



# MONASH GILLIES HALL

## SETTING THE BENCHMARK FOR THE NEXT GENERATION OF SUSTAINABLE BUILDINGS

ADRIAN DANIELS

NICK BAMFORD

CLARE PARRY

# MONASH UNIVERSITY

## GILLES HALL - PENINSULA HOUSING

First Commercial Scale Passive House & CLT Building in Australia

### Team



Adrian Daniels, Asset Planning Engineer Mechanical Services, Engineering and Sustainability



Nick Bamford, Associate Director, Building Services



Clare Parry, Director/Principal Consultant



# OUR AUSTRALIAN CAMPUSES

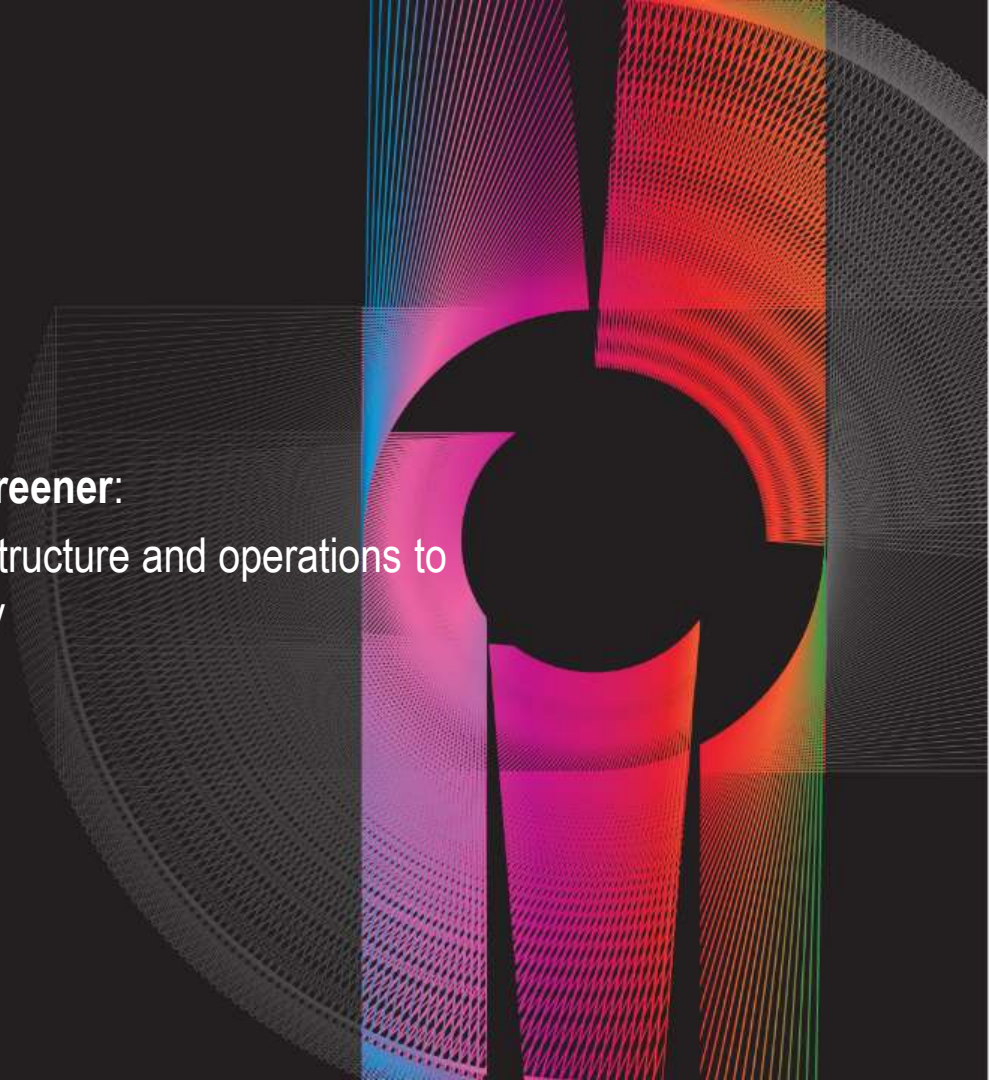
## 4 MELBOURNE LOCATIONS



MONASH  
**NET ZERO**  
INITIATIVE

**Being smarter, being greener:**

Managing campus infrastructure and operations to  
achieve carbon neutrality



# THE COMMITMENT

Through Monash's Net Zero Initiative launched in October 2017, the University committed \$135 million to achieve Net Zero emissions by **2030**.

***“The University strives to completely eliminate its dependence on fossil fuels.”***

*Vice-Chancellor Professor Margaret Gardner, October 2017*



# MONASH NET ZERO INITIATIVE

The Net Zero Emissions Initiative is a range of interrelated initiatives facilitating the transition to 100% renewable Energy by 2030.

## ENERGY EFFICIENCY



Reduce energy consumption

- Lighting
- Façade
- Appliances
- Bldg optimisation

## CAMPUS ELECTRIFICATION & THERMAL UPGRADES



Electricity becomes our only energy fuel

- High efficiency thermal precincts
- Heat pumps to replace gas boilers

## ON-SITE RENEWABLES



Maximise on-site solar generation

- Rooftop solar PV
- Solar thermal

## OFF-SITE RENEWABLES



Purchase off-site renewable energy

- Power Purchase Agreement: Murra Warra Wind Farm

## NET ZERO READY BUILDINGS



Net zero ready buildings

- Passive HAUS
- All electric plant
- High performance building envelope

## INTELLIGENT ENERGY NETWORK



Controls

- Micro-grid
- Battery Storage

## OFFSET RESIDUAL EMISSIONS



Offset residual Emissions

- Green Power
- Carbon offset



MOOROODUC HWY

TOWARDS FRANKSTON STATION  
STONY POINT TRAIN LINE

HASTINGS RD

MONASH  
UNIVERSITY  
PENINSULA  
CAMPUS

SUBJECT SITE

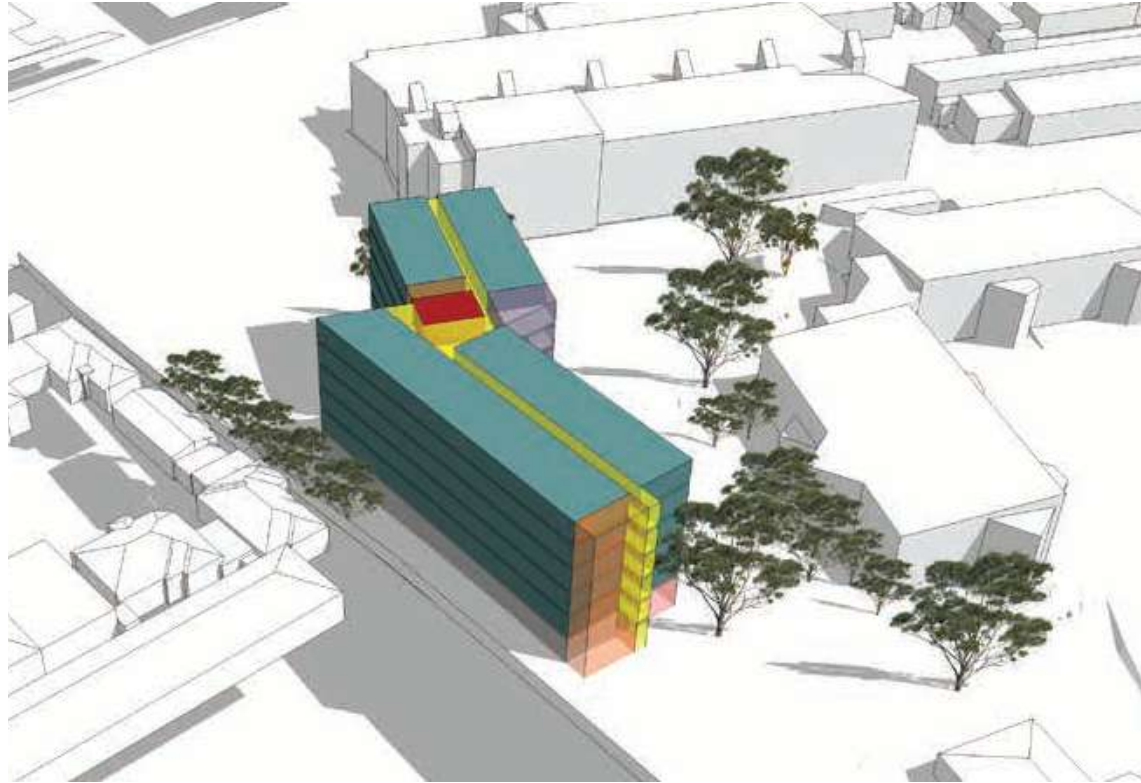
# THE BRIEF

## DELIVERABLES:

- 150 single-occupancy units (SOU's)
- Support Staff residencies (x2)
- Floor Lounges for building residents
- Communal spaces
- 6,500m<sup>2</sup> GFA

## REQUIREMENTS:

- Target Passive House certification
- Cross Laminated Timber (CLT) Construction
- Delivered For Semester One 2019 –  
**end to end timeframe of 20 months!**





# WHY PASSIVE HOUSE?

- Improved Energy Efficiency - typical 75% savings when compared with average new best-practice constructions
- Increased Occupant Thermal Comfort
- Exemplar Building - Rigorous Set of Performance Requirements to achieve Certification



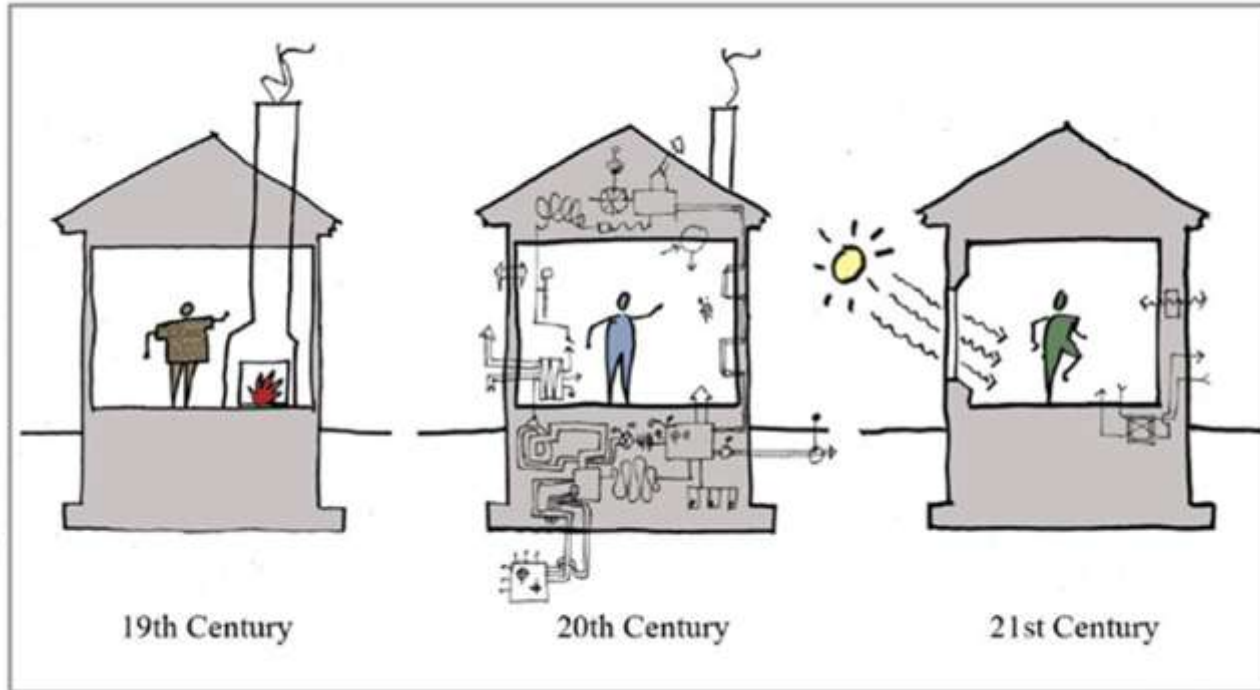
## NET ZERO INITIATIVE

Leading the way to a 100% renewable future

# PERFORMANCE GOALS



# PASSIVHAUS – PERFORMANCE REQUIREMENTS



*image source: Albert, Richter and Tittmann Architects*

## Criteria:

- ✓ Low heating load / demand
- ✓ Low cooling load / demand
- ✓ Low total energy use
- ✓ Airtight envelope
- ✓ Low frequency of overheating

