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Regulatory Impact Statement for a South Australian variation to the National Construction Code to increase the energy efficiency requirements for Class 2 residential buildings

Report prepared for Department of Premier and Cabinet, South Australia

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Executive summary

This report is a Regulatory Impact Statement (RIS) that assesses proposed amendments to energy efficiency requirements in the Building Code of Australia (the Building Code) for residential apartment buildings (Class 2 buildings in the Building Code) in South Australia.

Background

Regulation setting out minimum energy efficiency standards for residential dwellings has been a feature of the Building Code of Australia[1] for well over a decade. The standards set out the performance requirements that must be achieved for new building. Minimum energy efficiency ratings are a way to meet the requirements.

The inclusion of the standards recognises a persistent market failure in the housing market. Without the standards, stakeholders involved in design, material selection and construction of buildings may not fully consider the impact of their decisions on the thermal performance of the buildings, including the impacts associated with the use of energy to compensate for poor thermal performance. This can have long term impacts on the comfort and energy costs incurred by inhabitants of the buildings, and on greenhouse gas emissions over the life of the building.

Since the initial introduction of minimum energy efficiency standards, the measures have been progressively reviewed and increased by the Australian Building Codes Board (ABCB) and State Governments. Updates have been made where it was considered prudent to do so in terms of the relative costs and benefits.

Scope

There are a range of regulatory and other policy levers[2] available to Government in addressing the market failure problems in relation to energy efficiency, however the most practical starting point in considering Government stipulated remedies is to look to the effectiveness of existing regulations and how these, if enhanced, might deliver additional desired benefits.

The scope of this RIS is confined to consideration of options within the Building Code to address energy efficiency performance and the specific variations being considered are limited to amendments to Section J0.2(a) – which sets out energy efficiency requirements for Class 2 buildings.

Additional restrictions to the scope of the RIS and the analysis undertaken for this report are as follows:

- Analysis is limited to Class 2 buildings (i.e. analysis on parts of Class 4 building that may be impacted by the reform are not quantified in the analysis);

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1 Volume's One and Two of National Construction Code (NCC) comprise the Building Code of Australia, with Volume One primarily applying to Class 2 to 9 (multi-residential, commercial, industrial and public) buildings and structures and Volume Two primary applying to Class 1 (residential) and Class 10 (non-habitable) buildings and structures. The Building Code of Australia together with Plumbing Code of Australia (Volume Three of the NCC) together form the NCC.

2 Regulatory levers include traditional market interventions such as laws and regulation, enforcement, taxation and subsidies, as well as alternative and complementary interventions including education, incentive schemes, structured choice and facilitating feedback loops.

- No changes to common areas of Class 2 buildings considered; and
- Only the energy rating 'Deemed-to-Satisfy' Solution has been considered in this RIS. Approaches to compliance that are Performance Solutions (previously referred to as Alternative Solutions) are beyond the current scope.

Each of these scope limitations is explained in greater detail in Section 1.2.

Objectives of government action

The policy objective of the SA Government is to improve the efficiency of Class 2 dwellings when considering the construction costs and the operational costs for heating and cooling. This outcome would ensure apartments are more comfortable for inhabitants and help residents living in apartments save on energy bills.

The reforms also align with the State's energy efficiency targets aimed at addressing climate change by reducing greenhouse gas emissions. Target 60 in South Australia's Strategic Plan is:

> *To improve the energy efficiency of dwellings by 15% by 2020 (baseline: 2003-04) Milestone of 10% by 2014.* [3]

Base case and reform options

The base case or business as usual retains the current requirements of an average rating of 6 stars and a minimum heating and cooling requirement for individual apartments of 5 stars. It is against this option that the impacts (costs and benefits) for each for the reform options have been considered.

Three reform options are considered with each reform being able to be implemented via a State-based variation to section J0.2(a) of the Building Code. Each of the base case and reforms options are summarised diagrammatically in Figure 1 and are briefly outlined below.

[3] SA Government, *South Australia's Strategic Plan*, 2011, p. 47. For more information refer to: http://www.statedevelopment.sa.gov.au/resources/energy-efficiency/south-australias-energy-efficiency-targets

Figure 1: Base case and reform options for analysis

	Minimum average rating across all dwellings	Minimum rating for individual dwellings	Heating cap for individual dwellings	Cooling cap for individual dwellings
Base case	6.0	5.0	-	-
Option 1	7.0	6.0	-	-
Option 2	-	6.0	-	-
Option 3	-	-	Heating cap equivalent to six stars on average	Cooling cap equivalent to six stars on average

Picture credit: yourhome.gov.au

Base case: 6 star average rating, minimum 5 star individual rating

In addition to the base case retaining the current energy efficiency requirements, inherent in the base case are a number of forecast factors that remain consistent across the options including:

- growth in the residential Class 2 building stock;
- any baseline improvement in energy efficiency;
- baseline changes in energy prices and emissions; and
- major policy initiatives and other factors.

While forecasts of these factors are included in the modelling, it is important to remember that these are consistent across scenarios and thus cancel out when net benefits are calculated comparing the reform options (options 1, 2 and 3) to the base case.

Option 1: 7 star average, 6 star minimum individual rating

Option 1 represents a marginal increase in the star ratings that must be achieved relative to the base case. Under option 1, the average rating across apartments that must be achieved increases from 6 stars to 7 stars; and the minimum rating to be achieved by each apartment individually increases from 5 stars to 6 stars.

Option 2: No average rating, 6 star minimum individual rating

Option 2 removes the average rating requirement, thus removing the ability to trade off less than 6 star performance in some apartments for above 6 star performance in others. Instead every apartment would be required to achieve minimum 6 star rating.

The removal of the average rating acts to increase the onus on each individual apartment to be designed and constructed to meet the 6 star rating requirements, which may involve higher costs (but also lower energy costs) for those apartments that currently perform at less than 6 stars.

Option 3: Separate cooling and heating caps

Option 3 removes the requirement for dwellings to meet a specified star rating and instead requires dwellings to comply with heating and cooling caps that are an on average equivalent to a 6 star rating. It means that not all apartments continue to meet the 6 star minimum rating (since it is not specifically required).

These caps are set at levels that do not change the overall 6 star (annual) requirement. However, additional cost may be incurred to ensure that all apartments meet the separate summer and winter caps. Where such costs do arise, occupants will also experience the benefits of lower energy costs over time relative to the base case.

The separation of heating and cooling loads is, in principle, more stringent than an annual 'heating and cooling' requirement, because it limits the ability of the designer to trade-off improved winter performance for worse summer performance, or vice versa.

Effectively, the requirement would ensure Class 2 building apartments are designed to remain both warm in the winter (thus reducing the heating needed by occupants) and cool in the summer (reducing the cooling needs of occupants). This approach, of separate heating and cooling caps, is being considered for roll-out Australia-wide in the National Construction Code for 2019.[4]

Key assumptions

The thermal modelling and cost benefit analysis are necessarily underpinned by a number of assumptions. These are outlined in the main body of the report in Chapter 4 (thermal modelling assumptions) and Chapter 5 (cost benefit analysis assumptions).

The thermal modelling has been developed based on apartments in four stories of a building that contained six apartments per story, with the layout of apartments consistent across the stories.

Thermal modelling results are presented for four of the six unit (units 204, 205, 207, and 208) for each of four floors (the top, upper middle, lower middle and ground floors).

[4] As per the Australian Building Codes Board work program. Refer to: http://www.abcb.gov.au/Connect/Articles/2017/03/09/Section-J-Overhaul-big-changes-are-coming-your-way

Figure 2: Floorplan of modelled apartment building

Source: Strategy.Policy.Research, 2017

The building is a concrete framed building with masonry external walls and the building fabric modelled under the base case (which are subsequently varied under the reform scenarios is summarised in Table 1.

Table 1: Building fabric details

Element	Base case	Option 1	Option 2	Option 3
External walls	Brick veneer, internal plasterboard lining	Add R1.5 wall insulation	Add R1.5 wall insulation	Add R1.5 wall insulation) to: ▪ Unit 208, Mt Gambier & Ceduna (top floor) ▪ Unit 204, Mt Gambier (upper mid floor)
External balcony wall	Fibre-cement sheet, internal plasterboard lining	Add R1.5 wall insulation	Add R1.5 wall insulation	-
Internal walls	Plasterboard and solid blockwork	-	-	-
Floors between units	200 mm concrete slab	-	-	-
Top floor ceiling	200 mm concrete slab, R3.0 insulation, plasterboard lining	-	-	-
Windows	Aluminium single-glazed High Solar Gain Low-E: U = 5.40: SHGC = 0.58	-	-	Change to double-gazing: ▪ Unit 208, Ceduna (top floor)
External shading	Balconies shaded by balcony above. Top floor balconies shaded by roof overhang. No other external shading.	▪ Unit 204, Mt Gambier (top floor) - remove a west window in the living room ▪ Unit 207, Adelaide (top floor) - reduced glazing area of north window in living room ▪ Unit 208, Ceduna and Mt Gambier (top floor) - reduce glazing in east wall of living room	-	-
Average incremental cost of compliance				
Adelaide		$8.09 per sqm	$7.68 per sqm	-
Ceduna		$4.22 per sqm	$3.81 per sqm	$0.61 per sqm
Mt Gambier		$7.42 per sqm	$7.01 per sqm	$1.93 per sqm

Source: Strategy.Policy.Research, Donald Cant Watts Corke, 2017

We assume that any new requirement would apply from 1 May 2019, aligned with the commencement date for changes to the National Construction Code, and would apply for two regulatory cycles of three years each; that is, for six years in total.

Additionally, it is assumed that:

- compliance costs are fully passed onto the user of the asset (the owner-occupier)
- all new building work requiring approval from the relevant regulatory authority is assumed to comply with the amended BCA.

Expected net impacts for the economy

The net public benefit delivered by each of the reform options as assessed incrementally to the base case are summarised in Table 2 with further detail in Chapter 5.

The key findings from the cost benefit analysis are:

- Option 1 would deliver the highest net present value benefits, with option 2 delivering a similar, but slightly lower, level of benefits.
- The benefit cost ratio is most favourable under option 3 (3.9), indicating the benefits are highest as a ratio of costs for this option. However both options 1 and 2 have favourable benefit cost ratios of 2.8 and 2.5 respectively.
- The social return on investment is also highest under option 3 (at 29%), however the return is also above 20% for both option 1 (24%) and option 2 (22%).
- Cumulative energy savings and greenhouse gas emissions are highest under option 1, with option 2 also delivering significantly more savings compared to option 3.

Table 2: Summary of benefit cost analysis indicators ($2017, real)

Indicator	Option 1 (7 star average, 6 star minimum individual rating)	Option 2 (No average rating, 6 star minimum individual rating)	Option 3 (Separate cooling and heating caps)
Net Present Value	$3,063,376	$2,447,784	$97,829
Benefit Cost Ratio	2.8	2.5	3.9
Social Return on Investment	24%	22%	29%
Cumulative energy savings, 2020 to 2050 (TJ)	68	59	2
Cumulative GHG emissions, 2020 to 2050 (t CO2-e)	6,834	5,838	187

Source: Strategy.Policy.Research, 2017

Costs

Two key types of cost were identified:

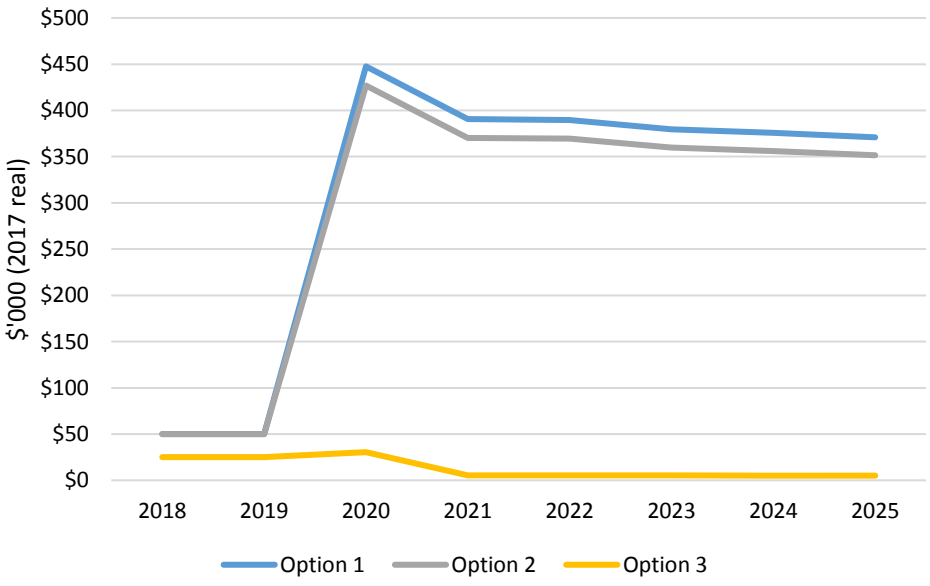
- **Costs of compliance with the National Construction Code** are estimated as an incremental costs based on changes in the building materials required to meet the higher energy efficiency standards. The costs of compliance with the Code is assumed to be higher in the

initial years following implementation of the higher standards and reduced in line with an assumed 'learning rate' of 2% per annum before levelling out.

- **Training and redesign costs** of up to $50,000 per year have also been included for the first three years following implementation of the reform. While ongoing training and updating of knowledge base is ongoing in the industry, this marginal amount allows for current efforts to be "ramped" up. Note that the training and redesign costs are assumed to be lower under option 3 as there is no changes required to meet revised standards in the Adelaide region.

Figure 3 (below) summarised the combined costs of compliance and training incurred under the reform options relative to the base case.

Figure 3: Total costs of compliance for reform options relative to the base case



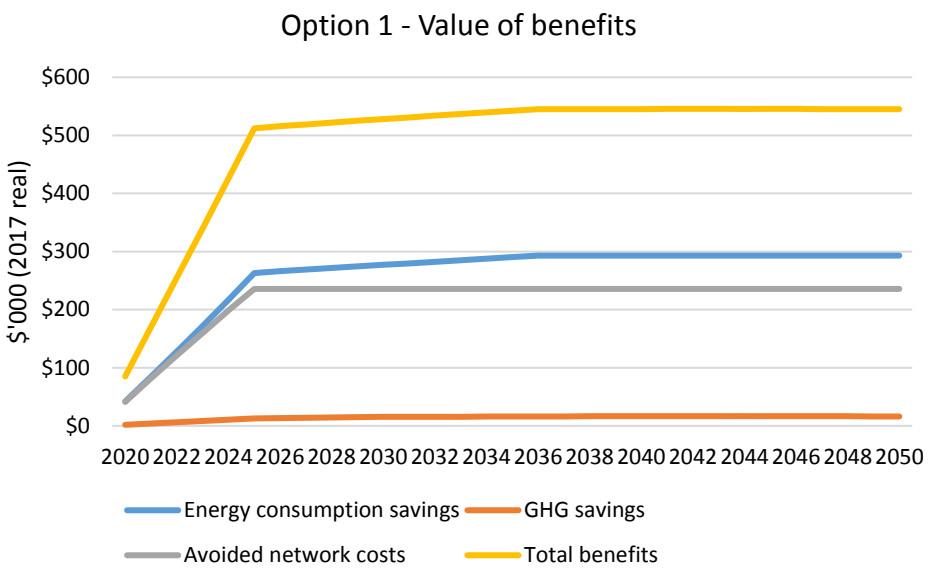
Source: Strategy.Policy.Research, 2017

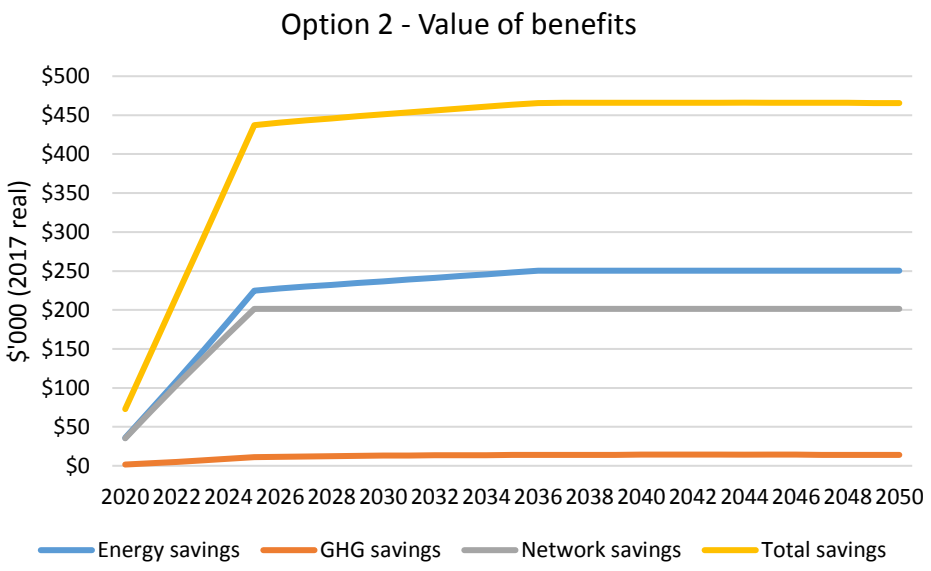
Benefits

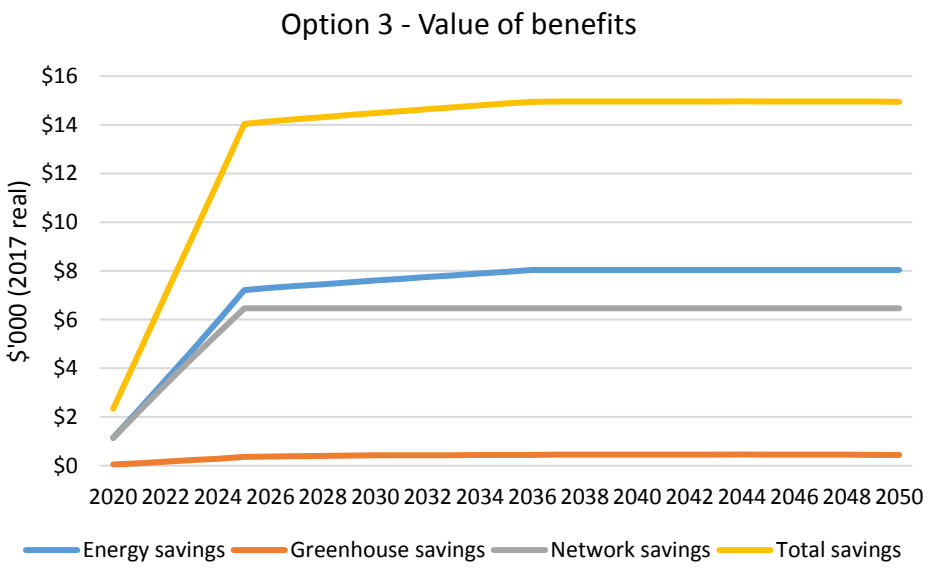
Three types of benefits were quantified as part of the cost benefit analysis:

- Energy cost savings are expected to accrue to the home occupier (either owner or tenant) over the life of the building;
- Avoided network costs resulting reduced peak electricity demand are expected to benefit all energy users over the life of the building; and
- Greenhouse gas emission savings have been quantified using conservative shadow carbon prices and are expected to benefit the whole community in the form of environmental benefits (if there is no formal price on carbon) or the home occupiers (if there is a price on carbon).

The relative magnitude of the benefits under each of the reform options relative to the base case are summarised graphically below.







Source: Strategy.Policy.Research, 2017

Distributional impacts

The stakeholders identified as likely to be impacted by changes to energy efficiency requirements for Class 2 building have been considered by stakeholder class as follows:

- Commonwealth, State and local Government – no significant impacts quantified.
- Industry
  - Building industry (builders and property developers) – increased training and awareness costs as well as increased cost of compliance with Code (which may be passed directly onto property owners).
  - Energy industry – no significant impacts quantified.
  - Heating and cooling appliance industry – no significant impacts quantified.
- Community
  - Property owners – increased construction costs to be passed on from building industry.
  - Residents and tenants living in Class 2 buildings – reduced electricity costs, potentially for increased construction costs to be passed on from building industry (via higher purchases prices for owner occupiers or increased rent for tenants).
  - All community – avoided network expenditure costs from reduced electricity demand.
- Environment – reduced greenhouse gas emissions from lower electricity consumption.

The full range of impacts identified (including those which have not been quantified on the basis that they are unlikely to be significant) are outlined in section 5.9.

Table 3 summarised the net present value of costs and benefits and the stakeholders to whom they are expected to accrue.

Home occupiers (owner-occupiers and tenants) and the environment are the main beneficiaries of changes under all reform options. Home occupiers will receive the greatest benefit in the form of reduced electricity costs as heating and cooling requirements are reduced.

Costs are expected to fall to industry in the form of increased training and reside costs as well as increased building construction costs (or compliance with Code costs). It is noted that the later cost – increased compliance with Code costs) – are likely to be passed directly onto property owners in the form of higher purchase prices for apartments. As highlighted in the subsequent section, this is expected to be a maximum of around $1,000 per apartment.

Table 3: Distribution of costs and benefits (net present value, $2017)

	Benefit/Cost will be distributed to	Option 1	Option 2	Option 3
Incremental benefits				
Value of Energy Consumption Savings	Home occupier (either owner or tenant)	$2,514,913	$2,148,432	$68,980
Value of greenhouse gas savings	Depends: - Whole community (if no price on carbon) - Home occupier (if there is a price on carbon)	$134,130	$114,585	$3,679

Value of Avoided Network Expenditure	All energy users (whole community is a reasonable proxy)	$2,148,818	$1,835,686	$58,938
TOTAL		**$4,797,862**	**$4,098,702**	**$131,597**
Incremental Costs				
Increased Construction Costs	Property developers (probably passed onto home owners)	$1,603,270	$1,519,703	$22,043
Training/redesign costs	Property developers (probably passed onto home owners)	$131,216	$131,216	$65,608
TOTAL		**$1,734,486**	**$1,650,919**	**$87,651**

Source: Marsden Jacob Associates, Strategy.Policy.Research, 2017

Recommended reform option

On balance, option 1 is the preferred reform option. Option 1 delivers the best public value as it has the highest net present value benefits, at nearly three-quarters of a million dollars higher than option 2. It also affords the most energy and greenhouse gas emissions savings (an outcome which aligns to the South Australian government's focus on reducing emissions).

This option also provides a strong social return on investment and the mid-range benefit cost ratio of 2.8 (compared to 3.9 for option 3 and 2.5 for option 2). While option 3 has a higher benefit cost ratio, the absolute value of benefits delivered by this option is small.

Further we note that the results from the sensitivity analysis, including the 'worst case' scenario test, do not yield a difference in results or ranking based on the cost benefit analysis alone.

The legitimacy and support for this option is also potentially marginally higher for this option, while operational capabilities are consistent across the three reform options.

1. Introduction

This Regulatory Impact Statement (RIS) assesses the costs and benefits of proposed amendments to energy efficiency requirements in the Building Code of Australia (the Building Code) for residential apartment buildings (Class 2 building in the Building Code).

The RIS and underlying analysis has been prepared by Marsden Jacob Associates (Marsden Jacob) and *Strategy.Policy.Research* (S.P.R) on behalf of the Department of Premier and Cabinet in South Australia.

1.1 Background

Regulation setting out minimum energy efficiency standards for residential dwellings has been a feature of the Building Code of Australia[5] for well over a decade. Standards were first introduced for Class 1 buildings on 1 January 2003.[6] In early 2005, the standards were expanded to apply to Classes 2, 3 and since 2006, non-residential buildings have also been required to meet energy efficiency standards.

The inclusion of the standards recognises a persistent market failure. Without the standards, stakeholders involved design, material selection and construction of buildings may not fully consider the impact of their decisions on the thermal performance of the buildings, including the impacts associated with the use of energy to compensate for poor thermal performance. This can have long term impacts on the comfort and energy costs incurred by inhabitants of the buildings, and on greenhouse gas emissions over the life of the building.

The standards set out the performance requirements that must be achieved for new building. Minimum energy efficiency ratings are a way to meet the requirements.

Since the initial introduction of the standards and the minimum energy efficiency rating system, the measures have been progressively reviewed and increased by the Australian Building Codes Board (ABCB) and State Governments. Updates have been made where it was considered prudent to do so in terms of the relative costs and benefits.

The most recent update of the energy efficiency requirements in Section J that apply to Class 2 buildings in South Australia was undertaken in 2010. Since then, energy prices have risen and there has been increased pressure to undertake energy efficiency measures to increase energy productivity and reduce greenhouse gas emissions. Additionally, the number of Class 2 buildings (described in Box 1) has increased and the proportion of new residential dwellings being approved that are classified as Class 2 compared to alternative Class 1 dwelling structures is increasing.

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5 Volume's One and Two of National Construction Code (NCC) comprise the Building Code of Australia, with Volume One primarily applying to Class 2 to 9 (multi-residential, commercial, industrial and public) buildings and structures and Volume Two primary applying to Class 1 (residential) and Class 10 (non-habitable) buildings and structures. The Building Code of Australia together with Plumbing Code of Australia (Volume Three of the NCC) together form the NCC.

6 Australian Uniform Building Regulations Co-ordinating Council (1990) *Building Code of Australia 1990 Housing Extract*, refer to ACT F6.2 and VIC F6.2.

Box 1: What are Class 2 buildings?

Class 2 buildings are buildings which containing two or more sole-occupancy units each being a separate dwelling. Class 2 buildings are predominately multi-story residential developments, often referred to as multi-unit dwellings or MUDs.

The classification of multi-residential developments does not depend on the number of units proposed but the design. The simple way of determining the classification of residential buildings is by checking whether a wall or a floor separates each dwelling.[7]

1.2 Scope

There are a range of regulatory and other policy levers[8] available to Government in addressing the market failure problems defined in Section 2 of this report. However, the most practical starting point in considering Government stipulated remedies is to look to the effectiveness of existing regulations and how these, if enhanced, might deliver additional desired benefits.

The scope of this RIS is confined to consideration of options within the Building Code to address energy efficiency performance and the specific variations being considered are limited to amendments to Section J0.2(a) – which sets out energy efficiency requirements for Class 2 buildings.

Additional restrictions to the scope of the RIS and the analysis undertaken for this report are as follows:

- Analysis is limited to Class 2 dwellings;
- No changes to common areas of Class 2 buildings considered; and
- Only the Deemed-to-Satisfied Solutions have been considered in this RIS. Approaches to compliance that are Performance Solutions (previously referred to as Alternative Solutions) are beyond the current scope.

Each of these scope limitations is explained in turn.

1.2.1 Exclusion of Class 4 buildings parts

Although the reform options being considered in this RIS contemplates changes to drafting that currently also covers Class 4 parts of buildings, these impacts on these parts of buildings have not been quantified.

A Class 4 part of a building is a dwelling or residence within a building of a non-residential nature. The dwelling must be the only dwelling in the building and can only be located in a Class 5 to 9 building. Class 4 parts of buildings are typically on-site caretaker's residences.

The reason for excluding these parts of Class 4 building are as follows:

- The number of parts of Class 4 buildings is likely to be very low such that the impact compared to Class 2 stock will be minimal.

7 Master Builders, 'BCA: Class 1A vs Class 2', accessed April 2017, Refer to: http://www.mbawa.com/blog/bca-class-1a-vs-class-2/

8 Regulatory levers include traditional market interventions such as laws and regulation, enforcement, taxation and subsidies, as well as alternative and complementary interventions including education, incentive schemes, structured choice and facilitating feedback loops.

