

Darwin Home Comfort Rating System design and analysis

DATA ANALYSIS, SIMULATIONS, AND RATING RECOMMENDATIONS

QUT Presentation for Darwin Home Comfort Rating Forum 30 March 2023
Assoc. Professor Dr Wendy Miller

'0' to '10' Comfort Rating bandwidths developed through analysis of:

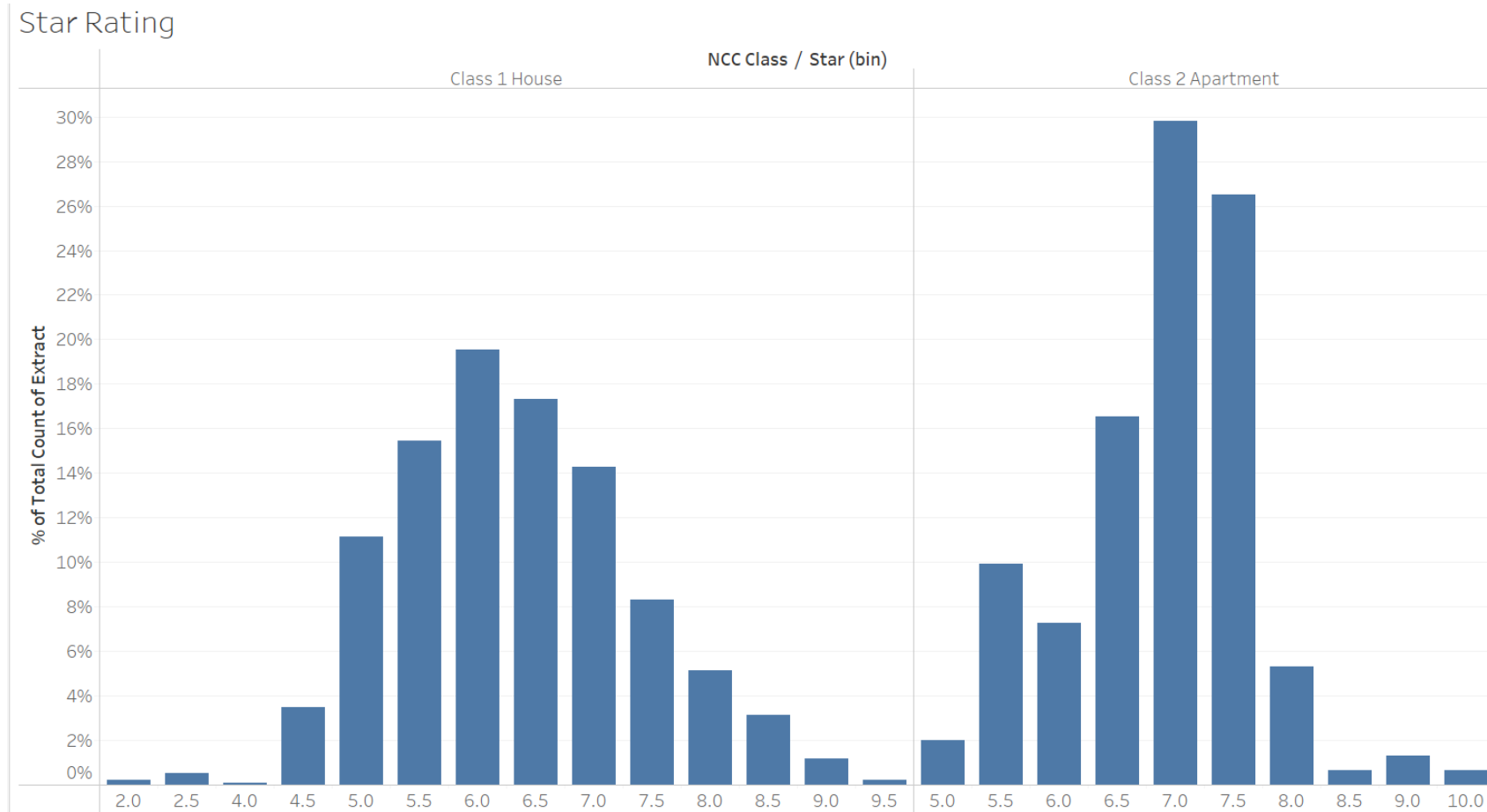
Australian Housing Dataset (AHD):

- CSIRO re-modelled 1043 NT dwellings (NatHERS Climate Zone 1) that had Energy Ratings over 5 stars and NatHERS certificates issued in 2020 and 2021

QUT Simulations:

- Modelled 132 variants of 4 houses, 2 townhouse and 2 apartment designs
- Also modified best performing living room and bedroom to examine the lowest Degree hours of Discomfort (DDs) that could be achieved

NatHERS Climate Zone 1 Class 1 and Class 2 energy rating distribution (1103 dwellings in 2020 and 2021)



AHD Data Analysis - Comfort

Data was analysed by

% of hours (total hours in year) > threshold – representing the duration of overheating

Degree hours of Discomfort (DD, occupied hours) – representing the magnitude and duration of overheating

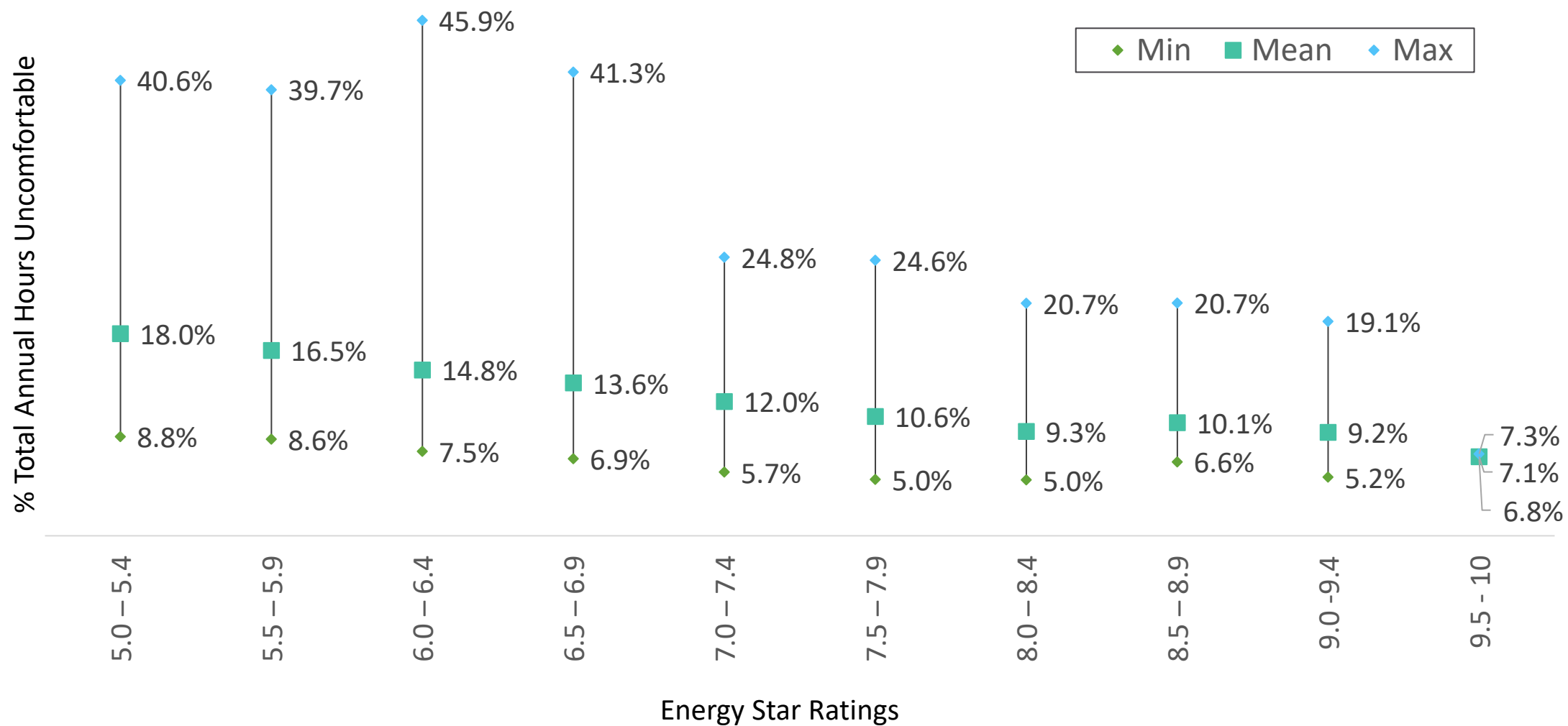
Performance indicator options were analysed based on the occupancy schedules utilised in NatHERS