# HIGH PERFORMANCE BUILDINGS

HIGH  
PERFORMANCE  
BUILDINGS

Graphic © Hammer & Hand



# HIGH PERFORMANCE BUILDINGS



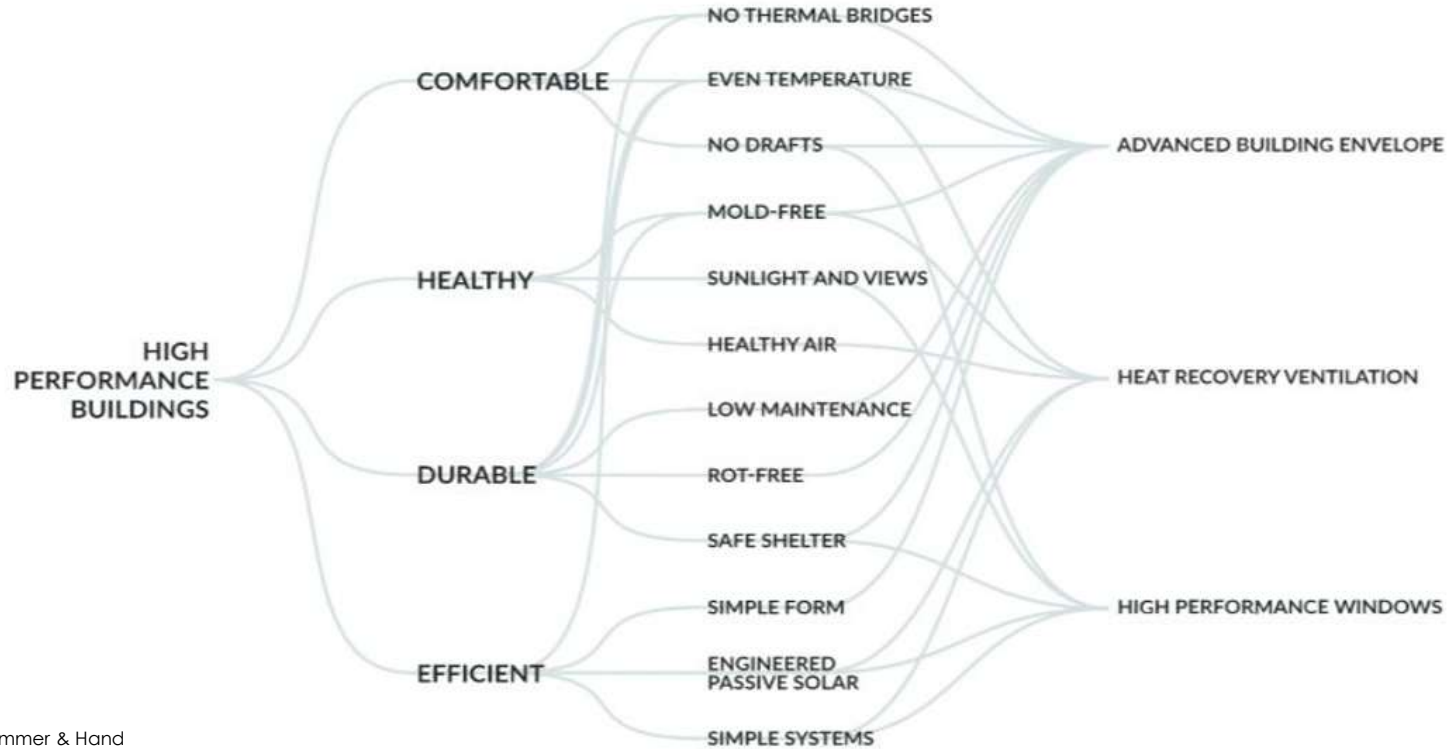
Graphic © Hammer & Hand

# HIGH PERFORMANCE BUILDINGS



Graphic © Hammer & Hand

# HIGH PERFORMANCE BUILDINGS



Graphic © Hammer & Hand

# NET ZERO IMPERATIVE

## World Green Building Council – Net Zero Carbon Building

*A net zero carbon building is a building that is highly energy efficient, and is fully powered from on-site and/or off-site renewable energy sources.*

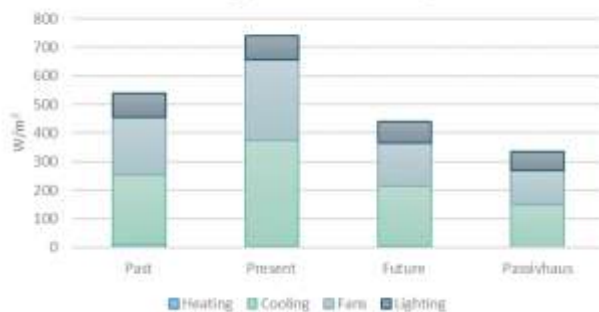
### A new definition

*A net zero carbon building is a building that is designed and constructed to best practice energy efficiency, as certified by the Passive House Institute, and is fully powered from on-site renewable energy sources. Systems are all electric with no gas used for electricity generation, space heating or water heating*

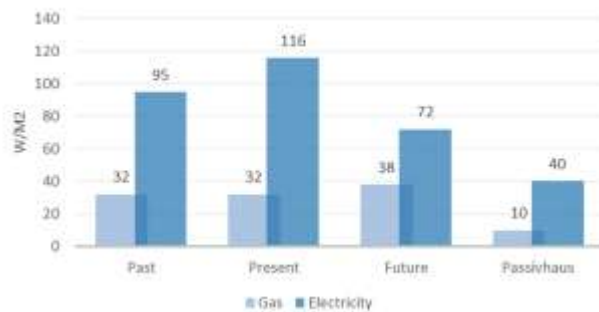


# THE PATH TO HERE

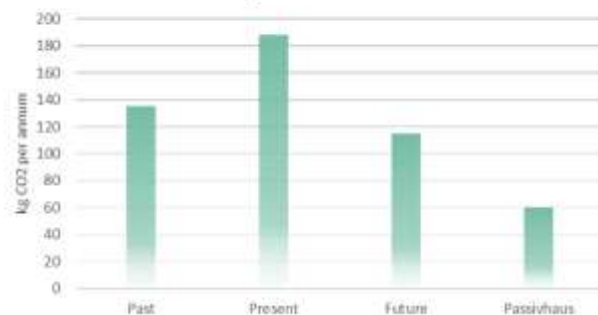
## Energy Use Intensity



## Peak Demand

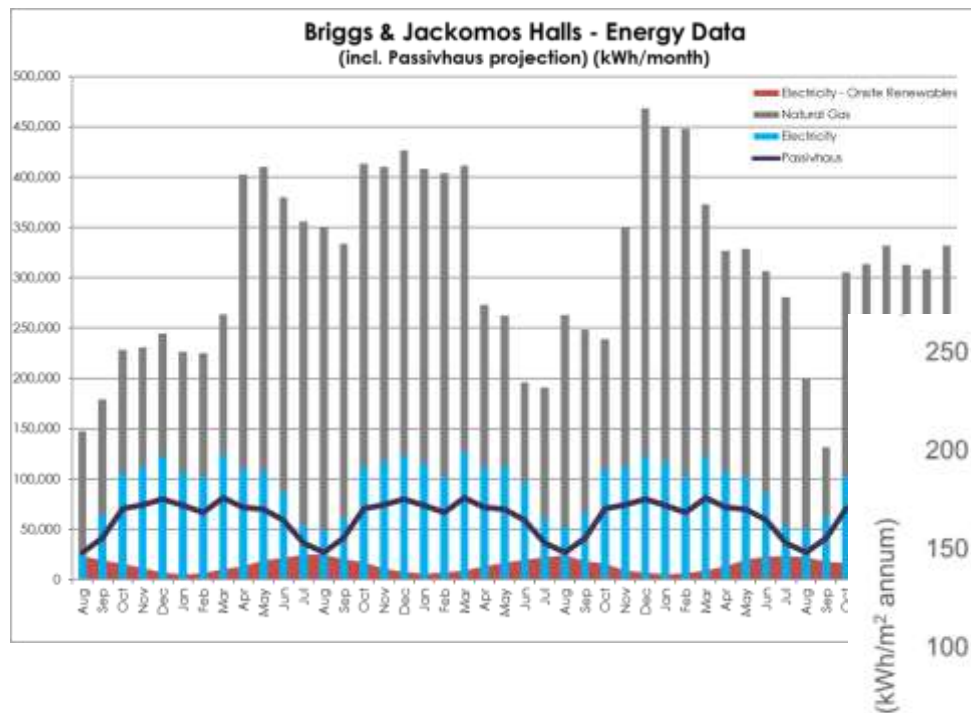


## CO<sub>2</sub> Emissions



# THE PATH TO HERE

Briggs & Jackomos Halls - Energy Data  
(incl. Passivhaus projection) (kWh/month)

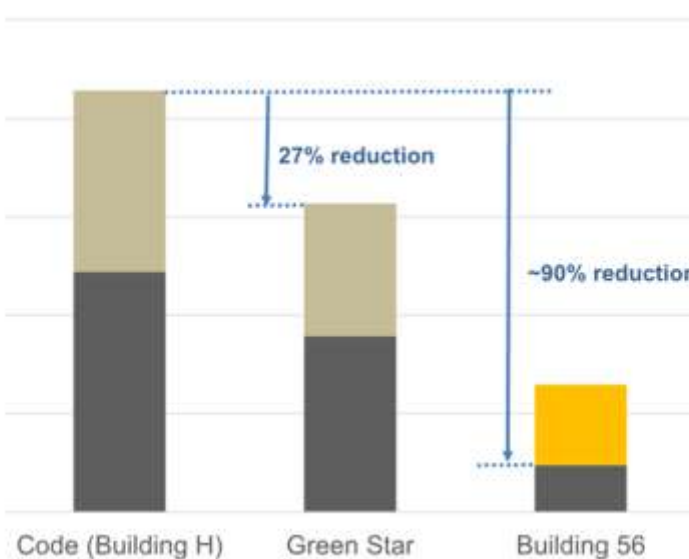


(kWh/m<sup>2</sup> annum)

250

100

0



■ Grid demand

■ Gas

■ Solar

# THE PATH TO HERE



**Building 56**

Image: McGlashan Everist



**Learning & Teaching Building**

Image: Inhabit Group



**Biomedical Learning & Teaching Building**

Image: Inhabit Group

# DESIGN RESPONSE

## DELIVERABLES:

- 150 single-occupancy units (SOU's)
- Support Staff residencies (x2)
- Floor Lounges for building residents
- Communal spaces
- 6,500m<sup>2</sup> GFA

## REQUIREMENTS:

- Target Passive House certification
- Cross Laminated Timber (CLT) Construction
- Delivered For Semester One 2019 – **end to end timeframe of 20 months!**

## DESIGN CHALLENGES

- **No engineering precedent!.**
- Requirement for high levels of occupant comfort
- Early Contractor Involvement – Short design phase
- CLT Construction – early procurement of timber
- Project budget

## STAKEHOLDERS

- Monash Residential Services (MRS)
- Monash Building and Property – Engineering
- Monash Building and Property – Sustainability
- Monash Chancellery

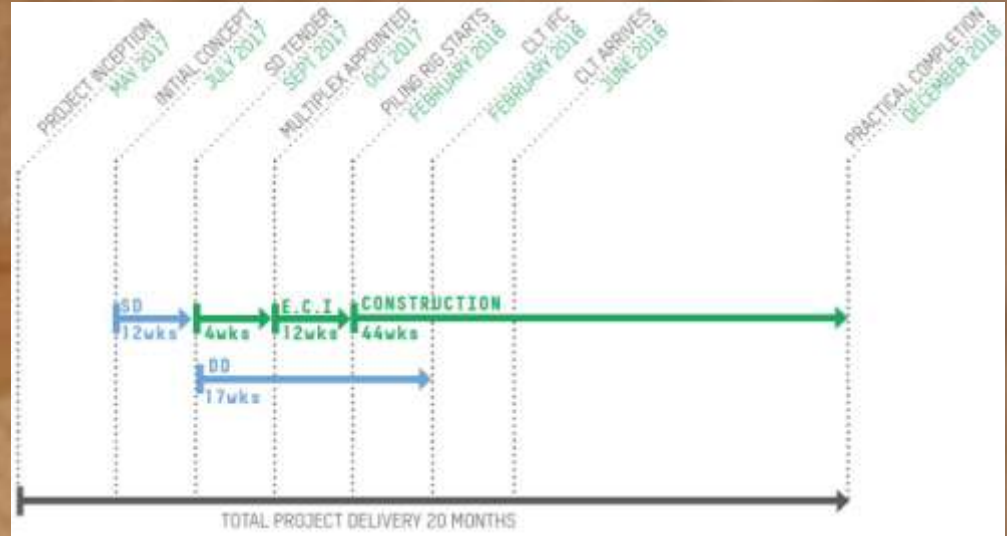


# CROSS LAMINATED TIMBER (CLT)

- Speed of Construction
- Less Disruptive
- Safety
- Lightweight
- Sustainable

# CROSS LAMINATED TIMBER (CLT)

- Speed of Construction
- Less Disruptive
- Safety
- Lightweight
- Sustainable



# CROSS LAMINATED TIMBER (CLT)

- Speed of Construction
- Less Disruptive
- Safety
- Lightweight
- Sustainable



# CROSS LAMINATED TIMBER (CLT)

- Speed of Construction
- Less Disruptive
- Safety
- Lightweight
- Sustainable





# CROSS LAMINATED TIMBER (CLT)

- Speed of Construction
- Less Disruptive
- Safety
- Lightweight
- Sustainable



# PASSIVE HOUSE PERFORMANCE CRITERIA

Building energy performance	
Specific heating demand	$\leq 15 \text{ kWh/m}^2 \cdot \text{yr}$
or Specific Peak load	$\leq 10 \text{ W/m}^2$
Specific cooling demand	$\leq 15 \text{ kWh/m}^2 \cdot \text{yr}$
Primary energy demand	$\leq 120 \text{ kWh/m}^2 \cdot \text{yr}$
Elemental performance requirements	
Airtightness	$\leq 0.6 \text{ ac/h (n50)}$
Window U value	$\leq 0.80 \text{ W/m}^2 \text{K}$
Window installed U value	$\leq 0.85 \text{ W/m}^2 \text{K}$
Services performance	
MVHR heat recovery efficiency	$\geq 75\%*$
MVHR electrical efficiency	$\leq 0.45 \text{ Wh/m}^3$
Thermal and acoustic comfort criteria	
Overheating frequency	$> 25^\circ\text{C} \leq 10\%$ of year
Maximum sound from MVHR unit	35 dB(A)
Maximum transfer sound in occupied rooms	25 dB(A)
* Note MVHR efficiency must be calculated according to Passivhaus standards not manufacturer's rating	