- The range of designs and forms of parts of Class 4 building is considerable. Inclusion of a suitable range of designs would have increased the cost of analysis being undertaken where the benefit of quantifying the impacts from changes to this type of building on various stakeholders would be marginal.

1.2.2 Exclusion of common areas in Class 2 buildings

Changes to regulations impacting the thermal efficiency of common areas within Class 2 buildings are not considered for the following reasons:

- The SA Government energy efficiency goals set out in Chapter 3 specifically target dwellings.
- Common area requirements in the Building Code only indirectly impact the energy costs faced by residents living within the buildings where energy costs are paid by building owners (e.g. via strata) fees and may not be passed on in their entirety. Hence, the market failures (discussed in section 2) may be less prevalent (but not non-existing) where common areas are concerned compared to for individual dwellings within Class 2 buildings.

It is noted that the Australian Building Codes Board is has recently announced that it is considering changes targeting the common areas of Class 2 buildings – as well as buildings in Class 3 and Classes 5 to 9.[9]

1.2.3 Alternative 'Performance Solutions' not considered

The Performance Requirements of the NCC can be met by either using a Performance Solution (previously referred to as an Alternative Solution), a Deemed-to-Satisfy Solution (i.e. complying with detailed provisions in the NCC), or a combination of both.

For the purposes of this study, alternative solutions that achieve the relevant Performance Requirements have not been considered and all modelled quantitative analysis assumes compliance is met via only Deemed-to-Satisfy Solutions (DTS). We note that, in principle, alternative solutions should generate results that are equivalent to the DTS in terms of energy performance.

1.2.4 Economic costs and benefits accrued in South Australia

The RIS considers economic costs and benefits from a South Australian perspective. This has two simplifying but important consequences for the analysis:

- South Australia is a net importer of electricity. Reductions in electricity consumption resulting from higher energy efficiency in building design are assumed to result in a reduction in the quantity of electricity imported. This assumption allows for any reduction in electricity use to be considered a direct benefit to South Australia, rather than being a transfer between generators and retailers / customers as may be the case elsewhere in the National Electricity Market. This assumption is stress tested in a sensitivity analysis.
- The majority of building materials which need to be varied to achieve increased efficiency ratings are assumed to be imported to South Australia. Hence, costs associated with these products represent an economic cost rather than a transfer (as would be the case if South Australia was a primary manufacturer of these products).

[9] Refer to: http://www.abcb.gov.au/Connect/Articles/2017/03/09/Section-J-Overhaul-big-changes-are-coming-your-way

1.3 Structure of this report

The remainder of this report is structured to align with the seven RIS elements outlined in the SA Government's *Better Regulation Handbook*[10] as follows:

- Chapter 2: Description of the problem (Element 1)
- Chapter 3: Objectives of Government action (Element 2)
- Chapter 4: Statement of options (Element 3)
- Chapter 5: Analysis of costs and benefits (Element 4)
- Chapter 6: Consultation (Element 5)
- Chapter 7: Conclusion and recommended option (Element 6)
- Chapter 9: Implementation, monitory and review (Element 7)

The report is supported by one Appendix that provides details on the incremental costs of achieving the performance outcomes described in Chapter 4 independently quantified by quantity surveyors, Daniel Cant Watts Corke.

[10] SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January. Available at: http://www.treasury.sa.gov.au/__data/assets/pdf_file/0020/14951/SA_Better-Regulation-Handbook_2011.pdf

2. Description of the problem

Element 1: Describing the problem requires that the RIS clearly identify the problem, an assessment on the significance of the problem, and that a case for government action is established based.

The case for government intervention requires identification of the cause of the program or the type of program to be clearly identified.

Reasons may include that market forces are failing to generate an efficient outcome or maximise benefits (i.e. market failure exists), existing regulation is failing to achieve its objective or creating unwanted consequence (regulator failure), an unacceptable hazard or risk is posed, social goals or equity issues need to be addressed or issue of public order or protection need to be addressed. [11]

In this section, the market failures to be addressed are clearly set out. The range and types of stakeholders involved and impacts on each stakeholder type are detailed. Finally, recent developments which have altered the range and magnitude of impacts and the relative costs and benefits from regulation of energy efficiency measure for Class 2 building are summarised.

2.1 Description of market failure

The primary market failure that minimum energy efficiency requirements seek to remedy is referred to by economists as split incentives. Split incentives occur when those responsible for paying energy bills (i.e. tenants or future occupants) are not the same entity as those making the capital investment decision (the landlord or original building owner).

Split incentives are a barrier to the increased use of energy efficient measures in buildings as the building developer is not incentivised to upgrade building materials or alter design features. This is because the benefits associated with the resulting energy savings accrue to subsequent owners and tenants. Some benefits may also flow to the broader community – dependent on how carbon emissions and climate change considerations are priced included).[12]

2.2 Rationale for government intervention

As there are existing regulations stating minimum energy efficiency standards for Class 2 buildings the question to be considered is whether increasing the existing standards delivers a net public benefit.

Recent developments that impact the economic value delivered from energy efficiency standards for Class 2 buildings include:

- changes in energy prices;

[11] SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 13-14

[12] Department of the Environment and Energy, *HVAC HESS Factsheet: Overcoming Split Incentives*, September 2013. Available at: https://www.environment.gov.au/system/files/energy/files/hvac-factsheet-split-incentives.pdf

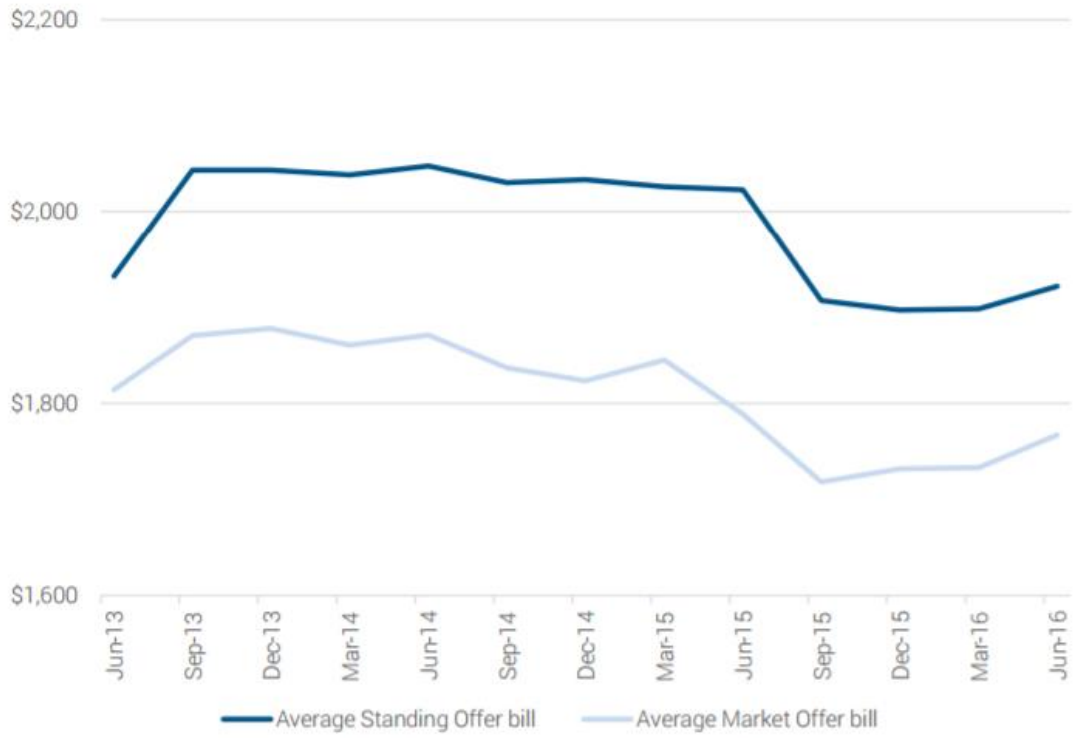
- changes in the composition of housing stock;
- changing public priorities– such as the increased importance of climate change impacts; and
- changes in the costs incurred to achieve benefits– where it may not have been prudent to adopt more stringent requirements earlier, evidence elsewhere suggests this is no longer the case.

Each change is considered in turn.

2.2.1 Changes in energy prices

Cost of energy to residential consumers remains a key concern for governments. In South Australia, both standard and market offers to residential customers in electricity have decreased in recent years (Figure 4).

Figure 4: Movements in the average annual electricity Standard and Market Offer bills for residential customers ($ nominal)



Note: (a) Annual consumption of electricity for residential customers is assumed to be 5,000 kWh

Source: Essential Services Commission of South Australia, Energy Retail Offers Comparison Report 2015-16, report to the Minister for Mineral Resources and Energy, August 2016.[13]

2.2.2 Changing composition of housing stock

Since the previous revision of the energy efficiency requirements for Class 2 buildings in 2010, the composition of housing stock for residential dwellings has altered.

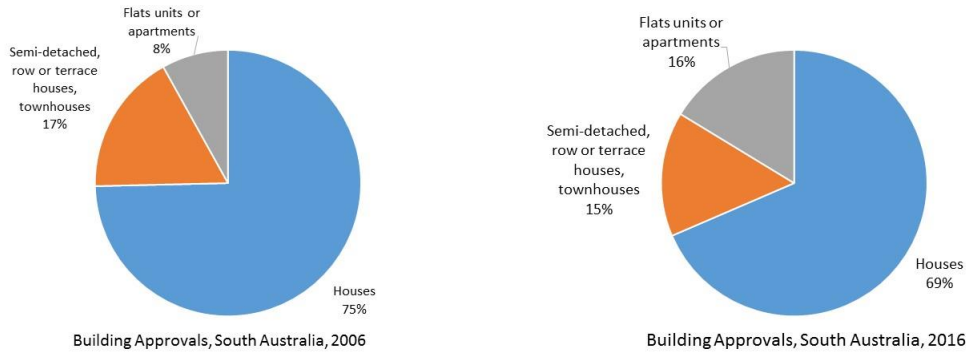
Based on the number of building approvals, the number of multi-residential developments is increasing faster than other types of residential dwelling developments. Figure 5 provides a snap

[13] Available at: http://www.escosa.sa.gov.au/industry/electricity/reporting-compliance/energy-retail-offer-prices

shot of the proportion building approvals for dwelling units that are houses; semi-detached row or terrace houses, townhouses; or flats, units or apartments in 2006 and 2016 in South Australia. The proportion of building approvals that represent flats, units or apartments has increased from 8 per cent in 2006 to 16 per cent in 2016.

As changes in housing demand result in higher number of apartments, the number of households impacted by higher energy costs due to design inefficiencies increases.

Figure 5: Proportion of new flats or apartments is rising



Source: ABS, 8731.0 Building Approvals, Australia, TABLE 25. Dwelling Units Approved in New Residential Buildings, Number and Value, Original - South Australia, May 2017

2.2.3 Changing public priorities

A number of local and state government initiatives reflect the public prioritisation of climate sensitive programs. South Australia was the first Australian state to legislate a specific target to reduce greenhouse gas emissions in the *Climate Change and Greenhouse Emissions Reduction Act 2007.* In November 2015, the Premier and Minister for Climate Change released a new climate change strategy for South Australia - *South Australia' Climate Change Strategy 2015-2050: Towards a low carbon economy*, at the centre of which is a 'bold and ambitious' target for the state to achieve net zero emissions by 2050.[14]

The development of the strategy was underpinned by an extensive consultation process during which more than 300 people attended workshops, 46 people contributed to the online discussion forum and more than 200 written submission were received. [15]

In Adelaide, where the significant majority of Class 2 dwellings are currently located and where the majority of new Class 2 dwellings are expected to be built in the future, initiatives include:

- ***Carbon Neutral Adelaide*** is the community's shared ambition to make the City of Adelaide the world's first carbon neutral city and one of the six pillars underpinning South Australia's target to achieve net zero emission by 2050.[16] The Carbon Neutral Strategy 2015-2025 for South Australia highlights the City's achievements to date of reducing carbon emission by

[14] Department of Environment, Water and Natural Resources, 'SA Climate Change Strategy', last updated 29 November 2015. Refer to: http://www.environment.sa.gov.au/Science/Science_research/climate-change/climate-change-initiatives-in-south-australia/sa-climate-change-strategy

[15] SA Government, *South Australia's Climate Change Strategy 2015- 2050: Towards a low carbon economy*, November 2015, p. 12

[16] Department of Environment, Water and Natural Resources, 'Carbon Neutral Adelaide', last updated 19 June 2017. Refer to: https://www.environment.sa.gov.au/Science/Science_research/climate-change/climate-change-initiatives-in-south-australia/sa-climate-change-strategy/carbon-neutral-adelaide

20% between 2007 and 2013. The Strategy also in the shared aspiration for Adelaide to achieve carbon neutrality by 2025. [17]

- The ***Building Upgrade Finance*** mechanism is design to help stimulate jobs in South Australia while also helping Adelaide to become the world's first carbon neutral city. The mechanism, which was launched on 20 August 2016, helps building owners to access loans to improve the energy, water and environmental efficiency of existing commercial buildings. [18]

In March 2017, the South Australian State government unveiled the *South Australian Power for South Australians* energy plan.[19] The plan looks to ensure more to the State's power is sourced, generated and controlled in South Australia with the aim of ensuring an energy future that delivers reliable, affordable and clean power for South Australia.[20]

Initiatives outlined in the plan relevant to cleaner and more efficient use of energy sources include:

- Building Australia's largest battery to store energy from the wind and sun, part of a new Renewable Technology Fund that supports clean, dispatchable and affordable power; and
-
- Building a government owned gas-fired electricity generator, capable of providing up to 250 megawatts of generation, which can be switched on in times of emergency.

2.2.4 Changing economics of energy efficiency

The economics of increasingly energy efficiency requirements is improving. The *Pathway to 2020 for Increased Stringency in New Building Energy Efficiency Standards: Benefit Cost Analysis: 2016 Update for Residential Building*, shows there is cost-effective potential to lift the efficiency performance requirements for Class 2 buildings *inter alia*.

The report, prepared by pitt&sherry, provided updated cost benefit analysis findings from the original Pathway to 2020 report published in 2012. While the methodology and design for houses assessed were the same as those from the 2012, updated energy price projects, learning rates and cost projections were incorporated.[21]

Also relevant is a recently study prepared by pitt&sherry's Carbon & Energy Team (now *SPR*) for the NSW Office of Environment and Heritage NABERS program, that provides a quantitative

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17 Adelaide City Council, *Carbon Neutral Strategy 2015-2025, Adelaide, South Australia*, [undated], p. 6 and 7

18 Department of Environment, Water and Natural Resources, 'Building Upgrade Finance', last updated 20 April 2017. Refer to: http://www.environment.sa.gov.au/Science/Science_research/climate-change/climate-change-initiatives-in-south-australia/reducing-greenhouse-emissions-to-mitigate-climate-change/building-upgrade-finance

19 Refer to ourenergyplan.sa.gov.au for more information on the plan

20 Weatherill, Jay MP (14 Marhc 2017) *South Australia is taking charge of its energy future*, media release, viewed 11 August 2017. Refer to: https://www.premier.sa.gov.au/index.php/jay-weatherill-news-releases/7198-south-australia-is-taking-charge-of-its-energy-future

21 Pitt & Sherry (2016) *Pathway to 2020 for Increased Stringency in new Building Energy Efficiency Standards: Benefit Cost Analysis: 2016 Update for Residential Buildings*, report prepared for the Department of Industry, Innovation and Science, 13 May 2016, p. 1

analysis of Class 2 common area energy and water consumption by State, based on extensive bottom-up data capture.[22]

Pitt&sherry's recent report *Accelerating Net-Zero High-Rise Residential Buildings in Australia*[23], prepared with *ark resources* for the international Carbon Neutral Cities Alliance, provides the most thorough analysis of abatement potentials in Class 2 buildings ever undertaken in Australia. This provides further evidence of the changing economics of energy efficient improvements in Class 2 buildings.

[22] Unpublished, but see: https://nabers.gov.au/public/webpages/ContentStandard.aspx?module=10&template=3&include=mediarelease.htm&side=latest-news-tertiary.htm#New funding to tackle apartment energy efficiency

[23] Available at: http://www.cityofsydney.nsw.gov.au/vision/towards-2030/sustainability/carbon-reduction/net-zero-apartment-buildings

3. Objectives of government action

Element 2: Objectives of Government action provides for clear outcomes and objectives for the government action to be stated. The objective should be stated in specific terms, where progress will be measurable. It should be achievable in the prevailing economic conditions, specified time frames and with the resources available. It must be within the realm of government influence.[24]

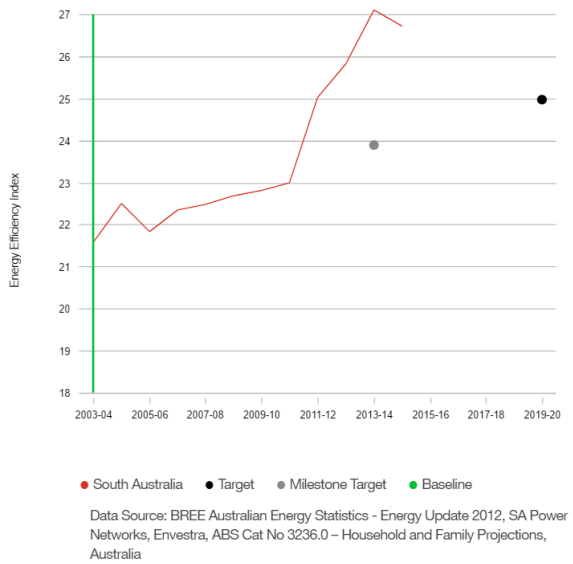
The policy objective of the SA Government is to improve the efficiency of class 2 dwellings when considering the construction costs and the operational costs for heating and cooling. This outcome would ensure apartments are more comfortable for inhabitants and help residents living in apartments save on energy bills.

The reforms also align with the State's energy efficiency targets aimed at addressing climate change by reducing greenhouse gas emissions. Target 60 in South Australia's Strategic Plan is:

> *To improve the energy efficiency of dwellings by 15% by 2020 (baseline: 2003-04) Milestone of 10% by 2014.* [25]

In 2014-15, tracking based on the Energy Efficiency Index[26] indicated South Australian households had achieved energy efficiency improvements in excess of the 2014 target and were on track towards achievement of the 2020 (Figure 6).

Figure 6: South Australian residential energy efficiency index (EEI) [27]



24 SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 16.

25 SA Government, *South Australia's Strategic Plan*, 2011, p. 47. For more information refer to: http://www.statedevelopment.sa.gov.au/resources/energy-efficiency/south-australias-energy-efficiency-targets

26 The Energy Efficiency Index (EEI) is defined as the number of average residential dwellings that can have their annual energy needs met by a given quantity of energy – in this case 1 terajoule (TJ) of energy.

27 Department of State Development, SA Strategic Plan website: 'Target: 60. Energy efficiency – dwellings: Improve the energy efficiency of dwellings by 15% by 2020'. Refer to http://saplan.org.au/targets/60-energy-efficiency-dwellings

The SA Government recognise the current trend as being influenced by energy efficiency policies (such as Minimum Energy Performance Standards, buildings standards, the Retailer Energy Efficiency Scheme and SA's low emission water heater installation requirements), policies promoting the residential use of photovoltaic systems, and consumer responses to rising energy costs.

In order to ensure achievement of the 2020 energy efficiency target efforts to increase building standards on energy efficiency need to continue where these improvements deliver public value.

It was agreed with the Department that the Public Value Scorecard would be used to assess the outcomes of the reform options ahead of undertaking the cost benefit analysis.

Public Value Scorecard

Developed by Harvard Professor Mark Moore, the public value scorecard provides a framework for establishing what constitutes public value, and to whom, within a particular context. Under this approach, the creation of public value and the success of public sector programs is achieved through the alignment of three elements:

- **Public value delivered** – as defined by the outcomes that the proposal aims to achieve and for whom;
- **Legitimacy and support –** recognising that building a coalition of stakeholders whose support is necessary to sustain active and ensuring formal authorising requirements are met; and
- **Operational capabilities –** ensuring capacity and mobilising operational resources to implement proposals and achieve desired public value outcomes.

Consideration and articulation of each of the above elements helps public policy make decisions on proposals. The articulation of the elements helps by clarifying the degree to which proposals are valuable, plausible, authorisable, and doable.

In making an assessment of the proposed reform (refer to Chapter 7) consideration is given both the overall government objectives as well as the outcomes of a Public Value Scorecard based assessment.

4. Statement of Options

Element 3: Statement of Options ensure that a RIS clearly demonstrates a range of alternative ways of solving the problem.

One of the options must include maintaining the status quo and options may consist of various types of regulatory interventions but may also include variations of the same form of regulation (such is the case for this project).

The main criteria for the options are that they are feasible and described in sufficient detail too allow assessment of the costs and benefits of the option. Consideration of how options would be implemented and enforced are covered as part of this element.[28]

4.1 How to address the issue?

The existing energy efficiency regulations being considered as part of this reform are outlined in the Background section of this report. This RIS is confined to consideration of options within the Building Code to address energy efficiency performance.

Section J0.2 addresses energy efficiency outcomes for Class 2 building by requiring stated star energy ratings to be achieved for heating and cooling loads where achievement is determined by modelling design aspects using house energy rating software.

Under the current drafting of clause J0.2 contemplates collective achievement of energy ratings by the apartments within a complex and the achievement of energy ratings by the individual apartments on a stand-alone basis.

4.2 Reform options for assessment

The Department has identified a number of alternative reform options to achieve the reform objective. The reform options vary key components of the energy efficiency requirements set out in J0.2(a), including:

- changes to the star rating(s) to be achieved;
- removal of the collective rating, such that only an individual rating remains; and
- separation of requirement for heating and cooling loads.

Figure 7 (below) summarises the proposed drafting of each of the reform options (option 1 to 3) as well as the base case with no changes to the current drafting. The naming of each of the options (left hand column of Figure 7) are based on the core change characterising the option. Each of the options are described qualitatively below and further detail underpinning the cost benefit analysis is provided in Chapter 5.

[28] SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 16.

Figure 7: Revised drafting for options

Option	Proposed drafting
Base Case: **6 star average rating, minimum 5 star individual rating**	*No change to NCC J0.2(a).* The sole-occupancy units of a Class 2 building or a Class 4 part of a building must— (a) for reducing the heating and cooling load – i. collectively achieve an average energy rating of not less than 6 stars; and ii. individually achieve an energy rating of not less than 5 stars, using *house energy rating software*.
Option 1: **7 star average rating, 6 star minimum individual rating**	*Amend NCC J0.2(a) to:* The sole-occupancy units of a Class 2 building or a Class 4 part of a building must— (a) for reducing the heating and cooling load – i. collectively achieve an average energy rating of not less than **7 stars**; and ii. individually achieve an energy rating of not less than **6 stars** using *house energy rating software*
Option 2: **No average rating, 6 star minimum individual rating**	*Amend NCC J0.2(a) to:* The sole-occupancy units of a Class 2 building or a Class 4 part of a building must— (a) for reducing the heating and cooling load – i. individually achieve an energy rating of not less than 6 stars using *house energy rating software*
Option 3: **Separate cooling and heating caps**	*Amend NCC J0.2(a) to:* The sole-occupancy units of a Class 2 building or a Class 4 part of a building must— (a) for reducing the heating and cooling load – i. individually achieve maximum annual **cooling load** of not less than equivalent to 6 stars; and ii. individually achieve maximum annual **heating load** of not less than equivalent to 6 stars using *house energy rating software*.

4.3 Thermal modelling assumptions

Thermal modelling outputs underpin the analysis of each of the reform options. The approach to thermal modelling is described in the first section below and the approach to the cost benefit analysis is subsequently outlined.

Thermal modelling and the determination of changes in materials required to meet more stringent energy efficient rating requirements consisted of a three-step process:

- Step 1 involved the identification of a typical Class 2 building likely to be built in South Australia. The building design selected consisted of four stories, with the layout for each story remaining the same and each story consisting of 6 apartments. We investigated whether a second, curtain wall construction method with a highly glazed façade – typical of new apartment buildings in Sydney or Melbourne – should be modelled, but were advised

by the City of Adelaide that such a building would be unlikely to be compliant with Adelaide's planning scheme (and would be even less likely to be built in the Ceduna or Mt Gambier climate zones) – although it was stressed that a range of building solutions might be judged compliant with performance-based requirements, and a curtain-wall building could not be ruled out. This issue is discussed further below.

- Step 2 required the specification of a base set of building materials that would be varied to achieve energy efficiency ratings in an iterative processes along-side thermal modelling.
- Step 3 consisted of the thermal modelling of the base case and alternative reform options with the materials being varied to ensure achievement of required ratings whilst minimising the incremental cost.

Each step is briefly discussed below.

Indicative building design

The approach to assessing these options involved, first, identifying a typical Class 2 building of the kind likely to be built in South Australia. To do this we consulted with the Department and also with the Planning Department of Adelaide City Council (ACC). ACC referred us to the *Adelaide (City) Development Plan Consolidated – 24 September 2015*, which provides guidance, inter alia, on the principles underpinning acceptable building solutions. These include design considerations (for Class 2 buildings) such as access to natural daylight and ventilation; solar access requirements; window positioning and aspect; balconies; disposition of living areas; cross-ventilation and other factors. This document provides indicative floor plans that reflect appropriate solutions, and we have incorporated these within our modelled building (see below).

Also, we reviewed a number of actual Class 2 buildings undergoing review by South Australia's Development Assessment Commission (Capital City Development Assessment Committee), which applies to developments over $10 million in value. The documentation for developments includes floorplans, and so a number of these were reviewed as indication of current and acceptable building solutions.

Based on these considerations, we then developed a model building for thermal modelling purposes. The floor plan of the Class 2 building used for the modelling is shown in Figure 8 below.

The building is four storeys tall and the floor plan is the same for each storey. Each unit, except those on the ground floor has a balcony, which is an Adelaide City Council planning requirement.

The orientation of the apartment as shown in Figure 8 means individual units that have been used in the thermal modelling have the following orientation and sun exposure:

- Unit 204 in located in the North West corner. Corner units have a longer façade-to-floor-are ratio than middle units, which means that they are more exposed and sensitive to the external environment. A North West unit is, however, advantageous from a solar passive perspective, receiving low sun angles on winter mornings (helping to warm the unit), and potentially shaded from the North East sun on summer afternoons/evenings. Good solar design would see appropriate shading structures used to limit overheating, in particular, during periods (all year round) with low sun angles.
- Unit 205 is the middle apartment on the North facing side of the building. Such units have the natural advantage of receiving useful sunshine in winter, when sun angles are lower, and – provided suitable shading devices are used – should be shaded from direct sunstrike on windows in summer. Their reduced façade-to-floor-area ratio makes them less sensitive

to changes in ambient temperate, and almost invariably these apartments will achieve the highest star ratings

- Unit 207 is in the North West corner. The unit therefore has, like the North East corner, a longer façade for its floor area, but is also more exposed to westerly sun on hot summer afternoons. The primary risk for such units is overheating. Minimising glazing on the western façade, shading windows and lifting glazing quality (e.g., low-e double-glazed units) are key strategies to improve comfort and reduce space conditioning energy demand.
- Unit 208 is the in the south east corner. These units receive some but limited early morning winter sunshine, but are well protected from strong summer afternoon sunshine. Therefore their energy performance will be dominating by winter rather than summer design considerations, such as improving glazing quality, reducing window-to-wall ratios, and insulating walls.

Units 206 and 209 have not been modelled. Unit 206 has a very similar orientation and sun exposure to unit 205, and its energy performance would be very similar to unit 205. As Unit 209 is located in the South West corner, it is likely to receive the lowest amount of sun compared to other apartments, but risk overheating in summer. On average, its performance over a year is likely to be similar to unit 208, albeit with stress points reversed from winter (in 208) to summer (in 209).