Living Zones – 07:00 – 24:00 = 17 hrs/day = 6205 occupied annual hours

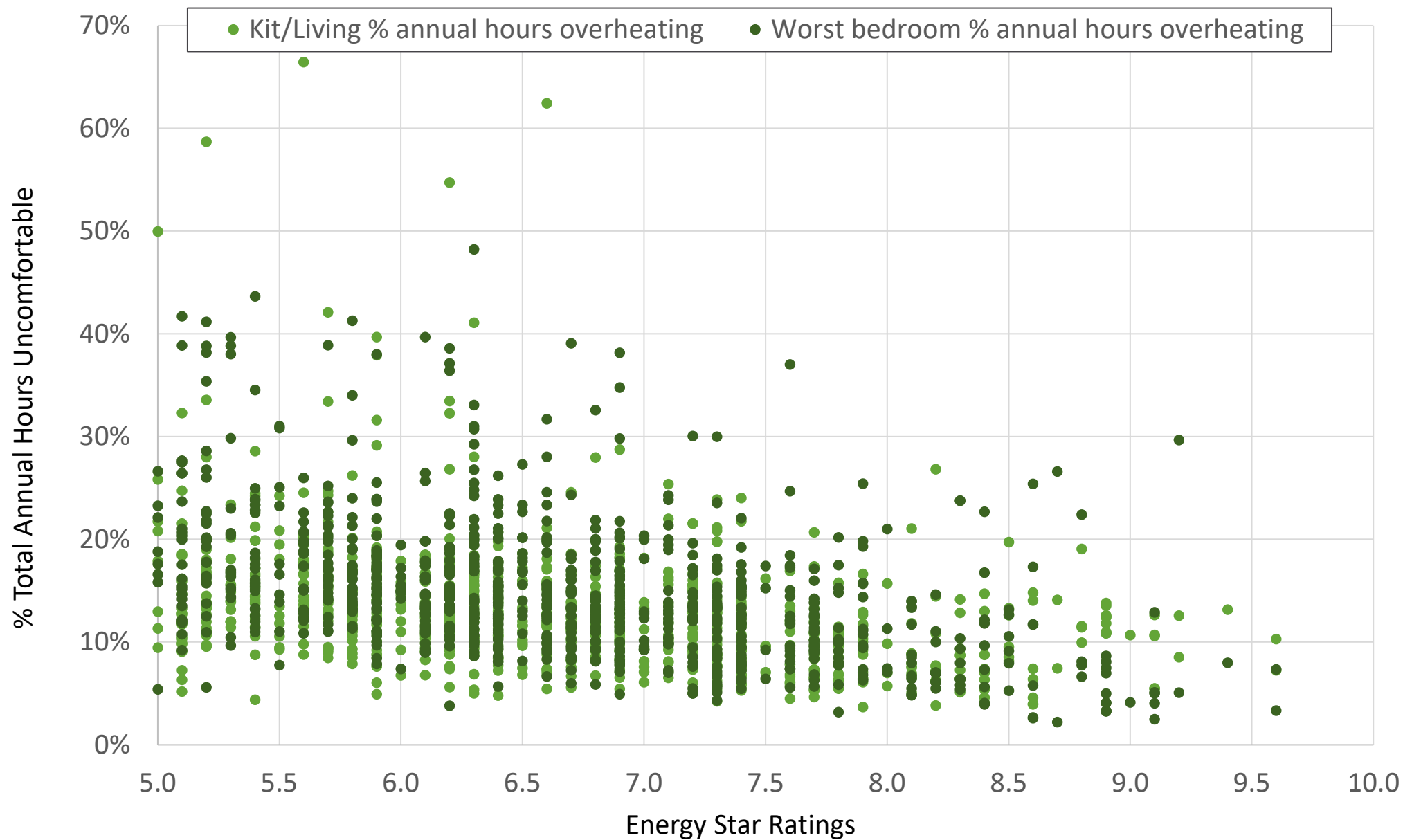
Bed Zones – 16:00 – 09:00 = 17 hrs/day = 6205 occupied annual hours

893 Darwin Houses and Townhouses (Class 1) Energy Rated in 2020 and 2021

Average Overheating % (sum of the living/kitchen zone and the worst bedroom)

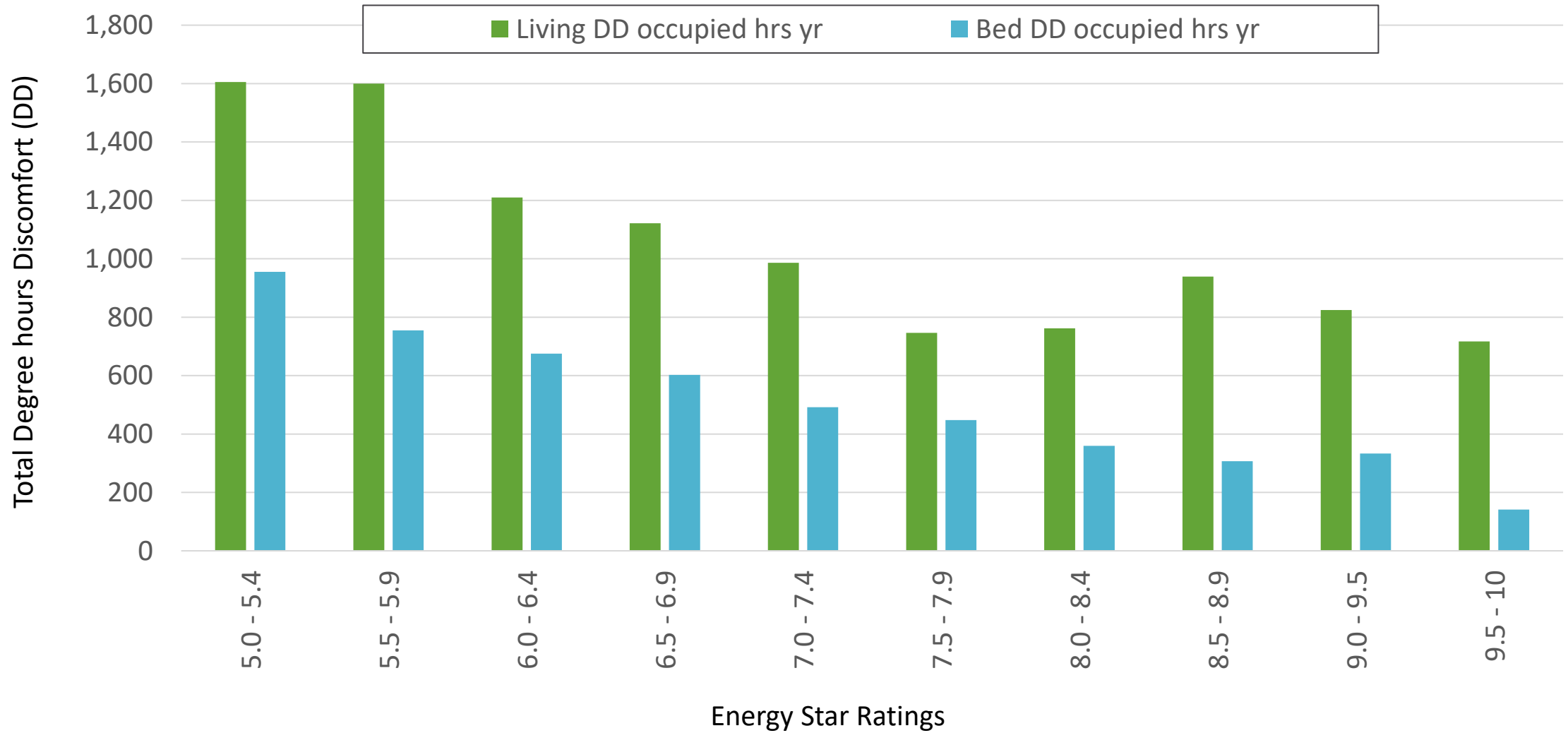


893 Darwin Houses (Class 1) Energy Rated in 2020 and 2021

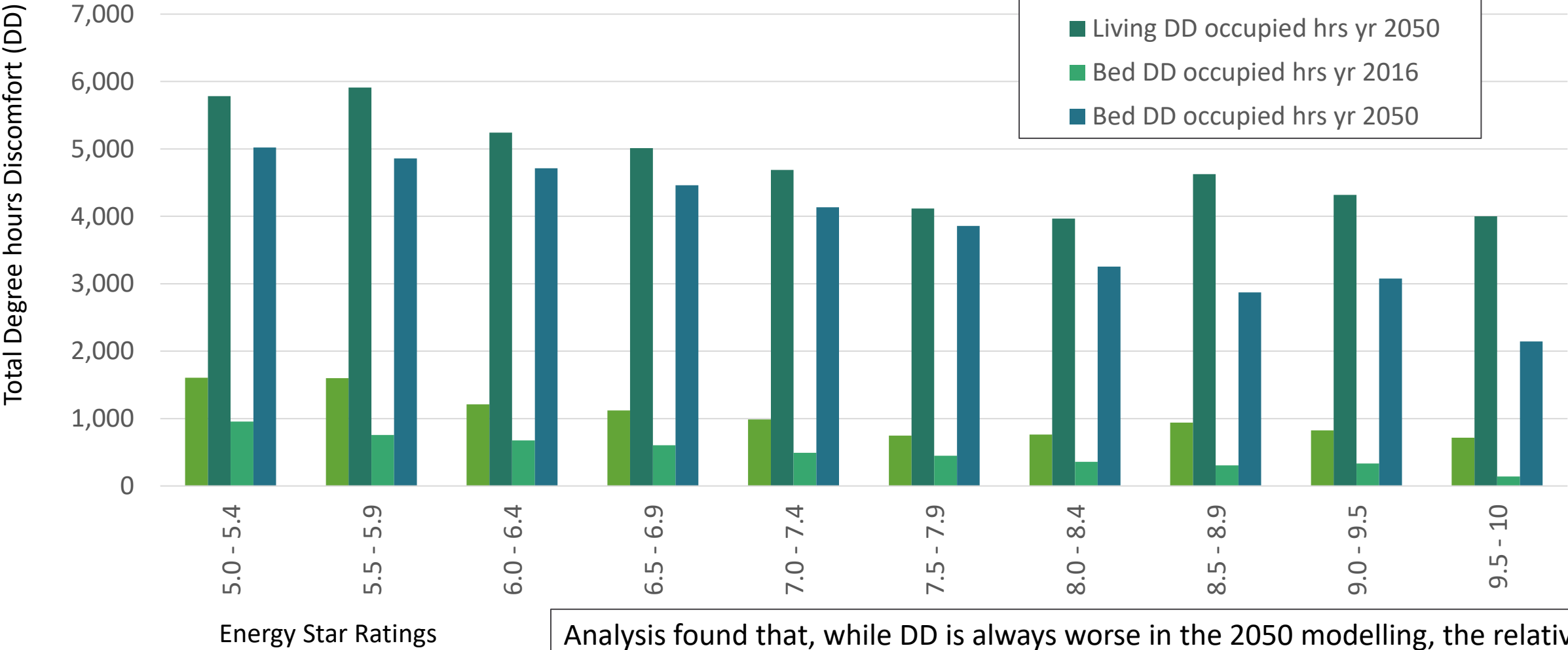


893 Darwin Detached Houses (Class 1) Energy Rated in 2020 and 2021

Average total DD - occupied hours



2050 Climate Scenario Modelling Results - CSIRO 2050 'RCP 8.5' Scenario
893 Darwin Detached Houses (Class 1) Energy Rated in 2020 and 2021
Average total DD - occupied hours

