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Class 2 dwelling modelling results

Introduction

The following memorandum is provided to summarise the results of the typical 2018 Class 2 dwellings for both Increases 1 and 2 as described below.

Approach

Due to previous identified limitations in both the residential baseline study (RBS) and the NatHERS operational profiles, the approach taken to estimate the heating and cooling loads was based on the following methodology:

1. Use the NatHERS heating/cooling loads as modelled by the AusZEH software;
2. Modify the occupancy profile and thermostat settings to match the Composite Weekday Profile and cooling thermostat settings adopted in the RBS;
3. Apply the heating and cooling efficiencies as provided by the RBS

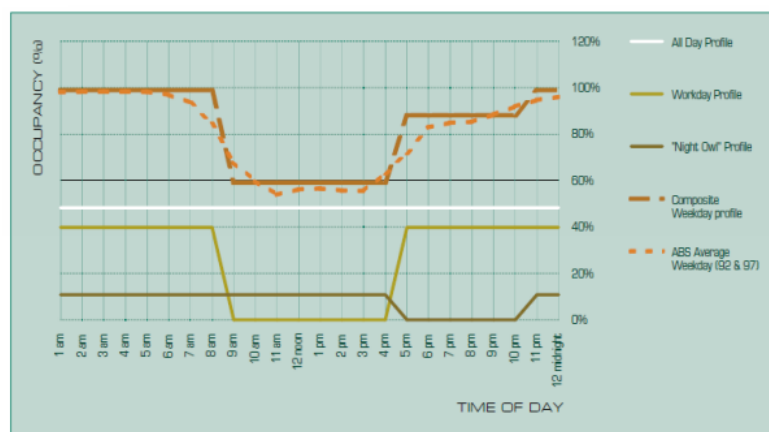


Figure 1: RBS Composite weekday profile (brown dotted line)

Thermostat settings were altered based on location as follows:

Table 1. Altered thermostat settings

NCC Climate Zone	1	2	3	4	5	6	7
Thermostat Setting	24	23.5	23.5	23	23	23	23

Increase 1

Described in the document 'Trajectory for Low Energy Homes – draft document for stakeholder input,' provided by the Department of the Environment and Energy in June 2018, Increase 1 consists of business as usual and assumes proposed NCC 2019 changes (Table 3).

Table 2. Increase 1

Class 2 Building	Equivalent to: <ul style="list-style-type: none"> • 5.0 star minimum, 6.0 star average (with regional variations between jurisdictions and NCC climate zones, and good passive solar) • Heating cap • Cooling cap
Class 2 Services	Overall carbon/energy load equivalent to the combined use of: <ul style="list-style-type: none"> • 4* gas or 3.5* electric conditioning • Gas or electric hot water • LED lighting • Energy loading to allow for cooking and plugged appliances • Renewable energy uptake as per AEMO data

Source: Department of the Environment and Energy

The star ratings as determined under the NatHERS protocol are identified in Table 3 **Error! Reference source not found.** below.

Table 3 Increase 1 Star Ratings (modelled as per NatHERS protocol)

Location	NatHERS Climate Zone	Required Average Rating	NatHERS Portal data Average Rating	Increase 1 Average Rating
Canberra	24	6.0	7.5	6.6
Wagga Wagga	20	5.5	5.9	5.8
Nowra	18	5.5	5.9	5.9
Sydney East	17	5.5	5.9	5.9
Sydney	56	5.5	5.9	5.7
Darwin	1	3.5	7.5	5.7
Brisbane	10	5.0	5.8	5.4
Cairns	32	5.0	5.8	6.0
Adelaide	16	6.0	6.3	6.1
Hobart	26	6.0	6.9	6.5
Melbourne	21	6.0	6.4	6.3
Broome	33	6.0	6.7	6.0

Location	NatHERS Climate Zone	Required Average Rating	NatHERS Portal data Average Rating	Increase 1 Average Rating
Albany	58	6.0	6.7	6.0
Perth	13	6.0	6.7	6.1
Swanbourne	52	6.0	6.7	6.1

Source: AECOM

The results for each location for Increase 1 are as shown in Table 2 below. Results are provided as an average of the apartments modelled.