Figure 8: Floorplan of modelled apartment building

Source: Strategy.Policy.Research, 2017

Building fabric

The building is a concrete framed building with masonry external walls. The building fabric of the building modelled under the base case is shown in the description of the base case in section 4.4 below.

A masonry veneer was selected because this wall type is used current plans that are most representative of South Australian units. Alternative finishes, such as tilt-up panels, were also considered however the selection does not make a significant different to the thermal modelling where the tilt-up panels are insulated.[29] Both masonry veneer and tilt-up panels have a cavity built on the inside allowing for additional insulation to be added to reach higher star rating.

We note that curtain walls were not considered a viable option. We understand these types of finishes are unlikely to be compliant with Adelaide's planning scheme – the location where most Class 2 buildings are expected in our modelling. These types of configurations can also cost more than alternative veneers as more structural reinforcement is required in order to unload the other walls that are typically fully glass or at least highly glazed. This type of veneer is more frequently used for office buildings and is being applied to taller Class 2 building in CBD markets around Australia – just not yet as common for smaller Class 2 buildings in South Australia.

Changed building elements under reform options were determined via iterative processes alongside the thermal modelling (described below). The resulting building fabric details for options 1, 2 and 3 have been summarised in Table 1 (in the Executive Summary) and have been provided in the sections below for each reform option.

Details on the incremental costs of achieving the performance outcomes as independently quantified by quantity surveyors, Daniel Cant Watts Corke are outlined in Appendix 1. It has been assumed that builders would choose the lowest cost option to meet the requirements.

AccuRate thermal modelling

Having selected an appropriate and typical Class 2 building design, and the base case fabric element thermal modelling of the building was undertaken. Modelling was conducted using AccuRate thermal modelling software.

AccuRate is the reference standard rating tool, against which other ratings software packages (like FirstRate 5 and BERS Pro) must be accredited under the National House Energy Rating Scheme (NatHERS), which is administered by the Australian Government. The thermal modelling 'engine' powering AccuRate was originally developed by CSIRO, and CSIRO remains the primary developer of new versions and upgrades.

An iterative process was used to determine the required specification for the thermal performance of the building under the current, or NCC2016, energy performance requirements. Note that most elements, for most options, remain the same, regardless of the option – thus the table below notes only where changes were made.

Attached this this report are certificates that reflect the modelling of units as described below. Two units both on the upper mid-level have been selected – unit 204 and unit 208. In the appendix the following is provided for each:

- Base case certificates: These shows a rating of 4.9 for unit 204 and a rating of 5.3 for unit 208.

[29] Often panels are not insulated and a timber stud wall (with or without) insulation is built on the internal side of the panel to run services and then lined with plasterboard.

- Option 1 certificates: These show a rating of 6.9 for unit 204 and a rating of 7.2 for unit 208.
- Design details.

4.4 Base case: 6 star average rating, minimum 5 star individual rating

The base case or business as usual retains the current requirements of an average rating of 6 stars and a minimum heating and cooling requirement for individual apartments of 5 stars.

It is against this option that the impacts (costs and benefits) for each for the reform options have been considered.

The base case used in the cost benefit analysis also provides forward forecast of factors that remain the same across all options. It accounts for:

- growth in the residential Class 2 building stock;
- any baseline improvement in energy efficiency;
- baseline changes in energy prices and emissions; and
- major policy initiatives and other factors.

While forecasts of these factors are included in the modelling, it is important to remember that these are consistent across scenarios and thus cancel out when net benefits are calculated comparing the reform options (options 1, 2 and 3) to the base case.

The thermal modelling results used for the purposes of the cost benefit analysis are summarised below.

Thermal modelling results (base case)

Under the base case, each unit must achieve a minimum 5 star rating and the average of all units achieved must be a minimum of 6 stars.

The building is a concrete framed building with masonry external walls under all scenarios. The fabric of the building under the base case is shown in Table 4 below.

Table 4: Building fabric, base case

Element	Composition
External walls	Brick veneer, internal plasterboard lining
External balcony wall	Fibre-cement sheet, internal plasterboard lining
Internal walls	Plasterboard and solid blockwork
Floors between units	200 mm concrete slab
Top floor ceiling	200 mm concrete slab, R3.0 insulation, plasterboard lining
Windows	Aluminium single-glazed High Solar Gain Low-E: U = 5.40: SHGC = 0.58
Window size changes	Balconies shaded by balcony above. Top floor balconies shaded by roof overhang. No other external shading.
External shading	Brick veneer, internal plasterboard lining

Source: Strategy.Policy.Research

Table 5 below shows the star rating of each unit under the business as usual (or base case) scenario. The actual calculated heating and cooling requirement that corresponds to each star

rating is also shown. It is clear from the table that star rating of individual units within the building varies very widely depending on a unit's location. Star ratings vary from 4.9 to 8.6. Unit 205 has the best thermal performance on the mid and ground floors in all climate zones. The reason for this is because it is a central unit bounded on either side by another unit, leaving it with only one external wall. On the top floor, however, this unit doesn't perform as well, requiring a greater heating load. This reflects the greater exposure to the external environment that top floor apartments experience, relative to those on lower floors.

On the top floor, the west facing Unit 204 performs best in Adelaide and Ceduna, whereas the east facing Unit 207 performs the best in Mt Gambier. Unit 208 is south facing and, in most cases on each floor and in each climate zone it has lower star rating than the other units because of its orientation.

Overall, the building in this specification achieves the current regulatory requirement of a 6 star average and 5 star minimum, noting that Unit 204 shows 4.9 star on two floors. We consider that this is within a normal margin of error.

Table 5: Building performance summary, base case

	ADELAIDE			CEDUNA			MT GAMBIER		
	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)
Top Floor									
Unit 204*	7.3	18.2	52	7.8	16.2	31.7	5.6	151.1	30.9
Unit 205	6.3	43.9	55.2	6.4	40.2	38.1	6.4	132.2	10.2
Unit 207	5.3	29.5	85	6.2	24.6	59.4	6.7	109	20.9
Unit 208*	6.1	23.6	80.4	7.4	44.3	69.3	5.1	185.2	28.8
Upper Mid Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	5.4	161.7	15.4
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
Lower Mid Floor									
Unit 204	5.7	55.3	65.4	5.9	48.1	41.9	5.1	200.1	8.4
Unit 205	8.6	20.5	14.6	8.6	16.4	12.1	7	115.6	1.7
Unit 207	6.4	37.2	59.8	7.4	22.1	31.5	6	154.9	7.2
Unit 208	6.2	43.2	63.8	6.8	33.6	39.5	5.7	172.6	7.1
Ground Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	5.4	161.7	15.4
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
AVG	**6.2**	**35.3**	**64.9**	**6.9**	**28.9**	**40.7**	**6.1**	**140.0**	**12.8**

**In Adelaide and Ceduna Units 204 and 208 on the top floor need R1.5 wall insulation to meet the minimum 5 star rating under the base case.*

Source: Strategy.Policy.Research, 2017

4.5 Option 1: 7 star average, 6 star minimum individual rating

Option 1 represents a marginal increase in the star ratings that must be achieved relative to the base case. Under option 1, the average rating across apartments that must be achieved increases from 6 stars to 7 stars; and the minimum rating to be achieved by each apartment individually increases from 5 stars to 6 stars.

The thermal modelling results used for the purposes of the cost benefit analysis are summarised below.

Thermal modelling results (option 1)

Option 1 is each unit achieving a minimum 6 star rating and the average of all units achieving a minimum of 7 stars. The only changes required to the building fabric to achieve this were adding R1.5 wall insulation to all external walls, and reducing the glazing area in several units to reduce the cooling load. The changes are shown in bold and underlined in Table 6 below.

Table 6: Building fabric, option 1

Element	Composition
External walls	Brick veneer, **R1.5 wall insulation**, internal plasterboard lining
External balcony wall	Fibre-cement sheet, **R1.5 wall insulation**, internal plasterboard lining
Internal walls	Plasterboard
Floors between units	200mm concrete slab
Top floor ceiling	200mm concrete slab, R3.0 insulation, plasterboard lining
Windows	Aluminium single-glazed High Solar Gain Low-E: U = 5.40: SHGC = 0.58
Window size changes	**Unit 204, Mt Gambier (top floor) - remove a west window in the living room.** **Unit 207, Adelaide (top floor) - reduced glazing area of north window in living room** **Unit 208, Ceduna and Mt Gambier (top floor) - reduce glazing in east wall of living room**
External shading	Balconies shaded by balcony above. Top floor balconies shaded by roof overhang. No other external shading.
Average incremental cost of compliance	
Adelaide	$8.09 per sqm
Ceduna	$4.22 per sqm
Mt Gambier	$7.42 per sqm

Source: Strategy.Policy.Research, Donald Cant Watts Corke

Star rating and heating/cooling load results for this option are shown in Table 7 below.

Table 7: Option 1 - Building performance summary

	ADELAIDE			CEDUNA			MT GAMBIER		
	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)	Star Rating	Heating load (MJ/m²)	Cooling load (MJ/m²)
Top Floor									
Unit 204*	7.3	18.2	52	7.8	16.2	31.7	6.8	100.2	30.3
Unit 205	6.3	43.9	55.2	6.4	40.2	38.1	6.4	132.2	10.2
Unit 207	6.6	16	74.3	6.2	24.6	59.4	6.7	109	20.9
Unit 208	6.1	23.6	80.4	7.4	44.3	69.3	7	92.9	26.6
Upper Mid-Floor									
Unit 204	**6.9**	**12**	**65**	7.4	10.2	41.1	7.9	62.7	13
Unit 205	8.7	4.3	24.3	8.8	4.1	16.9	8.7	39.1	3.8
Unit 207	7.2	7.6	62.4	7	19.7	40.7	6.4	121	11.7
Unit 208	7.2	9	60.8	6.2	29.8	50.3	6.1	137	12.8
Lower Mid Floor									
Unit 204	6.9	12	65	7.4	10.2	41.1	7.9	62.7	13
Unit 205	7.8	21.6	30	8.1	4.1	16.9	7.4	89.6	4.5
Unit 207	7.2	7.6	62.4	7	4	30	6.4	121	11.7
Unit 208	7.2	9	60.8	6.2	6.2	35.2	6.1	137	12.8
Ground Floor									
Unit 204	7.7	15.9	46.5	5.9	48.1	41.9	7.4	95.4	6.8
Unit 205	8.6	20.5	14.6	8.6	16.4	12.1	7	115.6	1.7
Unit 207	6.4	37.2	59.8	7.4	22.1	31.5	6	154.9	7.2
Unit 208	6.2	43.2	63.8	6.8	33.6	39.5	7.9	78.4	4.3
AVG	**7.1**	**18.9**	**54.8**	**7.2**	**20.9**	**37.2**	**7.0**	**103.0**	**12.0**

**No west window*

Source: Strategy.Policy.Research, 2017

4.6 Option 2: No average rating, 6 star minimum individual rating

Option 2 removes the average rating requirement, thus removing the ability to trade off less than 6 star performance in some apartments for above 6 star performance in others. Instead every apartment would be required to achieve minimum 6 star rating.

The removal of the average rating acts to increase the onus on each individual apartment to be designed and constructed to meet the 6 star rating requirements, which may involve higher costs (but also lower energy costs) for those apartments that currently perform at less than 6 stars.

The thermal modelling results used for the purposes of the cost benefit analysis are summarised below.

Thermal modelling results (option 2)

Noting that between 8 and 11 of the 16 units already achieve 6 star ratings in the base case (depending upon the climate zone), relatively few changes were required to bring all units up to a 6 star minimum here was no change in the building fabric from either the base case or option 1 reform scenario except for those units highlighted by shading.

In the case of the highlighted units in Table 9 (overleaf), the level of wall insulation remains at R1.5 as per option 1, however the quality of glazing can be reduced from what was used in the base case and option 1, while still complying with the minimum 6 star requirement. This slightly reduces the cost of compliance with this option, along with the average energy performance. See Table 8 below.

Table 8: Building fabric, option 2

Element	Composition
External walls	Brick veneer, **R1.5 wall insulation**, internal plasterboard lining
External balcony wall	Fibre-cement sheet, **R1.5 wall insulation**, internal plasterboard lining
Internal walls	Plasterboard
Floors between units	200 mm concrete slab
Top floor ceiling	200 mm concrete slab, R3.0 insulation, plasterboard lining
Windows	Aluminium single-glazed High Solar Gain Low-E: U = 5.40: SHGC = 0.58
Window size changes	Balconies shaded by balcony above. Top floor balconies shaded by roof overhang. No other external shading.
External shading	Brick veneer, internal plasterboard lining
Average incremental cost of compliance	
Adelaide	$7.68 per sqm
Ceduna	$3.81 per sqm
Mt Gambier	$7.01 per sqm

Source: Strategy.Policy.Research, Donald Cant Watts Corke

Note that, because the Ceduna and Mt Gambier climate zones are more severe than Adelaide, the star ratings for the highlighting apartments increase more than strictly required in these two climate zones, leading to a slightly higher average star rating for these climate zones in option 2 when compared to option 1.

As discussed further in Chapter 5, because most of the new construction work is assumed to take place in the Adelaide climate zone, this result does not have a material impact. In reality, specifications for these climates could be 'detuned' slightly and still remain compliant.

Table 9: Building performance summary, option 2

	ADELAIDE			CEDUNA			MT GAMBIER		
	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)
Top Floor									
Unit 204*	7.3	18.2	52	7.8	16.2	31.7	6.8	100.2	30.3
Unit 205	6.3	43.9	55.2	6.4	40.2	38.1	6.4	132.2	10.2
Unit 207	6.6	16	74.3	7.4	12.5	42.1	7.8	69.7	13.8
Unit 208	6.1	23.6	80.4	7.4	44.3	69.3	7	92.9	26.6
Upper Mid Floor									
Unit 204	6.9	12	65	7.4	10.2	41.1	7.9	62.7	13
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	**6.8**	**14.4**	**65.2**	**7.9**	**8.3**	**32.5**	**7.8**	**69.2**	**9.5**
Unit 208	**6.8**	**15.6**	**64.9**	**7.5**	**11.4**	**38.4**	**7.8**	**71**	**10.1**
Lower Mid Floor									
Unit 204	6.9	12	65	7.4	10.2	41.1	7.9	62.7	13
Unit 205	7.8	21.6	30	8.1	4.1	16.9	7.4	89.6	4.5
Unit 207	6.8	14.4	65.2	7	4	30	6.4	121	11.7
Unit 208	6.8	15.6	64.9	6.2	6.2	35.2	6.1	137	12.8
Ground Floor									
Unit 204	**7.2**	**25.5**	**50.8**	**7.4**	**23.2**	**23.6**	**6.7**	**125.2**	**7.3**
Unit 205	8.6	20.5	14.6	8.6	16.4	12.1	7	115.6	1.7
Unit 207	6.4	37.2	59.8	7.4	22.1	31.5	6	154.9	7.2
Unit 208	6.2	43.2	63.8	6.8	33.6	39.5	7.9	78.4	4.3
AVG	**7.0**	**22.2**	**56.3**	**7.4**	**17.4**	**34.0**	**7.1**	**98.2**	**11.3**

**no west window*

Source: Strategy.Policy.Research, 2017

4.7 Option 3: Separate cooling and heating caps (equivalent to average 6 star rating)

Option 3 removes the requirement for dwellings to meet a specified star rating and instead requires dwellings to comply with heating and cooling caps. The heating and cooling caps selected for option 3 are on average equivalent to a 6 star rating, but do not necessarily mean all apartments continue to meet the 6 star minimum rating (since it is not specifically required).

The separation of heating and cooling loads is, in principle, more stringent than an annual 'heating and cooling' requirement, because it limits the ability of the designer to trade-off improved winter performance for worse summer performance, or vice versa.

Effectively, the requirement would ensure Class 2 building apartments are designed to remain both warm in the winter (thus reducing the heating needed by occupants) and cool in the summer (reducing the cooling needs of occupants). This approach, of separate heating and

cooling caps, is being considered for roll-out Australia-wide in the National Construction Code for 2019.[30]

For clarity it is noted that since caps used in modelling only equate to a six star rating on average, the costs (and benefits) may be limited for particular regions or designs where extremes are less prominent.

The thermal modelling results used for the purposes of the cost benefit analysis are summarised below.

Thermal modelling results (option 3)

Option 3 was to model the units so as not to exceed maximum area adjusted heating and cooling load caps. Options 1 and 2 were calculated using the actual rather than adjusted loads. The area adjustment accounts for the difference in total building surface area to floor area ratio in small versus larger dwellings. Smaller dwellings have a greater total building surface area to floor area than larger dwellings. Since heat transfer through the building fabric is proportionate to total building surface area, an area adjustment is required to ensure that smaller dwellings (with less building surface area but larger surface area to floor area ratio) are compared with larger dwellings fairly and therefore rated based on adjusted energy loads (NatHERS Protocols).

The caps specified to be used in this analysis are shown below. These values were sourced from the Australian Building Codes Board and derive from analysis (by third parties) which is still in draft form. Therefore, these values should not be treated as finals, and are not endorsed or recommended by the Board.

Table 10: Class 2 heating and cooling load caps

	Max Heating (MJ/m2)	Max Cooling (MJ/m2)
Adelaide	96	93
Ceduna	80	62
Mt Gambier	172	35

Source: Strategy.Policy.Research, 2017

Table 11 below shows the area adjusted heating and cooling loads of the **base case** (note that they are lower than the actual loads used for the analysis of option 1).

The units highlighted by shading are the only ones where either the maximum heating or maximum cooling load caps specified were exceeded. The table shows that:

- None of the caps were exceeded under the base case for units in the Adelaide climate zone.
- Only one unit in Ceduna and two in Mt Gambier required any treatments to meet the requirements.

We note that Unit 208 on the ground floor is marginal in Mt Gambier – but within a normal margin of error.

[30] As per the Australian Building Codes Board work program. Refer to: http://www.abcb.gov.au/Connect/Articles/2017/03/09/Section-J-Overhaul-big-changes-are-coming-your-way

Table 11: Area adjusted heating and cooling loads, base case

	ADELAIDE			CEDUNA			MT GAMBIER		
	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)
Top Floor									
Unit 204*	7.3	18.2	52	7.8	16.2	31.7	5.6	151.1	30.9
Unit 205	6.3	43.9	55.2	6.4	40.2	38.1	6.4	132.2	10.2
Unit 207	5.3	29.5	85	6.2	24.6	59.4	6.7	109	20.9
Unit 208	6.1	23.6	80.4	**7.4**	**44.3**	**69.3**	**5.1**	**185.2**	**28.2**
Upper Mid Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	5.4	161.7	15.4
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
Lower Mid Floor									
Unit 204	5.7	55.3	65.4	5.9	48.1	41.9	**5.1**	**200.1**	**8.4**
Unit 205	8.6	20.5	14.6	8.6	16.4	12.1	7	115.6	1.7
Unit 207	6.4	37.2	59.8	7.4	22.1	31.5	6	154.9	7.2
Unit 208	6.2	43.2	63.8	6.8	33.6	39.5	5.7	172.6	7.1
Ground Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	5.4	161.7	15.4
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
AVG	**6.2**	**35.3**	**64.9**	**6.9**	**26.8**	**38.6**	**6.4**	**127.6**	**12.5**

**No west window*

Source: Strategy.Policy.Research, 2017

For Unit 208 (top floor) in Ceduna under the base case the maximum heating cap was met, however the maximum cooling cap was exceeded. The treatment applied to ensure that both heating and cooling loads did not exceed the caps was the same as option 2 - R1.5 wall insulation and double-glazed windows.

For the two units highlighted in Mt Gambier, the heating cap was exceeded under base case, while the maximum cooling cap was easily met. The treatment applied in ensure that both heating and cooling loads did not exceed the caps was the same as option 1 - R1.5 wall insulation.

Table 12: Building fabric, option 3

Element	Composition
External walls	Brick veneer, internal plasterboard lining **(Unit 208 top – Mt Gambier & Ceduna, Unit 204 mid – Mt Gambier, R1.5 wall insulation**)
External balcony wall	Fibre-cement sheet, internal plasterboard lining
Internal walls	Plasterboard and solid blockwork
Floors between units	200 mm concrete slab
Top floor ceiling	200 mm concrete slab, R3.0 insulation, plasterboard lining
Windows	Aluminium single-glazed High Solar Gain Low-E: U = 5.40: SHGC = 0.58 **(Unit 208 top – Ceduna, double-glazed)**
Window size changes	Balconies shaded by balcony above. Top floor balconies shaded by roof overhang. No other external shading.
External shading	Brick veneer, internal plasterboard lining
Average incremental cost of compliance	
Adelaide	-
Ceduna	$0.61 per sqm
Mt Gambier	$1.93 per sqm

Source: Strategy.Policy.Research, Donald Cant Watts Corke

Star rating and heating/cooling load results for this option after changes to building material are shown in Table 13 below.

Table 13: Area adjusted heating and cooling loads, option 3

	ADELAIDE			CEDUNA			MT GAMBIER		
	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)
Top Floor									
Unit 204	7.3	18.2	52	7.8	16.2	31.7	5.6	151.1	30.9
Unit 205	6.3	43.9	55.2	6.4	40.2	38.1	6.4	132.2	10.2
Unit 207	5.3	29.5	85	6.2	24.6	59.4	6.7	109	20.9
Unit 208	6.1	23.6	80.4	**7.9**	**10.8**	**35.6**	**7**	**92.9**	**26.6**
Upper Mid Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	5.4	161.7	15.4
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
Lower Mid Floor									
Unit 204	4.9	51.1	85.1	5.4	42.8	52.5	**5.4**	**161.7**	**15.4**
Unit 205	7.8	21.6	30	8.1	16.1	20.1	7.4	89.6	4.5

	ADELAIDE			CEDUNA			MT GAMBIER		
	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)	Stars	Heating load (MJ/m²)	Cooling load (MJ/m²)
Unit 207	5.4	33.6	81.8	7	19.7	40.7	6.4	121	11.7
Unit 208	5.3	40	84.1	6.2	29.8	50.3	6.1	137	12.8
				Ground Floor					
Unit 204	5.7	55.3	65.4	5.9	48.1	41.9	7.4	95.4	6.8
Unit 205	8.6	20.5	14.6	8.6	16.4	12.1	7	115.6	1.7
Unit 207	6.4	37.2	59.8	7.4	22.1	31.5	6	154.9	7.2
Unit 208	6.2	43.2	63.8	6.8	33.6	39.5	5.7	172.6	7.1
AVG	**6.2**	**35.3**	**64.9**	**6.9**	**26.8**	**38.6**	**6.4**	**127.6**	**12.5**

Source: Strategy.Policy.Research, 2017

5. Cost benefit analysis results

Element 4: Analysis of costs and benefits. Every South Australian RIS must include a cost benefit analysis, with the resources devoted to undertaking the CBA proportional to the significance of the proposal and the size of the likely economic and social implications.

For each regulatory option proposed, the CBA should identify the impacts on all sectors of the community within the State – business, consumers, the wider community and the environment [31]

5.1 Summary of results

The purpose of the cost-benefit analysis (CBA) is to assess the economic costs and benefits of each of the options incrementally to the business-as-usual case. Economic impacts (costs and benefits) are assessed in the model by aggregating the relevant subset of financial (distributional) impacts and externality impacts. Financial transfers between stakeholder groups have been excluded from the analysis because they do not result in a net economic cost or benefit.

The results of the CBA and compares the performance of options using three key metrics:

- Net Present Value (NPV), which is the Present Value (PV) of economic benefits delivered by the option less the PV of economic costs incurred; and
- Benefit Cost Ratio (BCR), which is the ratio of the PV of economic benefits to PV of economic costs.
- Social return on investment, which expresses the net social benefits over time as an effective interest rate (%) on the investment induced by each option

The NPV measures the expected benefit (or cost) to society of implementing the policy expressed in monetary terms, whereas the BCR identifies the option that provides the highest benefit per unit of cost.

The analysis in this report is necessarily based on a series of assumptions, which means that there is a degree of uncertainty around the results. The assumptions outlined in the next section reflected current information at the time the assessment was completed.

Key findings of the analysis are as follows:

Key finding 1: All the options studied (options 1 – 3) would deliver net economic benefits relative to the base case

The analysis below indicates that all options have a positive net present value, which means that the value of benefits they create is larger than the costs they incur – see Table 14 below. This is a *prima facie* indication that any of three options could be implemented by the South Australian Government.

[31] SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 17-21

Table 14: Summary of benefit cost analysis indicators ($2017, real)

Indicator	Option 1 (7 star average, 6 star minimum individual rating)	Option 2 (No average rating, 6 star minimum individual rating)	Option 3 (Separate cooling and heating caps)
Net Present Value	$3,063,000	$2,448,000	$97,830
Benefit Cost Ratio	2.8	2.5	3.9
Social Return on Investment	24%	22%	29%
Cumulative energy savings, 2020 to 2050 (TJ)	68.5	58.5	1.9
Cumulative GHG emissions, 2020 to 2050 (t CO2-e)	6,834	5,839	188

Source: Strategy.Policy.Research, 2017

Key finding 2: Option 1 is clearly the preferred option on benefit cost grounds

Table 10 above also clearly indicates that option 1 has the highest net present value of the options studied, at nearly three-quarters of a million dollars higher than option 2. This is the preferred option on benefit cost grounds, as it would increase net social welfare by the greatest amount. In addition, we note that option 1 saves the greatest amount of energy and greenhouse gas emissions of the three options. While option 3 has a higher benefit cost ratio, the absolute value of benefits delivered by this option is small.

Key finding 3: All measures remain cost effective under sensitivity analysis, including the 'worst case scenario', and option 1 is the preferred option in each case

Section 5.7 below shows the results of varying key assumptions and input values, including discount rates, energy prices, shadow carbon prices, incremental costs and learning rates. It also includes a 'stress test', where the worst-case scenario is selected. Even in this case, option 1 returns a positive NPV of over $1 million and a benefit cost ratio of 1.7.

5.2 Key assumptions

This section details assumptions underpinning modelling for the cost benefit analyses. The following key inputs are covered in turn:

- General assumptions including discount rates and the timeframe for analysis
- Climate zones
- Population distribution and growth
- Building stock turnover model
- Space conditioning assumptions
- Energy prices
- Policy-affect cohort
- Shadow carbon prices
- Other modelling assumptions.

5.2.1 General assumptions

Several general assumptions have been used in the cost benefit analysis. These include the analysis base year, the base year for valuation (of costs and benefits), the discount rate applied to costs and benefits over time and sensitivity discount rates.

The general assumptions are outlined in Table 15 below. Discount rates and the time frame for analysis are discussed in greater detail below.

Table 15: General assumptions

Variable	Assumption
Base Year	FY 2016
Prices	$2017, real
Evaluation Period	FY 2017-2050
Discount Rate	7% (real)
Discount Rate Sensitivity	3% and 10% (real)
Period of regulation impact	2020 to 2030
Period over which benefit accrue	2020 to 2050

Discount rates

Results are presented in present value (PV) terms using the standard discount rate of 7 per cent per annum (real), with sensitivity testing applied at 3 per cent and 10 per cent levels.

The range of discount rates are consistent with the most recent national RIS on energy efficiency requirements for residential building completed in 2010 [32], as well as recent recommendations from Houston Kemp in their recent review of the *Residential Building Regulatory Impact Statement Methodology*[33].