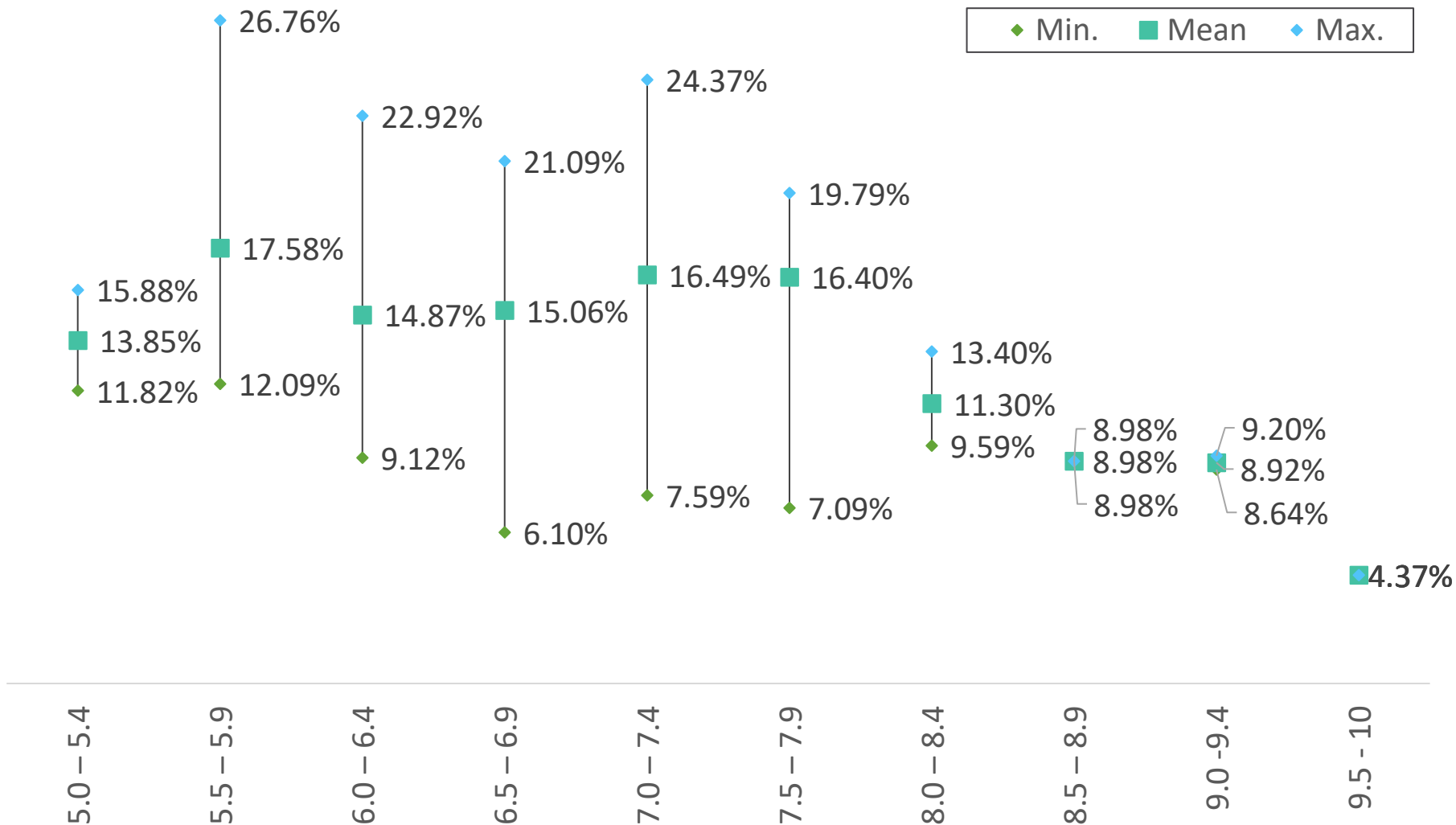


Analysis found that, while DD is always worse in the 2050 modelling, the relative comfort rankings between designs doesn't change significantly

150 Darwin Apartments (Class 2) Energy Rated in 2020 and 2021

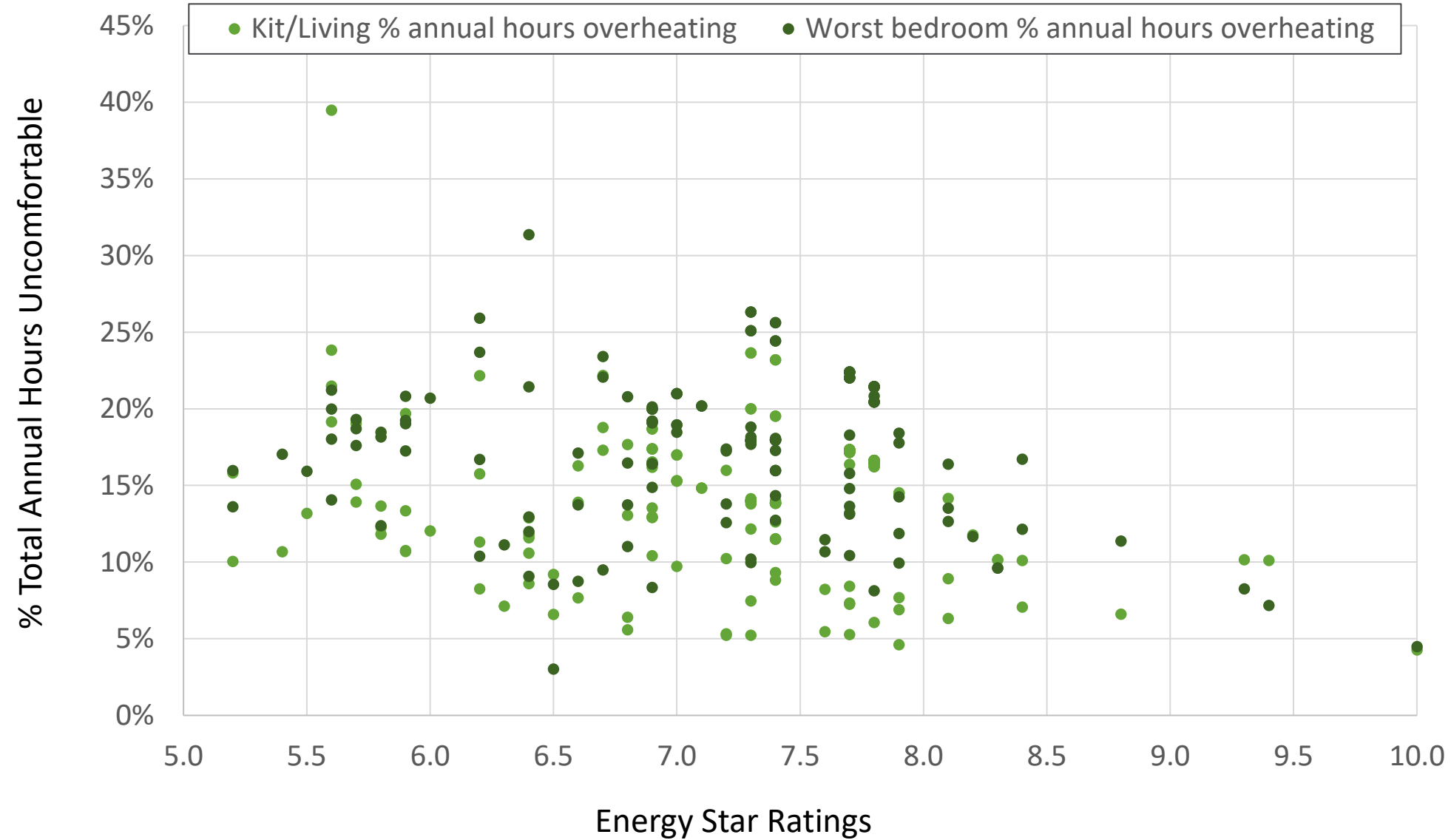
Average overheating % (sum of the living/kitchen zone and the worst bedroom)

