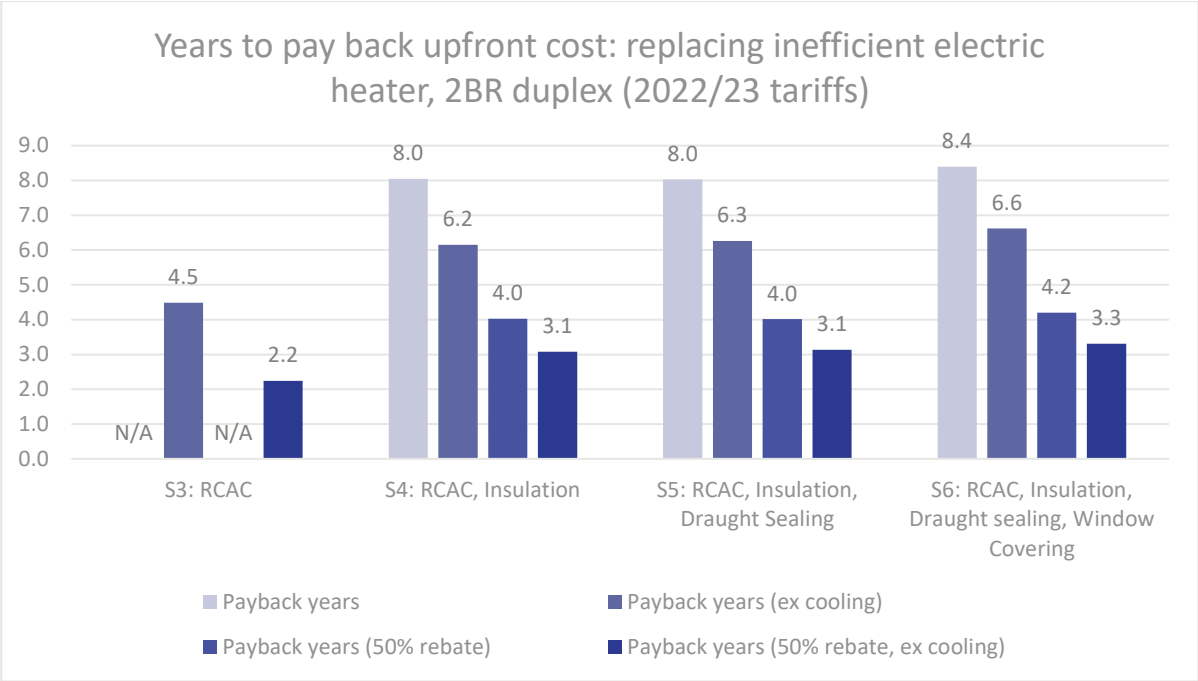


2BR DUPLEX, 2022/23 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)

Scenario 3: Reverse cycle air conditioner	$2375	$444.51	$1125.96	-$191.06	$528.89
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$4408	$1183.28	$1332.31	$547.71	$716.51
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$4508	$1197.29	$1336.13	$561.72	$719.98
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$4780	$1204.93	$1338.67	$569.36	$722.30