In particular, the 3 per cent level sensitivity has been included based on the Houston Kemp recommendation that:

> *Greater weight should be applied to lower discount rates, to take into account community values about the desirability of lowering greenhouse gases both now and into the future. (Houston Kemp, p. ii)*

The *SA Better Regulation Handbook* from 2011 recommends the use of a real discount rate of 6 per cent per annum[34] - the middle of the two reporting values selected for this study.

Timeframe for analysis

Modelling assumes the revised standards are adopted from 2020 and the new standards are assumed to impact new Class 2 dwellings built in the 10-year period following this (to 2030). The

[32] The Centre for International Economics (CIE) (2009) *Final Regulation Impact Statement for Residential Buildings (Class 1, 2, 4 and 10 Buildings)*, prepared for the Australian Building Codes Board, December 2009, p. 17

[33] Houston Kemp (2017) *Review of the Residential Building Regulatory Impact Statement Methodology*, 6 April 2017.

[34] *SA Government (2011) Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January. p. 57.

costs and benefits arising from the changed building standards during this 10-year period are then assessed over the life of the dwellings – 30-years to 2050.

These timeframes have been selected with consideration to:

- The expected length of time over which the proposed changes are expected to have a meaningful impact.
- The duration over which costs and benefits continue to flow from the changed behaviour during meaningful impact phase.

5.2.2 Climate zones

NatHERS divides Australia into 69 climate zones (Figure 9), this study focused on the impact in three of these regions where Class 2 buildings are currently located (Table 16) and are most likely to be built going forwards:

- Adelaide (NatHERS climate zone 16)
- Ceduna (NatHERS climate zone 53)
- Mt Gambier (NatHERS climate zone 61).

Table 16: Number of apartments broken down by number of bedrooms in SA Climate Zones, 2013

Number of bedrooms	NatHERS Climate Zones				
	Adelaide	Ceduna	Mt Gambier	Other Zones	South Australia
None (includes bedsitters)	168	-	-	6	**174**
1 bedroom	1,741	10	7	62	**1,820**
2 bedrooms	5,184	13	37	155	**5,389**
3 bedrooms	989	-	4	3	**996**
4 bedrooms	96	-	-	-	**96**
5+ bedrooms	12	-	-	-	**12**
Not stated	1,336	4	3	26	**1,369**
Total	**8,190**	**23**	**48**	**226**	**8,487**

Source: SA Government Data Directory, Dwelling Type, created 27 May 2013, last updated 30 October 2014, online.

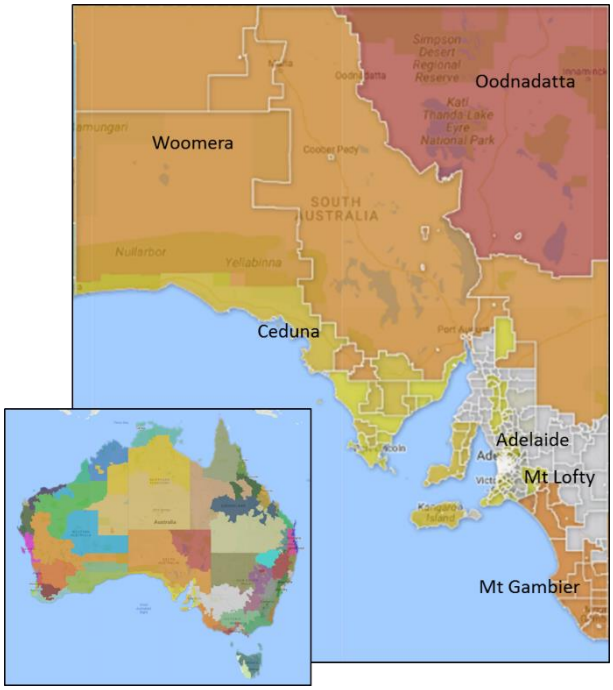
These three climate zones were mapped onto the Statistical Divisions used by the Australian Bureau of Statistics, which are shown in Table 17 below. The Northern Statistical Division is the only one excluded, on the grounds that very few Class 2 buildings are likely to be built in this zone.

Table 17: Mapping of ABS Statistical Divisions to NatHERS Climate Zones

Statistical Division (name)	NatHERS Climate Zone
Adelaide	Adelaide (16)
Outer Adelaide	Adelaide (16)
Yorke and Lower North	Ceduna (53)
Murray Lands	Adelaide (16)

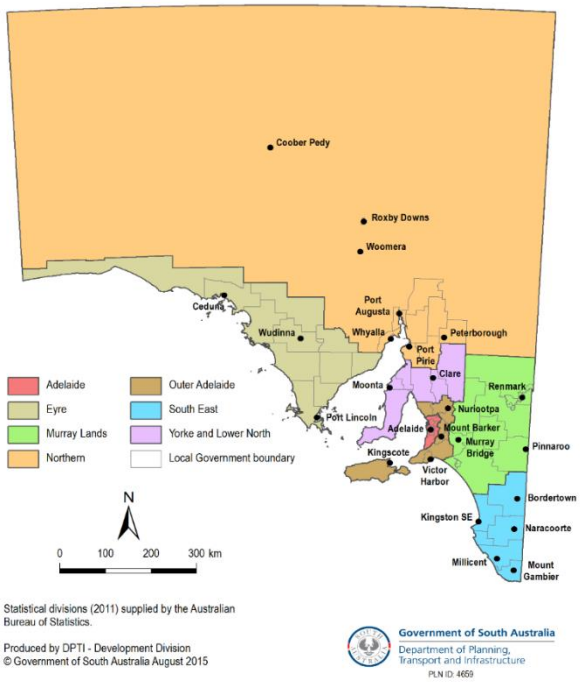
South East	Mt Gambier (61)
Eyre	Ceduna (53)
Northern	-

Figure 9: NaTHERS Climate Zones



Source: NatHERS Climate Zone Map

Figure 10: Statistical Divisions, South Australia



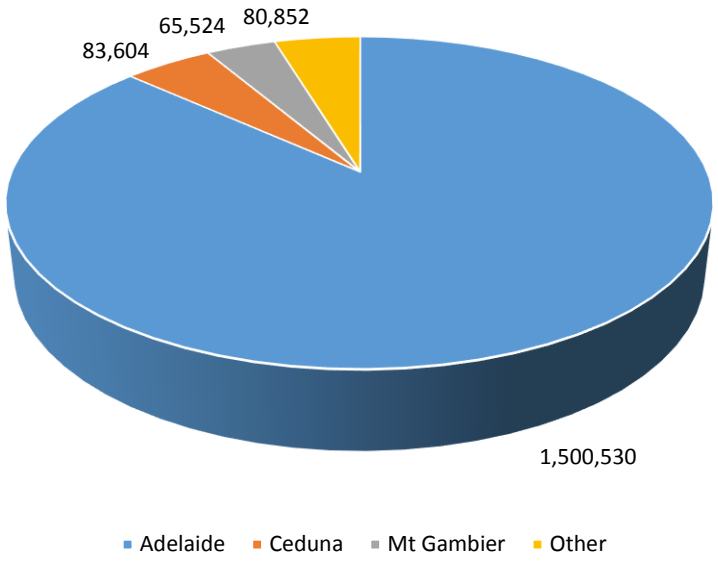
Source: ABS, Population Projections for South Australia and Statistical Divisions, 2011-41, September 2015 release

5.2.3 Population distribution and growth rates

The distribution of South Australia's population, by the above NatHERS climate zones, is heavily dominated by Adelaide. In 2017, some 91% of the population lived in this climate zone, with around 5% in Ceduna and 4% in Mt Gambier. By 2050, Adelaide's share is expected to grow to 92.3% of the total.

Population growth rates were taken directly from the ABS *Population Projections by Statistical Division* publication, referenced above, and mapped onto the NatHERS climate zones as described. Note that the ABS projections end in 2041, whereas our model extends to 2050, so we have simply extended the ABS growth rates over the 2041 - 2050 period by linear extrapolation.

Figure 11: Population Distribution by Region, South Australia, 2017 (no. of persons)

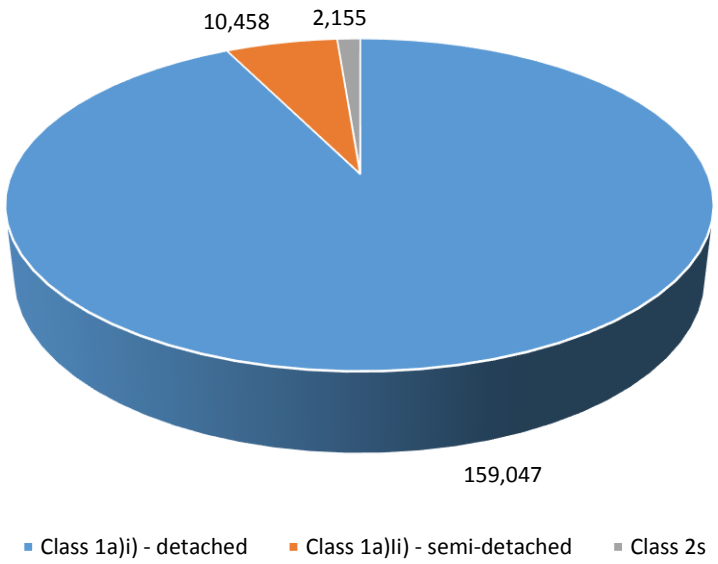


Source: ABS, Population Projections for South Australia and Statistical Divisions, 2011-41, September 2015 release

5.2.4 Building stock turnover model

The next step was to convert population projections to housing projections. For this, we begin with an observation of total 2015 apartment floor area from GeoSciences Australia's NEXIS database. This source indicates that in that year, some 2,155,200 sqm of Class 2s existed in South Australia in that year (and, for simplicity, we assume none of these are in the Northern Statistical Division). We note that this is the smallest share of the three housing types, with Class 1a)i) detached housing dominating the overall housing stock.

Figure 12: Housing Stock Shares by Type, South Australia, 2015 ('000 sqm)



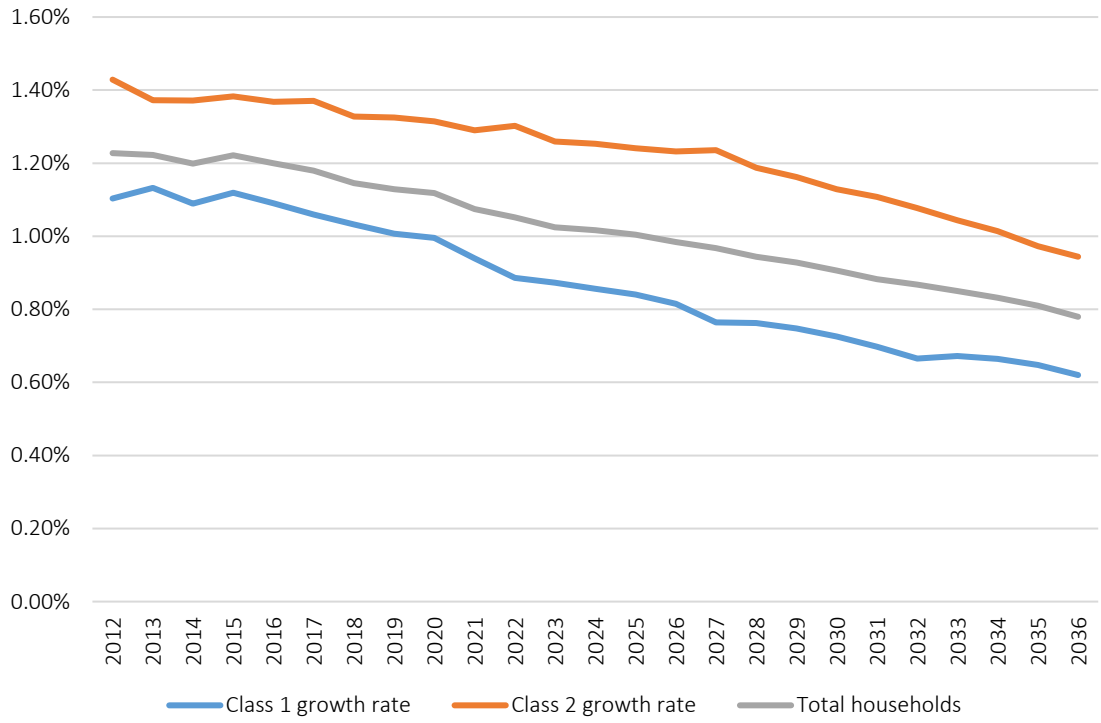
Source: GeoSciences Australia, NEXIS database

We note that in South Australia, as across most of the rest of Australia, there is a rising share of Class 2s in the new building stock. The trend towards Class 2 housing reflects changing consumer

preferences for inner city/urban living, and also changes in household composition, with an increase in single person households in particular. To represent these trends in the expected future growth of Class 2 dwellings, we drew on another Australian Bureau of Statistics document, *Household and Family Projections, Australia, 2011 to 2036.*[35] This reference projects population by 'living arrangement', which includes a range of different 'family households', 'group households' and 'lone person households' by state and region. We then applied the ABS projections about household composition, by weighting 100% of the sole person households and 20% of other households to Class 2s, for the Adelaide region. The sole person households are assumed by the ABS to grow faster than other household types, and this translates into a faster relative growth in Class 2 housing.

Specifically, in 2017, the growth rate for Class 2 floor area is assumed to be 1.37%, compared to 1.06% for Class 1s and 1.18% for the total households. We note that the ABS data shows an overall slowdown in the rate of household growth over the period to 2036, and therefore this assumption is also built into our projections, along with the relatively faster growth in Class 2 dwellings. See Figure 13 below.

Figure 13: Annual Rate of Growth in Households by Household Composition, South Australia



Source: From ABS, 32360DO001_20112036 Household and Family Projections, Australia, 2011 to 2036

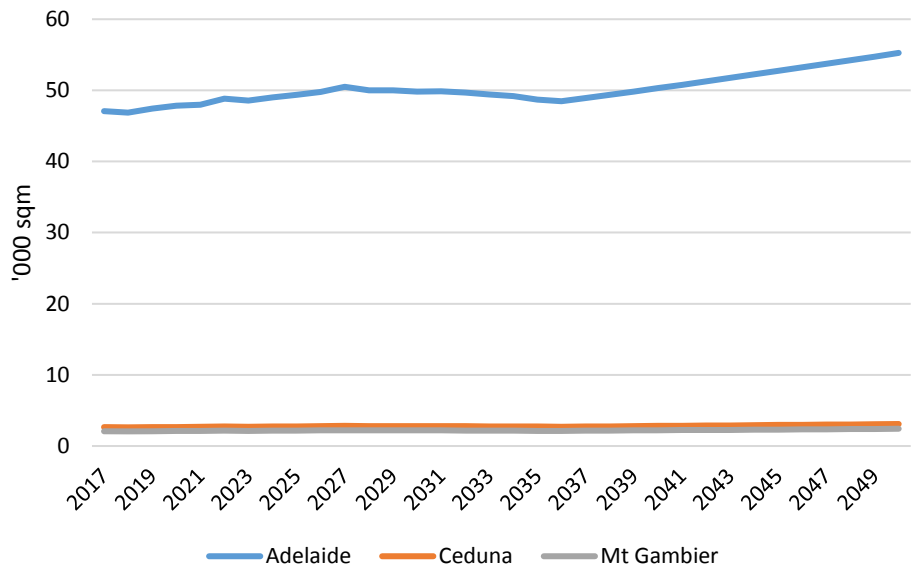
Since this study examines options for the National Construction Code, and noting that Code provisions apply to 'new building work' (which includes major refurbishments, extensions and additions, demolitions and rebuilds, in addition to the net growth in floor area every year), then the stock model must also take into account the expected rate of major refurbishment (this term is used as a summary for all of those above).

Unfortunately there is no authoritative data source on this rate. Industry sources assume that around 1% of the stock undergoes major refurbishment annually, sufficient to trigger Code

[35] ABS, 32360DO001_20112036 *Household and Family Projections, Australia, 2011 to 2036*; and assumed constant thereafter.

application, and we therefore apply this assumption. This results in a total of around 52,000 sqm of Class 2s being built to Code in South Australia per year at present, but growing to some 60,000 sqm per year by 2050, as indicated in Figure 14 below. Note that we have discussed this result with the Adelaide City Council and it appears that this is a realistic figure.

Figure 14: Annual floor area built to code (Class 2 dwellings), South Australia



Source: Strategy.Policy.Research, 2017

5.2.5 Space conditioning assumptions

The AccuRate modelling described in Section 4.3 above produces, as its key output metric, heating and cooling loads in mega joule per metre squared per annum (MJ/m^2.a). These can be thought of as the amounts of thermal energy required to maintain comfortable internal temperatures over a year – given assumptions about average climate conditions in each climate zone, and given the building design, orientation and specification modelled. However, since these are thermal or heat loads, some assumption has to be made about the nature of the space conditioning equipment use to generate the thermal energy.

Our baseline assumptions are, first, that 100% of the heating and cooling in the new stock is performed by heat pumps. As South Australia (and Adelaide in particular) is a cooling dominated climate, and given falling prices for air conditioning capacity, and rising gas prices, we believe this is a reasonable assumption.

Second, we assume that the average co-efficient of performance (COP) of space conditioning equipment installed is 3.0 in 2016, and rising at 3% per year (reaching 6.0 in 2050). Arguably these are conservative assumptions, as it is possible to source heat pumps today with COPs of 4 or 5, but where builders are involved in selecting the equipment, a least-first-cost approach is likely to apply, so we assume less efficient devices are installed on average. On the other hand, where gas is used for space heating, we would assume a COP of no more than 0.85. To the extent that this occurs, this would drag down the average space conditioning COP in new dwellings in South Australia.

We also assume that 90% of the floor area of apartment dwellings is conditioned.

5.2.6 Energy savings and prices

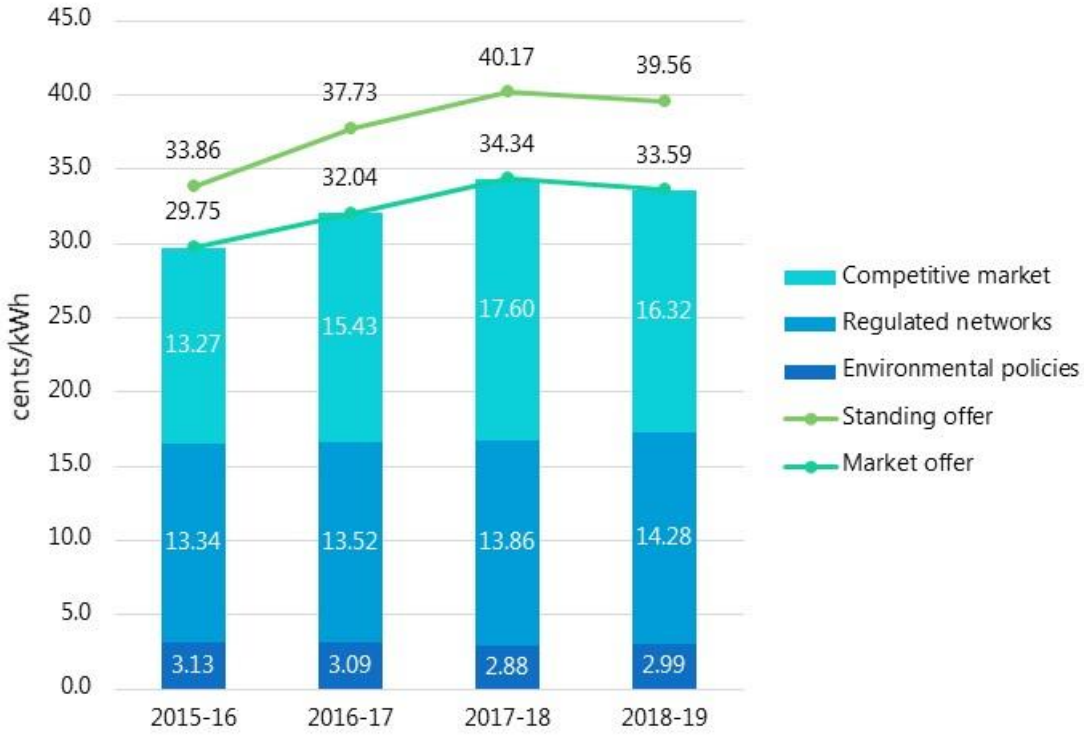
Energy savings

Electricity costs as faced by residential consumers are built up from costs incurred throughout the electricity supply chain. Figure 15 presents data published by the Australian Energy Market Commission (AEMC) that provides a recent snapshot of the proportion of each cost component that makes up residential bills in South Australia.

Reductions in energy costs considered sensitive to change in energy efficiency standards for Class 2 buildings include wholesale or generation costs (presented within the 'Competitive market' segment in Figure 15 – a value which also includes retail costs) and avoided network costs (regulated networks) where there are reductions in peak demand and therefore alleviation or deferment of constraints on the network. The assumptions underpinning our estimation of these two forms of energy savings are discussed in turn.

Note that energy savings in this report refers only to electricity savings as dwellings in Class 2 building in South Australia are not expected to incorporate gas for heating going forwards.

Figure 15: Trends in South Australia supply chain components



Source: AEMC, 2016 Residential Electricity Price Trends data (EPR0049)[36]

Electricity prices

Our energy price assumptions are based on the forecast reports produced by the Australian Energy Market Operator (AEMO) for both electricity and gas. There is enormous uncertainty about future energy prices in Australia at present. Electricity prices have already risen strongly over the past decade, and future trends are clouded by considerable uncertainty about NEM

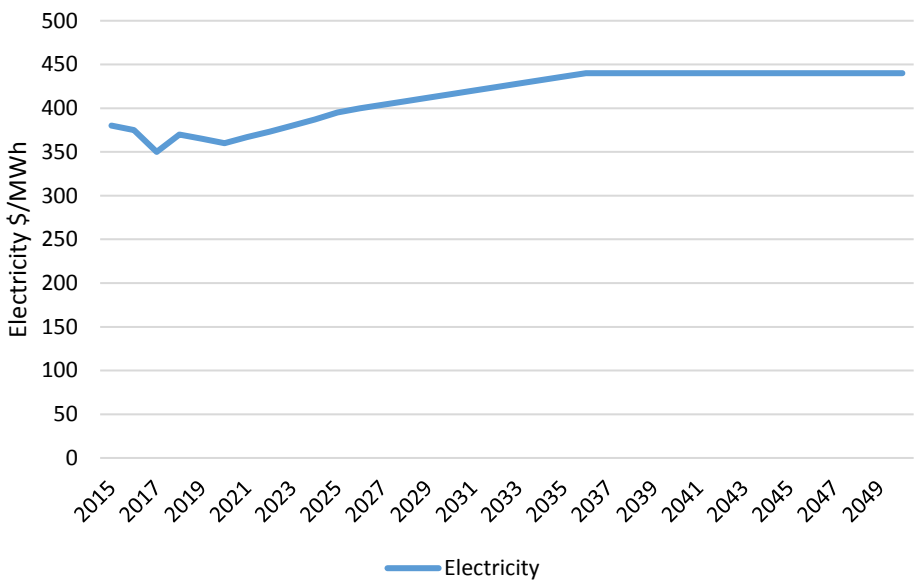
[36] Data available from: http://www.aemc.gov.au/Markets-Reviews-Advice/2016-Residential-Electricity-Price-Trends#

policies in particular – with the Finkel Review (Independent Review into the Future Security of the National Energy Market) having been released in June 2016. At the time of writing no formal government responses have been made to its large number of recommendations. In addition to that, key market based trends include a continuing steep reduction in the costs of new renewable energy technologies – notably solar and wind – but offset at the system level to some degree by the need for 'firming' investments either in storage, demand management, fast-start or flexible fossil fuel generation (usually gas), or some combination of these.

Our approach is to look through the short term noise and uncertainty, and adopt AEMO's price outlooks – not because we believe they are likely to prove more accurate than anyone else's, but rather because they provide an ongoing annual reference point which – if adopted in benefit cost analyses more generally – helps to limit random variation in results, and instead assist in the comparability of results realised in related studies. We note that the Australian Government advocates this approach, and for the same reason of consistency and comparability in results. Note that varying energy prices are tested in scenario analysis, as reported in Section 5.7 below.

Electricity prices used for modelling are from the 'residential retail' outlook scenario from AEMO's *National Electricity Forecasting Report*, 2016. Note that this report projects prices to 2037 only, and we assume constant real prices thereafter.

Figure 16: Energy Price Projections, Retail Residential, South Australia ($/MWh, $/GJ, 2016 real prices)



Source: AEMO, National Electricity Forecasting Report, 2016

Avoided network costs

The overall methodology used to value network savings draws from analysis conducted by the Institute for Sustainable Future and Energetics in a report prepared for the Department of Climate Change and Energy Efficiency, and is known as the Conservation Load Factor (CLF) method.[37]

[37] Institute for Sustainable Future and Energetics, *Building our savings: Reduced infrastructure costs from improving building energy efficiency,* report prepared for the Department of Climate Change and Energy Efficiency, July 2010. Available at: https://industry.gov.au/Energy/EnergyEfficiency/Documents/04_2013/building_our_savings.pdf

Input values including the CLF were informed by two additional references by Oakley Greenwood/Marchment Hill and SKM MMA.[38,39]

The reduction in energy that is attributable to avoided network costs is calculated based on the following formula:

$$\text{Peak demand reduction}^{i}_{\text{Summer, Winter}} = \frac{\dfrac{\text{Annual energy usage reduction}^{i}_{\text{jurisdiction}}}{8{,}760\ \text{h}}}{\text{CLF}^{i}_{\text{Summer, Winter}}}$$

Rearranging the above formula, the Conversion Load Factor (CLF) for a specific energy saving technology is defined as "…its average reduction in load divided by its peak reduction in load (annual energy savings in MWh divided by number of hours per year divided by system co-incident peak reduction (in MW))".[40]

The calculation of avoided network and electricity system infrastructure as a consequence of an improvement in energy efficiency is a complex calculation, potentially affected by many factors. It is not within the scope of this project to re-estimate appropriate values for South Australia. SKM note:

> *Due to…complexities discussed [in its Report], there is no definitive approach to produce a value per kW of peak demand reduction. Depending on the timing and location in the network, the value can vary from zero up to several times the average capacity cost, with large project deferral values tending to lie within this range. (p. 33)*

The Conversion Load Factor (CLF) used here is 0.10. This is based on the value appropriate for space conditioning end uses, as indicated in Oakley Greenwood et al (pp. 71-71). This is selected since the primary effect of a change in star rating is to change the demand for space conditioning. Space conditioning is a 'peaky' load, in that it is strongly correlated with temperature variability.

The avoided networks cost savings are then calculated as a multiple of the peak demand reduction and the average value of electricity infrastructure savings:

Avoided network expenditure = Peak demand reduction x average value of electricity infrastructure savings

Here we have used a value of $310,000/MW.a for the average value of electricity infrastructure savings, although we note that higher values are found in the literature cited above. Indeed, SKM cites a value of $2.44 million/MW for South Australia (p. 34), but notes that this value was derived using 5-year proposed system augmentation capital expenditure estimates and, as such, could be biased upwards. The more conservative value used here reflects past feedback from network businesses, who note that overall network expenditure has slowed markedly in recent years. On this basis, the value of avoided network costs is modelled to reach around $235,000 per year.

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38 Oakley Greenwood/Marchment Hill, Stocktake and Assessment of Energy Efficiency Policies and Programs tht Impact or Seek to Integrate with the NEM: Stage 2 Report, August 2012.

