Building Code Energy Performance Trajectory Technical Report – Northern Australia

Final Report

23 November 2018

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Final Report

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Executive Summary

This report presents the findings of the Building Code Energy Performance Trajectory project for commercial and residential archetypes relevant to Northern Australia. The methodology and results presented in this report draw heavily from the previously completed work for The Australian Built Environment Council (ASBEC), ClimateWorks Australia and the Cooperative Research Centre for Low Carbon Living (CRC LCL) presented in *Built to Perform* and *SP0016 Building Code Energy Performance Trajectory Project Final Technical Report*.

This report builds on *Built to Perform* and the *SP0016 Final Technical report* by summarising results from additional analysis undertaken by Energy Action and Team Catalyst relevant to Northern Australia. New buildings in the Northern Australia region present unique opportunities and challenges, due to factors including a warmer and more humid climate, different construction materials and climate-responsive design practices. These factors have been considered in assessing key opportunities for this region.

Eight building 'archetypes' were analysed, each of which was modelled in four orientations. The archetypes were developed to cover a range of typical attributes of common building types as a proxy for the entire building stock, to reflect as broadly as possible the diversity of Northern Australia's buildings. The modelled building archetypes were:

- For residential buildings:
  - Detached, single-storey house;
  - Attached, two-storey townhouse or terrace house; and
  - Apartment.
- For commercial and other non-residential buildings:
  - Office tower;
  - Hotel tower;
  - Medium retail shop;
  - Hospital ward; and
  - School.

The modelling was undertaken for buildings in Climate Zone 1 (both residential and commercial archetypes - hot humid summer, warm winter) and Climate Zone 3 (residential archetypes only - hot dry summer, warm winter).

The analysis shows that by 2030 (based on results relevant to the 2028 Code), even conservative improvements in Code energy efficiency requirements for Northern Australia could cost-effectively deliver the following contributions towards net zero energy buildings:

- For the modelled single apartment: 37% in Climate Zone 1, 25% in Climate Zone 2
- For the modelled attached house: 39% in Climate Zone 1, 29% in Climate Zone 3
- For the modelled detached house: 38% in Climate Zone 1, 31% in Climate Zone 3
- For the modelled Hotel: 26% in Climate Zone 1
- For the modelled office: 23% in Climate Zone 1
- For the modelled retail shop: 29% in Climate Zone 1
- For the modelled hospital ward: 36% in Climate Zone 1
- For the modelled school building: 57% in Climate Zone 1

Recommendations are provided in the 'synthesis report' *Built to Perform in Northern Australia*, available on the ASBEC and ClimateWorks websites. At a high level, ASBEC and ClimateWorks recommend:

1. COAG Energy Council and Building Ministers Forum commit to a forward plan for the Building Code
2. COAG Energy Council and Building Ministers Forum deliver a step change in the 2022 Code, with a focus on residential energy requirements and an incremental increase in non-residential requirements
3. State and Territory Governments continue to enable climate-responsive building design and construction practices
4. COAG Energy Council and Building Ministers Forum explore the potential to expand the scope of the Code and progress complementary measures

1. Introduction

The purpose of the Building Code Energy Performance Trajectory Project is to establish long term targets and trajectories for National Construction Code (NCC) energy requirements. The NCC Section J review proposed recommendations for a range of provisions to harness higher building performance at lower costs; through changes in methodology where appropriate. This report identifies cost-effective, energy efficient technologies that exist in industry to produce energy trajectories over the next 15 years, specifically for climate zone 1 and 3 buildings.

Climate zones 2, 5, 6, 7 have already been studied and the details of this analysis can be found in the issued reports *Built to Perform*[1] (published by ASBEC and ClimateWorks Australia, July 2018) and the *SP0016 Building Code Energy Performance Trajectory Project Final Technical Report*[2] (published by the CRC LCL, October 2018). This report relies heavily on the methodology from the *SP0016 Final Technical Report*, which can be referred to for further details.

1.1 Overarching methodology

This project involved analysis of two building sectors, these being residential and commercial (i.e. non-residential). The descriptions herein of these two parallel streams of work have similar overall structures but differ in detail, due in part to the fact that significant work had already been undertaken to determine current cost-effective opportunities to increase of energy requirements for commercial buildings as part of the update of the 2019 NCC led by the Australian Building Codes Board (ABCB), while no such work has been undertaken for residential buildings.

For the commercial analysis archetypes, five NCC building classes were combined with five representative building geometries to produce the simulation models. The archetypes include a 3 storey Hotel (NCC building Class 3), a 10 storey office building (NCC building Class 5), a single storey retail building (NCC building Class 6), a single storey hospital ward area (NCC building Class 9a) and a single storey school building (NCC building Class 9b).

The residential analysis used three different building types namely a single-storey standalone detached house (NCC building Class 1a), a two storey attached townhouse (NCC building Class 1a) and a single level of a residential apartment dwelling (NCC building Class 2).

The modelling investigates a range of energy efficiency improvements to the building fabric and fixed equipment, and also investigates on-site renewables (PV). The measures for both the residential and commercial analysis vary, with lists of these measures presented in the respective modelling methodology sections.

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1 Available at: https://www.asbec.asn.au/research-items/built-perform/
2 Available at: http://www.lowcarbonlivingcrc.com.au/resources/crc-publications/crclcl-project-reports/sp0016-final-building-code-energy-performance

The analysis was specific to Climate Zones 1 and 3, as defined by the ABCB.

- Climate Zone 1 (both residential and commercial archetypes): hot humid summer, warm winter; and
- Climate Zone 3 (residential archetypes only): hot dry summer, warm winter.

Single sites were used to represent the above climate zones. The representative sites selected were:

- For Climate Zone 1: Darwin. This was selected as the Climate Zone 1 location because any follow-up analysis undertaken by the ABCB for a regulatory impact statement (RIS) must include Darwin, so it is important for this analysis to include Darwin for relevance to a future RIS process. Darwin also represents the hot humid extreme of the Climate Zone 1 region. In recognition of the diverse climates present even within Climate Zone 1 the project team undertook additional analysis for the residential building archetypes in a Cairns location (representative of far north Queensland, denoted in this report as Climate Zone 1a). The Cairns analysis results are detailed in Section 5.3; and
- For Climate Zone 3: Alice Springs. This was selected as the largest population centre in the climate zone with the highest potential for new building growth.

To facilitate expedient simulation work to define the performance at fixed points in the future, a 5 year step period was used in the modelling process. Separate models were developed for building performance and economic viability at each time to determine how cost effectiveness changed for technologies over time, e.g. 0 years refers to what's cost effective today (and therefore for the 2019 Code), 5 years refers to what will be cost effective in 2024, 10 years for 2029 and 15 years refers to what will be cost effective in 2034.

The final trajectory was presented in 3 year step periods, to match the NCC revision timeframe, and the simulated results were interpolated to align with this sequence.

After the efficiency measures were defined, a **single-dimensional analysis** was undertaken to gauge the benefit of changing an individual efficiency measure to the buildings. Under the single-dimensional analysis, the performance of a single measure was varied from the baseline while keeping the performance of all other measures constant. This was repeated for each individual measure. Measures which had more than a 2% impact on the annual building energy were identified for subsequent analysis. A benefit-cost analysis was performed to determine which measures are currently cost-effective.

The **multi-dimensional analysis** involved combining multiple measures in a single model and examining the overall impact of these measures being implemented together. The accelerated deployment models (used for the accelerated trajectory) incorporated all measures that were predicted to have an impact on building energy of greater than 2% from the single-dimensional analysis. The conservative models were identified from the single-dimensional analysis as those which had a benefit-cost ratio greater than 1. The conservative multi-dimensional models were tuned to achieve an overall benefit-cost ratio between 1 and 1.5 by adding or removing efficiency measures. This benefit cost ratio is the ratio of life cycle energy costs over capital cost less network adjustments.

The project has established Northern Australia Technical Advisory Group comprising relevant experts in Northern Australia-specific building design, construction and operation, energy performance in buildings, building energy modelling and societal cost-benefit analysis, and the project team gratefully acknowledges the generous and highly valuable input they have provided throughout the project.

2. Commercial Modelling Methodology

2.1 Overview

Modelling for the commercial building archetypes was undertaken for Climate Zone 1.

Energy efficiency measures were modelled to identify their effectiveness on the archetypes. This single dimensional analysis used test cases based on the results from climate zone 2 presented in the *SP0016 Final Technical Report*.

2.2 Baseline Models

Refer to Appendix F of the *SP0016 Final Technical Report* for details on the geometries and internal loads modelled. The baseline models remain unchanged to those previously developed apart from:

1. Using a Darwin weather file (AUS_DARWIN-AP_941200_IW2.EPW) in addition to modifying the ground temperature profile;
2. A full re-sizing of the mechanical plant and associated systems.

Consistent with the methodology in *SP0016 Final Technical Report*, the baseline energy performance is based on energy requirements proposed for the 2019 update of the Code by the Australian Building Codes Board.

2.3 Simulation Parameters

2.3.1 Single Dimensional Parameters

The building provisions modelled remain the same as those described in the *SP0016 Final Technical Report* which covered climate zones 2, 5, 6 and 7. Table 1 below identifies measures tested in the single dimensional analysis (marked with an X). This selection is based on effective measures for climate zone 2.

Table 1: Selection of single dimensional modelling runs – based on effective CZ2 results.

Measure Name	Description	Hotel	Office	Retail	Ward	School
Fabric Colour	External wall solar absorptivity reduction	X	X	X	X	X
Active Mass	Night purge + thermal mass		X			
BIPV Wall	Generation from building integrated solar PV	X	X	X	X	X
PV	Generation from rooftop solar PV	X	X	X	X	X
Glazing2	External shutters activated by room temperature	X	X		X	X
Daylighting1	Lighting modulation from daylight sensors		X	X	X	
Daylighting2	WWR x 1.5 + Shading + daylight sensors				X	X

Measure Name	Description	Hotel	Office	Retail	Ward	School
Fans	Fans system pressure reduction of 25%		X		X	
Chillers/PACs	Chiller/PAC COP + IPLV performance increases	X	X	X	X	X
Economy Cycle	Economy cycle incorporation		X	X	X	
OA Treatment	Modulation of outside air by room CO_2 content				X	X
Lighting	Lighting IPD reduction (40%) + occupancy sensors	X	X	X	X	X

2.3.2 Multi-Dimensional Scenarios

Table 2: Conservative multi-dimensional modelling scenarios used in the commercial analysis.

	2019	2024	2029	2034
3B (Hotel)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Cost effective roof PV	Chiller COP 5.98/IPLV 9.95	Chiller COP 7.48/IPLV 11.45	Chiller COP 8.23/IPLV 12.2
	Lighting control by occupancy sensor	Cost effective roof PV	Lighting power density reduced by 20%	Lighting power density reduced by 40%
	Thermal mass (150mm Partition)	Lighting control by occupancy sensor	Cost effective roof PV	Cost effective roof PV
		Thermal mass (100mm Wall)	Cost effective BIPV (Wall)	Cost effective BIPV (Wall)
			Lighting control by occupancy sensor	Lighting control by occupancy sensor
			Thermal mass (200mm Wall)	Thermal mass (100mm Partition + 200mm Wall)
5A (Office)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Cost effective roof PV	Chiller COP 6.33/IPLV 10.12	Chiller COP 7.83/IPLV 12.12	Chiller COP 8.58/IPLV 12.87
	Lighting control by occupancy sensor	Cost effective roof PV	Lighting power density reduced by 20%	Lighting power density reduced by 40%
	Fan pressure reduction by 25%	Lighting control by occupancy sensor	Cost effective roof PV	Cost effective roof PV
	Thermal mass (100mm Partition)	Fan pressure reduction by 25%	Cost effective BIPV (Wall)	Cost effective BIPV (Wall)
		Thermal mass (100mm Wall)	Lighting control by occupancy sensor	Lighting control by occupancy sensor
			Fan pressure reduction by 25%	Fan pressure reduction by 25%
			Thermal mass (100mm Partition + 100mm Wall)	Thermal mass (100mm Partition + 150mm Wall)
6C (Retail)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	Cost effective roof PV	Cost effective roof PV	Cost effective roof PV	Cost effective roof PV
	Thermal mass (150mm Partition)	PAC COP 4.3	PAC COP 4.8	PAC COP 5.05
		Thermal mass (150mm Partition + 100mm Wall)	Lighting power density reduced by 20%	Lighting power density reduced by 40%
			Cost effective BIPV (Wall)	Cost effective BIPV (Wall)
			Thermal mass (200mm Partition + 150mm Wall)	Thermal mass (300mm Partition + 300mm Wall)
				Wall insulation (R3.0 Wall)

	2019	2024	2029	2034
9aD (Hospital Ward)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Fan pressure reduction by 25%	Fan pressure reduction by 25%	Fan pressure reduction by 25%	Fan pressure reduction by 25%
	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	Cost effective roof PV	Cost effective roof PV	Cost effective roof PV	Cost effective roof PV
	Thermal mass (100mm Partition)	Chiller COP 6.33/IPLV 10.12	Chiller COP 7.83/IPLV 12.12	Chiller COP 8.58/IPLV 12.87
	Wall insulation (R3.0 Wall)	Thermal mass (100mm Wall)	Lighting power density reduced by 20%	Lighting power density reduced by 40%
		Wall insulation (R3.0 Wall)	Cost effective BIPV (Wall)	Cost effective BIPV (Wall)
			Thermal mass (100mm Partition + 100mm Wall)	Thermal mass (150mm Partition + 100mm Wall)
			Wall insulation (R3.0 Wall)	Wall insulation (R3.0 Wall)
9bE (School)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	Cost effective roof PV	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment
	Wall insulation (R6.0 Wall)	Cost effective roof PV	Cost effective roof PV	Cost effective roof PV
		PAC COP 4.3	PAC COP 4.8	PAC COP 5.05
		Thermal mass (100mm Partition)	Lighting power density reduced by 20%	Lighting power density reduced by 40%
		Wall insulation (R6.0 Wall)	Cost effective BIPV (Wall)	Cost effective BIPV (Wall)
			Thermal mass (100mm Partition)	Thermal mass (100mm Partition + 100mm Wall)
			Wall insulation (R8.0 Wall)	Wall insulation (R8.0 Wall)

Table 3: Accelerated multi-dimensional modelling scenarios used in the commercial analysis.

	2019	2024	2029	2034
3B (Hotel)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Chiller COP 7.48/IPLV 11.45	Chiller COP 8.23/IPLV 12.2
	Thermal Mass (150mm Partition)	Thermal Mass (150mm Partition)	Lighting control by occupancy sensor	Lighting power density reduced by 40%
	Max roof PV	Max roof PV	Thermal Mass (200mm Partition)	Lighting control by occupancy sensor
	Chiller COP 5.98/IPLV 9.95	Chiller COP 6.73/IPLV 10.7	Max roof PV	Thermal Mass (200mm External Wall + 100mm Partition)
	Lift upgrade	Lift upgrade	Lift upgrade	Max roof PV
		Lighting power density reduced by 13%	Lighting power density reduced by 26%	Lift upgrade
			Max BIPV (Wall)	Max BIPV (Wall)
5A (Office)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall

	2019	2024	2029	2034
	External shutters	External shutters	External shutters	External shutters
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Chiller COP 7.83/IPLV 12.12	Chiller COP 8.58/IPLV 12.87
	Fan pressure reduction by 25%	Fan pressure reduction by 25%	Lighting control by occupancy sensor	Lighting power density reduced by 40%
	Thermal Mass (100mm Partition)	Thermal Mass (100mm External Wall	Fan pressure reduction by 25%	Lighting control by occupancy sensor
	Max roof PV	Max roof PV	Thermal Mass (100mm External Wall + 100mm Partition)	Fan pressure reduction by 25%
	Chiller COP 6.33/IPLV 10.12	Chiller COP 7.08/IPLV 11.12	Max roof PV	Thermal Mass (150mm External Wall + 100mm Partition)
	Lift upgrade	Lift upgrade	Lift upgrade	Max roof PV
		Lighting power density reduced by 13%	Lighting power density reduced by 26%	Lift upgrade
			Max BIPV (Wall)	Max BIPV (Wall)
6C (Retail)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	Thermal Mass (150mm Partition)	Thermal Mass (150mm External Wall + 100mm Partition)	PAC COP 4.8	PAC COP 5.05
	Max roof PV	Max roof PV	Thermal Mass (200mm External Wall + 150mm Partition)	Lighting power density reduced by 40%
	PAC COP 4.3	PAC COP 4.55	Max roof PV	Thermal Mass (300mm External Wall & 300mm Partition)
	Economy cycle installed onto all the PACs	Economy cycle installed onto all the PACs	Economy cycle installed onto all the PACs	R3 Insulation
		Lighting power density reduced by 13%	Lighting power density reduced by 26%	Max roof PV
			Max BIPV (Wall)	Economy cycle installed onto all the PACs
				Max BIPV (Wall)
9aD (Hospital Ward)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Fan pressure reduction by 25%	Fan pressure reduction by 25%	Fan pressure reduction by 25%	Fan pressure reduction by 25%
	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	Thermal Mass (100mm Partition)	Thermal Mass (100mm External Wall	Chiller COP 7.83/IPLV 12.12	Chiller COP 8.58/IPLV 12.87
	R3 Insulation	R3 Insulation	Thermal Mass (100mm External Wall & 100mm Partition)	Lighting power density reduced by 40%
	Max roof PV	Max roof PV	R3 Insulation	Thermal Mass (100mm External Wall & 150mm Partition)
	Chiller COP 6.33/IPLV 10.12	Chiller 7.08/IPLV 11.12	Max roof PV	R3 Insulation
	Economy cycle installed onto all the AHUs	Economy cycle installed onto all the AHUs	Lighting power density reduced by 26%	Max roof PV
		Lighting power density reduced by 13%	Max BIPV (Wall)	Max BIPV (Wall)

	2019	2024	2029	2034
			Economy cycle installed onto all the AHUs	Economy cycle installed onto all the AHUs
9bE (School)	Light colour for external wall	Light colour for external wall	Light colour for external wall	Light colour for external wall
	External shutters	External shutters	External shutters	External shutters
	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor	Lighting control by occupancy sensor
	R6 Insulation	CO2 control OA treatment	CO2 control OA treatment	CO2 control OA treatment
	Max roof PV	Thermal Mass (100mm Partition)	PAC COP 4.8	PAC COP 5.05
	PAC COP 4.3	R6 Insulation	Thermal Mass (100mm Partition)	Lighting power density reduced by 40%
	CO2 control OA treatment	Max roof PV	R8 Insulation	Thermal Mass (100mm External Wall & 100mm Partition)
		PAC COP 4.55	Max roof PV	R8 Insulation
		Lighting power density reduced by 13%	Lighting power density reduced by 26%	Max roof PV
			Max BIPV (Wall)	Max BIPV (Wall)

2.4 Dehumidification Test

Climate Zone 1 is usually more humid than other climate zones. In order to test impact of the dehumidification on the energy results, we simulated the archetypes with and without dehumidification for the following measures:

(1) Chiller improvement for the Office model

(2) Minimum outside air CO_2 control for the Hospital Ward model

The reason for these two measures is they are most likely to be impacted by the dehumidification. Table 4 shows the regulated energy savings for these models. Regulated energy is defined as energy consumption of the building included in the scope of the Code (i.e. heating and cooling, lighting).

Table 4: Regulated energy savings for the scenarios with/without dehumidification.

	Regulated Energy Savings			
	Office		Hospital Ward	
	With Dehumidification	Without Dehumidification	With Dehumidification	Without Dehumidification
Chiller improvement	19%	20%		
Minimum outside air CO_2 control			2.4%	3.7%

The results indicate that the impact of the dehumidification is small. In practice, VAV systems are robust and are less impact by RH variations in space. PACs using DX cooling cannot generally control humidity in the conditioned space. Therefore, we do not use the dehumidification in the models for this project.

2.5 Pricing Methodology

Refer to the *SP0016 Final Technical Report* for the full pricing methodology used. When climate zone specific pricing was required, construction costs for CZ1 were approximated by using CZ2 figures or by matching pricing data for similar HVAC system sizes. Based on anecdotal advice, absolute prices may be higher due to transport costs or a smaller local market (for example) but this is expected to apply evenly to all prices including the baseline. Therefore, for benefit cost analysis purposes, there is expected to be minimal impact.

Table 5: Measure and capex for single dimensional analysis including HVAC adjustment (reduction in required plant size from energy efficiency measures).

	Hotel		Office		Retail		Ward		School	
	Measure Capex	HVAC Adjustment	Measure Capex	HVAC Adjustment	Measure Capex	HVAC Adjustment	Measure Capex	HVAC Adjustment	Measure Capex	HVAC Adjustment
Fabric Colour	$0	-$3,785	$0	-$13,527	$0	$512	$0	-$678	$0	-$291
Active Mass	-	-	$965,726	-$114,358	-	-	-	-	-	-
BIPV Wall	$304,819	$132	$1,519,862	-$28,278	$393,725	$636	$84,672	-$154	$45,458	-$341
PV	$80,640	-$265	$111,104	$284	$111,104	$387	$65,856	-$265	$25,536	$380
Glazing2	$30,067	-$42,100	$159,702	-$244,538	-	-	$10,054	-$3,446	$7,683	-$3,149
Daylighting1	-	-	$34,584	$5,187	-	-	$1,729	-	$3,458	-
Daylighting2	-	-	$836,042	-	-	-	$69,608	$219	$41,323	$437
Fans	-	-	$419,965	$782	-	-	$2,806	-$693	-	-
Chillers/PACs	$0	$135	$0	-$311	$0	$0	$0	-$46	$0	$0
Economy Cycle	-	-	$27,059	$11,352	$10,292	-$214	$4,660	-$49	-	-
OA Treatment	-	-	-	-	-	-	$11,010	-$1,020	$5,505	-$519
Lighting	$41,501	-$893	$204,940	-$3,081	$21,615	-$8,631	$11,240	-$309	$4,323	$45

Table 6 sums the measure capex and any HVAC plant capacity adjustment (requiring a smaller or larger plant as a result of the efficiency measure) from the above table.

Table 6: Total capex as a result of the energy efficiency measures for each archetype.

	Hotel	Office	Retail	Ward	School
	Total Capex	Total Capex	Total Capex	Total Capex	Total Capex
Fabric Colour	-$3,785	-$13,527	$512	-$678	-$291
Active Mass	-	$851,368	-	-	-
BIPV Wall	$304,951	$1,491,584	$394,361	$84,518	$45,117
PV	$80,375	$111,388	$111,491	$65,591	$25,916
Glazing2	-$12,033	-$84,836	-	$6,608	$4,534
Daylighting1	-	$39,771	-	-	-
Daylighting2	-	-	-	$69,827	$41,760
Fans	-	$420,747	-	$2,113	-
Chillers/PACs	$135	-$311	$0	-$46	$0
Economy Cycle	-	$38,411	$10,078	$4,611	-
OA Treatment	-	-	-	$9,990	$4,986
Lighting	$40,608	$201,859	$12,984	$10,931	$4,368

No measure capital expenditure was included for the following measures and for the following reasons presented in Table 7 below.

Table 7: Measures modelled which do not have a capital cost (same methodology as the analysis for other climate zones).

Measure	Explanation
Fabric Colour	At the time of construction for a new building, the fabric colour selection has negligible capital cost.
Chillers/PACs	The improvement in chiller and PAC performance was implemented at points in time similar to the performance learning rate such that no additional construction cost was required.
Lighting	Measure capex for occupancy sensors was included but costing around IPD reductions were ignored. This is because the improvements in IPD were implemented at their expected performance and price learning rates.

3. Residential Modelling Methodology

3.1 Overview

For the purpose of the trajectory analysis, three archetypes (Apartment, Attached Dwelling and Detached Dwelling) were selected. Team Catalyst were provided with Accurate models for each archetype by the University of Wollongong (UOW) team. The floor plans and dimensions are consistent with the technical document provided by UOW in their earlier report titled SP0016 Building Code Energy Performance Trajectory Project Final Technical Report, published by the Cooperative Research Centre for Low Carbon Living (CRC LCL) and available on their website [http://www.lowcarbonlivingcrc.com.au/resources/crc-publications/crclcl-project-reports/sp0016-final-building-code-energy-performance].

Team Catalyst used the models provided by the UOW team, including all infiltration opening data, to maintain consistency of analyses across all climate zones.

3.2 Simulation Process

For this project Team Catalyst developed a customised scripting approach, using Python based scripts to glue together input scratch file descriptions to CheNath for each specific run. The runs were carried out in batches for each variation of the required single dimension model configurations. Output results were captured in a CSV format, allowing easy post processing by others (Energy Action) for benefit-cost calculations. A description of the method is given below.

The AccuRate engine which performs building energy simulations for all NatHERS compliant software takes as input a file called "scratch" which describes all details of the building model. The AccuRate software (and all other software which uses the AccuRate engine) produces this scratch file based on the data entered into the user interface software. The user interface is used to assist users in completely and correctly describing the building model. By directly manipulating the scratch file before it is passed to the AccuRate engine, it is possible to generate many variations on the building model without manual data entry. The simulation engine can then be run on a set of generated scratch files to obtain the energy performance of the model variations. Parametric studies are possible by specifying a set of base building models and variations.

TeamCatalyst developed a set of scripts to perform the following tasks:

- Read the scratch file of the original model
- Manipulate individual aspects of the building model
- Write the altered scratch file in the correct format
- Pass a set of scratch files to the simulation engine and run the simulations
- Process the results

The appropriate changes to the scratch file for each model variation are determined by making model changes in the AccuRate user interface software and observing the resulting changes in the scratch file prepared for simulation by the software. The scripts do not simply 'cut and paste' parts of scratch files together: they must replicate the behaviour of the user interface. The user interface restricts parameters to sensible ranges and combinations.

The scripts can make changes to the building model such as:

- Change model orientation
- Change model location (eg. climate zone)
- Select and replace construction elements (windows, walls, floors, ceilings etc)
- Change ventilation parameters
- Add or remove ceiling fans
- Change element properties (eg. roof or wall solar absorptance)
- Change element dimensions (windows, shading elements etc)

3.3 Baseline Models

For the Single Dimensional Analysis, three baseline models were developed with the following attributes (for locations Darwin, NT and Alice Springs, NT):

1. All building elements except Windows, were set to DTS provisions of the BCA 2005 as per NCC 2016.

2. Ceiling fans were added as per the matrix of baseline and increased stringency levels, which was developed and finalised with input from the Technical Advisory Group (TAG); this matrix is referred to in this report as the 'TAG provided matrix'.

3. Windows were selected to optimize performance for NATHERS 3.5 stars for Apartments and NATHERS 5 stars for Attached and Detached dwellings.

4. Infiltration openings in the form of Wall Vents were then modelled to increase air leakage. The Wall Vents were already in place in the models provided by the UOW team. It should be noted that Steps 1 to 3 listed above were performed after removing the vent data from the UOW model, to reflect the modelling assumptions that would have been made if a project was seeking a certified rating. Once the model was set to the required NatHERS Star rating, the infiltration openings were added back into the models. All other ceiling penetrations were left unsealed. This step was undertaken to assess the opportunities and costs of improving and verifying building air tightness (see SP0016 Technical Report for further details).

The baseline modelling parameters for each of the archetypes are presented in Table 8 to Table 10 below for both climate zones 1 and 3.

Table 8: Detached baseline modelling parameters.

Detached Archetype		
Archetype Parameter	**Construction Details for both CZ1 and CZ3**	**Source**
External Wall	Wall Construction: Concrete Block 190mm Airgap NonRef 20mm Plasterboard 10mm Total R : 0.61 m2K/W	TAG provided Matrix
External Wall Surface Absorptance	SA = 0.8	TAG provided Matrix
Roof Surface Colour	Tiles, Cottage Red SA=0.82 R Total = 0.18	TAG provided Matrix
Roof Ventilation	Standard	TAG provided Matrix
Ceiling Insulation	Cellulose Fiber 70mm Plasterboard 10mm R Total = 2.02 Roof + Ceiling = 0.18+2.02 =2.2 m2K/W	TAG provided Matrix
Floor Construction	Ground Floor : Concrete with carpet Concrete with tiles for wet areas	TAG provided Matrix
U / SHGC	Window performance set to Nathers 5 stars	TAG provided Matrix
Window to NCFA ratio	As original	As per University of Wollongong Accurate Models
Window Openability	As original	As per University of Wollongong Accurate Models
Ceiling Fans	1 x 1200 mm living, 1 x 900mm in beds	TAG provided Matrix
Infiltration settings	Wall Vents Zone1 : Wall vent 1 x200, Wall Exhaust Fan 1x 250 Zone 2: Wall Vent 1x 180 Zone3 : Wall vent 1 x200, Wall Exhaust Fan 1x 250 Zone 4: Wall Vent 1x 180 Zone 5: Wall Vent 1x 180 Zone 6: Wall Vent 1x 180 Zone 7: Wall Vent 1x 180 Zone 8: Ceiling Exhaust Fan 1x 200 Zone 9: None Zone 10: Wall Vent 1x 180 Zone 11: Wall Vent 1x 180 Zone12 :Wall Exhaust Fan 1x 200 Zone13: Wall vent 1 x160, Wall Exhaust Fan 1x 160 Zone14 : Wall vent 1 x200, Wall Exhaust Fan 1x 250	As per University of Wollongong Accurate Models
Eave extension	As drawn	As per University of Wollongong Accurate Models
Adjustable shade	None	TAG provided Matrix
Thermal Mass - Wall	Internal Walls PlasterBoard 10mm Conc Block Heavy 90mm PlasterBoard 10mm	TAG provided Matrix
Thermal Mass - Floor	100 mm thick slab on ground, carpeted except for wet areas	TAG provided Matrix

Table 9: Attached baseline modelling parameters.

Attached Archetype		
Archetype Parameter	**Construction Details for both CZ1 and CZ3**	**Source**
External Wall	Wall Construction: Concrete Block 190mm Airgap NonRef 20mm Plasterboard 10mm Total R : 0.61 m2K/W	TAG provided Matrix
External Wall Surface Absorptance	SA = 0.8	TAG provided Matrix
Roof Construction	Tiles, Cottage Red SA=0.82 R Total = 0.18	TAG provided Matrix
	Standard	TAG provided Matrix
	Cellulose Fiber 70mm Plasterboard 10mm R Total = 2.02 Roof + Ceiling = 0.18+2.02 =2.2 m2K/W	TAG provided Matrix
Floor Construction	Ground Floor : Concrete with carpet Concrete with tiles for wet areas First Floor : Concrete with carpet Concrete with tiles for wet areas	TAG provided Matrix
U / SHGC	Window performance set to Nathers 5 stars	TAG provided Matrix
Window to NCFA ratio	As original	As per University of Wollongong Accurate Models
Window Openability	As original	As per University of Wollongong Accurate Models
Ceiling Fans	1 x 1200 mm living, 1 x 900mm in beds	TAG provided Matrix
Infiltration settings	Wall Vents Laundry 1x180mm Kitchen 1x180mm Entry 1x180mm Bed 1 1x180mm Study 1x180mm Stairs 1x180mm Hall 1x180mm Bed 2 1x180mm Living 2x180mm Ceiling Exhaust Fans Bath 1x180mm Ens 1x180mm	As per University of Wollongong Accurate Models
Eave extension	As drawn	As per University of Wollongong Accurate Models
Adjustable shade	None	TAG provided Matrix
Thermal Mass - Wall	Party Wall PlasterBoard 10mm Conc Block Heavy 190mm PlasterBoard 10mm Internal Walls PlasterBoard 10mm Conc Block Heavy 90mm PlasterBoard 10mm	TAG provided Matrix
Thermal Mass - Floor	100 mm thick slab on ground, carpeted except for wet areas	TAG provided Matrix

Table 10: Apartment baseline modelling parameters.

Apartment Archetype		
Archetype Parameter	**Construction Details for both CZ1 and CZ3**	**Source**
External Wall	Wall Construction: Concrete Block 190mm Airgap NonRef 20mm Int. Plasterboard 10mm Total R : 0.61 m2K/W	TAG provided Matrix
External Wall Surface Absorptance	SA = 0.8	TAG provided Matrix
Roof Construction	L1 Apartment - Only Floor and Ceiling	As per University of Wollongong Accurate Models
Floor Construction	Tiles 8mm Concrete 150mm	TAG provided Matrix
U / SHGC	Window performance set to Nathers 3.5 stars.	
Window to NCFA ratio	As drawn	As per University of Wollongong Accurate Models
Window Openability	As Drawn	As per University of Wollongong Accurate Models
Ceiling Fans	No ceiling Fans	TAG provided Matrix
Infiltration settings	Wall vents to Outdoor Air Bed 1 x 1 225mm Vent Bed2 x 1 225mm Vent Living x 2 225mm Vent Kitchen x 1 225mm Vent Bathroom x 1 160mm Vent Laundry x 1 160mm Vent Corridor x 1 160mm Vent Kitchen, Ensuite and Bathroom Exhaust fans unsealed	As per University of Wollongong Accurate Models
Eave extension	As drawn	As per University of Wollongong Accurate Models
Adjustable shade	None	TAG provided Matrix

3.4 Simulation Parameters

3.4.1 Single Dimensional Parameters

Table 11: Detached archetype design parameters for single-dimensional and multi-dimensional analysis.

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
Walls	Insulation	Wall Construction: Concrete Block 190mm Airgap NonRef 20mm Plasterboard 10mm Total R : 0.61 m2K/W	Wall Construction: Concrete Block 190mm Airgap Ref 20mm Plasterboard 10mm Total R : 0.96 m2K/W	Wall Construction: Concrete Block 190mm Insulation 66mm Plasterboard 10mm Total R : 1.61 m2K/W	Wall Construction: Concrete Block 190mm Insulation 102mm Plasterboard 10mm Total R : 2.79 m2K/W	Wall Construction: Concrete Block 190mm Silica Aerogel Ins 57mm Plasterboard 10mm Total R : 4.52 m2K/W
	Surface Colour	Dark SA=0.8		Medium SA = 0.55	Light SA = 0.3	Light SA = 0.3
Roof/ Ceiling	Surface Colour	Tles, Cottage Red SA=0.82	Metal Deck WhiteHaven 0.23	Dark Cottage red tiles Reflective airgap 20mm Cellular insulation 14mm R = 0.84 W/m2 K		
	Roof Ventilation	Standard	Ventilated	Highly Ventilated		
	Ceiling Insulation	Cellulose Fiber 70mm Plasterboard 10mm R Total = 2.02 Roof + Ceiling = 0.18+2.02 =2.2 m2K/W	Cellulose Fiber 172mm Plasterboard 10mm R Total =4.52 Roof +Ceiling = 0.18+4.52 = 4.7 m2k/W	Basecase Ceiling R2.2	Cellulose Fiber 312mm Plasterboard 10mm R Total = 8.0	
Floors	Floor Insulation	Ground Floor : Concrete with carpet Concrete with tiles for wet areas	None	None	None	None
Windows	U/SHGC - prelim	See Detached Basecase Sheet	All Rooms A&L-012-10-A U=6.07, SHGC =0.50	All Rooms TND-078-29 A U=5.07, SHGC=0.40	All Rooms DAR-001-09A U=4.51, SHGC=0.30	All Rooms VAL-009-04 W U=3.00, SHGC = 0.35

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
	Window to NCFA ratio	As drawn	Reduce Living(Zone 1) 2 x Windows - width 1.94m to 1.2m Living(Zone14) Win W_17_2 from 2.85 m to 2.1m			
	Window Open-ability	As Drawn	Louvre windows to all windows			
Ventilation	**Ceiling Fans**	1 x 1200 mm living, 1 x 900mm in beds	900mm Ceiling Fan added to Kitchen (zone 3) and Study (zone 2)			
	Infiltration	Wall Vents Zone1 : Wall vent 1 x200, Wall Exhaust Fan 1x 250 Zone 2: Wall Vent 1x 180 Zone3 : Wall vent 1 x200, Wall Exhaust Fan 1x 250 Zone 4: Wall Vent 1x 180 Zone 5: Wall Vent 1x 180 Zone 6: Wall Vent 1x 180 Zone 7: Wall Vent 1x 180 Zone 8: Ceiling Exhaust Fan 1x 200 Zone 9: None Zone 10: Wall Vent 1x 180 Zone 11: Wall Vent 1x 180 Zone12 :Wall Exhaust Fan 1x 200 Zone13: Wall vent 1 x160, Wall Exhaust Fan 1x 160 Zone14 : Wall vent 1 x200, Wall Exhaust Fan 1x 250	No Vents , All exhaust fans Sealed Only Zone 8 Exhaust fan to remain			
Shading	**Eave extension**	As drawn	Increase both Living room eaves to 750 Eaves 1 L = 4700mm Eaves 2 L = 8450mm	Increase both Living room eaves to 1500 Eaves 1 L = 4700mm Eaves 2 L = 8450mm		
	Adjustable shade	None	Awnings Vented Living 1 Win 2100 x 2850mm Living 2 Win (1520 x 1940) x 2			

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
Thermal Mass	**Walls**	190 mm Concrete block party walls,		Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation

Table 12: Attached archetype design parameters for single-dimensional and multi-dimensional analysis.

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
Walls	Insulation	Wall Construction: Concrete Block 190mm Airgap Non Ref 20mm Plasterboard 10mm Total R : 0.61 m2K/W	Wall Construction: Concrete Block 190mm Airgap Ref 20mm Plasterboard 10mm Total R : 0.96 m2K/W	Wall Construction: Concrete Block 190mm Insulation 66mm Plasterboard 10mm Total R : 1.61 m2K/W	Wall Construction: Concrete Block 190mm Insulation 102mm Plasterboard 10mm Total R : 2.79 m2K/W	Wall Construction: Concrete Block 190mm Silica Aerogel Ins 57mm Plasterboard 10mm Total R : 4.52 m2K/W
	Surface Colour	Dark SA=0.8		Medium SA = 0.55	Light SA = 0.3	Light SA = 0.3
Roof/Ceiling	Surface Colour	Tles, Cottage Red SA=0.82	Metal Deck WhiteHaven 0.23	Dark Cottage red tiles Reflective airgap 20mm Cellular insulation 14mm R = 0.84 W/m2 K		
	Roof Ventilation	Standard	Ventilated	Highly Ventilated		
	Ceiling Insulation	Cellulose Fiber 70mm Plasterboard 10mm R Total = 2.02 Roof + Ceiling = 0.18+2.02 =2.2 m2K/W	Cellulose Fiber 172mm Plasterboard 10mm R Total =4.52 Roof +Ceiling = 0.18+4.52 = 4.7 m2k/W	Basecase Ceiling R2.2	Cellulose Fiber 312mm Plasterboard 10mm R Total = 8.0	
Floors	Floor Insulation	Ground Floor : Concrete with carpet Concrete with tiles for wet areas First Floor : Concrete with carpet Concrete with tiles for wet areas	None	None	None	None
Windows	U/SHGC - prelim	See Attached Basecase Sheet	All Rooms A&L-012-10-A U=6.07, SHGC =0.50	All Rooms TND-078-29 A U=5.07, SHGC=0.40	All Rooms DAR-001-09A U=4.51, SHGC=0.30	All Rooms VAL-009-04 W U=3.00, SHGC = 0.35

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
	Window to NCFA ratio	As drawn	Reduce width of the following windows width to, Living room to 2.64m to 1.2m Kitchen from2.03m to 1m			
	Window Openability	As Drawn	Louvre windows to all windows			
Ventilation	**Ceiling Fans**	1 x 1200 mm living, 1 x 900mm in beds	900mm Ceiling Fan added to Kitchen (CZ1 & 3) and Study (CZ1 only)	900mm Ceiling Fan added to Kitchen and Study (CZ3 only)		
	Infiltration	Wall Vents Laundry 1x180mm Kitchen 1x180mm Entry 1x180mm Bed 1 1x180mm Study 1x180mm Stairs 1x180mm Hall 1x180mm Bed 2 1x180mm Living 2x180mm Ceiling Exhaust Fans Bath 1x180mm Ens 1x180mm	No Vents , All exhaust fans Sealed			
Shading	**Eave extension**	As drawn	Increase Kitchen to 750mm Kitchen Eave L = 5850mm Living to 1650mm Living Eave L =3500mm	Increase Kitchen to 1500mm Living to 2400mm		
	Adjustable shade	None	Awnings Vented Kitchen Win= 1.52 x 2.03m Living Win = 2.1 x 2.64m			
Thermal Mass	**Walls**	190 mm Concrete block party walls,		Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation

Table 13: Apartment archetype design parameters for single-dimensional and multi-dimensional analysis.