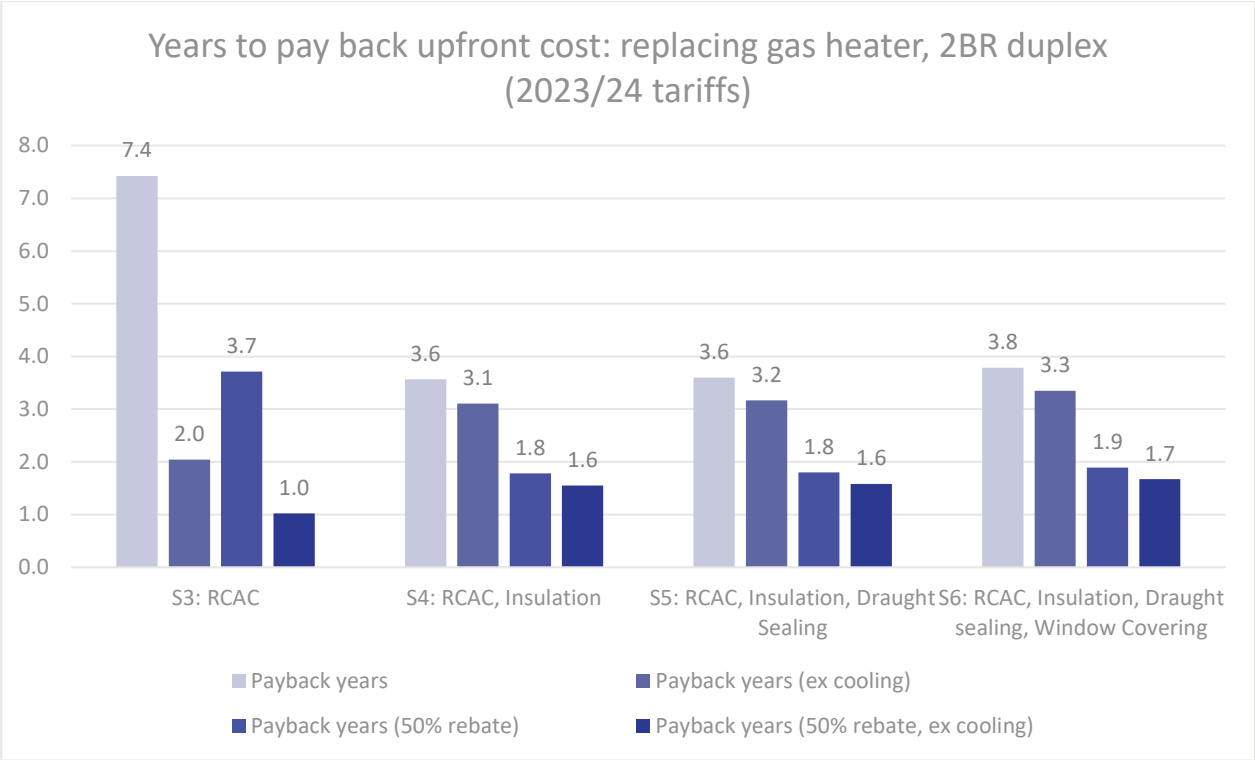
Assuming 2022/23 tariffs, the years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:

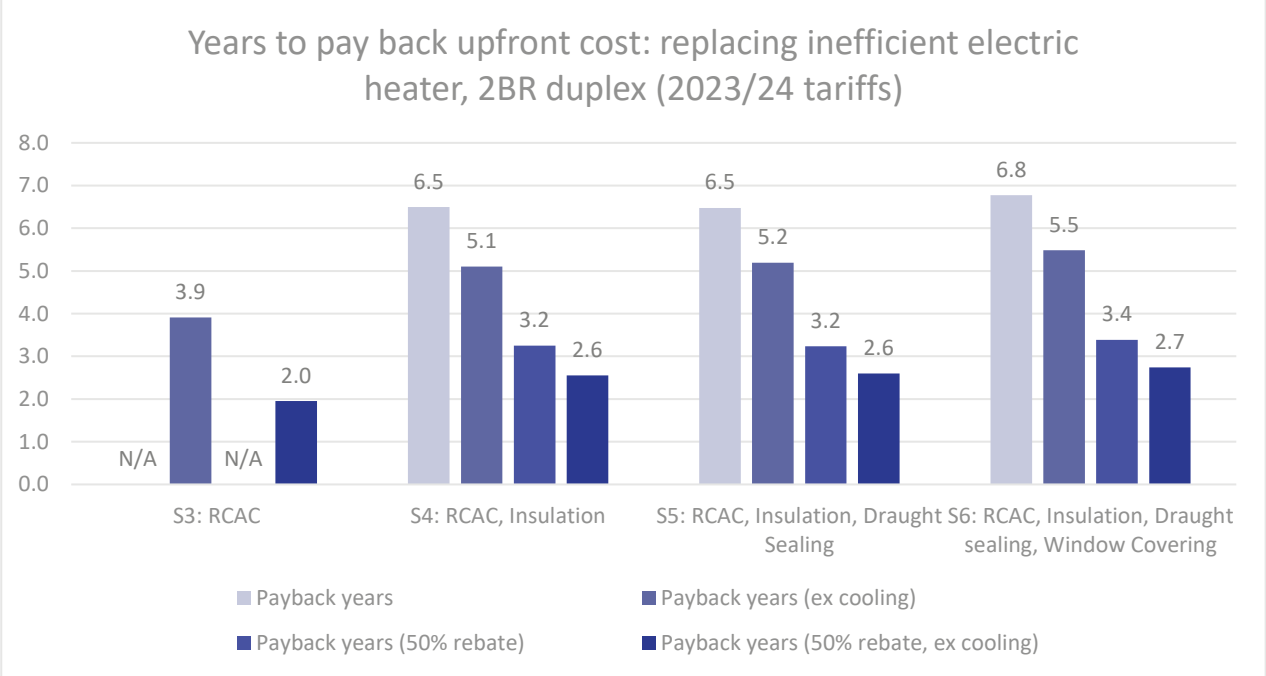




2BR DUPLEX, 2023/24 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)
Scenario 3: Reverse cycle air conditioner	$2375	$319.77	$1164.09	-$236.73	$607.59
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$4408	$1235.11	$1419.75	$678.61	$863.25
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$4508	$1252.47	$1424.49	$695.97	$867.99
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$4780	$1344.44	$1478.18	$705.44	$871.14

Assuming 2023/24 tariffs, the years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:


Years to pay back upfront cost: replacing gas heater, 2BR duplex (2023/24 tariffs)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
7.4
2.0
3.7
1.0
3.6
3.1
1.8
1.6
3.6
3.2
1.8
1.6
3.8
3.3
1.9
1.7
S3: RCAC
S4: RCAC, Insulation
S5: RCAC, Insulation, Draught Sealing
S6: RCAC, Insulation, Draught sealing, Window Covering
Payback years
Payback years (ex cooling)
Payback years (50% rebate)
Payback years (50% rebate, ex cooling)