% Total Annual Hours Uncomfortable

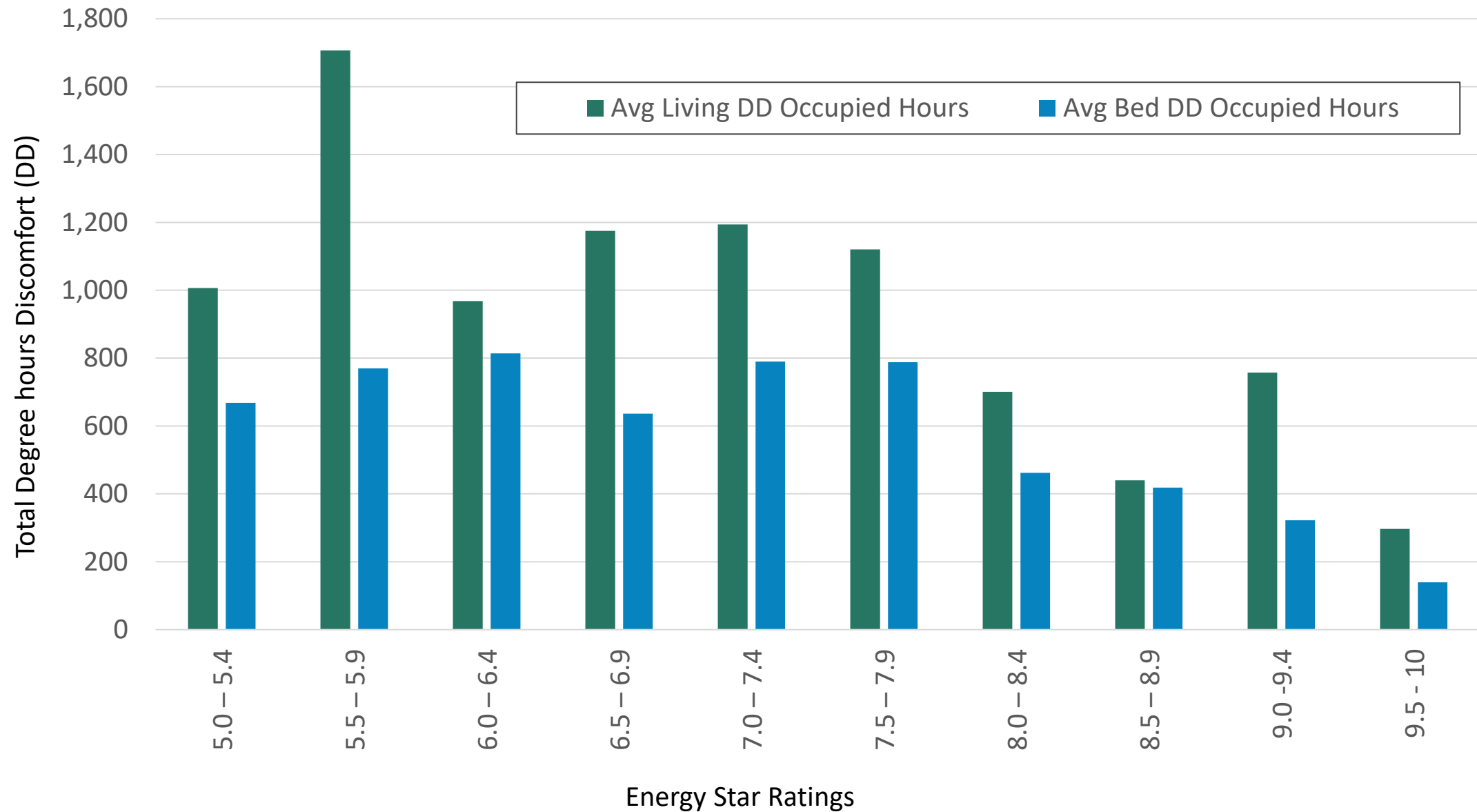


Energy Star Ratings

150 Darwin Apartments (Class 2) Energy Rated in 2020 and 2021



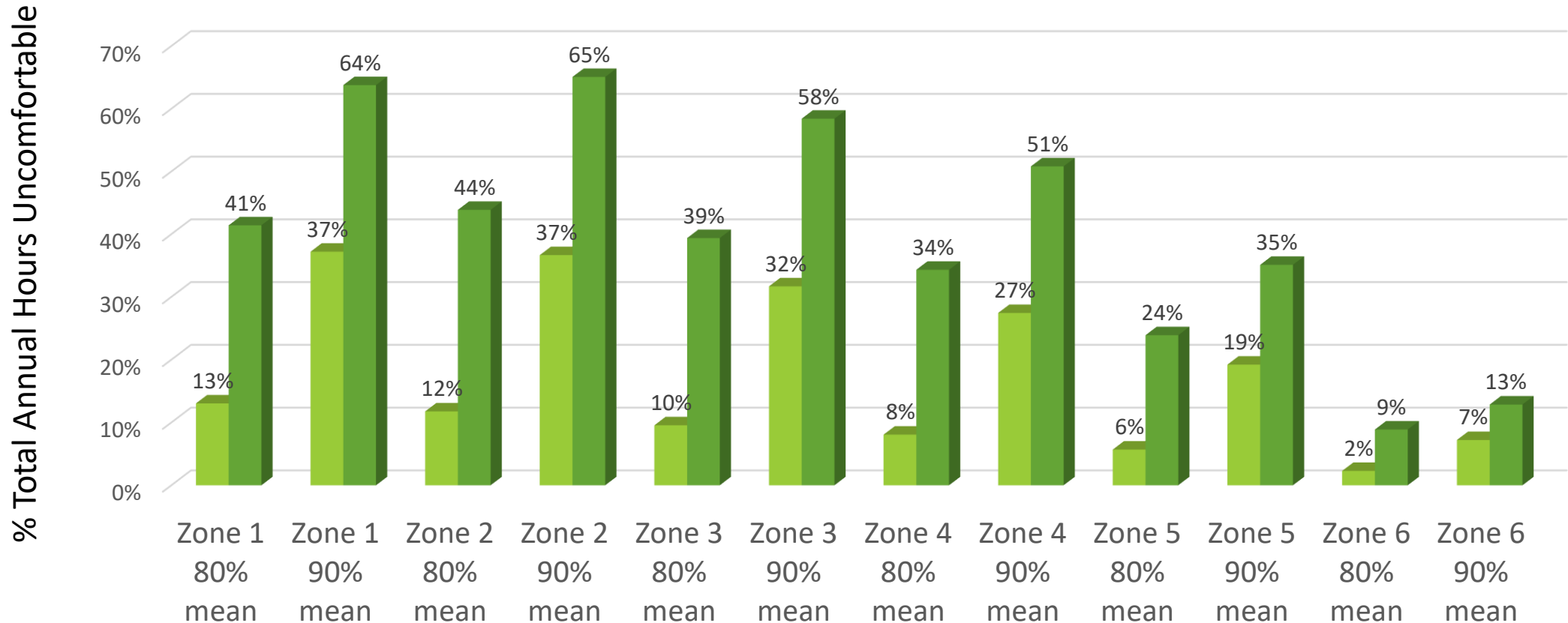
150 Darwin Apartments (Class 2) Energy Rated in 2020 and 2021



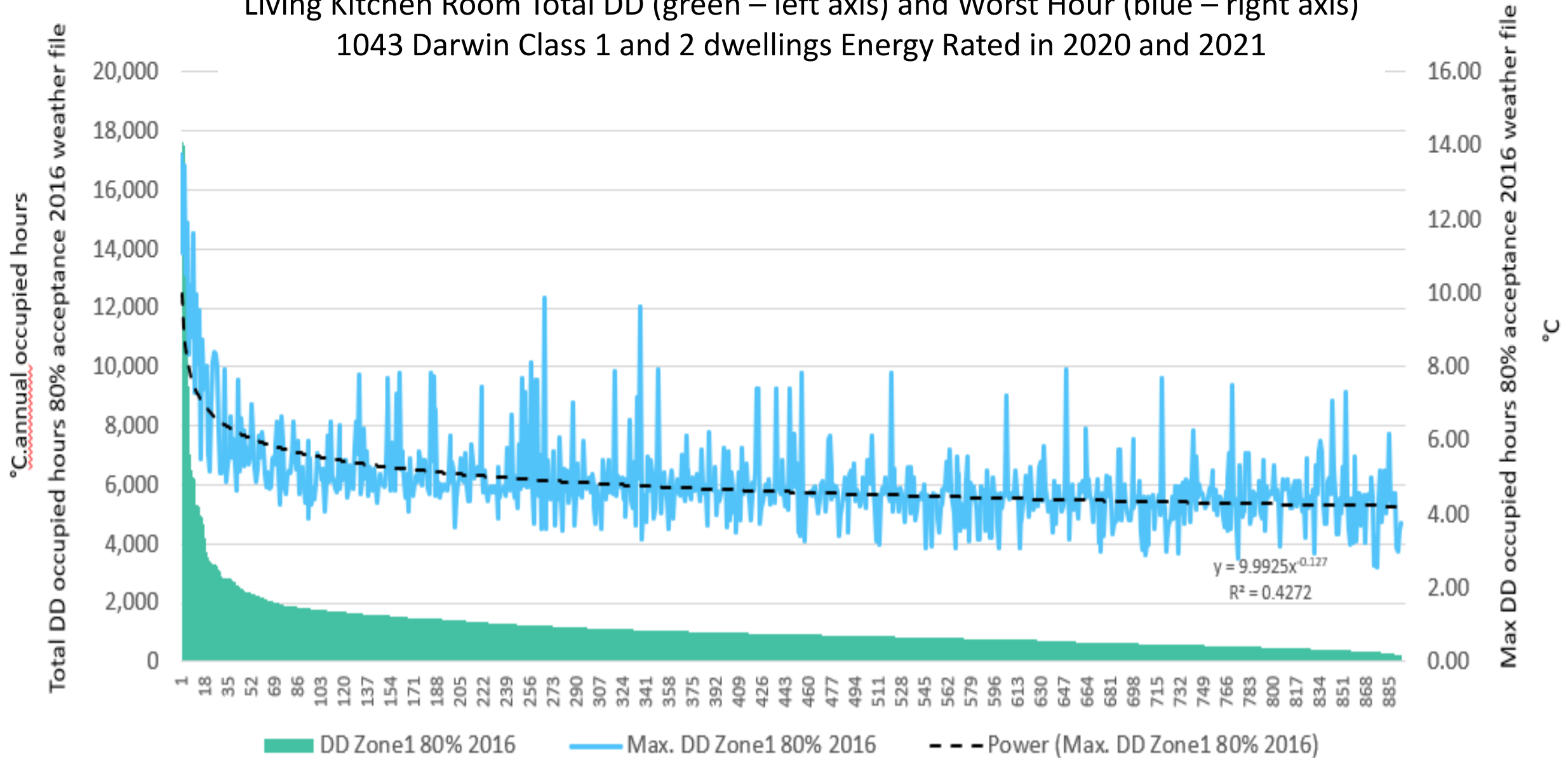
% of hours over-heating for vulnerable people (90% acceptance criteria)

Average % hours uncomfortable each year for all zones/rooms (Class 1 and 2 AHD dwellings rated in 2020 & 2021)

(80, 90% acceptance; **2016, 2050 RCP 8.5 Climate Projection**)



Living Kitchen Room Total DD (green – left axis) and Worst Hour (blue – right axis)
1043 Darwin Class 1 and 2 dwellings Energy Rated in 2020 and 2021