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
Walls	Insulation	Wall Construction: Concrete Block 190mm Airgap NonRef 20mm Plasterboard 10mm Total R : 0.61 m2K/W	Wall Construction: Concrete Block 190mm Airgap Ref 20mm Plasterboard 10mm Total R : 0.96 m2K/W	Wall Construction: Concrete Block 190mm Insulation 66mm Plasterboard 10mm Total R : 1.61 m2K/W	Wall Construction: Concrete Block 190mm Insulation 102mm Plasterboard 10mm Total R : 2.79 m2K/W	Wall Construction: Concrete Block 190mm Silica Aerogel Ins 57mm Plasterboard 10mm Total R : 4.52 m2K/W
	Surface Colour	Dark SA=0.8		Medium SA = 0.55	Light SA = 0.3	Light SA = 0.3
Floors	Floor Insulation	Tiles 8mm Concrete 150mm		Floor Construction 8mm Tile 150mm Concrete R2 Polystyrene		
Windows	U/SHGC - prelim	See Apartment Basecase Sheet	All Rooms A&L-012-10-A U=6.07, SHGC =0.50	All Rooms TND-078-29 A U=5.07, SHGC=0.40	All Rooms DAR-001-09A U=4.51, SHGC=0.30	All Rooms VAL-009-04 W U=3.00, SHGC = 0.35
	Window to NCFA ratio	As drawn	Reduce width of 2 x living room windows from 2.59m to 2.1m			
	Window Openability	As Drawn	Louvre windows to all windows			
Ventilation	**Ceiling Fans**	No ceiling Fans	Ceiling Fans to Living 1x1200, Kitchen 1x900 (CZ1 & 3) & Bed 1& 2 2x1200 (CZ1 only)	Ceiling Fans to Bed 1 & 2 2x1200		
	Infiltration	Wall vents to Outdoor Air Bed 1 x 1 225mm Vent Bed2 x 1 225mm Vent Living x 2 225mm Vent Kitchen x 1 225mm Vent Bathroom x 1 160mm Vent Laundry x 1 160mm Vent Corridor x 1 160mm Vent	No Vents , All exhaust fans Sealed			

Design Parameter		Baseline	Level 1 Changes	Level 2 Changes	Level 3 Changes	Maximum Changes
		Kitchen, Ensuite and Bathroom Exhaust fans unsealed				
Shading	**Eave extension**	As Drawn	Living width to 1550mm Eaves Length 6800+4600 = 11,400mm	Living width to 2300mm Eaves Length 6800+4600 = 11,400mm		
	Adjustable shade	None	Awnings Vented 2 x Living Room Windows 2100 x 2590			
Thermal Mass	**Walls**	190 mm Concrete block party walls,		Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation	Reverse veneer, using same level wall insulation

3.4.2 Equipment efficiency

The AccuRate simulations include modelling of thermal energy efficiency measures to calculate heating and cooling energy. Forward trajectories for energy efficiency of heating, ventilation and cooling (HVAC) equipment, lighting and domestic hot water (DHW) were developed based on recent energy efficiency trends for these products (see Appendix E of the *SP0016 Final Technical Report* for full details on the methodology). The analysis was based on baseline assumptions of:

- HVAC equipment: Reverse cycle heat pump with coefficient of performance (COP) of 3 (for heating and cooling)

- DHW: standard heat pump equipment type with COP 3

- Lighting: 5 W/m^2

3.4.3 Multi-Dimensional Scenarios

While the single dimensional results for the higher performance double glazing types (using wood and uPVC framing) showed them to be highly cost beneficial, based on TAG advice these glazing types were excluded from the conservative multi-dimensional scenarios due to their limited availability in northern states and current low uptake by home builders.

Table 14: Conservative Energy Efficiency Trajectory Scenarios – Detached Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	HVAC COP 4 Solar DHW COP 4 Lighting 4W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW heat pump (HP) COP 4.5 Lighting 3.5W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed
CZ3	Solar DHW COP 4 Lighting 4W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Awnings 3x Living Room No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Awnings 3x Living Room No Vents , All exhaust fans Sealed

CZ1a (Cairns)	Solar DHW COP 4 Lighting 4W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall Colour White SA=0.23 Ceiling Construction Metal Deck SA=0.23 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Shading eave living width 1.5m Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

Table 15: Conservative Energy Efficiency Trajectory Scenarios – Attached Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	Solar DHW COP 4 Lighting 4W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R4.52 Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R4.52 Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R4.52 Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 3 U-value=3.9 SHGC=0.51 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R4.52 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed
CZ3	Solar DHW COP 4 Lighting 4W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Ceiling insulation R4.52 Shading eaves Kitchen to 0.75m, Living to 1.65m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Ceiling insulation R4.52 Reverse Veneer Shading eaves Kitchen to 0.75m, Living to 1.65m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Ceiling insulation R4.52 Reverse Veneer Shading eaves Kitchen to 0.75m, Living to 1.65m Awnings Living Room & Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Ceiling insulation R4.52 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen No Vents , All exhaust fans Sealed

CZ1A (Cairns)	Solar DHW COP 4 Lighting 4W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R2.8 Ceiling insulation R4.52 Shading eaves Kitchen to 0.75m, Living to 1.65m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Ceiling insulation R8.0 Shading eaves Kitchen to 0.75m, Living to 1.65m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Ceiling insulation R8.0 Reverse Verneer Shading eaves Kitchen to 0.75m, Living to 1.65m Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Ceiling insulation R8.0 Reverse Verneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

Table 16: Conservative Energy Efficiency Trajectory Scenarios – Apartment Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	Solar DHW COP 4 Lighting 4W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.5 Shading eave living width 1.55m Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.5 Shading eave living width 1.55m Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.5 Shading eave living width 1.55m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R4.5 Shading eave living width 1.55m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed

CZ3	Solar DHW COP 4 Lighting 4W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Shading eaves Living to 1.55m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Shading eaves Living to 2.3m Fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 2 U-value=4.2 SHGC=0.62 Wall insulation R2.8 Shading eaves Living to 2.3m Fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed
CZ1A (Cairns)	Solar DHW COP 4 Lighting 4W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R2.8 Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Reverse Veneer Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 1 U-value=6.4 SHGC=0.7 Wall insulation R4.52 Reverse Veneer Ceiling fans Living, Bed 1 & 2, Kitchen No Vents , All exhaust fans Sealed

Table 17: Accelerated Energy Efficiency Trajectory Scenarios – Detached Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed…	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed…	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed…	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed…
CZ3	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 0.75m No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 0.75m No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 0.75m No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 0.75m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

CZ1A (Cairns)	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 Roof ventilation highly ventilated Ceiling insulation R8 Reverse Veneer Shading eave living width 1.5m Awnings 3x Living Room Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

Table 18: Accelerated Energy Efficiency Trajectory Scenarios – Attached Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed
CZ3	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

CZ1A (Cairns)	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.52 2 ventilators, 4 eave vents Ceiling insulation R8 Reverse Veneer Shading eaves Kitchen to 1.5m, Living to 2.4m Awnings Living Room & Kitchen Ceiling fans Kitchen and Study No Vents , All exhaust fans Sealed

Table 19: Accelerated Energy Efficiency Trajectory Scenarios – Apartment Archetype.

Climate Zone	Measure Combination (2019)	Measure Combination (2024)	Measure Combination (2029)	Measure Combination (2034)
CZ1	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans

CZ3	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling Fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling Fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling Fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling Fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans
CZ1A (Cairns)	DHW HP COP 4.5 Lighting 3.5W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 4.5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans	DHW HP COP 5 Lighting 3W/m² Window Type 6 U-value=1.9 SHGC=0.24 Wall insulation R4.5 Reverse Veneer Shading eave living width 2.3m Awnings 2x Living Room Ceiling fans Living, Bed 1 & 2, Kitchen No wall vents, 2 sealed fans

3.5 Pricing Methodology

Refer to the *SP0016 Final Technical Report* for the full pricing methodology used. Similar to the commercial section, when climate zone specific pricing was required but not available, construction costs for CZ1 and CZ3 were approximated by using CZ2 figures. Based on anecdotal advice, absolute prices may be higher due to transport costs or a smaller local market (for example) but this is expected to apply evenly to all prices including the baseline. Therefore, for benefit cost analysis purposes, there is expected to be minimal impact.

Previous pricing was used for CZ1 and CZ3 for all but the following measures:

1. Infiltration: walls vents, exhaust fans etc.
2. Wall Insulation: reflective foil pricing
3. Shading Awnings: metal bladed awning prices
4. Thermal Mass: external cladding costs
5. Window Openability: capital costs for openable windows

Refer to Appendix B.IV for greater detail regarding the residential pricing methodology used.

3.6 Cairns Residential Buildings

An alternative conservative energy efficiency trajectory was developed for the residential archetypes using a Cairns climate file, with modifications to the baseline energy models and addition of outdoor living areas as set out below. The initial selection of measures for the conservative trajectory was drawn from the results for Climate Zone 1 (Darwin) and Climate Zone 3 (Alice Springs), with additional optimisation work undertaken to select scenarios relevant to the Cairns climate file.

3.6.1 Geometry

For the purpose of the energy efficiency analysis for Cairns in Far North Queensland (FNQ), the three archetypes that were tested for Northern Climates (Darwin and Alice Springs) were modelled with the inclusion of an Outdoor Living Area (OLA) attached to each building. The OLA was modelled as a shading element. There is no provision to represent an outdoor unconditioned zone in Accurate software. The Building code allows for one Nathers star reduction with the provision of an OLA with a ceiling fan. However, as the OLA is not modelled as a zone, the electrical energy consumed by the ceiling fan and the outdoor lighting was manually calculated, based on 4 hours of operation for every day of the year.

3.6.2 Baseline Models

For the Single Dimensional Analysis, three baseline models were developed with the following attributes (for location Cairns, FNQ):

1. All building elements except Windows, were set to DTS provisions of the NCC2016.

2. Outdoor Living space (OLA) as described in the Queensland development code (QDC) was represented as a fixed shading in the model. The ceiling fan and outdoor lighting energy was manually calculated. This allows the baseline model performance to be reduced by 1 star for both the apartments (5 to 4 stars) and the Detached and Attached archetypes (6 to 5 stars).

3. Ceiling fans were added as per the matrix of baseline and increased stringency levels, which was developed and finalised with input from the Technical Advisory Group (TAG); this matrix is referred to in this report as the 'TAG provided matrix'.

4. Windows were selected to optimize performance for NATHERS 4.5 stars for Apartments and NATHERS 5 stars for Attached and Detached dwellings.

5. Infiltration openings in the form of Wall Vents were then modelled to increase air leakage. The Wall Vents were already in place in the models provided by the UOW team. It should be noted that Steps 1 to 3 listed above were performed after removing the vent data from the UOW model, to reflect the modelling assumptions that would have been made if a project was seeking a certified rating. Once the model was set to the required NatHERS Star rating, the infiltration openings were added back into the models. All other ceiling penetrations were left unsealed. This step was undertaken to assess the opportunities and costs of improving and verifying building air tightness (see SP0016 Technical Report for further details).

It is noted that setting all the building elements to the elemental provisions of NCC2016, except for windows, which have to be optimised to a Nathers star rating, have resulted in overestimating the baseline performance for the archetypes. The building modelled with worst possible window was still performing above the required Nathers star band.

3.6.3 Archetype Floor Plans

Figure 1 to Figure 3 below show the three archetype floor plans with outside living areas added.

Figure A.9 Dimensions of the detached house (Isaacs 2007, p. 12)

Figure 1: Outdoor Living area – Detached Archetype-TCPL Edit

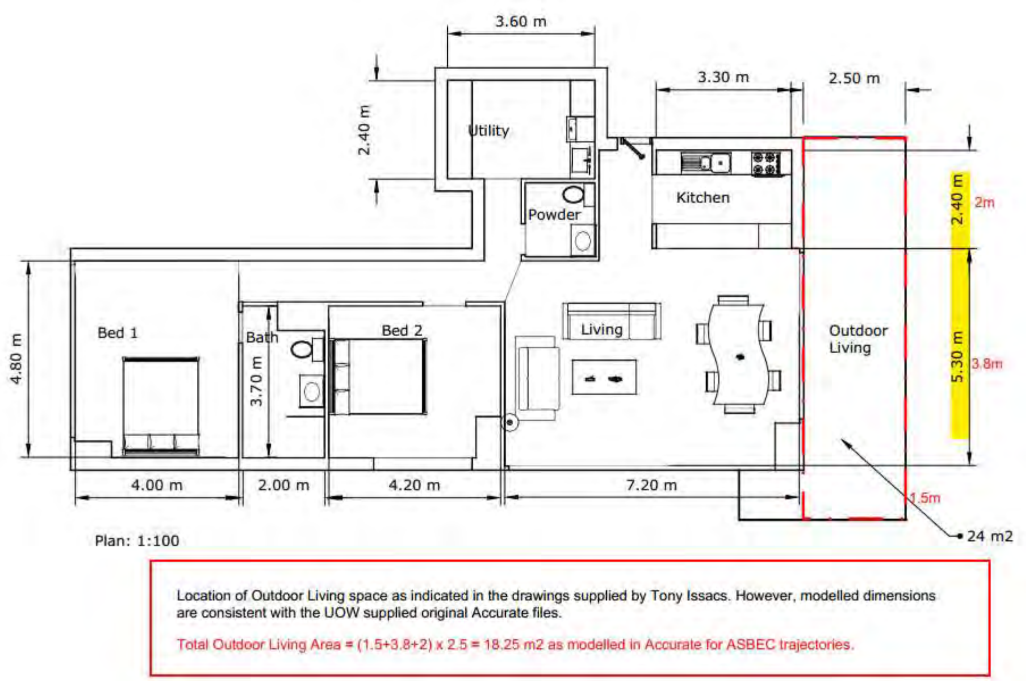

Figure 2: Outdoor Living Area – Apartment Archetype-TCPL Edit

Figure 3: Outdoor Living Area – Attached Archetype-TCPL Edit.

4. Commercial Modelling Results

This section summarises the multi-dimensional results for the commercial building archetypes. Refer to Appendix A.I to A.VII for a comprehensive breakdown of the results including single dimensional results and interpolated figures used for the trajectory.

4.1 Conservative Trajectory

The 'regulated' figures only include regulated building energy (HVAC plant & lighting etc.) whereas the 'whole' rows cover whole building energy (HVAC plant, lighting & equipment). The 'net' rows identify when solar PV generation has been included in the energy savings.

4.1.1 Energy Efficiency Trajectory

Table 20 below presents the conservative energy efficiency trajectory results (regulated energy and whole building energy totals), followed by the net trajectory for the accelerated analysis.

Table 20: Building energy consumption (kWh/m²) comparing test cases to the base case.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	110.33	91.27	85.46	81.59	79.90	74.85	73.17	71.80	69.74
Office – Regulated	72.93	56.53	53.68	51.78	50.31	45.93	44.47	42.38	39.25
Retail – Regulated	149.56	129.37	110.48	97.89	94.28	83.45	79.84	73.59	64.22
Ward – Regulated	131.61	84.88	79.29	75.56	73.97	69.21	67.63	66.01	63.59
School – Regulated	189.39	147.97	108.13	81.56	79.65	73.90	71.99	70.07	67.19
Hotel – Whole	110.33	85.97	78.58	73.65	70.86	62.51	59.72	58.14	55.76
Office – Whole	72.93	51.62	48.35	46.17	42.65	32.09	28.57	25.86	21.81
Retail – Whole	149.56	81.27	59.10	44.32	39.30	24.25	19.23	16.30	11.89
Ward – Whole	131.61	45.82	42.72	40.66	39.29	35.19	33.82	33.26	32.40
School – Whole	189.39	74.61	39.49	16.08	14.07	8.06	6.06	5.29	4.14

Table 21: Capex ($/m²) for the conservative modelling scope (including HVAC plant capacity adjustment).

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	$0	$58	$85	$110	$112	$119	$122	$138	$163
Office – Regulated	$0	$55	$76	$91	$97	$117	$123	$124	$124
Retail – Regulated	$0	$57	$138	$216	$218	$224	$227	$259	$308
Ward – Regulated	$0	$111	$170	$223	$229	$247	$253	$253	$254
School – Regulated	$0	$128	$277	$419	$426	$445	$451	$520	$623

Table 22: Commercial conservative analysis BCRs.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	-	1.23	1.20	1.10	1.17	1.38	1.45	1.38	1.28
Office – Regulated	-	1.15	1.08	1.00	1.02	1.08	1.10	1.24	1.46
Retail – Regulated	-	1.25	1.18	1.02	1.11	1.40	1.50	1.48	1.46
Ward – Regulated	-	1.46	1.25	1.01	1.03	1.11	1.14	1.22	1.33
School – Regulated	-	1.35	1.30	1.21	1.24	1.34	1.37	1.25	1.08

4.1.2 Net Energy Potential

Table 23: Building energy consumption (kWh/m²) comparing test cases to the base case.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated – Net	134.25	115.20	109.39	105.51	103.83	98.78	97.09	95.72	93.67
Office – Regulated – Net	116.54	100.14	97.29	95.39	93.93	89.54	88.08	85.99	82.86
Retail – Regulated – Net	170.37	150.17	131.28	118.69	115.08	104.26	100.65	94.40	85.02
Ward – Regulated – Net	175.41	128.69	123.09	119.36	117.77	113.02	111.43	109.81	107.39
School – Regulated – Net	201.69	160.28	120.43	93.86	91.95	86.21	84.29	82.37	79.50
Hotel – Whole – Net	134.25	104.63	97.20	92.24	89.36	80.71	77.83	76.12	73.55
Office – Whole – Net	116.54	95.07	91.71	89.47	85.49	73.55	69.57	67.57	64.56
Retail – Whole – Net	170.37	102.08	78.65	63.04	56.75	37.87	31.58	27.88	22.31
Ward – Whole – Net	175.41	73.86	70.18	67.74	66.05	61.00	59.32	58.59	57.50
School – Whole – Net	201.69	85.31	47.65	22.55	19.97	12.21	9.63	8.53	6.89

Table 24: Capex ($/m²) for the conservative modelling scope (including HVAC plant capacity adjustment).

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated – Net	$0	$133	$173	$198	$213	$259	$275	$299	$335
Office – Regulated – Net	$0	$76	$104	$115	$132	$181	$198	$201	$207
Retail – Regulated – Net	$0	$255	$366	$446	$477	$568	$598	$649	$726
Ward – Regulated – Net	$0	$345	$434	$496	$523	$602	$629	$649	$678
School – Regulated – Net	$0	$355	$533	$684	$711	$795	$823	$910	$1,041

Table 25: Commercial conservative analysis BCRs – Net analysis.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	-	0.63	0.70	0.75	0.76	0.81	0.83	0.82	0.80
Office – Regulated	-	1.04	1.02	0.98	0.99	1.03	1.04	1.13	1.27
Retail – Regulated	-	0.89	0.92	0.95	0.96	0.98	0.98	0.97	0.94
Ward – Regulated	-	0.83	0.77	0.72	0.71	0.69	0.68	0.69	0.71
School – Regulated	-	1.20	1.16	1.13	1.13	1.10	1.09	1.03	0.94

4.2 Accelerated Trajectory

4.2.1 Energy Efficiency Trajectory

Table 26 below presents the accelerated energy efficiency trajectory results (regulated energy and whole building energy totals), followed by the net trajectory for the accelerated analysis.

Table 26: Building energy consumption (kWh/m²) comparing test cases to the base case.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	110.33	81.99	78.23	75.73	74.83	72.14	71.24	70.01	68.16
Office – Regulated	72.93	47.36	45.26	43.86	42.93	40.15	39.22	37.81	35.70
Retail – Regulated	149.56	95.97	89.34	84.92	82.79	76.37	74.23	69.64	62.74
Ward – Regulated	131.61	71.83	71.55	71.36	70.46	67.77	66.87	65.49	63.41
School – Regulated	189.39	80.42	78.01	76.40	75.44	72.54	71.58	69.82	67.19
Hotel – Whole	134.25	105.92	102.16	99.66	98.76	96.06	95.16	93.93	92.09
Office – Whole	116.54	90.97	88.87	87.47	86.55	83.76	82.83	81.43	79.32
Retail – Whole	170.37	116.78	110.15	105.73	103.59	97.17	95.04	90.44	83.55
Ward – Whole	175.41	115.63	115.35	115.16	114.27	111.57	110.68	109.29	107.21
School – Whole	201.69	92.73	90.31	88.71	87.74	84.85	83.88	82.13	79.50

Table 27: Capex ($/m²) for the accelerated modelling scope (including HVAC plant capacity adjustment).

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	$0	$58	$85	$110	$112	$120	$122	$139	$163
Office – Regulated	$0	$55	$76	$90	$96	$114	$120	$122	$126
Retail – Regulated	$0	$69	$148	$224	$227	$234	$236	$269	$318
Ward – Regulated	$0	$121	$180	$234	$239	$257	$262	$263	$264
School – Regulated	$0	$242	$333	$418	$425	$446	$453	$521	$623

Table 28: Commercial accelerated analysis BCRs.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	-	1.19	1.17	1.08	1.15	1.36	1.43	1.36	1.26
Office – Regulated	-	1.15	1.08	1.00	1.02	1.08	1.10	1.24	1.46
Retail – Regulated	-	1.25	1.18	1.02	1.11	1.40	1.50	1.48	1.46
Ward – Regulated	-	1.46	1.25	1.01	1.03	1.11	1.14	1.22	1.33
School – Regulated	-	1.35	1.30	1.21	1.24	1.34	1.37	1.25	1.08

4.2.2 Net Energy Potential

Table 29: Building energy consumption (kWh/m²) comparing test cases to the base case.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated – Net	110.33	76.48	72.30	69.51	67.50	61.46	59.44	57.97	55.76
Office – Regulated – Net	72.93	46.23	43.77	42.13	39.14	30.17	27.18	25.13	22.05
Retail – Regulated – Net	149.56	48.35	39.81	34.12	30.69	20.40	16.97	14.82	11.59
Ward – Regulated – Net	131.61	38.10	38.13	38.16	37.42	35.19	34.45	33.58	32.27
School – Regulated – Net	189.39	19.32	15.68	13.25	11.78	7.37	5.90	5.19	4.14
Hotel – Whole – Net	134.25	96.92	91.64	88.11	86.00	79.66	77.54	75.95	73.55
Office – Whole – Net	116.54	89.68	87.08	85.34	81.90	71.60	68.17	66.82	64.80
Retail – Whole – Net	170.37	68.68	58.37	51.49	46.94	33.30	28.75	26.01	21.89
Ward – Whole – Net	175.41	65.64	65.30	65.07	64.05	60.98	59.95	58.91	57.35
School – Whole – Net	201.69	26.78	22.26	19.25	17.30	11.42	9.46	8.43	6.89

Table 30: Capex ($/m²) for the accelerated modelling scope (including HVAC plant capacity adjustment).

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated – Net	$0	$107	$160	$198	$213	$260	$275	$299	$335
Office – Regulated – Net	$0	$76	$103	$115	$130	$178	$194	$200	$209
Retail – Regulated – Net	$0	$267	$376	$455	$485	$577	$608	$659	$736
Ward – Regulated – Net	$0	$355	$444	$506	$533	$612	$639	$658	$688
School – Regulated – Net	$0	$468	$589	$682	$710	$796	$825	$911	$1,041

Table 31: Commercial accelerated analysis BCRs – Net analysis.

Model Reference	Baseline	2019	2022	2024	2025	2028	2029	2031	2034
Hotel – Regulated	-	0.75	0.81	0.85	0.86	0.90	0.92	0.90	0.89
Office – Regulated	-	1.05	1.03	0.99	1.02	1.08	1.10	1.18	1.29
Retail – Regulated	-	0.89	0.94	0.97	0.99	1.03	1.05	1.03	1.01
Ward – Regulated	-	0.98	0.91	0.85	0.84	0.82	0.81	0.82	0.84
School – Regulated	-	1.22	1.19	1.18	1.17	1.15	1.15	1.08	0.99

4.3 Commercial Trajectories (Normalised with conditioned floor area)

The simulation data was interpolated between our 5 data points to produce absolute (raw figures) and normalised (with floor area) results for the same years as the previous analysis for climate zones 2, 5, 6 and 7. The modelled data points include the baseline (not included in the following plots), 2019, 2024, 2029 and 2034 with interpolated points at 2022, 2025, 2028 and 2031.

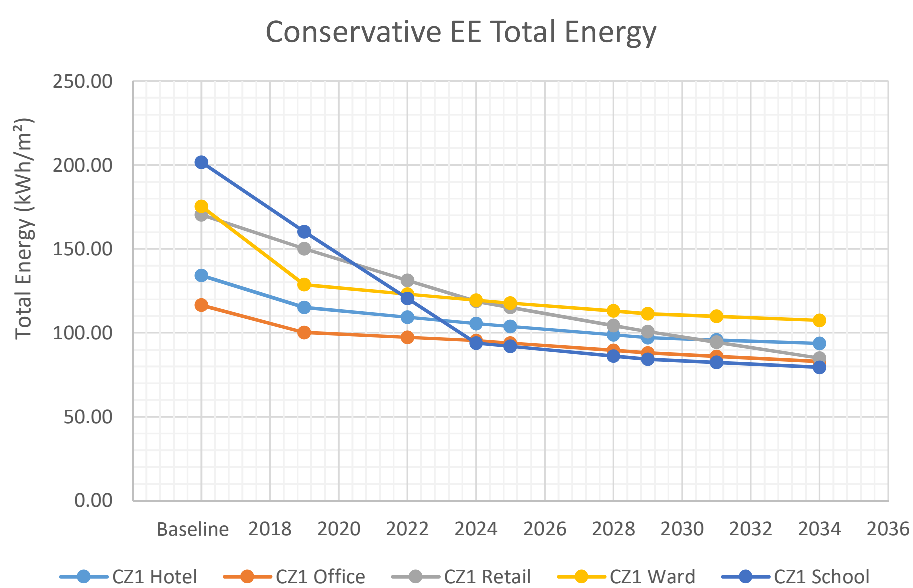

Figure 4: Commercial Conservative energy efficiency trajectory (kWh/m²).

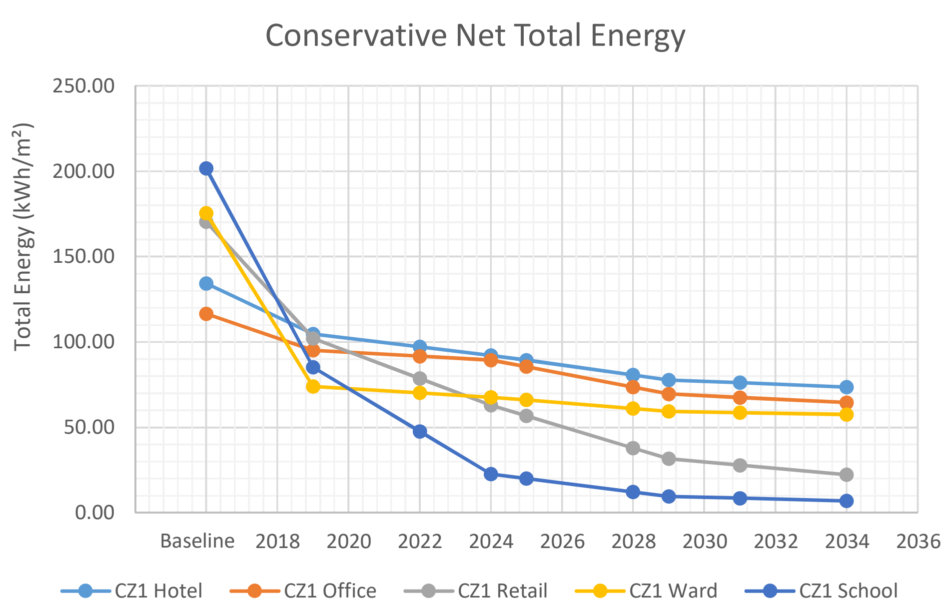

Figure 5: Commercial Conservative net trajectory (kWh/m²).

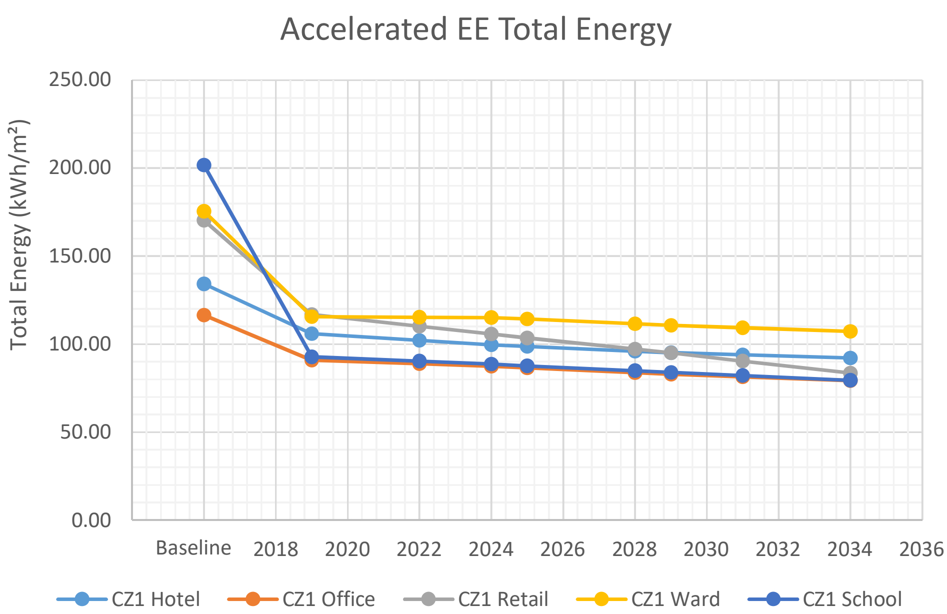

Figure 6: Commercial Accelerated energy efficiency trajectory (kWh/m²).

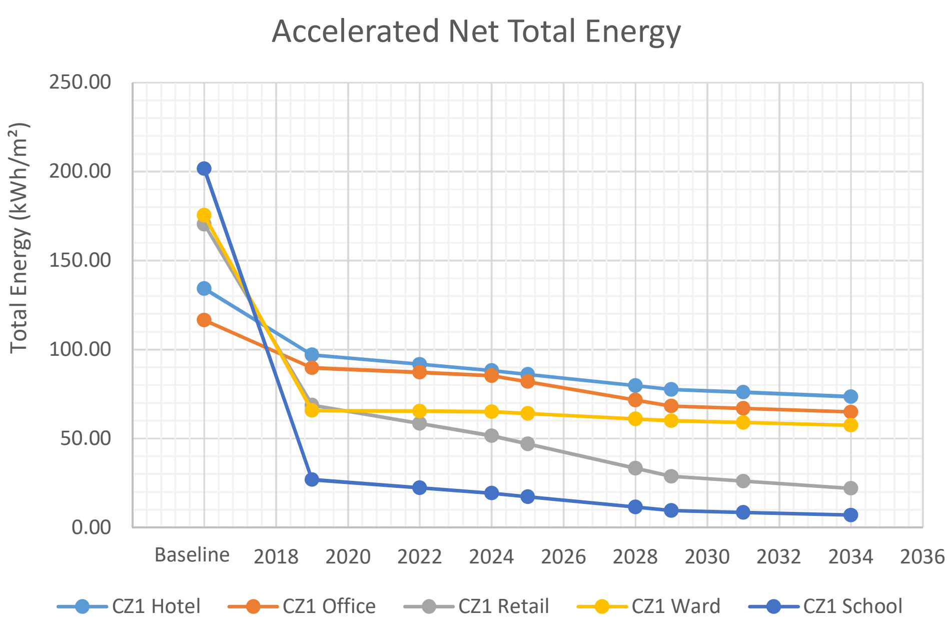

Figure 7: Commercial Accelerated net trajectory (kWh/m²).

5. Residential Modelling Results

This section summarises the multi-dimensional results for the commercial building archetypes. Refer to Appendix B.I to B.IV for a comprehensive breakdown of the results including single dimensional results and interpolated figures used for the trajectory.

5.1 Conservative Trajectory

5.1.1 Energy Efficiency Trajectory

Table 32: Residential conservative building total energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	75.4	54.0	50.71	48.03	46.49	45.19	44.0
1	Attached	79.8	55.4	52.45	49.96	48.46	47.02	45.6
1	Apartment	111.4	77.8	74.59	71.85	70.11	68.85	67.8
3	Detached	47.3	36.1	34.43	33.12	32.49	31.91	31.4
3	Attached	50.5	39.7	38.19	36.86	35.78	35.25	35.0
3	Apartment	76.2	62.2	59.88	58.04	57.23	56.78	56.5

Table 33: Residential total capex ($/m²) for the conservative modelling scope (including HVAC plant capacity adjustment).

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	$0.0	$93.7	$124.5	$144.3	$142.5	$161.2	$190.2
1	Attached	$0.0	$100.1	$136.8	$160.6	$158.4	$167.1	$181.3
1	Apartment	$0.0	$125.1	$148.9	$174.4	$203.1	$210.8	$208.1
3	Detached	$0.0	$59.9	$74.4	$85.4	$89.7	$95.6	$102.2
3	Attached	$0.0	$53.4	$65.1	$76.1	$85.7	$91.9	$96.4
3	Apartment	$0.0	$85.1	$97.8	$109.8	$120.5	$126.9	$131.2

Table 34: Residential conservative analysis BCRs.

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	-	1.26	1.23	1.21	1.39	1.45	1.24
1	Attached	-	1.31	1.25	1.18	1.29	1.40	1.42
1	Apartment	-	1.21	1.36	1.52	1.47	1.43	1.67
3	Detached	-	1.18	1.20	1.22	1.27	1.32	1.33
3	Attached	-	1.22	1.25	1.27	1.30	1.33	1.37
3	Apartment	-	1.04	1.15	1.27	1.27	1.27	1.33

5.1.2 Net Energy Potential

Table 35: Residential conservative building Net energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	75.4	-34.0	-58.20	-78.26	-89.97	-101.44	-112.8
1	Attached	79.8	10.6	3.32	-3.48	-9.28	-15.02	-20.7
1	Apartment	111.4	72.7	68.98	65.75	63.51	61.77	60.3
3	Detached	47.3	-44.9	-78.16	-104.23	-115.92	-127.55	-139.2
3	Attached	50.5	-9.1	-15.24	-21.25	-27.01	-32.22	-37.2
3	Apartment	76.2	56.5	53.62	51.23	49.88	48.88	48.1

5.2 Accelerated Trajectory

5.2.1 Energy Efficiency Trajectory

Table 36: Residential conservative building total energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	75.4	42.8	41.61	40.51	39.50	38.77	38.2
1	Attached	79.8	45.7	44.55	43.42	42.40	41.66	41.0
1	Apartment	111.4	66.8	65.66	64.51	63.32	62.53	61.9
3	Detached	47.3	30.7	30.42	30.08	29.70	29.47	29.3
3	Attached	50.5	33.8	33.46	33.09	32.71	32.53	32.5
3	Apartment	76.2	55.9	55.49	55.03	54.43	54.16	54.0

Table 37: Total capex ($/m²_for the accelerated modelling scope (including HVAC plant capacity adjustment).

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	$0.0	$93.7	$124.5	$144.3	$142.5	$161.2	$190.2
1	Attached	$0.0	$100.1	$136.8	$160.6	$158.4	$167.1	$181.3
1	Apartment	$0.0	$125.1	$148.9	$174.4	$203.1	$210.8	$208.1
3	Detached	$0.0	$59.9	$74.4	$85.4	$89.7	$95.6	$102.2
3	Attached	$0.0	$53.4	$65.1	$76.1	$85.7	$91.9	$96.4
3	Apartment	$0.0	$85.1	$97.8	$109.8	$120.5	$126.9	$131.2

Table 38: Residential accelerated analysis BCRs.

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	-	1.00	1.15	1.30	1.40	1.50	1.72
1	Attached	-	1.26	1.46	1.67	1.79	1.92	2.22
1	Apartment	-	0.77	0.95	1.14	1.22	1.30	1.47
3	Detached	-	0.71	0.82	0.92	0.99	1.05	1.00
3	Attached	-	0.72	0.83	0.94	1.01	1.08	1.25
3	Apartment	-	0.45	0.51	0.57	0.62	0.66	0.75

5.2.2 Net Energy Potential

Table 39: Residential conservative building Net energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1	Detached	75.4	-63.2	-74.51	-85.78	-96.96	-107.86	-118.6
1	Attached	79.8	0.9	-4.58	-10.01	-15.33	-20.38	-25.3
1	Apartment	111.4	61.7	60.05	58.41	56.73	55.44	54.4
3	Detached	47.3	-84.5	-95.86	-107.27	-118.71	-129.99	-141.2
3	Attached	50.5	-14.9	-19.97	-25.02	-30.08	-34.94	-39.7
3	Apartment	76.2	50.2	49.23	48.23	47.09	46.26	45.6

5.3 Cairns Residential Buildings

The results below show that buildings in Cairns (Far North Queensland) consumption less energy than comparable buildings in Darwin (and other parts of the Top End of Northern Territory and Western Australia), which reflects the differences in NatHERS star bands. This is due to the fact that the FNQ climate is milder compared with the top end, with more frequent cooling breezes providing relief from hot humid weather. Therefore, the overall percentage energy savings are lower than both Darwin (lower overall energy) and Alice Springs (no opportunity to save heating energy). The overall indicative pathway to the targets (Section 3.4.3) in broadly consistent between Darwin and Alice Springs, with measures focusing on managing heat gain and humidity including ceiling fans and shading.

5.3.1 Conservative Trajectory

Table 40: Residential conservative building total energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	38.9	37.3	36.3	35.5	35.1	34.7	34.4
1a	Attached	48.9	42.5	41.0	39.6	38.6	37.8	37.3
1a	Apartment	75.5	66.0	64.2	62.7	61.8	61.2	60.6

Table 41: Residential total capex ($/m²) for the conservative modelling scope (including HVAC plant capacity adjustment).

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	$0.0	$51.67	$57.44	$65.11	$76.58	$79.43	$77.97
1a	Attached	$0.0	$32.73	$44.39	$54.05	$59.72	$69.17	$80.52
1a	Apartment	$0.0	$41.81	$61.76	$78.69	$89.61	$91.44	$88.73

Table 42: Residential conservative analysis BCRs.

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	-	0.96	1.04	1.12	1.10	1.08	1.31
1a	Attached	-	1.15	1.16	1.17	1.22	1.28	1.15
1a	Apartment	-	1.30	1.20	1.10	1.10	1.10	1.34

5.3.2 Accelerated Trajectory

Table 43: Residential conservative building total energy consumption (kWh/m²/yr) trajectories

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	38.9	34.4	33.8	33.2	32.7	32.3	32.1
1a	Attached	48.9	36.9	36.3	35.7	35.2	34.9	34.7
1a	Apartment	75.5	59.3	58.7	58.0	57.2	56.8	56.5

Table 44: Total capex ($/m²_for the accelerated modelling scope (including HVAC plant capacity adjustment).