39 SKM/MMA, Energy Market Modelling of National Energy Savings Initiative Scheme – Assumptions Report, December 2011.

40 Oakley Greenwood et al, p. 70

The exact relationship between the mooted Code changes and avoided network investment would require separate – and potentially quite elaborate – analysis. Some relevant considerations would include:

- Modelling of 'thermal lag', or how long the benefits of more efficient envelopes last in heatwave conditions. This depends on many factors (housing size and form, thermal mass, degree of sealing and insulation, etc) and each heatwave event is also unique in terms of its severity, duration and diurnal range.
- More efficient dwellings will tend to heat up more slowly in heatwave conditions, as they tend to be better sealed, better insulated and may have better use of internal thermal mass.
- There is the risk that if a heatwave event goes on long enough, these factors could be swamped, but the counter-view is that day/night temperature variations still occur during a long heatwave, and the more efficient dwellings can cool down sufficiently (with heat pumps) to be able to regain enough thermal inertia to manage the next day.
- Occupant behaviours – such as 'pre-cooling' overnight, and opening and closing of windows – may become critical in heatwave conditions.
- Whether or not demand management schemes are in operation, for example to limit the power demand of air conditioning compressors during peak demand conditions.

5.2.7 Policy-affected cohort

This study examines scenarios for changed Code energy performance requirements. To quantify the benefits and costs associated with such changes, we need to assume:

- When the new measure would begin?
- When the measure would end?
- What is the economic life of the buildings built to the new standard?

We assume that the measure would take effect from 1 July 2019, the beginning of FY2020. In reality, Code changes in Australia tend to take effect from 1 May in the relevant year, but there is also a delay associated with the take-up of the new standard, as developments that already have building approval at that date are allowed to be completed at the old standard, while the new standard applies to buildings that receive development approval from 1 May.

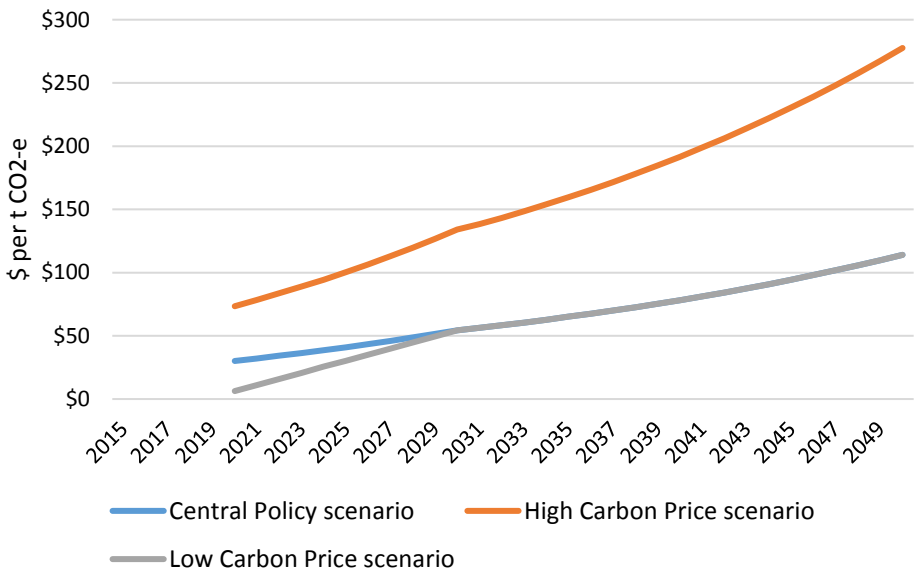
In terms of an end date, the notional practice of the Australian Building Codes Board is to review and potentially revise standards every three years, and we assume SA will do the same. That said, there is no evidence that standards were reviewed in either 2013 or 2016. We therefore assume that two regulatory periods (of three years each) are likely to pass for standards are again changed. This means that the mooted new standards would apply to the 'cohort' of Class 2 buildings built from 1 July 2019 to 30 June 2025. Note that the size of the cohort will affect the total energy and greenhouse gas savings that accumulate over time, but will not materially affect the benefit cost analysis, as lengthening the cohort period adds both costs and benefits in a proportionate manner.

Finally, the economic life of a house is conventionally assumed to be 40 years, however it is not as clear whether the current Class 2 buildings will prove as durable. An assumption of 30 years average economic life would be more conservative, but the effect of discounting means that the difference between these two, on the present value of energy costs for example, is virtually indistinguishable. As noted below, since we only model building stock turnover to 2050, our calculations assume a conservative maximum economic life of 30 years.

5.2.8 Shadow carbon price

We assume a shadow price for carbon; that is, that avoided emissions of greenhouse gases have value (see Figure 17). For this, we apply the 'Central Policy Scenario' projected by ACIL Allen in the context of the Climate Change Authority's 2013 *Targets and Progress Review*.[41] While these values date from 2013, it is notable that the Australian Government has not updated these values since, and indeed they remain the consultant's assumptions, rather than officially-endorsed values. These values are applied to the quantities of greenhouse gas emissions savings noted above. Other values are tested in sensitivity analysis. On this shadow carbon price assumption, the value of avoided emissions is less than $17,000 per year.

Figure 17: Shadow Carbon Price Assumptions (2011-12)



Source: ACIL Allen, 2013

5.2.9 Industry training and design costs

Training and re-design costs are assumed to occur only in the first three years following commencement of the reforms (2018, 2019, and 2020). As the changes required to comply with the options are very modest, these costs are assumed to be minimal, and likely to be accommodated within existing continuous professional development programs.

Nevertheless, the modelling assumes costs of $50,000 per year on training and awareness for the first three years spread across the industry.

5.2.10 Learning rates

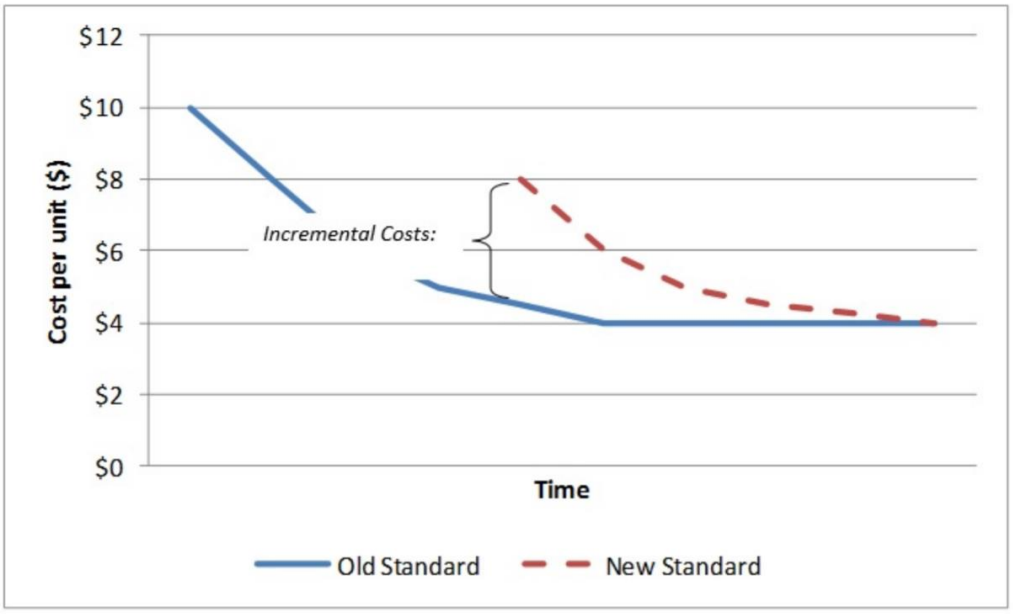
The learning rate is the rate at which extra costs that occur delivering new or innovative products decrease over time as firms adapt, adopt new technology and revise their designs and/ or production processes.

[41] ACIL Allen Consulting (2013) *Electricity Sector Emissions: Modelling of the Australian Electricity Generation Sector*, 4 September. Available from: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Electricity-Sector-Emission-to-2050/Electricty%20sector%20emissions.pdf

A learning rate of 2% per annum is assumed to reduce the average compliance costs over the period 2018 to 2025, based on the Houston Kemp report, *Residential Buildings Regulatory Impact Statement Methodology*.[42] Sensitivity tests have been undertaken at 0% and 5% learning rates.

The learning effect is described in more detail in pitt&sherry's 2016 report on *Commercial Building Learning Rates*.[43] Figure 18 (below) indicates a stylised situation where the incremental costs of complying with new standards reduces over time, eventually reaching the same cost as the previous standard.

Figure 18: Learning effects leading to zero incremental costs



Source: Pitt&Sherry, 2016

5.2.11 Compliance levels

The compliance levels impact the ability for meaningful impacts to result from changes in regulations. Both the current and future expected rate of under- and over-compliance impact costs and benefits. Under-compliance means costs are not incurred and similarly benefits are not delivered, whilst over-compliance can mean both the costs and the benefits of the reforms may be lower than expected.

For the purpose of the CBA, compliance rates only impact net outcomes if the rates alter between the base case and reform options. Measures enabling compliance under the changed reform options are expected to be consistent with current measures. As such, no change in compliance is expected. Lagged-compliance resulting from delays between the introduction of revised standards and industry updating their knowledge base are accounted for in the learning rate (detailed above).

42 Houston Kemp (2017) *Residential Buildings Regulatory Impact Statement Methodology*, 6 April.

43 Pitt&Sherry (2016) *Commercial Building Learning Rates: Final Report*, report prepared for the Department of Industry, Innovation and Science, 3 August. Available at: http://www.environment.gov.au/system/files/energy/files/learning-rate-methodology-final-report.pdf

5.3 Base case: 6 star average rating, 5 star minimum individual rating

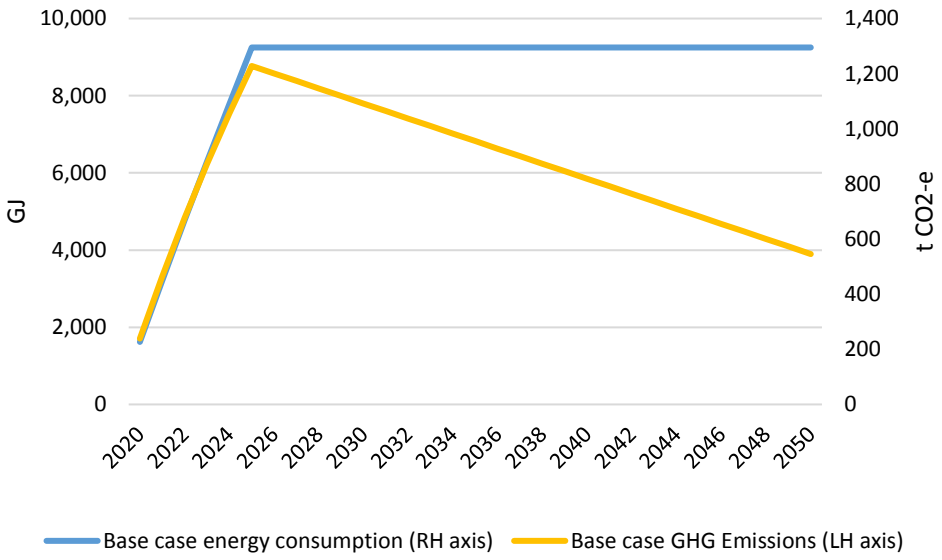
As noted in Chapter 4, the base case describes a 'business as usual' world in which, in particular, the current NCC requirements continue to apply to Class 2 dwellings throughout the regulatory period (i.e. to end FY2025). That is, Class 2 buildings must achieve an average star rating of 6 star, and a minimum star rating of 5 star.

We project the energy consumption by fuel, and the greenhouse gas emissions that would result from these performance requirements applying to the stock turnover described above based on the AccuRate simulations described in Chapter 4.

5.3.1 Energy consumption

Figure 19 below shows the space conditioning energy use of the cohort of buildings, constructed between 1 July 2019 and 30 June 2025, over the period to 2050. Note that this implies an average building economic life of 30 years, for the buildings built in FY2020, and just 25 years for those built in 2025, as we only model these buildings to 2050.

Figure 19: Energy consumption and greenhouse gas emissions, base case (regulated cohort)



Source: Strategy.Policy.Research, 2017

In Figure 19, energy consumption rises over the 6 year regulatory period, as new buildings are added each year. From 2026 onwards, we assume no new buildings are added (at the prevailing standard), effectively shutting off the regulated cohort at that date. This cohort then continues to use the same amount of energy annually (on average) for space conditioning purposes out to (at least) 2050. The greenhouse gas emissions associated with this energy consumption, however, fall over time, as we assume a declining greenhouse gas intensity of electricity consumption over time (see section 5.2.6), along with 100% electricity consumption for space conditioning purposes, in our reference scenario.

This scenario – of the energy consumption and greenhouse gas emissions associated with a six-year cohort of buildings built to the current NCC standard over the period to 2019 – 2025, and remaining in place until 2050 – defines our reference case against which the three policy scenarios below are compared.

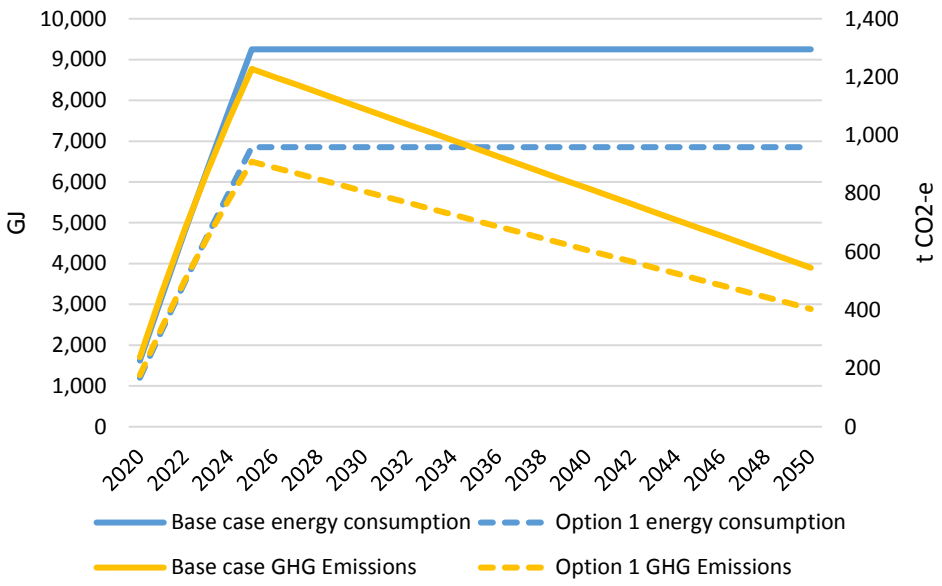
5.4 Option 1: 7 star average, 6 star minimum individual rating

As discussed in Chapter 4, this option differs from the base case in that it assumes that the FY2020 – FY2025 cohort of Class 2 dwellings is built to a 7 star average, 6 star minimum requirement. The resulting star ratings and maximum heating and cooling loads for each apartment and climate zone were shown in Chapter 4.

5.4.1 Quantity of savings

Applying these values to our stock turnover model results in the following energy and greenhouse gas emissions savings, as shown in Figure 20 below.

Figure 20: Energy consumption and greenhouse gas emissions, option 1 and base case

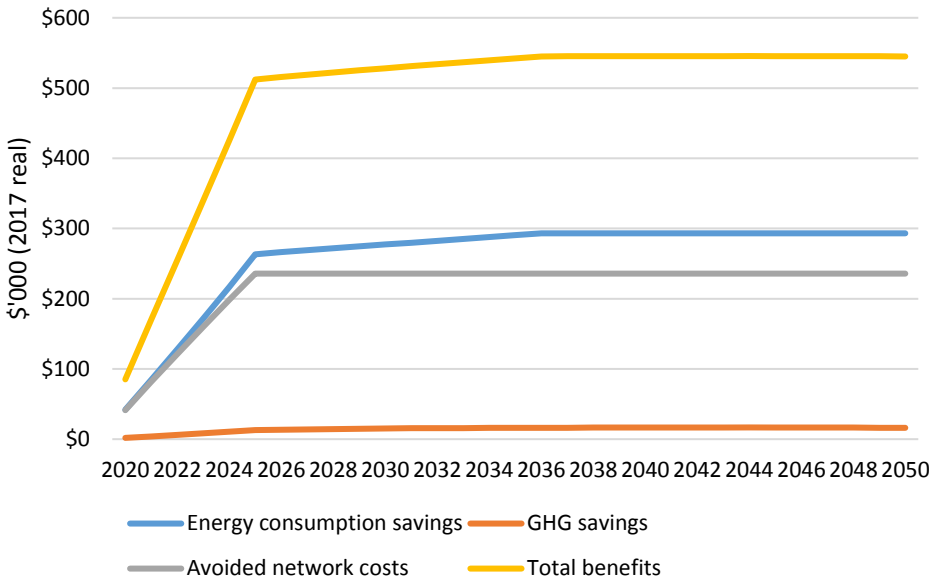


Source: Strategy.Policy.Research, 2017

Figure 20 indicates that option 1 would deliver significant energy and greenhouse gas emissions savings. The cohort would save around 68 TJ of energy, and up to 6,834 t CO2-e, per year.

Compiling the three benefit streams noted above results in the following values for option 1 – see Figure 21 below.

Figure 21: Value of benefits by type, option 1



Source: Strategy.Policy.Research, 2017

5.4.2 Value of Costs

The incremental costs of achieving the performance outcomes described in Chapter 4 were independently quantified by quantity surveyors, Daniel Cant Watts Corke. Details of these costings are provided in Appendix 1.

For option 1, the average incremental costs of compliance relative to the base case are as shown in Table 18 below. These are the costs associated with the changes (relative to the base case) specified in Chapter 4.

Table 18: Average incremental costs of compliance, option 1

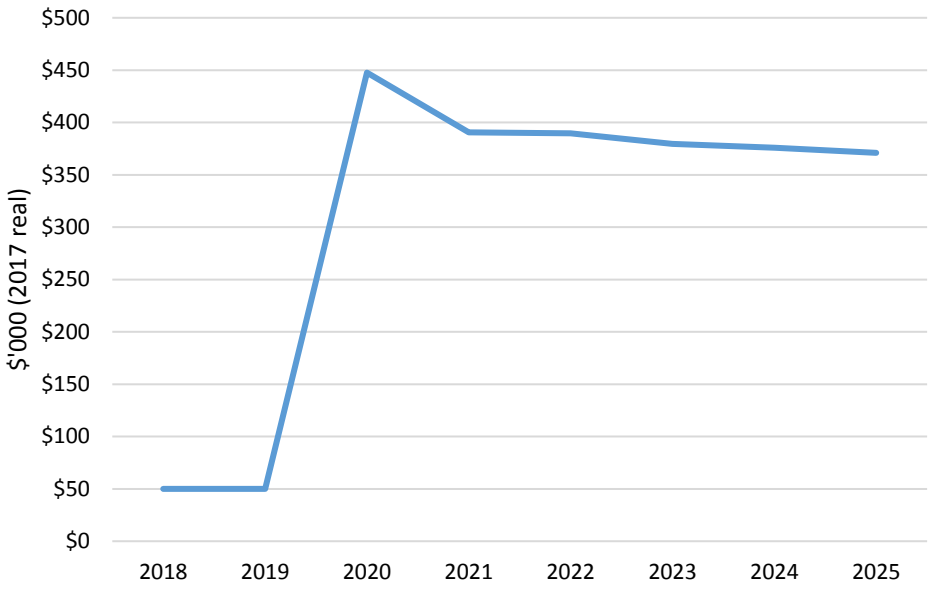
Climate Zone	Cost ($/sqm)
Adelaide	$8.09
Ceduna	$4.22
Mt Gambier	$7.42

Source: Strategy.Policy.Research, 2017

These costs relate to the current period, and we apply a 2% per year learning rate, or reduction in the incremental cost of compliance, in line with the recommendations of the Houston Kemp report, *Residential Buildings Regulatory Impact Statement Methodology*.[44] On this basis, the total annual costs of compliance around to a little under $400,000 in FY2020, falling to $370,000 by FY2025. To this we assume that some $50,000 per year is expended by the State Government to assist in alerting the SA industry to the change and in providing or assisting with the provision of training courses, in the two years leading up to the change and in the first year of implementation. Total costs therefore appear as shown in Figure 22 below.

[44] Houston Kemp, *Residential Buildings Regulatory Impact Statement Methodology*, 6 April 2017.

Figure 22: Total incremental costs of compliance (compared to the base case), option 1



Source: Strategy.Policy.Research, 2017

5.4.3 Net benefits and summary indicators

Figure 23 below shows that option 1 would initially generate net social costs, during the period when training and awareness costs, and then incremental construction costs, are being incurred. The value of savings climbs steadily each year, and by FY 2024 net benefits are being achieved. The net benefits then climb to over $500,000 per year for at least the period until 2050 (recalling our conservative economic life assumption for housing).

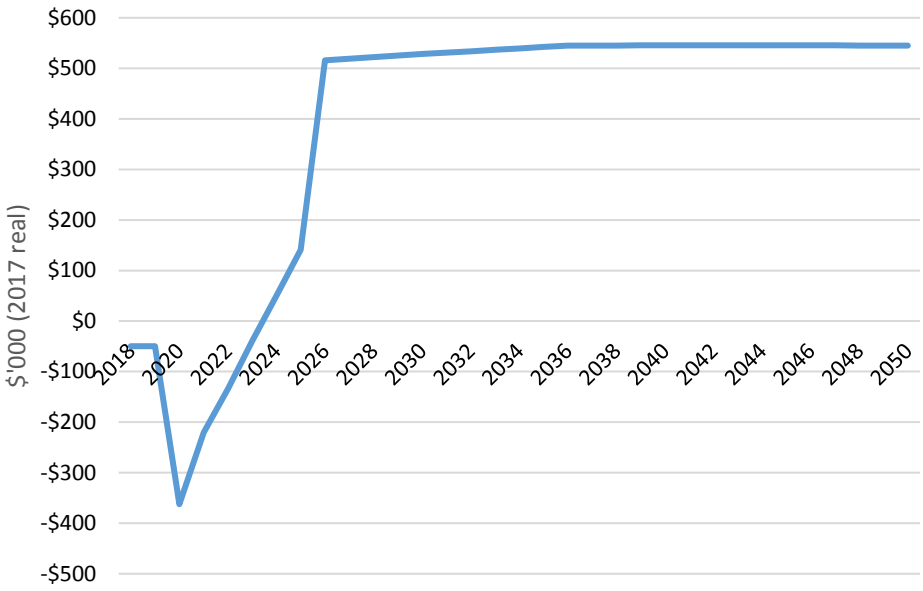
In terms of key indicators, option 1 is shown to be highly cost effective and – as will be demonstrated – the most valuable of the three policy options studied. The net present value of option 1 is just over $3 million, with a benefit cost ratio (averaged across the three climate zones) of 2.8. This option generates a social return on investment (equivalent to an interest rate on a public investment) of 24% per annum. See Table 19 below.

Table 19: Summary of benefit cost analysis indicators by region, option 1 ($2017, real)

Indicator	Adelaide	Ceduna	Mt Gambier	Total
Present value of benefits	$4,412,958	$107,720	$277,183	**$4,797,862**
Present value of costs	$1,618,473	$50,399	$65,614	**$1,734,486**
Net Present Value				**$3,063,376**
Benefit Cost Ratios	2.7	2.1	4.2	**2.8**
Social Return on Investment	24%	18%	40%	**24%**
Cumulative Energy Savings 2020 – 2050 (TJ)				**68**
Cumulative GHG Emissions Savings 2020 – 2050 (t Co2-e)				**6,834**

Source: Strategy.Policy.Research, 2017

Figure 23: Annualised net economic benefit, option 1



Source: Strategy.Policy.Research, 2017

5.5 Option 2: No average rating, 6 star minimum individual rating

This option has many similarities with option 1, as discussed in Chapter 4. The primary difference is that the average star rating that applies across apartments in a building is not specified. This enabled some apartments to be 'detuned' somewhat, reducing their costs (and benefits), while still delivering on the requirement for every apartment to be at least 6 star.

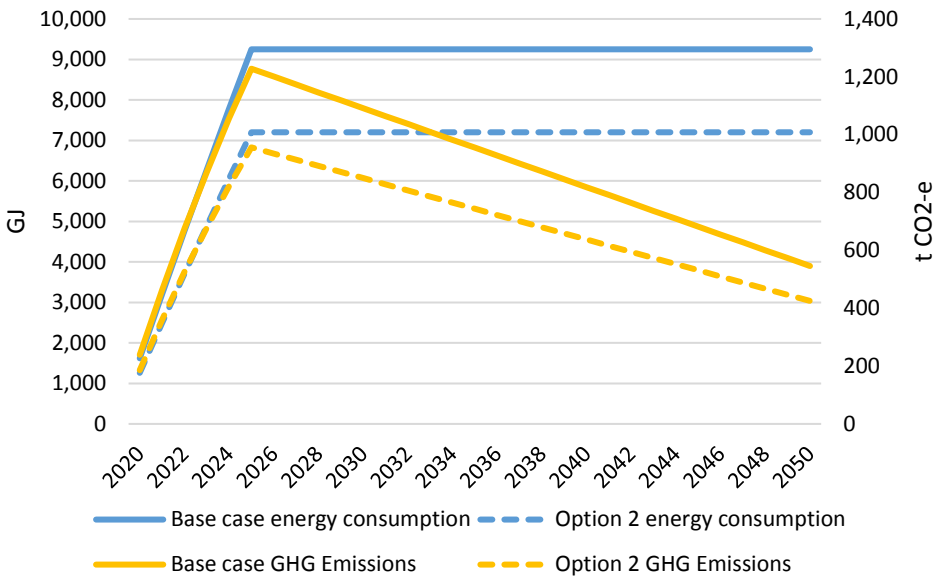
We note that, as modelled, some apartments over-comply with the requirement, particularly in the Mt Gambier and Ceduna climate zones. In principle, it would be possible to vary designs and/or specifications more, from unit to unit, and further reduce the costs of compliance. However, this would also introduce more variation in specification from one unit to the next, which is not consistent with conventional industry practice. As noted in the reference scenario above, there is very wide variation in the star rating performance of apartments within a typical Class 2 building already, and no evidence that builders detune individual apartments to just meet compliance requirements – although it would be perfectly legal to do so. We note, therefore, that it is possible that the incremental costs of compliance reported below are on the high side, making the overall analysis more conservative.

Noting the similarities with option 1, option 2 key results are reported in a more summary manner.

5.5.1 Quantity of Savings

Figure 24 below shows the space conditioning energy consumption and greenhouse gas emissions savings generated by option 2. The savings are somewhat less than for option 1, with energy savings peaking at just over 59 TJ per year (compared to 68 TJ for option 1), and greenhouse gas emissions savings of 5,838 t CO2-e (compared to 6,834 t CO2-e for option 1).

