Modelling Passive Ventilation

The Sustainable Approach to early-stage Design

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The Sustainable Approach to early-stage Design

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Sustainability & Building Physics Engineer

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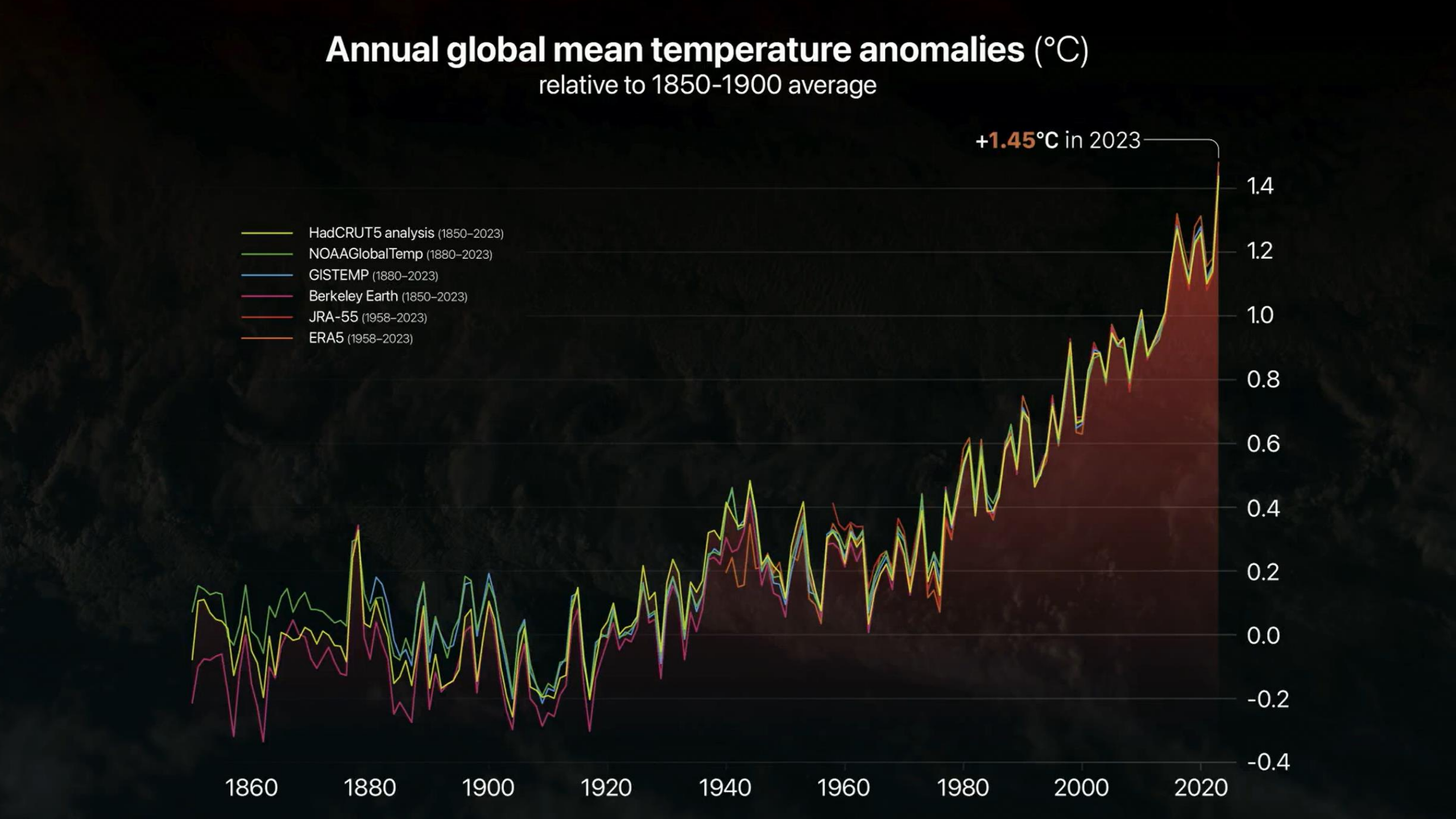
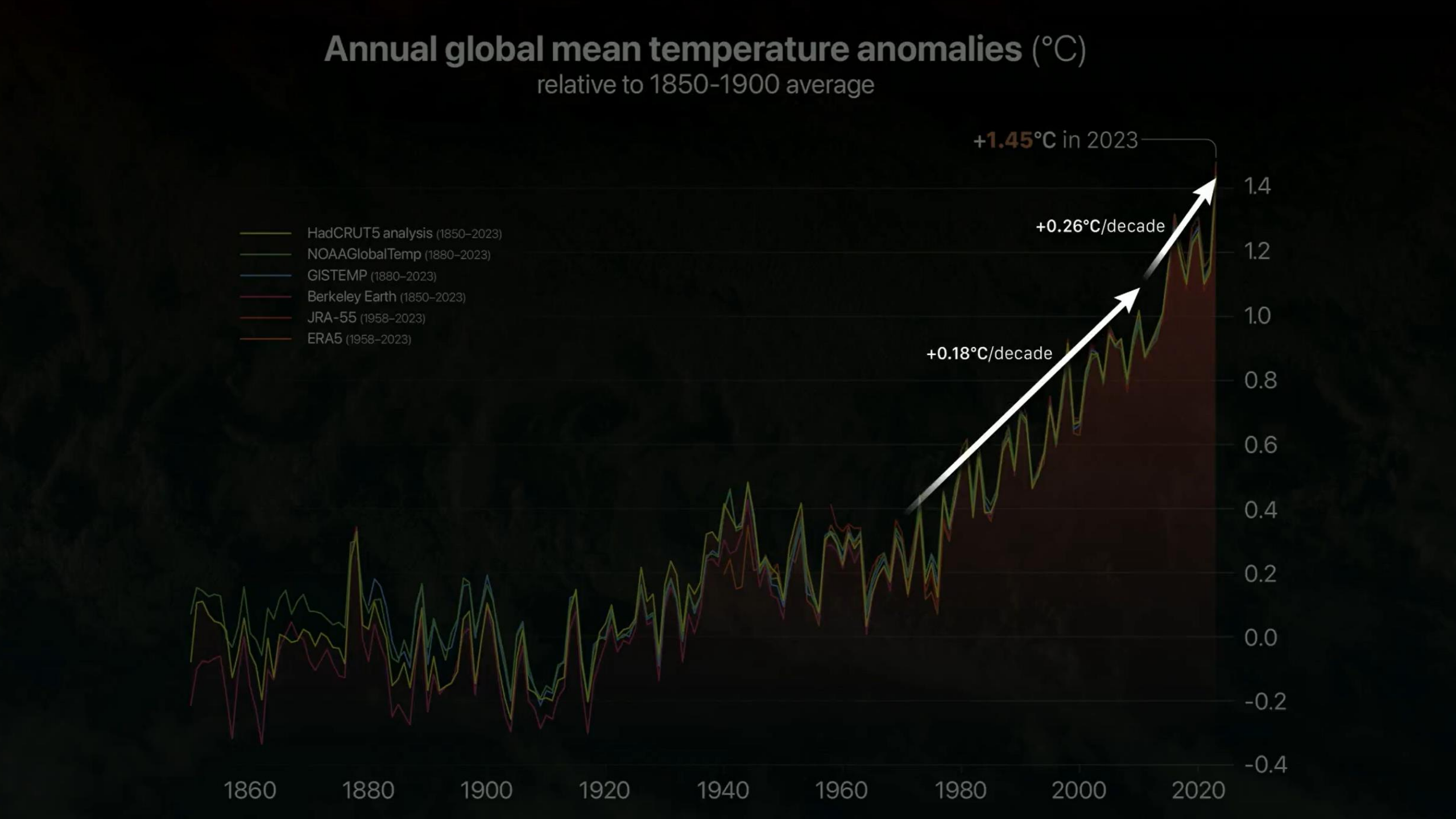
SCS


Annual global mean temperature anomalies (°C)
relative to 1850-1900 average
+1.45°C in 2023
HadCRUT5 analysis (1850–2023)
NOAAGlobalTemp (1880–2023)
GISTEMP (1880–2023)
Berkeley Earth (1850–2023)
JRA-55 (1958–2023)
ERA5 (1958–2023)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1860
1880
1900
1920
1940
1960
1980
2000
2020


Annual global mean temperature anomalies (°C)
relative to 1850-1900 average
+1.45°C in 2023
+0.26°C/decade
+0.18°C/decade
HadCRUT5 analysis (1850–2023)
NOAAGlobalTemp (1880–2023)
GISTEMP (1880–2023)
Berkeley Earth (1850–2023)
JRA-55 (1958–2023)
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1.4
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1860
1880
1900
1920
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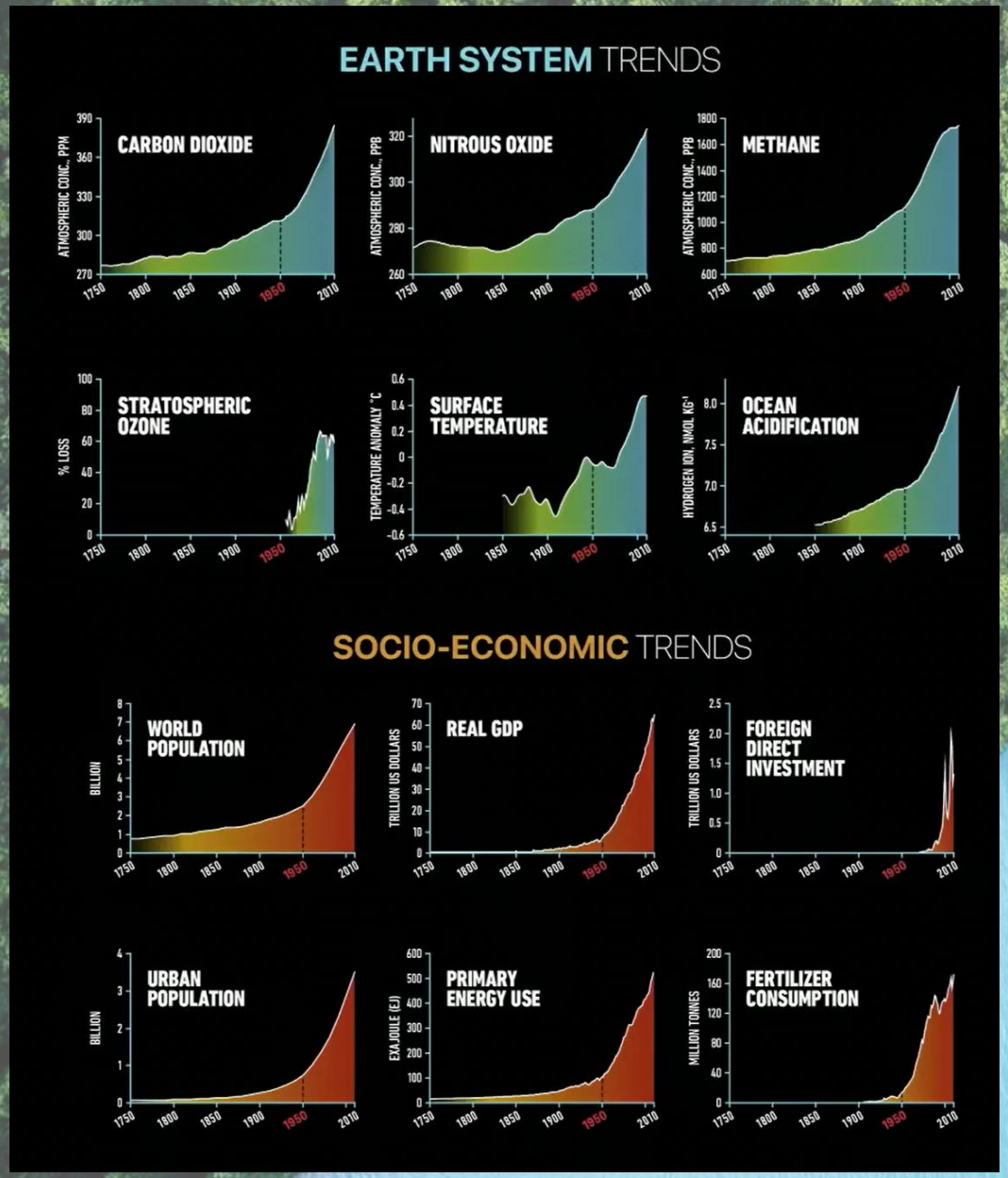
1960
1980
2000
2020