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	$0.00	$127.19	$125.74	$124.28	$122.82	$121.36	$119.91
1a	Attached	$0.00	$115.95	$114.88	$113.62	$112.00	$110.02	$107.86
1a	Apartment	$0.00	$171.76	$169.95	$168.14	$166.34	$164.53	$162.73

Table 45: Residential accelerated analysis BCRs.

Climate Zone	Archetype	Baseline	2019	2022	2025	2028	2031	2034
1a	Detached	-	0.57	0.67	0.77	0.83	0.89	1.02
1a	Attached	-	0.58	0.67	0.77	0.84	0.91	1.06
1a	Apartment	-	0.51	0.60	0.68	0.74	0.79	0.92

5.4 Residential Trajectories (Normalised with conditioned floor area)

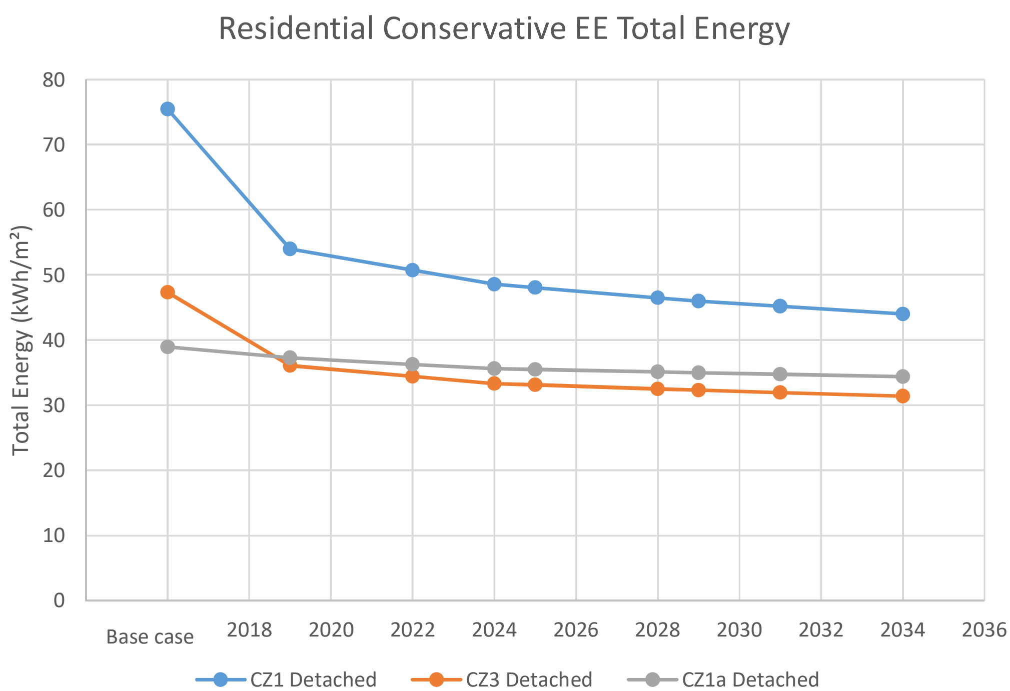

Figure 8: Residential Detached Conservative energy efficiency trajectory (kWh/m²).

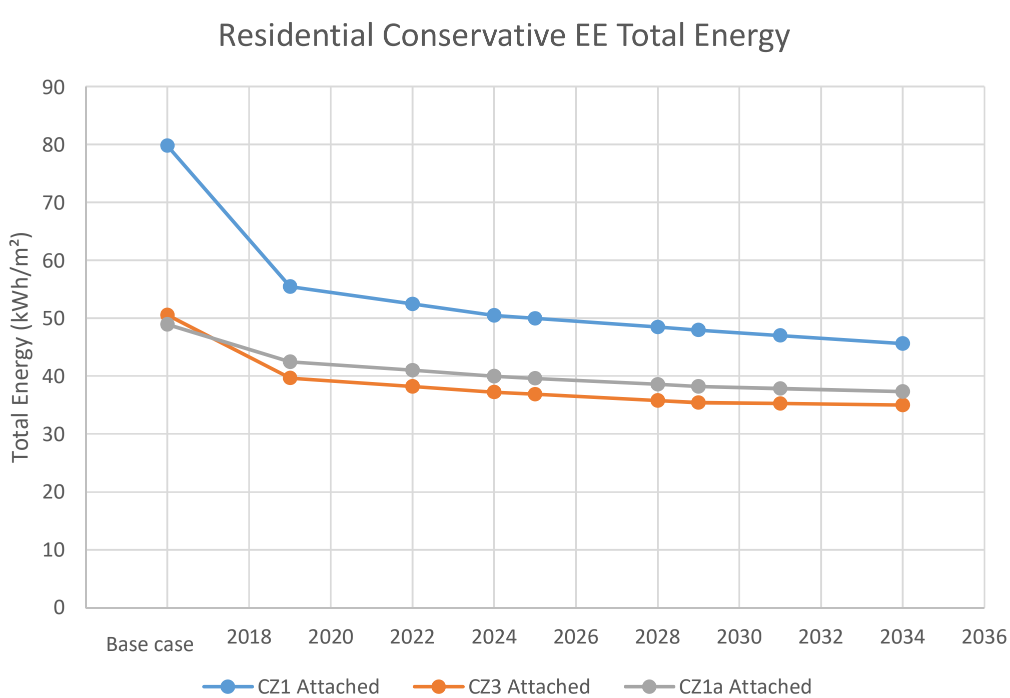

Figure 9: Residential Attached Conservative energy efficiency trajectory (kWh/m²).

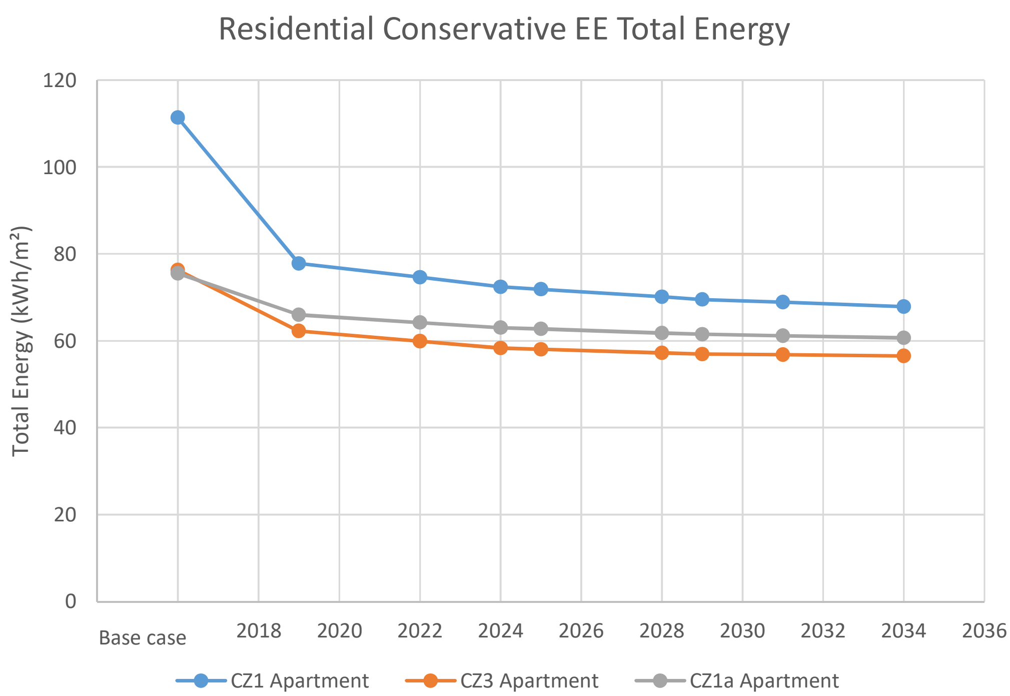

Figure 10: Residential Apartment Conservative energy efficiency trajectory (kWh/m²).

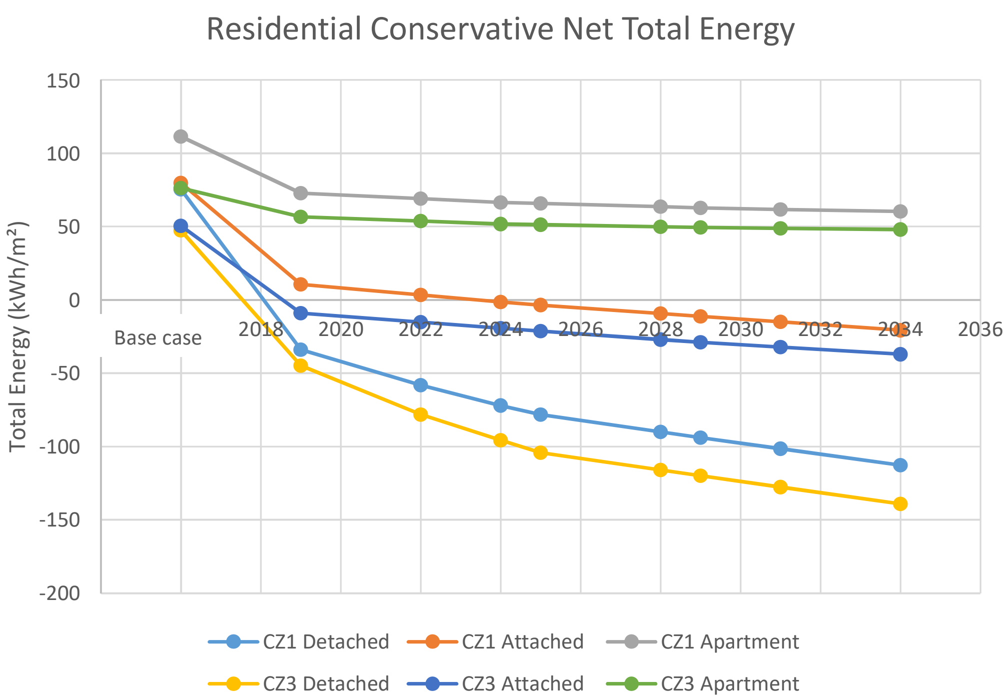

Figure 11: Residential Conservative net trajectory (kWh/m²).

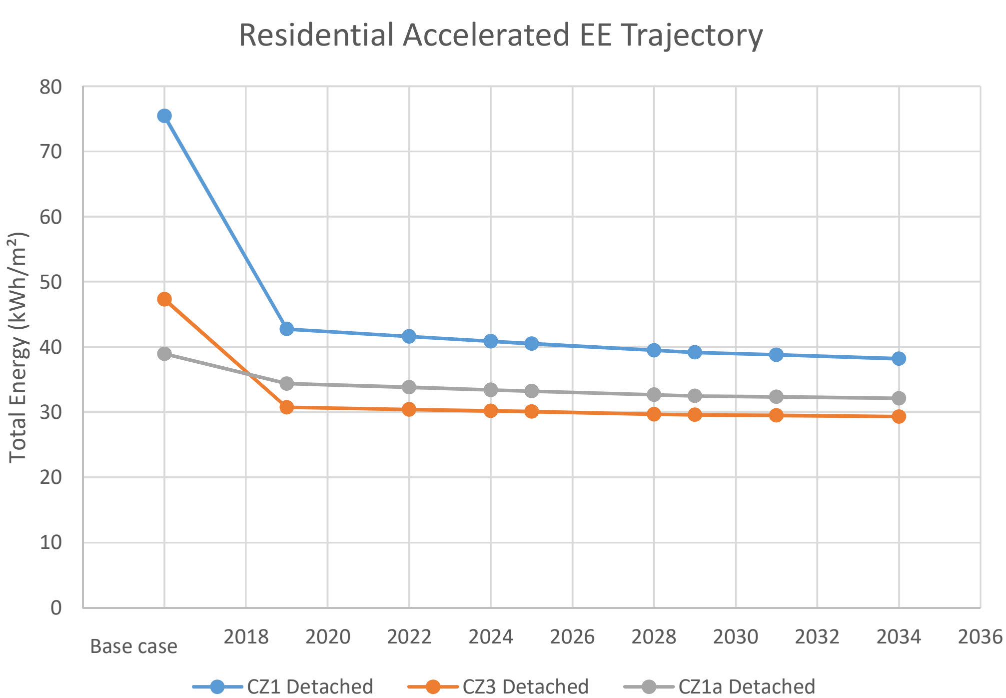

Figure 12: Residential Detached Accelerated energy efficiency trajectory (kWh/m²).

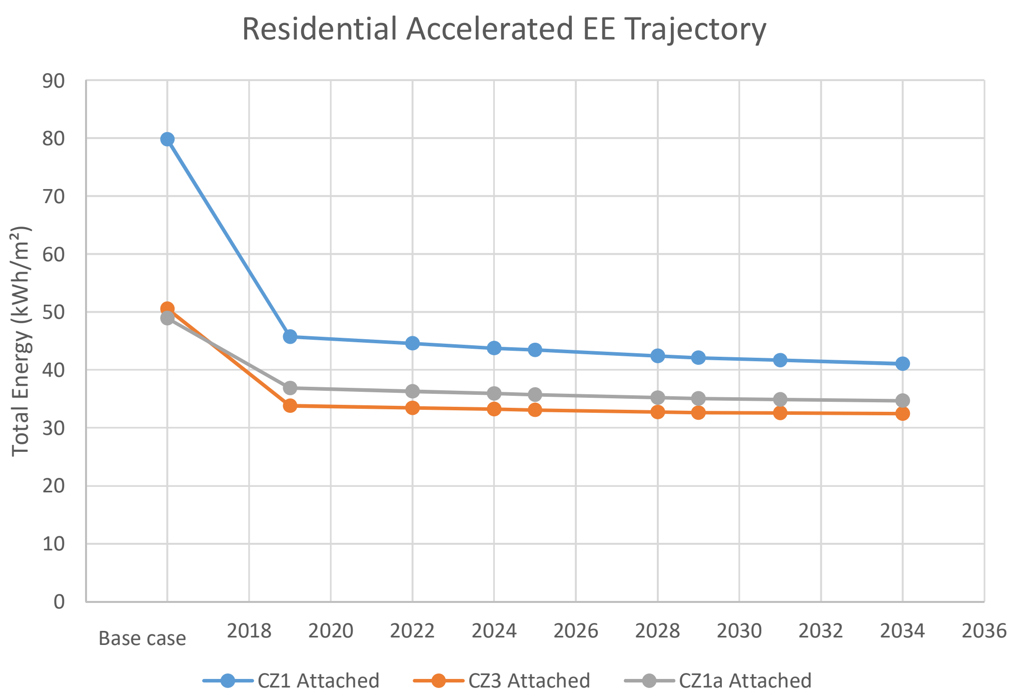

Figure 13: Residential Attached Accelerated energy efficiency trajectory (kWh/m²).

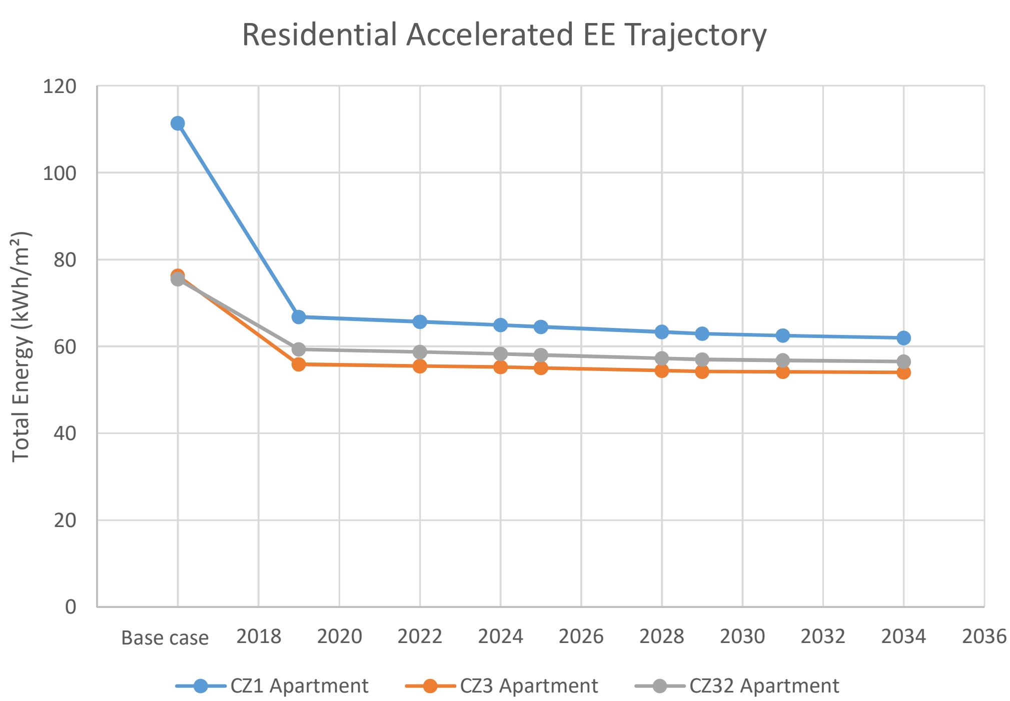

Figure 14: Residential Apartment Accelerated energy efficiency trajectory (kWh/m²).

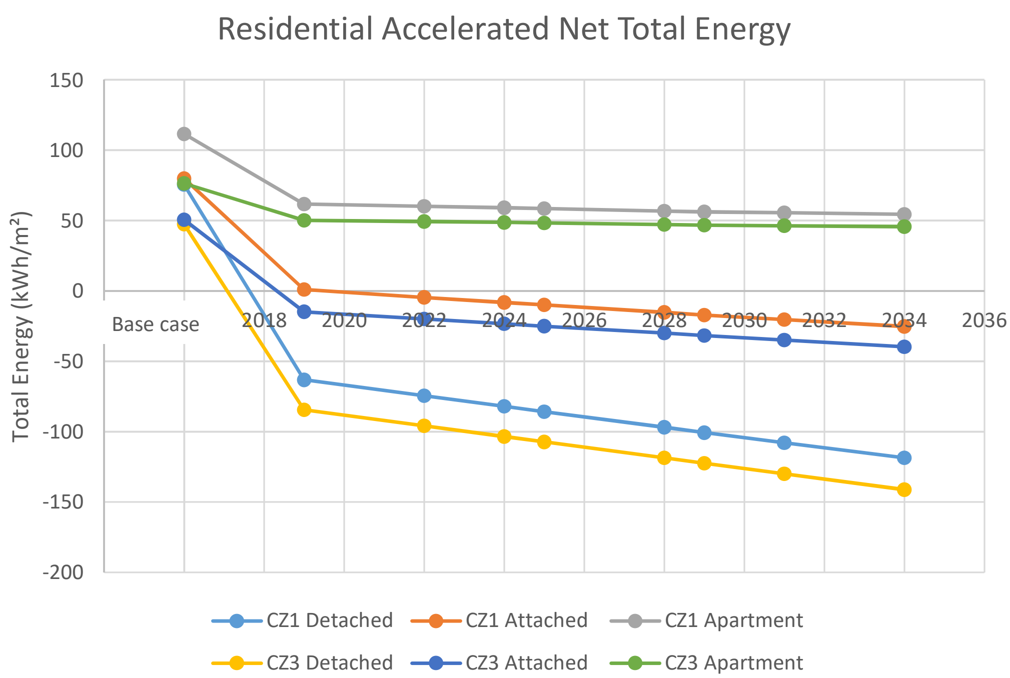

Figure 15: Residential Accelerated net trajectory (kWh/m²)

A. APPENDIX: Commercial Modelling Results

A.I Conservative Multi-Dimensional Summary (Whole Building Energy Results and BCRs only)

Table 46: Multi-Dimensional analysis results for the conservative commercial trajectory.

		Base Construction Cost (inc HVAC capital cost adjustment)	Energy Use (kWh)	Electricity Use (kWh)	Gas Use (GJ)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 years	BC Ratio - 15 years	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
CZ1 Hotel	Base case		241,654	241,654	0	51.59													
	0 yrs	$103,738	207,357	207,357	-	40.33	-$10,847	110,271				1.19				1.06			
	5 yrs	$197,568	189,923	189,923	-	36.33	-$14,567		197,670				1.08				1.00		
	10 yrs	$218,785	174,770	174,770	-	32.48	-$18,070			286,625				1.43				1.31	
	15 yrs	$293,775	168,600	168,600	-	31.08	-$19,201				345,830				1.26				1.18
CZ1 Office	Base case		1,048,877	1,048,848	0	367.85													
	0 yrs	$497,380	901,294	901,288	0	280.87	-$83,803	474,456				1.15				0.95			
	5 yrs	$817,430	858,493	858,490	0	274.40	-$89,179		727,400				1.00				0.89		
	10 yrs	$1,110,890	792,745	792,742	0	248.11	-$113,183			1,097,541				1.10				0.99	
	15 yrs	$1,114,192	745,747	745,746	0	229.78	-$129,263				1,434,884				1.46				1.29
CZ1 Retail	Base case		161,851	161,851	-	55.77													
	0 yrs	$54,330	142,663	142,663	-	50.44	-$5,132	61,691				1.25				1.14			
	5 yrs	$205,106	112,759	112,759	-	34.14	-$20,636		187,585				1.02				0.91		
	10 yrs	$215,219	95,614	95,614	-	28.91	-$25,382			283,850				1.50				1.32	
	15 yrs	$292,475	80,771	80,771	-	24.30	-$29,457				383,822				1.46				1.31

		Base Construction Cost (inc HVAC capital cost adjustment)	Energy Use (kWh)	Electricity Use (kWh)	Gas Use (GJ)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 years	BC Ratio - 15 years	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
CZ1 Ward	Base case		83,321	83,321	-	14.06													
	0 yrs	$52,790	61,126	61,126	-	9.84	-$4,072	71,361				1.46				1.35			
	5 yrs	$106,091	56,696	56,696	-	8.98	-$4,850		101,734				1.01				0.96		
	10 yrs	$119,959	52,929	52,929	-	8.12	-$5,614			130,240				1.14				1.09	
	15 yrs	$120,864	51,011	51,011	-	7.70	-$5,952				152,954				1.33				1.27
CZ1 School	Base case		38,322	38,322	-	27.75													
	0 yrs	$24,405	30,453	30,453	-	21.83	-$5,696	25,300				1.35				1.04			
	5 yrs	$79,679	17,834	17,834	-	12.04	-$14,992		78,286				1.21				0.98		
	10 yrs	$85,706	16,016	16,016	-	11.07	-$15,764			95,589				1.37				1.12	
	15 yrs	$118,362	15,104	15,104	-	10.42	-$16,223				109,910				1.08				0.93

A.II Accelerated Multi-Dimensional Summary (Whole Building Energy Results and BCRs only)

Table 47: Multi-Dimensional analysis results for the accelerated commercial trajectory.

		Base Construction Cost (inc HVAC capital cost adjustment)	Energy Use (kWh)	Electricity Use (kWh)	Gas Use (GJ)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 years	BC Ratio - 15 years	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
CZ1 Hotel	Base case		241,654	241,654	0	51.59													
	0 yrs	$103,735	190,654	190,654	-	37.34	-$13,729	163,974				1.82				1.58			
	5 yrs	$197,293	179,381	179,381	-	34.47	-$16,336		237,950				1.32				1.21		
	10 yrs	$219,738	171,294	171,294	-	32.45	-$18,092			301,519				1.50				1.37	
	15 yrs	$293,775	165,761	165,761	-	31.08	-$19,201				359,270				1.31				1.22
CZ1 Office	Base case		1,048,877	1,048,848	0	367.85													
	0 yrs	$497,380	818,748	818,741	0	271.12	-$93,196	739,856				1.83				1.49			
	5 yrs	$811,639	787,267	787,264	0	259.54	-$103,359		999,559				1.41				1.23		
	10 yrs	$1,076,335	745,510	745,508	0	242.28	-$118,688			1,299,955				1.36				1.21	
	15 yrs	$1,130,204	713,843	713,841	0	231.47	-$127,681				1,585,917				1.58				1.40
CZ1 Retail	Base case		161,851	161,851	-	55.77													
	0 yrs	$65,578	110,939	110,939	-	34.98	-$20,031	163,691				3.59				2.50			
	5 yrs	$212,871	100,443	100,443	-	30.91	-$23,720		234,645				1.24				1.10		
	10 yrs	$224,467	90,284	90,284	-	28.00	-$26,244			306,689				1.55				1.37	
	15 yrs	$302,410	79,370	79,370	-	24.66	-$29,119				390,456				1.43				1.29
CZ1 Ward	Base case		83,321	83,321	-	14.06													
	0 yrs	$57,450	54,925	54,925	-	9.17	-$4,713	91,298				1.73				1.59			
	5 yrs	$111,009	54,703	54,703	-	8.52	-$5,291		109,352				1.03				0.99		
	10 yrs	$124,576	52,571	52,571	-	8.07	-$5,660			131,776				1.11				1.06	
	15 yrs	$125,531	50,925	50,925	-	7.71	-$5,950				153,359				1.28				1.22

		Base Construction Cost (inc HVAC capital cost adjustment)	Energy Use (kWh)	Electricity Use (kWh)	Gas Use (GJ)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 years	BC Ratio - 15 years	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
CZ1 School	Base case		38,322	38,322	-	27.75													
	0 yrs	$45,927	17,618	17,618	-	12.12	-$15,058	66,566				2.16				1.45			
	5 yrs	$79,356	16,854	16,854	-	11.64	-$15,373		82,029				1.29				1.03		
	10 yrs	$86,061	15,938	15,938	-	11.27	-$15,577			95,923				1.36				1.11	
	15 yrs	$118,362	15,104	15,104	-	10.42	-$16,223				109,910				1.08				0.93

A.III Single Dimensional Modelling Results

The single dimensional modelling identified how effective particular efficiency measures are for climate zone 1 commercial archetypes. External shutters (glazing 2) and chiller/PAC efficiency upgrades resulted in the greatest energy reductions across the board. The external shutters measure cannot be used in conjunction with any daylighting measure for the multi-dimensional analysis as they operate in contrasting conditions. For Office, School and Ward, the greater energy benefit was gained from the external shutters measure (over daylighting measures) and thus was selected for the multi-dimensional modelling.

Table 48: Summary of single dimensional modelling results (PV generation not included in figures – regulated energy only).

	Hotel	Office	Retail	Ward	School
Fabric Colour	-1.93%	-1.26%	-0.66%	-2.22%	-2.93%
Active Mass		-1.14%			
BIPV Wall	-0.15%	-1.55%	-0.36%	-0.44%	-1.24%
PV	-0.11%	-0.01%	-0.23%	-0.80%	-0.06%
Glazing2	-13.72%	-12.05%		-14.45%	-9.67%
Daylighting1		-7.66%			
Daylighting2				+1.48%	-5.64%
Fans		-6.01%		-12.99%	
Chillers/PACs	-19.55%	-19.18%	-27.33%	-17.96%	-51.88%
Economy Cycle		+0.15%	-2.22%	-0.28%	
OA Treatment				-2.38%	-2.74%
Lighting	-3.95%	-14.51%	-33.86%	-2.91%	-4.30%

There were two occasions when a net increase (in regulated building energy) was identified; economy cycle implementation for Office and daylighting scenario 2 for Ward. The increase in energy for Ward is likely due to the larger glazing area which allows greater energy transfer (gain during the day, or even night, and loss during the night) requiring the plant to work harder to maintain the desired conditions. Table 49 below presents the benefit cost ratios from the single dimensional analysis in climate zone 1. The two scenarios which result in a higher energy consumption than the base case (negative benefit cost ratio) are highlighted red. The benefit cost ratio can be expressed as:

$$Benefit\ Cost\ Ratio = \frac{-\ Incremental\ Operational\ Cost}{Incremental\ Construction\ Cost}$$

Three main results are expected from the benefit cost ratio analysis; ‘Negative Cost’ will be displayed when the incremental construction cost between NCC2019 and NCC2016 is negative. A result between zero and one identifies a situation that is beneficial on an energy basis, but not economically viable over the lifetime of the analysis. A result greater than one identifies a scenario that is both economically viable and has a positive impact on energy performance.

Table 49: Single dimensional analysis benefit cost results for each archetype.

Measure	Archetype	0 Yrs	5 Yrs	10 Yrs	15 Yrs
Fabric Colour	Hotel	negative cost	negative cost	negative cost	negative cost
Glazing2	Hotel	negative cost	negative cost	negative cost	negative cost
Chillers + PACs	Hotel	negative cost	negative cost	negative cost	negative cost
Lighting	Hotel	0.63	0.75	0.84	0.93
Fabric Colour	Office	negative cost	negative cost	negative cost	negative cost
Active Mass	Office	0.03	0.03	0.04	0.04
Glazing2	Office	negative cost	negative cost	negative cost	negative cost
Daylighting1	Office	6.53	7.72	8.61	9.45
Fans	Office	0.31	0.37	0.41	0.46
Chillers + PACs	Office	negative cost	negative cost	negative cost	negative cost
Economy Cycle	Office	-0.08	-0.09	-0.10	-0.11
Lighting	Office	1.72	2.05	2.29	2.53
Fabric Colour	Retail	3.96	4.72	5.31	5.89
Daylighting2	Ward	-0.04	-0.05	-0.06	-0.06
Fans	Ward	31.47	36.85	40.75	44.39
Chillers + PACs	Ward	negative cost	negative cost	negative cost	negative cost
Economy Cycle	Ward	0.12	0.14	0.16	0.18
OA Treatment	Ward	0.50	0.59	0.66	0.73
Lighting	Ward	0.54	0.65	0.72	0.80
Fabric Colour	School	negative cost	negative cost	negative cost	negative cost
Glazing2	School	4.91	5.78	6.42	7.03
Daylighting2	School	0.16	0.19	0.21	0.23
Chillers + PACs	School	negative cost	negative cost	negative cost	negative cost
OA Treatment	School	0.71	0.84	0.94	1.04
Lighting	School	1.28	1.52	1.70	1.88

A.IV Conservative Results Summary (Absolute Figures) – Interpolated for 2022, 2025, 2028 & 2031

Table 50: Total energy (electricity and gas) consumption for the conservative multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kWh)	2019 (kWh)	2022 (kWh)	2024 (kWh)	2025 (kWh)	2028 (kWh)	2029 (kWh)	2031 (kWh)	2034 (kWh)
Hotel	Regulated	-	198,587	164,289	153,829	146,855	143,824	134,732	131,702	129,234	125,532
Office	Regulated	-	656,361	508,779	483,098	465,978	452,828	413,379	400,229	381,430	353,231
Retail	Regulated	-	142,086	122,899	104,956	92,994	89,565	79,278	75,849	69,912	61,007
Ward	Regulated	-	62,514	40,319	37,661	35,890	35,136	32,876	32,122	31,355	30,204
School	Regulated	-	35,984	28,115	20,544	15,496	15,133	14,042	13,678	13,313	12,766
Hotel	Regulated	Net	198,587	154,744	141,437	132,565	127,553	112,516	107,503	104,652	100,375
Office	Regulated	Net	656,361	464,594	435,158	415,534	383,848	288,790	257,104	232,785	196,306
Retail	Regulated	Net	142,086	77,210	56,147	42,105	37,338	23,038	18,271	15,482	11,299
Ward	Regulated	Net	62,514	21,763	20,292	19,312	18,663	16,715	16,066	15,796	15,391
School	Regulated	Net	35,984	14,177	7,503	3,055	2,674	1,532	1,151	1,005	786
Hotel	Whole	-	241,654	207,357	196,896	189,923	186,892	177,800	174,770	172,302	168,600
Office	Whole	-	1,048,877	901,294	875,614	858,493	845,343	805,894	792,745	773,945	745,747
Retail	Whole	-	161,851	142,663	124,721	112,759	109,330	99,043	95,614	89,677	80,771
Ward	Whole	-	83,321	61,126	58,468	56,696	55,943	53,683	52,929	52,162	51,011
School	Whole	-	38,322	30,453	22,882	17,834	17,470	16,379	16,016	15,651	15,104
Hotel	Whole	Net	241,654	188,327	174,955	166,041	160,850	145,279	140,089	137,009	132,390
Office	Whole	Net	1,048,877	855,639	825,390	805,223	769,410	661,970	626,157	608,100	581,014
Retail	Whole	Net	161,851	96,974	74,721	59,885	53,909	35,981	30,005	26,482	21,196
Ward	Whole	Net	83,321	35,082	33,337	32,175	31,375	28,976	28,176	27,831	27,313
School	Whole	Net	38,322	16,208	9,054	4,285	3,794	2,321	1,830	1,622	1,309

Table 51: Total electrical energy consumption for the conservative multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kWh)	2019 (kWh)	2022 (kWh)	2024 (kWh)	2025 (kWh)	2028 (kWh)	2029 (kWh)	2031 (kWh)	2034 (kWh)
Hotel	Regulated	-	198,586	164,289	153,829	146,855	143,824	134,732	131,702	129,234	125,532
Office	Regulated	-	656,333	508,772	483,093	465,975	452,825	413,376	400,226	381,428	353,230
Retail	Regulated	-	142,086	122,899	104,956	92,994	89,565	79,278	75,849	69,912	61,007
Ward	Regulated	-	62,514	40,319	37,661	35,890	35,136	32,876	32,122	31,355	30,204
School	Regulated	-	35,984	28,115	20,544	15,496	15,133	14,042	13,678	13,313	12,766
Hotel	Regulated	Net	198,586	154,744	141,437	132,565	127,553	112,516	107,503	104,652	100,375
Office	Regulated	Net	656,333	464,587	435,154	415,531	383,845	288,787	257,101	232,783	196,305
Retail	Regulated	Net	142,086	77,210	56,147	42,105	37,338	23,038	18,271	15,482	11,299
Ward	Regulated	Net	62,514	21,763	20,292	19,312	18,663	16,715	16,066	15,796	15,391
School	Regulated	Net	35,984	14,177	7,503	3,055	2,674	1,532	1,151	1,005	786
Hotel	Whole	-	241,654	207,357	196,896	189,923	186,892	177,800	174,770	172,302	168,600
Office	Whole	-	1,048,848	901,288	875,609	858,490	845,340	805,891	792,742	773,943	745,746
Retail	Whole	-	161,851	142,663	124,721	112,759	109,330	99,043	95,614	89,677	80,771
Ward	Whole	-	83,321	61,126	58,468	56,696	55,943	53,683	52,929	52,162	51,011
School	Whole	-	38,322	30,453	22,882	17,834	17,470	16,379	16,016	15,651	15,104
Hotel	Whole	Net	241,654	188,327	174,955	166,041	160,850	145,279	140,089	137,009	132,390
Office	Whole	Net	1,048,848	855,632	825,385	805,220	769,407	661,967	626,154	608,098	581,014
Retail	Whole	Net	161,851	96,974	74,721	59,885	53,909	35,981	30,005	26,482	21,196
Ward	Whole	Net	83,321	35,082	33,337	32,175	31,375	28,976	28,176	27,831	27,313
School	Whole	Net	38,322	16,208	9,054	4,285	3,794	2,321	1,830	1,622	1,309

Table 52: Peak electrical demand for the conservative multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kW)	2019 (kW)	2022 (kW)	2024 (kW)	2025 (kW)	2028 (kW)	2029 (kW)	2031 (kW)	2034 (kW)
Hotel	Regulated	-	48.1	33.5	30.9	29.1	28.3	26.0	25.3	24.7	23.7
Office	Regulated	-	268.8	181.9	178.0	175.4	170.1	154.4	149.1	141.8	130.8
Retail	Regulated	-	52.4	47.1	37.3	30.8	29.8	26.6	25.6	23.7	21.0
Ward	Regulated	-	11.7	7.5	6.9	6.6	6.4	5.9	5.7	5.6	5.3
School	Regulated	-	26.8	20.9	15.1	11.1	10.9	10.4	10.2	9.9	9.5
Hotel	Regulated	Net	48.1	32.3	30.1	28.6	27.8	25.4	24.6	23.9	23.0
Office	Regulated	Net	268.8	172.4	168.1	165.2	157.4	134.0	126.2	119.3	109.0
Retail	Regulated	Net	52.4	45.1	35.2	28.5	27.2	23.4	22.1	20.1	17.1
Ward	Regulated	Net	11.7	6.5	6.3	6.1	6.0	5.4	5.2	5.0	4.7
School	Regulated	Net	26.8	17.5	11.3	7.2	7.0	6.3	6.1	5.9	5.5
Hotel	Whole	-	51.6	40.3	37.9	36.3	35.6	33.2	32.5	31.9	31.1
Office	Whole	-	367.8	280.9	277.0	274.4	269.1	253.4	248.1	240.8	229.8
Retail	Whole	-	55.8	50.4	40.7	34.1	33.1	30.0	28.9	27.1	24.3
Ward	Whole	-	14.1	9.8	9.3	9.0	8.8	8.3	8.1	8.0	7.7
School	Whole	-	27.7	21.8	16.0	12.0	11.8	11.3	11.1	10.8	10.4
Hotel	Whole	Net	51.6	38.9	36.8	35.5	34.8	32.6	31.9	31.4	30.6
Office	Whole	Net	367.8	271.4	267.1	264.2	255.5	229.4	220.7	213.7	203.2
Retail	Whole	Net	55.8	48.4	38.5	31.8	30.6	26.7	25.5	23.5	20.5
Ward	Whole	Net	14.1	8.9	8.7	8.5	8.3	7.8	7.6	7.4	7.1
School	Whole	Net	27.7	18.4	12.0	7.7	7.5	6.7	6.4	6.2	5.8

Table 53: Total gas consumption for the conservative multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (MJ)	2019 (MJ)	2022 (MJ)	2024 (MJ)	2025 (MJ)	2028 (MJ)	2029 (MJ)	2031 (MJ)	2034 (MJ)
Hotel	Regulated	-	0	0	0	0	0	0	0	0	0
Office	Regulated	-	102	24	16	11	11	11	11	8	3
Retail	Regulated	-	0	0	0	0	0	0	0	0	0
Ward	Regulated	-	0	0	0	0	0	0	0	0	0
School	Regulated	-	0	0	0	0	0	0	0	0	0
Hotel	Regulated	Net	0	0	0	0	0	0	0	0	0
Office	Regulated	Net	102	24	16	11	11	11	11	8	3
Retail	Regulated	Net	0	0	0	0	0	0	0	0	0
Ward	Regulated	Net	0	0	0	0	0	0	0	0	0
School	Regulated	Net	0	0	0	0	0	0	0	0	0

Table 54: Total CAPEX for the conservative multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case ($)	2019 ($)	2022 ($)	2024 ($)	2025 ($)	2028 ($)	2029 ($)	2031 ($)	2034 ($)
Hotel	Regulated	-	-	$103,738	$152,775	$197,568	$201,811	$214,541	$218,785	$248,781	$293,775
Office	Regulated	-	-	$497,380	$686,751	$817,430	$876,122	$1,052,198	$1,110,890	$1,112,211	$1,114,192
Retail	Regulated	-	-	$54,330	$130,730	$205,106	$207,129	$213,196	$215,219	$246,121	$292,475
Ward	Regulated	-	-	$52,790	$80,827	$106,091	$108,864	$117,185	$119,959	$120,321	$120,864
School	Regulated	-	-	$24,405	$52,645	$79,679	$80,885	$84,501	$85,706	$98,769	$118,362
Hotel	Regulated	Net	-	$240,008	$312,045	$356,550	$384,081	$466,674	$494,205	$537,972	$603,623
Office	Regulated	Net	-	$685,130	$935,009	$1,036,472	$1,184,888	$1,630,134	$1,778,549	$1,813,253	$1,865,309
Retail	Regulated	Net	-	$242,081	$347,497	$424,149	$452,912	$539,203	$567,966	$616,506	$689,316
Ward	Regulated	Net	-	$163,782	$206,006	$235,581	$248,230	$286,175	$298,824	$308,129	$322,087
School	Regulated	Net	-	$67,443	$101,312	$129,890	$135,181	$151,055	$156,346	$172,940	$197,832

A.V Conservative Results Summary (Normalised with floor area) – Interpolated for 2022, 2025, 2028 & 2031

Table 55: Total energy (electricity and gas) consumption for the conservative multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case (kWh/m²)	2019 (kWh/m²)	2022 (kWh/m²)	2024 (kWh/m²)	2025 (kWh/m²)	2028 (kWh/m²)	2029 (kWh/m²)	2031 (kWh/m²)	2034 (kWh/m²)
Hotel	1,800	Regulated	-	110.33	91.27	85.46	81.59	79.90	74.85	73.17	71.80	69.74
Office	9,000	Regulated	-	72.93	56.53	53.68	51.78	50.31	45.93	44.47	42.38	39.25
Retail	950	Regulated	-	149.56	129.37	110.48	97.89	94.28	83.45	79.84	73.59	64.22
Ward	475	Regulated	-	131.61	84.88	79.29	75.56	73.97	69.21	67.63	66.01	63.59
School	190	Regulated	-	189.39	147.97	108.13	81.56	79.65	73.90	71.99	70.07	67.19
Hotel	1,800	Regulated	Net	110.33	85.97	78.58	73.65	70.86	62.51	59.72	58.14	55.76
Office	9,000	Regulated	Net	72.93	51.62	48.35	46.17	42.65	32.09	28.57	25.86	21.81
Retail	950	Regulated	Net	149.56	81.27	59.10	44.32	39.30	24.25	19.23	16.30	11.89
Ward	475	Regulated	Net	131.61	45.82	42.72	40.66	39.29	35.19	33.82	33.26	32.40
School	190	Regulated	Net	189.39	74.61	39.49	16.08	14.07	8.06	6.06	5.29	4.14
Hotel	1,800	Whole	-	134.25	115.20	109.39	105.51	103.83	98.78	97.09	95.72	93.67
Office	9,000	Whole	-	116.54	100.14	97.29	95.39	93.93	89.54	88.08	85.99	82.86
Retail	950	Whole	-	170.37	150.17	131.28	118.69	115.08	104.26	100.65	94.40	85.02
Ward	475	Whole	-	175.41	128.69	123.09	119.36	117.77	113.02	111.43	109.81	107.39
School	190	Whole	-	201.69	160.28	120.43	93.86	91.95	86.21	84.29	82.37	79.50
Hotel	1,800	Whole	Net	134.25	104.63	97.20	92.24	89.36	80.71	77.83	76.12	73.55
Office	9,000	Whole	Net	116.54	95.07	91.71	89.47	85.49	73.55	69.57	67.57	64.56
Retail	950	Whole	Net	170.37	102.08	78.65	63.04	56.75	37.87	31.58	27.88	22.31
Ward	475	Whole	Net	175.41	73.86	70.18	67.74	66.05	61.00	59.32	58.59	57.50
School	190	Whole	Net	201.69	85.31	47.65	22.55	19.97	12.21	9.63	8.53	6.89

Table 56: Total electrical energy consumption for the conservative multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case (kWh/m²)	2019 (kWh/m²)	2022 (kWh/m²)	2024 (kWh/m²)	2025 (kWh/m²)	2028 (kWh/m²)	2029 (kWh/m²)	2031 (kWh/m²)	2034 (kWh/m²)
Hotel	1,800	Regulated	-	110.33	91.27	85.46	81.59	79.90	74.85	73.17	71.80	69.74
Office	9,000	Regulated	-	72.93	56.53	53.68	51.77	50.31	45.93	44.47	42.38	39.25
Retail	950	Regulated	-	149.56	129.37	110.48	97.89	94.28	83.45	79.84	73.59	64.22
Ward	475	Regulated	-	131.61	84.88	79.29	75.56	73.97	69.21	67.63	66.01	63.59
School	190	Regulated	-	189.39	147.97	108.13	81.56	79.65	73.90	71.99	70.07	67.19
Hotel	1,800	Regulated	Net	110.33	85.97	78.58	73.65	70.86	62.51	59.72	58.14	55.76
Office	9,000	Regulated	Net	72.93	51.62	48.35	46.17	42.65	32.09	28.57	25.86	21.81
Retail	950	Regulated	Net	149.56	81.27	59.10	44.32	39.30	24.25	19.23	16.30	11.89
Ward	475	Regulated	Net	131.61	45.82	42.72	40.66	39.29	35.19	33.82	33.26	32.40
School	190	Regulated	Net	189.39	74.61	39.49	16.08	14.07	8.06	6.06	5.29	4.14
Hotel	1,800	Whole	-	134.25	115.20	109.39	105.51	103.83	98.78	97.09	95.72	93.67
Office	9,000	Whole	-	116.54	100.14	97.29	95.39	93.93	89.54	88.08	85.99	82.86
Retail	950	Whole	-	170.37	150.17	131.28	118.69	115.08	104.26	100.65	94.40	85.02
Ward	475	Whole	-	175.41	128.69	123.09	119.36	117.77	113.02	111.43	109.81	107.39
School	190	Whole	-	201.69	160.28	120.43	93.86	91.95	86.21	84.29	82.37	79.50
Hotel	1,800	Whole	Net	134.25	104.63	97.20	92.24	89.36	80.71	77.83	76.12	73.55
Office	9,000	Whole	Net	116.54	95.07	91.71	89.47	85.49	73.55	69.57	67.57	64.56
Retail	950	Whole	Net	170.37	102.08	78.65	63.04	56.75	37.87	31.58	27.88	22.31
Ward	475	Whole	Net	175.41	73.86	70.18	67.74	66.05	61.00	59.32	58.59	57.50
School	190	Whole	Net	201.69	85.31	47.65	22.55	19.97	12.21	9.63	8.53	6.89

Table 57: Peak electrical demand for the conservative multi-dimensional modelling.