Table 4. Increase 1 – Class 2 2018 - Results

Location	NatHERS Climate Zone	Total Annual Values						PV Offsets			
		Operating Cost to consumer (\$)	LPG (MJ)	Gas (MJ)	Elec (MJ)	Total Energy (MJ)	GHG emissions (kgCO2-e)	PV array size offset elec (kWp)	PV offset elec capital cost (\$)	PV array size offset emissions (kWp)	PV offset emissions capital cost (\$)
Canberra	24	\$983	-	8,521	4,509	23,030	4,268	2.88	\$3,188	3.21	\$3,553
Wagga Wagga	20	\$1,769	-	8,559	16,120	24,680	4,695	3.31	\$3,775	3.66	\$4,167
Nowra	18	\$1,656	-	8,559	14,878	23,437	4,367	3.25	\$3,700	3.61	\$4,116
Sydney East	17	\$1,621	-	8,559	14,493	23,052	4,265	3.22	\$3,559	3.59	\$3,969
Sydney	56	\$1,612	-	8,559	14,393	22,952	4,239	3.19	\$3,534	3.56	\$3,944
Darwin	1	\$2,079	6,970	-	24,401	31,372	5,370	4.44	\$11,549	4.82	\$12,534
Brisbane	10	\$1,738	-	639	19,638	20,276	5,106	3.87	\$4,775	3.90	\$4,806
Cairns	32	\$2,100	-	8,519	17,999	26,518	5,088	3.35	\$4,416	3.66	\$4,833
Adelaide	16	\$1,971	-	8,576	15,034	23,609	2,864	3.05	\$3,663	3.61	\$4,331
Hobart	26	\$1,349	-	8,602	15,742	24,345	1,186	4.05	\$5,475	6.46	\$8,737
Melbourne	21	\$1,690	-	8,548	14,441	22,988	5,174	3.27	\$4,381	3.57	\$4,788
Broome	33	\$1,907	-	8,526	20,617	29,142	4,792	3.44	\$4,947	3.78	\$5,446
Albany	58	\$1,433	-	8,526	14,332	22,857	3,465	3.22	\$3,559	3.69	\$4,075
Perth	13	\$1,445	-	8,526	14,498	23,023	3,500	2.70	\$2,589	3.08	\$2,961
Swanbourne	52	\$1,402	-	8,526	13,923	22,448	3,378	2.59	\$2,487	2.98	\$2,858

Source: AECOM

Increase 2

Described in the document 'Trajectory for Low Energy Homes – draft document for stakeholder input' provided by the Department of the Environment and Energy in June 2018, Increase 2 is the next potential step change in energy/emissions efficiency that could be considered within a national legislation.

Table 4. Increase 2

Class 2 Building	<ul style="list-style-type: none"> (no change)
Class 2 Services	<p>Overall carbon/energy load equivalent to the combined use of:</p> <ul style="list-style-type: none"> 5* gas or 4* electric conditioning Heat pump hot water LED lighting Energy loading to allow for cooking and plugged appliances Renewable energy

Upgrades to achieve the 0.5 Star increase were taken on a case by case basis. To understand their rating increase, they were first modelled using the NatHERS protocol, before applying the thermostat changes. A summary of upgrades, capital costs and simple paybacks are illustrated in Table 5 below.

It was intended to apply every upgrade uniformly to each of the 12 apartments (6 roof and 6 mid) in each location, however this was not feasible due to the highly variant star ratings. In some locations therefore, changes have been applied to only some of the apartments in order to comply with the overall average increase of 0.5 stars.

Results illustrated in Table 6 are provided as an average of the apartments modelled.