Figure 24: Energy consumption and greenhouse gas emissions, option 2 and base case

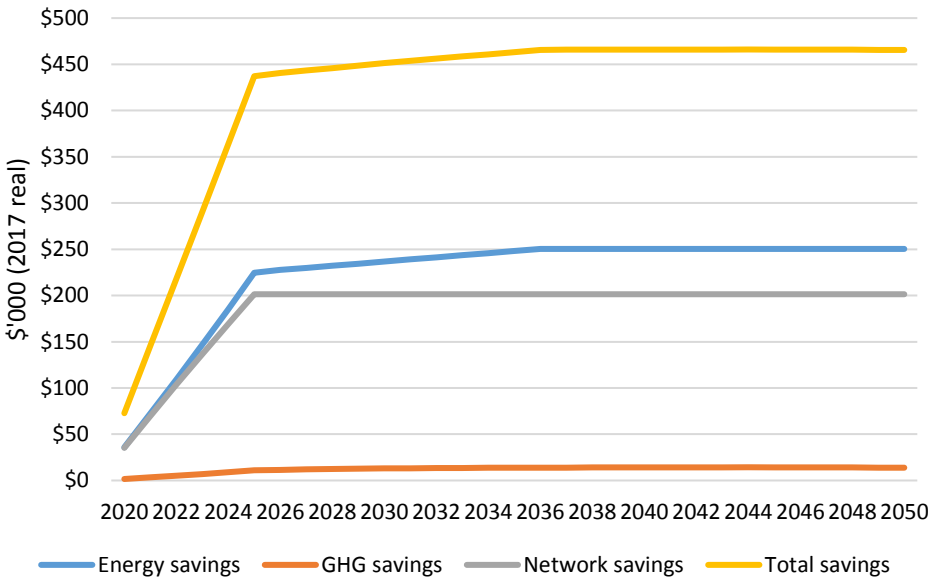


Source: Strategy.Policy.Research, 2017

5.5.2 Value of Savings

The value of savings for option 2 is similar to, but slightly less than, option 1, as summarised in Figure 25 below. The total value of benefits reaches almost $460,000 per year, compared to some $545,000 for option 1.

Figure 25: Value of benefits by type, option 2



Source: Strategy.Policy.Research, 2017

5.5.3 Value of Costs

For option 2, and reflecting the discussion in Chapter 4, incremental costs are somewhat lower than in option 1, given the opportunity this option offers to detune certain apartments – notably

in Ceduna and Mt Gambier, relative to the Adelaide specification – and thereby avoiding some costs. The average incremental costs of compliance relative to the base case for option 2 are summarised in Table 20 (below).

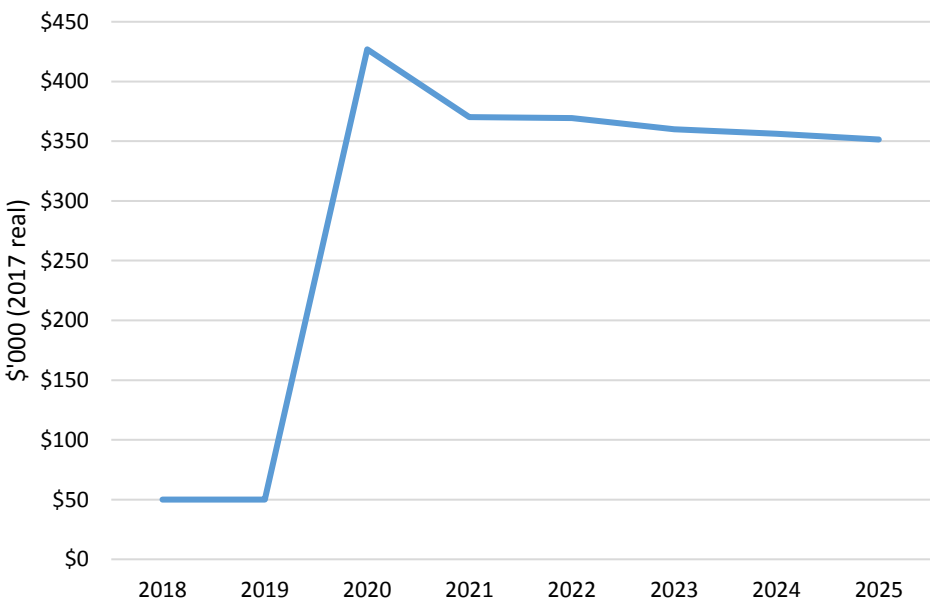
Table 20: Option 2 - Average incremental costs of compliance

Climate Zones	Cost ($/sqm, 2017 real)
Adelaide	$7.68
Ceduna	$3.81
Mt Gambier	$7.01

Source: Strategy.Policy.Research, 2017

Again applying a 2% annual learning rate to these costs, and also allowing $50,000 per year for three years for training and redesign costs, the annualised costs would appear as shown in Figure 26.

Figure 26: Total incremental cost of compliance (compared to the base case), option 2

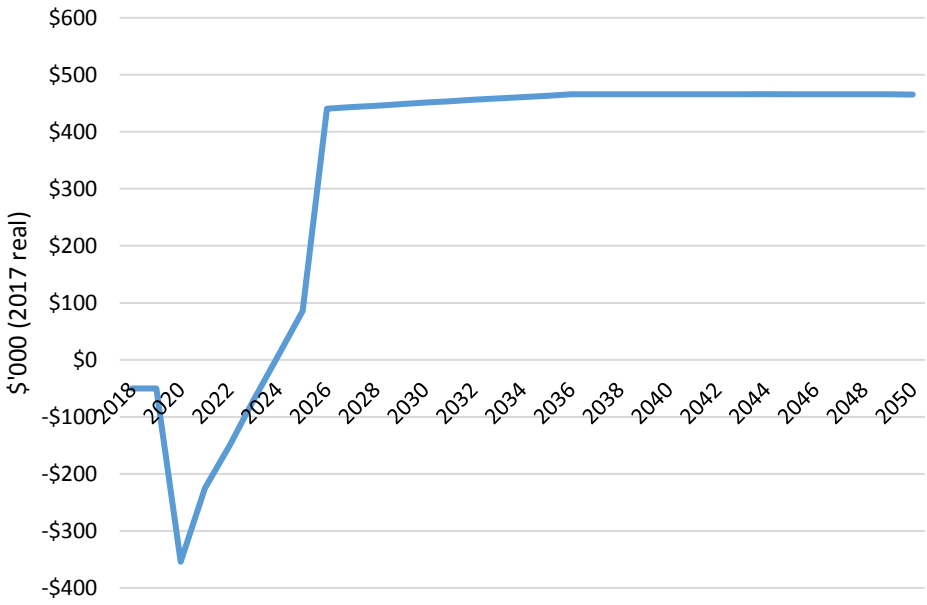


Source: Strategy.Policy.Research, 2017

5.5.4 Net benefits and summary indicators

Consistent with the above trends, the overall shape of the net economic benefit trace over time for option 2 is similar to option 1, but shifted downward towards slightly lower net benefit levels. The net economic benefit levels out at around $465,000 per annum for option 2, compared with $545,000 for option 1.

Figure 27: Annualised net economic benefit, option 2



Source: Strategy.Policy.Research, 2017

Table 21 below summarises the key benefit cost indicators for option 2. The net economic benefit associated with this option (net present value) is just under $2.5 million, on the reference real discount rate of 7%, compared to just over $3 million for option 1. The benefit cost ratio remains strong, at 2.3, but slightly less than for option 1 which has a benefit cost ratio of 2.8. Finally, the social return on investment is a little lower than for option 1 at 22% per annum – still a very healthy return, more than three times higher than the discount rate.

Overall, option 2 is attractive and offers clear net economic benefits, but to a lesser degree than for option 1.

Table 21: Summary of benefit cost analysis Indicators by region, option 2 ($2017, real)

Indicator	Adelaide	Ceduna	Mt Gambier	Total
Present value of benefits	$3,610,602	$170,479	$317,621	**$4,098,702**
Present value of costs	$1,542,505	$46,142	$62,272	**$1,650,919**
Net Present Value				**$2,447,784**
Benefit Cost Ratios	2.3	3.7	5.1	**2.5**
Social Return on Investment	20%	32%	49%	**22%**
Cumulative Energy Savings 2020 – 2050 (TJ)				**59**
Cumulative GHG Emissions Savings 2020 – 2050 (t Co2-e)				**5,838**

Source: Strategy.Policy.Research, 2017

5.6 Option 3: Separate heating & cooling caps

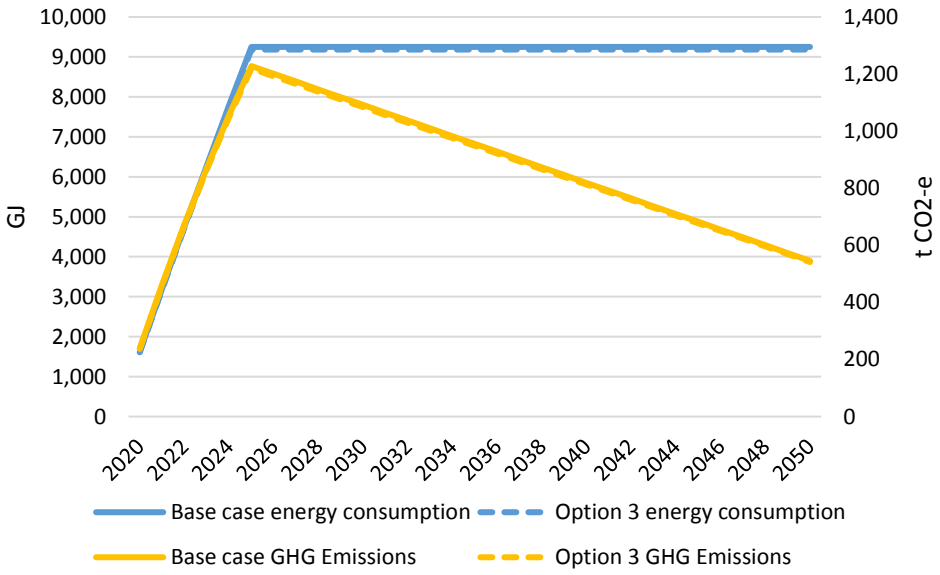
This option involves relatively few changes from the reference scenario, as described in Chapter 4. As a result, there are relatively few costs incurred, but also relatively small benefits created. The results for this option are presented in a summary manner.

5.6.1 Quantity of savings

Figure 28 below shows the space conditioning energy consumption and greenhouse gas emissions savings generated by option 3 compared to the base case

The energy and emissions savings for option 3 compared to the base case are hard to discern on this chart, as they amount to only around 2 GJ of energy and less than 187 t CO2-e.

Figure 28: Energy consumption and greenhouse gas emissions, option 3 and base case

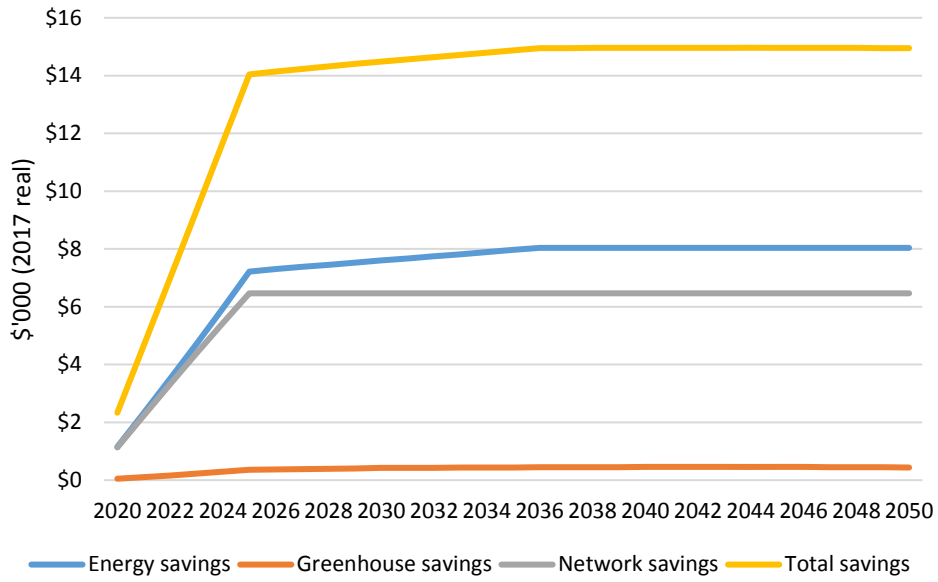


Source: Strategy.Policy.Research, 2017

5.6.2 Value of Savings

The value of savings for option 3 is also low, peaking at around $15,000 per year in total – see Figure 29 below.

Figure 29: Value of Benefits by class, option 3

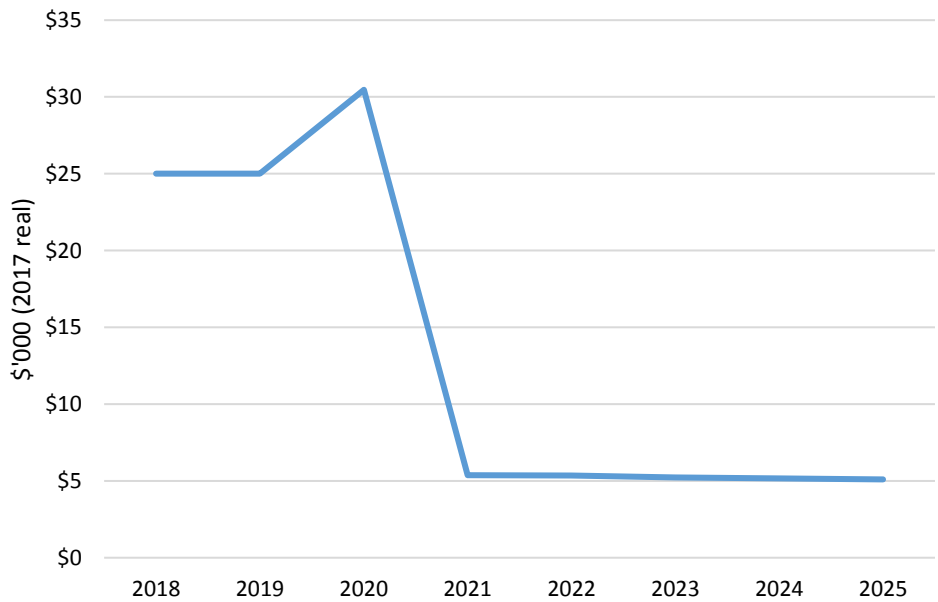


Source: Strategy.Policy.Research, 2017

5.6.3 Value of costs

Given the minor nature of changes involved in this option, we have revised downwards our allowance for government training and communication costs to $25,000 per year for 3 years (potentially still more than needed). This revision reflects that no changes are required for apartments built in the Adelaide region so effectively compliance costs would only be incurred in Ceduna and Mt Gambier. This results in the total costs of compliance shown in Figure 30 below.

Figure 30: Total incremental costs of compliance (compared to the base case), option 3

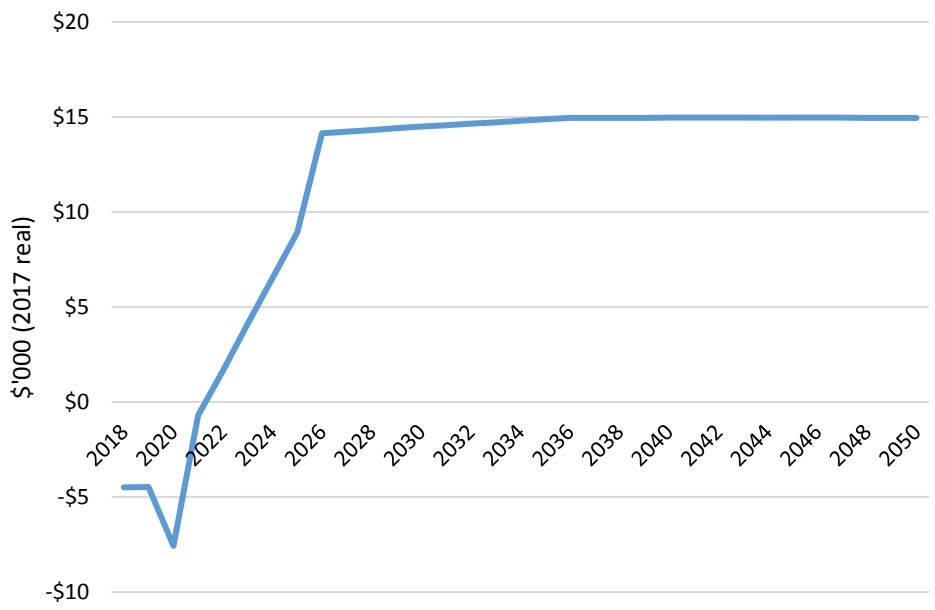


Source: Strategy.Policy.Research, 2017

5.6.4 Net benefits and summary indicators

While the shape of Figure 31 is similar to those for options 1 and 2 – costs upfront overtaken by benefits over time – the absolute values are much smaller, with the net economic benefit levelling out at some $15,000 per year.

Figure 31: Net economic benefits, option 3



Source: Strategy.Policy.Research, 2017

Despite this, option 3 has a positive net present value, delivering a small net present value of $97,829. The benefit cost ratio for option 3 is the highest of all the options studied, at 3.9, while the social return on investment is also the highest at 29% (Table 22).

Table 22: Summary of benefit cost analysis indicators by region, option 3 ($2017, real)

Indicator	Adelaide	Ceduna	Mt Gambier	Total
Present value of benefits	$0	$39,693	$91,904	**$131,597**
Present value of costs	$0	$12,897	$20,871	**$33,768**
Net Present Value				**$97,829**
Benefit Cost Ratios	n/a	3.1	4.4	**3.9**
Social Return on Investment	n/a	22%	35%	**29%**
Cumulative Energy Savings 2020 – 2050 (TJ)				**2**
Cumulative GHG Emissions Savings 2020 – 2050 (t Co2-e)				**187**

Source: Strategy.Policy.Research, 2017

These results provide a useful illustration of the relative significance of different benefit cost analysis indictors.

The most important indicator for comparing policy options is the net present value (NPV) of the measures. This metric indicates the net economic benefit (that is, the present value of total benefits minus the present value of total costs) associated with the option. The higher this value, the higher the net economic benefit created. On this basis, option 1 is the preferred option

(with just over $3 million of present value net benefits), and option 3 the least preferred (with only around $98,000 of present value net benefits).

Benefit cost ratio (BCR), on the other hand, only provides an indication of the *relative* sizes of benefits and costs, and is therefore a poor predictor of the solution that will generate the most value for society. Similarly, the social rate of return indicator tells us the annual percentage return on the social investment undertaken, but it ignores the size of that investment, and therefore the size of the benefit created.

5.7 Sensitivity Analyses

This section presents summary results of varying key inputs to the analysis. We test the following variables:

- Discount rate
- Energy prices
- Shadow carbon prices
- Incremental costs
- Learning rates.

The objective of sensitivity analysis is to determine if one or more assumptions or variables in the analysis are critical to the reported results and, more broadly, to test the extent to which the options remain cost effective – and retain the same order of priority – in the face of reasonable variation in these input values.

5.7.1 Discount rates

In line with Houston Kemp's *Review of the Residential Building Regulatory Impact Statement Methodology*[45] our default value for the real discount rate was 7%, while values of 10% and 3% are tested in sensitivity analysis. The higher the real discount rate, the greater is the weighting, in present value results, of values in the near-term, such as in the first 10 years, while values further out have little impact on the analysis. If a real discount rate of 0% were selected, values from all periods would have equal weighting.

Table 23 below indicates that while the real discount rate assumption changes the absolute values of the net present value (NPV) and benefit cost ratio (BCR) indicators, NPVs remain positive in all cases, and BCRs remain comfortably above 1 in all cases. Further, the 'order of merit' of the three options remains the same, regardless of the real discount rate selected.

Table 23: Sensitivity analysis results – Real discount rate

	Real discount rate of 3%		Real discount rate of 7% (central case)		Real discount rate of 10%	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$6.8m	4.2	$3.06m	2.8	$1.7m	2.1
Option 2	$5.6m	3.8	$2.45m	2.5	$1.3m	1.9
Option 3	$0.2m	6.1	$0.10m	3.9	$0.06m	2.9

[45] Houston Kemp (2017) *Review of the Residential Building Regulatory Impact Statement Methodology*, 6 April.

Source: Strategy.Policy.Research, 2017

5.7.2 Electricity prices

To test the sensitivity of the results to possible changes in electricity prices, we have assumed that price of residential retail electricity varies, from the reference case, by +/- 30%. The results are shown in Table 24 below.

Table 24: Sensitivity analysis results –Electricity prices

	-30% electricity prices		Electricity prices (central case)		+30% electricity prices	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$2.3m	2.3	$3.06m	2.8	$3.8m	3.2
Option 2	$1.8m	2.1	$2.45m	2.5	$3.1m	2.9
Option 3	$0.1m	3.3	$0.10m	3.9	$0.1m	4.5

Source: Strategy.Policy.Research, 2017

Results from the sensitivity testing indicate that net social benefit of all of the measures is higher when energy prices are higher than expected and lower when energy prices are lower. However, even in the low price scenario, all measures retain their positive NPVs and BCRs greater than 1, while the merit order of the three options remains the same as in the reference case. Overall, we can conclude that the options remain robust in the face of reasonable energy price variations.

5.7.3 Electricity imports

Under the central case, we assume that reduction in electricity consumption from enhanced building design benefit South Australia on the basis that this marginal electricity is imported into the state.

This treatment is consistent with South Australia's position in the National Electricity Market as a net importer of electricity. In 2014, 2015, and 2016 there was 1,797 GWh, 2,210 GWh and 2,637 GWh of electricity imported into South Australia from Victoria respectively[46].

On a half-hour interval basis, South Australia is also largely a net importer of electricity. In 2016, electricity was imported into South Australia across the Victorian to South Australia interconnectors in 86 per cent of half hour intervals for the year[47].

To test the sensitivity of the results to possible changes in the quantity of imports into South Australia and therefore the benefits that may accrue to the state, we have assumed that only 50 per cent and 85 per cent of the electricity saved can be counted as an economic benefit. The remaining amounts are treated as a transfer between customers (and retailers) to generators that are located within the State. The results are shown in Table 25 below.

[46] Data from NEO based on aggregate flows over the VIC-SA (Heywood) interconnector for each calendar year.

[47] Marsden Jacob analysis based on Victorian to South Australia flows for half hour trading intervals on the VIC-SA (Heywood) interconnector in 2016.

Table 25: Sensitivity analysis results – Electricity imports

	50% benefit to SA		85% benefit to SA (central case)		100% benefit to SA (central case)	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$1.81m	2.0	$2.69m	2.5	$3.06m	2.8
Option 2	$1.37m	1.8	$2.13m	2.3	$2.45m	2.5
Option 3	$0.06m	2.9	$0.09m	3.6	$0.10m	3.9

Source: Strategy.Policy.Research, 2017

As expected, results from the sensitivity testing indicate that net social benefit is highest when it is assumed that 100 per cent of electricity saved is accrued as a benefit, and lower for the 85 per cent and 50 per cent sensitivities respectively.

Of note, even in the low imports scenario, all measures retain their positive NPVs and BCRs greater than 1. The merit order of the three options also remains the same as in the reference case. Overall, we can conclude that variations to the assumed import levels of electricity do not alter the options analysis.

5.7.4 Shadow carbon prices

As discussed in Section 5.2.8, the Climate Change Authority commissioned work from ACIL Allen that includes projections of low, central and high estimates for shadow carbon prices, reflecting uncertainty in global and, by implication, local climate policy developments (refer to Figure 17 above). The effect of these scenarios is to vary the value of avoided greenhouse gas emissions.

As noted above, these values are relatively low – compared to the values associated with avoided energy consumption and network expenditure – and therefore they impact relatively little on the benefit cost analysis results, as indicated in Table 26 below.

Note that the scenarios are not symmetrical, in that the high scenario represents a proportionately bigger change, relative to the central scenario, than does the low scenario, hence the Building Code results are shown to be more sensitive to the high scenario. Overall, this is not a material consideration for the analysis, and the preferred order of ranking of options is unchanged.

Table 26: Sensitivity analysis results – Shadow carbon prices

	Low carbon price scenario		Central scenario		High carbon price scenario	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$3.0m	2.8	$3.06m	2.8	$3.3m	2.9
Option 2	$2.4m	2.5	$2.45m	2.5	$2.6m	2.6
Option 3	$0.1m	3.9	$0.10m	3.9	$0.1m	4.1

Source: Strategy.Policy.Research, 2017

5.7.5 Incremental costs

The sensitivity of the benefit cost analysis results to differing estimates of incremental costs is illustrated in Table 27 below, by testing values +/- 30% higher/lower than the estimates prepared by quantity surveyors, Donald Cant Watts Corke. The results are more sensitive to this

assumption than to other variables noted above, but overall the effect of these changed assumptions is modest, adding or subtracting about $0.5 million at the most. All options remain cost effective, even with 30% higher costs, and the order of ranking of the measures does not change.

Table 27: Sensitivity analysis results – Incremental construction costs

	+30% costs		Reference costs		-30% costs	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$3.3m	2.5	$3.06m	2.8	$4.2m	4.4
Option 2	$2.6m	2.2	$2.45m	2.5	$3.5m	3.9
Option 3	$0.1m	3.7	$0.10m	3.9	$0.12m	5.5

Source: Strategy.Policy.Research, 2017

5.7.6 Learning rates

To test the sensitivity of results to learning rates – or the rate of change in incremental costs over time – we vary our reference assumption of 2% per annum to 0% (indicating that the costs of compliance do not change over time) and to 5% per annum (indicating the costs of compliance reduce more quickly than expected based on the reference scenario).

Results are as indicated in Table 28 below. Overall, the results are modestly sensitive to these assumptions, but again not sufficiently to make any option sub-economic or to change the order of ranking of the measures.

Table 28: Sensitivity analysis results – Learning rates

	Learning rate of 0%		Learning rate of 2% (central case)		Learning rate of 5%	
	NPV	BCR	NPV	BCR	NPV	BCR
Option 1	$2.9m	2.6	$3.06m	2.8	$3.3m	3.1
Option 2	$2.3m	2.3	$2.45m	2.5	$2.6m	2.8
Option 3	$0.1m	3.7	$0.10m	3.9	$0.1m	4.2

Source: Strategy.Policy.Research, 2017

5.7.7 Stress test

Our final sensitivity analysis is a stress test. A stress test assumes that the 'worst' happens with all sensitivity variables – energy prices are low, shadow carbon prices are low, a 10% real discount rate is applied, costs are 30% higher than expected, and there is no learning. The results are shown in Table 29 below.

Not surprisingly, this worst case scenario damages the economic performance of each of the options. However, all options remain cost effective, with the lowest BCR falling only to 1.4, and the preferred option 1 still returning a net social benefit (NPV) of over $1 million. Also, the order of merit of the three options is unchanged. This result should give the South Australian government the comfort of knowing that, even if highly adverse circumstances, these policy measures – and particularly the preferred option 1 – would create net economic welfare, in additional to saving energy consumption and greenhouse gas emissions.

Table 29: Sensitivity analysis results – Stress test

	Worst case scenario		Central scenario	
	NPV	BCR	NPV	BCR
Option 1	$1.09m	1.7	$3.06m	2.8
Option 2	$0.77m	1.5	$2.45m	2.5
Option 3	$0.04m	2.3	$0.10m	3.9

Source: Strategy.Policy.Research, 2017

5.8 Limitations of analysis

Builder decision on material

The analysis assumes builders would always choose the lowest cost option to meet the requirements. While this is likely to be the case under most circumstances, there may be perceived trade-offs between different types of materials that have not been considered fully in this analysis and which would alter the outcomes in reality.

Minimal residual value

The model allows for establishment costs in 2018 and 2019 with the policy commencing in 2020.

The model looks at buildings constructed during 2020 – 2025 (inclusive) and looks at the impact on construction cost and on heating/cooling costs over the period from 2020 to 2050 (a 30 year period).

The model effectively assumes no residual value at the end of the period (2050) and no impact on maintenance costs for the life of the building.

Avoided network cost uncertainty

It is also worth noting that AEMO and other regulators are now less convinced with ever expanding demand than they were in 2010 when the previous RIS analysis was undertaken. This is important as the benefit only arises if the network is being expanded due to increased demand.

Similarly (but somewhat conversely) the benefit will also only arise if investment in upgrading the network is actually delayed. This would require the regulator to be confident that peak energy use had actually changed. If there was any risk that after several hot days the peak demand would still be at historical per capita highs, then the investment will still occur and there won't be any benefit.