UK 2024

UKCCC Data

x2
Likelihood of a hot summer

+16cm
Sea level rise since 1990

+11days
Intense rainfall

+1.2°C
Warmer than pre-industrial period

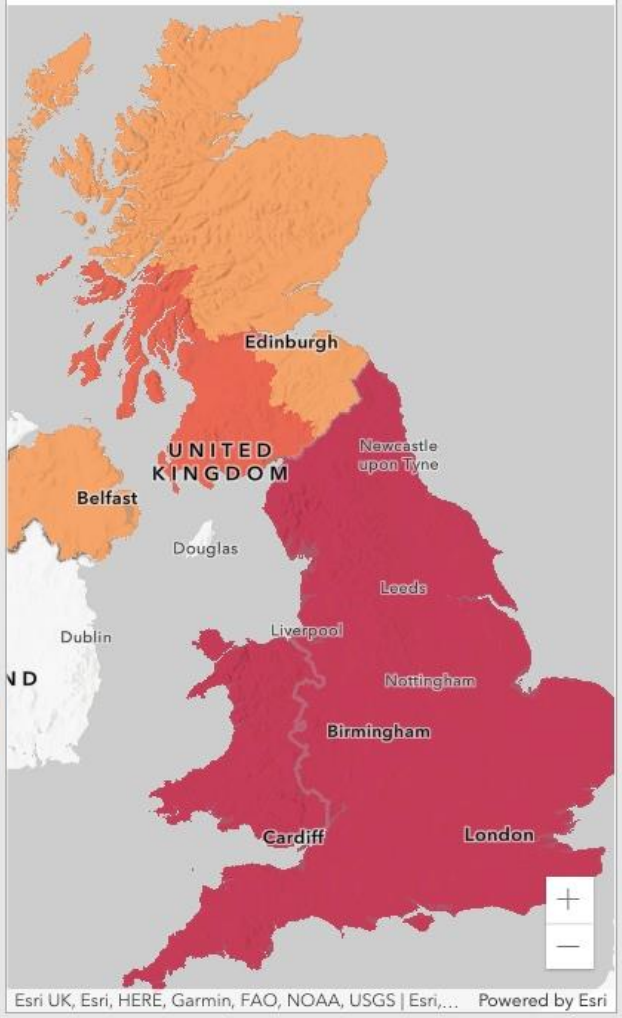
+146%
Drought Frequency

1981-2010 Annual Met Office heatwave % chance

33.4%
Map View Average

UK Maximum
49.6%
9.1%
UK Minimum

2041-2070 Annual Met Office heatwave % chance



85.2%
Map View Average

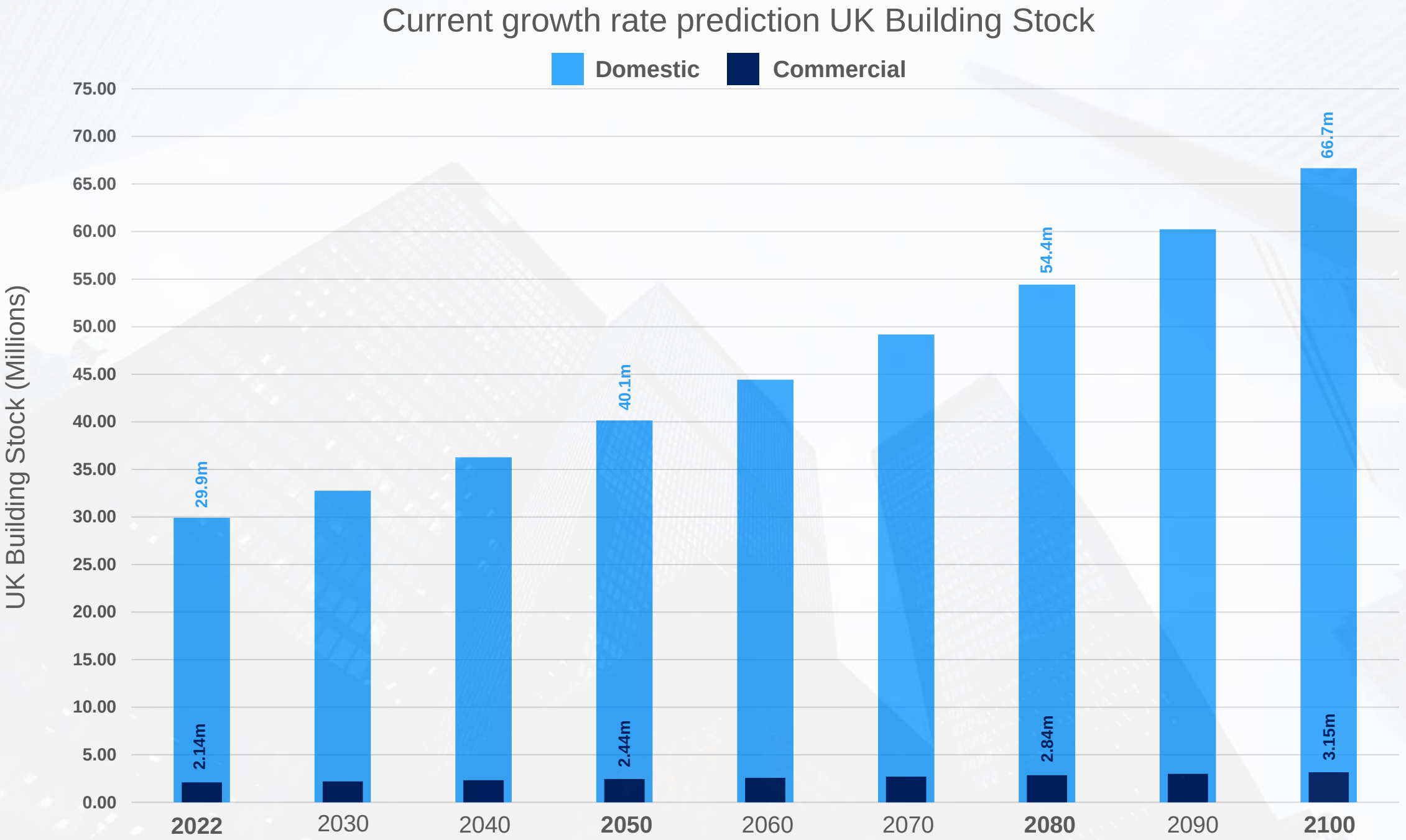
UK Maximum
98.5%
51.2%
UK Minimum

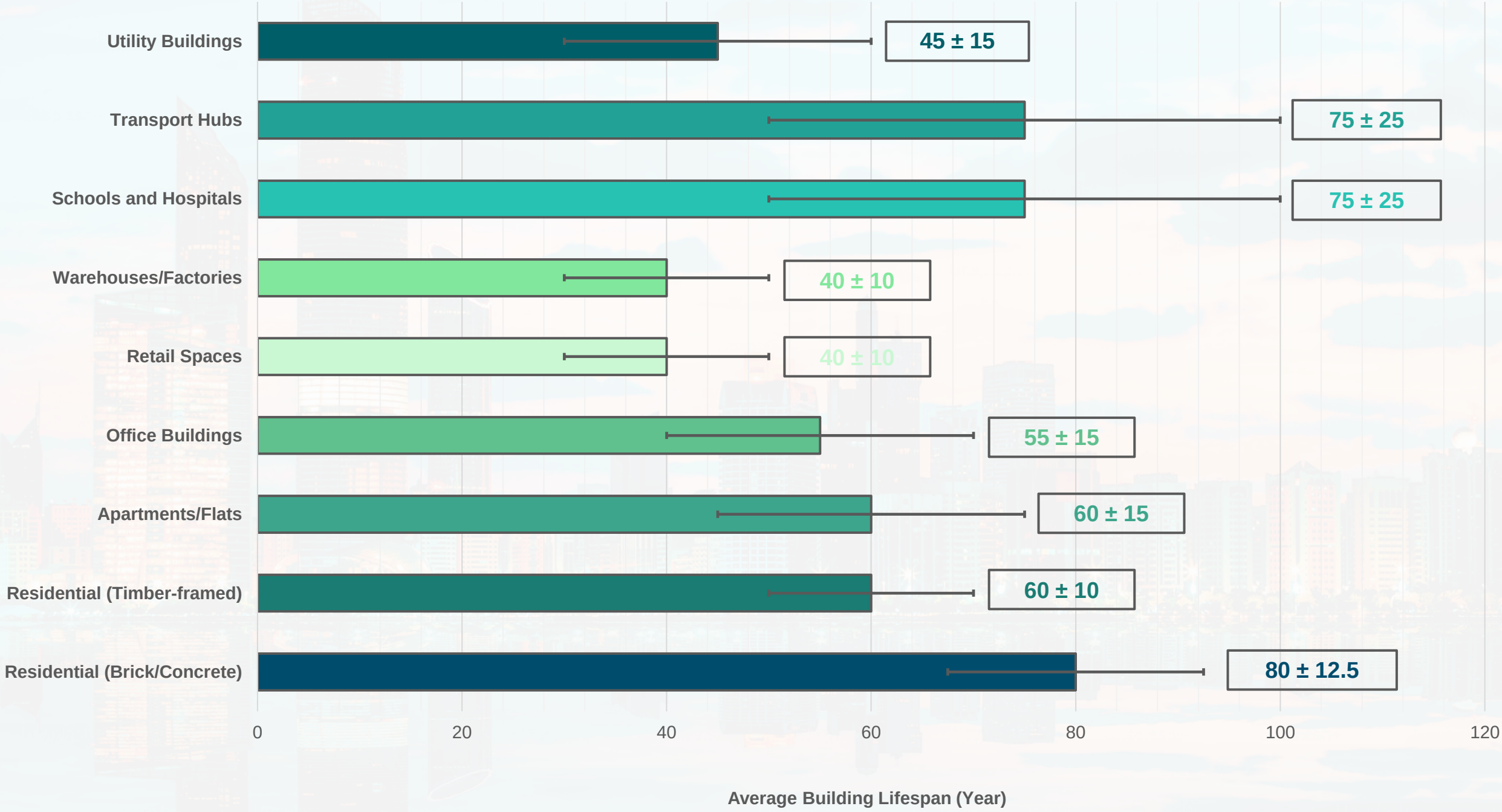
2071-2100 Annual Met Office heatwave % chance