Table 5. Upgrades to achieve Increase 2 – Class 2 2018

Location	NatHERS Climate Zone	Materials Upgrade	Appliances Upgrade	Average Star Rating Increase	Capital Costs			Simple Payback (years) per apartment average
					Thermal (\$)	Appliances (\$ total)	Total (\$)	
Canberra	24	All apartments: Low-e → double glazing	Hot water to heat pump COP 4.16 Heating to RCAC COP 3.92 Cooling to RCAC EER 5.63	0.52	-	\$1,960	\$1,960	12
Wagga Wagga	20	Mid apartments: 1,4 walls insulated to R1 → R1.5 Mid apartments: 2,3 walls insulated R0 → R1.5 Mid apartments: 5-6 no change Roof apartments: 1,4,5,6 no change Roof apartments: 2,3 walls R1, Roof R1.5 → walls R1.5, roof R2.5	Hot water to heat pump COP 4.64 Heating to RCAC COP 4.56 Cooling to RCAC EER 5.37	0.50	\$116	\$1,960	\$2,076	11

Location	NatHERS Climate Zone	Materials Upgrade	Appliances Upgrade	Capital Costs			Simple Payback (years) per apartment average
				Average Star Rating Increase	Thermal (\$)	Appliances (\$ total)	
Nowra	18	Mid apartments: 1,4 walls insulated to R1 → R1.5 Mid apartments: 2,3 walls insulated R0 → R1.5 Mid apartments: 5-6 no change Roof apartments: 1,4,5,6 no change Roof apartments: 2,3 walls R1, Roof R1.5 → walls R1.5, roof R2.5	Hot water to heat pump COP 4.64 Heating to RCAC COP 4.56 Cooling to RCAC EER 5.37	0.54	\$116	\$1,960	\$2,076 12
Sydney East	56	Mid apartments: 1,4 walls insulated to R1 → R1.5 Mid apartments: 2,3 walls insulated R0 → R1.5 Mid apartments: 5-6 no change Roof apartments: 1,4,5,6 no change Roof apartments: 2,3 walls R1, Roof R1.5 → walls R1.5, roof R2.5	Hot water to heat pump COP 4.64 Heating to RCAC COP 4.56 Cooling to RCAC EER 5.37	0.55	\$85	\$1,960	\$2,045 12
Sydney	17	Mid apartments: 1,4 walls insulated to R1 → R1.5 Mid apartments: 2,3 walls insulated R0 → R1.5 Mid apartments: 5-6 no change Roof apartments: 1,4,5,6 no change Roof apartments: 2,3 walls R1, Roof R1.5 → walls R1.5, roof R2.5	Hot water to heat pump COP 4.64 Heating to RCAC COP 4.56 Cooling to RCAC EER 5.37	0.49	\$93	\$1,960	\$2,053 13
Darwin	1	Mid apartments: 1-6 no change Roof apartments: 1, 2, 3 roof insulation R0 → R3.5 Roof apartments: 4,5,6 no change	Hot water to heat pump COP 5.56 Heating to RCAC COP 5.21 Cooling to RCAC EER 5.65	0.70	\$314	\$1,960	\$2,274 7

Location	NatHERS Climate Zone	Materials Upgrade	Appliances Upgrade	Average Star Rating Increase	Capital Costs			Simple Payback (years) per apartment average
					Thermal (\$)	Appliances (\$ total)	Total (\$)	
Brisbane	10	Mid apartments: 1-6 single → low-e glazing Roof apartments: 1-6 single → low-e glazing Roof R2.5 → R4.1	Hot water to heat pump COP 4.85 Heating to RCAC COP 5.2 Cooling to RCAC EER 6.39	0.46	\$2,003	\$1,960	\$3,963	35
Cairns	32	Mid apartments: 1-6 no change Roof apartments: 1-6 roof R0→R1	Hot water to heat pump COP 4.85 Heating to RCAC COP 5.14 Cooling to RCAC EER 6.04	0.42	\$203	\$1,960	\$2,163	5
Adelaide	16	Mid apartments: 1-6 walls R2.0 →R2.5, single → low-e glazing Roof apartments: 1-4 walls R2.0 →R2.5, single → low-e glazing Roof apartments: 5-6 walls R2.0 →R2.5	Hot water to heat pump COP 4.53 Heating to RCAC COP 5.21 Cooling to RCAC EER 5.32	0.52	\$1,376	\$1,960	\$3,336	14
Hobart	26	Mid & Roof apartments: 1-6 walls insulated to R1 → R2	Hot water to heat pump COP 4.08 Heating to RCAC COP 5.08 Cooling to RCAC EER 5.68	0.56	\$77	\$1,960	\$2,037	9
Melbourne	21	Mid apartments: 1-5 improved single glazing → double glazing Mid apartments: 6 no change Roof apartments: 1-5 improved single glazing → double glazing Roof apartments: 6 no change	Hot water to heat pump COP 4.41 Heating to RCAC COP 5.22 Cooling to RCAC EER 5.5	0.54	\$131	\$1,960	\$2,091	25