- Compactness :  $A/V$  (envelope area/volume)  $< 0.7$
- Form Factor: (Envelope area/ Treated Floor Area)  $< 3$
- Building thermal performance (U-values)
- Consideration of thermal bridging
- Management of solar gain / external shading
- Consideration of overheating **risk** in Melbourne



# COMPARISON BETWEEN PASSIVE HOUSE AND BAU

## Passive House

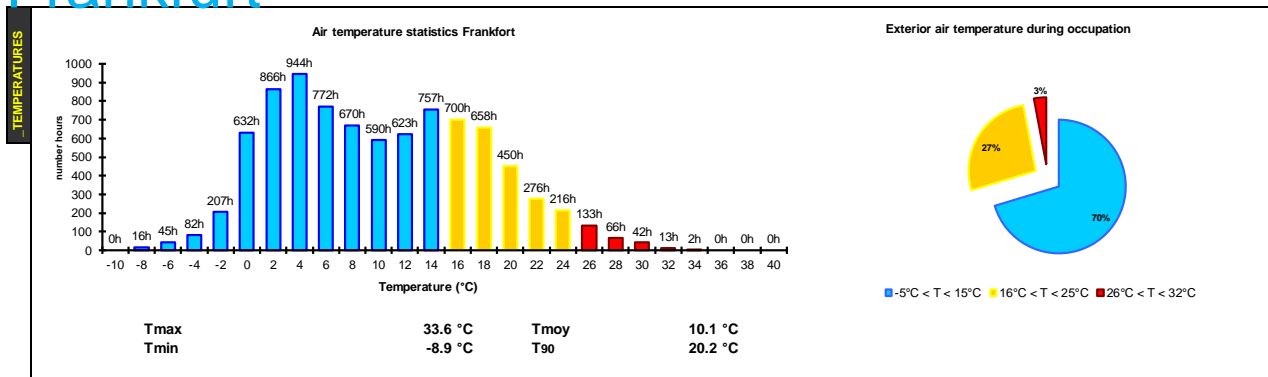
- Insulation:
  - External Walls – R3.4
  - Roofs – R7.3
- Glazing:
  - Thermal broken framing, high performance double glazing
  - U-Value – **1.2 W/m<sup>2</sup>K**
  - SHGC – 0.3 / 0.4
- Infiltration – **0.5 ACH**

## BAU

- Insulation:
  - External Walls – R2.8
  - Roofs – R3.2
- Glazing:
  - Aluminium framing, clear double glazing
  - U-Value – **4.1 W/m<sup>2</sup>K**
  - SHGC – 0.66
- Infiltration – **1.0 ACH**

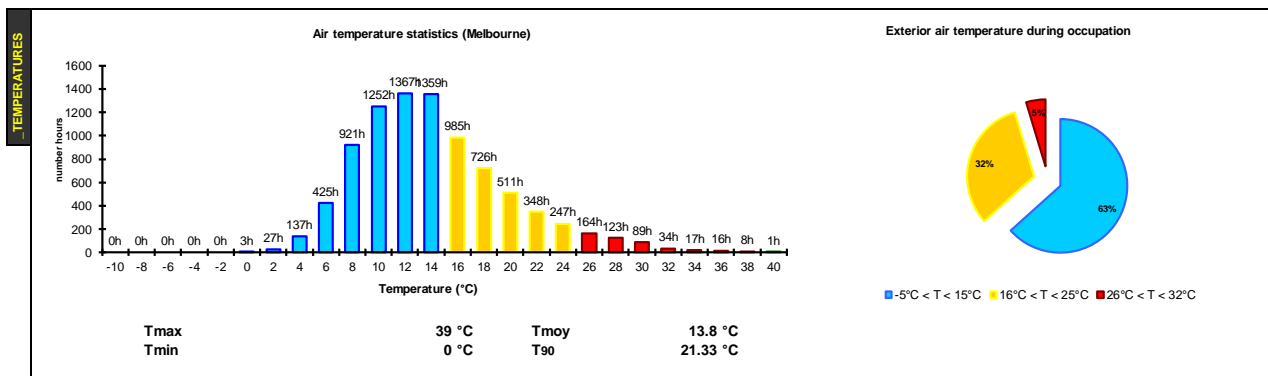
# WEATHER ANALYSIS

## Frankfurt



73kKh/a

## Melbourne



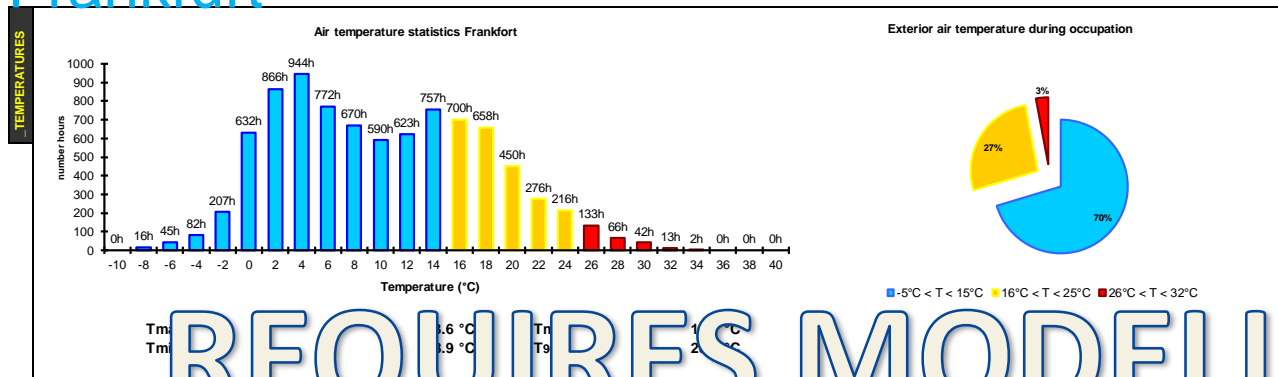
31kKh/a

Climate conditions

- constant low but not extremes temperatures
- occasional high temperatures

# WEATHER ANALYSIS

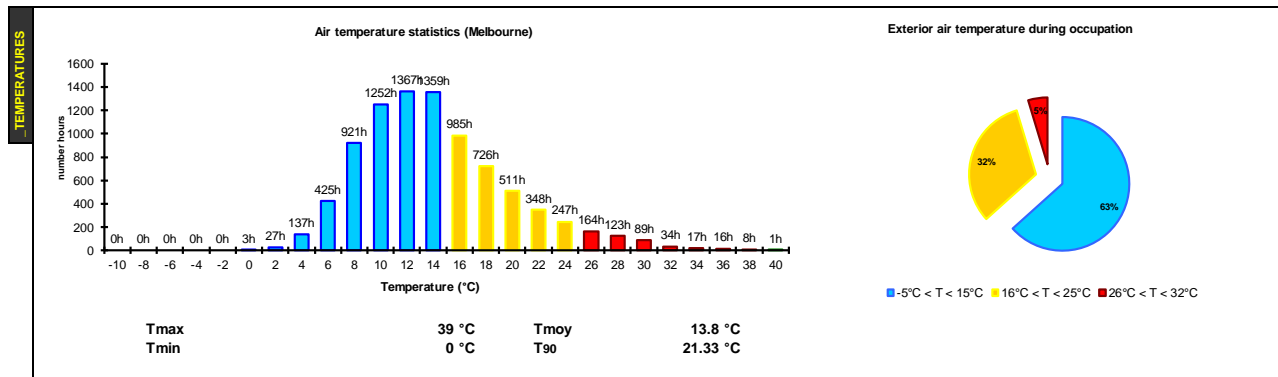
## Frankfurt



73kKh/a

# REQUIRES MODELLING!!

## Melbourne



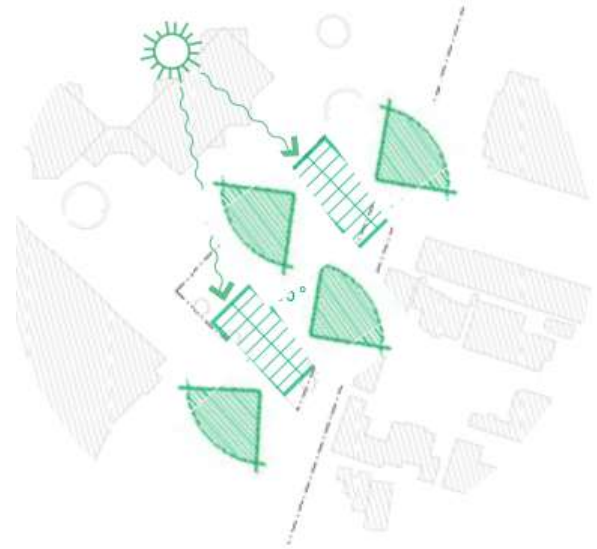
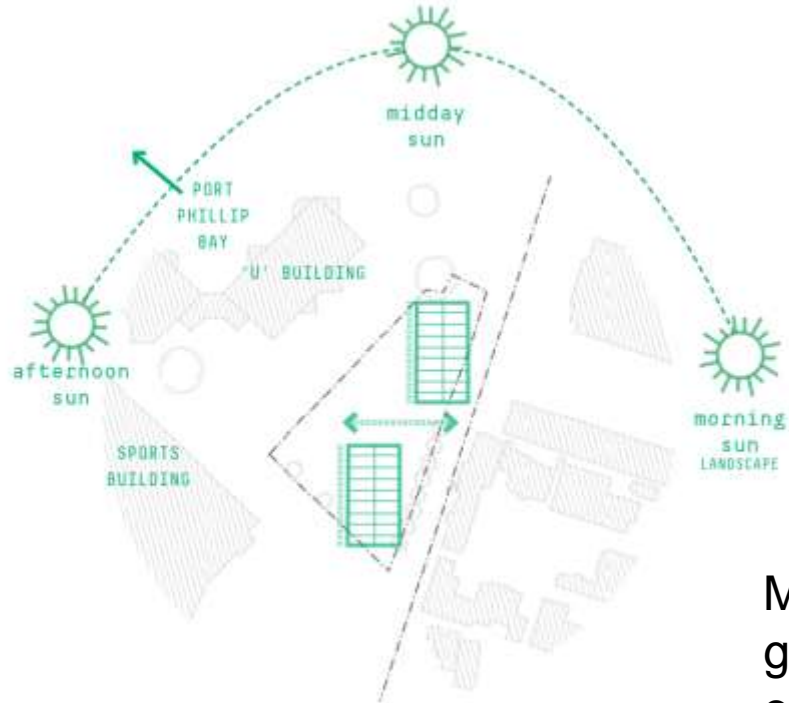
31kKh/a