Building Simulations

SIMULATIONS AND ANALYSIS BY QUT

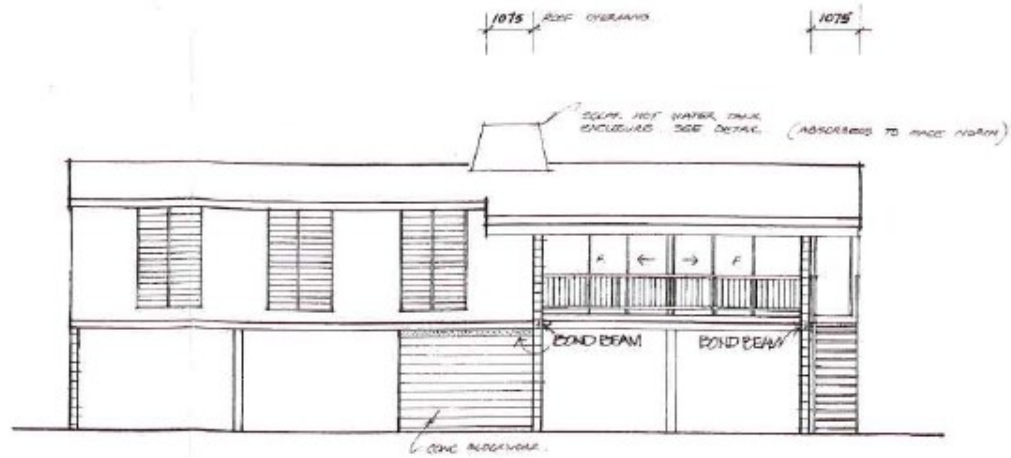
QUT Building Simulations

- 4 (5) houses, 2(4) apartments, 2 duplexes/terrace houses
- Typologies selected to be consistent with what is in the Darwin housing market
 - Size, materials, layout
- Models created using main construction materials and layouts as per dwelling plans
- Each dwelling modelled in four cardinal orientations
- Each of these orientations modelled with bad, medium and good variants
 - Focusing on solar absorption (colour), insulation and ventilation variants
- Each dwelling simulated using AccuRATE Sustainability V2.3.3 (for star rating) and AccuRATE Tropical Comfort Pilot
- Each dwelling simulated for 2016 weather file (NCC 2022) and 2050 future weather (RCP8.5)

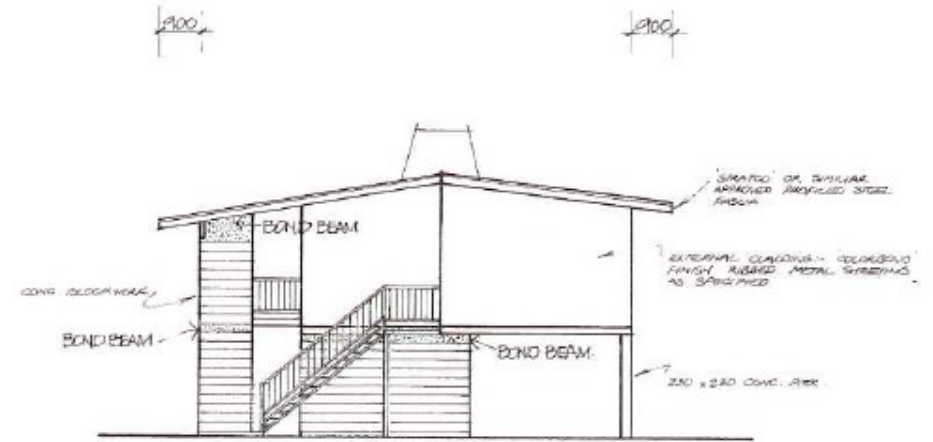
THEORETICAL DESIGN VARIANTS (regardless of constructability)

Element	‘BAD’ VARIANT	‘MEDIUM’ VARIANT	‘GOOD’ VARIANT
External walls	Foil wrap to steel frame Dark colour	- Medium colour uninsulated blockwork or - Medium colour; R2 insulation in steel framing	Light colour R2.7 bulk insulation (applied outside of blockwork where appropriate)
Internal walls	No insulation	No insulation	R1 insulation if framed walls
Party walls	No insulation	No insulation	R1.5 bulk insulation to both sides (acoustic separation)
Floor	No insulation	No insulation	No insulation
Ceiling	No insulation	No insulation	R2.5 batts
Roof	Dark colour Reflective air space (foil) Unventilated	Light colour Reflective air space (foil) Ventilated	Light colour R1.5 blanket Reflective air space (foil under blanket) Unventilated
Shading	No shade	0.9m eaves all orientations or - Larger eave or verandah where indicated on plans)	Houses and duplexes: 2.5m eaves on ground floor, 1.2m eaves on 2 nd storey Apartments: 2.5m eaves
Glazing	Alum., SG, clear	Alum., SG, clear	Alum., SG, low-e tinted (U5.6, SHGC 0.41)
Ventilation incl. 1400mm fans	20% window openings	45% window openings	90% window openings

DLLH01



ELEVATION 1.



ELEVATION 2



ELEVATION 3.

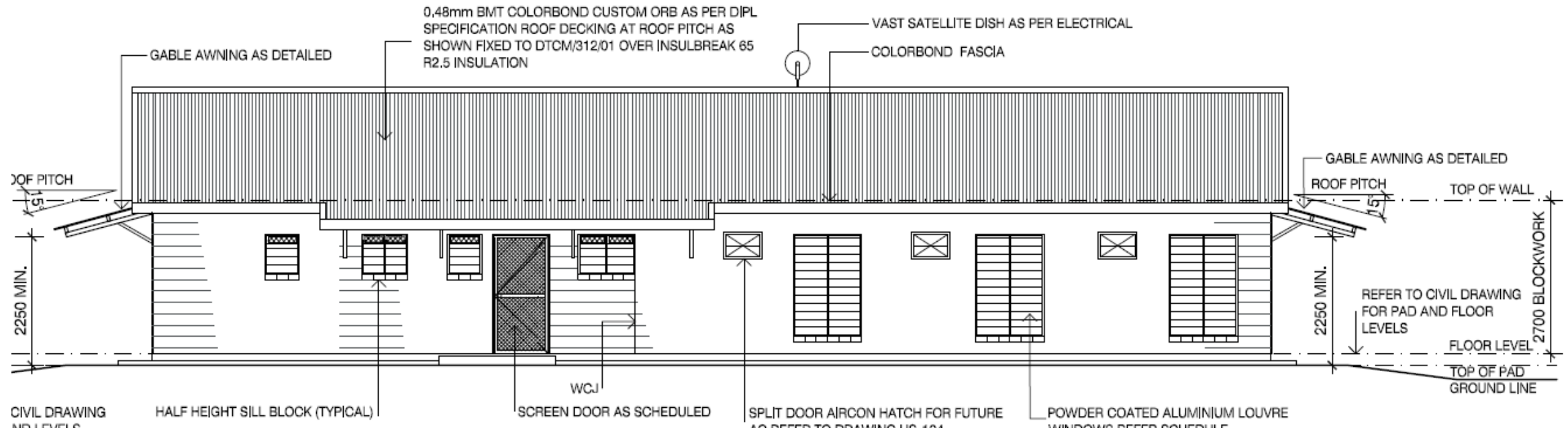


ELEVATION 4.