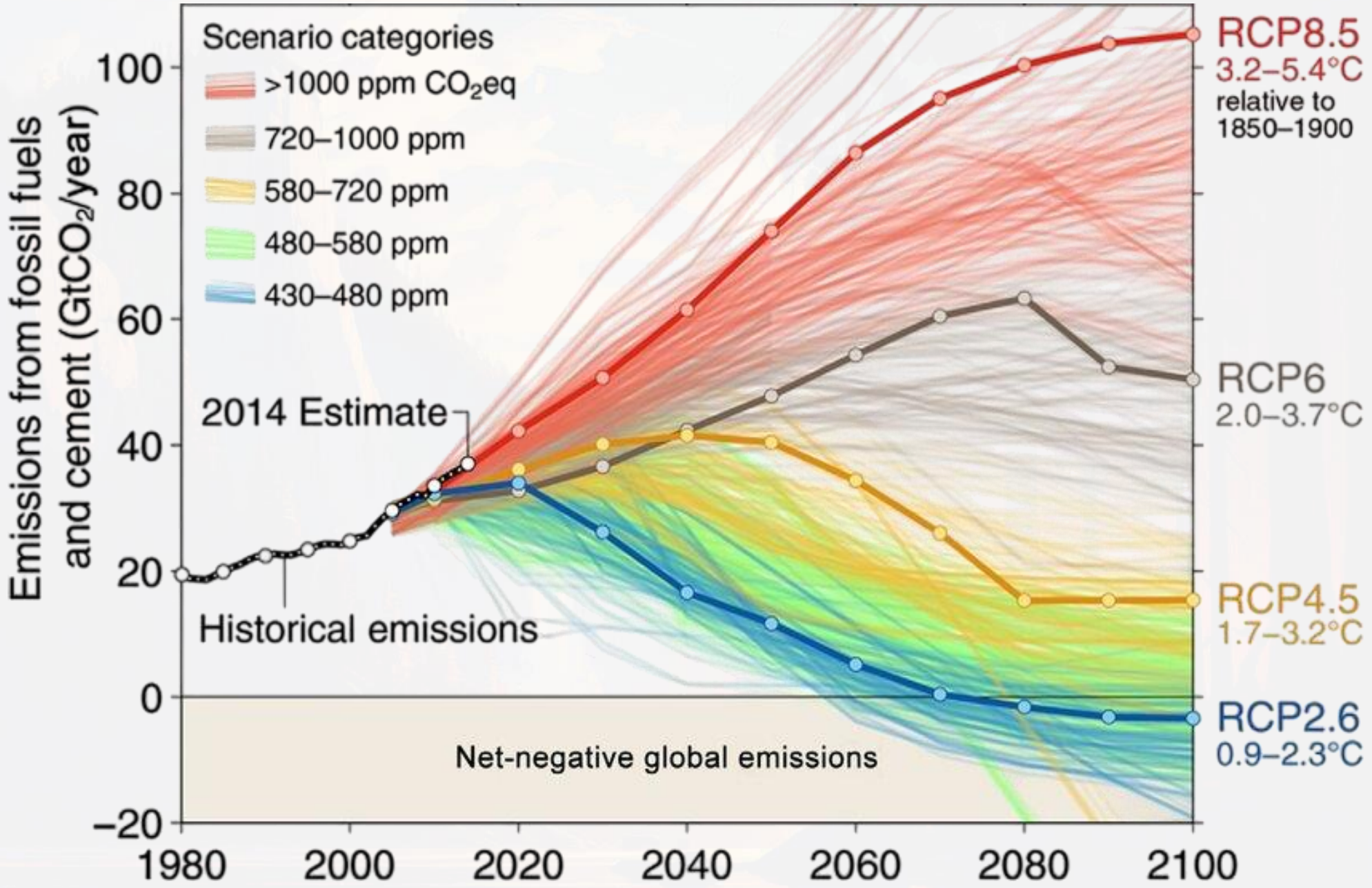
97.4%
Map View Average

UK Maximum
100%
80.3%
UK Minimum

7%	Lighting	15%
8%	Ventilation	20%
72%	Heating Space & Water	50%
2%	Cooling	10%
11%	Equipment & Appliances	5%

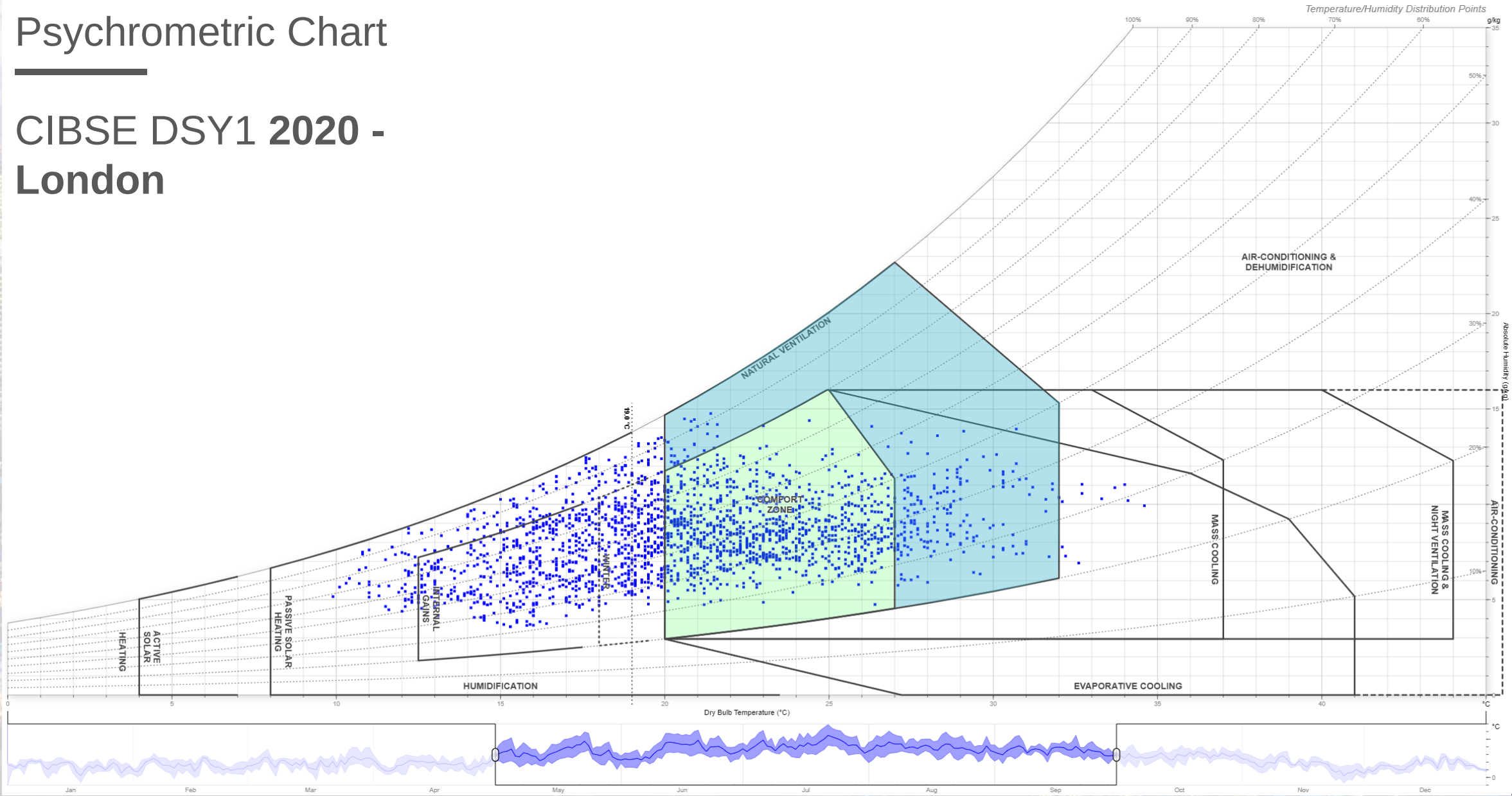

Current growth rate prediction UK Building Stock
Domestic
Commercial
UK Building Stock (Millions)
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
29.9m
40.1m
54.4m
66.7m
2.14m
2.44m
2.84m
3.15m
2022
2030
2040
2050
2060
2070
2080
2090
2100


Utility Buildings
45 ± 15
Transport Hubs
75 ± 25
Schools and Hospitals
75 ± 25
Warehouses/Factories
40 ± 10
Retail Spaces
40 ± 10
Office Buildings
55 ± 15
Apartments/Flats
60 ± 15
Residential (Timber-framed)
60 ± 10
Residential (Brick/Concrete)
80 ± 12.5
0
20
40
60
80
100
120
Average Building Lifespan (Year)


Scenario categories
>1000 ppm CO_2eq
720–1000 ppm
580–720 ppm
480–580 ppm
430–480 ppm
Emissions from fossil fuels and cement ($GtCO_2$/year)
100
80
60
40
20
0
−20
2014 Estimate
Historical emissions
Net-negative global emissions
1980
2000
2020
2040
2060
2080
2100
RCP8.5
3.2–5.4°C
relative to
1850–1900
RCP6
2.0–3.7°C
RCP4.5
1.7–3.2°C
RCP2.6
0.9–2.3°C