5.9 Equity and distributional considerations

The following stakeholders have been identified as likely to be impacted by changes to energy efficiency requirements for Class 2 buildings:

- Commonwealth, State and local Government
- Industry
  - Building industry – builders and property developers

  - Energy industry
  - Heating and cooling appliance industry
- Community
  - Property owners
  - Residents and tenants living in Class 2 buildings
- Environment

A summary of the expected impacts by stakeholder group is provided in Table 30 (below).

Table 30: Summary of impacts by stakeholder groups

Stakeholder group		Description of impacts	Modelled impact
Government	Commonwealth and other state and territory governments	The Australian and other state and territory governments will marginally benefit from additional good and services tax (GST) collected as expenditure shifts to more expensive types of building material and to reflect a more costly design stage. Note that this impact is very marginal (around $100 per apartment of additional GST based on the highest increase in building material costs) and as such the impact has not been quantified.	No significant impact
	SA Government	The development and implementation of a South Australian variation to the NCC will be undertaken by the SA Government. Activities to be undertaken include: • development of the changes to regulations • development of industry guidance and information on the new standards • ongoing administration, monitoring and enforcement. Discussions with the Department indicate that each of the above activities will be undertaken as part of existing activities. As such, no additional costs are assumed to be incurred if reform options are implemented. Similar to the impact of expenditure on more costly design and building material on the Commonwealth Government revenue, the SA Government will marginally benefit from an increase in GST. T There is also potential for some additional revenue to the SA Government in the form of increased stamp duty receipts. However, similar to the quantification of GST benefits the impact is likely to be exceedingly marginal.	No significant impact
Industry	Building industry – builders and property developers, designers	The building industry will incur costs associated with the transition and implementation of the higher energy efficiency standards. Additional costs include: • training awareness and re-design costs. • higher material costs where materials required to achieve standards are more expensive – if these costs are not able to be passed on to property buyers (noting we assume costs are passed on in the analysis) and that these costs reduce over time subject to the 'learning rate' (discussed in section 5.2.10).	Cost - Training/redesign costs (absorbed) Cost - Increased buildings construction costs (passed on to apartment owners)

Stakeholder group		Description of impacts	Modelled impact
	Energy industry	Impacts on the energy industry are expected to be mainly limited to the electricity industry. While gas connections feature in some new apartment developments, gas use is mostly limited to cooking, with most apartments relying on reverse-cycle air-conditioning units for both heating and cooling. Reductions in expected electricity consumption from more stringent energy efficiency standards will flow throughout the electricity supply chain. The impact will initial be felt by energy retailers in the form of lower revenue. Subsequent impacts are possible where there is a reduction in peak demand that alters planned network expenditure. Changes in the overall electricity consumption will also flow through to generators as retailers purchase reduced volumes of electricity through the wholesale market. Note: The treatment of energy industry impacts – from a South Australian perspective compared to other areas of the National Electricity Market (NEM) - was assumed in the scope of the project (refer to section 1.2.4).	No significant impact
	Heating and cooling appliance industry	At the very high of energy efficient building design the requirement for heating and cooling appliance becomes obsolete if the outside temperature provides a desirable inside temperature for inhabitants. The changes being considered in this reform however are not expected to reach this point with most new apartments likely have appliances installed in one or two rooms. As such, the impact on the heating and cooling appliance industry is likely to be minimal regarding number of installations. Changes in maintenance and average life of products may be impacted through reduced use of installed appliances, however, due to warranty requirements, changes in behaviour are likely to be minimal and therefore the impact on industry from this will also be minimal.	No significant impact
Community and Environment	Property owners	Property owners will initially bear most of the higher costs of design and construction from increased energy efficiency requirements. Costs will be borne directly by owner-builders (via higher material and design costs) or otherwise passed through to property owners/ investors via developers/ construction companies. The ability for these higher initial costs to be passed on to tenants is subject to competitive pressures across the rental market. Further, recovery of costs (where possible) will only occur over an extended period of time. The net impact on property owners of Class 2 buildings developments is likely to be slightly negative for this reason.	Cost - Increased buildings construction costs (passed on to apartment owners from building industry)

Stakeholder group		Description of impacts	Modelled impact
	Residents and tenants	Residents (or owner-occupiers) and tenants are both likely to benefit from reduced electricity costs as heating and cooling requirements are able to be meet more frequently without external appliances. For owner-occupiers, this benefit is offset by the higher property development or purchase costs that incorporate additional material and design costs. For tenants, the benefits are expected to be greater. Some of the higher property development or purchase costs will be passed on but this relationship is less direct than for owner-occupiers.	Benefit Value of energy consumption savings
	Environment	Reduced electricity consumption will deliver environmental benefits in the form of reduced greenhouse gas emissions. Note: Distribution depends on whether or not there is a carbon price: - Whole community (if no price on carbon) - Home occupier (if there is a price on carbon)	Benefit - Value of GHG Savings
	Community	Value of Avoided Network Expenditure (benefit accrues to all electricity users)	Benefit Value of Avoided Network Expenditure

Equity or distributional considerations

The impacts on stakeholder identified above has been quantified as part of the cost benefit analysis and the NPV results are presented below in Table 31 (below).

Home occupiers (owner-occupiers and tenants) and the environment are the main beneficiaries of changes under the reform options. Home occupiers will receive the greatest benefit in the form of reduced electricity costs as heating and cooling requirements are reduced.

Costs are expected to fall to industry in the form of increased training and redesign costs as well as increased building construction costs (or compliance with Code costs). It is noted that the later cost – increased compliance with Code costs) – are likely to be passed directly onto property owners in the form of higher purchase prices for apartments. As highlighted in the subsequent section, this is expected to be a maximum of around $1,000 per apartment.

Table 31: Distribution of costs and benefits (net present value, $2017)

	Benefit/Cost will be distributed to	Option 1	Option 2	Option 3
Incremental benefits				
Value of Energy Consumption Savings	Home occupier (either owner or tenant)	$2,514,913	$2,148,432	$68,980
Value of greenhouse gas savings	Depends: - Whole community (if no price on carbon) - Home occupier (if there is a price on carbon)	$134,130	$114,585	$3,679
Value of Avoided Network Expenditure	All energy users (whole community is a reasonable proxy)	$2,148,818	$1,835,686	$58,938
TOTAL		**$4,797,862**	**$4,098,702**	**$131,597**
Incremental Costs				
Increased Construction Costs	Property developers (probably passed onto home owners)	$1,603,270	$1,519,703	$22,043
Training/redesign costs	Property developers (probably passed onto home owners)	$131,216	$131,216	$65,608
TOTAL		**$1,734,486**	**$1,650,919**	**$87,651**

Source: Marsden Jacob Associates, Strategy.Policy.Research, 2017

Cumulative regulatory burden

The cumulative regulatory burden considers the effects of multiple layers of regulatory burden on particular groups. In this case, no new layers of regulation are being introduced and as such a cumulative impact has not been examined.

A potential area of concern is the impact of the higher standards on the upfront purchase price of properties for first home buyers and lower income home buyers. For these groups, apartment

purchases are likely to be higher than other forms of housing (due to the relatively lower cost of apartments). The potential impact is examined below.

The average apartment size in South Australia has fallen from a peak of more than 160 sqm in 2010 to around 131 sqm according to an ABS study commissioned by CommSec late last year.[48]

The following table (Table 32) presents the average compliance cost in year 1 (prior to learning rate assumptions taking effect) and the likely average compliance cost per unit based on the 131 sqm average size of apartment from the ABS study.

If the compliance cost was passed on in full to purchasers the incremental cost is estimated to range up to just over $1,000 (total) with the cost of compliance per unit likely to be slightly higher in Adelaide compare to Ceduna and Mt Gambier.

This is relatively small considering the value of apartments can fluctuated much more significantly with market movements. Hence, the impact on potential home owners is not considered to be unduly disproportionate such as to hinder participation in the market by first home buyers or lower income buyers.

The analysis is done as a 'point in time' analysis as prices for apartments tend to fluctuate significantly over time, however the change will remain fairly constant.

Table 32: Impact of changes in apartment purchase price

	Adelaide	Ceduna	Mt Gambier
Option 1			
Average compliance cost (year 1)	$8.09 per sqm	$4.22 per sqm	$7.42 per sqm
Average compliance cost per unit	$1,060	$553	$972
Option 2			
Average compliance cost (year 1)	$7.68 per sqm	$3.81 per sqm	$7.01 per sqm
Average compliance cost per unit	$1,006	$499	$918
Option 3			
Average compliance cost (year 1)	N/A	$0.61 per sqm	$1.93 per sqm
Average compliance cost per unit	-	$80	$253

Source: Marsden Jacob Associates, Strategy.Policy.Research, 2017

[48] The Advertiser, 'Average SA home floor space shrinking', 30 October 2016, Refer to: http://www.adelaidenow.com.au/realestate/news/adelaide-sa/average-sa-home-floor-space-shrinking/news-story/4f9d1035c1c79b53382164cddb0612dd

6. Consultation

Element 5: Consultation is required where there are likely to be significant impacts on business, families, society, the community or the environment, and/or where the views of parties/stakeholders who are affected by the proposal will be an important consideration for decision makers or the agency considering the various alternatives.[49]

As highlighted in section 2.2.3, public priorities in South Australia show a strong preference for carbon neutral and climate sensitive strategies.

During the development of the *South Australia's Climate Change Strategy 2015- 2050: Towards a low carbon economy*, released in November 2015, an extensive public consultation process was undertaken during which more than 300 people attended workshops, 46 people contributed to the online discussion forum and more than 200 written submissions were received.[50]

As highlighted in section 3 (Objectives of Government Action), Target 60 in the Plan targets an improvement in energy efficiency of dwellings by 15% by 2020 (baseline: 2003-04) Milestone of 10% by 2014. [51]

The implementation of six star energy efficiency requirements for new (Class 1) homes has already been implemented as a means to achieving this target (most of Australia since 2011) and extensive consultation has been undertaken to further progress this and Class 2 measures in line with the broader *National Energy Efficient Building Project*[52].

Consultation conducted as part of Phase 1 of the National Energy Efficient Building Project in 2014 has been the most extensive, reaching many of the same industry stakeholders likely to be impacted by changes outlined in this RIS. The consultation with building industry, stakeholders, regulators and policy makers across Australia on issues with the current efficiency standards and options to improve the standards included the engagement of over 1,000 stakeholders from across industry and Australia. Stakeholders participated in the review at the time by:[53]

- providing submissions to the Issues Paper (41 received)
- participating in one of seventeen workshops held in all capital cities and a range of regional centres (covering NCC climate zones 1 – 7, with over 271 participants);

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49 SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 22

50 SA Government, *South Australia's Climate Change Strategy 2015- 2050: Towards a low carbon economy*, November 2015, p. 12. Reports, workshop papers, submission and online forum discussions are available on the SA Government's YourSAy website here: https://yoursay.sa.gov.au/decisions/yoursay-engagements-climate-change-strategy-for-south-australia/about

51 SA Government, *South Australia's Strategic Plan*, 2011, p. 47. For more information refer to: http://www.statedevelopment.sa.gov.au/resources/energy-efficiency/south-australias-energy-efficiency-targets

52 National Energy Efficient Building Project is led by the Government of South Australia's Department of State Development and is co-funded by all Australian states and territories through the Council of Australian Government (COAG) Energy Council. The program commenced in 2012 and Phases 1, 2, and 3 have now been completed.

53 Sustainable Thinking and pitt&sherry, *National Energy Efficiency Building Project*, report prepared for the Department of State Development SA, November 2014, p. vii.

- meeting with members of the project team; and/or
- responding to an online survey (with 571 responses)

Based on the number and range of consultation undertaken on related changes the key stakeholders who would need to respond to the higher energy efficient standard proposed in this RIS, namely building, designers and construction industry, are likely to be well aware of the potential for developments.

These stakeholders are also likely to subscribe to updates provided by the SA government such as the e-newsletter '*The Building Standard*' produced and distributed by the Planning and Development Directorate of the Department of Planning, Transport and Infrastructure.

We understand the South Australian Government is currently considering the need for further consultation and input on this RIS.

7. Conclusion and recommended option

Element 6: Conclusion and recommended option describes the preferred regulatory option, how it will achieve the objective and the size and nature of the net benefits.

The groups affected by the preferred option and how they will be impacted should also be identified. Importantly, the RIS should demonstrated that the benefits of the preferred option to the community out weighty the costs and they the selected option delivers the greatest net benefit to the community.

Reasons that other proposed options were rejected should be stated and the interaction with existing State regulation and any required amendments outlined.[54]

7.1 Assessment

As outlined in Chapter 3, the assessment of the options for this RIS is against each of the three elements that together comprise the public value score card. This section considers the options in terms of:

- Public value delivered
- Legitimacy and support
- Operational capabilities

We consider each element in turn.

7.1.1 Public value delivered

The public value delivered from each of the reform options relative to the base case is evident from the outcomes of the cost benefit analysis. Table 33 (below) repeats the key cost benefit analysis indicators presented in Chapter 5.

The results indicate:

- Option 1 would deliver the highest net present value benefits, with option 2 delivering a similar, but slightly lower, level of benefits.
- The benefit cost ratio is most favourable under option 3, indicating the benefits are highest as a ratio of costs for this option. However both options 1 and 2 have favourable benefit cost ratios of 3.2 and 2.8 respectively.
- The social return on investment is also highest under option 3 (at 29%), however the return is also above 20% for both option 1 (24%) and option 2 (22%).
- Cumulative energy savings and greenhouse gas emissions are highest under option 1, with option 2 also delivering significantly more savings compared to option 3.

[54] SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 22

Table 33: Summary of benefit cost analysis indicators ($2017, real)

Indicator	Option 1 (7 star average, 6 star minimum individual rating)	Option 2 (No average rating, 6 star minimum individual rating)	Option 3 (Separate cooling and heating caps)
Net Present Value	$3,063,376	$2,447,784	$97,829
Benefit Cost Ratios	2.8	2.5	3.9
Social Return on Investment	24%	22%	29%
Cumulative energy savings, 2020 to 2050 (TJ)	68	59	2
Cumulative GHG emissions, 2020 to 2050 (t CO2-e)	6,834	5,838	187

Source: Strategy.Policy.Research, 2017

On balance, option 1 appears to deliver the most public value as it has the highest net present value benefits, at nearly three-quarters of a million dollars higher than option 2. It also affords the most energy and greenhouse gas emissions savings (an outcome which aligns to the SA government focus on reducing emissions).

This option also provides a strong social return on investment and the mid-range benefit cost ratio of 3.2 (compared to 4.5 for option 3 and 2.8 for option 2). While option 3 has a higher benefit cost ratio, the absolute value of benefits delivered by this option is small.

Further we note that the results from the sensitivity analysis, including the 'worst case' scenario test, do not yield a difference in results or ranking based on the cost benefit analysis alone.

7.1.2 Legitimacy and support

Legitimacy and support is evident where there is strong stakeholder feedback or evidence that the reform is likely to be understood, adopted and the change is sustainable.

The energy efficiency star rating process is a well-established regulator mechanism in South Australia. The reforms being proposed to not intend to dramatically alter the functioning of the requirement or the means by which compliance may be achieved.

Option 3 represents the reform with the greatest change as separation of cooling and heating caps while understood by thermal modelling practitioners, has less common application in practice.

There is current support for the concept of reducing energy consumption and emissions through regulatory requirements. Evidence exists in the numerous South Australian government programs that target emissions reductions, including the Carbon Neutral Adelaide initiative (outlined in section 2.2.3).

7.1.3 Operational capabilities

The operational capabilities element of the Public Value Scorecard focuses on the capacity and mobilising of operational resources required and available to implement proposals and achieved desired outcomes.

The iterative thermal modelling and building materials modification approach indicated that relatively few changes to building materials would be required to achieve each of the reform

options. The materials required are readily available in the current market and the additional compliance costs expected to be incurred by any individual dwelling buyer (upfront) are around $1,000 per apartment in the first year following implementation.

7.2 Ranking of options

On balance, option 1 is the preferred reform option. As highlighted above, it will deliver the highest public value. The legitimacy and support is potentially marginally higher for this option, while operational capabilities are consistent across the options.

The second best option is option 2. Similar to option 1, this option performs well it he public value delivered and has legitimacy and support.

Option 3 is the least preferred option on the basis that is delivers the lowest absolute value of benefits. This option potentially also has slightly less legitimacy and support in the current market on the basis that it represents the largest change in methodology used to demonstrate compliance from the current requirements compared to alternate options.

8. Implementation, monitoring and review

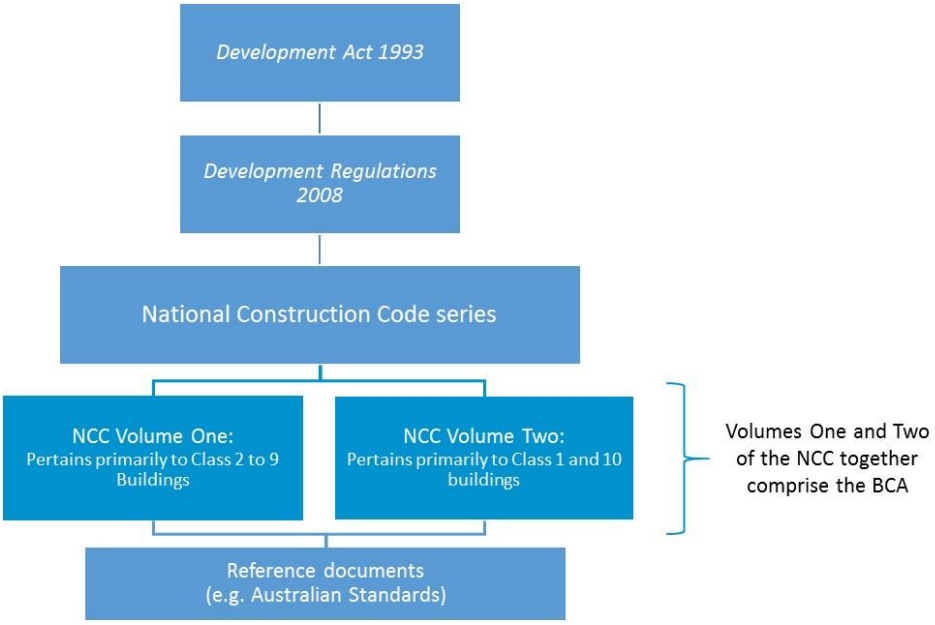
Element 7: Implementation monitoring and review. The final element of a RIS details how the preferred option will be implemented and monitored once implemented.[55]

8.1 Implementation

The NCC sets out the energy efficiency standards applying to all Class 2 buildings in South Australia. In South Australia, the NCC is given legal effect through[56] the *Development Act 1993* and associated *Development Regulations 2008* (Figure 32).

The South Australian variation to the NCC would be implemented via relevant South Australian regulations under the *Development Act 1993.*

Figure 32: South Australian building regulatory framework



Notional time frames for the implementation would see the revised standards coming into effect in 2020. This timing allows for the necessary amendments to be made to the standards and allows a period of time for training and awareness activities to commence before the first higher standard building is constructed.

55 SA Government (2011) *Better Regulation Handbook: How to design and review regulation and prepare a Regulatory Impact Statement*, January, p. 22-23

56 SA Government, 'About building rules for construction work', last updated 2 November 2015, Refer to: https://www.sa.gov.au/topics/property-and-land/land-and-property-development/building-rules-regulations-and-information/technical-building-rules-for-construction-work

8.2 Monitoring and review

Due to the similarities in the drafting of the regulations and policy setting framework, no new monitoring or compliance activities (beyond those already undertaken) are required by the South Australia Government.

Awareness and advertisement of the changes would be communicated via the existing means, including through information on relevant government webpages and notifications from the '*The Building Standard*' e-newsletter produced by the Planning and Development Directorate of the Department of Planning, Transport and Infrastructure.

To align with existing SA building processes for evaluation and review, we recommend the standards be reviewed following a five year period. Consistent with this assessment, the future review should consider whether there are additional benefits that can or should be made accessible to apartment occupants due to changes in technology or future increased energy costs.

Appendix 1: Incremental costs to achieve performance outcomes

This Appendix provides details on the incremental costs of achieving the performance outcomes described in Chapter 4 independently quantified by quantity surveyors, Daniel Cant Watts Corke, and collated by Strategy.Policy.Research.

The methodology report and itemised cost of materials is available in Appendix 2.

Option 1: Incremental costs by apartment and climate zone

		ADELAIDE		CEDUNA		MT GAMBIER	
		$ total	$/sqm	$ total	$/sqm	$ total	$/sqm
Top floor	Unit 204	$31.6	$0.74	$31.6	$0.74	$643.2	$15.06
	Unit 205	-	-	-	-	-	-
	Unit 207	$74.9	$1.48	$697.0	$13.77	$697.0	$13.77
	Unit 208	$540.0	$9.73	$540.0	$9.73	$878.0	$15.82
Upper mid-floor	Unit 204	$643.2	$15.06	$643.2	$15.06	$643.2	$15.06
	Unit 205	$320.0	$6.56	$320.0	$6.56	$320.0	$6.56
	Unit 207	$697.6	$13.79	-	-	-	-
	Unit 208	$878.0	$15.82	-	-	-	-
Lower mid-floor	Unit 204	$643.2	$15.06	$643.2	$15.06	$643.2	$15.06
	Unit 205	$320.0	$6.56	$320.0	$6.56	$320.0	$6.56
	Unit 207	$697.6	$13.79	-	-	-	-
	Unit 208	$878.0	$15.82	-	-	-	-
Ground-floor	Unit 204	$643.2	$15.06	-	-	$643.2	$15.06
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	-	-	$878.0	$15.82
Average (all units)		**$397.96**	**$8.09**	**$199.69**	**$4.22**	**$354.11**	**$7.42**
Average (excluding zeros)		**$530.61**	**$10.79**	**$456.43**	**$9.64**	**$629.53**	**$13.20**

Option 2: Incremental costs by apartment and climate zone

		ADELAIDE		CEDUNA		MT GAMBIER	
		$ total	$/sqm	$ total	$/sqm	$ total	$/sqm
Top floor	Unit 204	$31.6	$0.74	$31.6	$0.74	$643.2	$15.06
	Unit 205	-	-	-	-	-	-
	Unit 207	$74.9	$1.48	$697.0	$13.77	$697.0	$13.77
	Unit 208	$540.0	$9.73	$540.0	$9.73	$878.0	$15.82
Upper mid-floor	Unit 204	$643.2	$15.06	$643.2	$15.06	$643.2	$15.06

	Unit 205	-	-	-	-	-	-
	Unit 207	$697.6	$13.79	-	-	-	-
	Unit 208	$878.0	$15.82	-	-	-	-
Lower mid-floor	Unit 204	$643.2	$15.06	$643.2	$15.06	$643.2	$15.06
	Unit 205	$320.0	$6.56	$320.0	$6.56	$320.0	$6.56
	Unit 207	$697.6	$13.79	-	-	-	-
	Unit 208	$878.0	$15.82	-	-	-	-
Ground-floor	Unit 204	$643.2	$15.06	-	-	$643.2	$15.06
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	-	-	$878.0	$15.82
Average (all units)		**$377.96**	**$7.68**	**$179.69**	**$3.81**	**$334.11**	**$7.01**
Average (excluding zeros)		**$549.75**	**$11.17**	**$479.17**	**$10.15**	**$668.23**	**$14.03**

Option 3: Incremental costs by apartment and climate zone

		ADELAIDE		CEDUNA		MT GAMBIER	
		$ total	$/sqm	$ total	$/sqm	$ total	$/sqm
Top floor	Unit 204	-	-	-	-	-	-
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	$540.0	$9.73	$878.0	$15.82
Upper mid-floor	Unit 204	-	-	-	-	-	-
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	-	-	-	-
Lower mid-floor	Unit 204	-	-	-	-	-	-
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	-	-	-	-
Ground-floor	Unit 204	-	-	-	-	$643.2	$15.06
	Unit 205	-	-	-	-	-	-
	Unit 207	-	-	-	-	-	-
	Unit 208	-	-	-	-	-	-
Average (all units)		-	-	**$33.75**	**$0.61**	**$95.08**	**$1.93**
Average (excluding zeros)		-	-	**$540.00**	**$9.73**	**$760.60**	**$15.44**

Appendix 2: Quantity Surveyor Report

Please refer to the attached report from Donald Cant Watts Corke (ACT) Pty Ltd tilted *South Australia Class 2 Project*, dated 24 July 2017.

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24 July 2017

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File Ref. C17047 Class 2 Analysis 24.07.2017					

DONALD
CANT
WATTS
CORKE

Contents

1 EXECUTIVE SUMMARY

Donald Cant Watts Corke (DCWC) at the request of the Strategy. Policy. Research (S.P.R) has compiled actual cost observations in the review and analysis for upgrading Class 2 energy performance standards in South Australia. The aim is to provide costs in relation to building fabric changes such as insulation and window to wall ratios such as changing the existing glazed façade to a more efficient energy performance material.

The analysis encompasses 4 design options as detailed below with a number of sub-options, based on high and medium material specifications to the existing properties to analysis the costs based on the selected material specification

- **Design Option 204 – Top specification**
  - External Walls (2 types)
  - Windows (6 types)
  - Roof (1 type)
- **Design Option 205 Mid specification**
  - External Walls (1 type)
  - Windows (6 types)
- **Design Option 207 – Top specification**
  - External Walls (2 types)
  - Windows (6 types)
  - Roof (1 type)
- **Design Option 208 – Top specification**
  - External Walls (2 types)
  - Windows (6 types)
  - Roof (1 type)

1.1 Methodology

The Costs are presented in a summary table for each design option. The table details the elemental costs based on current market rates for South Australia. There are two different sources used in obtaining the information as listed below:

1. Database costs from Material Suppliers in South Australia;
2. Rawlinsons Australian Construction Handbook (Edition 22, 2004 to Edition 34, 2016); and

2 BASIS OF REPORT

2.1 Methodology

The aim of this study is to determine the cost implications in Class 2 energy performance standards in South Australia based on changing building fabric changes.

The brief was to cost the proposed design options based on the specification i.e. top or medium specification and develop costs relating to the different option designs. The main elements that were under review were external walls, windows and roof. These elements are significant in calculating energy performance.

The specified materials were split into sub-elements to enable cost comparison of the specified materials. For example 4mm thick clear glass cost $155/m2 compared to 6mm high solar gain with aluminium frame cost $420/m2

We provide a summary of the costs across all the design options:

1. Compile the costs of the design options broken down into various items to provide an example of the costs per m2 for materials. This is done based on the information furnished by the material suppliers, historical costing records from industry accepted construction cost publications:

    - Rawlinsons Australian Construction Handbook (Edition 22 to 34);

2.2 Documentation

The costs study has been undertaken on the basis of the following documentation:

1. Learning rates email dated 1 May 2017 confirming the specification of the design options 204/205/207/208

2.3 Abbreviations

S.P.R	Strategy. Policy. Research.
DCWC	Donald Cant Watts Corke (ACT) Pty Ltd

2.4 Clarifications

In relation to the actual costs provided the following clarifications are noted:

1. The historical costs obtained from Material suppliers are average supply only and exclude overheads, profits, freight and Good & Services Tax.
2. The rates obtained from Rawlinsons Australian Construction Handbook include supply, installation, allowance for Builder's overheads and profit, allowance for respective trade minor preliminaries items (small tools, hand plants and supervision) and exclude Builder's Preliminaries (site establishment, supervision, large plant, scaffolding, temporary services, notices and fees, insurances, etc.;), transportation systems, Base material prices and Good & Services Tax.
3. Viridian rates are average supply rates for supply of the glazing and associated powder coating framing and excluding OHP, Margin & GST.
4. The rates for fibre batt insulation are considered to be Bradford Glass fibre batt insulation and exclude overheads, profits, freight and Good & Services Tax
5. The 66mm and 132mm thick Glass fibre batt: R1.5 are a custom thickness overheads, and exclude profits, freight and Good & Services Tax

2.5 Exclusions

All actual costs contained in this report exclude:

- Overheads;
- Profits;
- Freight; and
- Goods and Services Tax (GST);

Appendix 3: Selected thermal modelling certificates

Please refer to attached certificates that reflect thermal modelling under taken for two of the units. The two units selected as examples are both on the upper mid-level have been selected – unit 204 and unit 208. The attachment provides the following certificates for each:

- Base case certificates: These shows a rating of 4.9 for unit 204 and a rating of 5.3 for unit 208.
- Option 1 certificates: These show a rating of 6.9 for unit 204 and a rating of 7.2 for unit 208.
- Design details.