Location	NatHERS Climate Zone	Materials Upgrade	Appliances Upgrade	Average Star Rating Increase	Capital Costs			Simple Payback (years) per apartment average
					Thermal (\$)	Appliances (\$ total)	Total (\$)	
Broome	33	Mid & Roof apartments: 1-6 single → toned single glazing	Hot water to heat pump COP 5.48 Heating to RCAC COP 5.21 Cooling to RCAC EER 5.48	0.76	\$891	\$1,960	\$2,851	9
Albany	58	Mid apartments: 1-5 single → improved single glazing Mid apartments: 6 single → double glazing (as revised base case) Roof apartments: 1-5 single → improved single glazing Roof apartments: 6 single → double glazing (as revised base case)	Hot water to heat pump COP 4.67 Heating to RCAC COP 5.16 Cooling to RCAC EER 5.4	0.54	\$1,778	\$1,960	\$3,738	17
Perth	13	Mid apartments: 1-6 single → improved single glazing Roof apartments: 1-5 single → improved single glazing Roof apartments: 6 single → improved double glazing (as revised base case)	Hot water to heat pump COP 4.67 Heating to RCAC COP 5.16 Cooling to RCAC EER 5.4	0.68	\$2,047	\$1,960	\$4,007	18
Swanbourne	52	Mid apartments: 1-6 Walls R1.5 → R2.5, single glazing → improved single glazing Roof apartments: 1-4 Walls R1.5 → R2.5, single → improved single glazing Roof apartments: 5-6 Walls R1.5 → R2.5, single → double glazing	Hot water to heat pump COP 5.48 Heating to RCAC COP 5.21 Cooling to RCAC EER 5.48	0.57	\$1,671	\$1,960	\$3,631	16

Source: AECOM

Table 6: Increase 2 – Class 2 2018 - Results

Location	NatHERS Climate Zone	Total Annual Values					PV Offsets				
		Operating Cost to consumer (\$)	LPG (MJ)	Gas (MJ)	Elec (MJ)	Total Energy (MJ)	GHG emissions (kgCO ₂ -e)	PV array size offset elec (kWp)	PV offset capital cost (\$)	PV array size offset emissions (kWp)	PV offset emissions capital cost (\$)
Canberra	24	\$798	-	641	15,535	16,176	4,132	3.08	\$3,413	3.11	\$3,441
Wagga Wagga	20	\$1,559	-	679	16,880	17,559	4,489	3.47	\$3,953	3.50	\$3,984
Nowra	18	\$1,469	-	679	15,885	16,564	4,227	3.47	\$3,951	3.50	\$3,984
Sydney East	17	\$1,433	-	679	15,487	16,167	4,122	3.44	\$3,803	3.47	\$3,835
Sydney	56	\$1,440	-	679	15,565	16,244	4,142	3.45	\$3,822	3.48	\$3,854
Darwin	1	\$1,697	666	-	23,284	23,950	4,762	4.24	\$11,020	4.27	\$11,114
Brisbane	10	\$1,380	-	639	15,497	16,135	4,036	3.06	\$3,768	3.08	\$3,799
Cairns	32	\$1,583	-	639	17,846	18,485	4,643	3.32	\$4,379	3.34	\$4,410
Adelaide	16	\$1,699	-	695	15,838	16,534	2,588	3.22	\$3,859	3.26	\$3,913
Hobart	26	\$1,073	-	722	16,241	16,963	804	4.17	\$5,648	4.38	\$5,922
Melbourne	21	\$1,588	-	667	15,248	15,915	5,032	3.45	\$4,626	3.48	\$4,657
Broome	33	\$1,542	-	646	20,082	20,728	4,273	3.35	\$4,819	3.37	\$4,857
Albany	58	\$1,182	-	646	15,317	15,963	3,267	3.45	\$3,803	3.48	\$3,843
Perth	13	\$1,197	-	646	15,509	16,154	3,307	2.89	\$2,770	2.91	\$2,798
Swanbourne	52	\$1,142	-	646	14,784	15,430	3,154	2.75	\$2,641	2.78	\$2,669