Model	Floor Area (m^2)	Energy Scope	Net?	Base Case (kW/m^2)	2019 (kW/m^2)	2022 (kW/m^2)	2024 (kW/m^2)	2025 (kW/m^2)	2028 (kW/m^2)	2029 (kW/m^2)	2031 (kW/m^2)	2034 (kW/m^2)
Hotel	1,800	Regulated	-	0.027	0.019	0.017	0.016	0.016	0.014	0.014	0.014	0.013
Office	9,000	Regulated	-	0.030	0.020	0.020	0.019	0.019	0.017	0.017	0.016	0.015
Retail	950	Regulated	-	0.055	0.050	0.039	0.032	0.031	0.028	0.027	0.025	0.022
Ward	475	Regulated	-	0.025	0.016	0.015	0.014	0.014	0.012	0.012	0.012	0.011
School	190	Regulated	-	0.141	0.110	0.079	0.059	0.058	0.055	0.054	0.052	0.050
Hotel	1,800	Regulated	Net	0.027	0.018	0.017	0.016	0.015	0.014	0.014	0.013	0.013
Office	9,000	Regulated	Net	0.030	0.019	0.019	0.018	0.017	0.015	0.014	0.013	0.012
Retail	950	Regulated	Net	0.055	0.047	0.037	0.030	0.029	0.025	0.023	0.021	0.018
Ward	475	Regulated	Net	0.025	0.014	0.013	0.013	0.013	0.011	0.011	0.011	0.010
School	190	Regulated	Net	0.141	0.092	0.060	0.038	0.037	0.033	0.032	0.031	0.029
Hotel	1,800	Whole	-	0.029	0.022	0.021	0.020	0.020	0.018	0.018	0.018	0.017
Office	9,000	Whole	-	0.041	0.031	0.031	0.030	0.030	0.028	0.028	0.027	0.026
Retail	950	Whole	-	0.059	0.053	0.043	0.036	0.035	0.032	0.030	0.028	0.026
Ward	475	Whole	-	0.030	0.021	0.020	0.019	0.019	0.017	0.017	0.017	0.016
School	190	Whole	-	0.146	0.115	0.084	0.063	0.062	0.059	0.058	0.057	0.055
Hotel	1,800	Whole	Net	0.029	0.022	0.020	0.020	0.019	0.018	0.018	0.017	0.017
Office	9,000	Whole	Net	0.041	0.030	0.030	0.029	0.028	0.025	0.025	0.024	0.023
Retail	950	Whole	Net	0.059	0.051	0.041	0.034	0.032	0.028	0.027	0.025	0.022
Ward	475	Whole	Net	0.030	0.019	0.018	0.018	0.018	0.016	0.016	0.016	0.015
School	190	Whole	Net	0.146	0.097	0.063	0.041	0.039	0.035	0.034	0.032	0.031

Table 58: Total gas consumption for the conservative multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case (MJ/m²)	2019 (MJ/m²)	2022 (MJ/m²)	2024 (MJ/m²)	2025 (MJ/m²)	2028 (MJ/m²)	2029 (MJ/m²)	2031 (MJ/m²)	2034 (MJ/m²)
Hotel	1,800	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office	9,000	Regulated	-	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail	950	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ward	475	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
School	190	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hotel	1,800	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office	9,000	Regulated	Net	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail	950	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ward	475	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
School	190	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 59: Total CAPEX for the conservative multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case ($/m²)	2019 ($/m²)	2022 ($/m²)	2024 ($/m²)	2025 ($/m²)	2028 ($/m²)	2029 ($/m²)	2031 ($/m²)	2034 ($/m²)
Hotel	1,800	Regulated	-	-	$58	$85	$110	$112	$119	$122	$138	$163
Office	9,000	Regulated	-	-	$55	$76	$91	$97	$117	$123	$124	$124
Retail	950	Regulated	-	-	$57	$138	$216	$218	$224	$227	$259	$308
Ward	475	Regulated	-	-	$111	$170	$223	$229	$247	$253	$253	$254
School	190	Regulated	-	-	$128	$277	$419	$426	$445	$451	$520	$623
Hotel	1,800	Regulated	Net	-	$133	$173	$198	$213	$259	$275	$299	$335
Office	9,000	Regulated	Net	-	$76	$104	$115	$132	$181	$198	$201	$207
Retail	950	Regulated	Net	-	$255	$366	$446	$477	$568	$598	$649	$726
Ward	475	Regulated	Net	-	$345	$434	$496	$523	$602	$629	$649	$678
School	190	Regulated	Net	-	$355	$533	$684	$711	$795	$823	$910	$1,041

A.VI Accelerated Results Summary (Absolute Figures) – Interpolated for 2022, 2025, 2028 & 2031

Table 60: Total energy (electricity and gas) consumption for the accelerated multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kWh)	2019 (kWh)	2022 (kWh)	2024 (kWh)	2025 (kWh)	2028 (kWh)	2029 (kWh)	2031 (kWh)	2034 (kWh)
Hotel	Regulated	-	198,587	147,586	140,822	136,313	134,696	129,844	128,226	126,013	122,693
Office	Regulated	-	656,361	426,232	407,344	394,751	386,400	361,346	352,994	340,327	321,327
Retail	Regulated	-	142,086	91,174	84,876	80,678	78,646	72,551	70,520	66,154	59,605
Ward	Regulated	-	62,514	34,118	33,985	33,896	33,469	32,190	31,764	31,105	30,118
School	Regulated	-	35,984	15,280	14,822	14,516	14,333	13,783	13,600	13,267	12,766
Hotel	Regulated	Net	198,587	137,666	130,141	125,124	121,499	110,623	106,998	104,349	100,375
Office	Regulated	Net	656,361	416,096	393,961	379,204	352,293	271,559	244,648	226,170	198,452
Retail	Regulated	Net	142,086	45,930	37,823	32,419	29,159	19,381	16,122	14,076	11,006
Ward	Regulated	Net	62,514	18,097	18,114	18,125	17,773	16,715	16,363	15,949	15,327
School	Regulated	Net	35,984	3,671	2,979	2,518	2,239	1,400	1,121	987	786
Hotel	Whole	-	241,654	190,654	183,890	179,381	177,764	172,911	171,294	169,081	165,761
Office	Whole	-	1,048,877	818,748	799,859	787,267	778,916	753,861	745,510	732,843	713,843
Retail	Whole	-	161,851	110,939	104,641	100,443	98,411	92,316	90,284	85,919	79,370
Ward	Whole	-	83,321	54,925	54,792	54,703	54,276	52,997	52,571	51,912	50,925
School	Whole	-	38,322	17,618	17,160	16,854	16,671	16,121	15,938	15,604	15,104
Hotel	Whole	Net	241,654	174,463	164,945	158,600	154,796	143,383	139,579	136,703	132,390
Office	Whole	Net	1,048,877	807,141	783,684	768,046	737,141	644,426	613,522	601,377	583,160
Retail	Whole	Net	161,851	65,251	55,448	48,912	44,593	31,634	27,315	24,708	20,798
Ward	Whole	Net	83,321	31,181	31,017	30,908	30,422	28,963	28,477	27,983	27,240
School	Whole	Net	38,322	5,088	4,230	3,658	3,286	2,169	1,797	1,602	1,309

Table 61: Total electrical energy consumption for the accelerated multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kWh)	2019 (kWh)	2022 (kWh)	2024 (kWh)	2025 (kWh)	2028 (kWh)	2029 (kWh)	2031 (kWh)	2034 (kWh)
Hotel	Regulated	-	198,586	147,586	140,822	136,313	134,696	129,844	128,226	126,013	122,693
Office	Regulated	-	656,333	426,225	407,339	394,749	386,397	361,344	352,993	340,326	321,325
Retail	Regulated	-	142,086	91,174	84,876	80,678	78,646	72,551	70,520	66,154	59,605
Ward	Regulated	-	62,514	34,118	33,985	33,896	33,469	32,190	31,764	31,105	30,118
School	Regulated	-	35,984	15,280	14,822	14,516	14,333	13,783	13,600	13,267	12,766
Hotel	Regulated	Net	198,586	137,666	130,141	125,124	121,499	110,623	106,998	104,349	100,375
Office	Regulated	Net	656,333	416,090	393,957	379,202	352,290	271,557	244,646	226,168	198,450
Retail	Regulated	Net	142,086	45,930	37,823	32,419	29,159	19,381	16,122	14,076	11,006
Ward	Regulated	Net	62,514	18,097	18,114	18,125	17,773	16,715	16,363	15,949	15,327
School	Regulated	Net	35,984	3,671	2,979	2,518	2,239	1,400	1,121	987	786
Hotel	Whole	-	241,654	190,654	183,890	179,381	177,764	172,911	171,294	169,081	165,761
Office	Whole	-	1,048,848	818,741	799,855	787,264	778,913	753,859	745,508	732,841	713,841
Retail	Whole	-	161,851	110,939	104,641	100,443	98,411	92,316	90,284	85,919	79,370
Ward	Whole	-	83,321	54,925	54,792	54,703	54,276	52,997	52,571	51,912	50,925
School	Whole	-	38,322	17,618	17,160	16,854	16,671	16,121	15,938	15,604	15,104
Hotel	Whole	Net	241,654	174,463	164,945	158,600	154,796	143,383	139,579	136,703	132,390
Office	Whole	Net	1,048,848	807,135	783,680	768,043	737,138	644,424	613,520	601,375	583,158
Retail	Whole	Net	161,851	65,251	55,448	48,912	44,593	31,634	27,315	24,708	20,798
Ward	Whole	Net	83,321	31,181	31,017	30,908	30,422	28,963	28,477	27,983	27,240
School	Whole	Net	38,322	5,088	4,230	3,658	3,286	2,169	1,797	1,602	1,309

Table 62: Peak electrical demand for the accelerated multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (kW)	2019 (kW)	2022 (kW)	2024 (kW)	2025 (kW)	2028 (kW)	2029 (kW)	2031 (kW)	2034 (kW)
Hotel	Regulated	-	48.1	30.2	28.4	27.1	26.7	25.5	25.1	24.6	23.7
Office	Regulated	-	268.8	172.1	165.2	160.5	157.1	146.7	143.3	139.0	132.5
Retail	Regulated	-	52.4	31.7	29.2	27.6	27.0	25.3	24.7	23.3	21.3
Ward	Regulated	-	11.7	6.8	6.4	6.1	6.1	5.8	5.7	5.6	5.3
School	Regulated	-	26.8	11.2	10.9	10.7	10.7	10.4	10.4	10.0	9.5
Hotel	Regulated	Net	48.1	29.3	27.7	26.7	26.2	24.9	24.4	23.8	23.0
Office	Regulated	Net	268.8	162.6	155.4	150.5	144.6	126.9	121.0	116.8	110.6
Retail	Regulated	Net	52.4	29.6	27.1	25.5	24.6	22.2	21.3	19.6	17.1
Ward	Regulated	Net	11.7	5.9	5.8	5.7	5.6	5.2	5.1	5.0	4.7
School	Regulated	Net	26.8	7.2	6.9	6.8	6.6	6.2	6.1	5.9	5.5
Hotel	Whole	-	51.6	37.3	35.6	34.5	34.1	32.9	32.5	31.9	31.1
Office	Whole	-	367.8	271.1	264.2	259.5	256.1	245.7	242.3	238.0	231.5
Retail	Whole	-	55.8	35.0	32.5	30.9	30.3	28.6	28.0	26.7	24.7
Ward	Whole	-	14.1	9.2	8.8	8.5	8.4	8.2	8.1	7.9	7.7
School	Whole	-	27.7	12.1	11.8	11.6	11.6	11.3	11.3	10.9	10.4
Hotel	Whole	Net	51.6	36.1	34.7	33.7	33.4	32.2	31.9	31.4	30.6
Office	Whole	Net	367.8	261.6	254.4	249.5	242.6	221.9	214.9	210.9	204.8
Retail	Whole	Net	55.8	33.0	30.5	28.8	28.0	25.5	24.7	23.0	20.4
Ward	Whole	Net	14.1	8.3	8.1	8.1	7.9	7.6	7.5	7.3	7.1
School	Whole	Net	27.7	8.0	7.4	7.0	6.9	6.5	6.4	6.1	5.8

Table 63: Total gas consumption for the accelerated multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case (MJ)	2019 (MJ)	2022 (MJ)	2024 (MJ)	2025 (MJ)	2028 (MJ)	2029 (MJ)	2031 (MJ)	2034 (MJ)
Hotel	Regulated	-	0	0	0	0	0	0	0	0	0
Office	Regulated	-	102	24	16	10	9	7	6	7	7
Retail	Regulated	-	0	0	0	0	0	0	0	0	0
Ward	Regulated	-	0	0	0	0	0	0	0	0	0
School	Regulated	-	0	0	0	0	0	0	0	0	0
Hotel	Regulated	Net	0	0	0	0	0	0	0	0	0
Office	Regulated	Net	102	24	16	10	9	7	6	7	7
Retail	Regulated	Net	0	0	0	0	0	0	0	0	0
Ward	Regulated	Net	0	0	0	0	0	0	0	0	0
School	Regulated	Net	0	0	0	0	0	0	0	0	0

Table 64: Total CAPEX for the accelerated multi-dimensional modelling.

Model	Energy Scope	Net?	Base Case ($)	2019 ($)	2022 ($)	2024 ($)	2025 ($)	2028 ($)	2029 ($)	2031 ($)	2034 ($)
Hotel	Regulated	-	-	$103,735	$152,758	$197,293	$201,782	$215,249	$219,738	$249,353	$293,775
Office	Regulated	-	-	$497,380	$680,979	$811,639	$864,579	$1,023,396	$1,076,335	$1,097,883	$1,130,204
Retail	Regulated	-	-	$65,578	$140,384	$212,871	$215,190	$222,148	$224,467	$255,644	$302,410
Ward	Regulated	-	-	$57,450	$85,586	$111,009	$113,722	$121,863	$124,576	$124,958	$125,531
School	Regulated	-	-	$45,927	$63,312	$79,356	$80,697	$84,720	$86,061	$98,982	$118,362
Hotel	Regulated	Net	-	$192,311	$288,181	$356,275	$384,052	$467,382	$495,159	$538,544	$603,623
Office	Regulated	Net	-	$685,130	$929,237	$1,030,682	$1,173,345	$1,601,332	$1,743,994	$1,798,925	$1,881,321
Retail	Regulated	Net	-	$253,328	$357,151	$431,913	$460,974	$548,155	$577,215	$626,029	$699,251
Ward	Regulated	Net	-	$168,442	$210,765	$240,500	$253,088	$290,853	$303,441	$312,766	$326,754
School	Regulated	Net	-	$88,965	$111,979	$129,567	$134,993	$151,274	$156,701	$173,153	$197,832

A.VII Accelerated Results Summary (Normalised with floor area) – Interpolated for 2022, 2025, 2028 & 2031

Table 65: Total energy (electricity and gas) consumption for the accelerated multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case (kWh/m²)	2019 (kWh/m²)	2022 (kWh/m²)	2024 (kWh/m²)	2025 (kWh/m²)	2028 (kWh/m²)	2029 (kWh/m²)	2031 (kWh/m²)	2034 (kWh/m²)
Hotel	1,800	Regulated	-	110.33	81.99	78.23	75.73	74.83	72.14	71.24	70.01	68.16
Office	9,000	Regulated	-	72.93	47.36	45.26	43.86	42.93	40.15	39.22	37.81	35.70
Retail	950	Regulated	-	149.56	95.97	89.34	84.92	82.79	76.37	74.23	69.64	62.74
Ward	475	Regulated	-	131.61	71.83	71.55	71.36	70.46	67.77	66.87	65.49	63.41
School	190	Regulated	-	189.39	80.42	78.01	76.40	75.44	72.54	71.58	69.82	67.19
Hotel	1,800	Regulated	Net	110.33	76.48	72.30	69.51	67.50	61.46	59.44	57.97	55.76
Office	9,000	Regulated	Net	72.93	46.23	43.77	42.13	39.14	30.17	27.18	25.13	22.05
Retail	950	Regulated	Net	149.56	48.35	39.81	34.12	30.69	20.40	16.97	14.82	11.59
Ward	475	Regulated	Net	131.61	38.10	38.13	38.16	37.42	35.19	34.45	33.58	32.27
School	190	Regulated	Net	189.39	19.32	15.68	13.25	11.78	7.37	5.90	5.19	4.14
Hotel	1,800	Whole	-	134.25	105.92	102.16	99.66	98.76	96.06	95.16	93.93	92.09
Office	9,000	Whole	-	116.54	90.97	88.87	87.47	86.55	83.76	82.83	81.43	79.32
Retail	950	Whole	-	170.37	116.78	110.15	105.73	103.59	97.17	95.04	90.44	83.55
Ward	475	Whole	-	175.41	115.63	115.35	115.16	114.27	111.57	110.68	109.29	107.21
School	190	Whole	-	201.69	92.73	90.31	88.71	87.74	84.85	83.88	82.13	79.50
Hotel	1,800	Whole	Net	134.25	96.92	91.64	88.11	86.00	79.66	77.54	75.95	73.55
Office	9,000	Whole	Net	116.54	89.68	87.08	85.34	81.90	71.60	68.17	66.82	64.80
Retail	950	Whole	Net	170.37	68.68	58.37	51.49	46.94	33.30	28.75	26.01	21.89
Ward	475	Whole	Net	175.41	65.64	65.30	65.07	64.05	60.98	59.95	58.91	57.35
School	190	Whole	Net	201.69	26.78	22.26	19.25	17.30	11.42	9.46	8.43	6.89

Table 66: Total electrical energy consumption for the accelerated multi-dimensional modelling.

Model	Floor Area (m^2)	Energy Scope	Net?	Base Case (kWh/m^2)	2019 (kWh/m^2)	2022 (kWh/m^2)	2024 (kWh/m^2)	2025 (kWh/m^2)	2028 (kWh/m^2)	2029 (kWh/m^2)	2031 (kWh/m^2)	2034 (kWh/m^2)
Hotel	1,800	Regulated	-	110.33	81.99	78.23	75.73	74.83	72.14	71.24	70.01	68.16
Office	9,000	Regulated	-	72.93	47.36	45.26	43.86	42.93	40.15	39.22	37.81	35.70
Retail	950	Regulated	-	149.56	95.97	89.34	84.92	82.79	76.37	74.23	69.64	62.74
Ward	475	Regulated	-	131.61	71.83	71.55	71.36	70.46	67.77	66.87	65.49	63.41
School	190	Regulated	-	189.39	80.42	78.01	76.40	75.44	72.54	71.58	69.82	67.19
Hotel	1,800	Regulated	Net	110.33	76.48	72.30	69.51	67.50	61.46	59.44	57.97	55.76
Office	9,000	Regulated	Net	72.93	46.23	43.77	42.13	39.14	30.17	27.18	25.13	22.05
Retail	950	Regulated	Net	149.56	48.35	39.81	34.12	30.69	20.40	16.97	14.82	11.59
Ward	475	Regulated	Net	131.61	38.10	38.13	38.16	37.42	35.19	34.45	33.58	32.27
School	190	Regulated	Net	189.39	19.32	15.68	13.25	11.78	7.37	5.90	5.19	4.14
Hotel	1,800	Whole	-	134.25	105.92	102.16	99.66	98.76	96.06	95.16	93.93	92.09
Office	9,000	Whole	-	116.54	90.97	88.87	87.47	86.55	83.76	82.83	81.43	79.32
Retail	950	Whole	-	170.37	116.78	110.15	105.73	103.59	97.17	95.04	90.44	83.55
Ward	475	Whole	-	175.41	115.63	115.35	115.16	114.27	111.57	110.68	109.29	107.21
School	190	Whole	-	201.69	92.73	90.31	88.71	87.74	84.85	83.88	82.13	79.50
Hotel	1,800	Whole	Net	134.25	96.92	91.64	88.11	86.00	79.66	77.54	75.95	73.55
Office	9,000	Whole	Net	116.54	89.68	87.08	85.34	81.90	71.60	68.17	66.82	64.80
Retail	950	Whole	Net	170.37	68.68	58.37	51.49	46.94	33.30	28.75	26.01	21.89
Ward	475	Whole	Net	175.41	65.64	65.30	65.07	64.05	60.98	59.95	58.91	57.35
School	190	Whole	Net	201.69	26.78	22.26	19.25	17.30	11.42	9.46	8.43	6.89

Table 67: Peak electrical demand for the accelerated multi-dimensional modelling.

Model	Floor Area (m^2)	Energy Scope	Net?	Base Case (kW/m^2)	2019 (kW/m^2)	2022 (kW/m^2)	2024 (kW/m^2)	2025 (kW/m^2)	2028 (kW/m^2)	2029 (kW/m^2)	2031 (kW/m^2)	2034 (kW/m^2)
Hotel	1,800	Regulated	-	0.027	0.017	0.016	0.015	0.015	0.014	0.014	0.014	0.013
Office	9,000	Regulated	-	0.030	0.019	0.018	0.018	0.017	0.016	0.016	0.015	0.015
Retail	950	Regulated	-	0.055	0.033	0.031	0.029	0.028	0.027	0.026	0.025	0.022
Ward	475	Regulated	-	0.025	0.014	0.013	0.013	0.013	0.012	0.012	0.012	0.011
School	190	Regulated	-	0.141	0.059	0.058	0.056	0.056	0.055	0.055	0.053	0.050
Hotel	1,800	Regulated	Net	0.027	0.016	0.015	0.015	0.015	0.014	0.014	0.013	0.013
Office	9,000	Regulated	Net	0.030	0.018	0.017	0.017	0.016	0.014	0.013	0.013	0.012
Retail	950	Regulated	Net	0.055	0.031	0.029	0.027	0.026	0.023	0.022	0.021	0.018
Ward	475	Regulated	Net	0.025	0.012	0.012	0.012	0.012	0.011	0.011	0.010	0.010
School	190	Regulated	Net	0.141	0.038	0.036	0.036	0.035	0.033	0.032	0.031	0.029
Hotel	1,800	Whole	-	0.029	0.021	0.020	0.019	0.019	0.018	0.018	0.018	0.017
Office	9,000	Whole	-	0.041	0.030	0.029	0.029	0.028	0.027	0.027	0.026	0.026
Retail	950	Whole	-	0.059	0.037	0.034	0.033	0.032	0.030	0.029	0.028	0.026
Ward	475	Whole	-	0.030	0.019	0.018	0.018	0.018	0.017	0.017	0.017	0.016
School	190	Whole	-	0.146	0.064	0.062	0.061	0.061	0.060	0.059	0.058	0.055
Hotel	1,800	Whole	Net	0.029	0.020	0.019	0.019	0.019	0.018	0.018	0.017	0.017
Office	9,000	Whole	Net	0.041	0.029	0.028	0.028	0.027	0.025	0.024	0.023	0.023
Retail	950	Whole	Net	0.059	0.035	0.032	0.030	0.029	0.027	0.026	0.024	0.021
Ward	475	Whole	Net	0.030	0.017	0.017	0.017	0.017	0.016	0.016	0.015	0.015
School	190	Whole	Net	0.146	0.042	0.039	0.037	0.036	0.034	0.034	0.032	0.031

Table 68: Total gas consumption for the accelerated multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case (MJ/m²)	2019 (MJ/m²)	2022 (MJ/m²)	2024 (MJ/m²)	2025 (MJ/m²)	2028 (MJ/m²)	2029 (MJ/m²)	2031 (MJ/m²)	2034 (MJ/m²)
Hotel	1,800	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office	9,000	Regulated	-	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail	950	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ward	475	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
School	190	Regulated	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hotel	1,800	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office	9,000	Regulated	Net	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail	950	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ward	475	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
School	190	Regulated	Net	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 69: Total CAPEX for the accelerated multi-dimensional modelling.

Model	Floor Area (m²)	Energy Scope	Net?	Base Case ($/m²)	2019 ($/m²)	2022 ($/m²)	2024 ($/m²)	2025 ($/m²)	2028 ($/m²)	2029 ($/m²)	2031 ($/m²)	2034 ($/m²)
Hotel	1,800	Regulated	-	-	$58	$85	$110	$112	$120	$122	$139	$163
Office	9,000	Regulated	-	-	$55	$76	$90	$96	$114	$120	$122	$126
Retail	950	Regulated	-	-	$69	$148	$224	$227	$234	$236	$269	$318
Ward	475	Regulated	-	-	$121	$180	$234	$239	$257	$262	$263	$264
School	190	Regulated	-	-	$242	$333	$418	$425	$446	$453	$521	$623
Hotel	1,800	Regulated	Net	-	$107	$160	$198	$213	$260	$275	$299	$335
Office	9,000	Regulated	Net	-	$76	$103	$115	$130	$178	$194	$200	$209
Retail	950	Regulated	Net	-	$267	$376	$455	$485	$577	$608	$659	$736
Ward	475	Regulated	Net	-	$355	$444	$506	$533	$612	$639	$658	$688
School	190	Regulated	Net	-	$468	$589	$682	$710	$796	$825	$911	$1,041

A.VIII Detailed Solar Methodology - Commercial

The BCR is dependent on the construction cost of the PV array, the amount of generation and the export percentage which determines the energy cost savings. Since the amount of generation is proportional to the size of the PV array, which is also proportional to the construction cost, the BCR is essentially a function of the export percentage.

Therefore, the first step is to derive the export percentage required to achieve a target BCR of 1.25. This was determined for each archetype in each scenario using the hourly building energy consumption and maximum sized PV array generation from simulation results as a starting point. If the BCR was too high, the export percentage was increased, since the export tariff was lower than the grid tariff, and if the BCR was too low, the export percentage was decreased.

With the required export percentages derived, they are compared to the maximum export percentage based on the maximum PV array generation. If the maximum export percentage is greater, then the PV array is reduced until the required export percentage is achieved. If the maximum export percentage is lower, then no further tuning can be done and the maximum PV array is taken to be the cost effective PV array size. This process is illustrated in Figure 1.

Some important assumptions in the tuning process:

- A feed-in tariff of 35.04% of the grid power tariff was assumed, based on an export price of 5.5c/kWh and a today's grid tariff of 15.7c/kWh
- PV was modelled as having learning rates for both cost and efficiency
- Percentage of export was derived based on hourly generation and building energy consumption from simulation results

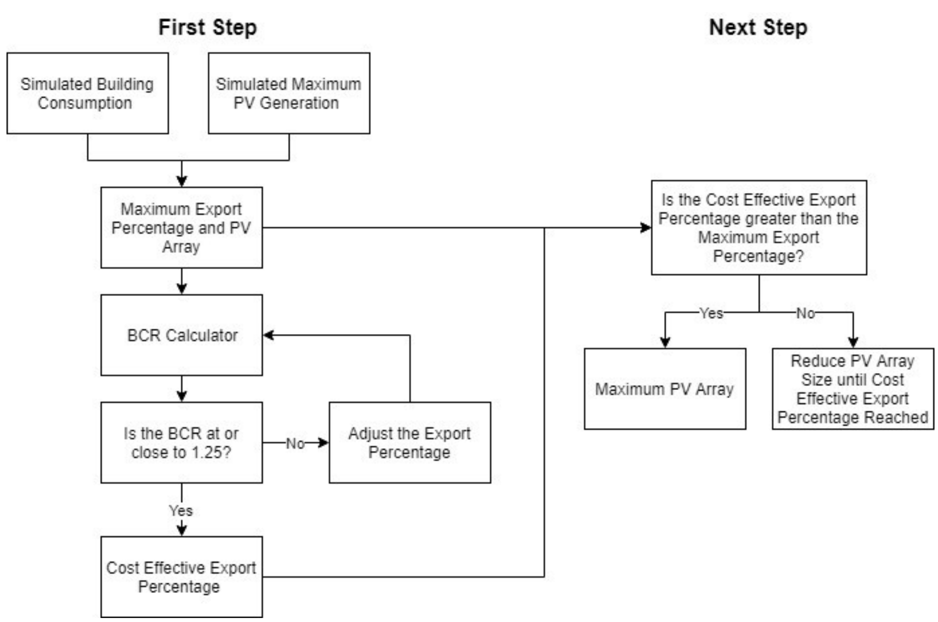

Figure 16: Process to derive the required export percentage for 1.25 BCR.

A.IX Solar PV Analysis Inputs and Results

The PV array sizes and PV contribution for the five commercial archetypes used in the conservative and accelerated analyses are presented in Table 70 through to Table 73 below. The PV contribution shown below is not the annual PV generation, but the total building electricity variation due to the solar generation.

Table 70: PV system capacities for the conservative analysis (kW).

Archetype	2019	2022	2024	2025	2028	2029	2031	2034
Hotel	25.9	28.5	30.2	42.2	77.9	89.9	94.3	101.1
Office	23.8	26.2	27.78	83.7	251.5	307.5	322.8	345.9
Retail	23.8	26.2	27.78	42.9	88.1	103.2	108.3	116.1
Hospital Ward	28.2	31.0	32.92	36.9	49.0	53.0	55.6	59.6
School	10.9	12.0	12.76	14.8	20.8	22.8	23.9	25.6

Table 71: PV system annual contribution for the conservative analysis (kWh).

Archetype	2019	2022	2024	2025	2028	2029	2031	2034
Hotel	9,545	12,392	14,290	16,271	22,217	24,198	24,582	25,157
Office	44,185	47,940	50,443	68,980	124,589	143,125	148,645	156,925
Retail	45,689	48,809	50,889	52,227	56,240	57,578	54,430	49,708
Hospital Ward	18,556	17,369	16,578	16,474	16,160	16,056	15,558	14,812
School	13,938	13,040	12,442	12,459	12,510	12,527	12,308	11,980

Table 72: PV system capacities for the accelerated analysis (kW).

Archetype	2019	2022	2024	2025	2028	2029	2031	2034
Hotel	25.9	28.5	30.2	42.2	77.9	89.9	94.3	101.1
Office	23.8	26.2	27.78	83.7	251.5	307.5	322.8	345.9
Retail	23.8	26.2	27.78	42.9	88.1	103.2	108.3	116.1
Hospital Ward	28.2	31.0	32.92	36.9	49.0	53.0	55.6	59.6
School	10.9	12.0	12.76	14.8	20.8	22.8	23.9	25.6

Table 73: PV system annual contribution for the accelerated analysis (kWh).

Archetype	2019	2022	2024	2025	2028	2029	2031	2034
Hotel	9,920	10,681	11,189	13,197	19,221	21,229	21,664	22,318
Office	10,136	13,382	15,547	34,107	89,786	108,346	114,158	122,875
Retail	45,244	47,053	48,259	49,487	53,170	54,398	52,078	48,599
Hospital Ward	16,021	15,871	15,771	15,697	15,475	15,401	15,157	14,791
School	11,609	11,843	11,998	12,095	12,383	12,479	12,280	11,980

B. APPENDIX: Residential Modelling Results

B.I Conservative Multi-Dimensional Summary (Whole Building Energy Results and BCRs Only)

Table 74: Multi-Dimensional analysis results for the conservative residential trajectory, climate zone 1.

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 1 North	Base case	$66,793		$66,793	10,003	5.19													
	0 yrs	$85,696	-$1,150	$84,546	6,088	3.64	-$1,498	$19,630				1.21				1.11			
	5 yrs	$95,967	-$1,840	$94,127	5,055	3.12	-$1,995		$28,699				1.13				1.05		
	10 yrs	$95,967	-$2,300	$93,667	4,566	2.77	-$2,337			$34,773				1.41				1.29	
	15 yrs	$105,800	-$2,990	$102,810	4,192	2.45	-$2,642				$40,448				1.21				1.12
Detached Climate Zone 1 South	Base case	$66,793		$66,793	10,248	5.18													
	0 yrs	$85,696	-$1,150	$84,546	6,039	3.55	-$1,575	$21,102				1.30				1.19			
	5 yrs	$95,967	-$1,610	$94,357	5,019	3.27	-$1,844		$30,325				1.18				1.10		
	10 yrs	$95,967	-$2,300	$93,667	4,535	2.90	-$2,202			$36,540				1.48				1.36	
	15 yrs	$105,800	-$2,990	$102,810	4,160	2.34	-$2,734				$42,374				1.27				1.18
Attached Climate Zone 1 North	Base case	$38,631		$38,631	7,081	4.12													
	0 yrs	$54,732	-$1,150	$53,582	3,815	2.45	-$1,614	$16,374				1.23				1.10			
	5 yrs	$60,985	-$1,840	$59,145	3,215	2.06	-$1,985		$22,424				1.21				1.09		
	10 yrs	$60,985	-$2,300	$58,685	2,906	1.83	-$2,211			$26,702				1.49				1.33	
	15 yrs	$65,510	-$2,760	$62,750	2,690	1.65	-$2,380				$30,564				1.40				1.27
Attached Climate Zone 1 South	Base case	$38,019		$38,019	7,037	4.58													
	0 yrs	$50,911	-$920	$49,991	4,086	3.18	-$1,346	$14,799				1.39				1.24			
	5 yrs	$61,689	-$1,610	$60,079	3,409	2.61	-$1,898		$21,044				1.04				0.95		
	10 yrs	$61,689	-$2,070	$59,619	3,078	2.31	-$2,184			$25,322				1.30				1.17	
	15 yrs	$64,568	-$2,990	$61,578	2,696	1.79	-$2,684				$30,216				1.44				1.28

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Apartment Climate Zone 1 North	Base case	$29,291		$29,291	5,243	2.97													
	0 yrs	$37,562	-$460	$37,102	2,715	2.21	-$739	$8,236				1.16				1.05			
	5 yrs	$41,278	-$920	$40,358	2,242	1.76	-$1,173		$17,407				1.76				1.57		
	10 yrs	$44,332	-$1,380	$42,952	2,002	1.44	-$1,476			$20,729				1.70				1.52	
	15 yrs	$44,332	-$1,840	$42,492	1,874	1.30	-$1,618				$23,450				2.02				1.78
Apartment Climate Zone 1 South	Base case	$29,291		$29,291	5,170	2.82													
	0 yrs	$41,278	-$690	$40,588	2,572	1.84	-$944	$13,023				1.26				1.15			
	5 yrs	$44,332	-$920	$43,412	2,221	1.61	-$1,164		$17,104				1.32				1.21		
	10 yrs	$49,496	-$1,380	$48,116	2,017	1.44	-$1,331			$20,164				1.15				1.07	
	15 yrs	$49,496	-$1,610	$47,886	1,888	1.29	-$1,472				$22,846				1.33				1.23

Table 75: Multi-Dimensional analysis results for the conservative residential trajectory, climate zone 3.