Climate conditions

- constant low but not extremes temperatures
- occasional high temperatures

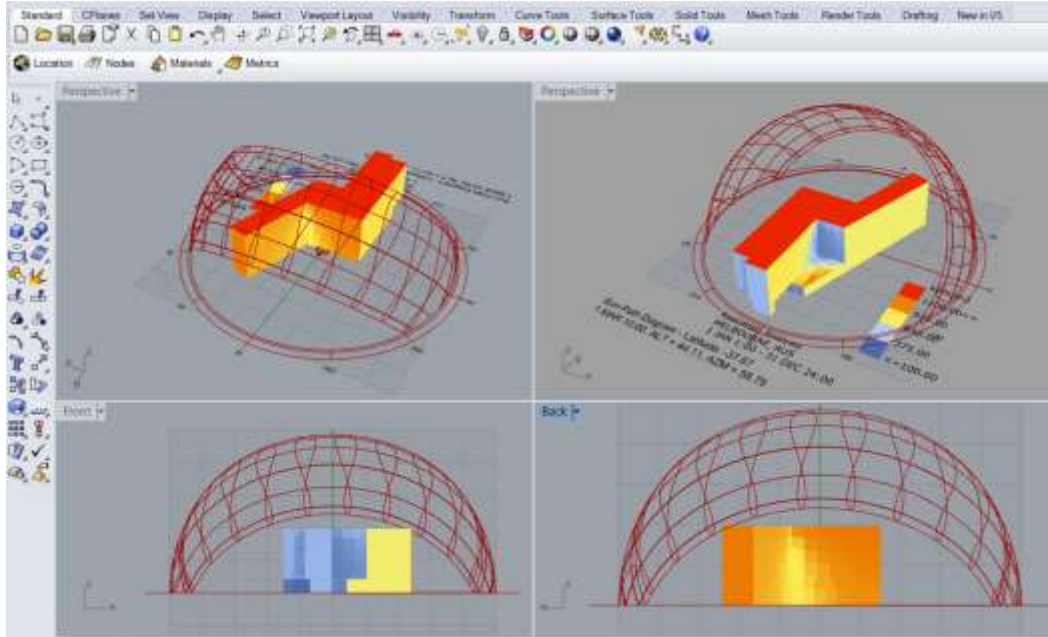
# INTEGRATION TO SITE CONTEXT

Consideration of orientation for solar

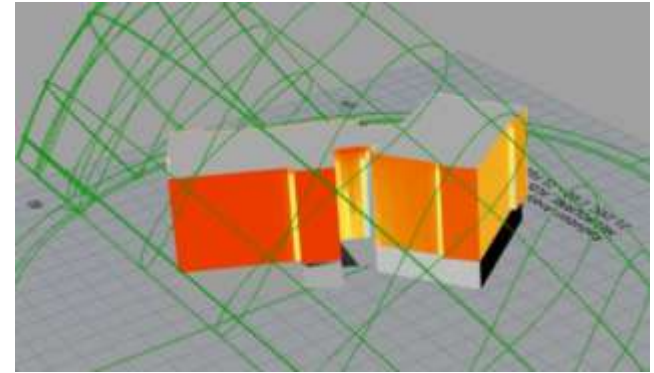


Minimise western solar gain whilst providing outlook from SOUs

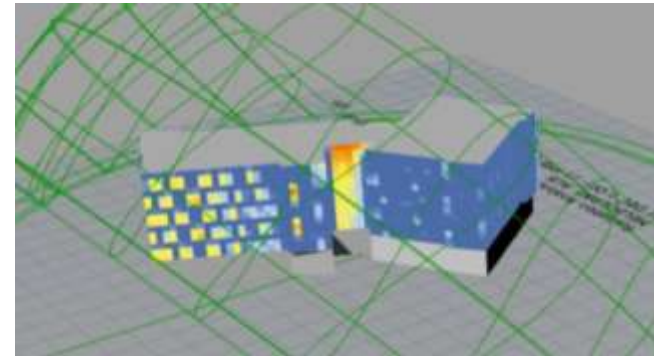
# BUILDING FORM OPTIMISATION



**Architectural form and  
orientation testing**

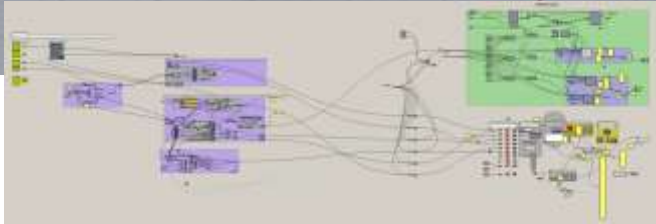
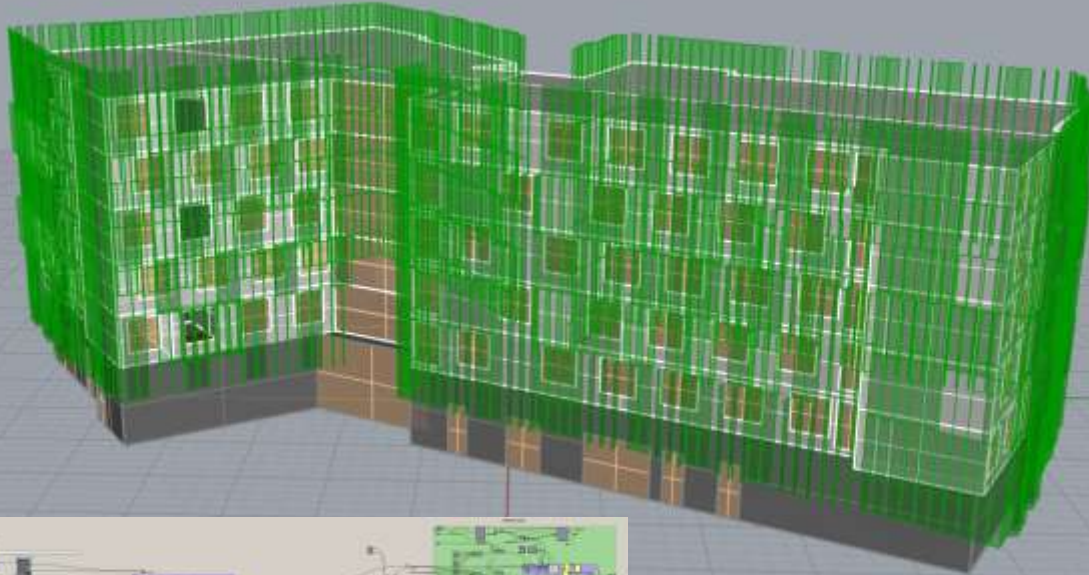


**North Façade - Without Shading**

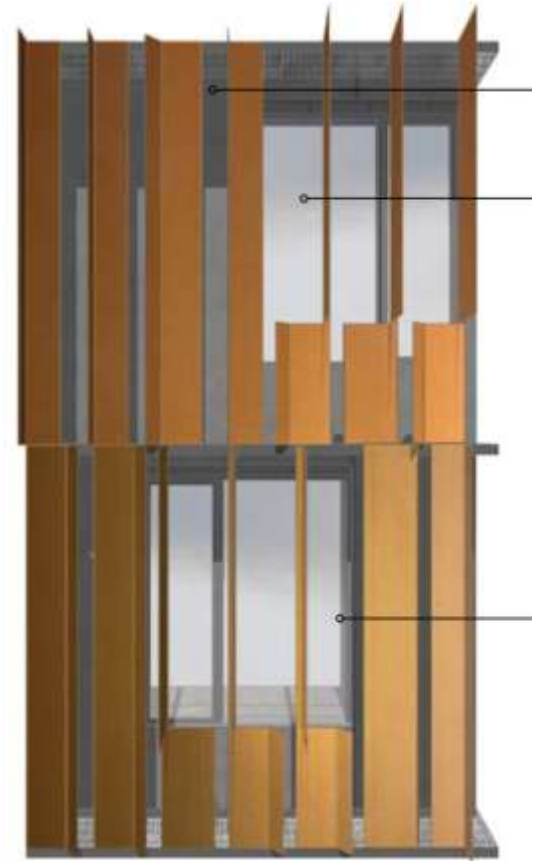


**North Façade – With Shading**

# EXTERNAL SHADING OPTIMISATION



Parametric modelling  
optimisation to balance  
performance with  
experience



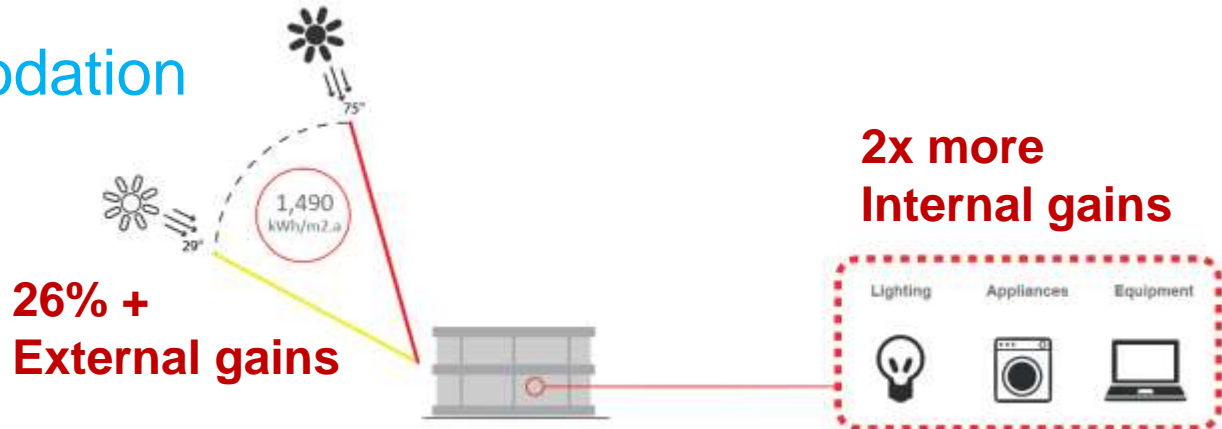


# HEAT GAINS

## Classic



## Student Accommodation





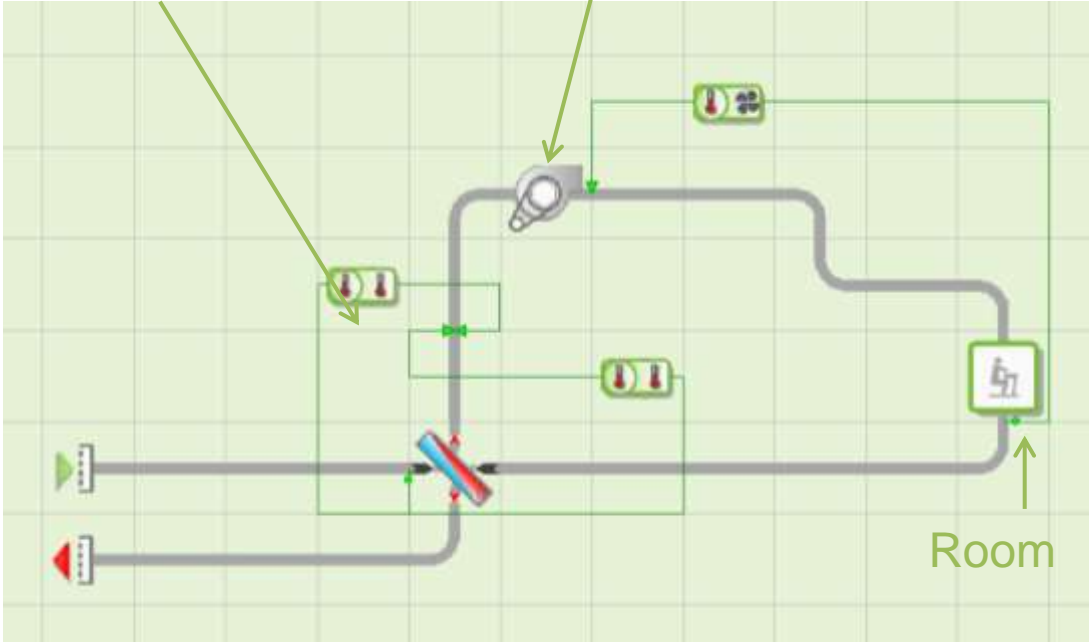
SEARCHING FOR THE RIGHT FRIDGE

# MECHANICAL SYSTEMS

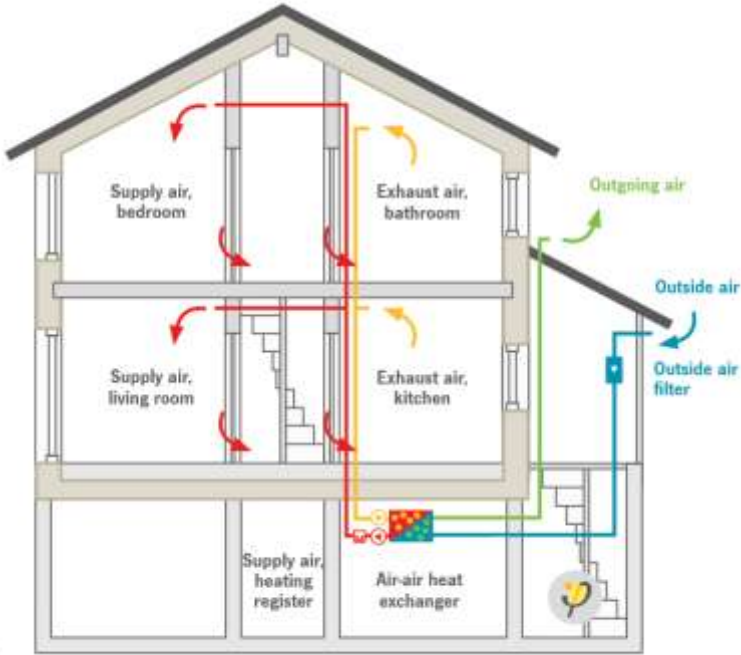
Plate Heat  
Exchanger (80%  
efficiency)