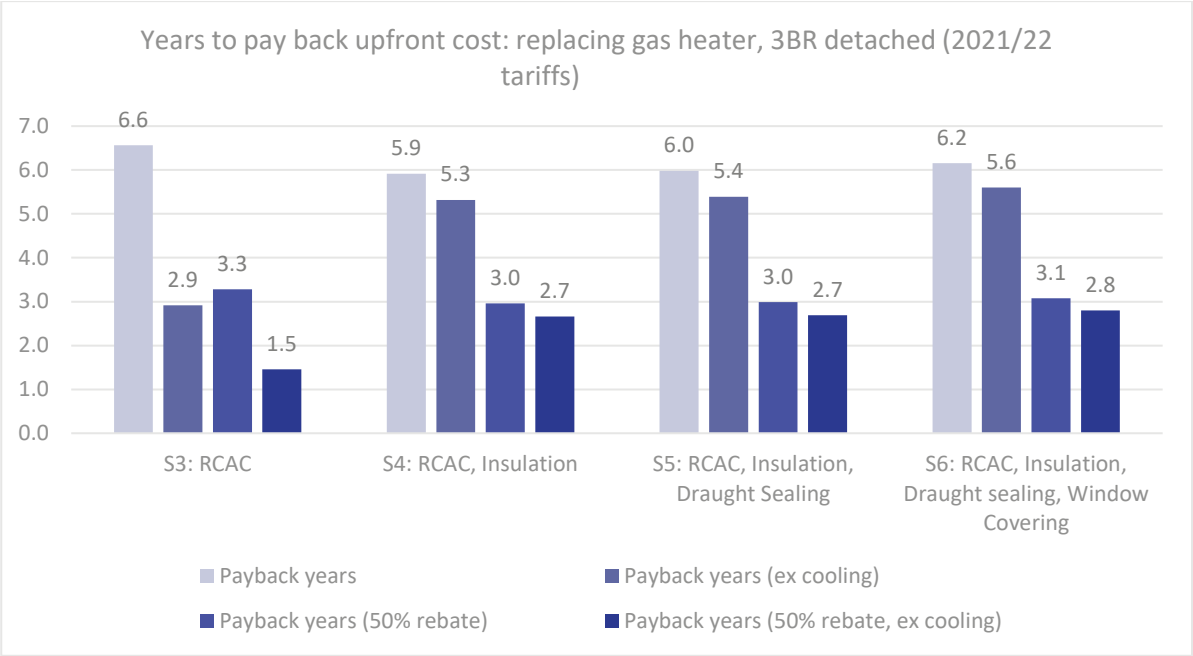

Years to pay back upfront cost: replacing inefficient electric heater, 2BR duplex (2023/24 tariffs)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
N/A
3.9
N/A
2.0
6.5
5.1
3.2
2.6
6.5
5.2
3.2
2.6
6.8
5.5
3.4
2.7
S3: RCAC
S4: RCAC, Insulation
S5: RCAC, Insulation, Draught Sealing
S6: RCAC, Insulation, Draught sealing, Window Covering
Payback years
Payback years (ex cooling)
Payback years (50% rebate)
Payback years (50% rebate, ex cooling)

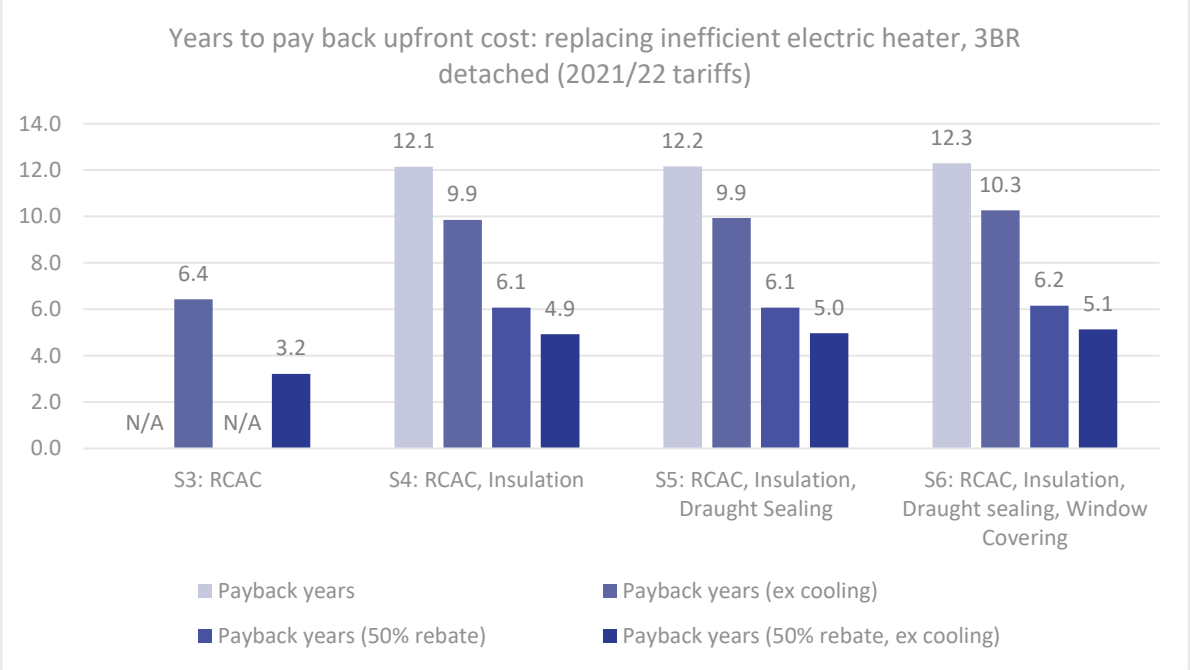
4.2.4. Results: 3BR detached house

The total costs of retrofits and yearly savings for the **3BR detached** house were as follows:

3BR DETACHED HOUSE, 2021/22 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)
Scenario 3: Reverse cycle air conditioner	$2375	$361.66	$814.49	- $83.38	$369.45
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$5136	$867.76	$966.21	$422.72	$521.17
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$5236	$875.87	$972.00	$430.83	$526.96
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$5485	$890.93	$978.95	$445.89	$533.91