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 3 North	Base case	$65,951		$65,951	4,730	5.76													
	0 yrs	$79,021	-$1,610	$77,411	2,719	3.64	-$2,037	$10,084				1.07				0.88			
	5 yrs	$84,623	-$2,760	$81,863	2,186	2.55	-$3,090		$14,755				1.15				0.93		
	10 yrs	$84,623	-$3,450	$81,173	2,024	2.26	-$3,369			$17,312				1.45				1.14	
	15 yrs	$90,191	-$4,140	$86,051	1,735	1.94	-$3,674				$20,853				1.26				1.04
Detached Climate Zone 3 South	Base case	$65,951		$65,951	4,875	5.75													
	0 yrs	$79,021	-$1,840	$77,181	2,634	3.16	-$2,495	$11,239				1.29				1.00			
	5 yrs	$84,623	-$2,760	$81,863	2,123	2.61	-$3,023		$15,967				1.24				1.00		
	10 yrs	$88,704	-$3,450	$85,254	1,889	2.25	-$3,370			$19,102				1.19				0.99	
	15 yrs	$88,704	-$4,140	$84,564	1,831	2.02	-$3,592				$21,190				1.40				1.14

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Attached Climate Zone 3 North	Base case	$38,019		$38,019	3,318	4.42													
	0 yrs	$46,881	-$1,380	$45,501	1,738	2.61	-$1,738	$7,919				1.38				1.06			
	5 yrs	$49,761	-$1,840	$47,921	1,491	2.13	-$2,204		$10,596				1.38				1.07		
	10 yrs	$52,809	-$2,530	$50,279	1,329	1.83	-$2,493			$12,719				1.30				1.04	
	15 yrs	$54,346	-$2,990	$51,356	1,282	1.64	-$2,672				$14,169				1.32				1.06
Attached Climate Zone 3 South	Base case	$38,019		$38,019	3,325	5.40													
	0 yrs	$46,881	-$1,380	$45,501	2,123	3.50	-$1,826	$6,024				1.07				0.81			
	5 yrs	$49,930	-$1,840	$48,090	1,747	3.28	-$2,036		$9,154				1.14				0.91		
	10 yrs	$52,809	-$2,990	$49,819	1,449	2.29	-$2,992			$11,994				1.35				1.02	
	15 yrs	$54,346	-$3,680	$50,666	1,388	2.03	-$3,244				$13,482				1.42				1.07
Apartment Climate Zone 3 North	Base case	$29,291		$29,291	2,625	3.81													
	0 yrs	$36,830	-$920	$35,910	1,470	2.56	-$1,201	$5,791				1.07				0.88			
	5 yrs	$39,022	-$1,610	$37,412	1,178	1.83	-$1,907		$8,391				1.35				1.03		
	10 yrs	$41,846	-$2,070	$39,776	1,061	1.62	-$2,110			$10,003				1.19				0.95	
	15 yrs	$41,846	-$2,530	$39,316	1,029	1.45	-$2,269				$11,109				1.42				1.11
Apartment Climate Zone 3 South	Base case	$29,291		$29,291	2,421	3.44													
	0 yrs	$36,830	-$1,150	$35,680	1,436	1.92	-$1,463	$4,939				1.00				0.77			
	5 yrs	$39,022	-$1,610	$37,412	1,126	1.57	-$1,802		$7,507				1.19				0.92		
	10 yrs	$39,593	-$1,840	$37,753	1,038	1.40	-$1,968			$8,840				1.35				1.04	
	15 yrs	$41,846	-$2,530	$39,316	1,001	1.19	-$2,166				$9,881				1.25				0.99

Table 76: Multi-Dimensional analysis results for the conservative residential trajectory, climate zone 1a (Cairns).

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 1a East	Base case	$65,339		$65,339	4,718	4.13													
	0 yrs	$75,815	-$690	$75,125	3,145	2.97	-$1,115	$7,888				0.91				0.81			
	5 yrs	$78,211	-$1,150	$77,061	2,836	2.71	-$1,371		$10,915				1.05				0.93		
	10 yrs	$82,292	-$1,840	$80,452	2,550	2.30	-$1,768			$13,865				1.04				0.92	
	15 yrs	$82,292	-$2,300	$79,992	2,425	2.06	-$1,994				$15,960				1.26				1.09
Detached Climate Zone 1a South	Base case	$65,339		$65,339	5,038	4.19													
	0 yrs	$75,815	-$690	$75,125	3,289	3.02	-$1,125	$8,770				1.01				0.90			
	5 yrs	$78,211	-$1,380	$76,831	2,962	2.64	-$1,489		$12,042				1.20				1.05		
	10 yrs	$82,292	-$1,610	$80,682	2,632	2.43	-$1,688			$15,388				1.12				1.00	
	15 yrs	$82,292	-$2,070	$80,222	2,499	2.19	-$1,928				$17,675				1.36				1.19
Attached Climate Zone 1a South	Base case	$37,861		$37,861	2,892	2.78													
	0 yrs	$42,392	-$460	$41,932	2,117	2.09	-$665	$3,885				1.14				0.95			
	5 yrs	$45,223	-$690	$44,533	1,822	1.84	-$907		$6,207				1.08				0.93		
	10 yrs	$46,775	-$1,150	$45,625	1,625	1.61	-$1,130			$8,106				1.22				1.04	
	15 yrs	$49,655	-$1,380	$48,275	1,543	1.44	-$1,296				$9,392				1.03				0.90
Attached Climate Zone 1a West	Base case	$37,861		$37,861	3,335	3.19													
	0 yrs	$42,392	-$230	$42,162	2,464	2.67	-$506	$4,367				1.15				1.02			
	5 yrs	$45,223	-$690	$44,533	2,122	2.33	-$829		$7,036				1.20				1.05		
	10 yrs	$46,775	-$920	$45,855	1,864	2.15	-$1,002			$9,407				1.34				1.18	
	15 yrs	$49,655	-$1,610	$48,045	1,721	1.75	-$1,391				$11,233				1.27				1.10
Apartment Climate Zone 1a North	Base case	$29,291		$29,291	2,497	2.29													
	0 yrs	$32,485	-$230	$32,255	1,768	1.89	-$387	$3,653				1.42				1.23			
	5 yrs	$35,370	-$460	$34,910	1,536	1.61	-$654		$5,573				1.12				0.99		
	10 yrs	$36,990	-$690	$36,300	1,420	1.45	-$810			$6,888				1.11				0.98	
	15 yrs	$36,990	-$920	$36,070	1,351	1.30	-$953				$7,974				1.36				1.18

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Apartment Climate Zone 1a West	Base case	$29,291		$29,291	2,439	2.18													
	0 yrs	$32,485	$0	$32,485	1,711	2.07	-$115	$3,649				1.18				1.14			
	5 yrs	$35,370	-$460	$34,910	1,489	1.63	-$531		$5,509				1.08				0.98		
	10 yrs	$36,990	-$690	$36,300	1,374	1.42	-$732			$6,814				1.08				0.97	
	15 yrs	$36,990	-$920	$36,070	1,310	1.28	-$872				$7,860				1.33				1.16

B.II Accelerated Multi-Dimensional Summary (Whole Building Energy Results and BCRs Only)

Table 77: Multi-Dimensional analysis results for the accelerated residential trajectory, climate zone 1.

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 1 North	Base case	$66,793		$66,793	10,003	5.19													
	0 yrs	$85,696	-$1,150	$84,546	6,088	3.64	-$1,498	$30,618				1.00				0.92			
	5 yrs	$95,967	-$1,840	$94,127	5,055	3.12	-$1,995		$37,492				1.26				1.14		
	10 yrs	$95,967	-$2,300	$93,667	4,566	2.77	-$2,337			$43,355				1.50				1.35	
	15 yrs	$105,800	-$2,990	$102,810	4,192	2.45	-$2,642				$48,465				1.72				1.54
Detached Climate Zone 1 South	Base case	$66,793		$66,793	10,248	5.18													
	0 yrs	$85,696	-$1,150	$84,546	6,039	3.55	-$1,575	$31,397				1.00				0.93			
	5 yrs	$95,967	-$1,610	$94,357	5,019	3.27	-$1,844		$38,452				1.25				1.15		
	10 yrs	$95,967	-$2,300	$93,667	4,535	2.90	-$2,202			$44,465				1.49				1.36	
	15 yrs	$105,800	-$2,990	$102,810	4,160	2.34	-$2,734				$49,719				1.72				1.56
Attached Climate Zone 1 North	Base case	$38,631		$38,631	7,081	4.12													

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		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	0 yrs	$54,732	-$1,150	$53,582	3,815	2.45	-$1,614	$21,761				1.23				1.09			
	5 yrs	$60,985	-$1,840	$59,145	3,215	2.06	-$1,985		$26,653				1.56				1.36		
	10 yrs	$60,985	-$2,300	$58,685	2,906	1.83	-$2,211			$30,803				1.87				1.62	
	15 yrs	$65,510	-$2,760	$62,750	2,690	1.65	-$2,380				$34,441				2.16				1.85
Attached Climate Zone 1 South	Base case	$38,019		$38,019	7,037	4.58													
	0 yrs	$50,911	-$920	$49,991	4,086	3.18	-$1,346	$21,879				1.29				1.13			
	5 yrs	$61,689	-$1,610	$60,079	3,409	2.61	-$1,898		$26,745				1.65				1.41		
	10 yrs	$61,689	-$2,070	$59,619	3,078	2.31	-$2,184			$30,866				1.97				1.67	
	15 yrs	$64,568	-$2,990	$61,578	2,696	1.79	-$2,684				$34,474				2.28				1.91
Apartment Climate Zone 1 North	Base case	$29,291		$29,291	5,243	2.97													
	0 yrs	$37,562	-$460	$37,102	2,715	2.21	-$739	$12,869				0.68				0.63			
	5 yrs	$41,278	-$920	$40,358	2,242	1.76	-$1,173		$20,847				1.12				1.03		
	10 yrs	$44,332	-$1,380	$42,952	2,002	1.44	-$1,476			$23,954				1.33				1.21	
	15 yrs	$44,332	-$1,840	$42,492	1,874	1.30	-$1,618				$26,591				1.50				1.36
Apartment Climate Zone 1 South	Base case	$29,291		$29,291	5,170	2.82													
	0 yrs	$41,278	-$690	$40,588	2,572	1.84	-$944	$16,851				0.87				0.81			
	5 yrs	$44,332	-$920	$43,412	2,221	1.61	-$1,164		$20,328				1.07				0.99		
	10 yrs	$49,496	-$1,380	$48,116	2,017	1.44	-$1,331			$23,393				1.27				1.17	
	15 yrs	$49,496	-$1,610	$47,886	1,888	1.29	-$1,472				$25,989				1.43				1.31

Table 78: Multi-Dimensional analysis results for the accelerated residential trajectory, climate zone 3.

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 3 North	Base case	$65,951		$65,951	4,730	5.76													

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	0 yrs	$79,021	-$1,610	$77,411	2,719	3.64	-$2,037	$15,309				0.69				0.59			
	5 yrs	$84,623	-$2,760	$81,863	2,186	2.55	-$3,090		$18,318				0.86				0.73		
	10 yrs	$84,623	-$3,450	$81,173	2,024	2.26	-$3,369			$20,928				1.02				0.85	
	15 yrs	$90,191	-$4,140	$86,051	1,735	1.94	-$3,674				$23,168				0.98				0.83
Detached Climate Zone 3 South	Base case	$65,951		$65,951	4,875	5.75													
	0 yrs	$79,021	-$1,840	$77,181	2,634	3.16	-$2,495	$16,141				0.73				0.62			
	5 yrs	$84,623	-$2,760	$81,863	2,123	2.61	-$3,023		$19,267				0.91				0.76		
	10 yrs	$88,704	-$3,450	$85,254	1,889	2.25	-$3,370			$22,045				1.08				0.89	
	15 yrs	$88,704	-$4,140	$84,564	1,831	2.02	-$3,592				$24,234				1.02				0.86
Attached Climate Zone 3 North	Base case	$38,019		$38,019	3,318	4.42													
	0 yrs	$46,881	-$1,380	$45,501	1,738	2.61	-$1,738	$10,704				0.67				0.58			
	5 yrs	$49,761	-$1,840	$47,921	1,491	2.13	-$2,204		$12,835				0.84				0.71		
	10 yrs	$52,809	-$2,530	$50,279	1,329	1.83	-$2,493			$14,665				1.00				0.84	
	15 yrs	$54,346	-$2,990	$51,356	1,282	1.64	-$2,672				$16,078				1.14				0.94
Attached Climate Zone 3 South	Base case	$38,019		$38,019	3,325	5.40													
	0 yrs	$46,881	-$1,380	$45,501	2,123	3.50	-$1,826	$10,720				0.76				0.61			
	5 yrs	$49,930	-$1,840	$48,090	1,747	3.28	-$2,036		$12,856				0.96				0.75		
	10 yrs	$52,809	-$2,990	$49,819	1,449	2.29	-$2,992			$14,690				1.16				0.90	
	15 yrs	$54,346	-$3,680	$50,666	1,388	2.03	-$3,244				$16,107				1.36				1.02
Apartment Climate Zone 3 North	Base case	$29,291		$29,291	2,625	3.81													
	0 yrs	$36,830	-$920	$35,910	1,470	2.56	-$1,201	$8,294				0.49				0.42			
	5 yrs	$39,022	-$1,610	$37,412	1,178	1.83	-$1,907		$9,877				0.60				0.52		
	10 yrs	$41,846	-$2,070	$39,776	1,061	1.62	-$2,110			$11,383				0.71				0.61	
	15 yrs	$41,846	-$2,530	$39,316	1,029	1.45	-$2,269				$12,489				0.81				0.68
Apartment Climate Zone 3 South	Base case	$29,291		$29,291	2,421	3.44													
	0 yrs	$36,830	-$1,150	$35,680	1,436	1.92	-$1,463	$7,318				0.42				0.37			

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	5 yrs	$39,022	-$1,610	$37,412	1,126	1.57	-$1,802		$8,741				0.51				0.45		
	10 yrs	$39,593	-$1,840	$37,753	1,038	1.40	-$1,968			$10,125				0.60				0.53	
	15 yrs	$41,846	-$2,530	$39,316	1,001	1.19	-$2,166				$11,115				0.68				0.59

Table 79: Multi-Dimensional analysis results for the accelerated residential trajectory, climate zone 1a (Cairns).

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Detached Climate Zone 1a East	Base case	$65,339		$65,339	4,718	4.13													
	0 yrs	$75,815	-$690	$75,125	3,145	2.97	-$1,115	$6,949				0.63				0.58			
	5 yrs	$78,211	-$1,150	$77,061	2,836	2.71	-$1,371		$10,407				1.02				0.90		
	10 yrs	$82,292	-$1,840	$80,452	2,550	2.30	-$1,768			$13,053				1.38				1.17	
	15 yrs	$82,292	-$2,300	$79,992	2,425	2.06	-$1,994				$15,166				1.73				1.42
Detached Climate Zone 1a South	Base case	$65,339		$65,339	5,038	4.19													
	0 yrs	$75,815	-$690	$75,125	3,289	3.02	-$1,125	$7,234				0.65				0.60			
	5 yrs	$78,211	-$1,380	$76,831	2,962	2.64	-$1,489		$10,933				1.07				0.94		
	10 yrs	$82,292	-$1,610	$80,682	2,632	2.43	-$1,688			$13,799				1.45				1.24	
	15 yrs	$82,292	-$2,070	$80,222	2,499	2.19	-$1,928				$16,123				1.83				1.51
Attached Climate Zone 1a South	Base case	$37,861		$37,861	2,892	2.78													
	0 yrs	$42,392	-$460	$41,932	2,117	2.09	-$665	$3,885				1.14				0.95			
	5 yrs	$45,223	-$690	$44,533	1,822	1.84	-$907		$6,207				1.08				0.93		
	10 yrs	$46,775	-$1,150	$45,625	1,625	1.61	-$1,130			$7,808				1.52				1.26	
	15 yrs	$49,655	-$1,380	$48,275	1,543	1.44	-$1,296				$9,045				1.90				1.51
Attached Climate Zone 1a West	Base case	$37,861		$37,861	3,335	3.19													
	0 yrs	$42,392	-$230	$42,162	2,464	2.67	-$506	$4,367				1.15				1.02			

		Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	5 yrs	$45,223	-$690	$44,533	2,122	2.33	-$829		$7,036				1.20				1.05		
	10 yrs	$46,775	-$920	$45,855	1,864	2.15	-$1,002			$8,940				1.66				1.39	
	15 yrs	$49,655	-$1,610	$48,045	1,721	1.75	-$1,391				$10,466				2.21				1.75
Apartment Climate Zone 1a North	Base case	$29,291		$29,291	2,497	2.29													
	0 yrs	$32,485	-$230	$32,255	1,768	1.89	-$387	$2,894				0.80				0.76			
	5 yrs	$35,370	-$460	$34,910	1,536	1.61	-$654		$4,826				1.08				0.96		
	10 yrs	$36,990	-$690	$36,300	1,420	1.45	-$810			$6,137				1.51				1.27	
	15 yrs	$36,990	-$920	$36,070	1,351	1.30	-$953				$7,240				1.96				1.58
Apartment Climate Zone 1a West	Base case	$29,291		$29,291	2,439	2.18													
	0 yrs	$32,485	$0	$32,485	1,711	2.07	-$115	$2,915				0.80				0.76			
	5 yrs	$35,370	-$460	$34,910	1,489	1.63	-$531		$4,802				0.99				0.91		
	10 yrs	$36,990	-$690	$36,300	1,374	1.42	-$732			$6,071				1.37				1.20	
	15 yrs	$36,990	-$920	$36,070	1,310	1.28	-$872				$7,135				1.87				1.56

B.III Single Dimensional Raw Modelling Results

B.III.I Energy Results

Table 80: Detached archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	134.6	0	4	11.8	0.0	0.6	19.5	0.0	1.0	24.1	0.0	1.3	26.7	0.0	1.4
		Thermal Mass							22.6	0.0	1.2	27.1	0.0	1.5	27.5	0.0	1.5
		Surface Colour							8.3	0.0	0.4	16.3	0.0	0.9			
	Roof	Construction				22.5	0.0	1.2									
		Roof Ventilation				6.8	0.0	0.4	8.9	0.0	0.5						
	Ceiling	Ceiling Insulation				16.5	0.0	0.9				23.5	0.0	1.3			
	Floor	Insulation				6.3	0.0	0.3	6.6	0.0	0.3						
		Thermal Mass															
	External Shading	Eave Extension				2.0	0.0	0.1	6.1	0.0	0.3						
		Awnings				5.4	0.0	0.3									
	Ventilation	Ceiling Fans				3.7	0.0	0.2									
	Infiltration	Infiltration				22.9	0.0	1.2									
90°	External Wall	Insulation	134.7	0	4	11.1	0.0	0.6	18.5	0.0	1.0	23.0	0.0	1.2	25.7	0.0	1.4
		Thermal Mass							21.7	0.0	1.2	26.2	0.0	1.4	26.4	0.0	1.4
		Surface Colour							7.8	0.0	0.4	15.5	0.0	0.8			
	Roof	Construction				21.7	0.0	1.2									
		Roof Ventilation				6.7	0.0	0.4	8.5	0.0	0.4						
	Ceiling	Ceiling Insulation				16.2	0.0	0.9				23.2	0.0	1.2			
	Floor	Insulation				5.3	0.0	0.3	6.2	0.0	0.3						
		Thermal Mass															
	External Shading	Eave Extension				2.0	0.0	0.1	5.7	0.0	0.3						
		Awnings				5.9	0.0	0.3									
	Ventilation	Ceiling Fans				3.9	0.0	0.2									
	Infiltration	Infiltration				23.0	0.0	1.2									

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	138.8	0	3.8	13.5	0.0	0.7	22.6	0.0	1.2	28.0	0.0	1.5	31.2	0.0	1.7
		Thermal Mass							26.0	0.0	1.4	31.3	0.0	1.7	32.0	0.0	1.7
		Surface Colour							9.7	0.0	0.5	19.3	0.0	1.0			
	Roof	Construction				22.6	0.0	1.2									
		Roof Ventilation				6.6	0.0	0.3	8.9	0.0	0.5						
	Ceiling	Ceiling Insulation				16.6	0.0	0.9				23.7	0.0	1.3			
	Floor	Insulation				6.0	0.0	0.3	7.0	0.0	0.4						
		Thermal Mass															
	External Shading	Eave Extension				1.5	0.0	0.1	3.6	0.0	0.2						
		Awnings				3.0	0.0	0.2									
	Ventilation	Ceiling Fans				3.7	0.0	0.2									
	Infiltration	Infiltration				23.9	0.0	1.3									
270°	External Wall	Insulation	136.9	0	3.9	12.6	0.0	0.7	21.1	0.0	1.1	26.2	0.0	1.4	29.1	0.0	1.6
		Thermal Mass							24.0	0.0	1.3	29.2	0.0	1.6	29.9	0.0	1.6
		Surface Colour							8.9	0.0	0.5	17.6	0.0	0.9			
	Roof	Construction				21.6	0.0	1.1									
		Roof Ventilation				6.6	0.0	0.3	8.5	0.0	0.4						
	Ceiling	Ceiling Insulation				16.1	0.0	0.8				22.7	0.0	1.2			
	Floor	Insulation				5.2	0.0	0.3	5.8	0.0	0.3						
		Thermal Mass															
	External Shading	Eave Extension				1.3	0.0	0.1	3.5	0.0	0.2						
		Awnings				3.6	0.0	0.2									
	Ventilation	Ceiling Fans				3.9	0.0	0.2									
	Infiltration	Infiltration				23.3	0.0	1.2									

Table 81: Detached archetype climate zone 3 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	35.4	10.3	4.7	6.2	2.3	0.8	10.1	3.7	1.3	12.1	4.5	1.7	13.6	4.9	1.9
		Thermal Mass							14.5	4.5	2.0	16.5	5.2	2.3	14.2	5.3	2.0
		Surface Colour							4.1	-1.3	0.2	8.2	-3.0	0.4			
	Roof	Construction				13.2	-1.8	1.1									
		Roof Ventilation				4.0	-0.2	0.3	5.3	-0.3	0.4						
	Ceiling	Ceiling Insulation				10.6	2.1	1.2				15.2	3.1	1.9			
	Floor	Insulation				11.3	-0.4	1.0	10.6	1.0	1.1						
		Thermal Mass															
	External Shading	Eave Extension				1.2	-0.1	0.1	3.4	-0.6	0.2						
		Awnings				2.8	0.0	0.2									
	Ventilation	Ceiling Fans				0.3	0.0	0.0	0.3	0.0	0.0						
	Infiltration	Infiltration				1.6	3.0	0.4									
90°	External Wall	Insulation	35.4	10.2	4.7	6.1	2.3	0.8	9.9	3.7	1.3	12.1	4.5	1.7	13.5	4.9	1.9
		Thermal Mass							14.4	4.3	1.9	16.3	5.0	2.2	14.1	5.2	2.0
		Surface Colour							4.1	-1.4	0.2	7.8	-3.1	0.4			
	Roof	Construction				13.4	-2.1	1.1									
		Roof Ventilation				3.9	-0.3	0.3	5.3	-0.5	0.4						
	Ceiling	Ceiling Insulation				10.5	2.0	1.2				15.1	3.0	1.9			
	Floor	Insulation				11.2	-0.1	1.0	10.7	0.7	1.1						
		Thermal Mass															
	External Shading	Eave Extension				1.1	-0.3	0.1	3.1	-0.9	0.2						
		Awnings				2.9	0.0	0.2									
	Ventilation	Ceiling Fans				0.3	0.0	0.0	0.3	0.0	0.0						
	Infiltration	Infiltration				1.4	3.2	0.4									

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	38	10.2	4.5	7.8	2.3	0.9	12.6	3.6	1.5	15.3	4.4	2.0	17.1	4.9	2.2
		Thermal Mass							17.2	4.4	2.2	19.5	5.1	2.5	17.8	5.3	2.3
		Surface Colour							5.6	-1.4	0.3	10.6	-3.1	0.6			
	Roof	Construction				14.1	-2.0	1.1									
		Roof Ventilation				4.2	-0.3	0.3	5.7	-0.4	0.4						
	Ceiling	Ceiling Insulation				10.9	2.1	1.2				15.8	3.1	1.8			
	Floor	Insulation				11.7	-0.6	1.0	11.1	0.6	1.0						
		Thermal Mass															
	External Shading	Eave Extension				0.4	-0.3	0.0	1.0	-1.3	0.0						
		Awnings				1.5	0.0	0.1									
	Ventilation	Ceiling Fans				0.3	0.0	0.0	0.3	0.0	0.0						
	Infiltration	Infiltration				1.6	3.2	0.4									
270°	External Wall	Insulation	37.8	10.5	4.5	7.6	2.3	0.9	12.2	3.7	1.5	14.7	4.5	1.9	16.6	5.0	2.2
		Thermal Mass							16.8	4.4	2.1	19.1	5.2	2.5	17.2	5.4	2.3
		Surface Colour							5.2	-1.4	0.3	10.2	-3.1	0.6			
	Roof	Construction				13.8	-1.9	1.1									
		Roof Ventilation				4.0	-0.3	0.3	5.5	-0.4	0.4						
	Ceiling	Ceiling Insulation				10.9	2.1	1.2				15.7	3.0	1.8			
	Floor	Insulation				11.2	-0.4	0.9	10.8	0.8	1.0						
		Thermal Mass															
	External Shading	Eave Extension				0.5	-0.2	0.0	1.1	-0.8	0.0						
		Awnings				0.9	0.0	0.1									
	Ventilation	Ceiling Fans				0.4	0.0	0.0	0.4	0.0	0.0						
	Infiltration	Infiltration				1.6	3.1	0.4									

Table 82: Attached archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	143.1	0	4	7.5	0.0	0.4	12.4	0.0	0.6	15.5	0.0	0.8	16.9	0.0	0.8
		Thermal Mass							11.9	0.0	0.6	14.9	0.0	0.7	17.7	0.0	0.9
		Surface Colour							5.9	0.0	0.3	11.8	0.0	0.6			
	Roof	Construction				11.4	0.0	0.6									
		Roof Ventilation				3.6	0.0	0.2	4.9	0.0	0.2						
	Ceiling	Ceiling Insulation				6.7	0.0	0.3	4.0	0.0	0.2	9.2	0.0	0.5			
	Floor	Insulation				0.0	0.0	0.0	0.8	0.0	0.0						
		Thermal Mass															
	External Shading	Eave Extension				8.2	0.0	0.4	10.1	0.0	0.5						
		Awnings				4.0	0.0	0.2									
	Ventilation	Ceiling Fans				3.6	0.0	0.2	3.6	0.0	0.2						
	Infiltration	Infiltration				24.9	0.0	1.3									
90°	External Wall	Insulation	143.3	0	4	7.5	0.0	0.4	12.5	0.0	0.6	15.7	0.0	0.8	17.2	0.0	0.9
		Thermal Mass							12.6	0.0	0.6	15.5	0.0	0.8	18.2	0.0	0.9
		Surface Colour							5.8	0.0	0.3	11.4	0.0	0.6			
	Roof	Construction				11.1	0.0	0.5									
		Roof Ventilation				3.4	0.0	0.2	4.6	0.0	0.2						
	Ceiling	Ceiling Insulation				6.6	0.0	0.3	4.1	0.0	0.2	9.3	0.0	0.5			
	Floor	Insulation				2.2	0.0	0.1	2.6	0.0	0.1						
		Thermal Mass															
	External Shading	Eave Extension				7.8	0.0	0.4	8.5	0.0	0.4						
		Awnings				6.0	0.0	0.3									
	Ventilation	Ceiling Fans				3.7	0.0	0.2	3.7	0.0	0.2						
	Infiltration	Infiltration				27.3	0.0	1.4									

Final Report

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	143	0	4	8.6	0.0	0.4	14.3	0.0	0.7	17.6	0.0	0.9	19.2	0.0	1.0
		Thermal Mass							14.7	0.0	0.7	18.0	0.0	0.9	20.2	0.0	1.0
		Surface Colour							6.2	0.0	0.3	12.5	0.0	0.6			
	Roof	Construction				9.8	0.0	0.5									
		Roof Ventilation				3.1	0.0	0.2	4.3	0.0	0.2						
	Ceiling	Ceiling Insulation				6.2	0.0	0.3	4.0	0.0	0.2	9.0	0.0	0.4			
	Floor	Insulation				0.6	0.0	0.0	1.1	0.0	0.1						
		Thermal Mass															
	External Shading	Eave Extension				10.8	0.0	0.5	13.6	0.0	0.7						
		Awnings				8.2	0.0	0.4									
	Ventilation	Ceiling Fans				3.6	0.0	0.2	3.6	0.0	0.2						
	Infiltration	Infiltration				25.7	0.0	1.3									
270°	External Wall	Insulation	147.1	0	3.8	8.1	0.0	0.4	13.5	0.0	0.7	16.7	0.0	0.8	18.3	0.0	0.9
		Thermal Mass							13.8	0.0	0.7	16.8	0.0	0.8	19.5	0.0	1.0
		Surface Colour							5.8	0.0	0.3	11.7	0.0	0.6			
	Roof	Construction				9.5	0.0	0.5									
		Roof Ventilation				3.0	0.0	0.1	4.0	0.0	0.2						
	Ceiling	Ceiling Insulation				6.1	0.0	0.3	3.9	0.0	0.2	8.5	0.0	0.4			
	Floor	Insulation				1.2	0.0	0.1	2.6	0.0	0.1						
		Thermal Mass															
	External Shading	Eave Extension				11.3	0.0	0.5	13.3	0.0	0.6						
		Awnings				9.3	0.0	0.4									
	Ventilation	Ceiling Fans				3.7	0.0	0.2	3.7	0.0	0.2						
	Infiltration	Infiltration				27.8	0.0	1.4									

Table 83: Attached archetype climate zone 3 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	38.2	10.5	4.7	4.0	1.6	0.5	6.5	2.6	0.8	7.9	3.2	1.0	8.8	3.6	1.1
		Thermal Mass							9.3	3.2	1.1	10.7	3.8	1.3	9.7	3.9	1.2
		Surface Colour							3.0	-0.8	0.2	5.9	-1.6	0.3			
	Roof	Construction				6.2	-1.5	0.4									
		Roof Ventilation				1.7	-0.3	0.1	2.5	-0.5	0.1						
	Ceiling	Ceiling Insulation				4.1	1.0	0.4	3.3	1.0	0.3	6.2	1.5	0.6			
	Floor	Insulation				5.4	2.0	0.6	5.6	1.3	0.6						
		Thermal Mass															
	External Shading	Eave Extension				4.4	-1.9	0.2	5.4	-3.1	0.2						
		Awnings				2.0	0.0	0.1									
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.5	0.0	0.0						
	Infiltration	Infiltration				2.2	3.5	0.5									
90°	External Wall	Insulation	41.8	6.2	4.8	3.6	1.6	0.4	6.0	2.6	0.7	7.4	3.2	0.9	8.2	3.5	1.0
		Thermal Mass							8.3	3.2	1.0	9.8	3.7	1.2	8.9	3.8	1.1
		Surface Colour							3.1	-0.6	0.2	6.1	-1.2	0.4			
	Roof	Construction				6.8	-1.0	0.5									
		Roof Ventilation				2.1	-0.2	0.1	2.9	-0.3	0.2						
	Ceiling	Ceiling Insulation				4.4	1.0	0.4	3.4	0.9	0.3	6.2	1.5	0.7			
	Floor	Insulation				6.5	-0.1	0.5	7.8	-0.2	0.6						
		Thermal Mass															
	External Shading	Eave Extension				5.0	-3.6	0.1	5.9	-4.6	0.1						
		Awnings				1.6	0.0	0.1									
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.4	0.0	0.0						
	Infiltration	Infiltration				1.6	2.6	0.3									

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	38.8	10	4.7	4.7	1.4	0.5	7.4	2.3	0.8	9.1	2.8	1.0	10.1	3.2	1.2
		Thermal Mass							10.2	3.1	1.2	11.8	3.6	1.4	10.9	3.4	1.3
		Surface Colour							3.2	-1.1	0.2	6.5	-2.4	0.3			
	Roof	Construction				5.2	-1.3	0.3									
		Roof Ventilation				1.3	-0.3	0.1	2.0	-0.4	0.1						
	Ceiling	Ceiling Insulation				3.7	1.1	0.4	3.0	1.0	0.3	5.5	1.6	0.6			
	Floor	Insulation				3.9	0.8	0.4	5.0	0.6	0.4						
		Thermal Mass															
	External Shading	Eave Extension				7.8	-1.6	0.5	10.0	-2.1	0.7						
		Awnings				5.9	0.0	0.5									
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.5	0.0	0.0						
	Infiltration	Infiltration				2.3	3.6	0.5									
270°	External Wall	Insulation	37.8	9.9	4.8	4.6	1.9	0.5	7.4	3.1	0.9	9.1	3.8	1.2	10.1	4.2	1.3
		Thermal Mass							10.1	3.7	1.3	11.6	4.4	1.5	10.8	4.4	1.4
		Surface Colour							3.1	-0.8	0.2	6.4	-1.8	0.4			
	Roof	Construction				5.2	-1.5	0.3									
		Roof Ventilation				1.3	-0.3	0.1	1.9	-0.5	0.1						
	Ceiling	Ceiling Insulation				3.4	1.1	0.4	2.7	0.9	0.3	5.5	1.5	0.6			
	Floor	Insulation				3.7	0.4	0.3	4.6	0.1	0.4						
		Thermal Mass															
	External Shading	Eave Extension				8.3	-2.0	0.5	10.3	-2.5	0.7						
		Awnings				4.6	0.0	0.4									
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.5	0.0	0.0						
	Infiltration	Infiltration				1.9	3.6	0.5									

Table 84: Apartment archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	188.5	0	2.1	15.5	0.0	0.5	26.4	0.0	1.0	32.9	0.0	1.3	36.4	0.0	1.4
		Thermal Mass							27.6	0.0	1.0	33.7	0.0	1.3	37.0	0.0	1.4
		Surface Colour							10.6	0.0	0.4	21.1	0.0	0.8			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-4.3	0.0	-0.1						
	External Shading	Eave Extension				25.8	0.0	1.0	32.7	0.0	1.3						
		Awnings				6.9	0.0	0.2									
	Ventilation	Ceiling Fans				20.7	0.0	0.7									
	Infiltration	Infiltration				45.4	0.0	1.8									
90°	External Wall	Insulation	190.2	0	2	16.7	0.0	0.6	27.6	0.0	1.0	34.4	0.0	1.3	38.1	0.0	1.5
		Thermal Mass							28.5	0.0	1.1	35.4	0.0	1.4	38.9	0.0	1.5
		Surface Colour							11.2	0.0	0.4	22.3	0.0	0.8			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-4.4	0.0	-0.1						
	External Shading	Eave Extension				26.1	0.0	1.0	32.6	0.0	1.2						
		Awnings				9.4	0.0	0.3									
	Ventilation	Ceiling Fans				20.1	0.0	0.7									
	Infiltration	Infiltration				46.6	0.0	1.9									

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	185.1	0	2.2	13.3	0.0	0.5	23.0	0.0	0.9	29.2	0.0	1.1	32.2	0.0	1.3
		Thermal Mass							24.7	0.0	0.9	30.2	0.0	1.2	32.5	0.0	1.3
		Surface Colour							9.2	0.0	0.3	18.4	0.0	0.7			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-5.3	0.0	-0.2						
	External Shading	Eave Extension				26.5	0.0	1.0	31.7	0.0	1.2						
		Awnings				10.4	0.0	0.4									
	Ventilation	Ceiling Fans				20.6	0.0	0.8									
	Infiltration	Infiltration				44.7	0.0	1.8									
270°	External Wall	Insulation	192.4	0	1.9	14.4	0.0	0.5	24.2	0.0	0.9	30.1	0.0	1.1	33.4	0.0	1.2
		Thermal Mass							26.2	0.0	0.9	31.9	0.0	1.2	34.8	0.0	1.3
		Surface Colour							9.5	0.0	0.3	19.3	0.0	0.7			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-9.1	0.0	-0.3						
	External Shading	Eave Extension				26.2	0.0	0.9	31.7	0.0	1.2						
		Awnings				8.8	0.0	0.3									
	Ventilation	Ceiling Fans				21.7	0.0	0.8									
	Infiltration	Infiltration				46.9	0.0	1.8									

Table 85: Apartment archetype climate zone 3 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
0°	External Wall	Insulation	54.5	12.9	3.5	8.4	2.7	0.6	13.8	4.5	1.1	16.7	5.5	1.4	18.4	6.1	1.6
		Thermal Mass							17.2	5.0	1.4	20.0	6.0	1.7	18.5	6.2	1.6
		Surface Colour							5.8	-1.2	0.2	10.7	-2.7	0.4			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-3.5	-1.5	-0.2						
	External Shading	Eave Extension				13.8	-4.3	0.5	17.4	-6.4	0.6						
		Awnings				5.3	0.0	0.3									
	Ventilation	Ceiling Fans				0.5	0.0	0.0	1.8	0.0	0.1						
	Infiltration	Infiltration				3.7	4.5	0.4									
90°	External Wall	Insulation	53.9	8.8	3.8	8.6	2.4	0.7	14.3	3.8	1.2	17.5	4.6	1.6	19.4	5.0	1.8
		Thermal Mass							18.2	4.4	1.6	21.2	5.1	2.0	20.0	5.2	1.8
		Surface Colour							6.2	-1.4	0.3	11.7	-3.1	0.5			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-3.5	-0.7	-0.2						
	External Shading	Eave Extension				13.8	-7.8	0.3	17.6	-9.7	0.5						
		Awnings				3.2	0.0	0.2									
	Ventilation	Ceiling Fans				0.6	0.0	0.0	2.0	0.0	0.1						
	Infiltration	Infiltration				2.9	3.6	0.4									

Orientation	Design Parameters		Base Case			Level 1 Change			Level 2 Change			Level 3 Change			Maximum Change		
			Load (MJ/m²/year)		Equivalent Star Rating	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change	Saving (MJ/m²/year)		Rating Change
			Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating		Cooling	Heating	
180°	External Wall	Insulation	50.2	7.8	4	6.6	2.2	0.6	11.0	3.6	1.0	13.3	4.3	1.3	15.0	4.8	1.5
		Thermal Mass							14.6	4.8	1.5	16.8	5.4	1.8	15.3	4.9	1.6
		Surface Colour							4.4	-1.0	0.2	8.4	-2.2	0.4			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-3.0	-0.2	-0.2						
	External Shading	Eave Extension				12.9	-5.4	0.5	15.6	-8.6	0.5						
		Awnings				6.0	0.0	0.4									
	Ventilation	Ceiling Fans				0.6	0.0	0.0	2.0	0.0	0.1						
	Infiltration	Infiltration				3.1	3.5	0.4									
270°	External Wall	Insulation	51.1	14.5	3.6	7.1	3.3	0.6	12.2	5.6	1.1	14.8	6.9	1.4	16.5	7.6	1.6
		Thermal Mass							15.9	5.9	1.4	18.3	7.2	1.7	16.7	7.7	1.6
		Surface Colour							4.5	-1.2	0.2	9.2	-2.6	0.3			
	Roof	Construction															
		Roof Ventilation															
	Ceiling	Ceiling Insulation															
	Floor	Insulation															
		Thermal Mass							-3.3	-1.7	-0.2						
	External Shading	Eave Extension				11.9	-6.4	0.3	14.4	-7.6	0.4						
		Awnings				3.0	0.0	0.2									
	Ventilation	Ceiling Fans				0.7	0.0	0.0	2.0	0.0	0.1						
	Infiltration	Infiltration				2.8	4.7	0.4									