Source: AECOM

Apartment Performances

Table 7 and Table 8 below further breakdown the NatHERS star results into minimum performance and averages per size of apartment for both Increase 1 and Increase 2.

Table 7. Increase 1 – Class 2 2018 – Minimum Performance and results by no. bedrooms

Location	NatHERS Climate Zone	Average Performance	Minimum Performing Dwelling	Minimum Performing Dwelling Result	1 Bedroom Average	2 Bedroom Average	3 Bedroom Average
Canberra	24	6.6	Apt 6 Roof	5.0	7.4	6.6	5.2
Wagga Wagga	20	5.8	Apt 5 Roof	5.5	5.7	5.9	5.7
Nowra	18	5.8	Apt 3 Roof	5.5	5.7	6.0	5.6
Sydney East	56	5.9	Apt 5 Roof	5.5	5.9	5.8	5.8
Sydney	17	5.9	Apt 6 Roof	5.5	5.9	5.9	5.8
Darwin	1	5.7	Apt 3 Roof	3.9	5.7	6.0	4.7

Brisbane	10	5.4	Apt 6 Roof	4.0	7.0	4.8	4.1
Cairns	32	6.0	Apt 4 Roof	4.0	7.1	5.5	5.2
Adelaide	16	6.1	Apt 6 Roof	5.1	6.8	5.8	5.2
Hobart	26	6.5	Apt 6 Roof	5.4	7.4	6.3	5.2
Melbourne	21	6.3	Apt 6 Roof	5.2	7.0	6.0	5.4
Broome	33	5.9	Apt 6 Roof	5.0	7.3	6.4	5.1
Albany	58	6.0	Apt 6 Roof	5.2	7.0	5.9	5.5
Perth	13	6.1	Apt 5 Mid	5.0	7.6	6.0	5.1
Swanbourne	52	6.1	Apt 1 Roof	4.7	7.1	5.7	5.2

Table 8. Increase 2 – Class 2 2018 – Minimum Performance and results by no. bedrooms

Location	NatHERS Climate Zone	Average Performance	Minimum Performing Dwelling	Minimum Performing Dwelling Result	1 Bedroom Average	2 Bedroom Average	3 Bedroom Average
Canberra	24	7.2	Apt 6 Roof	4.0	7.9	7.1	5.7
Wagga Wagga	20	6.3	Apt 5 Roof	5.5	7.0	6.0	5.7
Nowra	18	6.4	Apt 5 Roof	5.5	7.2	6.1	5.6
Sydney East	56	6.4	Apt 5 Roof	5.5	7.2	6.1	5.8
Sydney	17	6.4	Apt 6 Roof	5.5	7.2	6.0	5.8
Darwin	1	6.3	Apt 6 Roof	4.4	7.3	6.3	4.7
Brisbane	10	5.9	Apt 6 Roof	4.3	7.5	5.3	4.4
Cairns	32	6.4	Apt 6 Roof	4.4	7.5	6.1	5.2
Adelaide	16	6.6	Apt 6 Roof	5.3	7.4	6.5	5.3
Hobart	26	7.0	Apt 6 Roof	5.4	7.8	7.0	5.6
Melbourne	21	6.8	Apt 6 Roof	5.2	7.6	6.8	5.4
Broome	33	6.6	Apt 6 Roof	5.0	7.4	6.5	5.3
Albany	58	6.5	Apt 6 Roof	5.2	7.4	6.3	5.5
Perth	13	6.8	Apt 5 Roof	5.1	7.8	6.5	5.4
Swanbourne	52	6.7	Apt 1 Roof	5.2	7.7	6.3	5.7