P R E V I E W

Interim Simulation Result

***NOT FOR RATING

Run: Base

***NOT FOR RATING	PROJECT DETAILS	NOT FOR RATING***
Project Name: Class 2 analysis		**File Name:** SA job.PRO
Postcode: 5000		**Climate Zone:** 16
Design Option: 204 mid, no wall ins		
Description:		

***NOT FOR RATING	Client Details	NOT FOR RATING***
Client Name:		
Phone:	**Fax:**	**Email:**
Postal Address:		
Site Address: 205 87-89 Glenayr Avenue, Adelaide 5000, SA		**Exposure:** Suburban
Council submitted to (if known by assessor):		

***NOT FOR RATING	Assessor Details	NOT FOR RATING***
Assessor Name:		**Assessor No.**
Phone:	**Fax:**	**Email:**
Project Code:	**Assessment Date:** 07/09/2017	**Time:** 16:32:25
Assessor Signature:		

CALCULATED ENERGY REQUIREMENTS*

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
56.4	73.7	4.3	134.4	MJ/m².annum

* These energy requirements have been calculated using a standard set of occupant behaviours and so do not necessarily represent the usage pattern or lifestyle of the intended occupants. They should be used solely for the purposes of rating the building. They should not be used to infer actual energy consumption or running costs. The settings used for the simulation are shown in the building data report.

AREA-ADJUSTED ENERGY REQUIREMENTS

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
53.0	69.2	4.1	126.3	MJ/m².annum

Floor area	conditioned:	42.7 m²	unconditioned:	4.4 m²	garage:	0.0 m²

BAND RESULT

4.9

Area-adjusted band score thresholds

Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
480	325	227	165	125	96	70	46	22	3

P R E V I E W

Interim Simulation Result

***NOT FOR RATING

Run: Base

***NOT FOR RATING	PROJECT DETAILS	NOT FOR RATING***
Project Name: Class 2 analysis		**File Name:** SA job.PRO
Postcode: 5000		**Climate Zone:** 16
Design Option: 204, mid		
Description:		

***NOT FOR RATING	Client Details	NOT FOR RATING***
Client Name:		
Phone:	**Fax:**	**Email:**
Postal Address:		
Site Address: 205 87-89 Glenayr Avenue, Adelaide 5000, SA		**Exposure:** Suburban
Council submitted to (if known by assessor):		

***NOT FOR RATING	Assessor Details	NOT FOR RATING***
Assessor Name:		**Assessor No.**
Phone:	**Fax:**	**Email:**
Project Code:	**Assessment Date:** 24/09/2017	**Time:** 17:11:33
Assessor Signature:		

CALCULATED ENERGY REQUIREMENTS*

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
12.0	61.0	4.0	77.1	MJ/m².annum

* These energy requirements have been calculated using a standard set of occupant behaviours and so do not necessarily represent the usage pattern or lifestyle of the intended occupants. They should be used solely for the purposes of rating the building. They should not be used to infer actual energy consumption or running costs. The settings used for the simulation are shown in the building data report.

AREA-ADJUSTED ENERGY REQUIREMENTS

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
11.3	57.3	3.8	72.4	MJ/m².annum

Floor area	conditioned:	42.7 m²	unconditioned:	4.4 m²	garage:	0.0 m²

BAND RESULT

6.9

Area-adjusted band score thresholds

Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
480	325	227	165	125	96	70	46	22	3

AccuRate Sustainability V2.3.3.13 SP3

Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
Client Name:		
Site Address:		
Design Option: 204 mid, no wall ins		
Date: 06/09/2017	**Time:** 16:43:28	**Page:** 1

Construction details: External Walls

Description: Balcony wall		
External colour: Medium	**Internal colour:** Medium	**Area:** 12.2 m²
External absorptance (%): 50	**Internal absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Fibre-cement sheet (compressed)	6
2	Air gap vertical 31-65 mm (40 nominal) ventilated non-reflective (0.9/0.9; E = 0.82)	40
3	Plasterboard	10

Description: Masonry veneer		
External colour: Medium	**Internal colour:** Medium	**Area:** 28.0 m²
External absorptance (%): 50	**Internal absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Brickwork: generic extruded clay brick (typical density)	110
2	Air gap vertical 31-65 mm (40 nominal) unventilated reflective (0.6/0.9; E = 0.56)	40
3	Plasterboard	10

Construction details: Windows

Description: ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58		
Manufacturer: DEFAULTS		
Version: 2.3.3.13.0.9	**Expiry Date:** 15/06/2019	
System U-value (NFRC): 5.40	**SHGC (NFRC):** 0.58	**Area:** 15.9 m²
Frame type: Custom	**Frame colour:** Medium	
Frame fraction (%): 25	**Frame absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Glass	4

Construction details: Floor/Ceilings

Description: Carpeted floor		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 11.0 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Carpet 10 + rubber underlay 8	18
2	Concrete: standard (2400 kg/m³)	200

AccuRate Sustainability V2.3.3.13 SP3

Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
Client Name:		
Site Address:		
Design Option: 204 mid, no wall ins		
Date: 06/09/2017	**Time:** 16:43:28	**Page:** 2

Description: tiled floor		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 4.4 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Ceramic tile	8
2	Concrete: standard (2400 kg/m³)	200

Description: floating timber		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 31.7 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Timber (softwood)	8
2	Concrete: standard (2400 kg/m³)	200

Description: ceiling		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 47.1 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Concrete: standard (2400 kg/m³)	200

Construction details: Internal Walls

Description: Plasterboard on studs		
First colour: Medium	**Last colour:** Medium	**Area:** 26.3 m²
First absorptance (%): 50	**Last absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Plasterboard	10
2	Air gap vertical >66 mm (90 nominal) unventilated non-reflective (0.9/0.9; E = 0.82)	90
3	Plasterboard	10

Description: common wall		
First colour: Medium	**Last colour:** Medium	**Area:** 54.3 m²
First absorptance (%): 50	**Last absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Plasterboard	10
2	Concrete block 190 denseweight (core-filled at 1800 centres)	190
3	Plasterboard	10

AccuRate Sustainability V2.3.3.13 SP3

Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
Client Name:		
Site Address:		
Design Option: 204 mid, no wall ins		
Date: 06/09/2017	**Time:** 16:43:28	**Page:** 3

Habitable zones

Name	Type	Volume (m^3)	Floor height (m)	Ceiling height above floor (m)	Heated	Cooled
Bedroom 1	Bedroom	30.8	3.0	2.8	Y	Y
kitchen/living	Living/Kitchen	88.8	3.0	2.8	Y	Y
bath/laundry	Other (daytime usage)	12.4	3.0	2.8	N	N

Habitable zones (continued)

Name	Chimneys		Wall/Ceiling vents	Exhaust fans		Vented downlights	Unflued gas heaters	Ceiling fans	Type
	U/S	S		U/S	S				
Bedroom 1	0	0	0	0	0	0	0	0	-
kitchen/living	0	0	0	0	0	0	0	0	-
bath/laundry	0	0	0	0	0	0	0	0	-

AccuRate Sustainability V2.3.3.13 SP3

Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
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Bedroom 1: External walls main data

Wall	Construction	Azi (deg.)	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Fixed shade	Opening (m²)	Opening Type
1	Masonry veneer	220	3.00	2.80	8.40	5.71	None	0.00	Controlled
2	Masonry veneer	0	1.00	2.80	2.80	1.90	None	0.00	Controlled
3	Masonry veneer	270	0.60	2.80	1.68	1.68	None	0.00	Controlled

Bedroom 1: External walls wing wall data

	Left Wing Wall			Right Wing Wall			
Wall	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Part of courtyard?
2	-	-	-	6.50	0.00	0.00	N
3	1.00	0.00	0.00	-	-	-	N

Bedroom 1: Windows in walls

Wall	Window Name	Type	Construction	Azi. (deg.)	H (m)	W (m)	Area (m²)
1	w4	Awning	ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	220	1.60	1.68	2.69
2	w1	Double or Single Hung	ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	0	1.54	0.58	0.90

Bedroom 1: Windows in walls (continued)

Wall	Window Name	Indoor covering	Outdoor covering	Fixed shade	HH (m)	HO (m)	Opening (%)	Weather stripped	Gap size
1	w4	Hollandblinds	None		2.50	0.65	30.00	Y	
2	w1	Hollandblinds	None		2.10	0.20	45.00	Y	

Bedroom 1: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Adjacent Zone	Opening (m²)	Opening Type
1	common wall	3.20	2.80	8.96	9.0	Neighbour	0.00	Controlled
2	Plasterboard on studs	6.60	2.80	18.48	16.8	kitchen/living	1.72	Controlled

Bedroom 1: Floors

Floor	Construction	Area (gross) (m²)	Area (net) (m²)	Under the floor	Edge Ins.	Opening (m²)	Opening Type
1	Carpeted floor	11.0	11.0	Neighbour		0.00	Controlled

Bedroom 1: Ceilings

Ceiling	Construction	Area (gross) (m²)	Area (net) (m²)	Above the ceiling	Opening (m²)	Opening Type
1	ceiling	11.0	11.0	Neighbour	0.00	Controlled

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Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
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kitchen/living: External walls main data

Wall	Construction	Azi (deg.)	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Fixed shade	Opening (m²)	Opening Type
1	Masonry veneer	270	5.40	2.80	15.12	10.72	None	0.00	Controlled
2	Balcony wall	0	4.35	2.80	12.18	4.22	roof over balcony	0.00	Controlled

kitchen/living: External walls wing wall data

	Left Wing Wall			Right Wing Wall			
Wall	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Part of courtyard?
1	1.00	0.60	0.00	-	-	-	N
2	-	-	-	2.40	0.00	0.00	N

kitchen/living: External walls horizontal shading data

		Eaves				Other fixed shading				
Wall	Name	Projection (m)	Vertical Offset (m)	Horizontal Offset (m)	Length (m)	Projection (m)	Vertical Offset (m)	Horizontal Offset (m)	Length (m)	Monthly blocking factors (%)
2	roof over balcony	2.40	0.00	0.00	4.40	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100

kitchen/living: Windows in walls

Wall	Window Name	Type	Construction	Azi. (deg.)	H (m)	W (m)	Area (m²)
1	w2	Sliding	ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	270	1.60	2.75	4.40
2	w2	Sliding	ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	0	2.20	3.62	7.96

kitchen/living: Windows in walls (continued)

Wall	Window Name	Indoor covering	Outdoor covering	Fixed shade	HH (m)	HO (m)	Opening (%)	Weather stripped	Gap size
1	w2	Hollandblinds	None		2.50	1.20	30.00	Y	
2	w2	Hollandblinds	None		2.20	0.35	50.00	Y	

kitchen/living: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Adjacent Zone	Opening (m²)	Opening Type
1	common wall	8.40	2.80	23.52	23.5	Neighbour	0.00	Controlled
2	Plasterboard on studs	6.60	2.80	18.48	16.8	Bedroom 1	1.72	Controlled
3	Plasterboard on studs	2.80	2.80	7.84	6.1	bath/laundry	1.72	Controlled

kitchen/living: Floors

Floor	Construction	Area (gross) (m²)	Area (net) (m²)	Under the floor	Edge Ins.	Opening (m²)	Opening Type
1	floating timber	31.7	31.7	Neighbour		0.00	Controlled

kitchen/living: Ceilings

Ceiling	Construction	Area (gross) (m²)	Area (net) (m²)	Above the ceiling	Opening (m²)	Opening Type
1	ceiling	31.7	31.7	Neighbour	0.00	Controlled

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Nationwide House Energy Rating Scheme

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bath/laundry: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m^2)	Area (net) (m^2)	Adjacent Zone	Opening (m^2)	Opening Type
1	common wall	7.80	2.80	21.84	21.8	Neighbour	0.00	Controlled
2	Plasterboard on studs	2.80	2.80	7.84	6.1	kitchen/living	1.72	Controlled

bath/laundry: Floors

Floor	Construction	Area (gross) (m^2)	Area (net) (m^2)	Under the floor	Edge Ins.	Opening (m^2)	Opening Type
1	tiled floor	4.4	4.4	Neighbour		0.00	Controlled

bath/laundry: Ceilings

Ceiling	Construction	Area (gross) (m^2)	Area (net) (m^2)	Above the ceiling	Opening (m^2)	Opening Type
1	ceiling	4.4	4.4	Neighbour	0.00	Controlled

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Nationwide House Energy Rating Scheme

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File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
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Shading Schemes

	Eaves				Other fixed shading				
Name	**Projection (m)**	**Vert Offset (m)**	**Horiz Offset (m)**	**Length (m)**	**Projection (m)**	**Vert Offset (m)**	**Horiz Offset (m)**	**Length (m)**	**Monthly blocking factors (%)**
roof over balcony	2.40	0.00	0.00	4.40	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100

Ventilation

Footprint: vertical dimension (m)	**Footprint: horizontal dimension (m)**	**Azimuth of highlighted facade (degrees)**	**Insect screens**
10.0	4.5	0	N

P R E V I E W

Interim Simulation Result

***NOT FOR RATING

Run: Base

***NOT FOR RATING	PROJECT DETAILS	NOT FOR RATING***
Project Name: Class 2 analysis		**File Name:** SA job.PRO
Postcode: 5000		**Climate Zone:** 16
Design Option: 208 mid, no wall ins		
Description:		

***NOT FOR RATING	Client Details	NOT FOR RATING***
Client Name:		
Phone:	**Fax:**	**Email:**
Postal Address:		
Site Address: 205 87-89 Glenayr Avenue, Adelaide 5000, SA		**Exposure:** Suburban
Council submitted to (if known by assessor):		

***NOT FOR RATING	Assessor Details	NOT FOR RATING***
Assessor Name:		**Assessor No.**
Phone:	**Fax:**	**Email:**
Project Code:	**Assessment Date:** 07/09/2017	**Time:** 16:38:13
Assessor Signature:		

CALCULATED ENERGY REQUIREMENTS*

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
39.4	82.0	3.5	125.0	MJ/m².annum

* These energy requirements have been calculated using a standard set of occupant behaviours and so do not necessarily represent the usage pattern or lifestyle of the intended occupants. They should be used solely for the purposes of rating the building. They should not be used to infer actual energy consumption or running costs. The settings used for the simulation are shown in the building data report.

AREA-ADJUSTED ENERGY REQUIREMENTS

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
36.8	76.5	3.3	116.7	MJ/m².annum

Floor area	conditioned:	55.6 m²	unconditioned:	6.7 m²	garage:	0.0 m²

BAND RESULT

5.3

Area-adjusted band score thresholds

Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
480	325	227	165	125	96	70	46	22	3

P R E V I E W

Interim Simulation Result

***NOT FOR RATING

Run: Base

***NOT FOR RATING	PROJECT DETAILS	NOT FOR RATING***
Project Name: Class 2 analysis		**File Name:** SA job.PRO
Postcode: 5000		**Climate Zone:** 16
Design Option: Unit 208, mid		
Description:		

***NOT FOR RATING	Client Details	NOT FOR RATING***
Client Name:		
Phone:	**Fax:**	**Email:**
Postal Address:		
Site Address: 205 87-89 Glenayr Avenue, Adelaide 5000, SA		**Exposure:** Suburban
Council submitted to (if known by assessor):		

***NOT FOR RATING	Assessor Details	NOT FOR RATING***
Assessor Name:		**Assessor No.**
Phone:	**Fax:**	**Email:**
Project Code:	**Assessment Date:** 24/09/2017	**Time:** 17:14:23
Assessor Signature:		

CALCULATED ENERGY REQUIREMENTS*

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
9.0	57.7	3.1	69.7	MJ/m².annum

* These energy requirements have been calculated using a standard set of occupant behaviours and so do not necessarily represent the usage pattern or lifestyle of the intended occupants. They should be used solely for the purposes of rating the building. They should not be used to infer actual energy consumption or running costs. The settings used for the simulation are shown in the building data report.

AREA-ADJUSTED ENERGY REQUIREMENTS

Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
8.4	53.8	2.9	65.1	MJ/m².annum

Floor area	conditioned:	55.6 m²	unconditioned:	6.7 m²	garage:	0.0 m²

BAND RESULT

7.2

Area-adjusted band score thresholds

Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
480	325	227	165	125	96	70	46	22	3

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Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
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Construction details: External Walls

Description: Balcony wall		
External colour: Medium	**Internal colour:** Medium	**Area:** 9.0 m²
External absorptance (%): 50	**Internal absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Fibre-cement sheet (compressed)	6
2	Air gap vertical 31-65 mm (40 nominal) unventilated non-reflective (0.9/0.9; E = 0.82)	40
3	Plasterboard	10

Description: external wall		
External colour: Medium	**Internal colour:** Medium	**Area:** 45.9 m²
External absorptance (%): 50	**Internal absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Brickwork: generic extruded clay brick (typical density)	110
2	Air gap vertical 31-65 mm (40 nominal) unventilated non-reflective (0.9/0.9; E = 0.82)	40
3	Plasterboard	10

Construction details: Windows

Description: ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58		
Manufacturer: DEFAULTS		
Version: 2.3.3.13.0.9	**Expiry Date:** 15/06/2019	
System U-value (NFRC): 5.40	**SHGC (NFRC):** 0.58	**Area:** 20.2 m²
Frame type: Custom	**Frame colour:** Medium	
Frame fraction (%): 25	**Frame absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Glass	4

Construction details: Floor/Ceilings

Description: Carpeted floor		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 13.1 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Carpet 10 + rubber underlay 8	18
2	Concrete: standard (2400 kg/m³)	200

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Nationwide House Energy Rating Scheme

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Description: tiled floor		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 6.7 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Ceramic tile	8
2	Concrete: standard (2400 kg/m³)	200

Description: floating timber		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 42.5 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Timber (softwood)	8
2	Concrete: standard (2400 kg/m³)	200

Description: ceiling		
Top colour: Medium	**Bottom colour:** Medium	**Area:** 62.3 m²
Top absorptance (%): 50	**Bottom absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Concrete: standard (2400 kg/m³)	200

Construction details: Internal Walls

Description: Plasterboard on studs		
First colour: Medium	**Last colour:** Medium	**Area:** 32.5 m²
First absorptance (%): 50	**Last absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Plasterboard	10
2	Air gap vertical >66 mm (90 nominal) unventilated non-reflective (0.9/0.9; E = 0.82)	90
3	Plasterboard	10

Description: common wall		
First colour: Medium	**Last colour:** Medium	**Area:** 48.7 m²
First absorptance (%): 50	**Last absorptance (%):** 50	

Layer	Material	Thickness (mm)
1	Plasterboard	10
2	Concrete block 190 denseweight (core-filled at 1800 centres)	190
3	Plasterboard	10

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Nationwide House Energy Rating Scheme

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Habitable zones

Name	Type	Volume (m^3)	Floor height (m)	Ceiling height above floor (m)	Heated	Cooled
Bedroom 1	Bedroom	36.7	3.0	2.8	Y	Y
kitchen/living	Living/Kitchen	119.0	3.0	2.8	Y	Y
bath/laundry	Other (daytime usage)	18.8	3.0	2.8	N	N

Habitable zones (continued)

Name	Chimneys		Wall/Ceiling vents	Exhaust fans		Vented downlights	Unflued gas heaters	Ceiling fans	Type
	U/S	S		U/S	S				
Bedroom 1	0	0	0	0	0	0	0	0	-
kitchen/living	0	0	0	0	0	0	0	0	-
bath/laundry	0	0	0	0	0	0	0	0	-

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Nationwide House Energy Rating Scheme

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Bedroom 1: External walls main data

Wall	Construction	Azi (deg.)	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Fixed shade	Opening (m²)	Opening Type
1	external wall	0	4.00	2.80	11.20	6.14	None	0.00	Controlled
2	external wall	90	3.20	2.80	8.96	8.96	None	0.00	Controlled

Bedroom 1: External walls wing wall data

	Left Wing Wall			Right Wing Wall			
Wall	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Part of courtyard?
2	-	-	-	3.60	0.00	0.00	N

Bedroom 1: Windows in walls

Wall	Window Name	Type	Construction	Azi. (deg.)	H (m)	W (m)	Area (m²)
1	w1	Sliding	ALM-002-03 A Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	0	2.40	2.11	5.06

Bedroom 1: Windows in walls (continued)

Wall	Window Name	Indoor covering	Outdoor covering	Fixed shade	HH (m)	HO (m)	Opening (%)	Weather stripped	Gap size
1	w1	Hollandblinds	None		2.80	1.00	30.00	Y	

Bedroom 1: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Adjacent Zone	Opening (m²)	Opening Type
1	common wall	1.20	2.80	3.36	3.4	Neighbour	0.00	Controlled
2	Plasterboard on studs	7.60	2.80	21.28	19.6	kitchen/living	1.72	Controlled

Bedroom 1: Floors

Floor	Construction	Area (gross) (m²)	Area (net) (m²)	Under the floor	Edge Ins.	Opening (m²)	Opening Type
1	Carpeted floor	13.1	13.1	Neighbour		0.00	Controlled

Bedroom 1: Ceilings

Ceiling	Construction	Area (gross) (m²)	Area (net) (m²)	Above the ceiling	Opening (m²)	Opening Type
1	ceiling	13.1	13.1	Neighbour	0.00	Controlled

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Nationwide House Energy Rating Scheme

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File Name: C:\AccuRate\Projects\SA job.PRO		
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Client Name:		
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kitchen/living: External walls main data

Wall	Construction	Azi (deg.)	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Fixed shade	Opening (m²)	Opening Type
1	external wall	0	3.20	2.80	8.96	3.84	None	0.00	Controlled
2	external wall	270	2.40	2.80	6.72	4.28	roof baclont to east	0.00	Controlled
3	Balcony wall	0	3.20	2.80	8.96	4.28	roof over balcony to south	0.00	Controlled
4	external wall	270	3.60	2.80	10.08	7.15	None	0.00	Controlled

kitchen/living: External walls wing wall data

	Left Wing Wall			Right Wing Wall			
Wall	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Projection (m)	Horizontal Offset (m)	Vertical Offset (m)	Part of courtyard?
2	3.20	0.00	0.00	-	-	-	N
3	-	-	-	3.20	0.00	0.00	N

kitchen/living: External walls horizontal shading data

		Eaves				Other fixed shading				
Wall	Name	Projection (m)	Vertical Offset (m)	Horizontal Offset (m)	Length (m)	Projection (m)	Vertical Offset (m)	Horizontal Offset (m)	Length (m)	Monthly blocking factors (%)
2	roof baclont to east	2.40	0.00	0.00	3.60	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100
3	roof over balcony to south	3.60	0.00	0.00	2.40	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100

kitchen/living: Windows in walls

Wall	Window Name	Type	Construction		Azi. (deg.)	H (m)	W (m)	Area (m²)
1	w2	Sliding	ALM-002-03 A	Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	0	2.40	2.13	5.12
2	w3	Awning	ALM-002-03 A	Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	270	2.10	1.16	2.44
3	w4	Sliding	ALM-002-03 A	Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	0	2.20	2.13	4.68
4	w5	Sliding	ALM-002-03 A	Aluminium B SG High Solar Gain Low-E: U = 5.40: SHGC = 0.58	270	1.60	1.83	2.93

kitchen/living: Windows in walls (continued)

Wall	Window Name	Indoor covering	Outdoor covering	Fixed shade	HH (m)	HO (m)	Opening (%)	Weather stripped	Gap size
1	w2	Hollandblinds	None		2.80	0.50	30.00	Y	
2	w3	Hollandblinds	None		2.40	1.00	60.00	Y	
3	w4	Hollandblinds	None		2.20	0.20	30.00	Y	
4	w5	Hollandblinds	None		2.20	1.00	30.00	Y	

kitchen/living: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Adjacent Zone	Opening (m²)	Opening Type
1	common wall	9.60	2.80	26.88	26.9	Neighbour	0.00	Controlled
2	Plasterboard on studs	4.00	2.80	11.20	9.5	bath/laundry	1.72	Controlled
3	Plasterboard on studs	7.60	2.80	21.28	19.6	Bedroom 1	1.72	Controlled

kitchen/living: Floors

Floor	Construction	Area (gross) (m²)	Area (net) (m²)	Under the floor	Edge Ins.	Opening (m²)	Opening Type
1	floating timber	42.5	42.5	Neighbour		0.00	Controlled

kitchen/living: Ceilings

Ceiling	Construction	Area (gross) (m²)	Area (net) (m²)	Above the ceiling	Opening (m²)	Opening Type
1	ceiling	42.5	42.5	Neighbour	0.00	Controlled

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Nationwide House Energy Rating Scheme

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File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
Client Name:		
Site Address:		
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bath/laundry: Internal walls

Wall	Construction	L (m)	H (m)	Area (gross) (m²)	Area (net) (m²)	Adjacent Zone	Opening (m²)	Opening Type
1	common wall	6.60	2.80	18.48	18.5	Neighbour	0.00	Controlled
2	Plasterboard on studs	4.00	2.80	11.20	9.5	kitchen/living	1.72	Controlled

bath/laundry: Floors

Floor	Construction	Area (gross) (m²)	Area (net) (m²)	Under the floor	Edge Ins.	Opening (m²)	Opening Type
1	tiled floor	6.7	6.7	Neighbour		0.00	Controlled

bath/laundry: Ceilings

Ceiling	Construction	Area (gross) (m²)	Area (net) (m²)	Above the ceiling	Opening (m²)	Opening Type
1	ceiling	6.7	6.7	Neighbour	0.00	Controlled

AccuRate Sustainability V2.3.3.13 SP3

Nationwide House Energy Rating Scheme

Project Name: Class 2 analysis		
File Name: C:\AccuRate\Projects\SA job.PRO		
Postcode: 5000	**Climate Zone:** 16	**Exposure:** Suburban
Client Name:		
Site Address:		
Design Option: 208 mid, no wall ins		
Date: 06/09/2017	**Time:** 16:46:30	**Page:** 7

Shading Schemes

	Eaves				Other fixed shading				
Name	**Projection (m)**	**Vert Offset (m)**	**Horiz Offset (m)**	**Length (m)**	**Projection (m)**	**Vert Offset (m)**	**Horiz Offset (m)**	**Length (m)**	**Monthly blocking factors (%)**
roof over balcony to south	3.60	0.00	0.00	2.40	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100
roof baclont to east	2.40	0.00	0.00	3.60	0.00	0.00	0.00	0.00	100,100,100,100,100,100,100,100,100,100,100,100

Ventilation

Footprint: vertical dimension (m)	**Footprint: horizontal dimension (m)**	**Azimuth of highlighted facade (degrees)**	**Insect screens**
6.5	12.0	180	N