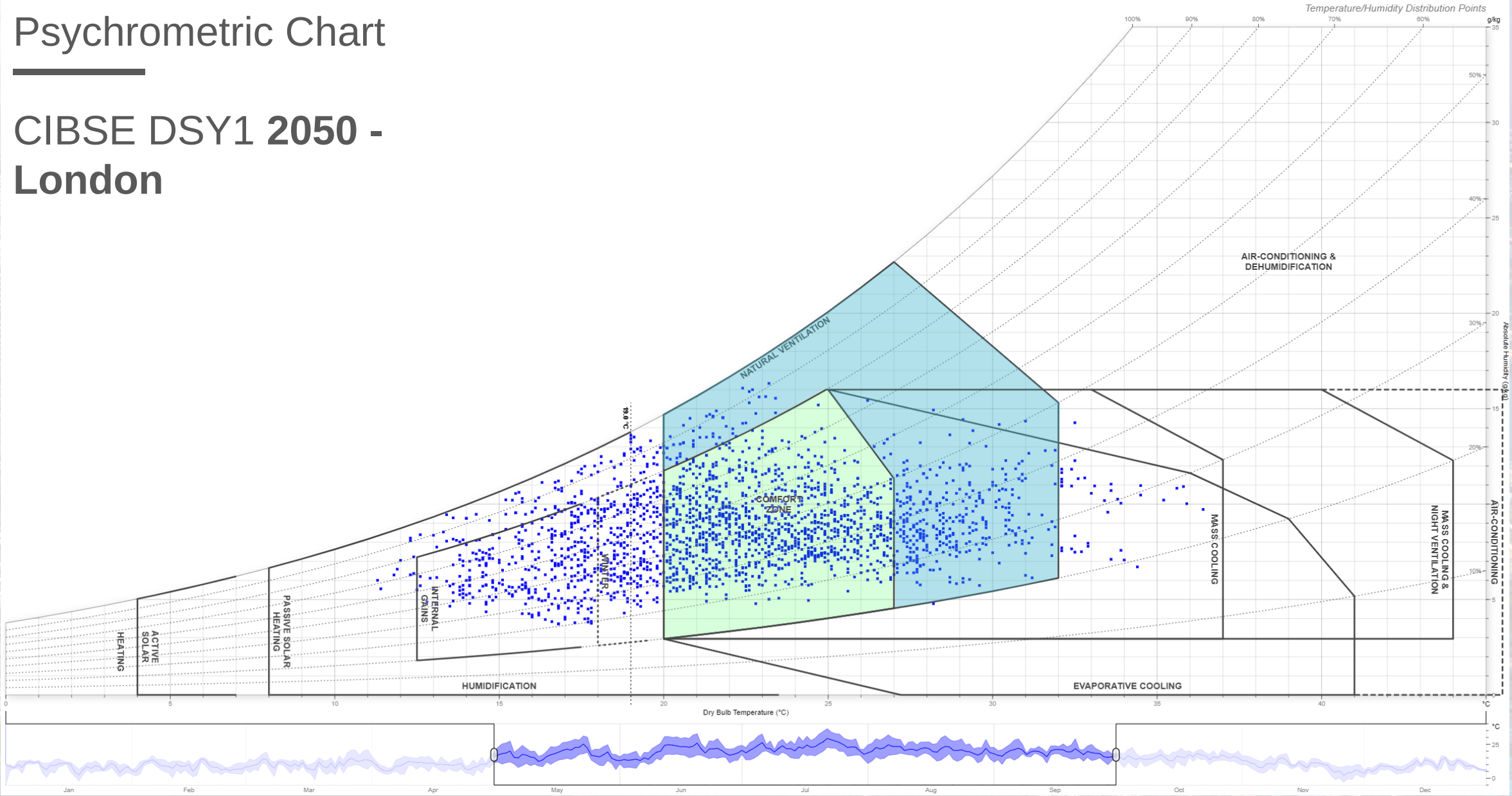
Psychrometric Chart

CIBSE DSY1 **2020 - London**



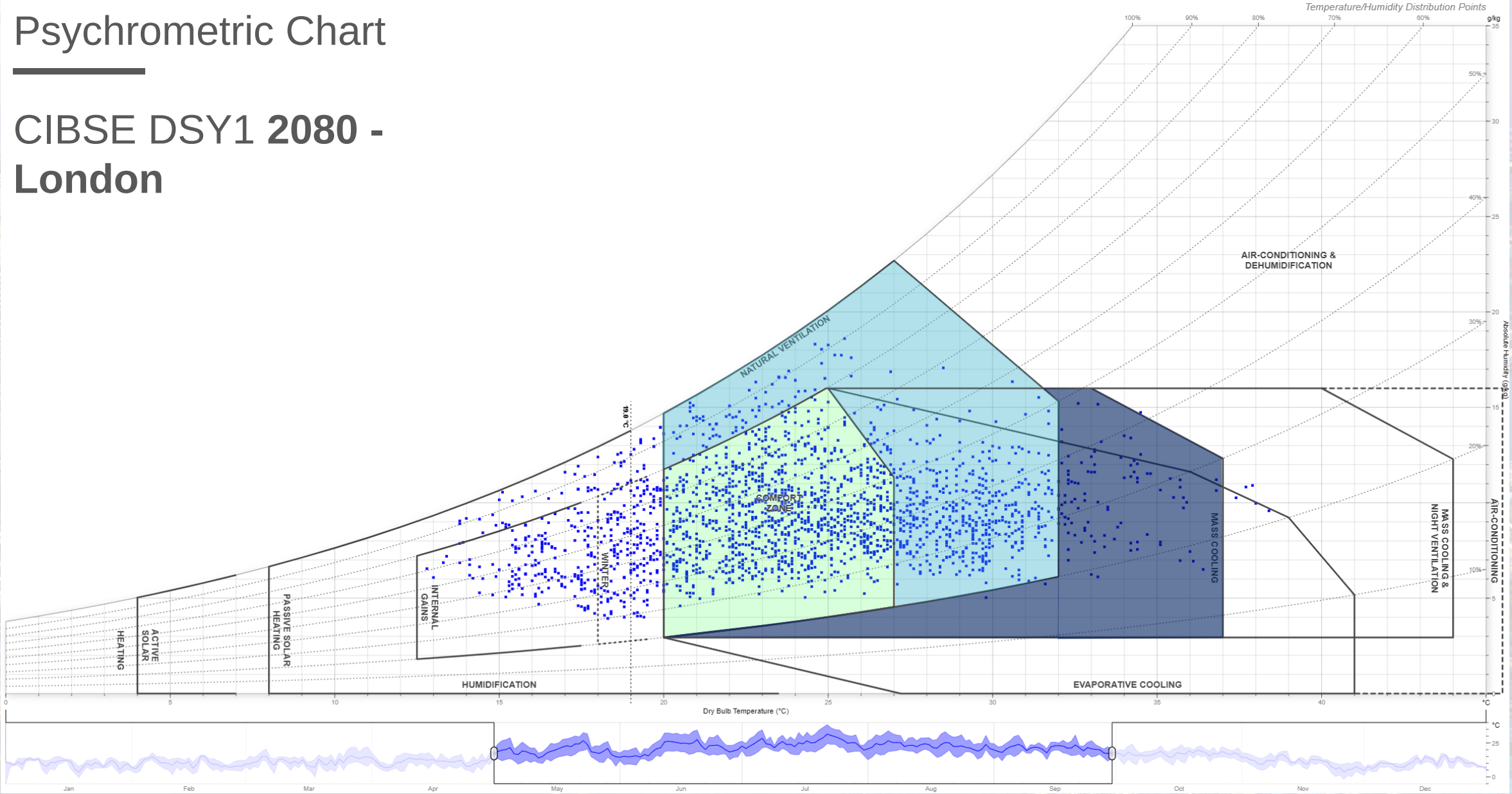
Psychrometric Chart

CIBSE DSY1 **2050 - London**

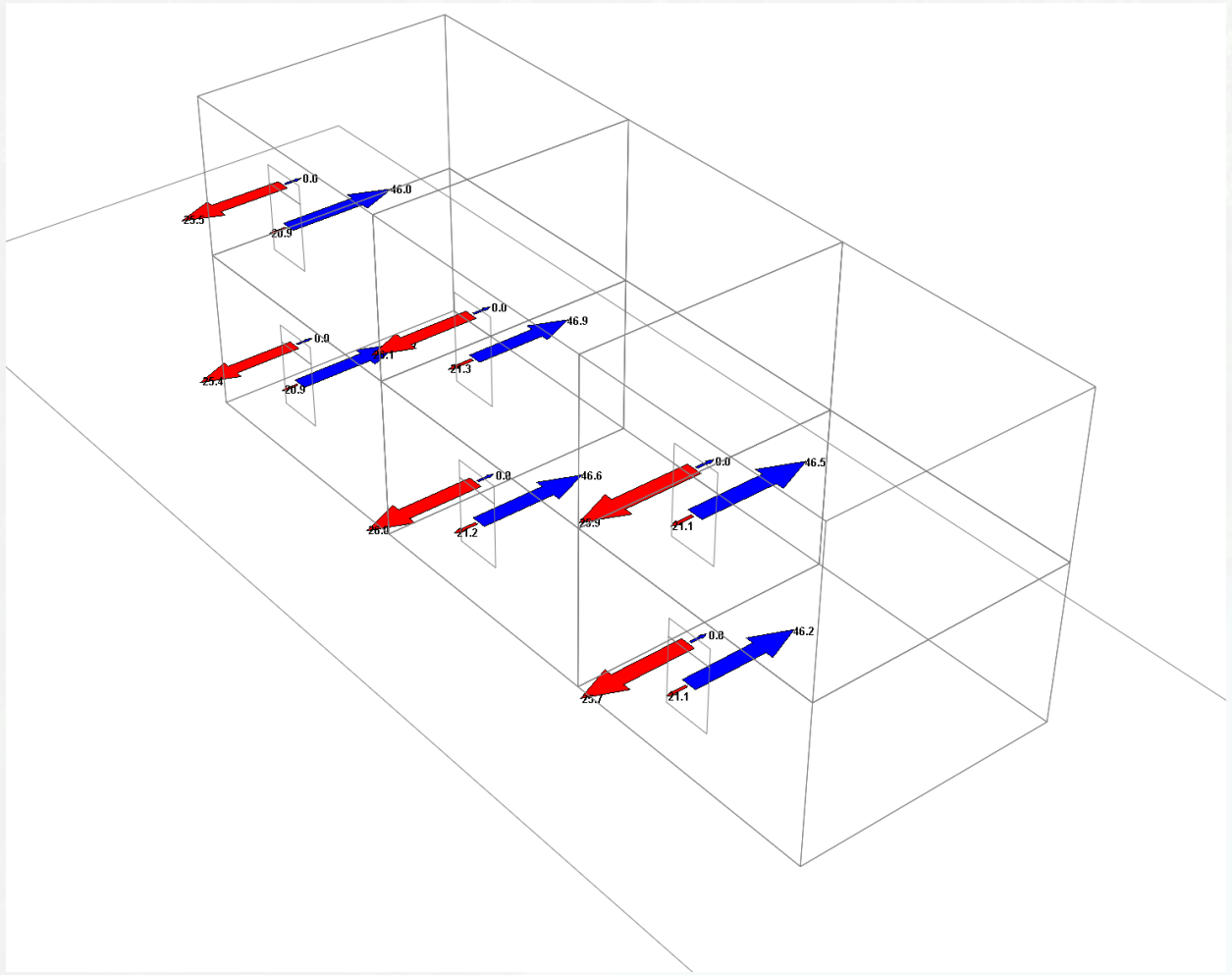