Fan

Room



IES – HVAC Modelling

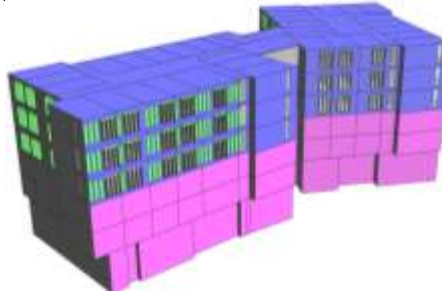


Passive House HVAC Strategy

# TEMPERATURES FOR A NORTH-FACING ROOM

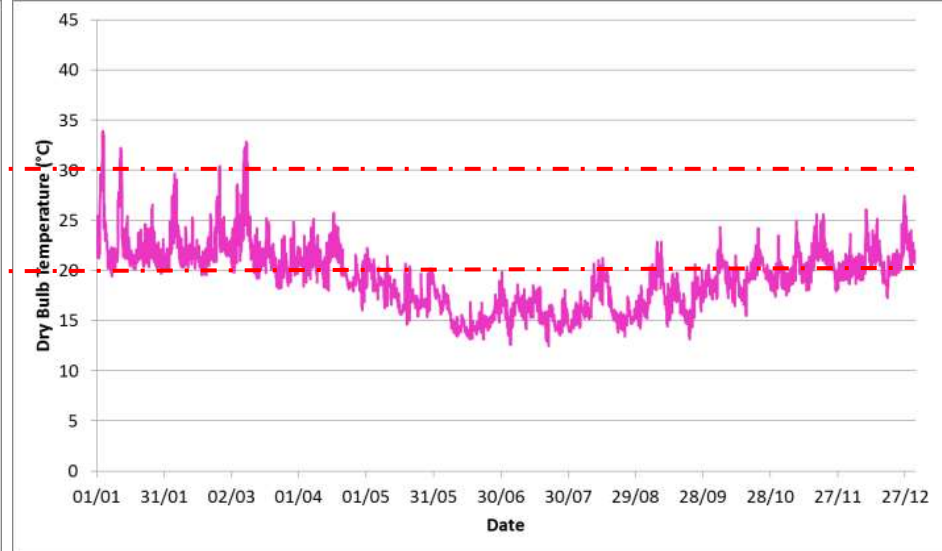
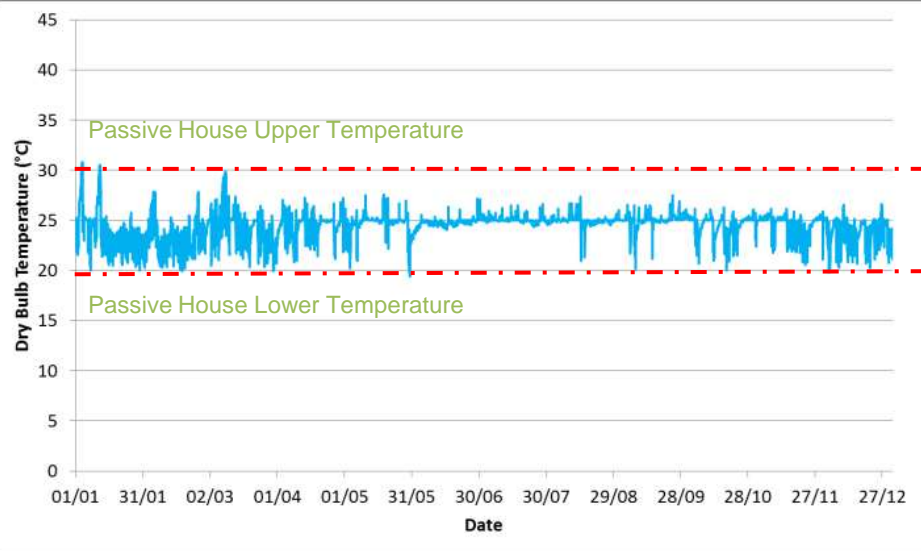
## Passive House

- Max DB temperature = 30.8°C
- Min DB temperature = 19.4°C
- Max Mean Radiant temperature = 30.5°C



## BAU

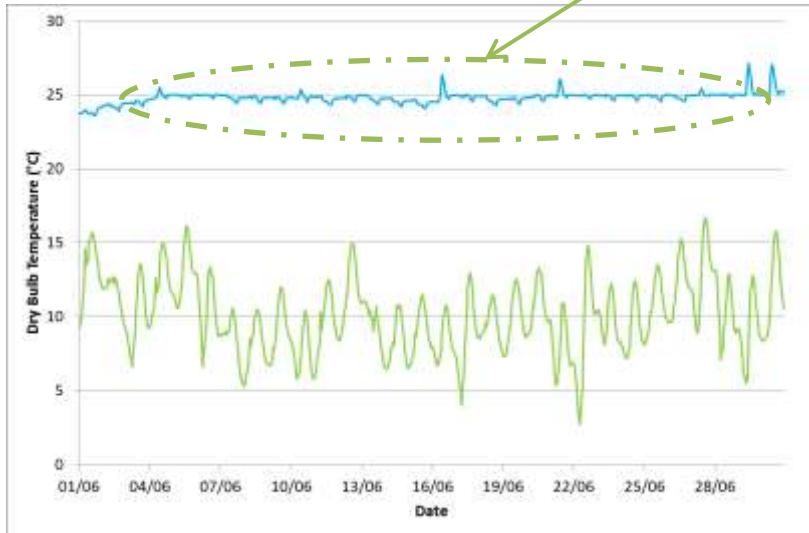
- Max DB temperature = 33.9°C
- Min DB temperature = 12.5°C
- Max Mean Radiant temperature = 33.5°C



# JUNE TEMPERATURES FOR A NORTH-FACING ROOM

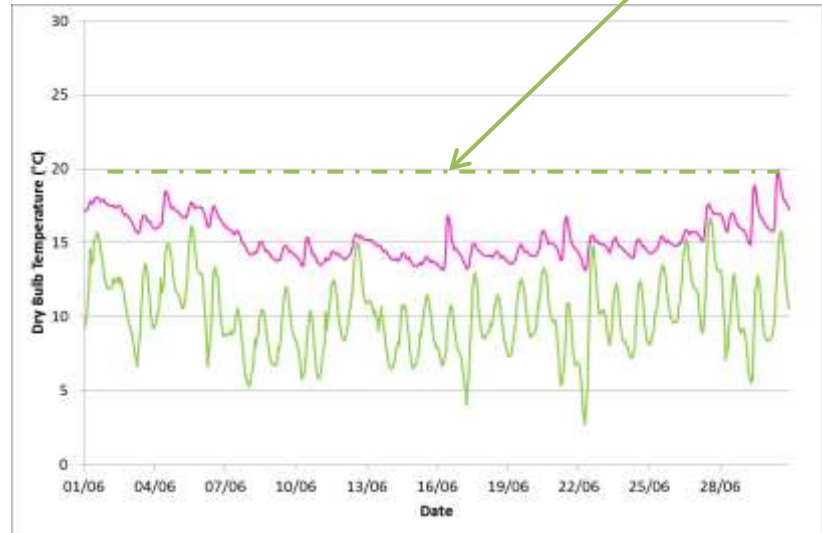
## Passive House

During winter, the spaces are kept almost at a constant 25° C. Small peaks occur due to solar load.



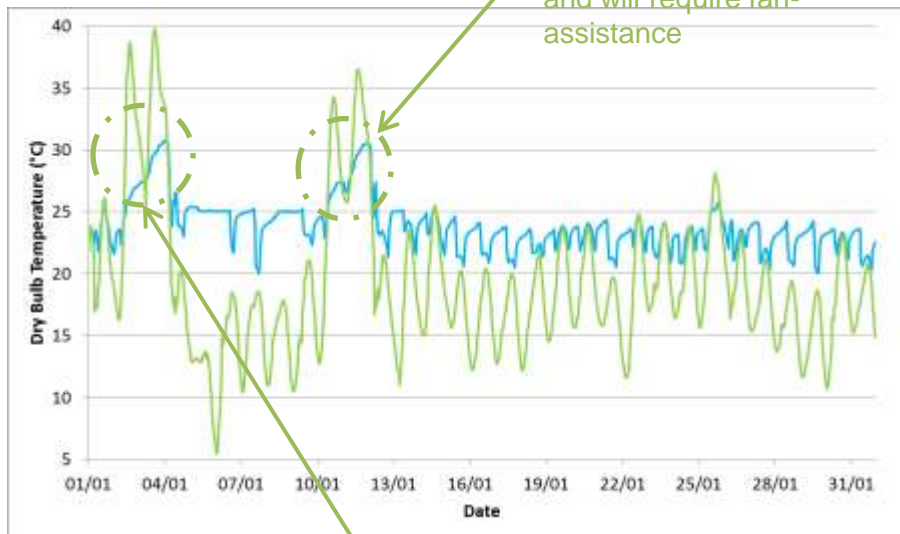
## BAU

The temperatures are all below 20°C, which is uncomfortable for occupants and will require heating



# JANUARY TEMPERATURES FOR A NORTH-FACING ROOM

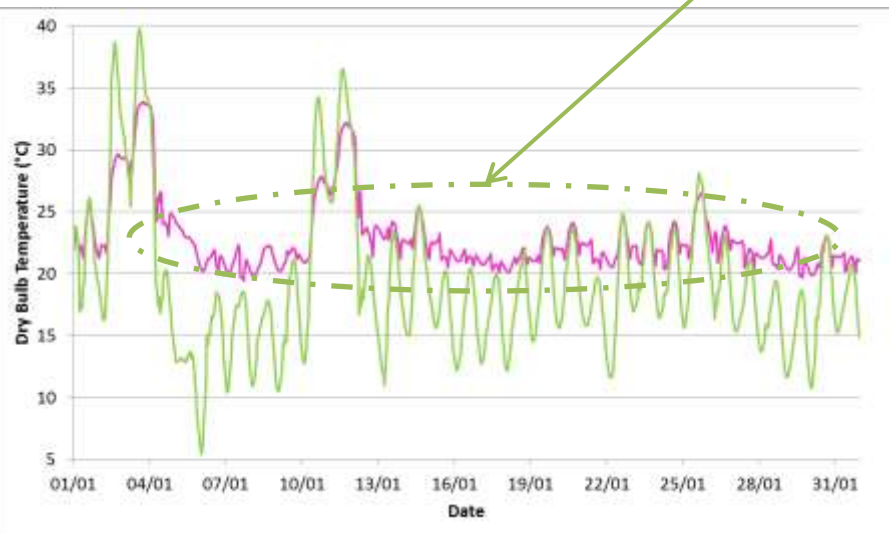
## Passive House



However, second hot day will result in temperatures that exceed comfort criteria and will require fan-assistance

First hot day only sees a small increase in temperatures

## BAU



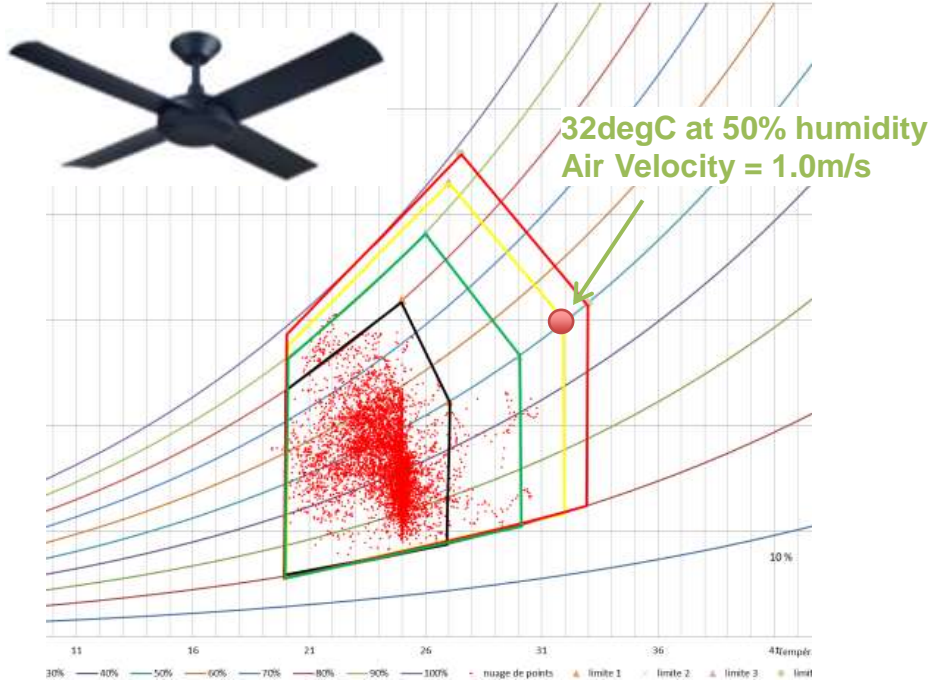
BAU has lower temperatures outside of peak temperature days due to leakage / conduction losses