The years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:

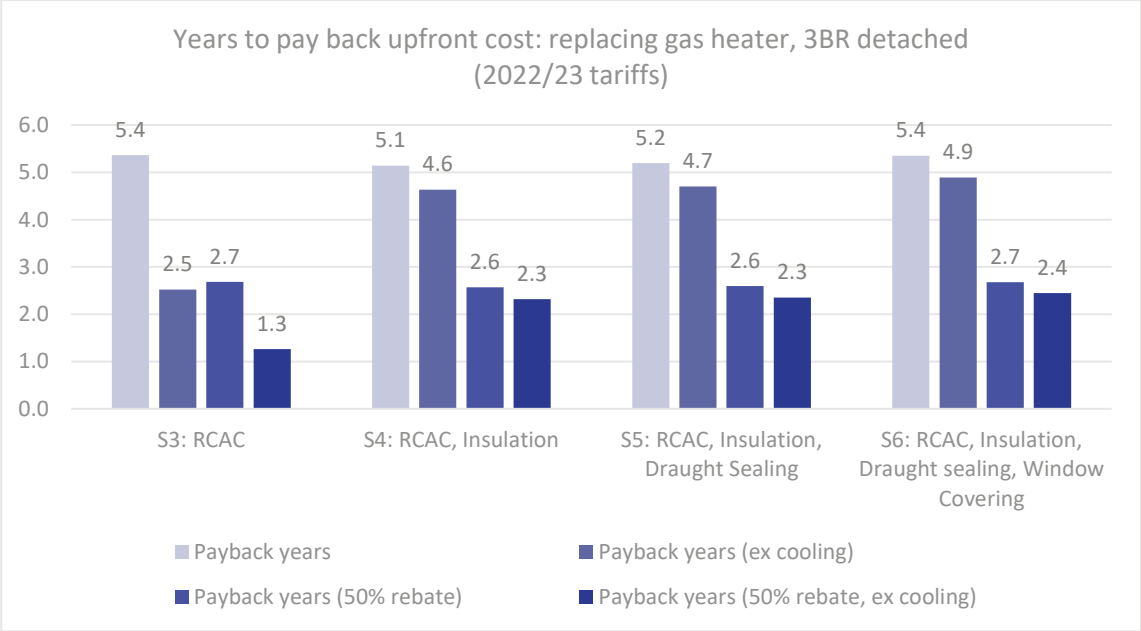


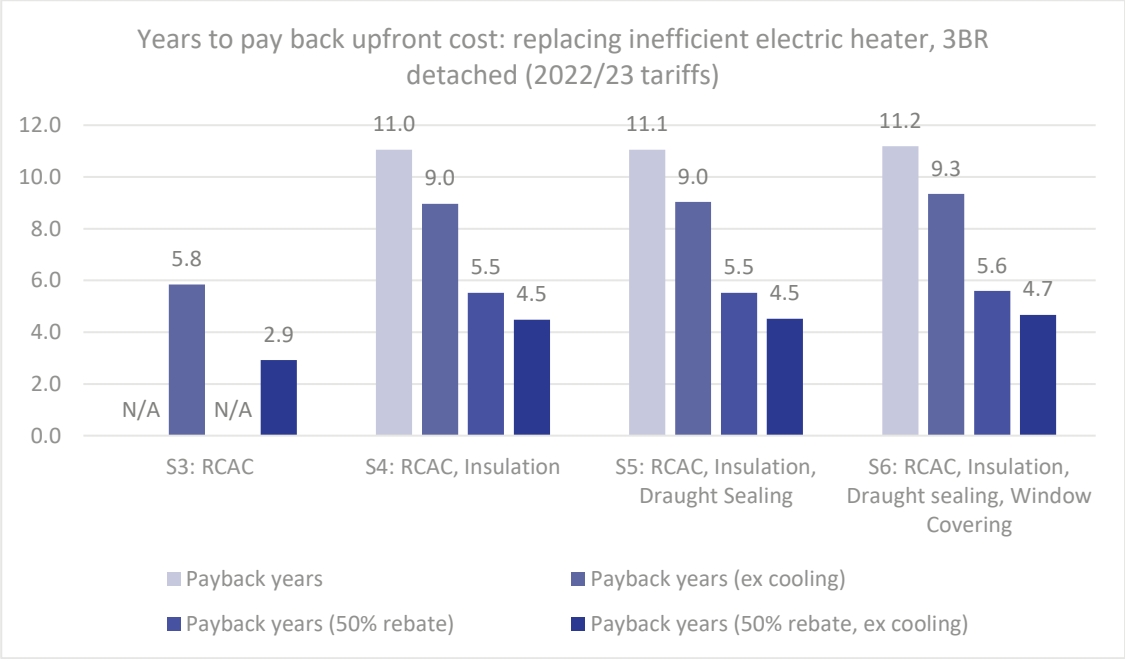


3BR DETACHED HOUSE, 2022/23 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)
Scenario 3: Reverse cycle air conditioner	$2375	$442.85	$940.88	-$91.71	$406.32