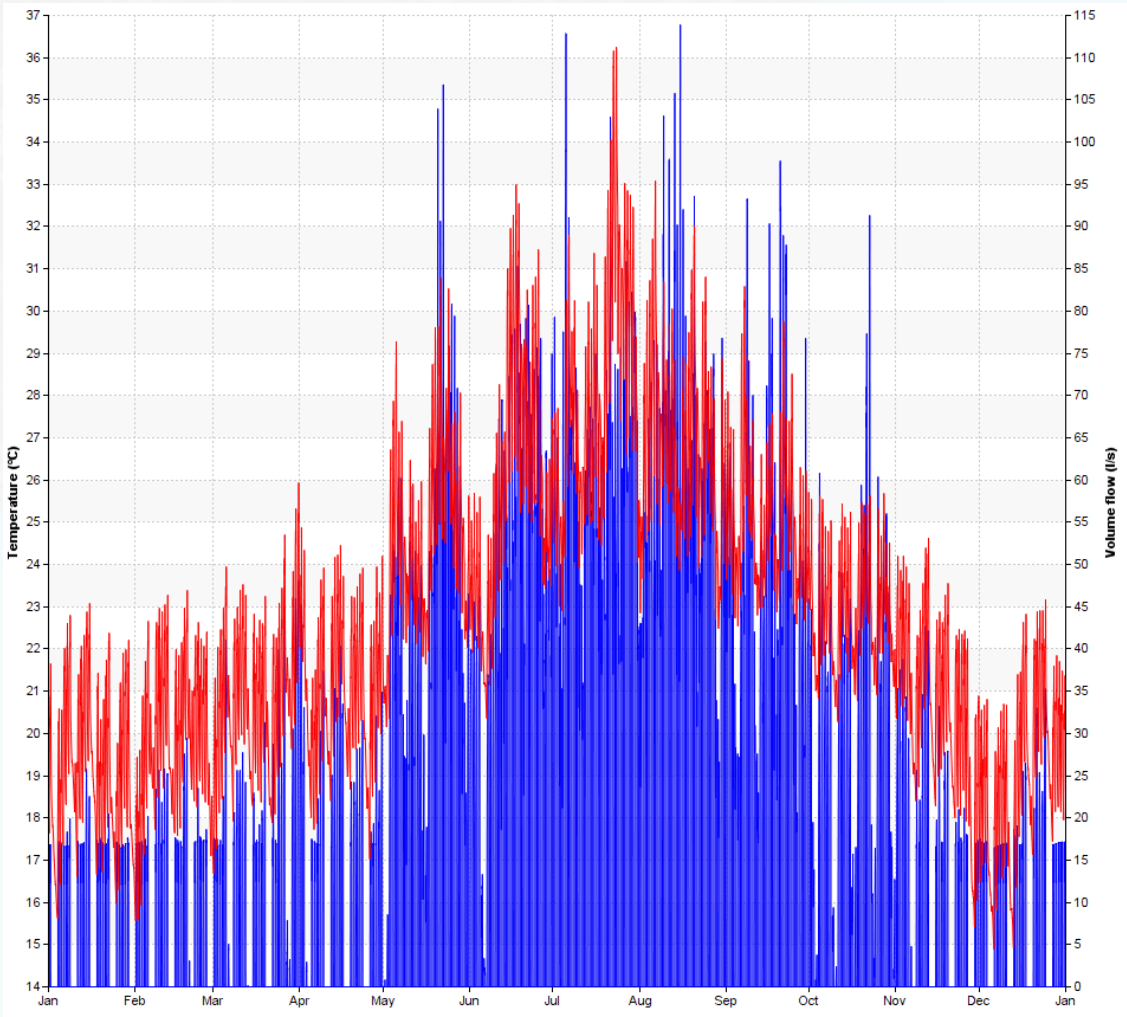
Psychrometric Chart

CIBSE DSY1 **2080 - London**



Single Sided Ventilation



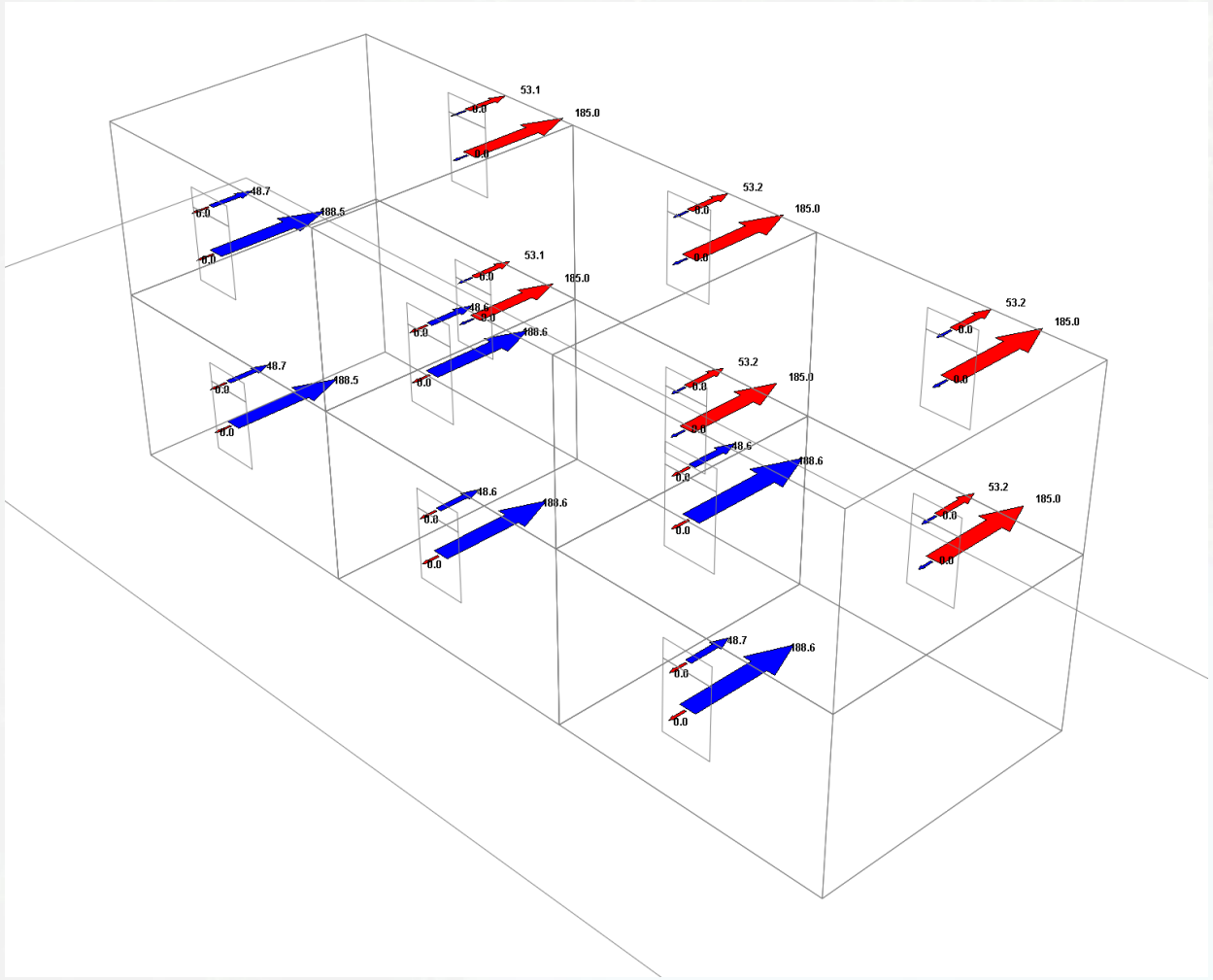


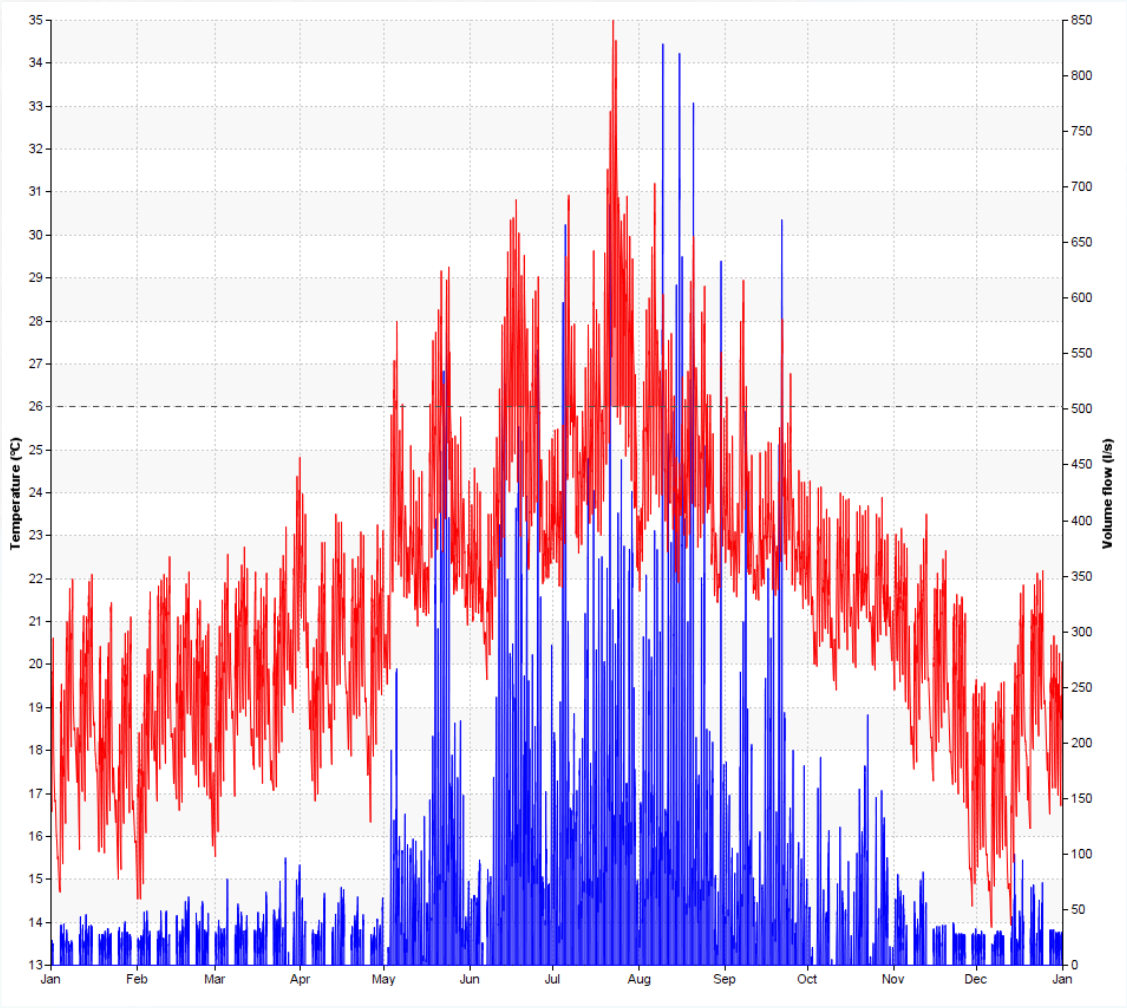
23.89˚C

Internal Temperature ˚C

External Flow Rate (l/s)