B.III.II Peak Demand

Table 86: Detached archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	56.1	0	4	4.3	0.0	6.6	0.0	8.3	0.0	9.4	0.0
		Thermal Mass						7.1	0.0	9.2	0.0	11.1	0.0
		Surface Colour						2.4	0.0	4.4	0.0		
	Roof	Construction				7.5	0.0						
		Roof Ventilation				2.0	0.0	2.7	0.0				
	Ceiling	Ceiling Insulation				7.5	0.0			9.6	0.0		
	Floor	Insulation				-3.7	0.0	-1.0	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.6	0.0	1.6	0.0				
		Awnings				2.0	0.0						
	Ventilation	Ceiling Fans				-0.3	0.0						
	Infiltration	Infiltration				3.8	0.0						
90°	External Wall	Insulation	55.8	0	4	4.3	0.0	6.9	0.0	8.5	0.0	9.2	0.0
		Thermal Mass						7.3	0.0	9.4	0.0	11.0	0.0
		Surface Colour						2.3	0.0	4.7	0.0		
	Roof	Construction				7.4	0.0						
		Roof Ventilation				2.0	0.0	2.8	0.0				
	Ceiling	Ceiling Insulation				6.7	0.0			11.2	0.0		
	Floor	Insulation				-2.2	0.0	-0.7	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.5	0.0	1.4	0.0				
		Awnings				2.1	0.0						
	Ventilation	Ceiling Fans				-0.1	0.0						
	Infiltration	Infiltration				4.4	0.0						

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
180°	External Wall	Insulation	56	0	3.8	2.7	0.0	3.9	0.0	5.2	0.0	5.9	0.0
		Thermal Mass						4.1	0.0	6.6	0.0	8.8	0.0
		Surface Colour						2.6	0.0	5.0	0.0		
	Roof	Construction				7.7	0.0						
		Roof Ventilation				2.0	0.0	2.8	0.0				
	Ceiling	Ceiling Insulation				6.9	0.0			10.2	0.0		
	Floor	Insulation				-2.3	0.0	-1.2	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.3	0.0	-0.6	0.0				
		Awnings				1.3	0.0						
	Ventilation	Ceiling Fans				-1.3	0.0						
	Infiltration	Infiltration				4.7	0.0						
270°	External Wall	Insulation	56.5	0	3.9	4.4	0.0	3.8	0.0	8.5	0.0	9.4	0.0
		Thermal Mass						7.0	0.0	8.2	0.0	10.9	0.0
		Surface Colour						2.6	0.0	5.1	0.0		
	Roof	Construction				6.9	0.0						
		Roof Ventilation				3.2	0.0	3.6	0.0				
	Ceiling	Ceiling Insulation				6.1	0.0			8.0	0.0		
	Floor	Insulation				-1.7	0.0	-1.4	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.2	0.0	0.6	0.0				
		Awnings				0.6	0.0						
	Ventilation	Ceiling Fans				-1.1	0.0						
	Infiltration	Infiltration				1.7	0.0						

Table 87: Detached archetype climate zone 3 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	62.2	41.4	4.7	5.5	6.1	8.8	10.2	13.4	12.6	17.5	14.0
		Thermal Mass						14.9	13.5	19.4	16.1	19.7	17.8
		Surface Colour						2.2	-0.7	4.2	-1.4		
	Roof	Construction				9.0	-0.2						
		Roof Ventilation				2.4	0.0	3.4	0.0				
	Ceiling	Ceiling Insulation				8.8	6.3			17.7	9.1		
	Floor	Insulation				1.2	0.6	-5.2	0.5				
		Thermal Mass											
	External Shading	Eave Extension				0.5	-0.1	1.8	-0.2				
		Awnings				2.6	0.0						
	Ventilation	Ceiling Fans				0.1	0.0	0.1	0.0				
	Infiltration	Infiltration				4.9	7.5						
90°	External Wall	Insulation	60.8	39.1	4.7	5.2	6.2	8.8	10.1	13.4	12.5	15.8	13.8
		Thermal Mass						15.6	13.2	17.4	15.5	20.7	16.9
		Surface Colour						1.7	-1.1	3.8	-2.0		
	Roof	Construction				15.6	-0.4						
		Roof Ventilation				2.3	-0.1	3.5	-0.1				
	Ceiling	Ceiling Insulation				8.0	6.9			16.5	9.8		
	Floor	Insulation				1.6	1.3	2.5	0.8				
		Thermal Mass											
	External Shading	Eave Extension				0.0	-0.1	1.2	-0.5				
		Awnings				2.3	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				2.1	8.5						

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
180°	External Wall	Insulation	62.1	41.6	4.5	5.7	6.2	15.5	10.4	13.8	12.9	21.0	14.2
		Thermal Mass						16.2	13.7	14.6	16.6	19.5	18.3
		Surface Colour						2.0	-0.7	5.1	-1.4		
	Roof	Construction				8.4	-0.3						
		Roof Ventilation				3.1	0.0	2.9	0.0				
	Ceiling	Ceiling Insulation				10.6	6.5			13.8	9.2		
	Floor	Insulation				5.4	0.8	-2.1	0.8				
		Thermal Mass											
	External Shading	Eave Extension				0.1	-0.2	0.2	-0.6				
		Awnings				2.0	0.0						
	Ventilation	Ceiling Fans				-0.1	0.0	-0.1	0.0				
	Infiltration	Infiltration				1.8	8.0						
270°	External Wall	Insulation	64.6	40.8	4.5	8.5	6.1	12.7	10.2	14.9	12.7	21.5	14.1
		Thermal Mass						17.4	13.6	19.8	16.3	20.5	17.8
		Surface Colour						4.9	-0.8	8.0	-1.5		
	Roof	Construction				11.2	-0.3						
		Roof Ventilation				4.5	0.0	5.4	0.0				
	Ceiling	Ceiling Insulation				8.8	6.4			12.4	9.2		
	Floor	Insulation				-1.2	0.9	-4.7	0.6				
		Thermal Mass											
	External Shading	Eave Extension				0.1	-0.1	0.4	-0.4				
		Awnings				0.5	0.0						
	Ventilation	Ceiling Fans				-0.2	0.0	-0.2	0.0				
	Infiltration	Infiltration				6.5	7.9						

Table 88: Attached archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	44.5	0	4	1.7	0.0	3.0	0.0	3.5	0.0	4.3	0.0
		Thermal Mass						3.7	0.0	6.7	0.0	4.9	0.0
		Surface Colour						1.1	0.0	2.4	0.0		
	Roof	Construction				6.1	0.0						
		Roof Ventilation				3.1	0.0	4.2	0.0				
	Ceiling	Ceiling Insulation				5.0	0.0	4.8	0.0	7.0	0.0		
	Floor	Insulation				0.3	0.0	-0.5	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.9	0.0	0.9	0.0				
		Awnings				4.6	0.0						
	Ventilation	Ceiling Fans				-0.2	0.0	-0.2	0.0				
	Infiltration	Infiltration				4.1	0.0						
90°	External Wall	Insulation	47.8	0	4	2.9	0.0	10.5	0.0	9.7	0.0	8.8	0.0
		Thermal Mass						7.8	0.0	11.2	0.0	10.3	0.0
		Surface Colour						1.4	0.0	8.9	0.0		
	Roof	Construction				3.3	0.0						
		Roof Ventilation				1.8	0.0	2.1	0.0				
	Ceiling	Ceiling Insulation				2.0	0.0	2.0	0.0	3.8	0.0		
	Floor	Insulation				6.1	0.0	7.0	0.0				
		Thermal Mass											
	External Shading	Eave Extension				0.5	0.0	7.6	0.0				
		Awnings				-0.4	0.0						
	Ventilation	Ceiling Fans				-0.5	0.0	-0.5	0.0				
	Infiltration	Infiltration				10.6	0.0						

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
180°	External Wall	Insulation	49.5	0	4	1.9	0.0	2.4	0.0	2.7	0.0	1.0	0.0
		Thermal Mass						2.3	0.0	7.7	0.0	4.4	0.0
		Surface Colour						-0.5	0.0	1.7	0.0		
	Roof	Construction				1.4	0.0						
		Roof Ventilation				-0.4	0.0	-1.0	0.0				
	Ceiling	Ceiling Insulation				0.4	0.0	0.4	0.0	1.8	0.0		
	Floor	Insulation				-2.8	0.0	-4.1	0.0				
		Thermal Mass											
	External Shading	Eave Extension				3.3	0.0	4.1	0.0				
		Awnings				1.3	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				3.9	0.0						
270°	External Wall	Insulation	48	0	3.8	1.4	0.0	4.4	0.0	5.9	0.0	2.9	0.0
		Thermal Mass						4.3	0.0	6.3	0.0	5.6	0.0
		Surface Colour						0.5	0.0	1.5	0.0		
	Roof	Construction				4.3	0.0						
		Roof Ventilation				1.6	0.0	2.0	0.0				
	Ceiling	Ceiling Insulation				2.2	0.0	2.9	0.0	4.3	0.0		
	Floor	Insulation				-2.3	0.0	-2.8	0.0				
		Thermal Mass											
	External Shading	Eave Extension				1.9	0.0	2.5	0.0				
		Awnings				1.2	0.0						
	Ventilation	Ceiling Fans				1.5	0.0	1.5	0.0				
	Infiltration	Infiltration				3.7	0.0						

Table 89: Attached archetype climate zone 3 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	47.7	28.1	4.7	1.7	2.9	2.2	4.4	0.4	5.3	1.4	5.8
		Thermal Mass						1.9	5.8	0.6	7.0	4.2	7.3
		Surface Colour						1.2	-0.2	1.3	-0.6		
	Roof	Construction				5.0	0.0						
		Roof Ventilation				-1.4	0.0	-1.3	0.0				
	Ceiling	Ceiling Insulation				4.6	1.8	5.0	1.6	6.5	2.7		
	Floor	Insulation				-5.5	2.6	-5.5	2.1				
		Thermal Mass											
	External Shading	Eave Extension				1.6	-1.0	0.6	-2.1				
		Awnings				-1.1	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.1	0.0				
	Infiltration	Infiltration				-2.2	5.9						
90°	External Wall	Insulation	47.7	23.2	4.8	-0.1	3.2	3.4	5.2	1.8	6.4	2.4	7.2
		Thermal Mass						4.2	7.2	1.3	8.8	4.4	9.3
		Surface Colour						-0.9	-0.4	0.0	-0.8		
	Roof	Construction				6.6	-0.1						
		Roof Ventilation				1.0	0.0	2.3	0.0				
	Ceiling	Ceiling Insulation				4.0	2.0	1.4	1.7	7.3	3.1		
	Floor	Insulation				-1.9	-0.4	-6.1	-2.1				
		Thermal Mass											
	External Shading	Eave Extension				-0.6	-3.2	-0.5	-3.8				
		Awnings				0.7	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				-1.5	6.1						

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
180°	External Wall	Insulation	58.3	25.5	4.7	2.2	2.5	3.6	4.0	7.0	4.8	8.6	5.3
		Thermal Mass						7.4	4.7	10.2	5.6	10.5	6.7
		Surface Colour						1.3	-0.4	4.6	-0.6		
	Roof	Construction				5.5	0.0						
		Roof Ventilation				2.2	0.0	0.8	0.0				
	Ceiling	Ceiling Insulation				4.1	1.7	3.5	1.5	5.0	2.6		
	Floor	Insulation				-2.0	1.0	1.2	-0.4				
		Thermal Mass											
	External Shading	Eave Extension				5.2	-0.7	6.5	-1.2				
		Awnings				5.1	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.1	0.0				
	Infiltration	Infiltration				3.7	5.3						
270°	External Wall	Insulation	51.2	23.2	4.8	0.0	2.7	4.2	4.5	6.6	5.6	2.9	6.1
		Thermal Mass						5.1	5.2	9.2	6.3	11.2	7.3
		Surface Colour						0.5	-0.2	-1.0	-0.5		
	Roof	Construction				1.3	0.1						
		Roof Ventilation				-0.9	0.1	0.7	0.1				
	Ceiling	Ceiling Insulation				0.6	1.6	0.4	1.4	8.3	2.4		
	Floor	Insulation				3.7	0.6	4.6	-0.7				
		Thermal Mass											
	External Shading	Eave Extension				3.0	-0.7	1.9	-1.0				
		Awnings				3.7	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.3	0.0				
	Infiltration	Infiltration				0.0	4.3						

Table 90: Apartment archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	32.1	0	2.1	1.6	0.0	2.6	0.0	4.0	0.0	3.2	0.0
		Thermal Mass						2.9	0.0	3.6	0.0	4.2	0.0
		Surface Colour						0.6	0.0	1.6	0.0		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-0.1	0.0				
	External Shading	Eave Extension				3.8	0.0	4.8	0.0				
		Awnings				2.7	0.0						
	Ventilation	Ceiling Fans				-0.4	0.0						
	Infiltration	Infiltration				1.7	0.0						
90°	External Wall	Insulation	29.5	0	2	0.2	0.0	-0.4	0.0	-1.4	0.0	-1.4	0.0
		Thermal Mass						-2.4	0.0	-1.4	0.0	0.0	0.0
		Surface Colour						-1.4	0.0	-1.3	0.0		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-0.1	0.0				
	External Shading	Eave Extension				-1.1	0.0	-0.3	0.0				
		Awnings				-0.6	0.0						
	Ventilation	Ceiling Fans				-1.3	0.0						
	Infiltration	Infiltration				0.7	0.0						

Orientation	Design Parameters		Base Case – Peak Load (kW) Cooling	Base Case – Peak Load (kW) Heating	Base Case – Equivalent Star Rating	Level 1 Change – Peak Load Saving (kW) Cooling	Level 1 Change – Peak Load Saving (kW) Heating	Level 2 Change – Peak Load Saving (kW) Cooling	Level 2 Change – Peak Load Saving (kW) Heating	Level 3 Change – Peak Load Saving (kW) Cooling	Level 3 Change – Peak Load Saving (kW) Heating	Maximum Change – Peak Load Saving (kW) Cooling	Maximum Change – Peak Load Saving (kW) Heating
180°	External Wall	Insulation	30.4	0	2.2	1.8	0.0	2.6	0.0	1.9	0.0	3.5	0.0
		Thermal Mass						2.6	0.0	2.8	0.0	3.8	0.0
		Surface Colour						0.9	0.0	1.3	0.0		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						0.8	0.0				
	External Shading	Eave Extension				2.1	0.0	2.7	0.0				
		Awnings				1.6	0.0						
	Ventilation	Ceiling Fans				0.5	0.0						
	Infiltration	Infiltration				2.8	0.0						
270°	External Wall	Insulation	31.5	0	1.9	1.7	0.0	2.9	0.0	2.0	0.0	2.1	0.0
		Thermal Mass						0.9	0.0	1.3	0.0	2.4	0.0
		Surface Colour						0.8	0.0	1.4	0.0		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-1.2	0.0				
	External Shading	Eave Extension				2.2	0.0	3.3	0.0				
		Awnings				0.7	0.0						
	Ventilation	Ceiling Fans				-0.4	0.0						
	Infiltration	Infiltration				0.9	0.0						

Table 91: Apartment archetype climate zone 1 raw modelling results.

Orientation	Design Parameters		Base Case			Level 1 Change		Level 2 Change		Level 3 Change		Maximum Change	
			Peak Load (kW)		Equivalent Star Rating	Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)		Peak Load Saving (kW)	
			Cooling	Heating		Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating
0°	External Wall	Insulation	41.1	20.2	3.5	3.1	2.6	8.2	5.2	5.6	6.4	9.6	7.1
		Thermal Mass						7.3	6.5	7.7	7.7	10.8	8.0
		Surface Colour						1.4	-0.5	2.4	-0.6		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-0.4	0.7				
	External Shading	Eave Extension				4.3	-2.1	5.0	-3.1				
		Awnings				5.7	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				4.3	3.7						
90°	External Wall	Insulation	34	18.4	3.8	2.4	3.1	3.3	5.4	3.4	6.7	3.3	7.6
		Thermal Mass						1.1	6.8	1.5	7.8	3.9	8.7
		Surface Colour						1.6	-0.5	2.7	-0.6		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-0.3	0.2				
	External Shading	Eave Extension				2.5	-2.1	3.1	-2.4				
		Awnings				-0.3	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				1.2	4.7						

Orientation	Design Parameters		Base Case Peak Load (kW) Cooling	Base Case Peak Load (kW) Heating	Base Case Equivalent Star Rating	Level 1 Change Peak Load Saving (kW) Cooling	Level 1 Change Peak Load Saving (kW) Heating	Level 2 Change Peak Load Saving (kW) Cooling	Level 2 Change Peak Load Saving (kW) Heating	Level 3 Change Peak Load Saving (kW) Cooling	Level 3 Change Peak Load Saving (kW) Heating	Maximum Change Peak Load Saving (kW) Cooling	Maximum Change Peak Load Saving (kW) Heating
180°	External Wall	Insulation	37.1	17.3	4	5.5	3.6	7.4	5.9	5.9	7.1	6.0	7.6
		Thermal Mass						3.6	8.5	3.9	9.5	9.0	8.7
		Surface Colour						3.8	0.0	4.6	-0.9		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-1.5	0.8				
	External Shading	Eave Extension				6.8	-2.2	7.2	-3.0				
		Awnings				5.7	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				3.9	5.2						
270°	External Wall	Insulation	36.6	22.1	3.6	2.7	3.4	3.3	5.8	4.4	7.3	3.9	8.2
		Thermal Mass						2.5	6.9	3.6	8.6	5.6	9.6
		Surface Colour						1.1	-0.2	1.6	-0.4		
	Roof	Construction											
		Roof Ventilation											
	Ceiling	Ceiling Insulation											
	Floor	Insulation											
		Thermal Mass						-0.1	0.2				
	External Shading	Eave Extension				1.7	-0.7	3.4	-1.0				
		Awnings				0.5	0.0						
	Ventilation	Ceiling Fans				0.0	0.0	0.0	0.0				
	Infiltration	Infiltration				1.5	4.3						

B.IV Single Dimensional BCR Modelling Results

The following sections provide a summary of the inputs and economic outcomes for each of the single dimensional scenarios analysed including an outline of capital costs for implementation, benefit cost analysis results, and subsequent recommendations. Capital costs refer to the actual costs of physical works, of which the incremental cost over the base case is used for the economic analysis. Network adjustments are based on an overall network (rather than local dwelling) impact on required network sizing based on the peak demand to be serviced. HVAC adjustment costs are derived from the reduction in HVAC unit capacity required to service the peak cooling or heating load (whichever is higher).

B.IV.I Infiltration

Capital Costs:

The capital costs associated with improved infiltration control are based on removing wall vents that are included as standard in the base case and undertaking a blower door test and sealing exhaust fans. Costs are based on available retail costs as follows:

Table 92: Single dimensional measure description and capital cost.

Measure Level	Measure Description	Capital Cost
Base case	Wall vent	$24
Level 1	Exhaust Fan	$35
	Pressure test	$800

Benefit Cost Analysis:

Table 93: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 7.2	Base case	9 wall vents, 2 unsealed fans	$216		$216	5,672	4.39													
	Level 1	No wall vents, 2 sealed fans	$905	-$230	$675	4,636	3.88	-$496	$5,194	$6,009	$6,626	$7,211	negative cost	negative cost	negative cost	negative cost	11.32	13.09	14.44	15.71
Att 3 A 7.2	Base case	9 wall vents, 2 unsealed fans	$216		$216	1,879	4.74													
	Level 1	No wall vents, 2 sealed fans	$905	$ -	$905	1,672	4.74	$ 1	$1,039	$1,202	$1,325	$1,442	1.50	1.74	1.92	2.09	1.51	1.74	1.92	2.09
Det 1 A 7.2	Base case	11 wall vents, 3 unsealed fans	$264		$264	8,023	5.19													
	Level 1	No wall vents, 3 sealed fans	$1,010	-$230	$780	6,651	4.85	-$328	$6,877	$7,956	$8,773	$9,548	36.64	42.38	45.24	48.47	13.33	15.42	17.00	18.50
Det 3 A 7.2	Base case	11 wall vents, 3 unsealed fans	$264		$264	2,727	5.78													
	Level 1	No wall vents, 3 sealed fans	$1,010	-$230	$780	2,456	5.42	-$341	$1,361	$1,574	$1,736	$1,889	7.75	8.97	9.54	10.21	2.64	3.05	3.36	3.66
Apa 1 A 7.2	Base case	7 wall vents, 2 unsealed fans	$168		$168	4,090	2.86													
	Level 1	No wall vents, 2 sealed fans	$905	$ -	$905	3,097	2.72	-$135	$4,978	$5,759	$6,351	$6,912	8.27	9.57	10.50	11.41	6.75	7.81	8.62	9.38
Apa 3 A 7.2	Base case	7 wall vents, 2 unsealed fans	$168		$168	1,372	3.45													
	Level 1	No wall vents, 2 sealed fans	$905	$ -	$905	1,217	3.20	-$241	$780	$902	$995	$1,083	1.57	1.82	1.99	2.15	1.06	1.22	1.35	1.47

B.IV.II Ceiling Fans

Capital Costs:

Fans used were electrical ceiling fans of 900mm, 1200mm and 1400mm diameter. Prices obtained for the various sizes include:

HPM 900mm 55W celling fan: $66 each

HPM 1200mm 65W celling fan: $85 each

HPM 1400mm 65W celling fan: $95 each

Benefit Cost Analysis:

Table 94: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 7.1	Base case	Fans Living & Bedrooms	$637		$637	5,672	4.39													
	Level 1	Fans Living & Bedrooms, Kitchen, Study	$769	$ -	$769	5,576	4.38	-$19	$483	$559	$617	$671	4.26	4.93	5.42	5.89	3.66	4.24	4.67	5.09
Att 3 A 7.1	Base case	Fans Living & Bedrooms	$637		$637	1,879	4.74													
	Level 1	Fans Living & Bedrooms, Kitchen	$703	$ -	$703	1,879	4.74	$ -	$ -	$ -	$ -	$ -	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Level 2	Fans Living & Bedrooms, Kitchen, Study	$769	$ -	$769	1,866	4.73	-$11	$66	$76	$84	$91	0.54	0.63	0.69	0.75	0.50	0.57	0.63	0.69
Det 1 A 7.1	Base case	Fans Living & Bedrooms	$637		$637	8,023	5.19													
	Level 1	Fans Living & Bedrooms, Kitchen, Study	$769	$ -	$769	7,881	5.26	$61	$711	$822	$907	$987	3.68	4.26	4.72	5.16	5.39	6.23	6.87	7.48
Det 3 A 7.1	Base case	Fans Living & Bedrooms	$637		$637	2,727	5.78													
	Level 1	Fans Living & Bedrooms, Kitchen, Study	$769	$ -	$769	2,717	5.78	$ 6	$52	$61	$67	$73	0.38	0.44	0.48	0.53	0.40	0.46	0.51	0.55
Apa 1 A 7.1	Base case	No ceiling fans	$ -		$ -	4,090	2.86													
	Level 1	Fans Living, Bed 1 & 2, Kitchen	$571	$ -	$571	3,739	2.90	$35	$1,758	$2,034	$2,243	$2,441	2.90	3.36	3.71	4.04	3.08	3.56	3.93	4.27
Apa 3 A 7.1	Base case	No ceiling fans	$ -		$ -	1,372	3.45													

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	Level 1	Fans Living, Kitchen	$295	$ -	$295	1,361	3.45	$ -	$55	$64	$70	$77	0.19	0.22	0.24	0.26	0.19	0.22	0.24	0.26
	Level 2	Fans Living, Bed 1 & 2, Kitchen	$571	$ -	$571	1,339	3.45	-$ 0	$169	$195	$215	$234	0.30	0.34	0.38	0.41	0.30	0.34	0.38	0.41

B.IV.III Wall Insulation

Capital Costs:

The following underlying cost figures were used in the assessment of insulation, based on available retail costs for insulation:

- Silversark reflective foil (average price $1.85/m²)
- Expanded polystyrene batts used Foamex EPS Expanded Polystyrene Styroboard SL (price for coverage at required thicknesses estimated at $0.12/mm/m² based average costs of 4 products with differing thickness and batt coverage).
- Glass fibre batts used Bradford Gold Wall Batts (price for coverage at required thicknesses estimated at $0.04/mm/m² based average costs of 4 products with differing thickness and batt coverage).
- Polyurethane rigid foamed aged Knauf XPS Multi-Use Foam Board at (average price at $0.40/mm/m² based average costs of 4 products with differing thickness and batt coverage).
- Polyester batts used Bradford Polymax Wall Batts (price for coverage at required thicknesses estimated at $0.09/mm/m² based average costs of 8 products with differing thickness and batt coverage).

No learning rate has been applied to either performance or cost. The modelled costs for each insulation construction (for all archetypes and climate zones) were as follows:

Table 95: Single dimensional measure description and capital cost.

Measure Description	Capital Cost ($/m²)
R0.0	$0.00
R0.0 foil	$1.85
R1.6	$4.67
R2.8	$16.03
R4.5	$36.83

Benefit Cost Analysis:

Table 96: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 2.1	Base case	R0.0	$ -		$ -	5,672	4.39													
	Level 1	R0.0 foil	$ 131	$ -	$ 131	5,368	4.21	-$ 176	$ 1,523	$ 1,762	$ 1,943	$ 2,115	negative cost	negative cost	negative cost	negative cost	11.59	13.40	14.78	16.09
	Level 2	R1.6	$ 822	-$ 230	$ 592	5,169	3.92	-$ 455	$ 2,523	$ 2,918	$ 3,218	$ 3,502	18.49	21.39	22.19	23.46	4.26	4.93	5.44	5.92
	Level 3	R2.8	$ 1,628	-$ 230	$ 1,398	5,047	3.89	-$ 486	$ 3,132	$ 3,624	$ 3,996	$ 4,349	3.43	3.97	4.34	4.70	2.24	2.59	2.86	3.11
	Level 4	R4.5	$ 3,105	-$ 230	$ 2,875	4,989	4.00	-$ 378	$ 3,423	$ 3,960	$ 4,367	$ 4,753	1.37	1.59	1.74	1.90	1.19	1.38	1.52	1.65
Att 3 A 2.1	Base case	R0.0	$ -		$ -	1,879	4.74													
	Level 1	R0.0 foil	$ 131	$ -	$ 131	1,652	4.66	-$ 85	$ 1,136	$ 1,314	$ 1,449	$ 1,577	24.30	28.12	29.97	32.10	8.64	9.99	11.02	11.99
	Level 2	R1.6	$ 822	$ -	$ 822	1,511	4.43	-$ 300	$ 1,842	$ 2,131	$ 2,350	$ 2,558	3.53	4.09	4.46	4.83	2.24	2.59	2.86	3.11
	Level 3	R2.8	$ 1,628	-$ 230	$ 1,398	1,429	4.38	-$ 354	$ 2,256	$ 2,610	$ 2,878	$ 3,133	2.16	2.50	2.74	2.97	1.61	1.87	2.06	2.24
	Level 4	R4.5	$ 3,105	-$ 230	$ 2,875	1,378	4.39	-$ 342	$ 2,508	$ 2,901	$ 3,200	$ 3,482	0.99	1.15	1.26	1.37	0.87	1.01	1.11	1.21
Det 1 A 2.1	Base case	R0.0	$ -		$ -	8,023	5.19													
	Level 1	R0.0 foil	$ 286	-$ 230	$ 56	7,320	4.83	-$ 349	$ 3,524	$ 4,077	$ 4,496	$ 4,892	negative cost	negative cost	negative cost	negative cost	62.74	72.58	80.04	87.11
	Level 2	R1.6	$ 1,772	-$ 230	$ 1,542	6,853	4.70	-$ 472	$ 5,864	$ 6,784	$ 7,480	$ 8,141	5.48	6.34	6.94	7.52	3.80	4.40	4.85	5.28
	Level 3	R2.8	$ 3,528	-$ 460	$ 3,068	6,576	4.49	-$ 681	$ 7,255	$ 8,393	$ 9,255	$10,072	3.04	3.52	3.86	4.19	2.36	2.74	3.02	3.28
	Level 4	R4.5	$ 6,742	-$ 460	$ 6,282	6,413	4.41	-$ 758	$ 8,071	$ 9,337	$10,296	$11,205	1.46	1.69	1.86	2.02	1.28	1.49	1.64	1.78
Det 3 A 2.1	Base case	R0.0	$ -		$ -	2,727	5.78													
	Level 1	R0.0 foil	$ 286	-$ 230	$ 56	2,194	5.20	-$ 557	$ 2,673	$ 3,092	$ 3,410	$ 3,711	negative cost	negative cost	negative cost	negative cost	47.59	55.06	60.71	66.08
	Level 2	R1.6	$ 1,772	-$ 690	$ 1,082	1,867	4.71	-$ 1,024	$ 4,312	$ 4,988	$ 5,500	$ 5,986	74.19	85.83	70.98	68.77	3.99	4.61	5.08	5.53
	Level 3	R2.8	$ 3,528	-$ 690	$ 2,838	1,684	4.49	-$ 1,238	$ 5,231	$ 6,052	$ 6,673	$ 7,263	3.27	3.78	4.11	4.44	1.84	2.13	2.35	2.56
	Level 4	R4.5	$ 6,742	-$ 1,150	$ 5,592	1,563	4.02	-$ 1,692	$ 5,834	$ 6,750	$ 7,443	$ 8,100	1.50	1.73	1.89	2.05	1.04	1.21	1.33	1.45

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Apa 1 A 2.1	Base case	R0.0	$ -		$ -	4,090	2.86													
	Level 1	R0.0 foil	$ 150	$ -	$ 150	3,766	2.74	-$ 117	$ 1,622	$ 1,877	$ 2,070	$ 2,252	49.63	57.41	59.28	62.56	10.82	12.51	13.80	15.02
	Level 2	R1.6	$ 938	$ -	$ 938	3,542	2.68	-$ 171	$ 2,744	$ 3,174	$ 3,500	$ 3,809	3.58	4.14	4.54	4.93	2.92	3.38	3.73	4.06
	Level 3	R2.8	$ 1,859	$ -	$ 1,859	3,405	2.71	-$ 143	$ 3,434	$ 3,972	$ 4,380	$ 4,767	2.00	2.31	2.55	2.77	1.85	2.14	2.36	2.56
	Level 4	R4.5	$ 3,544	$ -	$ 3,544	3,332	2.69	-$ 165	$ 3,800	$ 4,396	$ 4,848	$ 5,276	1.12	1.30	1.43	1.56	1.07	1.24	1.37	1.49
Apa 3 A 2.1	Base case	R0.0	$ -		$ -	1,372	3.45													
	Level 1	R0.0 foil	$ 150	$ -	$ 150	1,148	3.13	-$ 307	$ 1,122	$ 1,298	$ 1,431	$ 1,557	negative cost	negative cost	negative cost	negative cost	7.48	8.65	9.54	10.38
	Level 2	R1.6	$ 938	-$ 230	$ 708	1,000	2.93	-$ 495	$ 1,866	$ 2,158	$ 2,380	$ 2,590	8.73	10.10	10.67	11.38	2.63	3.05	3.36	3.66
	Level 3	R2.8	$ 1,859	-$ 230	$ 1,629	920	3.00	-$ 430	$ 2,269	$ 2,625	$ 2,894	$ 3,150	1.89	2.19	2.40	2.60	1.39	1.61	1.78	1.93
	Level 4	R4.5	$ 3,544	-$ 230	$ 3,314	870	2.92	-$ 510	$ 2,516	$ 2,910	$ 3,209	$ 3,493	0.90	1.04	1.14	1.24	0.76	0.88	0.97	1.05

B.IV.IV Wall Colour

Capital Costs:

Costs were assumed to be the same for all external render colours. :

Table 97: Single dimensional measure description and capital cost.

Scenarios	Measure Description
Base Case	External render, 80%
Level 2	50%, light green external render
Level 3	30%, light cream

Benefit Cost Analysis:

Table 98: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	5,672	4.39													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	5,446	4.34	-$ 57	$ 1,132	$ 1,310	$ 1,444	$ 1,572	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	5,219	4.06	-$ 324	$ 2,273	$ 2,630	$ 2,900	$ 3,156	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Att 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	1,879	4.74													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	1,790	4.70	-$ 46	$ 447	$ 517	$ 570	$ 621	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	1,705	4.63	-$ 110	$ 871	$ 1,007	$ 1,111	$ 1,209	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	8,023	5.19													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	7,526	4.96	-$ 222	$ 2,490	$ 2,881	$ 3,177	$ 3,458	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	7,038	4.75	-$ 427	$ 4,935	$ 5,710	$ 6,296	$ 6,852	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	2,727	5.78													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	2,531	5.53	-$ 241	$ 985	$ 1,139	$ 1,256	$ 1,367	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	2,373	5.29	-$ 469	$ 1,778	$ 2,057	$ 2,268	$ 2,468	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	4,090	2.86													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	3,870	2.84	-$ 19	$ 1,101	$ 1,274	$ 1,405	$ 1,529	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	3,651	2.79	-$ 68	$ 2,201	$ 2,547	$ 2,808	$ 3,056	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	1,372	3.45													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	1,285	3.26	-$ 179	$ 438	$ 507	$ 559	$ 608	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	1,213	3.19	-$ 252	$ 800	$ 925	$ 1,020	$ 1,110	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost

B.IV.V Roof Insulation

Capital Costs:

The following cost figures were used in the assessment of insulation, based on available retail costs for insulation.

Expanded polystyrene batts used Foamex EPS Expanded Polystyrene Styroboard SL (price for coverage at required thicknesses estimated at $0.12/mm/m² based average costs of 4 products with differing thickness and batt coverage)

Loose fill blown in cellulose (price for coverage estimated at $0.12/mm/m² based on $33 per bag that provides 6.5m² coverage at 100mm thickness plus $1,500 for machine blown in installation)

Glass fibre batts used Bradford Polymax Ceiling Batts (price for coverage at required thicknesses estimated at $0.04/mm/m² based average costs of 8 products with differing thickness and batt coverage)

No learning rate has been applied to either performance or cost. The modelled costs for each insulation construction were as follows:

Table. Per m² insulation costs used for the analysis

Table 99: Single dimensional measure description and capital cost.

Attached & Detached	
All zones	
R2.02	$11.43
R4.52	$16.61
R6.7	$21.68
R8.0	$23.71

Benefit Cost Analysis:

Table 100: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 3.3	Base case	R2.02	$ 728		$ 728	5,672	4.39													
	Level 1	R4.52	$ 1,058	$ -	$ 1,058	5,427	4.17	-$ 217	$ 1,227	$ 1,420	$ 1,565	$ 1,704	10.82	12.52	13.33	14.26	3.72	4.30	4.74	5.16
	Level 2	R6.7	$ 1,381	$ -	$ 1,381	5,519	4.16	-$ 224	$ 768	$ 888	$ 979	$ 1,066	1.79	2.07	2.26	2.45	1.18	1.36	1.50	1.63
	Level 3	R8.0	$ 1,511	-$ 230	$ 1,281	5,327	4.01	-$ 374	$ 1,728	$ 1,999	$ 2,204	$ 2,399	9.64	11.16	11.83	12.64	3.13	3.62	3.99	4.34
Att 3 A 3.3	Base case	R2.02	$ 728		$ 728	1,879	4.74													
	Level 1	R4.52	$ 1,058	$ -	$ 1,058	1,687	4.44	-$ 297	$ 959	$ 1,110	$ 1,224	$ 1,332	28.81	33.33	31.45	31.95	2.91	3.36	3.71	4.04
	Level 2	R6.7	$ 1,381	$ -	$ 1,381	1,723	4.50	-$ 231	$ 781	$ 904	$ 996	$ 1,084	1.85	2.14	2.33	2.53	1.20	1.38	1.52	1.66
	Level 3	R8.0	$ 1,511	-$ 230	$ 1,281	1,593	4.12	-$ 604	$ 1,433	$ 1,658	$ 1,828	$ 1,989	negative cost	negative cost	negative cost	negative cost	2.59	3.00	3.31	3.60
Det 1 A 3.3	Base case	R2.02	$ 2,177		$ 2,177	8,023	5.19													
	Level 1	R4.52	$ 3,164	-$ 460	$ 2,704	6,855	4.51	-$ 663	$ 5,855	$ 6,774	$ 7,470	$ 8,129	negative cost	negative cost	negative cost	negative cost	11.12	12.87	14.19	15.44
	Level 2	R8.0	$ 4,131	-$ 460	$ 3,671	6,667	4.27	-$ 888	$ 6,795	$ 7,861	$ 8,669	$ 9,434	11.22	12.98	13.92	14.95	4.55	5.26	5.80	6.32
Det 3 A 3.3	Base case	R2.02	$ 2,177		$ 2,177	2,727	5.78													
	Level 1	R4.52	$ 3,164	-$ 690	$ 2,474	1,798	4.68	-$ 1,052	$ 4,657	$ 5,388	$ 5,941	$ 6,466	negative cost	negative cost	negative cost	negative cost	15.71	18.17	20.04	21.81
	Level 2	R8.0	$ 4,131	-$ 920	$ 3,211	1,648	4.24	-$ 1,481	$ 5,409	$ 6,257	$ 6,900	$ 7,509	negative cost	negative cost	negative cost	negative cost	5.23	6.05	6.68	7.26

B.IV.VI Roof Colour

Capital Costs:

The following costs were used to determine the cost benefit ratio:

Table 101: Single dimensional measure description and capital cost.

Scenarios	Measure Description	Attached	Detached
Base Case	Roof tiles, 82%	$ 153.32	$131.58
Level 1	Steel deck 23%, white	$ 125.00	$125.66

No learning rate has been applied to either performance or cost.

Benefit Cost Analysis:

Table 102: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	5,672	4.39													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	5,446	4.34	-$ 57	$ 1,132	$ 1,310	$ 1,444	$ 1,572	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	5,219	4.06	-$ 324	$ 2,273	$ 2,630	$ 2,900	$ 3,156	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Att 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	1,879	4.74													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	1,790	4.70	-$ 46	$ 447	$ 517	$ 570	$ 621	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	1,705	4.63	-$ 110	$ 871	$ 1,007	$ 1,111	$ 1,209	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	8,023	5.19													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	7,526	4.96	-$ 222	$ 2,490	$ 2,881	$ 3,177	$ 3,458	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	7,038	4.75	-$ 427	$ 4,935	$ 5,710	$ 6,296	$ 6,852	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	2,727	5.78													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	2,531	5.53	-$ 241	$ 985	$ 1,139	$ 1,256	$ 1,367	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	-$ 230	-$ 230	2,373	5.29	-$ 469	$ 1,778	$ 2,057	$ 2,268	$ 2,468	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 1 A 2.2	Base case	Dark SA=0.8	$ -		$ -	4,090	2.86													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	3,870	2.84	-$ 19	$ 1,101	$ 1,274	$ 1,405	$ 1,529	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	3,651	2.79	-$ 68	$ 2,201	$ 2,547	$ 2,808	$ 3,056	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 3 A 2.2	Base case	Dark SA=0.8	$ -		$ -	1,372	3.45													
	Level 2	Medium SA=0.55	$ -	$ -	$ -	1,285	3.26	-$ 179	$ 438	$ 507	$ 559	$ 608	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Level 3	Light SA=0.3	$ -	$ -	$ -	1,213	3.19	-$ 252	$ 800	$ 925	$ 1,020	$ 1,110	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost

B.IV.VII Roof Ventilation

Capital Costs:

The capital costs for roof ventilation were as follows:

- Roof ventilators used are the 300mm CRS Edmonds Windmaster natural roof vents ($120 each).
- The eave vents are Haron 400mm x 200mm Aluminium vents ($21 – 2 pack).
- Installation labour of $160 for every 2 ventilators has been allowed for.