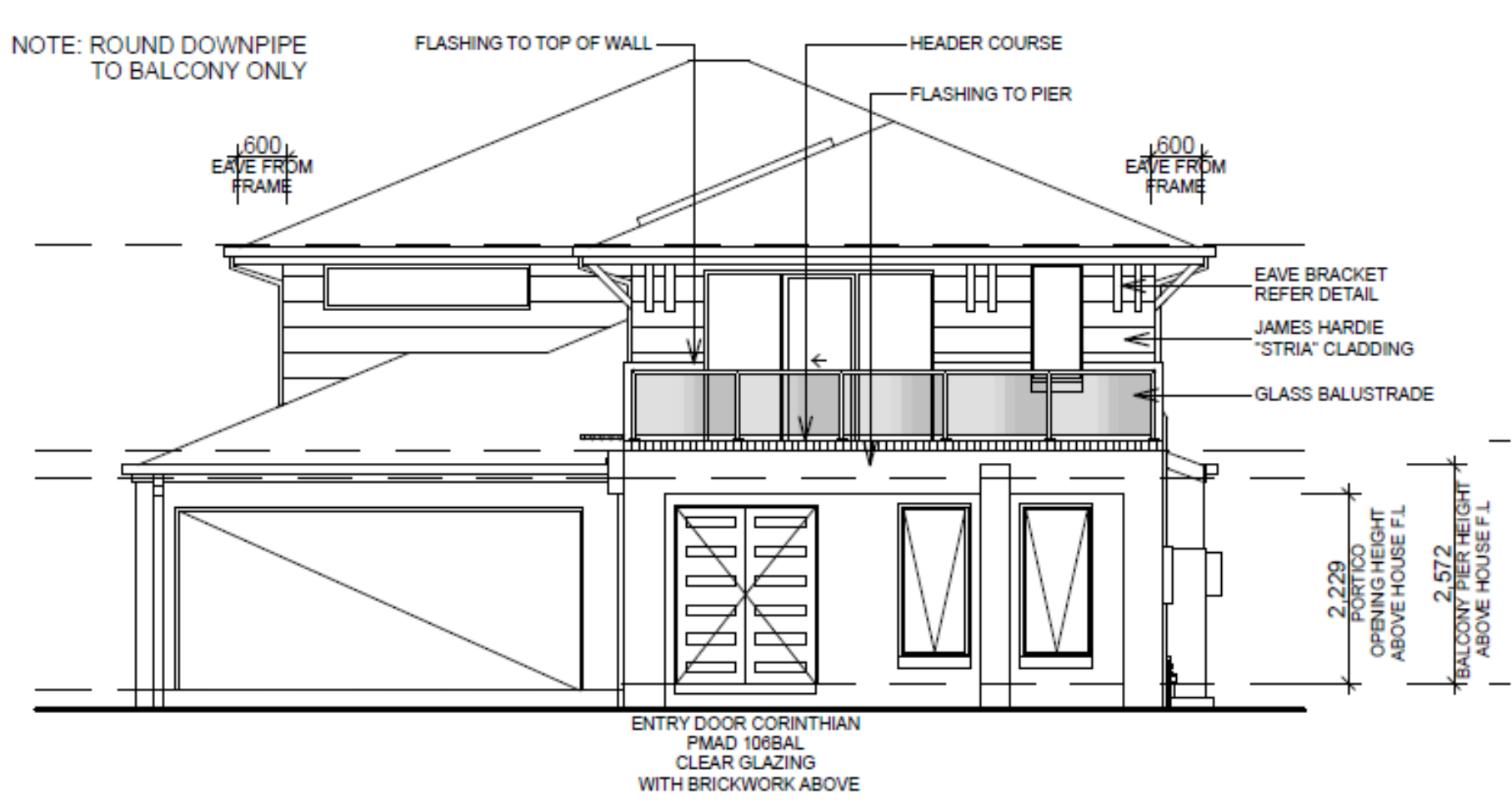
DLLH02



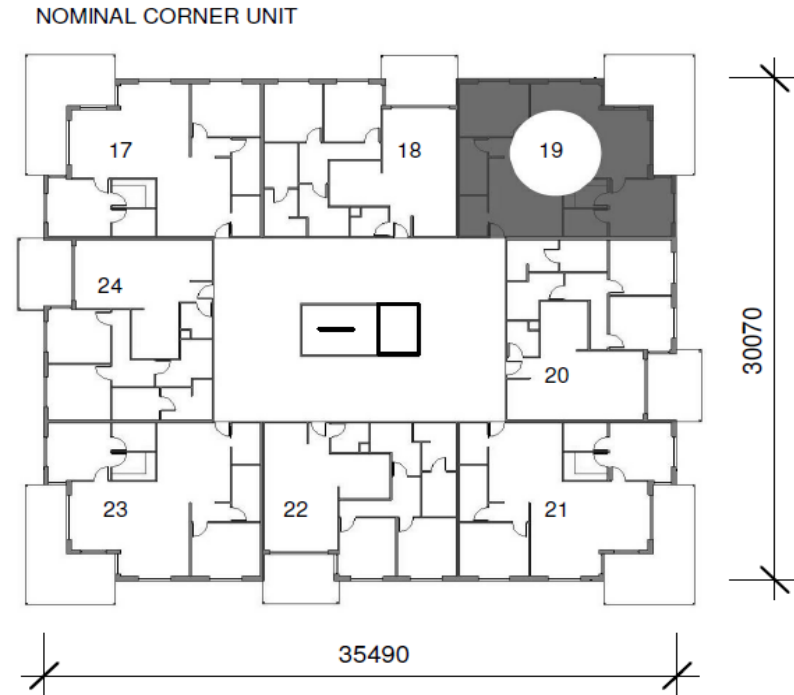
DLLH03 – Block work variant & Steel frame variant



DLLH04 - Blockwork

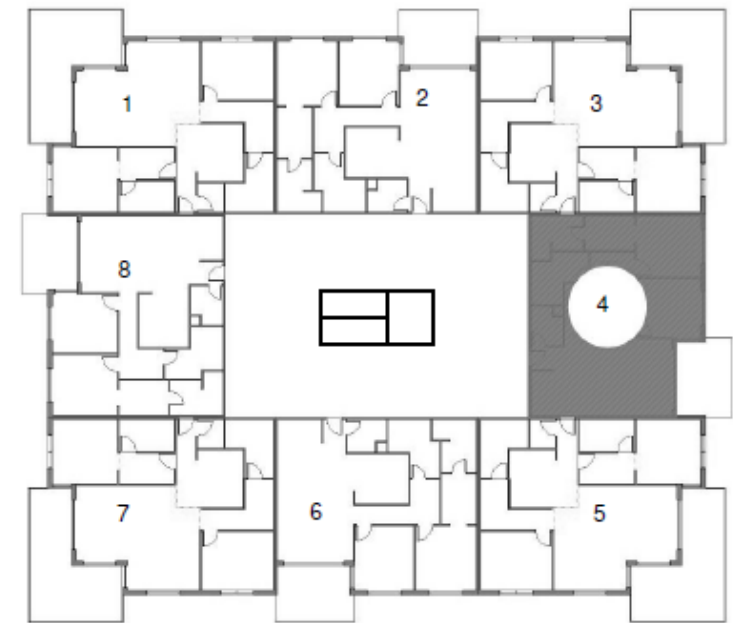


DLLA01- Corner apartment - Top floor variant & middle floor variant

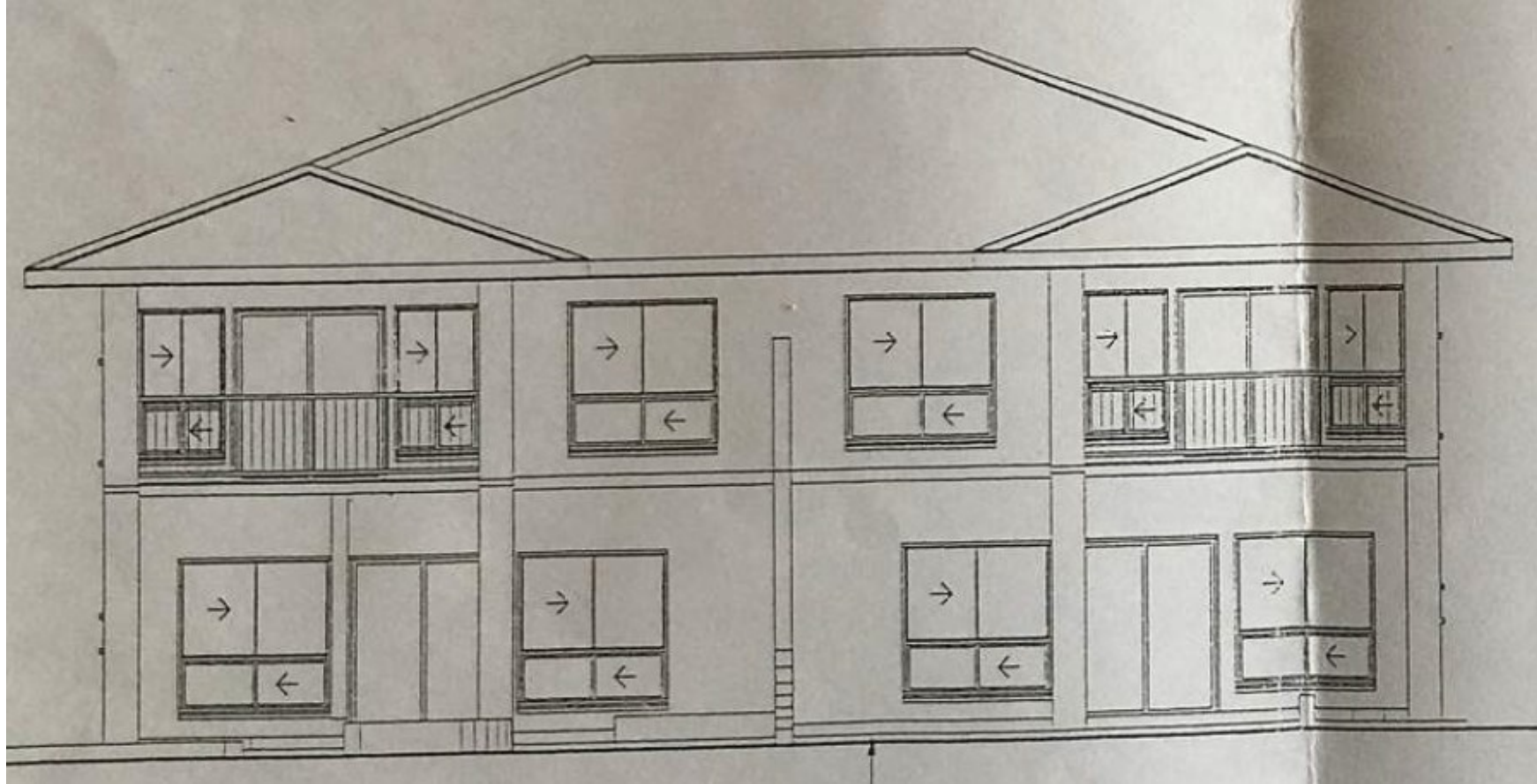


DLLA01- Single aspect middle apartment

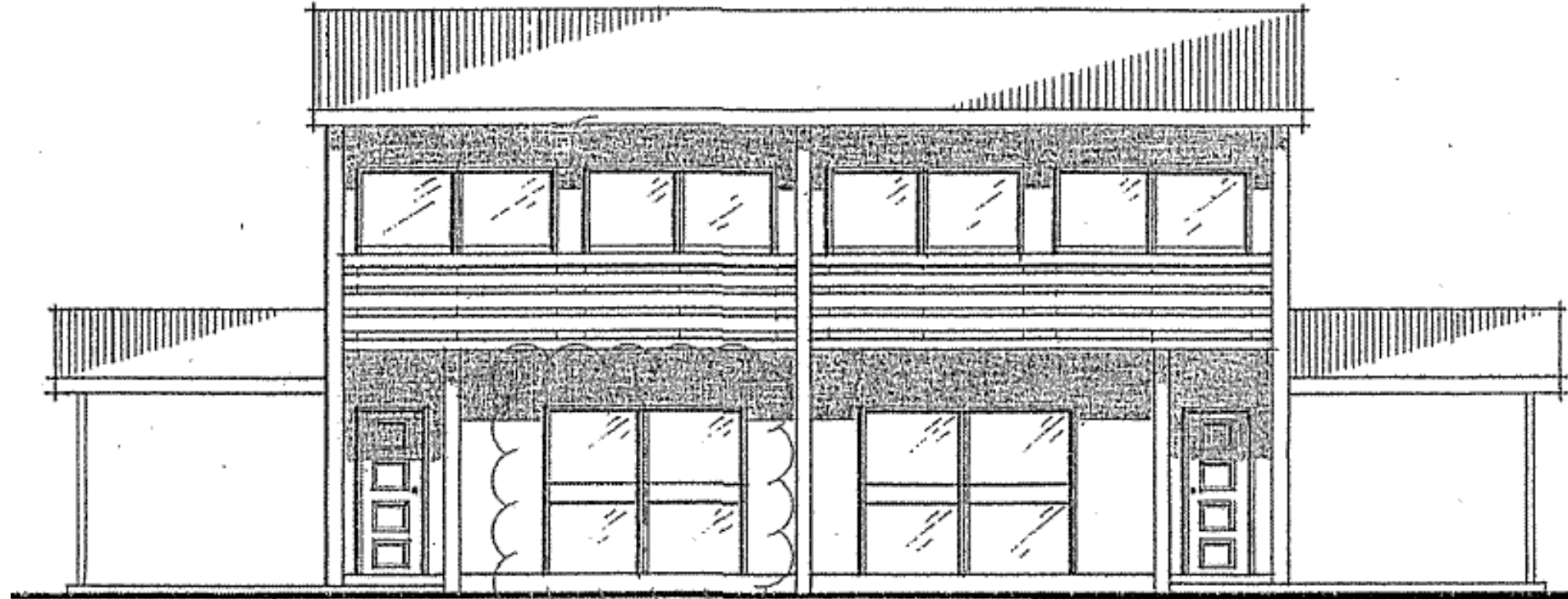
Top floor variant & middle floor variant