Cross Ventilation



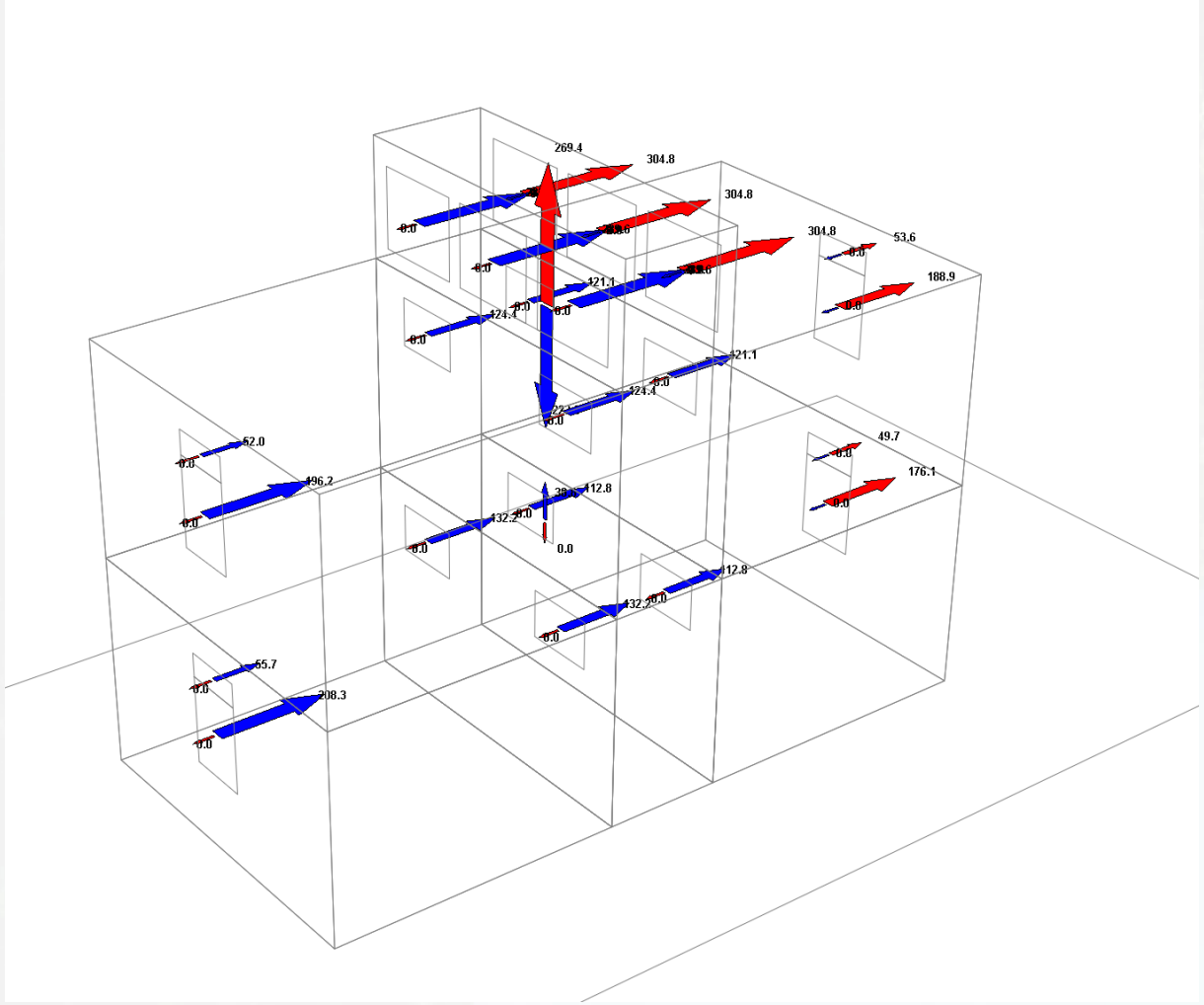


23.11˚C

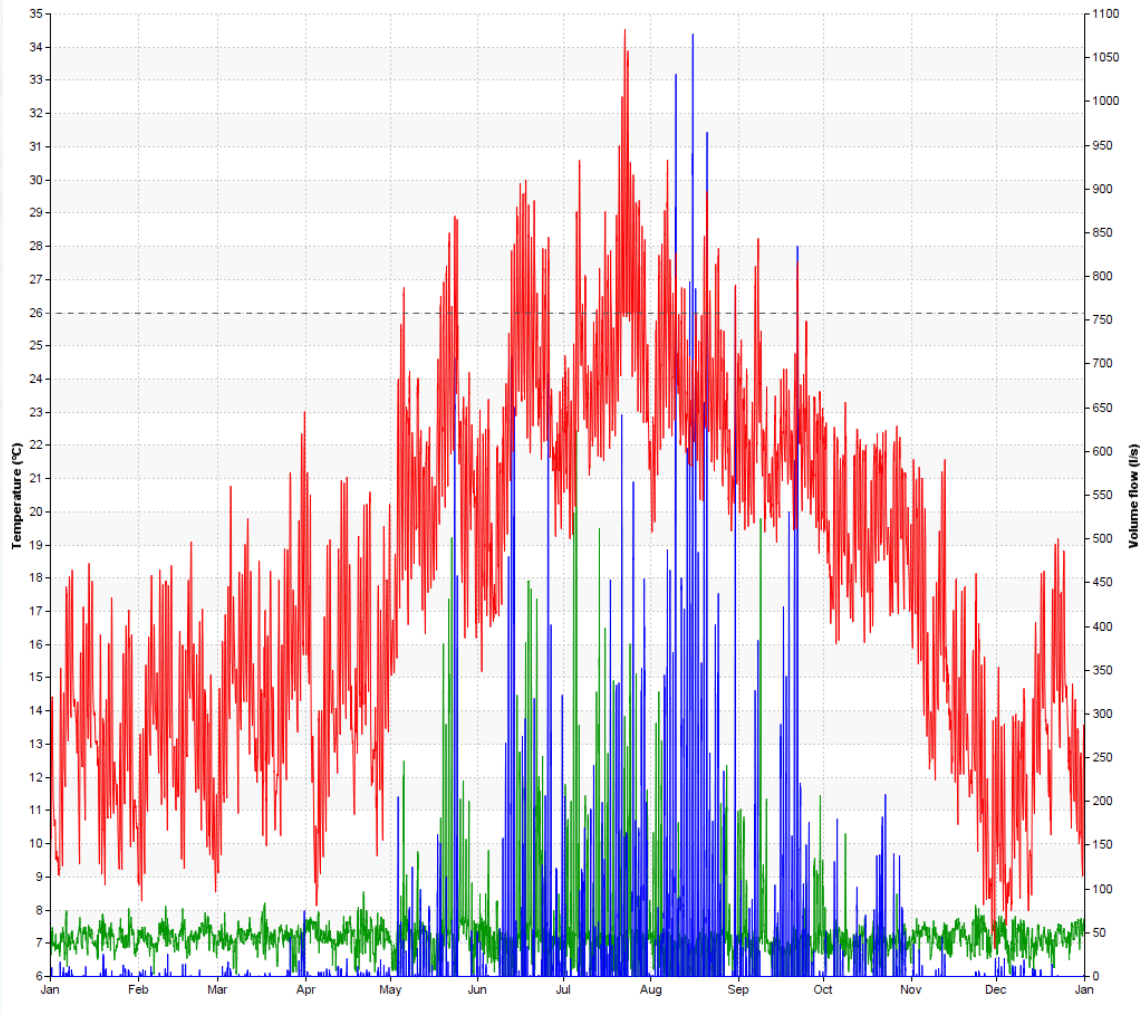
Internal Temperature ˚C

External Flow Rate (l/s)

Stack Ventilation



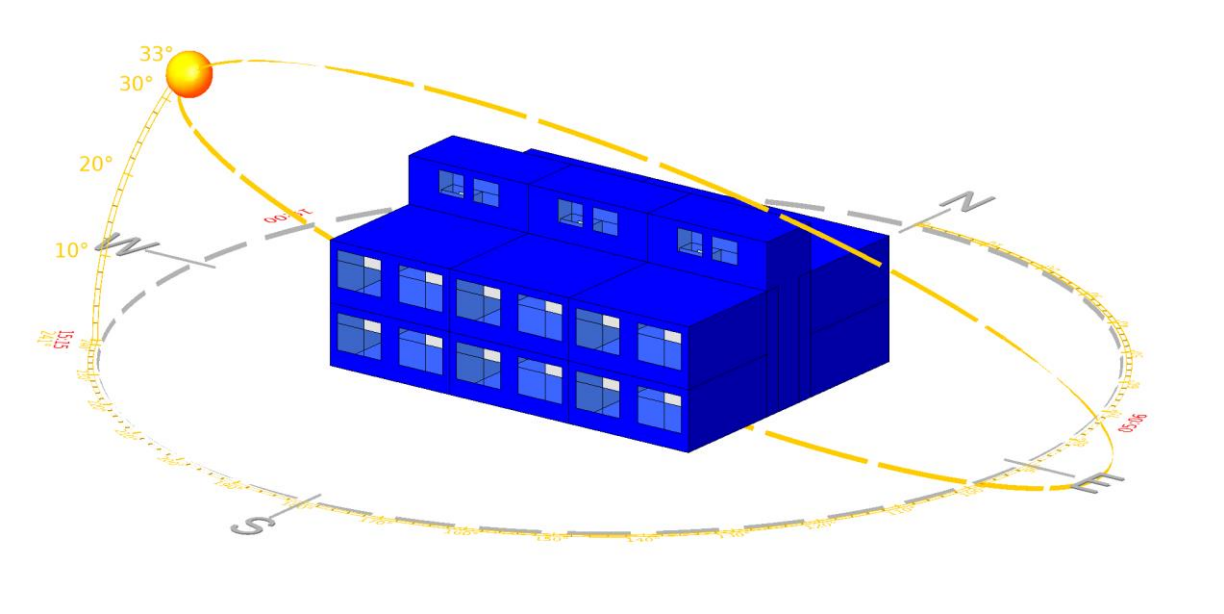
22.69˚C (-1.20)

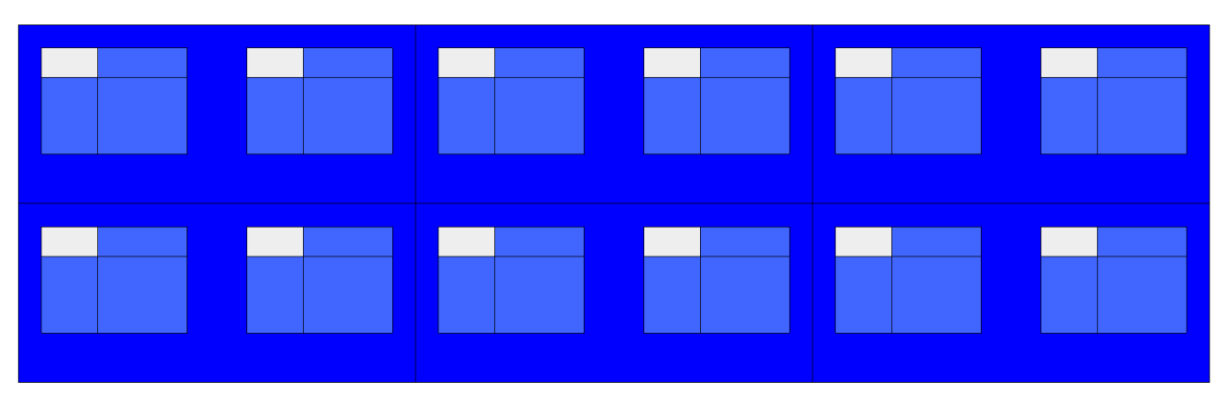


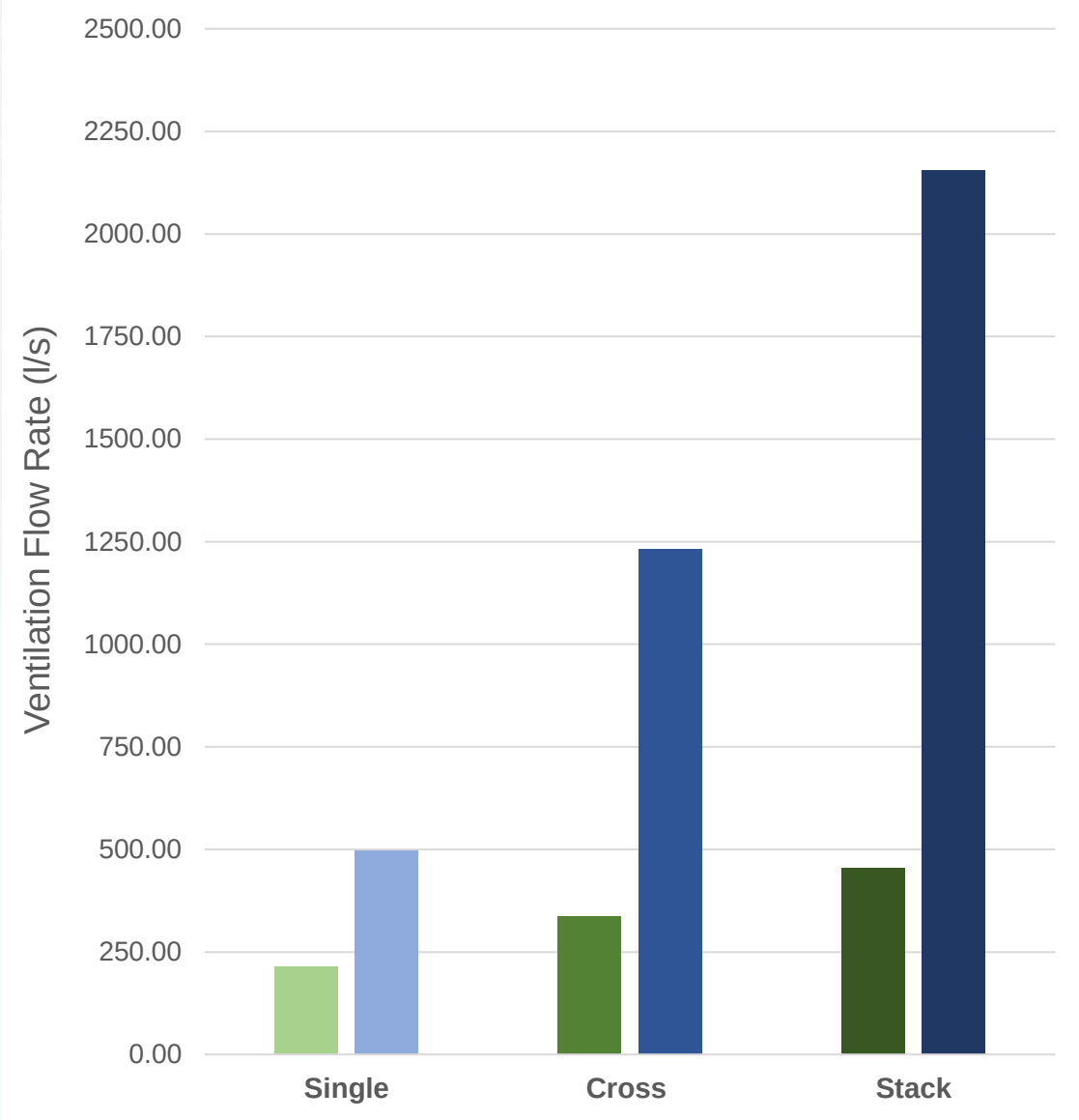
Internal Temperature ˚C

External Flow Rate (l/s)