Benefit Cost Analysis:

Table 103: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 3.2	Base case	No vents	$ -		$ -	5,672	4.39													
	Level 1	2 ventilators, 4 eave vents	$ 442	$ -	$ 442	5,547	4.26	-$ 134	$ 625	$ 723	$ 798	$ 868	2.03	2.35	2.57	2.79	1.41	1.64	1.80	1.96
	Level 2	4 ventilators, 8 eave vents	$ 884	$ -	$ 884	5,500	4.23	-$ 162	$ 861	$ 996	$ 1,098	$ 1,195	1.19	1.38	1.51	1.64	0.97	1.13	1.24	1.35
Att 3 A 3.2	Base case	No vents	$ -		$ -	1,879	4.74													
	Level 1	2 ventilators, 4 eave vents	$ 442	$ -	$ 442	1,828	4.72	-$ 21	$ 255	$ 295	$ 325	$ 354	0.60	0.70	0.77	0.84	0.58	0.67	0.73	0.80
	Level 2	4 ventilators, 8 eave vents	$ 884	$ -	$ 884	1,806	4.68	-$ 58	$ 363	$ 420	$ 463	$ 504	0.44	0.51	0.56	0.61	0.41	0.47	0.52	0.57
Det 1 A 3.2	Base case	No vents	$ -		$ -	8,023	5.19													
	Level 1	4 ventilators, 8 eave vents	$ 884	$ -	$ 884	7,639	4.98	-$ 207	$ 1,922	$ 2,224	$ 2,452	$ 2,669	2.84	3.28	3.60	3.91	2.17	2.52	2.77	3.02
	Level 2	8 ventilators, 16 eave vents	$ 1,684	$ -	$ 1,684	7,524	4.92	-$ 264	$ 2,498	$ 2,890	$ 3,186	$ 3,468	1.76	2.03	2.24	2.43	1.48	1.72	1.89	2.06
Det 3 A 3.2	Base case	No vents	$ -		$ -	2,727	5.78													
	Level 1	4 ventilators, 8 eave vents	$ 884	$ -	$ 884	2,511	5.49	-$ 276	$ 1,083	$ 1,253	$ 1,381	$ 1,503	1.78	2.06	2.25	2.44	1.22	1.42	1.56	1.70
	Level 2	8 ventilators, 16 eave vents	$ 1,684	-$ 230	$ 1,454	2,436	5.42	-$ 341	$ 1,459	$ 1,688	$ 1,861	$ 2,025	1.31	1.52	1.66	1.80	1.00	1.16	1.28	1.39

B.IV.VIII Shading Awnings

Capital Costs:

Shading awnings used were fixed-in-place metal bladed awnings extending 600mm from the external wall surface. Prices were obtained for individual window sizes that ranged from $800 to $1,100 per window, with costs for mounting brackets at $700 per window.

Benefit Cost Analysis:

Table 104: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 6.2	Base case	No Awnings	$ -		$ -	5,672	4.39													
	Level 1	Awnings Living Room & Kitchen	$ 2,879	$ -	$ 2,879	5,411	4.24	-$ 150	$ 1,311	$ 1,516	$ 1,672	$ 1,820	0.48	0.56	0.61	0.67	0.46	0.53	0.58	0.63
Att 3 A 6.2	Base case	No Awnings	$ -		$ -	1,879	4.74													
	Level 1	Awnings Living Room & Kitchen	$ 2,879	$ -	$ 2,879	1,743	4.55	-$ 188	$ 680	$ 787	$ 868	$ 945	0.25	0.29	0.32	0.35	0.24	0.27	0.30	0.33
Det 1 A 6.2	Base case	No Awnings	$ -		$ -	8,023	5.19													
	Level 1	Awnings 3x Living Room	$ 4,081	$ -	$ 4,081	7,766	5.06	-$ 133	$ 1,284	$ 1,486	$ 1,638	$ 1,783	0.33	0.38	0.41	0.45	0.31	0.36	0.40	0.44
Det 3 A 6.2	Base case	No Awnings	$ -		$ -	2,727	5.78													
	Level 1	Awnings 3x Living Room	$ 4,081	$ -	$ 4,081	2,611	5.61	-$ 164	$ 585	$ 676	$ 746	$ 812	0.15	0.17	0.19	0.21	0.14	0.17	0.18	0.20
Apa 1 A 6.2	Base case	No Awnings	$ -		$ -	4,090	2.86													
	Level 1	Awnings 2x Living Room	$ 3,054	$ -	$ 3,054	3,898	2.76	-$ 97	$ 963	$ 1,114	$ 1,228	$ 1,336	0.33	0.38	0.41	0.45	0.32	0.36	0.40	0.44
Apa 3 A 6.2	Base case	No Awnings	$ -		$ -	1,372	3.45													
	Level 1	Awnings 2x Living Room	$ 3,054	$ -	$ 3,054	1,277	3.18	-$ 261	$ 475	$ 549	$ 606	$ 659	0.17	0.20	0.22	0.24	0.16	0.18	0.20	0.22

B.IV.IX Shading Eaves Extension

Capital Costs:

The capital costs for the eaves extension were as follows:

Table 105: Single dimensional measure description and capital cost.

Space	Eave length (m)	Scenarios	Performance Value	Construction cost (per m)
Apartment living		Base Case	Balcony 0.8 m overhang and eave 0.45 m length	$45.23
		Level 1	Extend eaves to 1.55 m	$237.55
		Level 2	Extend eaves to 2.3m	$435.20
Townhouse kitchen		Base Case	Balcony 0.8 m overhang and eave 0.45 m length	$45.23
		Level 1	Extend eaves to 0.7 m	$86.17
		Level 2	Extend eaves to 1.5m	$226.29
Townhouse living		Base Case	Balcony 0.8 m overhang and eave 0.45 m length	$45.23
		Level 1	Extend eaves to 1.65 m	$260.78
		Level 2	Extend eaves to 2.4m	$465.63
Detached living		Base Case	Balcony 0.8 m overhang and eave 0.45 m length	$46.41
		Level 1	Extend eaves to 0.75 m	$91.55
		Level 2	Extend eaves to 1.5m	$254.14

Costs are based on linear metres of eaves, no soffits, painted timber extensions, no barge board or gutters, no wall plates

Benefit Cost Analysis:

Table 106: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 6.1	Base case	All eaves 0.45m	$ 423		$ 423	5,672	4.39													
	Level 1	Kitchen to 0.75m, Living to 1.65m	$ 1,417	$ -	$ 1,417	5,306	4.24	-$ 146	$ 1,836	$ 2,124	$ 2,342	$ 2,549	2.17	2.50	2.75	2.99	1.85	2.14	2.36	2.56
	Level 2	Kitchen to 1.5m, Living to 2.4m	$ 2,953	-$ 230	$ 2,723	5,236	4.04	-$ 338	$ 2,187	$ 2,530	$ 2,790	$ 3,036	1.11	1.29	1.42	1.54	0.95	1.10	1.21	1.32
Att 3 A 6.1	Base case	All eaves 0.45m	$ 423		$ 423	1,879	4.74													
	Level 1	Kitchen to 0.75m, Living to 1.65m	$ 1,417	$ -	$ 1,417	1,720	4.53	-$ 205	$ 796	$ 920	$ 1,015	$ 1,104	1.01	1.17	1.28	1.39	0.80	0.93	1.02	1.11
	Level 2	Kitchen to 1.5m, Living to 2.4m	$ 2,953	$ -	$ 2,953	1,693	4.55	-$ 190	$ 932	$ 1,078	$ 1,189	$ 1,294	0.40	0.46	0.51	0.55	0.37	0.43	0.47	0.51
Det 1 A 6.1	Base case	All eaves 0.45m	$ 610		$ 610	8,023	5.19													
	Level 1	Living to 0.75m	$ 1,204	$ -	$ 1,204	7,923	5.16	-$ 33	$ 499	$ 578	$ 637	$ 693	0.89	1.03	1.14	1.24	0.84	0.97	1.07	1.17
	Level 2	Living to 1.5m	$ 3,342	$ -	$ 3,342	7,752	5.12	-$ 66	$ 1,357	$ 1,570	$ 1,731	$ 1,884	0.51	0.59	0.65	0.71	0.50	0.57	0.63	0.69
Det 3 A 6.1	Base case	All eaves 0.45m	$ 610		$ 610	2,727	5.78													
	Level 1	Living to 0.75m	$ 1,204	$ -	$ 1,204	2,696	5.76	-$ 15	$ 157	$ 182	$ 201	$ 219	0.27	0.31	0.35	0.38	0.27	0.31	0.34	0.37
	Level 2	Living to 1.5m	$ 3,342	$ -	$ 3,342	2,653	5.70	-$ 79	$ 372	$ 430	$ 474	$ 516	0.14	0.16	0.18	0.19	0.14	0.16	0.17	0.19
Apa 1 A 6.1	Base case	All eaves 0.45m	$ 516		$ 516	4,090	2.86													
	Level 1	Living to 1.55m	$ 2,708	$ -	$ 2,708	3,524	2.70	-$ 157	$ 2,837	$ 3,282	$ 3,619	$ 3,938	1.39	1.61	1.78	1.93	1.29	1.50	1.65	1.80
	Level 2	Living to 2.3m	$ 4,961	$ -	$ 4,961	3,394	2.62	-$ 234	$ 3,489	$ 4,036	$ 4,451	$ 4,844	0.83	0.96	1.06	1.15	0.78	0.91	1.00	1.09
Apa 3 A 6.1	Base case	All eaves 0.45m	$ 516		$ 516	1,372	3.45													
	Level 1	Living to 1.55m	$ 2,708	-$ 230	$ 2,478	1,219	3.09	-$ 341	$ 770	$ 891	$ 983	$ 1,069	0.48	0.55	0.60	0.66	0.39	0.45	0.50	0.54
	Level 2	Living to 2.3m	$ 4,961	-$ 230	$ 4,731	1,195	3.01	-$ 418	$ 889	$ 1,029	$ 1,135	$ 1,235	0.23	0.27	0.30	0.32	0.21	0.24	0.27	0.29

B.IV.X Floor Insulation

Capital Costs:

Insulation materials were represented as expanded polystyrene board, with costs of $9.06/m² for R2.0, to be applied under the floor for apartments only. No floor insulation was used for the attached or detached archetypes.

Benefit Cost Analysis:

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Apa 1 A 5.1	Base case	No Insulation	$ -		$ -	4,090	2.86													
	Level 2	R2.0	$ 779	$ -	$ 779	4,214	2.88	$ 16	-$ 625	-$ 723	-$ 797	-$ 867	-0.79	-0.91	-1.00	-1.09	-0.80	-0.93	-1.02	-1.11
Apa 3 A 5.1	Base case	No Insulation	$ -		$ -	1,372	3.45													
	Level 2	R2.0	$ 779	$ -	$ 779	1,467	3.50	$ 50	-$ 473	-$ 548	-$ 604	-$ 657	-0.57	-0.66	-0.73	-0.79	-0.61	-0.70	-0.78	-0.84

B.IV.XI Thermal Mass

Capital Costs:

The capital costs for the thermal mass were determined based on the addition of wall insulation to the same level, plus cladding cost of $20/m².as follows:

Table 107: Single dimensional measure description and capital cost.

Archetype	Wall area (m²)	Cladding cost
Apartment	81	$1,620
Attached	71	$1,420
Detached	154.5	$3,091

Benefit Cost Analysis:

Table 108: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 4.1	Base case		$ -		$ -	5,672	4.39													
	Level 2	R1.6 Reverse Veneer	$ 2,242	-$ 230	$ 2,012	5,170	3.98	-$ 404	$ 2,519	$ 2,914	$ 3,213	$ 3,497	1.57	1.81	1.99	2.16	1.25	1.45	1.60	1.74
	Level 3	R2.8 Reverse Veneer	$ 3,048	-$ 460	$ 2,588	5,053	3.66	-$ 712	$ 3,102	$ 3,589	$ 3,957	$ 4,307	1.65	1.91	2.09	2.27	1.20	1.39	1.53	1.66
	Level 4	R4.5 Reverse Veneer	$ 4,525	-$ 230	$ 4,295	4,951	3.81	-$ 562	$ 3,614	$ 4,181	$ 4,610	$ 5,017	0.97	1.12	1.23	1.34	0.84	0.97	1.07	1.17
Att 3 A 4.1	Base case		$ -		$ -	1,879	4.74													
	Level 2	R1.6 Reverse Veneer	$ 2,242	-$ 230	$ 2,012	1,385	4.31	-$ 417	$ 2,475	$ 2,863	$ 3,157	$ 3,436	1.55	1.80	1.97	2.14	1.23	1.42	1.57	1.71
	Level 3	R2.8 Reverse Veneer	$ 3,048	-$ 230	$ 2,818	1,304	4.25	-$ 475	$ 2,879	$ 3,331	$ 3,673	$ 3,997	1.23	1.42	1.56	1.70	1.02	1.18	1.30	1.42
	Level 4	R4.5 Reverse Veneer	$ 4,525	-$ 460	$ 4,065	1,339	4.04	-$ 674	$ 2,704	$ 3,128	$ 3,449	$ 3,754	0.80	0.92	1.01	1.10	0.67	0.77	0.85	0.92
Det 1 A 4.1	Base case		$ -		$ -	8,023	5.19													
	Level 2	R1.6 Reverse Veneer	$ 4,862	-$ 230	$ 4,632	6,680	4.60	-$ 569	$ 6,731	$ 7,787	$ 8,587	$ 9,345	1.66	1.92	2.11	2.29	1.45	1.68	1.85	2.02
	Level 3	R2.8 Reverse Veneer	$ 6,618	-$ 460	$ 6,158	6,403	4.42	-$ 746	$ 8,119	$ 9,393	$10,357	$11,272	1.50	1.74	1.91	2.07	1.32	1.53	1.68	1.83
	Level 4	R4.5 Reverse Veneer	$ 9,833	-$ 460	$ 9,373	6,373	4.23	-$ 930	$ 8,270	$ 9,567	$10,550	$11,482	0.98	1.13	1.25	1.36	0.88	1.02	1.13	1.23
Det 3 A 4.1	Base case		$ -		$ -	2,727	5.78													
	Level 2	R1.6 Reverse Veneer	$ 4,862	-$ 920	$ 3,942	1,566	4.29	-$ 1,431	$ 5,822	$ 6,735	$ 7,427	$ 8,083	2.32	2.68	2.93	3.17	1.48	1.71	1.88	2.05
	Level 3	R2.8 Reverse Veneer	$ 6,618	-$ 920	$ 5,698	1,401	4.13	-$ 1,588	$ 6,647	$ 7,689	$ 8,479	$ 9,228	1.62	1.87	2.05	2.22	1.17	1.35	1.49	1.62
	Level 4	R4.5 Reverse Veneer	$ 9,833	-$ 1,150	$ 8,683	1,507	3.92	-$ 1,793	$ 6,118	$ 7,077	$ 7,804	$ 8,493	0.89	1.03	1.13	1.22	0.70	0.82	0.90	0.98
Apa 1 A 4.1	Base case		$ -		$ -	4,090	2.86													
	Level 2	R1.6 Reverse Veneer	$ 2,558	$ -	$ 2,558	3,511	2.77	-$ 90	$ 2,901	$ 3,356	$ 3,700	$ 4,027	1.18	1.36	1.50	1.63	1.13	1.31	1.45	1.57
	Level 3	R2.8 Reverse Veneer	$ 3,479	$ -	$ 3,479	3,380	2.71	-$ 143	$ 3,558	$ 4,116	$ 4,539	$ 4,940	1.07	1.23	1.36	1.48	1.02	1.18	1.30	1.42
	Level 4	R4.5 Reverse Veneer	$ 5,164	$ -	$ 5,164	3,315	2.62	-$ 230	$ 3,884	$ 4,493	$ 4,954	$ 5,392	0.79	0.91	1.00	1.09	0.75	0.87	0.96	1.04
Apa 3 A 4.1	Base case		$ -		$ -	1,372	3.45													

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	Level 2	R1.6 Reverse Veneer	$ 2,558	-$ 230	$ 2,328	907	3.11	-$ 325	$ 2,330	$ 2,696	$ 2,973	$ 3,235	1.16	1.35	1.48	1.61	1.00	1.16	1.28	1.39
	Level 3	R2.8 Reverse Veneer	$ 3,479	-$ 230	$ 3,249	832	3.06	-$ 371	$ 2,710	$ 3,136	$ 3,458	$ 3,763	0.94	1.09	1.20	1.30	0.83	0.97	1.06	1.16
	Level 4	R4.5 Reverse Veneer	$ 5,164	-$ 460	$ 4,704	861	2.77	-$ 653	$ 2,561	$ 2,962	$ 3,267	$ 3,555	0.63	0.73	0.80	0.87	0.54	0.63	0.69	0.76

B.IV.XII Window Construction

Capital Costs:

The capital costs used for the different glass types were the same as used for economic analysis in climate zones 2, 5, 6 & 7, with glass 7 being the average cost of glass 1 & 2, as follows:

Table 109: Single dimensional measure description and capital cost.

Type	U-value (W/m²K)	SHGC	VT	Description	Window ($/m²)	Door ($/m²)
Glass 1	6.4	0.7	0.75	Al frame, Single glazing (SG) clear glass	$ 247	$422
Glass 2	4.2	0.62	0.66	Al frame, double glazing (DG), air fill, glass: High solar gain low-e - Clear	$ 416	$559
Glass 3	3.9	0.51	0.6	Al frame, DG, Argon fill, glass: High solar gain low-E - Clear	$ 676	$973
Glass 4	3.8	0.37	0.29	Composite frame, SG Low solar gain and low-e	$ 430	$679
Glass 5	2.6	0.29	0.41	Timber frame, DG, Argon fill, glass: Clear - Clear	$ 318	$273
Glass 6	1.9	0.24	0.24	uPVC frame DG, air fill, glass: Low solar gain low-e - Clear	$ 458	$458
Glass 7	6.85	0.3	-	Al Frame, single glazing SG, glass: low-e	$ 332	$490

Table 110: Single dimensional measure description and capital cost.

Scenarios	Performance Value	Climate Zone 2 Construction cost (per unit)	Climate Zone 5 Construction cost (per unit)	Climate Zone 6 Construction cost (per unit)
Base Case	200 mm concrete and carpet, Brick veneer	$403.68	$431.51	$450.27
Level 1	200 mm concrete and carpet, Reverse brick veneer	$435.46	$459.04	$489.19
Level 2	Increase concrete floor to 300mm and leave it expose	$366.69	$386.03	$403.03
Level 3	300 mm exposed concretes floors and reverse brick veneer	$398.47	$413.56	$441.96
Number of units for construction cost:		77.06 m² (apartment)		

Benefit Cost Analysis:

Table 111: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 1.4	Glass 1	Al frame, SG, clear	$ 6,129		$ 6,129	5,550	4.36													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 9,484	$ -	$ 9,484	5,273	4.23	-$ 126	$ 1,389	$ 1,607	$ 1,772	$ 1,929	0.43	0.50	0.55	0.60	0.41	0.48	0.53	0.57
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$15,764	$ -	$15,764	5,073	4.13	-$ 220	$ 2,391	$ 2,766	$ 3,050	$ 3,320	0.25	0.29	0.32	0.35	0.25	0.29	0.32	0.34
	Glass 4	Composite frame, SG, Low solar gain, low-e	$10,364	$ -	$10,364	4,942	4.05	-$ 298	$ 3,051	$ 3,530	$ 3,892	$ 4,236	0.77	0.90	0.99	1.07	0.72	0.83	0.92	1.00
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 6,387	-$ 460	$ 5,927	4,572	3.66	$ 6,387	$ 4,902	$ 5,671	$ 6,254	$ 6,806	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 9,569	-$ 460	$ 9,109	4,327	3.51	-$ 823	$ 6,134	$ 7,096	$ 7,825	$ 8,515	2.84	3.29	3.60	3.91	2.06	2.38	2.63	2.86
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 7,806	$ -	$ 7,806	5,246	4.25	$ 7,806	$ 1,525	$ 1,764	$ 1,946	$ 2,117	0.97	1.12	1.23	1.34	0.91	1.05	1.16	1.26
Att 3 A 1.4	Glass 1	Al frame, SG, clear	$ 6,129		$ 6,129	1,812	4.73													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 9,484	$ -	$ 9,484	1,625	4.62	-$ 105	$ 942	$ 1,089	$ 1,201	$ 1,307	0.29	0.34	0.37	0.40	0.28	0.32	0.36	0.39
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$15,764	$ -	$15,764	1,539	4.64	-$ 91	$ 1,368	$ 1,583	$ 1,746	$ 1,900	0.14	0.17	0.18	0.20	0.14	0.16	0.18	0.20

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	Glass 4	Composite frame, SG, Low solar gain, low-e	$10,364	$ -	$10,364	1,522	4.49	-$ 230	$ 1,454	$ 1,682	$ 1,855	$ 2,018	0.36	0.42	0.46	0.50	0.34	0.40	0.44	0.48
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 6,387	-$ 460	$ 5,927	1,331	4.01	$ 6,387	$ 2,411	$ 2,789	$ 3,076	$ 3,347	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 9,569	-$ 460	$ 9,109	1,206	3.89	-$ 813	$ 3,040	$ 3,516	$ 3,878	$ 4,220	1.40	1.62	1.78	1.93	1.02	1.18	1.30	1.42
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 7,806	$ -	$ 7,806	1,793	4.94	$ 7,806	$ 95	$ 110	$ 122	$ 132	0.05	0.06	0.06	0.07	0.06	0.07	0.07	0.08
Det 1 A 1.4	Glass 1	Al frame, SG, clear	$ 2,358		$ 2,358	9,191	5.48													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 3,599	$ -	$ 3,599	8,855	5.36	-$ 117	$ 1,683	$ 1,948	$ 2,148	$ 2,337	1.50	1.73	1.91	2.07	1.36	1.57	1.73	1.88
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$ 6,005	$ -	$ 6,005	8,610	5.28	-$ 195	$ 2,910	$ 3,366	$ 3,712	$ 4,040	0.84	0.98	1.07	1.17	0.80	0.92	1.02	1.11
	Glass 4	Composite frame, SG, Low solar gain, low-e	$ 3,969	$ -	$ 3,969	8,485	5.20	-$ 269	$ 3,536	$ 4,090	$ 4,511	$ 4,909	2.63	3.05	3.35	3.64	2.19	2.54	2.80	3.05
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 2,369	-$ 230	$ 2,139	8,019	5.05	$ 2,369	$ 5,876	$ 6,797	$ 7,496	$ 8,158	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 3,576	-$ 230	$ 3,346	7,736	4.90	-$ 559	$ 7,293	$ 8,437	$ 9,303	$ 10,125	17.02	19.69	21.19	22.79	7.38	8.54	9.42	10.25
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 2,978	$ -	$ 2,978	8,836	5.49	$ 2,978	$ 1,778	$ 2,057	$ 2,269	$ 2,469	2.82	3.26	3.60	3.92	2.87	3.32	3.66	3.98
Det 3 A 1.4	Glass 1	Al frame, SG, clear	$ 2,358		$ 2,358	3,200	5.96													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 3,599	$ -	$ 3,599	3,014	5.99	$ 23	$ 932	$ 1,078	$ 1,189	$ 1,294	0.74	0.85	0.94	1.02	0.75	0.87	0.96	1.04
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$ 6,005	$ -	$ 6,005	2,925	5.89	-$ 65	$ 1,375	$ 1,591	$ 1,754	$ 1,909	0.38	0.44	0.49	0.53	0.38	0.44	0.48	0.52
	Glass 4	Composite frame, SG, Low solar gain, low-e	$ 3,969	$ -	$ 3,969	2,918	5.85	-$ 113	$ 1,410	$ 1,632	$ 1,799	$ 1,958	0.94	1.09	1.20	1.30	0.88	1.01	1.12	1.22
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 2,369	-$ 230	$ 2,139	2,717	5.59	$ 2,369	$ 2,422	$ 2,802	$ 3,089	$ 3,362	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 3,576	-$ 230	$ 3,346	2,584	5.39	-$ 549	$ 3,085	$ 3,569	$ 3,936	$ 4,283	7.03	8.14	8.77	9.43	3.12	3.61	3.98	4.34
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 2,978	$ -	$ 2,978	3,174	6.21	$ 2,978	$ 130	$ 151	$ 166	$ 181	0.15	0.18	0.19	0.21	0.21	0.24	0.27	0.29
Apa 1 A 1.4	Glass 1	Al frame, SG, clear	$ 2,586		$ 2,586	3,645	2.55													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 4,170	$ -	$ 4,170	3,551	2.52	-$ 30	$ 472	$ 547	$ 603	$ 656	0.30	0.35	0.39	0.42	0.30	0.35	0.38	0.41
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$ 6,852	$ -	$ 6,852	3,481	2.51	-$ 42	$ 825	$ 954	$ 1,052	$ 1,145	0.20	0.23	0.25	0.27	0.19	0.22	0.25	0.27
	Glass 4	Composite frame, SG, Low solar gain, low-e	$ 4,434	$ -	$ 4,434	3,450	2.45	-$ 105	$ 980	$ 1,134	$ 1,251	$ 1,361	0.56	0.65	0.72	0.78	0.53	0.61	0.68	0.74
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 2,992	$ -	$ 2,992	3,300	2.48	$ 2,992	$ 1,732	$ 2,004	$ 2,210	$ 2,405	5.12	5.92	6.50	7.06	4.26	4.93	5.44	5.92

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 4,396	$ -	$ 4,396	3,207	2.49	-$ 64	$ 2,199	$ 2,544	$ 2,805	$ 3,053	1.26	1.46	1.61	1.75	1.22	1.41	1.55	1.69
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 3,378	$ -	$ 3,378	3,606	2.51	$ 3,378	$ 195	$ 226	$ 249	$ 271	0.26	0.30	0.33	0.36	0.25	0.28	0.31	0.34
Apa 3 A 1.4	Glass 1	Al frame, SG, clear	$ 2,586		$ 2,586	1,077	2.66													
	Glass 2	Al frame, DG, air fill, High solar gain, low-e	$ 4,170	$ -	$ 4,170	1,029	2.63	-$ 31	$ 243	$ 281	$ 309	$ 337	0.16	0.18	0.20	0.22	0.15	0.18	0.20	0.21
	Glass 3	Al frame, DG, Argon fill, High solar gain, low-E	$ 6,852	$ -	$ 6,852	1,015	2.64	-$ 20	$ 314	$ 363	$ 401	$ 436	0.07	0.09	0.09	0.10	0.07	0.09	0.09	0.10
	Glass 4	Composite frame, SG, Low solar gain, low-e	$ 4,434	$ -	$ 4,434	1,019	2.62	-$ 38	$ 291	$ 337	$ 372	$ 405	0.16	0.19	0.21	0.22	0.16	0.18	0.20	0.22
	Glass 5	Timber frame, DG, Argon fill, Clear	$ 2,992	$ -	$ 2,992	978	2.56	$ 2,992	$ 496	$ 574	$ 633	$ 689	1.59	1.84	2.02	2.19	1.22	1.41	1.56	1.70
	Glass 6	uPVC frame DG, air fill, Low solar gain, low-e	$ 4,396	$ -	$ 4,396	947	2.57	-$ 89	$ 652	$ 754	$ 832	$ 905	0.38	0.44	0.48	0.53	0.36	0.42	0.46	0.50
	Glass 7	Al Frame, SG, low solar gain, low-e	$ 3,378	$ -	$ 3,378	1,100	2.82	$ 3,378	-$ 111	-$ 128	-$ 141	-$ 154	-0.12	-0.14	-0.15	-0.16	-0.14	-0.16	-0.18	-0.19

B.IV.XIII Window Area

Capital Costs:

Capital costs were based on reducing the areas of some windows and doors, using glass type 1, as follows:

Table 112: Single dimensional measure description and capital cost.

Archetype	Space	Door/Window	Quantity	Initial Width	Reduced Width (m)	Initial Area (m²)	Reduced Area (m²)
Detached	Living 1	Door	2	1.52	1.20	2.95	1.82
	Living 2	Door	1	2.85	2.10	6.00	4.41
Attached	Kitchen	Window	1	2.02	1.00	3.09	1.52
	Living	Door	1	2.64	1.20	5.54	2.52
Apartment	Living	Door	2	2.59	2.10	5.44	4.41

Benefit Cost Analysis:

Table 113: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 1.2	Base case	Normal windows	$ 6,103		$ 6,103	5,672	4.39													
	Level 1	Narrower Living Room & Kitchen windows	$ 4,440	$ -	$ 4,440	5,672	4.39	$ -	$ -	$ -	$ -	$ -	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Att 3 A 1.2	Base case	Normal windows	$ 6,103		$ 6,103	1,879	4.74													
	Level 1	Narrower Living Room & Kitchen windows	$ 4,440	$ -	$ 4,440	1,597	4.70	-$ 44	$ 1,412	$ 1,634	$ 1,802	$ 1,961	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 1 A 1.2	Base case	Normal windows	$10,000		$10,000	8,023	5.19													
	Level 1	Narrower Living Room windows	$ 8,780	$ -	$ 8,780	7,936	5.13	-$ 60	$ 434	$ 502	$ 553	$ 602	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Det 3 A 1.2	Base case	Normal windows	$10,000		$10,000	2,727	5.78													
	Level 1	Narrower Living Room windows	$ 8,780	$ -	$ 8,780	2,682	5.60	-$ 172	$ 226	$ 261	$ 288	$ 314	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 1 A 1.2	Base case	Normal windows	$ 7,847		$ 7,847	4,090	2.86													
	Level 1	Narrower Living Room windows	$ 6,978	$ -	$ 6,978	3,986	2.82	-$ 39	$ 519	$ 600	$ 662	$ 721	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost
Apa 3 A 1.2	Base case	Normal windows	$ 7,847		$ 7,847	1,372	3.45													
	Level 1	Narrower Living Room windows	$ 6,978	$ -	$ 6,978	1,310	3.29	-$ 148	$ 311	$ 360	$ 397	$ 432	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost	negative cost

B.IV.XIV Window Openability

Capital Costs:

The capital costs for openable windows were based on adding a 75% levy to existing window costs, using glass type 1, for the addition of louvres. This levy was applied to all windows and doors.

Benefit Cost Analysis:

Table 114: Benefit cost analysis summary including results without network adjustments.

		Performance value	Base Construction Cost	HVAC sizing capital cost adjustment	Capital cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 yrs	BC Ratio - 15 yrs	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Att 1 A 1.3	Base case	Normal windows	$ 6,103		$ 6,103	5,672	4.39													
	Level 1	All louvred windows	$10,680	$ -	$10,680	5,277	4.30	-$ 87	$ 1,981	$ 2,292	$ 2,528	$ 2,751	0.44	0.51	0.56	0.61	0.43	0.50	0.55	0.60
Att 3 A 1.3	Base case	Normal windows	$ 6,103		$ 6,103	1,879	4.74													
	Level 1	All louvred windows	$10,680	$ -	$10,680	1,755	4.83	$ 83	$ 618	$ 715	$ 789	$ 858	0.13	0.15	0.17	0.18	0.14	0.16	0.17	0.19
Det 1 A 1.3	Base case	Normal windows	$10,000		$10,000	8,023	5.19													
	Level 1	All louvred windows	$17,500	$ -	$17,500	7,886	5.22	$ 23	$ 687	$ 794	$ 876	$ 953	0.09	0.11	0.12	0.13	0.09	0.11	0.12	0.13
Det 3 A 1.3	Base case	Normal windows	$10,000		$10,000	2,727	5.78													
	Level 1	All louvred windows	$17,500	$ -	$17,500	2,682	5.78	$ 1	$ 227	$ 262	$ 289	$ 315	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.04
Apa 1 A 1.3	Base case	Normal windows	$ 7,847		$ 7,847	4,090	2.86													
	Level 1	All louvred windows	$13,733	$ -	$13,733	4,001	2.88	$ 17	$ 442	$ 512	$ 564	$ 614	0.07	0.09	0.10	0.10	0.08	0.09	0.10	0.10
Apa 3 A 1.3	Base case	Normal windows	$ 7,847		$ 7,847	1,372	3.45													
	Level 1	All louvred windows	$13,733	$ -	$13,733	1,272	3.35	-$ 96	$ 503	$ 581	$ 641	$ 698	0.09	0.10	0.11	0.12	0.09	0.10	0.11	0.12

B.IV.XV Lighting

Capital Costs:

Lighting design for each of the archetypes assumed that CFL technology was used in the base case line scenarios, and that LED technologies were used in the improved design factors. Since the same luminaire was used throughout all models with just the lamp being replaced, luminaire pricing remained consistent throughout all models at $70.

Lamp pricing was referenced from Bunnings website as of October 2017.

Osram and Philips lamps tend to cost the same so we assumed the 11W and 13W Osram lamps used in the original model would cost the same as the 15W Philips lamps on the Bunnings website- $6.49 including GST.

https://www.bunnings.com.au/philips-15w-cool-white-bc-tornado-spiral-globe-cfl_p4320539

LED case – pricing and lumen output referenced from Bunnings website - $7.95 + GST

Osram 10W 1050lm B22d Warm White 114mm long LED Value stick

https://www.bunnings.com.au/osram-10w-1050lm-warm-white-led-value-stick-b22d-globe_p4320899

Osram 7W 700lm B22d Warm White 114mm long LED Value stick

https://www.bunnings.com.au/osram-7w-700lm-warm-white-led-value-stick-b22d-globe_p4320892

The cost benefit analysis compares a base case of compact fluorescent lamps (CFL) which are in common use in 2017, to an LED case which is in increasing use in 2017 and is on track to become the dominant lighting technology used in residential buildings.

Simulations were conducted to find the energy consumption and lighting power density (LPD) of each archetype for the base case and the LED case. To calculate kWh the NatHERS protocol for individual room type's hours of use were applied.

Learning Rates:

Pricing learning rates for the residential lighting benefit cost analysis were based on analysis done previous by Energy Action for the purposes of Section J Lighting measures development, based on a survey of 13 luminaire manufacturers comparing 394 LED luminaires. The luminaire types included and compared in the survey were:

- Diffused battens
- Recessed troffers
- Down lights
- High bays

Pricing, lumen output and power consumption data was surveyed for all luminaires using archived and current price lists, IES files and data sheets and tables filled in by suppliers, covering the years 1999 – 2017. Some predictions were provided by 2 suppliers for the years 2018 and 2019.

The data from this survey was graphed and the percentage figure for the learning rates were calculated based on the trend line created from the historical data for each of the following technology groups:

- Linear battens and troffers
- Down lights
- High bays

This report uses the results produced for down lights as down lights are the most commonly used luminaire type in residential lighting. The graphs and description of the analysis from the report are provided below.

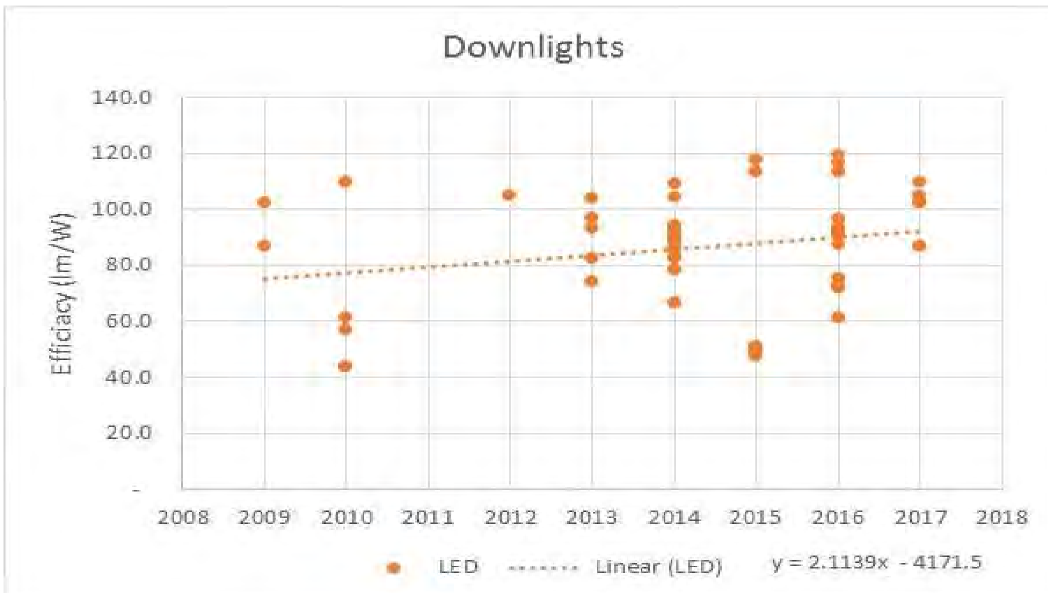

Figure 17: Pricing learning rate for LED down lights over time.

According to the graph in Figure 17 the price of LED down lights is dropping at a rate of $0.075 per lumen, per year equivalent to 11% p.a. Based on this the projected price reduction by 2021 would be 37%. We have conservatized this to 30%.

The 30% decrease in the cost has been applied to the residential lighting analysis for the first 5 years, with the expectation that the cost would plateau after that.

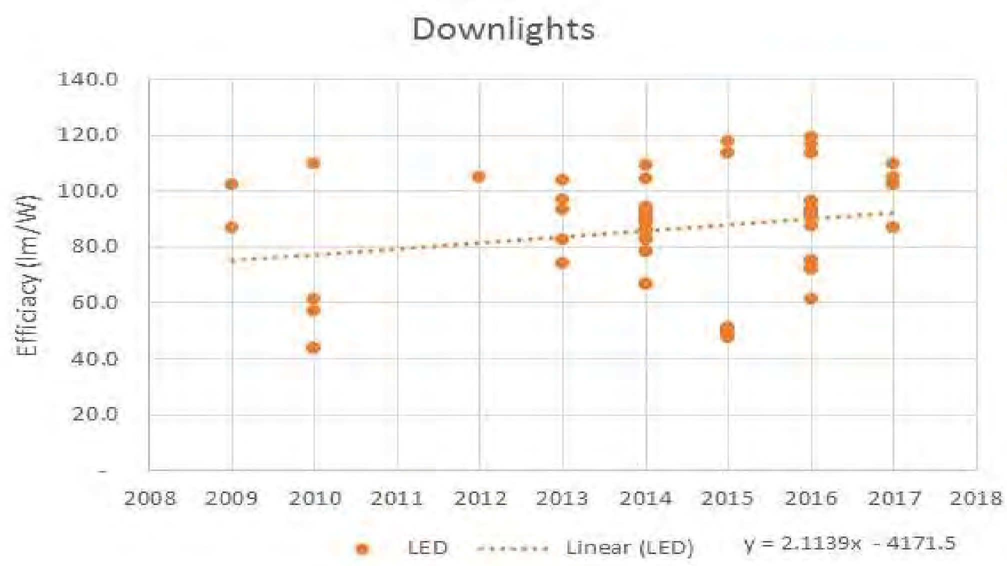

Figure 18: Efficacy learning rate for LED down lights over time.

According to the graph in Figure 18, the efficacy of LED down lights is improving at a rate of 2 lumens per Watt, per year. This is equivalent to a 2021 learning rate of 9% relative to 2017.

Energy Consumption and Savings:

As the NatHERS protocol specifies a set lighting schedule for individual room types, it was adopted for the purposes of this study. Lighting was assumed to remain unchanged through different orientations and climate zones. Table 115 summarises the annual lighting electrical energy consumption for CFL and LED technologies.