DLLD01 Townhouse 1



DLLD02 – Townhouse 2



Summary of Results

Lowest and highest values in red

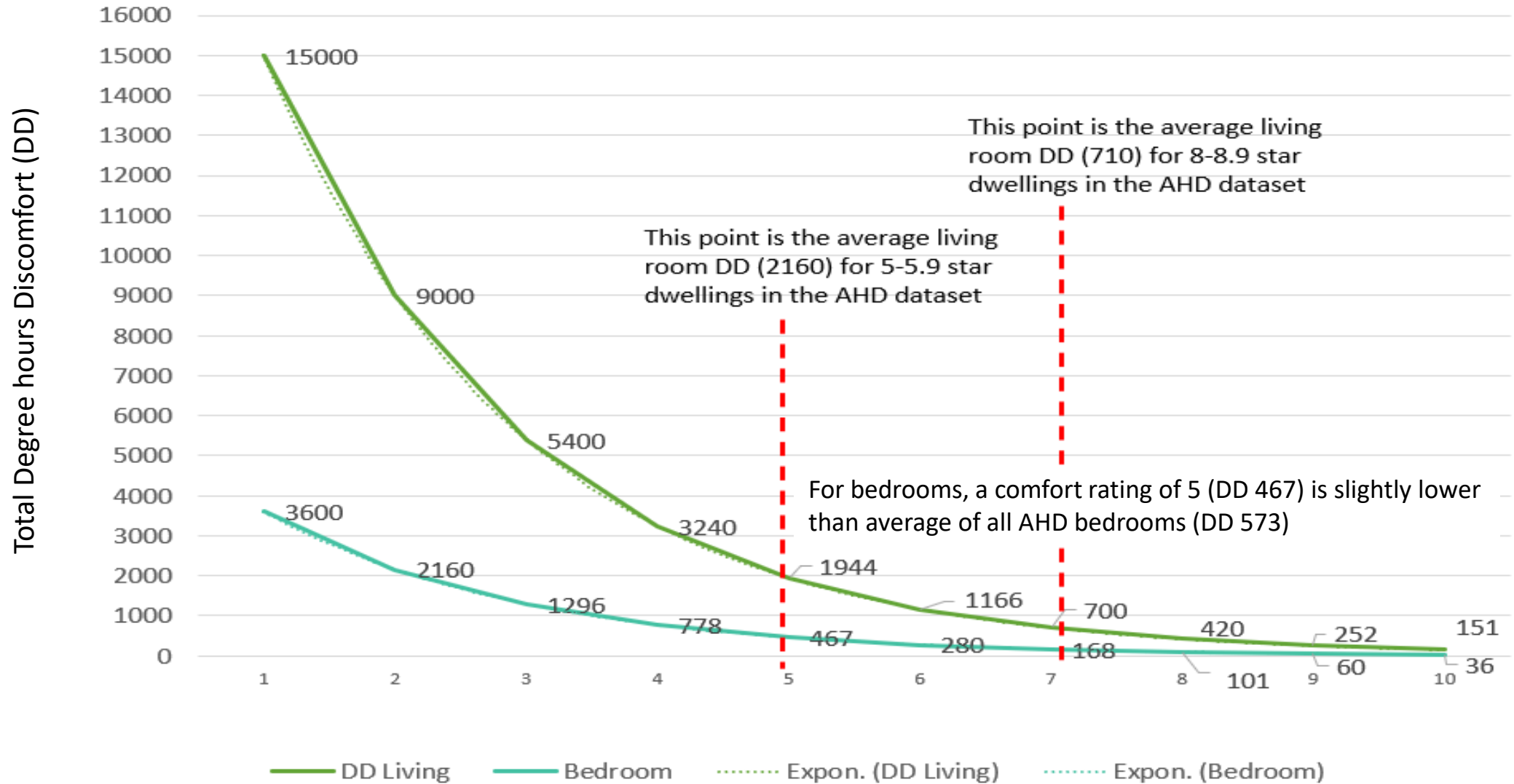
CRITERIA	AHD	QUT SIMULATION (OPTIMISED VARIATION IN BRACKETS)
LOWEST DD KIT/LIVING ZONE	233	699 (614)
HIGHEST DD KIT/LIVING ZONE	17,611	4,230
LOWEST DD BEDROOM	5	66 (Worst bedroom in DLLH03BLK was 252; optimised to 144)
HIGHEST DD BEDROOM	3,185	3,678

Comfort Rating Bandwidths

COMFORT RATING	LIVING DD	BED DD
1	15,000	3,600
2	9,000	2,160
3	5,400	1,296
4	3,240	778
5	1,944	467
6	1,166	280
7	700	168
8	420	101
9	252	60
10	151	36

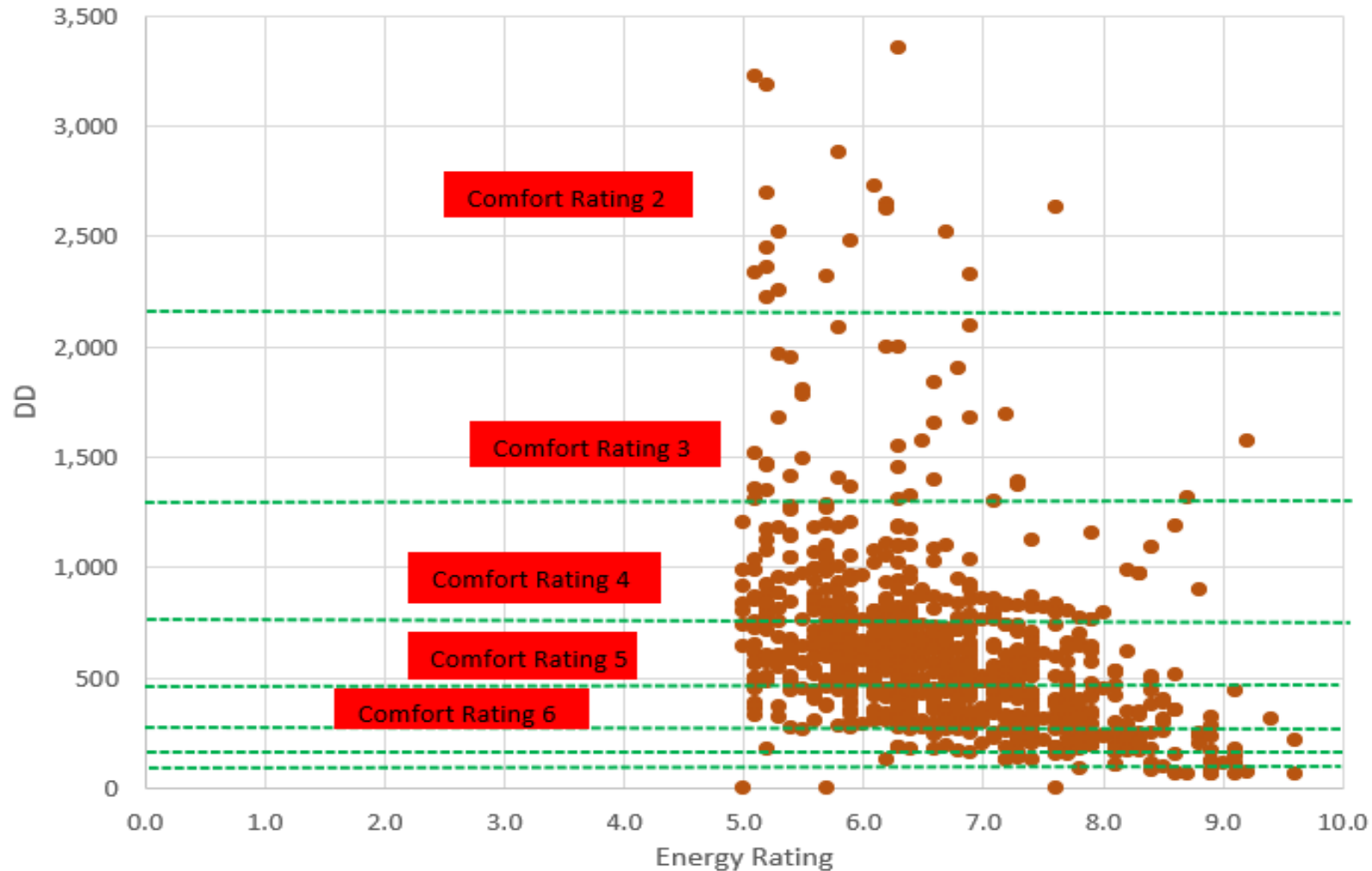
Each bandwidth reduces by a factor 0.6 as ratings get higher, a similar concept to the Energy Star Rating methodology

Resulting Comfort Rating Scales



Class 1 Bedroom Energy Rating and DD Correlations

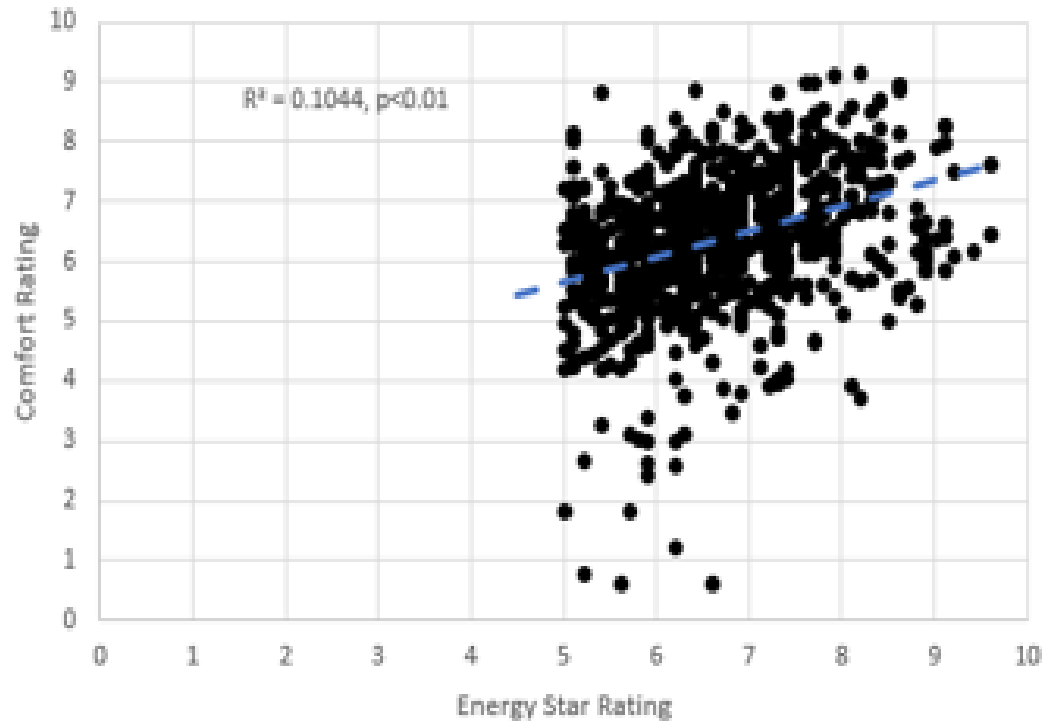
NatHERS Climate Zone 1 2020 & 2021 AHD dataset analysis