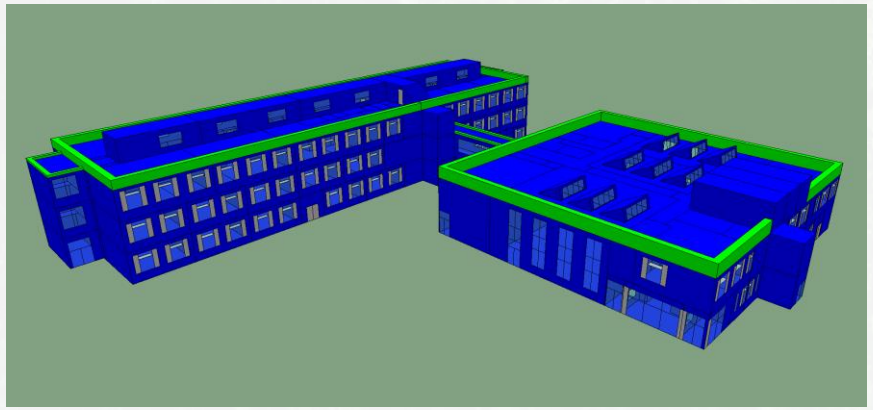
Internal Flow Rate (l/s)

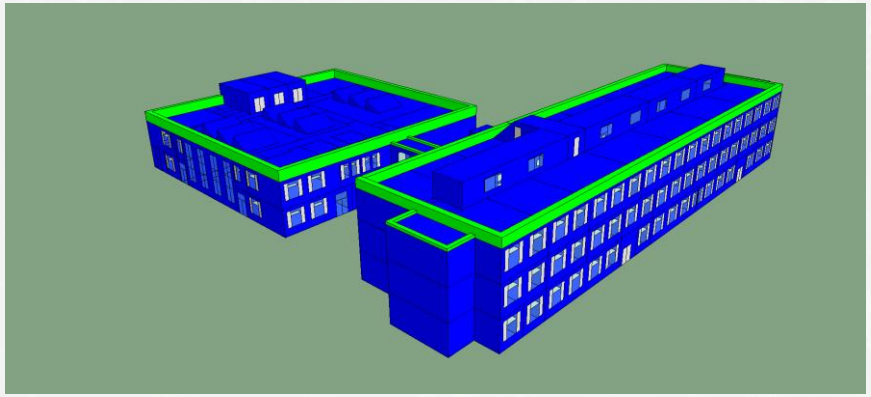

33°
30°
20°
10°
N
E
S

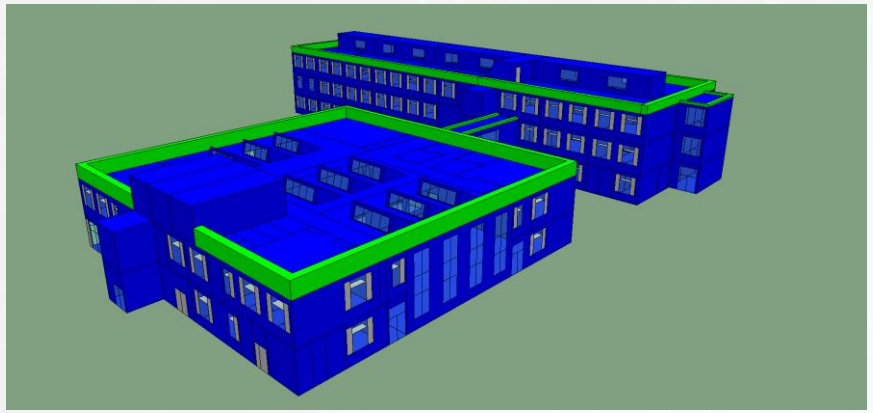


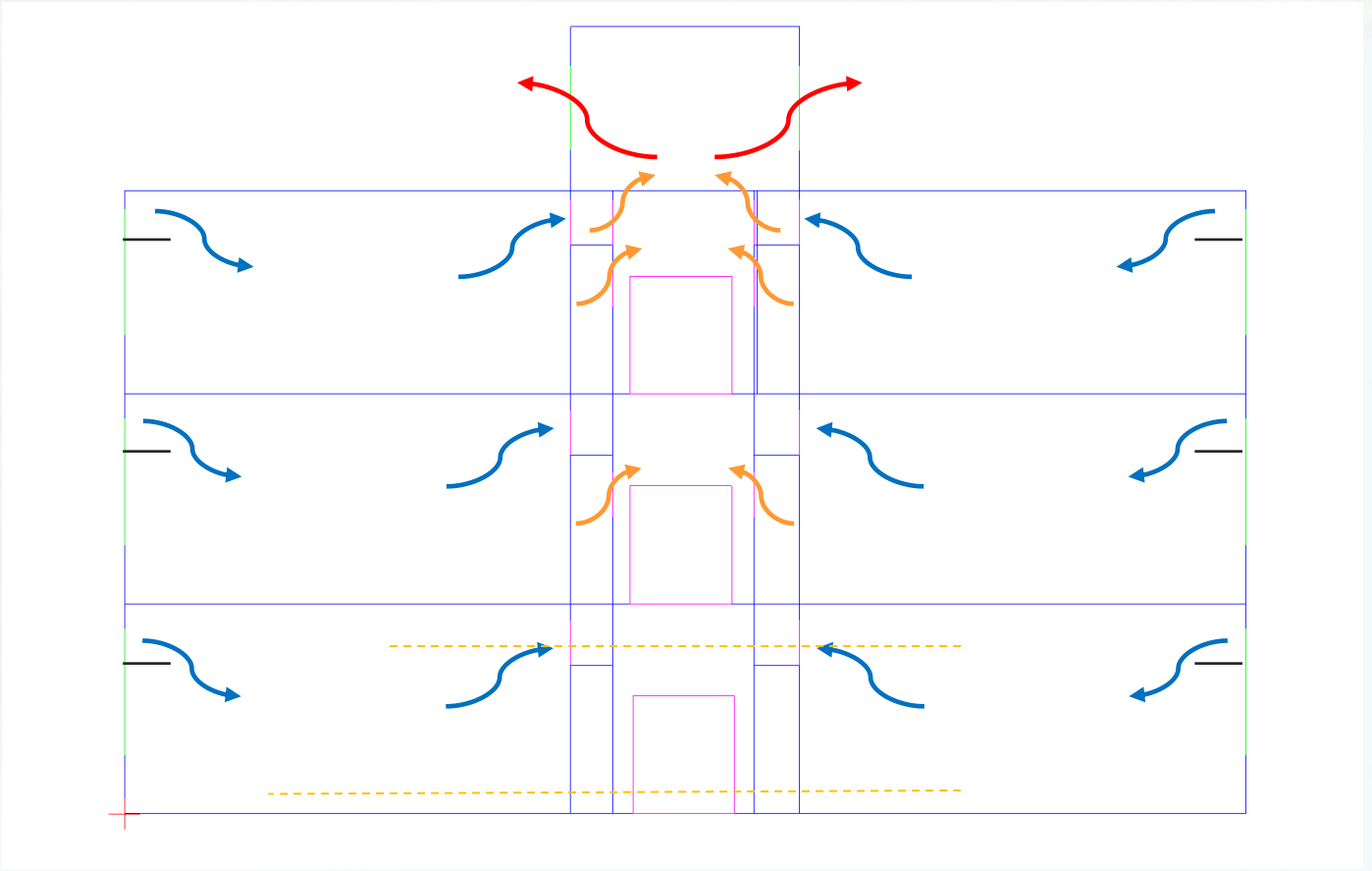

2500.00
2250.00
2000.00
1750.00
1500.00
1250.00
1000.00
750.00
500.00
250.00
0.00
Ventilation Flow Rate (l/s)
Single
Cross
Stack
Average Flow Rate (l/s)
Max Flow Rate (l/s)

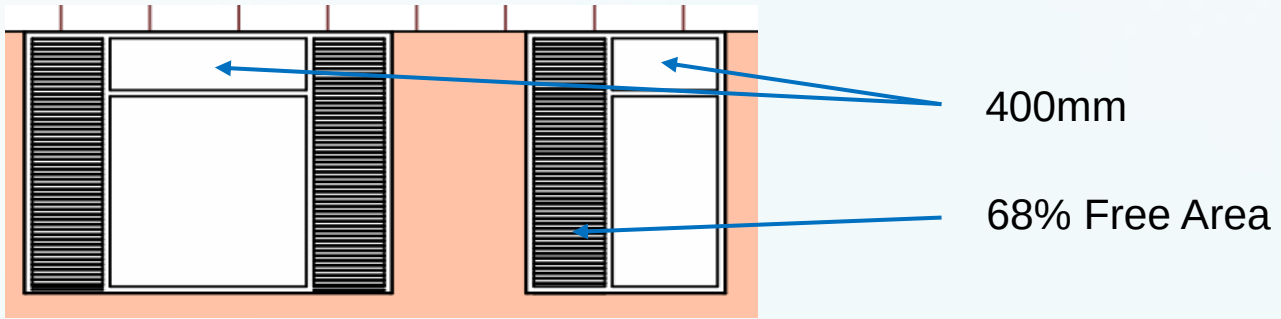
GenZero School Design (Manchester)