Table 115: Lighting annual energy demand for CFL and LED technologies for each archetype

	Design Technology	Details	Lighting Power Density (W/m²)	Annual Energy (kWh/year)	Annual Energy Density (kWh/m²/year)
Apartment	CFL (MF 0.8)	21 x 13W oysters on ceiling, 6 x 11W wall lights	4.25	270	3.48
	LED (MF 0.7)	LED: 21 x 10W oysters on ceiling, 6 x 7W wall lights	3.22	203	2.61
	Savings (kWh/m²/year)				0.87
Attached	CFL (MF 0.8)	Ground: 15 x 20W oysters on ceiling, 5 x 12W oysters on walls. 1st floor: 10 x 20W oysters on ceiling, 7 x 12W oysters on walls	4.4	429	3.1
	LED (MF 0.7)	Ground: 15 x 16W oysters on ceiling, 5 x 7W oysters on walls. 1st floor: 10 x 16W oysters on ceiling, 7 x 7W oysters on walls	3.3	322	2.3
	Savings (kWh/m²/year)				0.77
Detached	CFL (MF 0.8)	37 x 20W oysters on ceiling, 8 x 12W oysters on walls	4.4	351	1.9
	LED (MF 0.7)	37 x 16W oysters on ceiling, 8 x 7W oysters on walls	3.4	266	1.4
	Savings (kWh/m²/year)				0.46

Benefit Cost Analysis:

Table 116: Benefit cost analysis summary including results without network adjustments.

		Performance value (e.g. R value)	Base Construction Cost	HVAC sizing capital cost adjustment	Capital Cost (not inc network adjustments)	Energy Use (kWh)	Peak Demand (kW)	Network adjustments to capital cost	Lifecycle energy cost savings (today)	Lifecycle energy cost savings (5 yrs)	Lifecycle energy cost savings (10 yrs)	Lifecycle energy cost savings (15 yrs)	BC Ratio - Today	BC Ratio - 5 yrs	BC Ratio - 10 years	BC Ratio - 15 years	BC Ratio (without network adjustment) - Today	BC Ratio (without network adjustment) - 5 yrs	BC Ratio (without network adjustment) - 10 yrs	BC Ratio (without network adjustment) - 15 yrs
Attached	Base case	CFL	$2,677.15		$2,677.15	526.0	0.3													
	Level 1	LED	$3,034.50	$ -	$3,034.50	406.0	0.2	-$ 75.15	$368.48	$430.75	$486.93	$542.64	1.31	negative cost	negative cost	negative cost	0.00	0.00	0.00	0.00
Detached	Base case	CFL	$3,518.54		$3,518.54	760.0	0.4													
	Level 1	LED	$3,974.60	$ -	$3,974.60	594.0	0.3	-$ 90.56	$509.73	$595.87	$673.58	$750.65	1.39	negative cost	negative cost	negative cost	0.00	0.00	0.00	0.00
Apartment	Base case	CFL	$2,065.23		$2,065.23	270.0	0.2													
	Level 1	LED	$2,092.65	$ -	$2,092.65	203.0	0.1	-$ 41.91	$205.73	$240.50	$271.87	$302.97	negative cost	negative cost	negative cost	negative cost	0.00	0.00	0.00	0.00

Table 117: Results of lighting benefit cost analysis. Note that the results do not include allowance for the 9% projected efficiency improvement in LEDs; inclusion of this, however, has no significant impact to the overall outcome.

	Apartment	Detached House	Attached House
Today	negative cost	0.53	0.74
5 years	negative cost	negative cost	negative cost
10 years	negative cost	negative cost	negative cost
15 years	negative cost	negative cost	negative cost

The results indicate that it is not cost effective to install LED in a residential building instead of CFL today, but that it will become cost effective within the next 5 years. The negative cost for apartments today is driven by a reduction in network demand; actual upfront capital costs are very marginally higher for the LED option than the CFL option.

B.IV.XVI Domestic Hot Water

Domestic hot water is a significant energy use within Australian homes, and indeed is dominant in mild climates where heating and cooling needs are limited. Australian homes currently use a mix of technologies for domestic hot water, including:

- Electric storage
- Instantaneous electric
- Gas storage
- Instantaneous gas
- Electric heat pump
- Solar – electric boosted
- Solar – gas boosted

For the purposes of this study, only electric options are being considered as this enables many building types to become net zero emission buildings through the use of PV. This however is only a reflection of the scenario development process and is not a recommendation against gas DHW per se. A full Code development process would need to properly address the complex issues of the electricity/gas question.

Scenario Formulation:

The available electric DHW technologies have been characterised as presented in Table 118 below.

Table 118: Electric DHW technologies considered. Efficiency COP is the number of units of hot water produced per unit of energy put in, not including standing losses. It is noted that the actual efficiency of solar varies widely based on the installation and climate zone, and the efficiency of heat pump units is temperature dependent.

Technology	Description	Effective Efficiency (COP)
Electric storage	Direct electric heating elements in a storage tank.	1.0
Standard Heat Pump	HCFC refrigerant heat pump with storage tank. Examples: Rheem MPi series	3.0
High Performance Heat Pump	CO2 refrigerant heat pump with storage tank. Examples: Sanden EcoPlus	4.5
Solar with electric boost	Roof mounted solar panel/storage tank unit. Examples: Rheem Hiline series	4.0

For the townhouse and detached house archetypes, all of the nominated technologies are viable. For apartments, however, only direct electric heating is viable as a technology for DHW on an individual apartment basis; other technologies require a centralised system (which is common practice, albeit typically gas fired, in larger apartment buildings). As it is beyond the scope of this study to assess centralised DHW versus individual unit DHW, and as it is possible for heat pump and solar technologies to be used with centralised systems, we have elected not to analyse DHW for apartments, and instead extrapolate the results for the other archetypes to the apartment case.

Assuming a townhouse occupancy of 3 persons and a detached house occupancy of 5 persons, both can be served adequately using a system of any technology with approximately 300-325 litre storage. Costs vary but based on a survey of prices available on the web it is possible to characterise costs as follows:

Table 119: Capital cost and system description.

Technology	Sample System	Capital Cost
Electric storage	3.6kW direct electric heating elements in a 315 litre storage tank.	$1,200
Standard Heat Pump	R134a heat pump plus 3.6kW booster elements in a 325 litre storage	$3,000
High Performance Heat Pump	CO2 pump with 315 litre storage tank	$4,800
Solar with electric boost	300 litre roof mounted solar panel/storage tank unit with 3.6kW boost.	$4,500

Based on work by Whaley et al, annual standing losses from storage systems have been estimated at around 1.8kWh/day. The same reference identifies average hot water use as 39 litre per person per day; for the purposes of the current calculation, a 40°C temperature rise has been assumed. In practice this varies with inlet temperature and thus with climate zone; however this is a second order factor and has been disregarded for the purpose of the current calculation.

Based on these assumptions the calculated energy use figures are as shown in Table 120 and Table 121.

Table 120: DHW energy use calculations for the townhouse.

Technology	Annual water use (litres)	Water use energy (kWhe)	Standing losses (kWhth)	Standing losses (kWhe)	Annual energy use (kWhe)
Direct Elec	42705	1993	664	664	2657
Standard HP	42705	664	664	221	886
Hi Perf HP	42705	443	664	148	590
Solar DHW	42705	498	664	166	664

Table 121: DHW calculations for the detached house.

Technology	Annual water use (litres)	Water use energy (kWhe)	Standing losses (kWhth)	Standing losses (kWhe)	Annual energy use (kWhe)
Direct Elec	71175	3322	664	664	3986
Standard HP	71175	1107	664	221	1329
Hi Perf HP	71175	738	664	148	886
Solar DHW	71175	830	664	166	996

It is noted that there is a significant difference in the peak demand from each of these systems. However, as all are typically connected to ripple or off-peak control, no allowance has been included in the economic analysis for the impacts on network infrastructure.

A 15 year lifespan has been assumed for all systems.

Results – Baseline Analysis:

All three upgraded technologies are cost effective relative to direct electric heating, as shown in Figure 19.

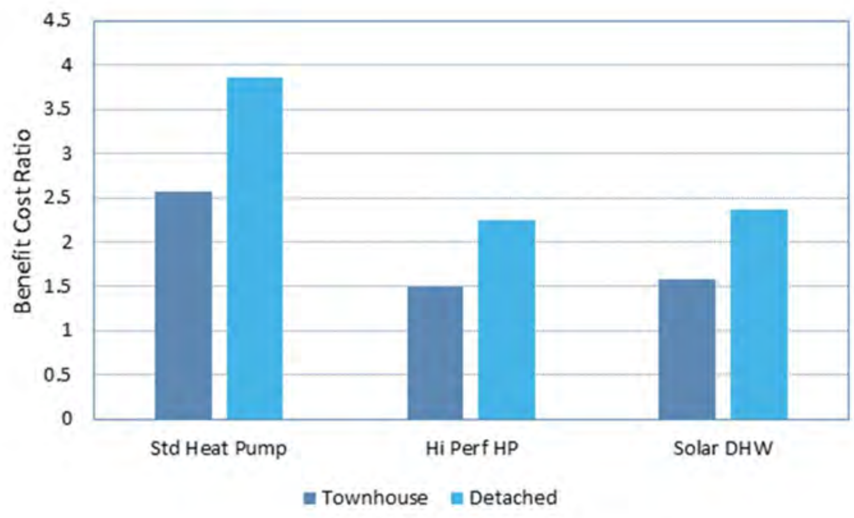

Figure 19: Benefit cost results for DHW technologies relative to direct electric.

However, the cost benefit for high performance heat pumps and solar DHW relative to standard heat pump is not attractive, at 0.43/0.39 (HP/solar respectively) for townhouses and 0.64/0.58 for the detached house. As NCC 2016 DTS largely (but not totally) proscribes the use of direct electric heating for hot water3, the standard heat pump is a more suitable baseline for economic assessment.

Based on these results, the appropriate level of stringency for DHW based on current economics is taken to be that of standard heat pump technology. Under today's economic conditions, the unit cost for the high efficiency heat pump would have to drop from $4,800 to $3,750 to become economic relative to a standard heat pump.

3 Section BP2.8(b) of the Plumbing Code rules out the use of direct electricity for domestic hot water heating unless there are no alternatives, but only for Class 1 and 10 buildings. Class 2 buildings (apartments) do not have this limitation and thus can use direct electric heating

Future Economic Scenarios:

The high performance heat pump currently carries a significant (60%) price premium relative to the standard heat pump, and yet comprises essentially the same technological components while using a different refrigerant (albeit at higher pressure).

However, it is reasonable to expect that the real cost of the high performance heat pump will reduce significantly as production volumes and market competition increase. Given the 85% phase down of R134a over the next 20 years, it is reasonable to project that the current R134a technology will be phased out of the market and gradually replaced with the higher performance CO2 units. As there are few technical differences between the R134a and CO2 systems, it is expected that the vast majority of the current rice difference is due to supply and scale issues rather than inherent technical cost. As a result, it is projected that the cost of the high performance units will reduce to approximately 110% of the standard heat pump over the next 10 years. Based on this assertion, a price path has been derived and the forward economic scenarios developed, as shown in Figure 20.

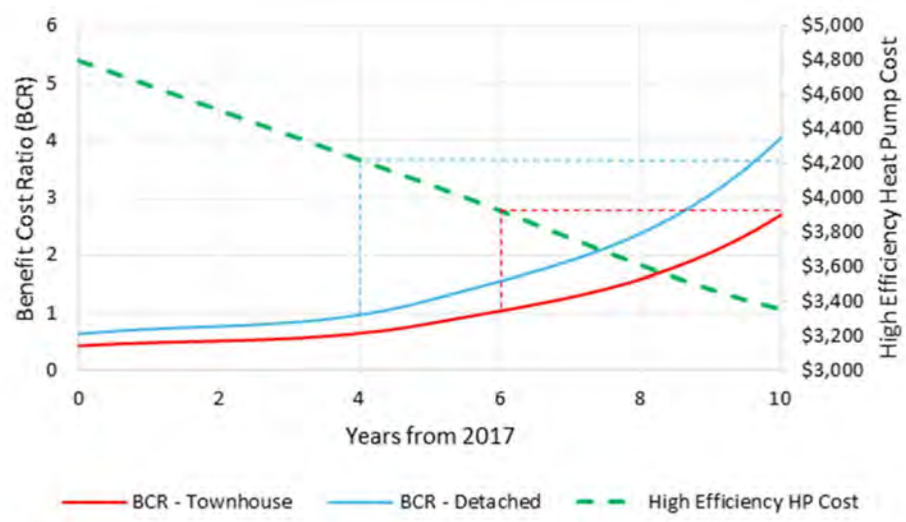

Figure 20: Projected future economics of high efficiency heat pumps (relative to standard heat pumps) based on an assumed learning curve for capital cost. It can be seen that the technology is expected to become cost effective relative to standard heat pumps win.

B.V Window Analysis Methodology

B.V.I Geometry

The Geometry for Window analysis was provided by the team at University of Wollongong (UOW). The floor plans were essentially the same as the models that were used in the Northern Climates analysis trajectory. However, the Window to wall ratio was set to the code minimum requirement for daylight and ventilation at 10% of the floor area. All other non – window elements are set as per the main baseline model.

B.V.II Glazing Selection

Glazing systems were selected to represent a series of real, readily available windows that varied in solar-thermal performance across the available range. The figure below encapsulates the range of window systems available, and the table below lists the performance values for window systems used for the study.

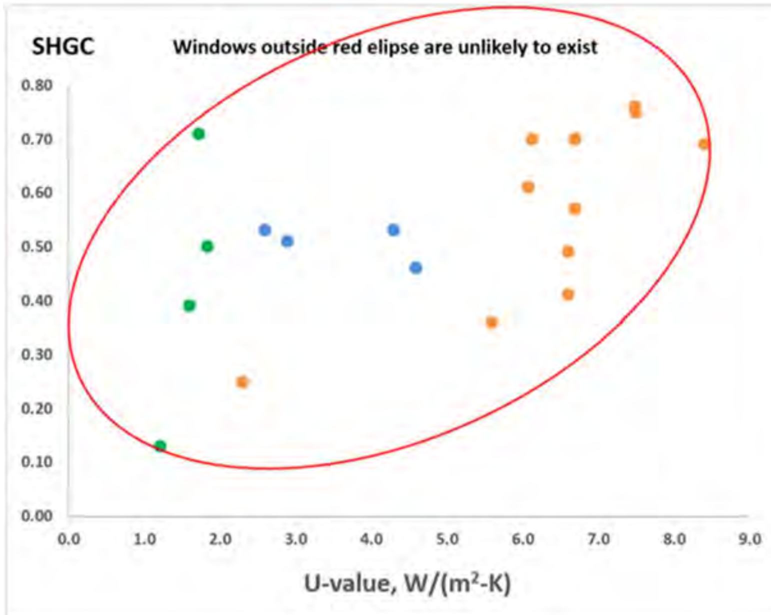

Figure 21: Window systems available for selection.

Table 122: Performance values used for the various window systems.

No	Description	Window ID	Type	U value	SHGC	Tv
Glass 1	Al frame, Single glazing (SG) clear glass	CAP-030-03	Sliding Window	6.4	0.7	0.75
Glass 2	Al frame, double glazing (DG), air fill, glass: High solar gain low-e - Clear	DOW-018-01	Sliding Window	4.2	0.62	0.66
Glass 3	Al frame, DG, Argon fill, glass: High solar gain low-E - Clear	DOW-018-04	Sliding Window	3.9	0.51	0.6
Glass 4	Composite frame, SG Low solar gain and low-e	STG-054015	Sliding Window	3.8	0.37	0.29
Glass 5	Timber frame, DG, Argon fill, glass: Clear - Clear	STG-022-09	Sliding Window	2.6	0.29	0.41
Glass 6	uPVC frame DG, air fill, glass: Low solar gain low-e - Clear	DEC-003-12	Sliding Window	1.9	0.24	0.24
Glass 7	Al Frame, Single Glazing low e	CAP-028-02	Sliding Window	6.85	0.3	0.07

B.VI Detailed Solar Methodology – Residential

The Building Code Energy Performance Trajectory study includes an analysis of the impact of PV generation. We have repeated the analysis using the method described in Appendix J of the *SP0016 Final Technical Report* for two additional climates relevant to Northern Australia: Darwin (Climate Zone 1) and Alice Springs (Climate Zone 3).

For PV analysis, Climate Zones 1 and 3 were represented by weather data from Darwin and Alice Springs coordinates to establish nominal solar irradiance levels.

Table 123: Maximum percentage of export of PV generation permissible while maintaining a BCR>1.25 extended to climate zones 1 and 3.

Building Type	Climate Zone	Cost ($)		Energy Use (kWh/year)							PV % Export				Export BCR			
		Base	Scenario	Base	Full Export	Full Internal	0yrs	5yr	10yr	15yr	0yr	5yr	10yr	15yr	0yr	5yr	10yr	15yr
Attached	CZ 1	$0	$8,625	0	1,824	5,733	3,435	2,426	1,824	1,824	58.8%	84.6%	100.0%	100.0%	1.25	1.25	1.35	1.42
Attached	CZ 3	$0	$8,625	0	1,984	6,235	3,448	2,426	1,984	1,984	65.6%	89.6%	100.0%	100.0%	1.25	1.25	1.47	1.55
Detached	CZ 1	$0	$30,188	0	6,385	20,066	12,022	8,492	6,385	6,385	58.8%	84.6%	100.0%	100.0%	1.25	1.25	1.35	1.42
Detached	CZ 3	$0	$30,188	0	6,944	21,823	12,070	8,491	6,944	6,944	65.6%	89.6%	100.0%	100.0%	1.25	1.25	1.47	1.55

The PV system capacity (kW) and yield (kWh) for each archetype are presented in the following figures for both conservative and accelerated deployment trajectories and shown in Table 124 through to Table 127.

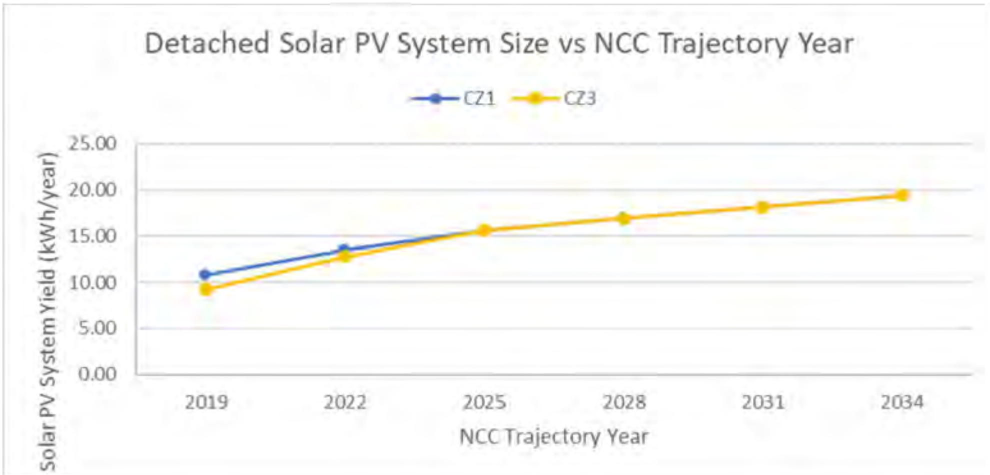

Figure 22: Conservative trajectories solar PV system rating (kW) for the detached archetype extended to climate zones 1 and 3.

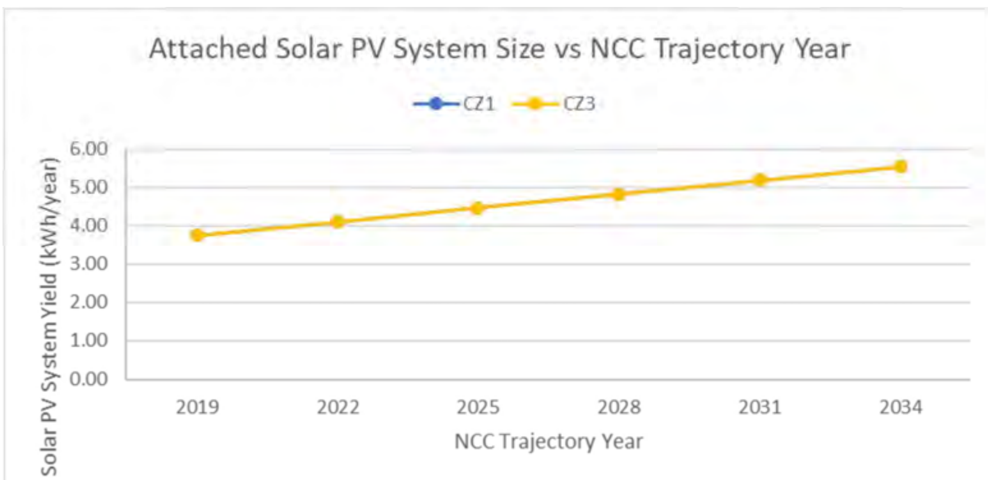

Figure 23: Conservative trajectories solar PV system rating (kW) for the attached archetype extended to climate zones 1 and 3.

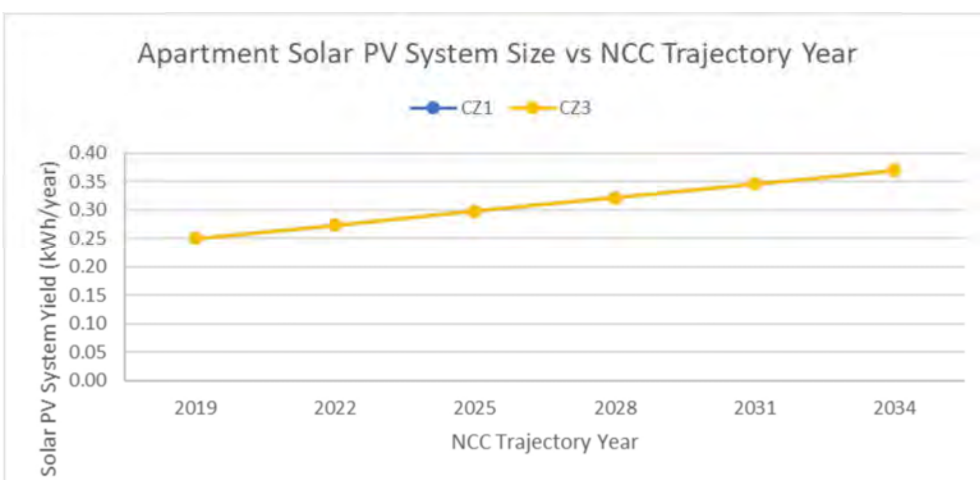

Figure 24: Conservative trajectories solar PV system rating (kW) for the apartment archetype extended to climate zones 1 and 3.

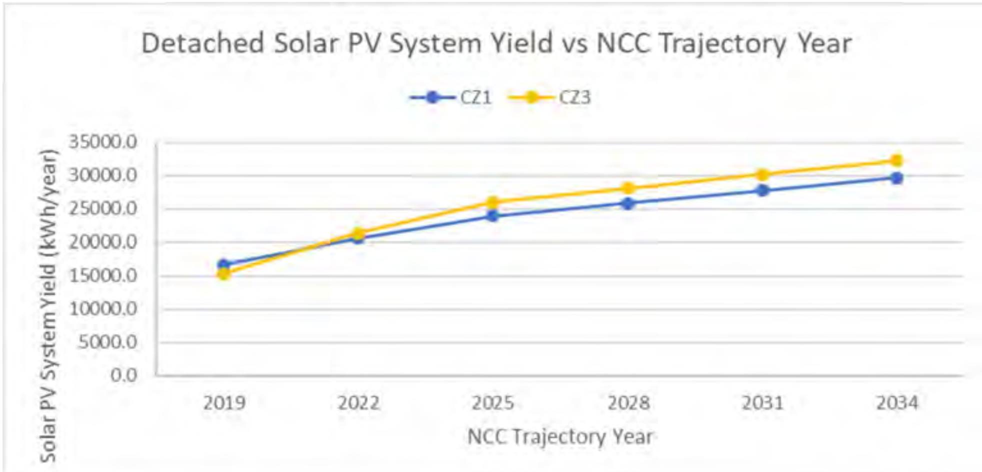

Figure 25: Conservative trajectories solar PV system yield (kWh) for the detached archetype extended to climate zones 1 and 3.

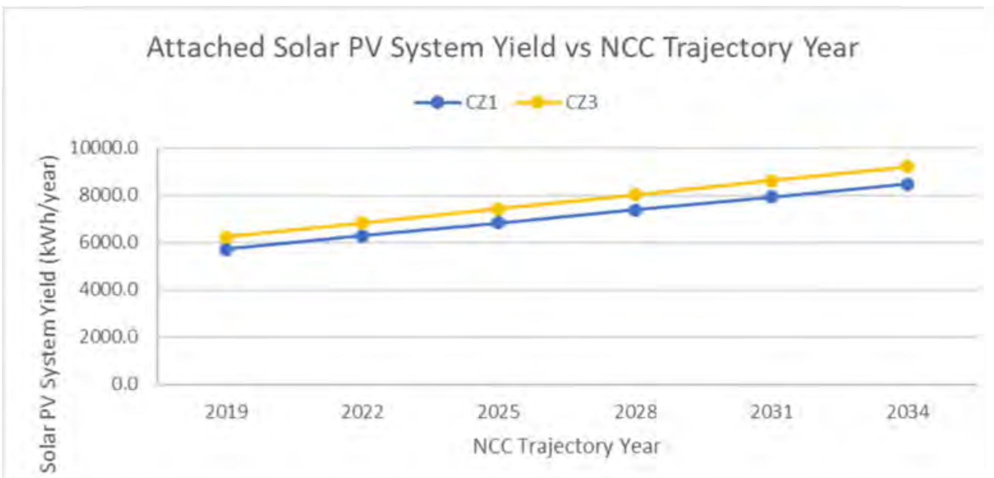

Figure 26: Conservative trajectories solar PV system yield (kWh) for the attached archetype extended to climate zones 1 and 3.

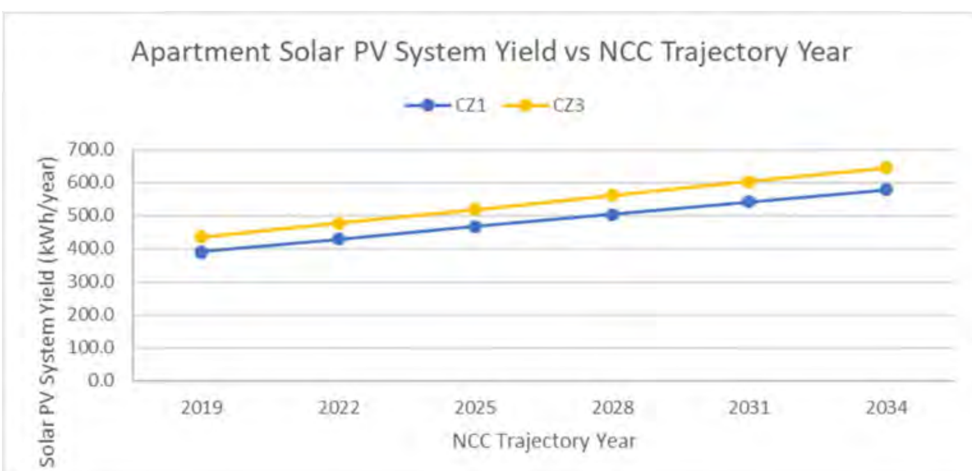

Figure 27: Conservative trajectories solar PV system yield (kWh) for the apartment archetype extended to climate zones 1 and 3.

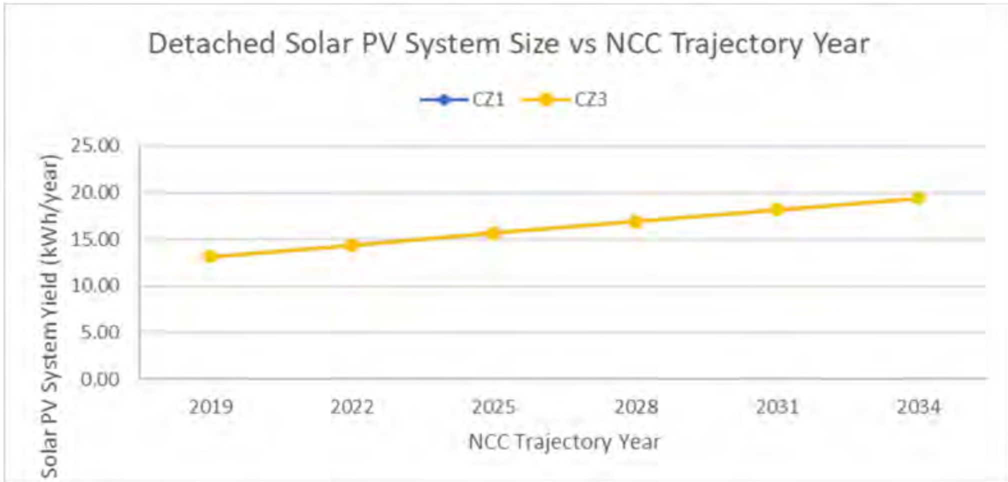

Figure 28: Accelerated trajectories solar PV system rating (kW) for the detached archetype extended to climate zones 1 and 3.

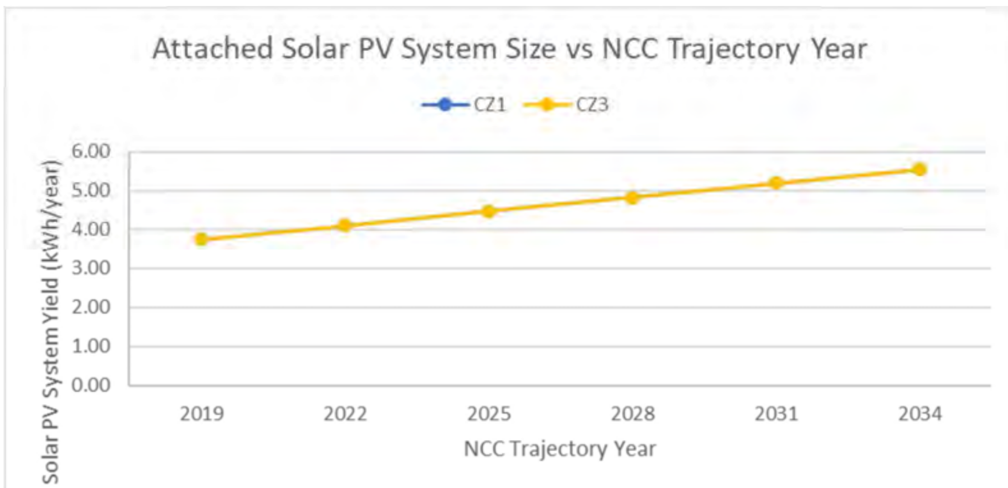

Figure 29: Accelerated trajectories solar PV system rating (kW) for the attached archetype extended to climate zones 1 and 3.

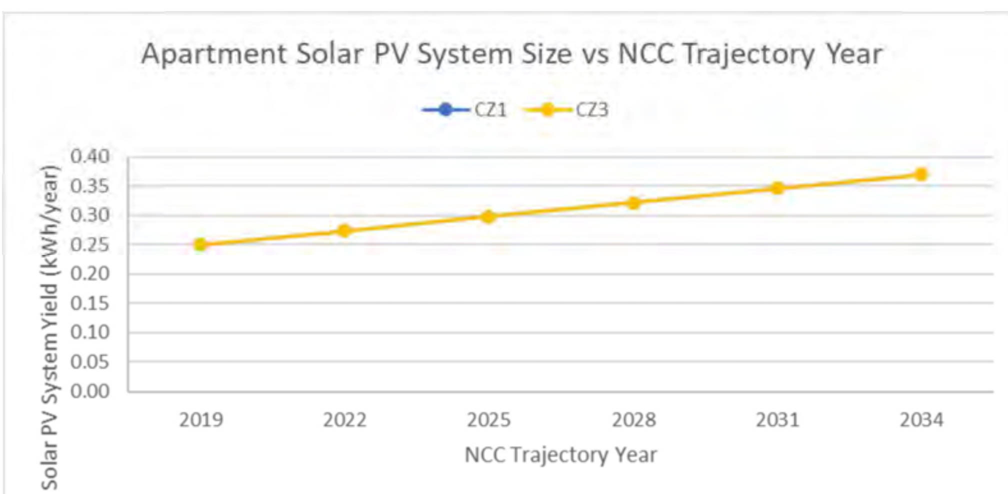

Figure 30: Accelerated trajectories solar PV system rating (kW) for the apartment archetype extended to climate zones 1 and 3.

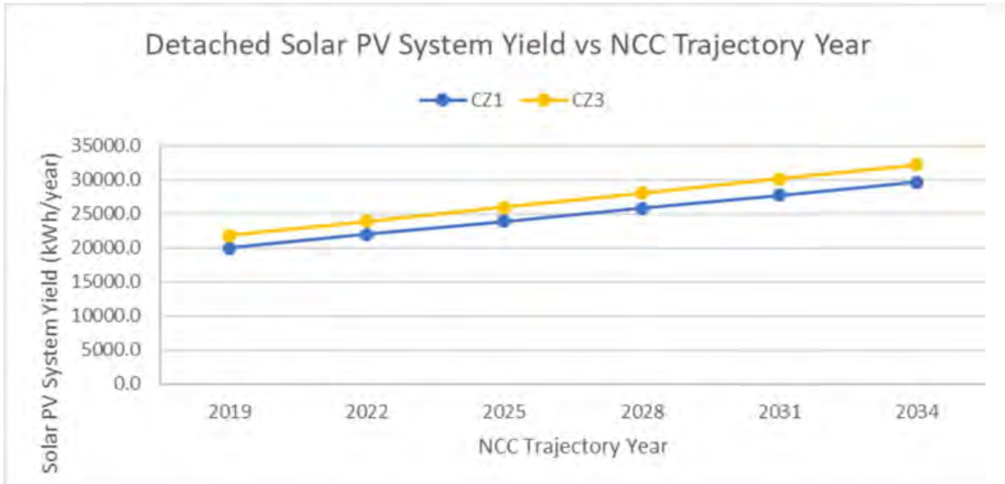

Figure 31: Accelerated trajectories solar PV system yield (kWh) for the detached archetype extended to climate zones 1 and 3.

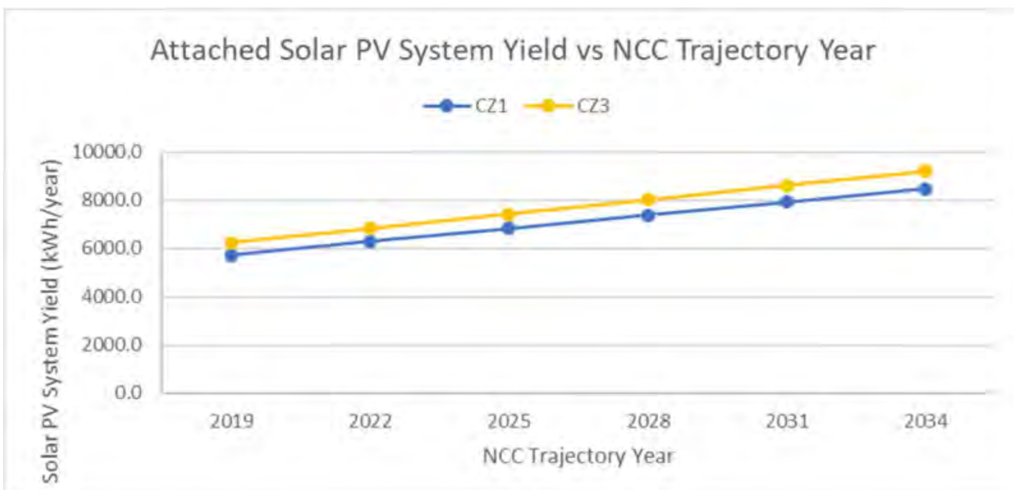

Figure 32: Accelerated trajectories solar PV system yield (kWh) for the attached archetype extended to climate zones 1 and 3.

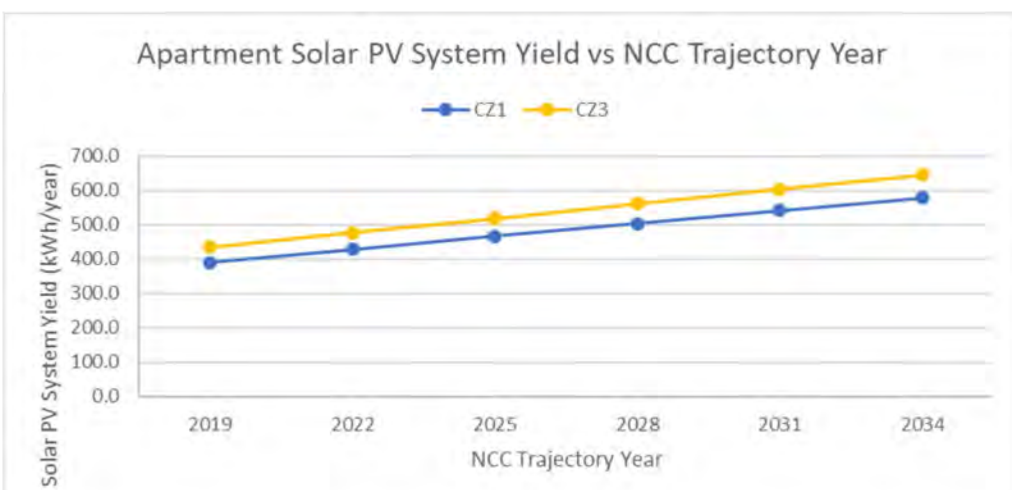

Figure 33: Accelerated trajectories solar PV system yield (kWh) for the apartment archetype extended to climate zones 1 and 3.

Table 124: Conservative trajectory PV array sizes extended to climate zones 1 and 3.

Archetype	Climate Zone	2019	2022	2025	2028	2031	2034
Apartment	CZ 1	0.25	0.274	0.298	0.322	0.346	0.37
	CZ 3	0.25	0.274	0.298	0.322	0.346	0.37
Attached	CZ 1	3.75	4.11	4.47	4.83	5.19	5.55
	CZ 3	3.75	4.11	4.47	4.83	5.19	5.55
Detached	CZ 1	10.875	13.485	15.645	16.905	18.165	19.425
	CZ 3	9.25	12.835	15.645	16.905	18.165	19.425

Table 125: Accelerated trajectory PV array sizes extended to climate zones 1 and 3.

Archetype	Climate Zone	2019	2022	2025	2028	2031	2034
Apartment	CZ 1	0.25	0.274	0.298	0.322	0.346	0.37
	CZ 3	0.25	0.274	0.298	0.322	0.346	0.37
Attached	CZ 1	3.75	4.11	4.47	4.83	5.19	5.55
	CZ 3	3.75	4.11	4.47	4.83	5.19	5.55
Detached	CZ 1	13.125	14.385	15.645	16.905	18.165	19.425
	CZ 3	13.125	14.385	15.645	16.905	18.165	19.425

Table 126: Conservative trajectory PV yield (kWh/year) extended to climate zones 1 and 3.

Archetype	Climate Zone	2019	2022	2025	2028	2031	2034
Apartment	CZ 1	391.3	428.8	466.4	503.9	541.5	579.1
	CZ 3	435.9	477.7	519.6	561.4	603.3	645.1
Attached	CZ 1	5733.3	6283.7	6834.0	7384.4	7934.8	8485.2
	CZ 3	6235.1	6833.7	7432.3	8030.8	8629.4	9228.0
Detached	CZ 1	16653.5	20627.6	23919.2	25845.5	27771.9	29698.3
	CZ 3	15339.5	21324.5	26012.9	28107.9	30202.9	32297.9

Table 127: Accelerated trajectory PV system yield (kWh/year) extended to climate zones 1 and 3.

Archetype	Climate Zone	2019	2022	2025	2028	2031	2034
Apartment	CZ 1	391.3	428.8	466.4	503.9	541.5	579.1
	CZ 3	435.9	477.7	519.6	561.4	603.3	645.1
Attached	CZ 1	5733.3	6283.7	6834.0	7384.4	7934.8	8485.2
	CZ 3	6235.1	6833.7	7432.3	8030.8	8629.4	9228.0
Detached	CZ 1	20066.4	21992.8	23919.2	25845.5	27771.9	29698.3
	CZ 3	21822.9	23917.9	26012.9	28107.9	30202.9	32297.9