# THERMAL COMFORT FOR A NORTH-FACING ROOM

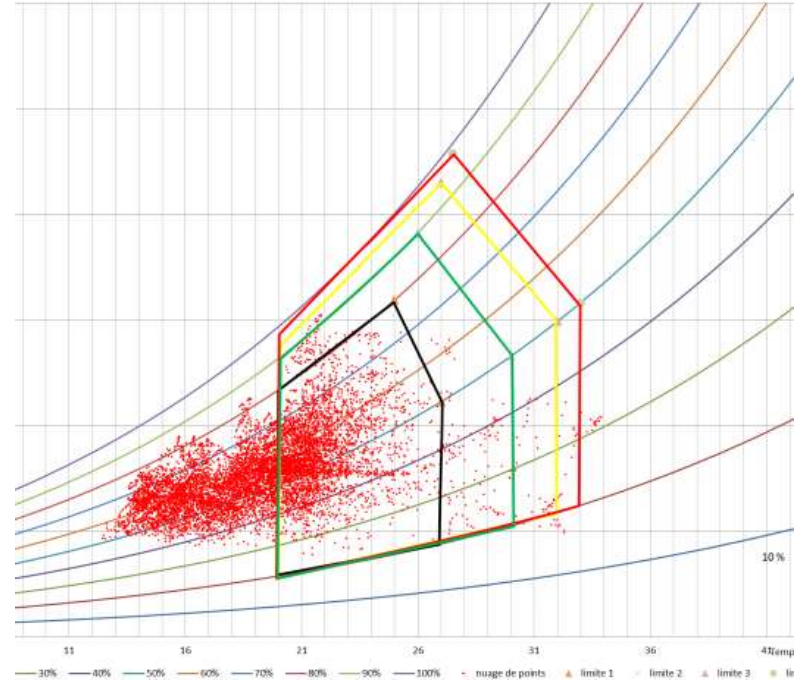
## Passive House

Diagramme de confort

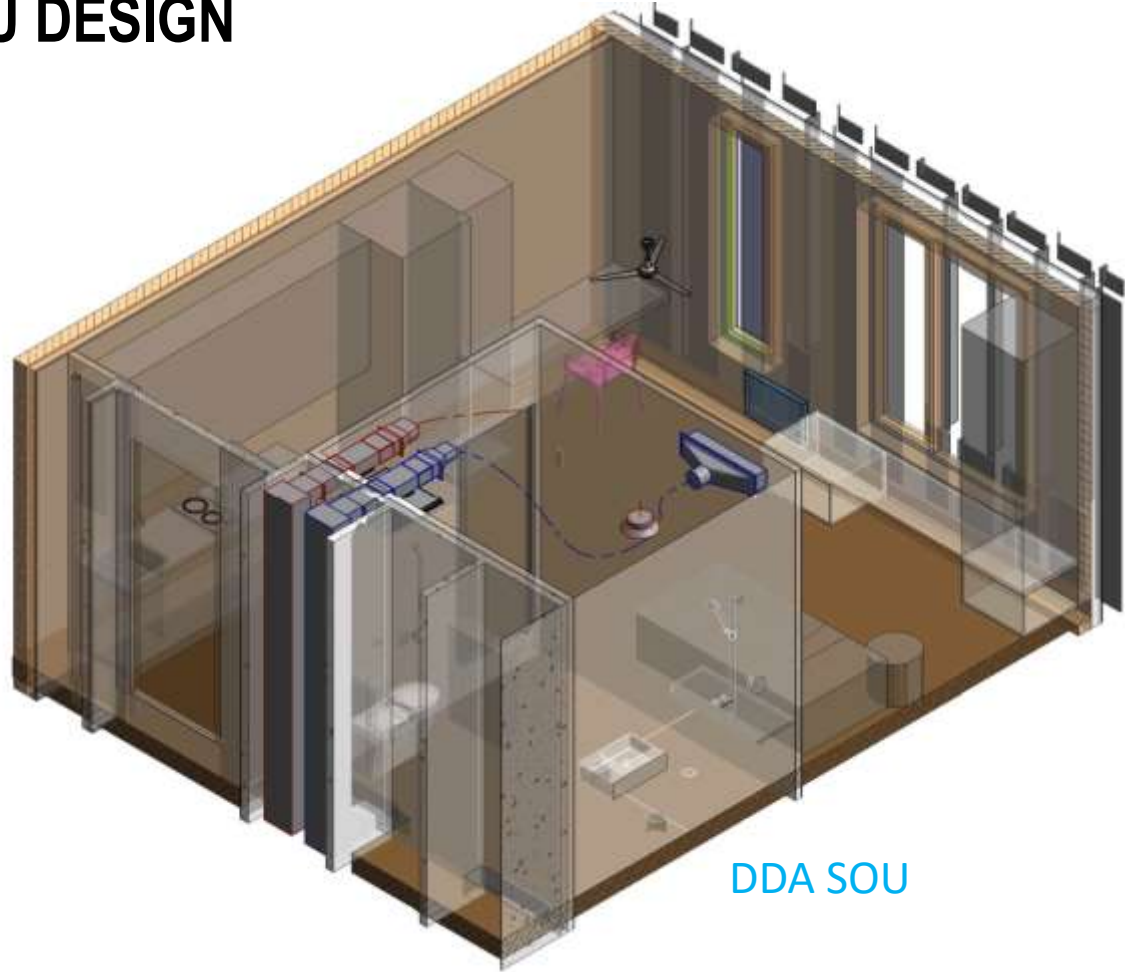
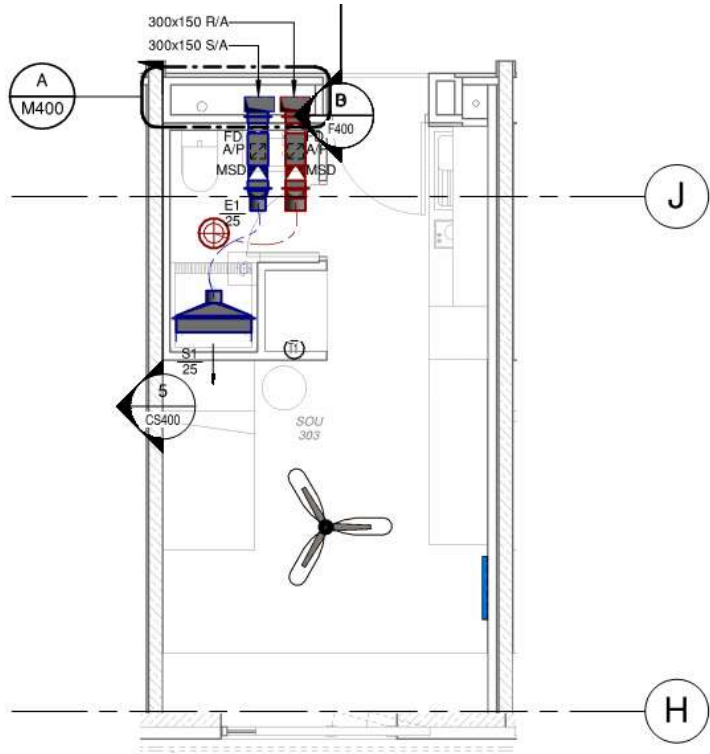


## BAU

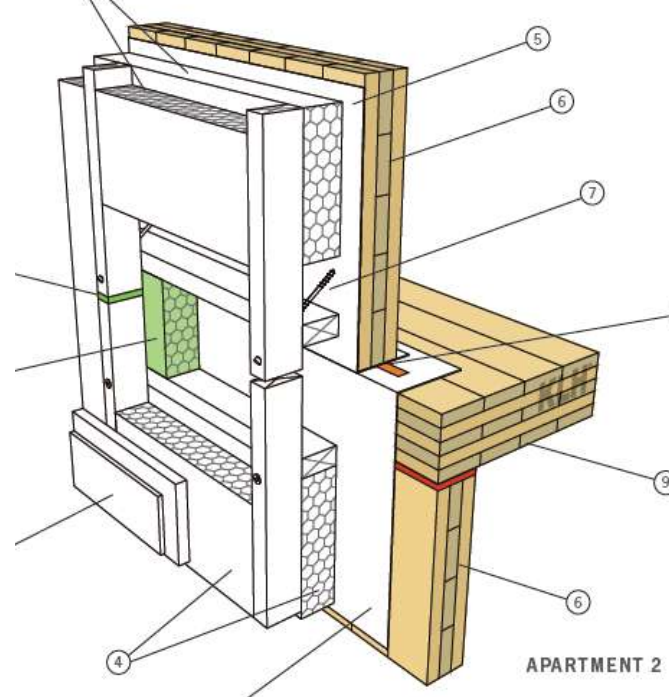
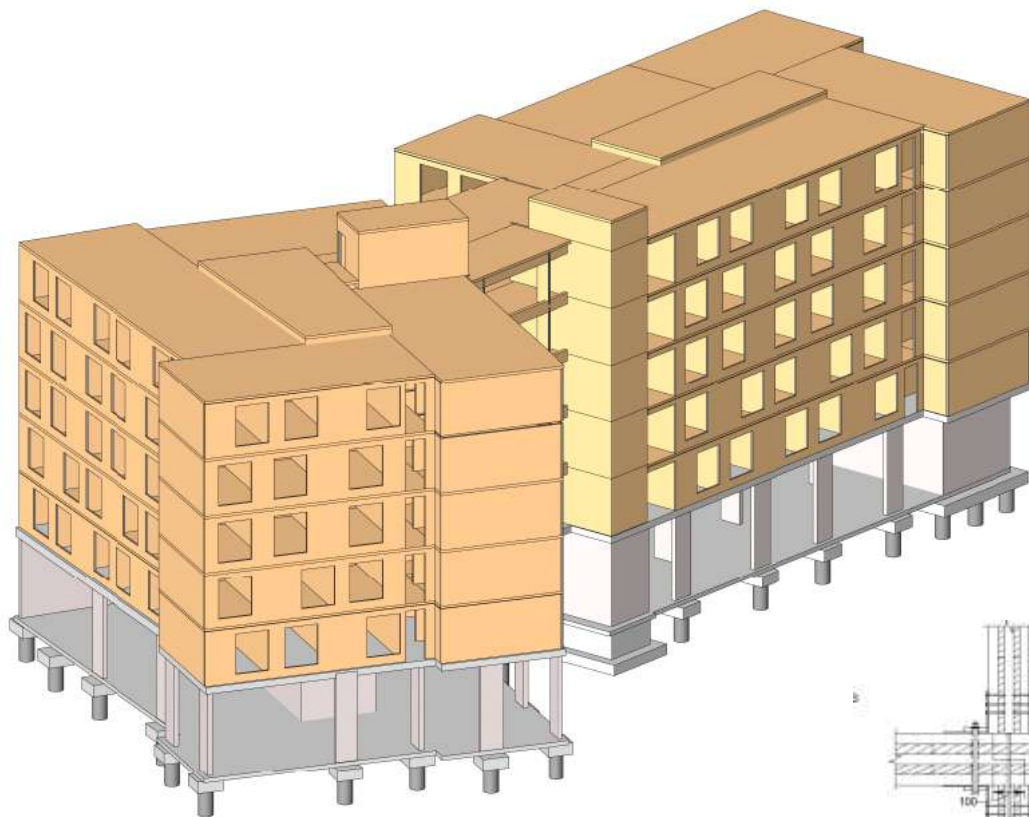
Diagramme de confort



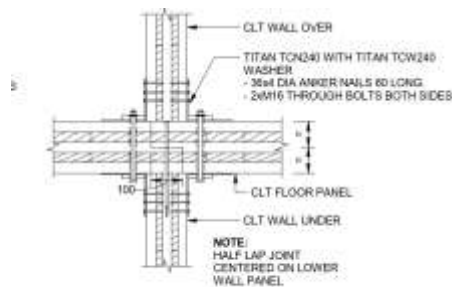
# FINAL PASSIVE HOUSE SOU DESIGN



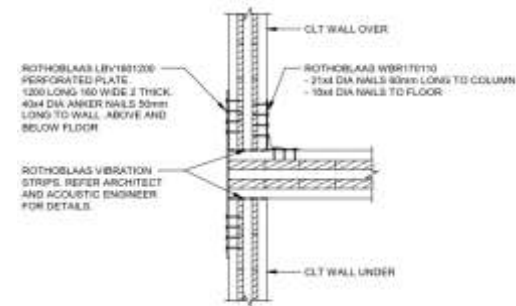
# FINAL CLT STRUCTURAL DESIGN



APARTMENT 2



CLT WALL TO FLOOR CONNECTION  
TYPE C2



CLT WALL TO FLOOR AT LIFT CORE  
TYPE C7



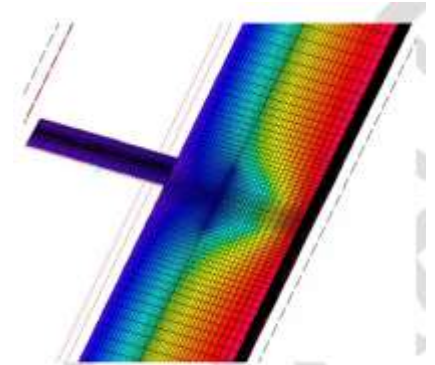
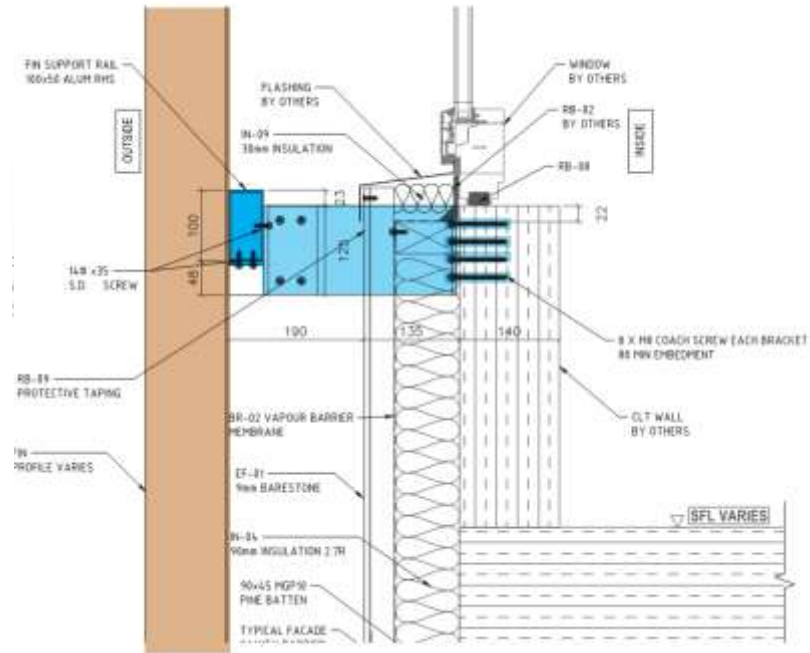