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$5136	$999.48	$1107.74	$464.91	$573.18

Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$5236	$1008.39	$1114.11	$473.83	$579.55
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$5485	$1024.95	$1121.76	$490.39	$587.19

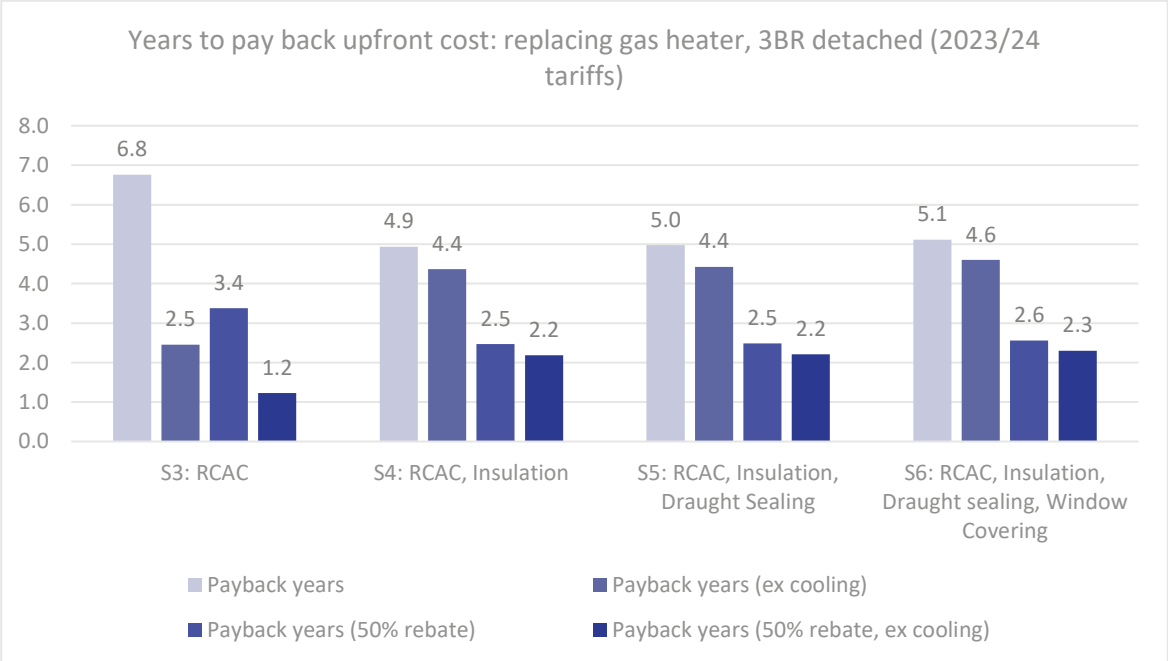
The years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:

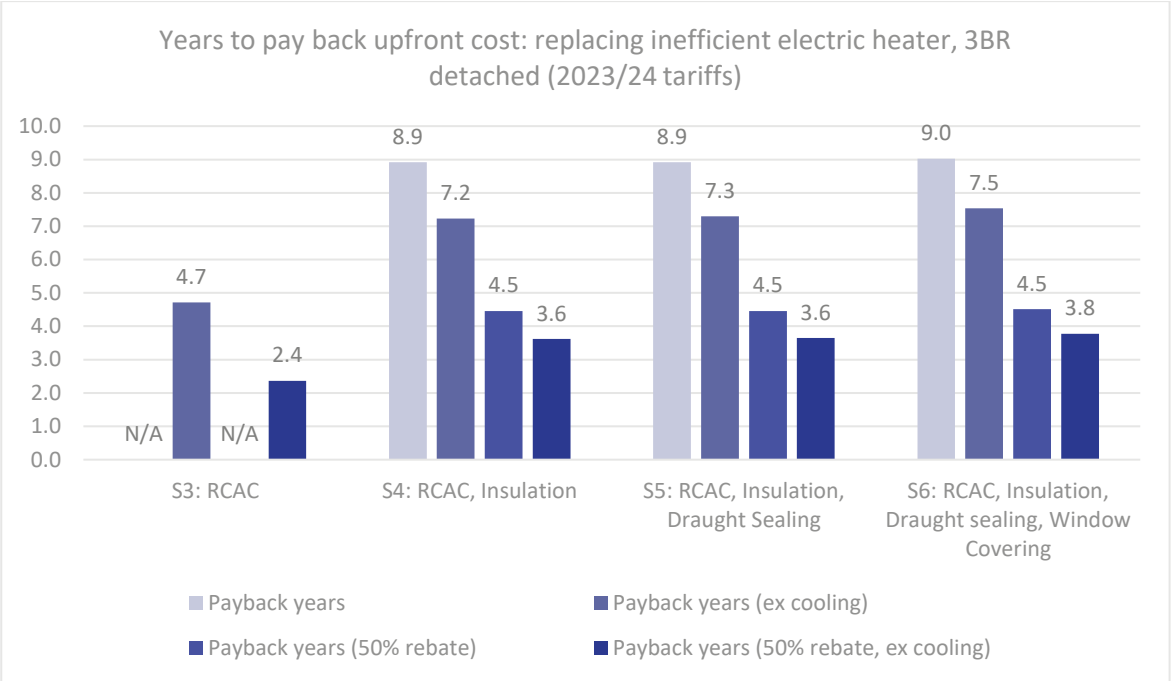




3BR DETACHED HOUSE, 2023/24 TARIFFS	COST OF RETROFIT	ANNUAL BILL SAVINGS VS GAS	ANNUAL BILL SAVINGS VS GAS (EXCL COOLING)	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC	ANNUAL BILL SAVINGS VS INEFFICIENT ELECTRIC (EXCL COOLING)
Scenario 3: Reverse cycle air conditioner	$2375	$351.18	$968.24	-$113.63	$503.43
Scenario 4: Reverse cycle air conditioner and ceiling insulation	$5136	$1040.84	$1174.98	$576.03	$710.17
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	$5236	$1051.89	$1182.87	$587.08	$718.06
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing, and blinds	$5485	$1072.40	$1192.34	$607.59	$727.53

The years to pay back the upfront cost of retrofits through reduced annual energy bills were as follows:




Years to pay back upfront cost: replacing inefficient electric heater, 3BR detached (2023/24 tariffs)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
N/A
4.7
N/A
2.4
8.9
7.2
4.5
3.6
8.9
7.3
4.5
3.6
9.0
7.5
4.5
3.8
S3: RCAC
S4: RCAC, Insulation
S5: RCAC, Insulation, Draught Sealing
S6: RCAC, Insulation, Draught sealing, Window Covering
Payback years
Payback years (ex cooling)
Payback years (50% rebate)
Payback years (50% rebate, ex cooling)

5. Analysis

Our findings demonstrate that:

- More efficient appliances reduce the cost of heating
- The high cost of gas makes gas heating more expensive than electric heating
- Increasing the thermal efficiency of homes with simple measures such as ceiling insulation can significantly reduce bills
- Rising energy prices increase annual bill savings from energy efficiency improvements
- Reverse cycle air conditioners are cheaper to run for Adelaide homes than gas or inefficient electric heaters, though alone may increase bills if no cooling was previously available
- When thermal efficiency improvements are combined with reverse cycle air conditioners, energy bills could be reduced even with the addition of summer cooling
- The replacement of gas appliances already reduces emissions and can be expected to reduce emissions further as renewables continue to grow

The replacement of gas appliances is consistent with other goals of decarbonisation, reducing household costs, and improving health and amenity. Our findings suggest that replacing gas heaters with reverse cycle air conditioners can provide Adelaide households with summer cooling options while not increasing energy bills. Furthermore, as South Australia continues to rapidly transition to renewable energy, the replacement of gas appliances further reduces greenhouse gas emissions. In our view, these findings suggest that there is simply no reason to install new gas connections or heaters.

The analysis in this report has not included rooftop solar, however we note that homes with rooftop solar would see further benefits with reverse cycle air conditioners due to the option to consume energy produced onsite.

Our analysis found that energy efficiency measures were highly complementary with the installation of efficient reverse cycle air conditioners. In our analysis, scenario 2 (with an inefficient plug-in electric heater) had overall lower annual bills than scenario 3 (a reverse cycle air conditioner) when the homes had the same (low) level of thermal efficiency. However, the major reason for the overall lower bills was that scenario 2 did not provide mechanical cooling at all. Scenarios 4, 5 and 6 (reverse cycle air conditioner with higher thermal efficiency) resulted in lower ongoing costs *and* the option of heating. Cooling a home with low thermal efficiency was found to be relatively costly. The energy required to cool a home falls significantly with increases in NatHERS thermal efficiency ratings, indeed relatively more than for heating.

The upfront cost of replacing appliances is a barrier for many households. Low-income homeowners or other households experiencing financial stress may be unable to afford the one-off expense of replacing appliances. Renters and social housing residents are dependent on their landlord to undertake the replacement; the ‘split incentive’ in which landlords pay upfront costs while renters pay ongoing costs through energy bills is believed to result in rental homes overall having worse energy performance than owner-occupied homes.

Our findings suggest that policies to ensure that retrofits and appliance replacement are accessible to rental homes and would benefit renters through ongoing energy bill reduction and the availability of cooling. Policy options available to governments include support for retrofits through rebates and government programs and minimum energy standards for rental homes. Minimum energy standards that should be considered include minimum appliance efficiency and requirements for insulation and draught sealing. Our findings further suggest that cooling as a minimum standard is viable without increasing energy bills or emissions, particularly when combined with energy efficiency requirements.

6. Appendix: modelled heating and cooling loads

The following tables provide the annual energy use predicted by our Sunulator analysis by scenario.

2-bedroom duplex:

SCENARIO	GAS MJ	ELECTRICITY KWH (HEATING)	ELECTRICITY KWH (COOLING)
Scenario 1: gas heater	29,857	0	0
Scenario 2: inefficient portable heater	0	2,620.7	0
Scenario 3: Reverse cycle air conditioner	0	1,215.45	1,952.75
Scenario 4: Reverse cycle air conditioner and ceiling insulation	0	624.15	427.05
Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	0	613.2	397.85
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing and blinds	0	605.9	383.25

3-bedroom detached house:

SCENARIO	GAS MJ	ELECTRICITY KWH (HEATING)	ELECTRICITY KWH (COOLING)
Scenario 1: gas heater	25,531.75	0	0
Scenario 2: inefficient portable heater	0	2,266.65	0
Scenario 3: Reverse cycle air conditioner	0	1,102.3	1,427.15
Scenario 4: Reverse cycle air conditioner and ceiling insulation	0	624.15	310.25

Scenario 5: Reverse cycle air conditioner, ceiling insulation and draught sealing	0	605.9	302.95
Scenario 6: Reverse cycle air conditioner, ceiling insulation, draught sealing and blinds	0	584.0	277.4