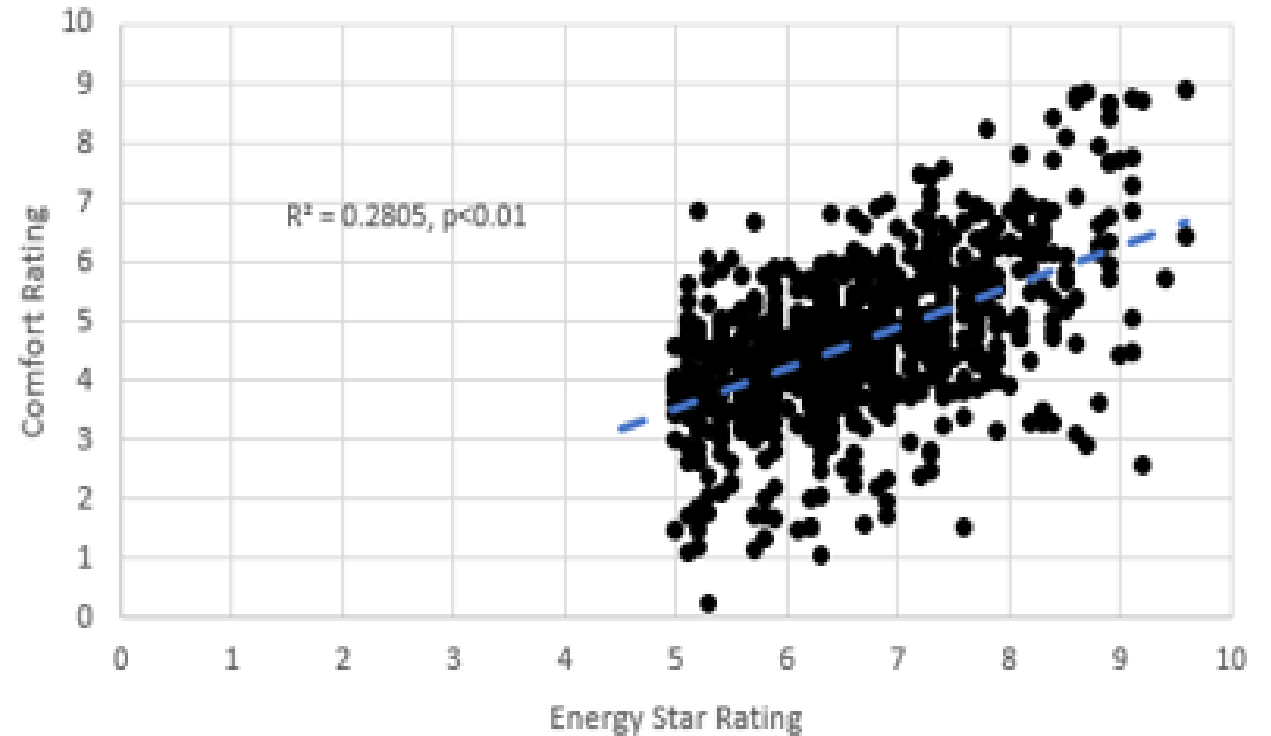
Weak Comfort Rating and Energy Rating Correlations

NatHERS Climate Zone 1 2020 & 2021 AHD dataset analysis – Comfort ratings in 0.1 increments

Living Zones - Class 1



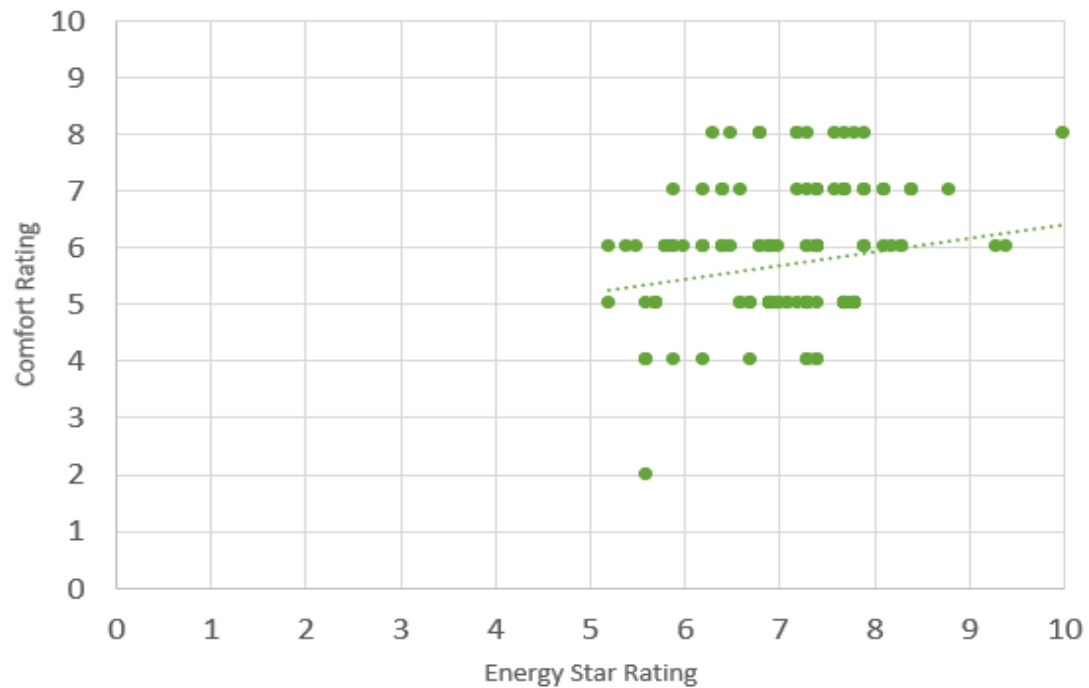
Worst Bedroom- Class 1



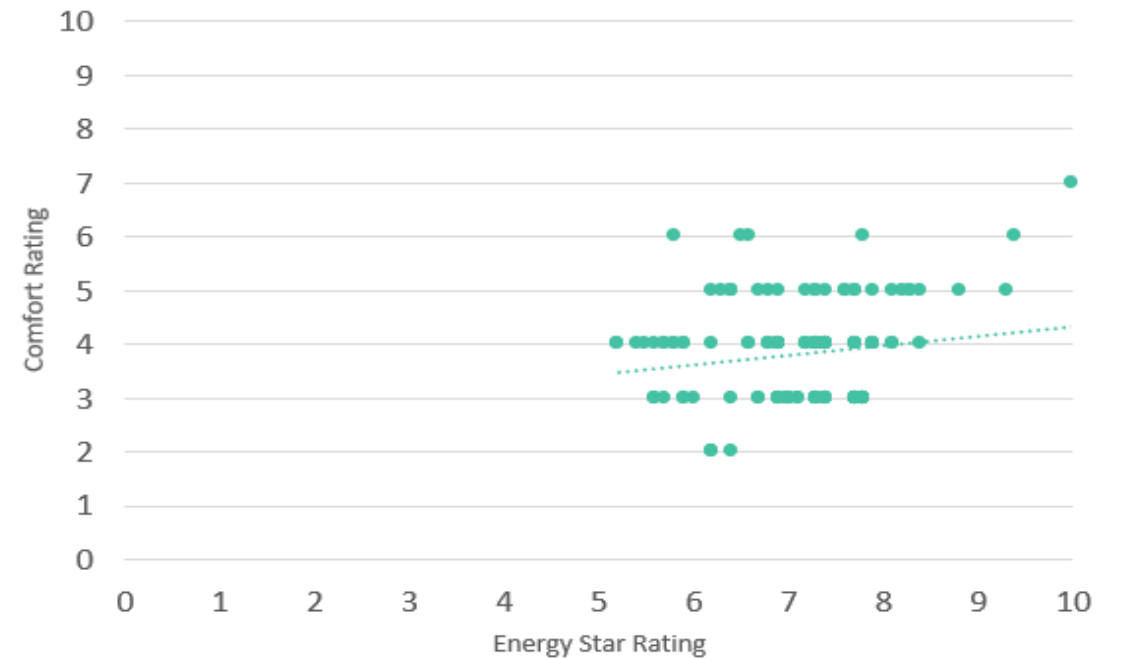
Weak Comfort Rating and Energy Rating Correlations

NatHERS Climate Zone 1 2020 & 2021 AHD dataset analysis – Comfort ratings in integers

Living Zones - Class 2



Worst Bedroom – Class 2



Key Recommendations

1. Designs should strive for comfort ratings of:
 - 9 for living zones, equating to approximately 4% of annual occupied hours over the comfort threshold.
 - 7 for worst bedrooms, representing approximately 2.7% of annual occupied hours over the comfort threshold.
2. Housing specifically meant for vulnerable populations should ideally use the comfort threshold formulae relating to 90% acceptability.
3. Designs should consider both current and future weather conditions, as dwellings constructed today are likely to be in operation in 2050.
 - The data analysis suggests that housing in 2050 could have 30% more annual hours above the comfort thresholds compared to current overheating based on the 2016 weather file (at 80% acceptability).

More information and analysis is included in QUT report
available on Darwin Living Lab Project website:

[Darwin Home Comfort Rating – Darwin Living Lab \(csiro.au\)](https://research.csiro.au/darwinlivinglab/darwin-home-comfort-rating/)

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