# PASSIVE HOUSE CERTIFICATION

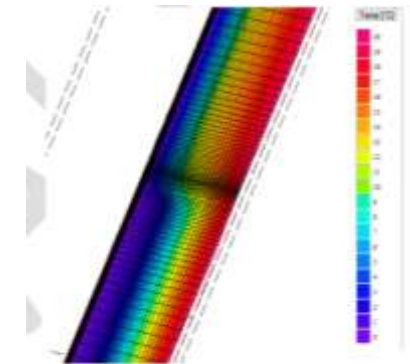




# PASSIVE HOUSE CERTIFICATION



(c) Heat field image – with bracket



(d) Temperature field image – without bracket



# PASSIVE HOUSE CERTIFICATION



# PASSIVE HOUSE CERTIFICATION







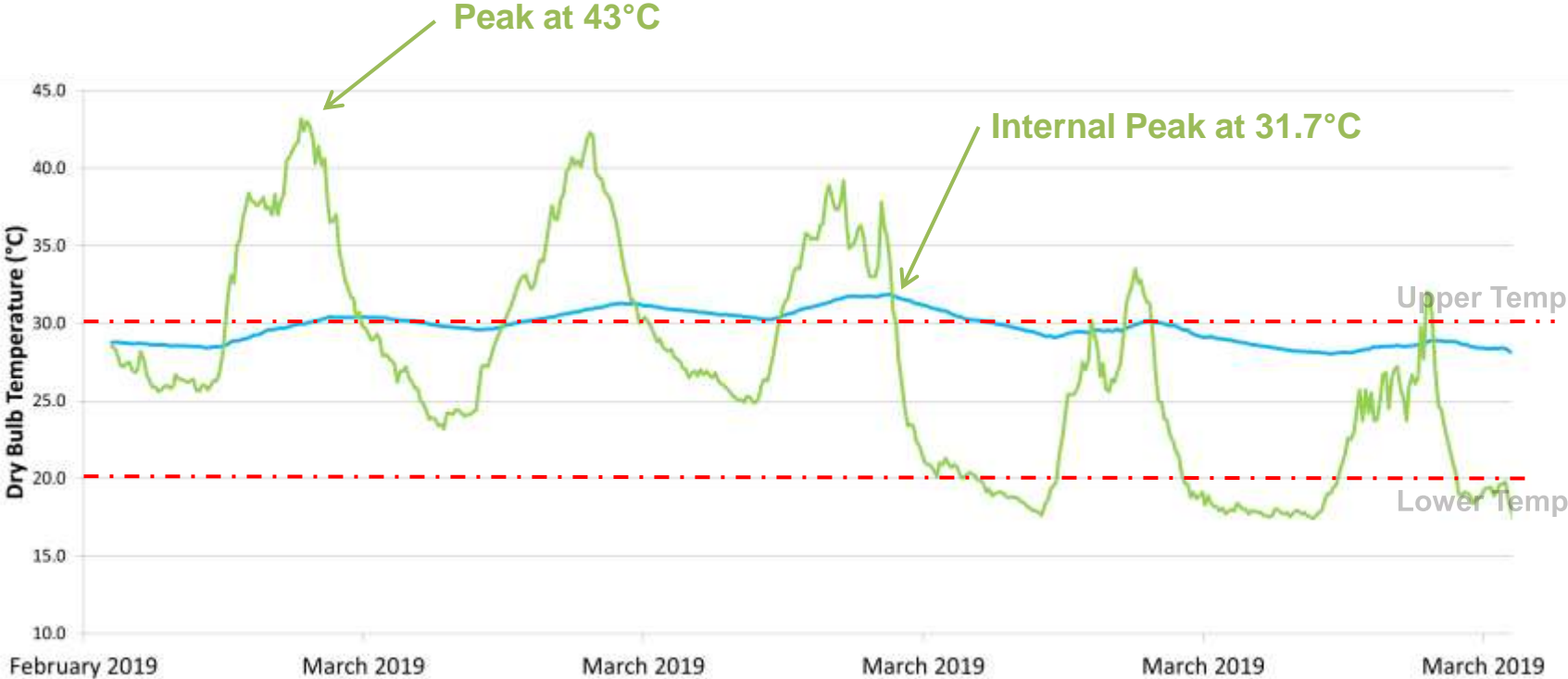
# PASSIVE HOUSE CERTIFICATION



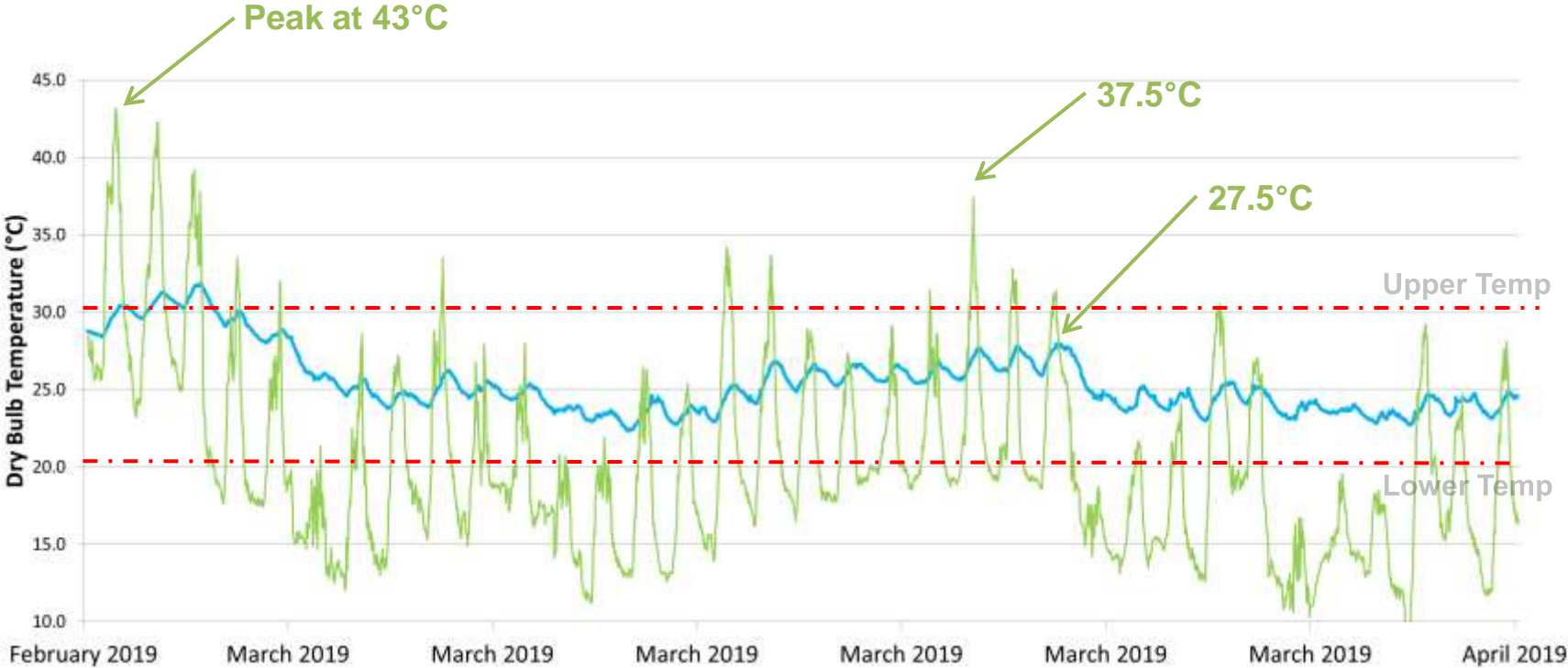
# HOW DOES IT PERFORM?



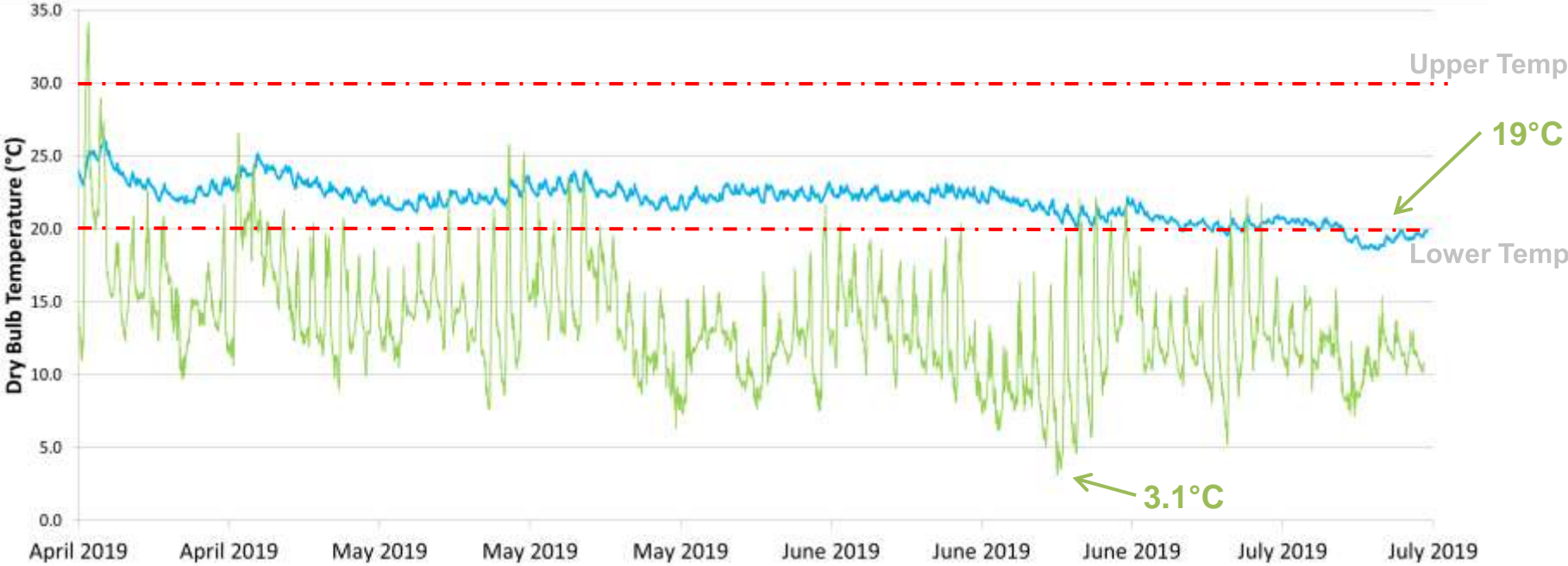
# PERFORMANCE - SUMMER



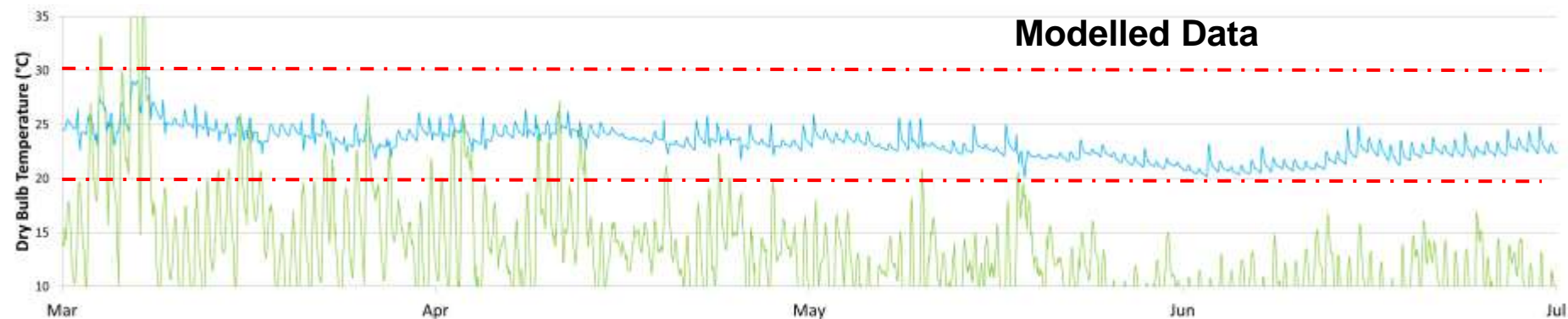
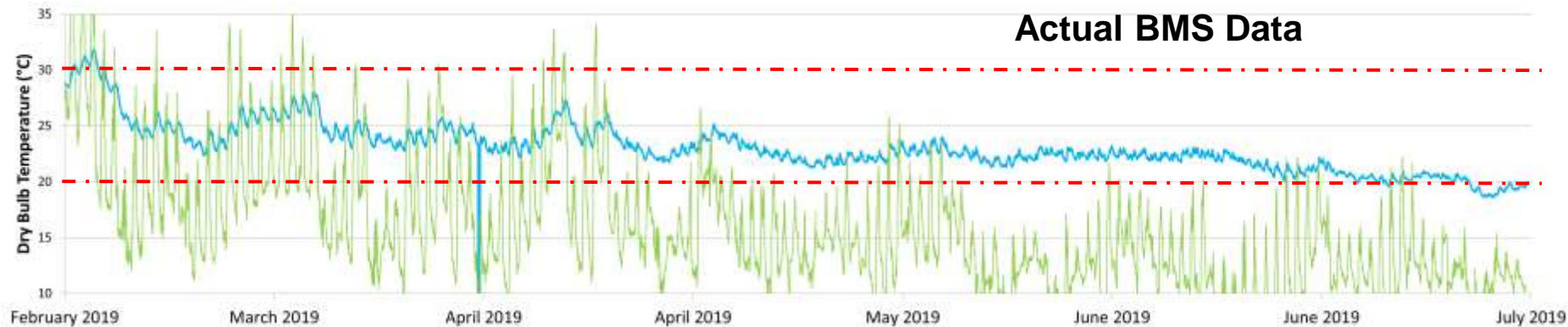
# PERFORMANCE - SUMMER



# PERFORMANCE - WINTER

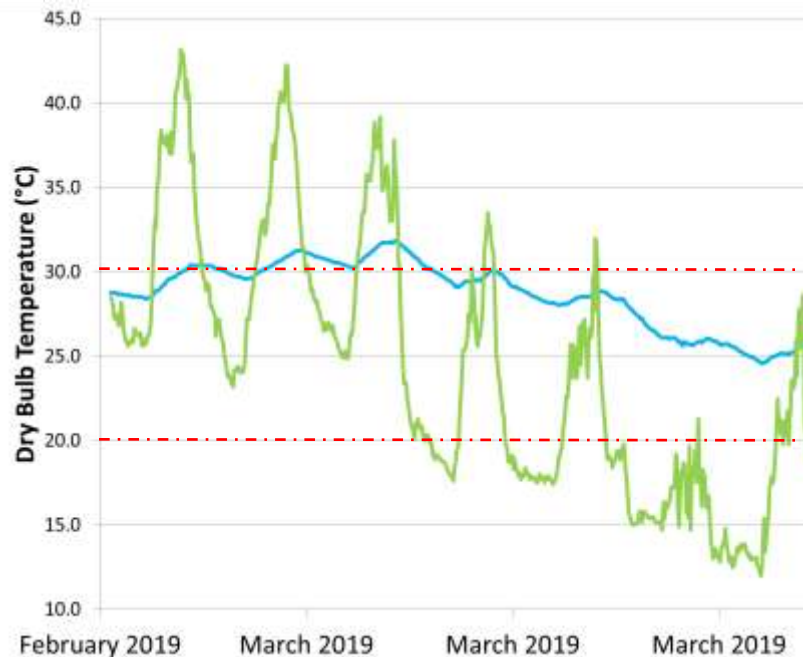


# ACTUAL VS MODELLED DATA

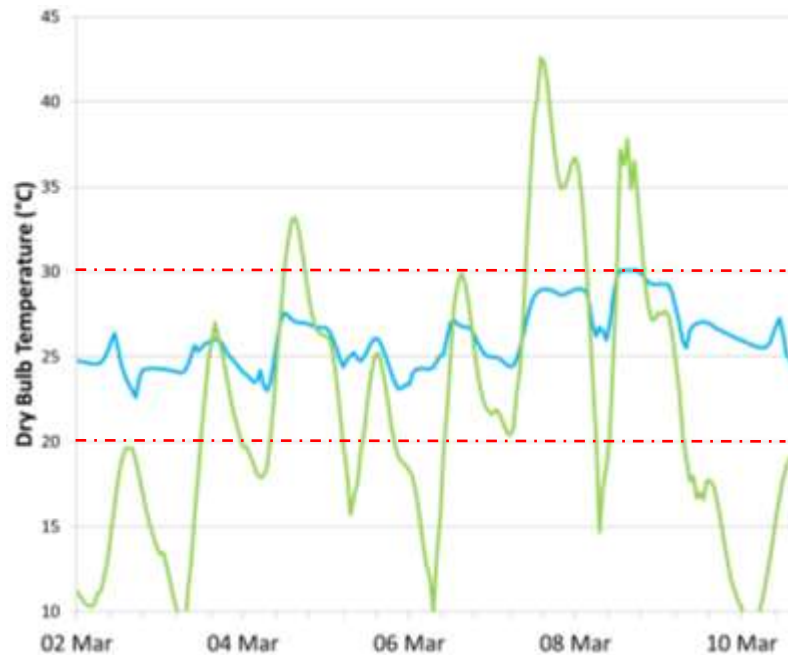


# ACTUAL VS MODELLED DATA

## Actual BMS Data



## Modelled Data





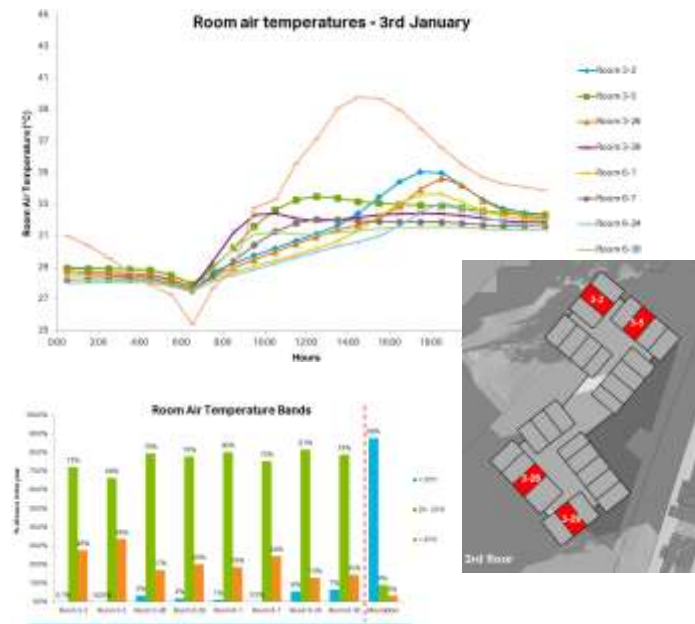
# LESSONS LEARNT

- Passive House potential in the Australian climate!



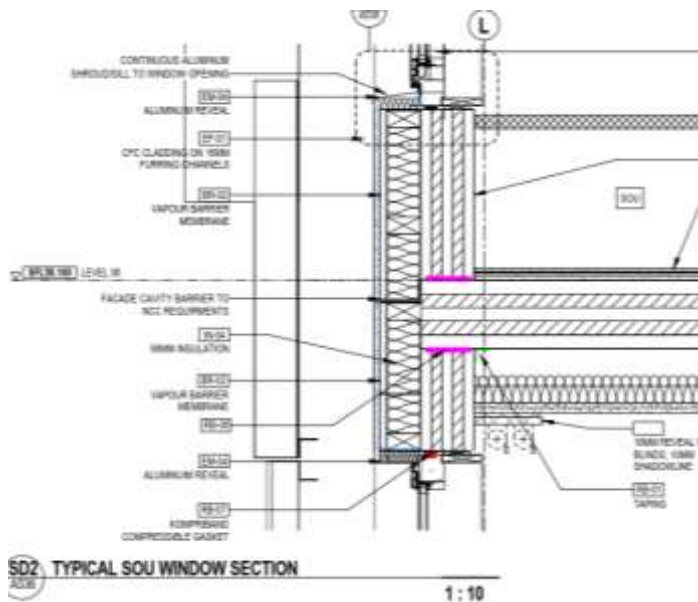
# LESSONS LEARNT

- Designing from first principles.



# LESSONS LEARNT

- Focus on the detailing









## LESSONS LEARNT

- Engage with Design/Team Early



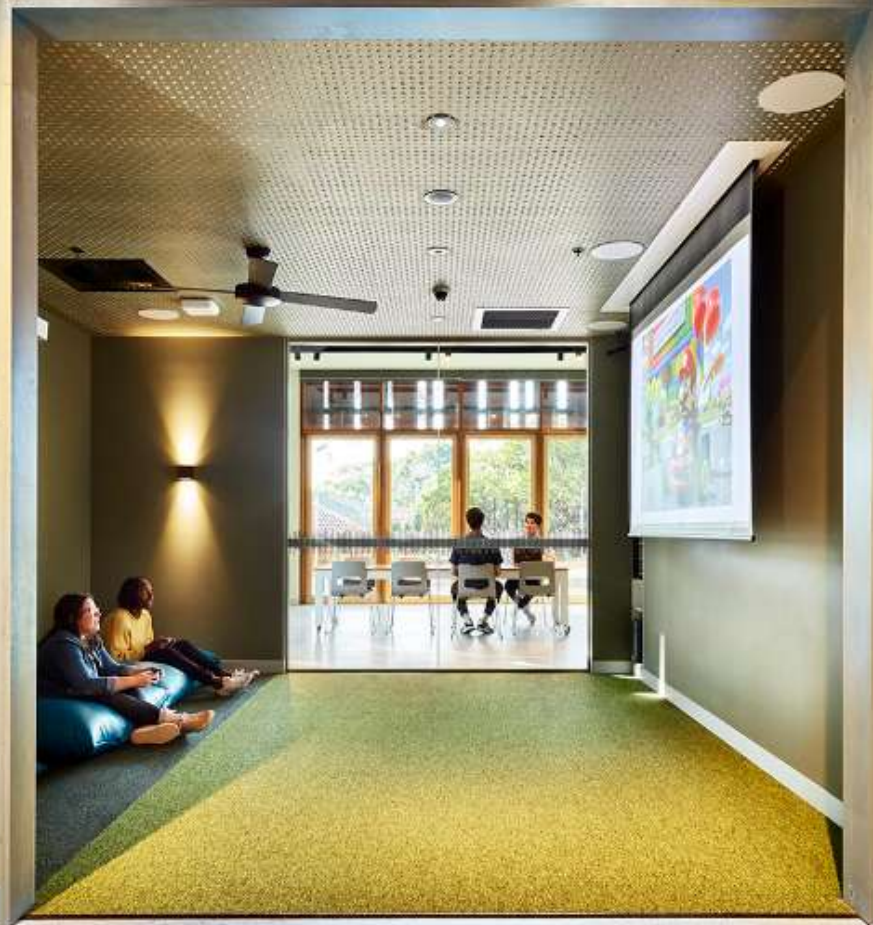



## LESSONS LEARNT

- Testing - Functional BAS Architecture fundamental to Performance Monitoring and Reporting

# LESSONS LEARNT

- Total Commissioning – Is a Non Negotiable for Delivery of Performance





*“These activities  
shine a light on  
scalable climate  
action around the  
world. They are proof  
that climate action  
isn’t only possible, it’s  
innovative, it’s  
exciting and it makes  
a difference”.*

**Patricia Espinosa**  
Executive Secretary  
of UN Climate  
Change

# NET ZERO INITIATIVE

United Nations 2018  
Momentum for Change  
Award winner.



# STUDENT EXPERIENCE

**Preeti Kale** – *Bachelor of Education*

“It’s very social. I’m learning to cook and gaining a lot of life skills. I really like my privacy so I choose to stay in the new studio apartments. My room is a great place to study in; it’s a really nice cosy space.”

**Chole Pate** – *Bachelor of Paramedicine*

“I love the studio apartments. I really like that we can use the communal kitchens with the bigger bench space on each floor. Everything is very clean and there is also a lot of sitting space to chill out.”





# Awards

**Construction 21 – Awards Winner**

**Melbourne Design Awards 2019 – Gold Medal**

**AFR Higher Education Award 2019 – Facilities  
Innovation Award**

...

**Premiers Sustainability Award– Finalist**

**Australian Timber Design Awards – Finalist**

...

***More to Come!***



# Acknowledgements

**Architecture** – Jackson Clements Burrows

**Building Services** – AECOM

**Structural** – AECOM

**ESD** – AECOM

**Fire Engineering** – AECOM

**Acoustics** – AECOM

**Passive House Certifier** – Grün Consulting

**Project Manager** – Ryan Spittel

**Builder** – Multiplex

GILLIES HALL