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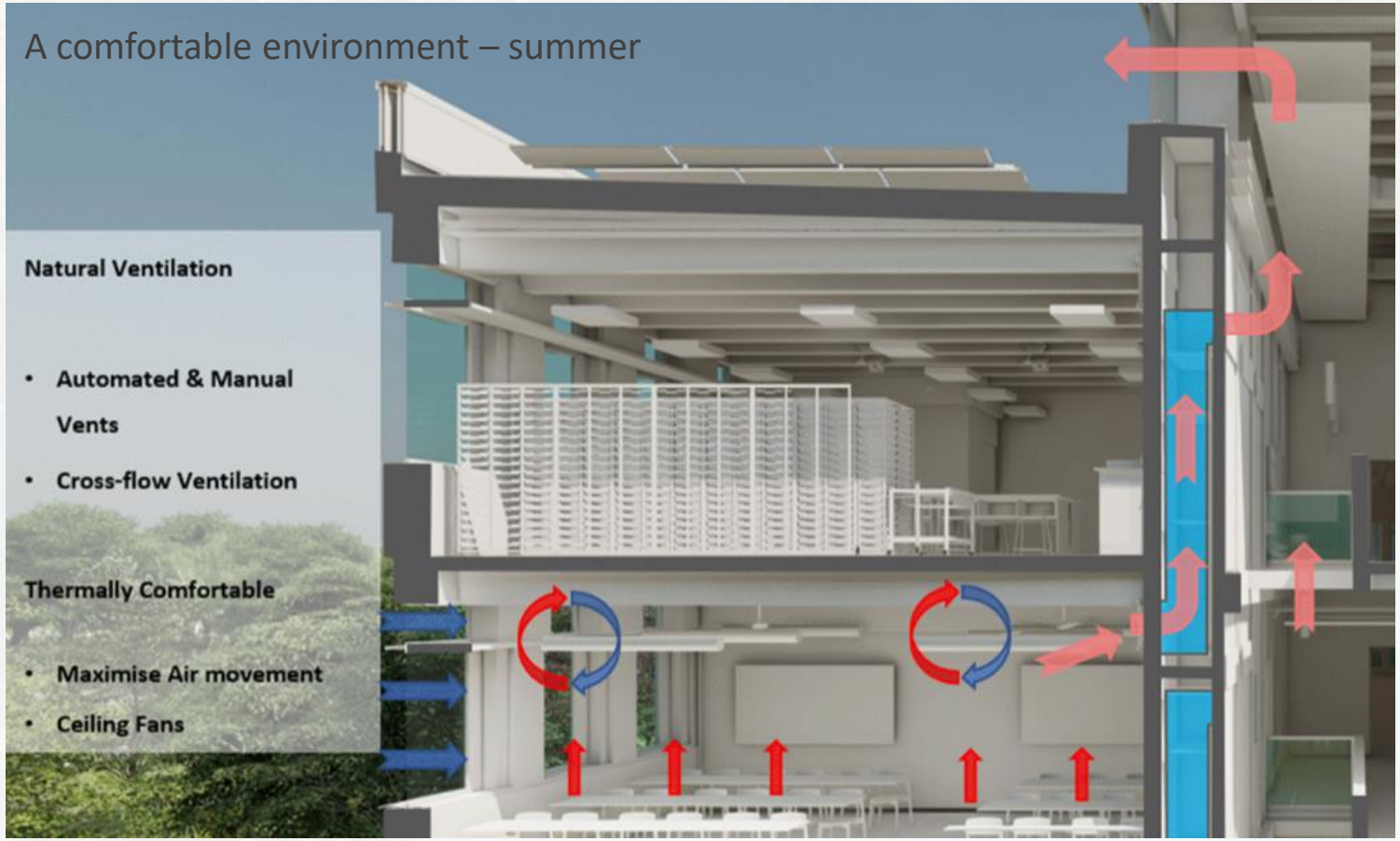
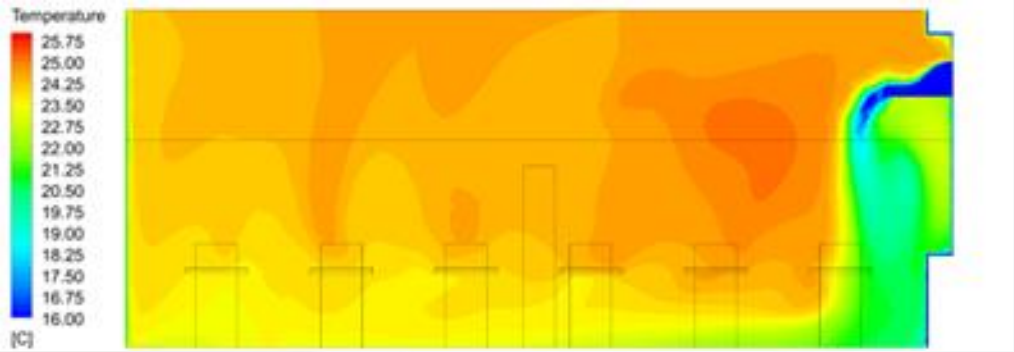
A comfortable environment – summer





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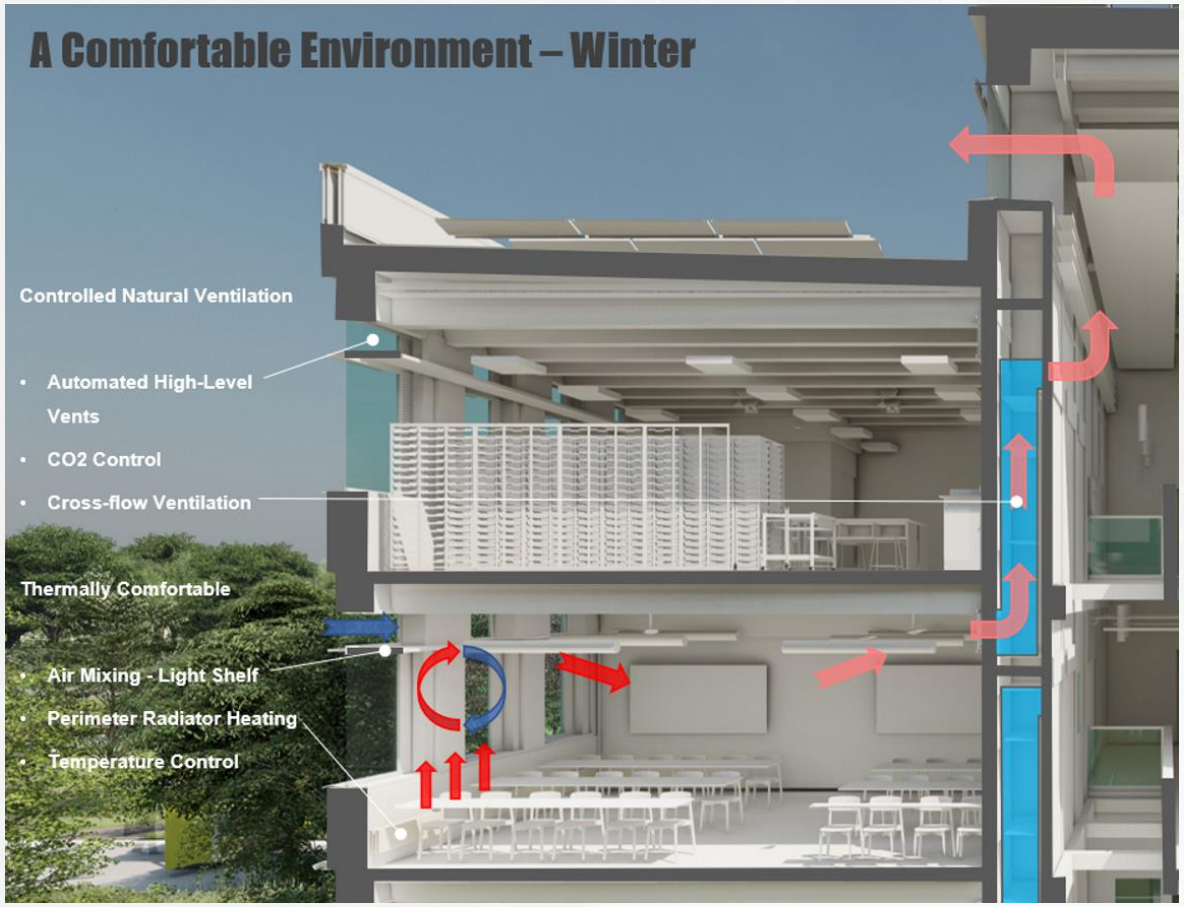
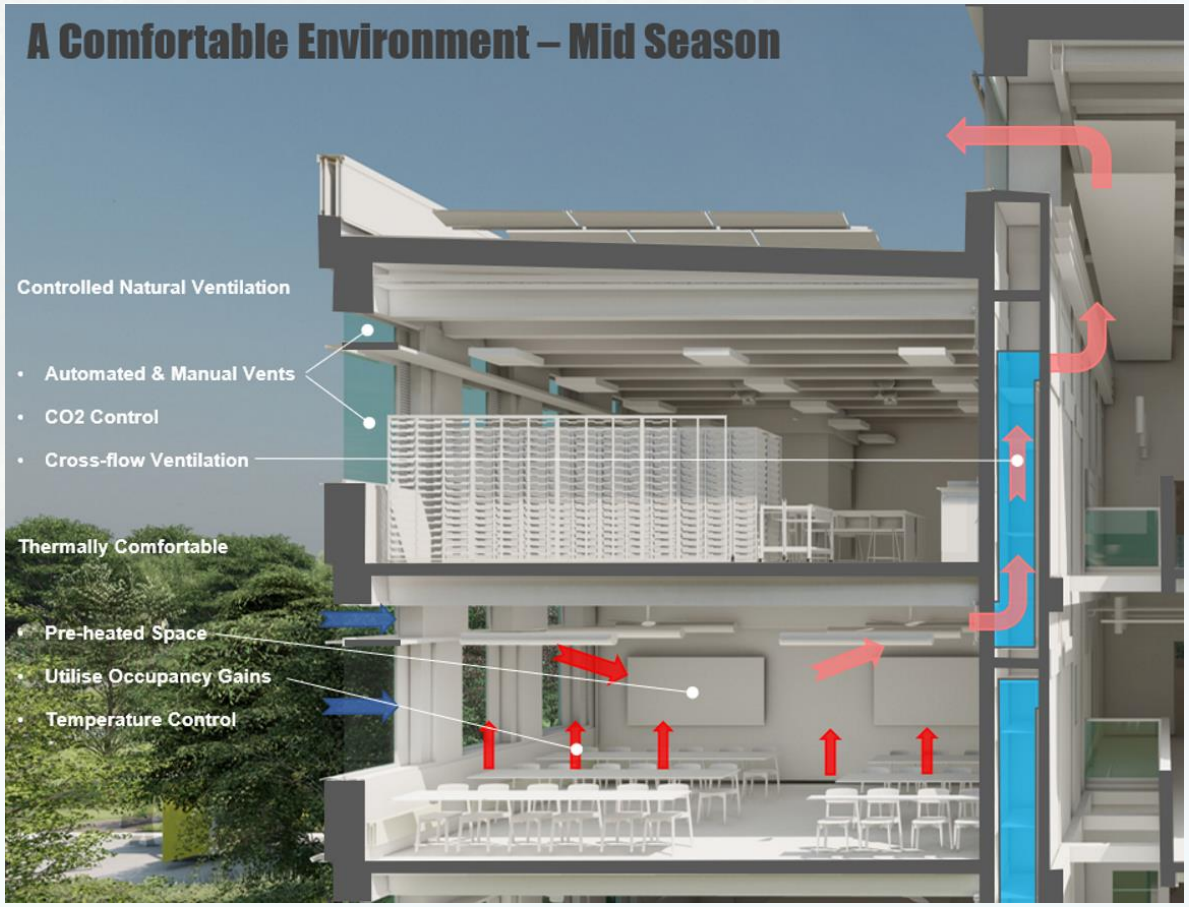

A Comfortable Environment – Winter
Controlled Natural Ventilation
• Automated High-Level Vents
• CO2 Control
• Cross-flow Ventilation
Thermally Comfortable
• Air Mixing - Light Shelf
• Perimeter Radiator Heating
• Temperature Control


A Comfortable Environment – Mid Season
Controlled Natural Ventilation
• Automated & Manual Vents
• CO2 Control
• Cross-flow Ventilation
Thermally Comfortable
• Pre-heated Space
• Utilise Occupancy Gains
• Temperature Control

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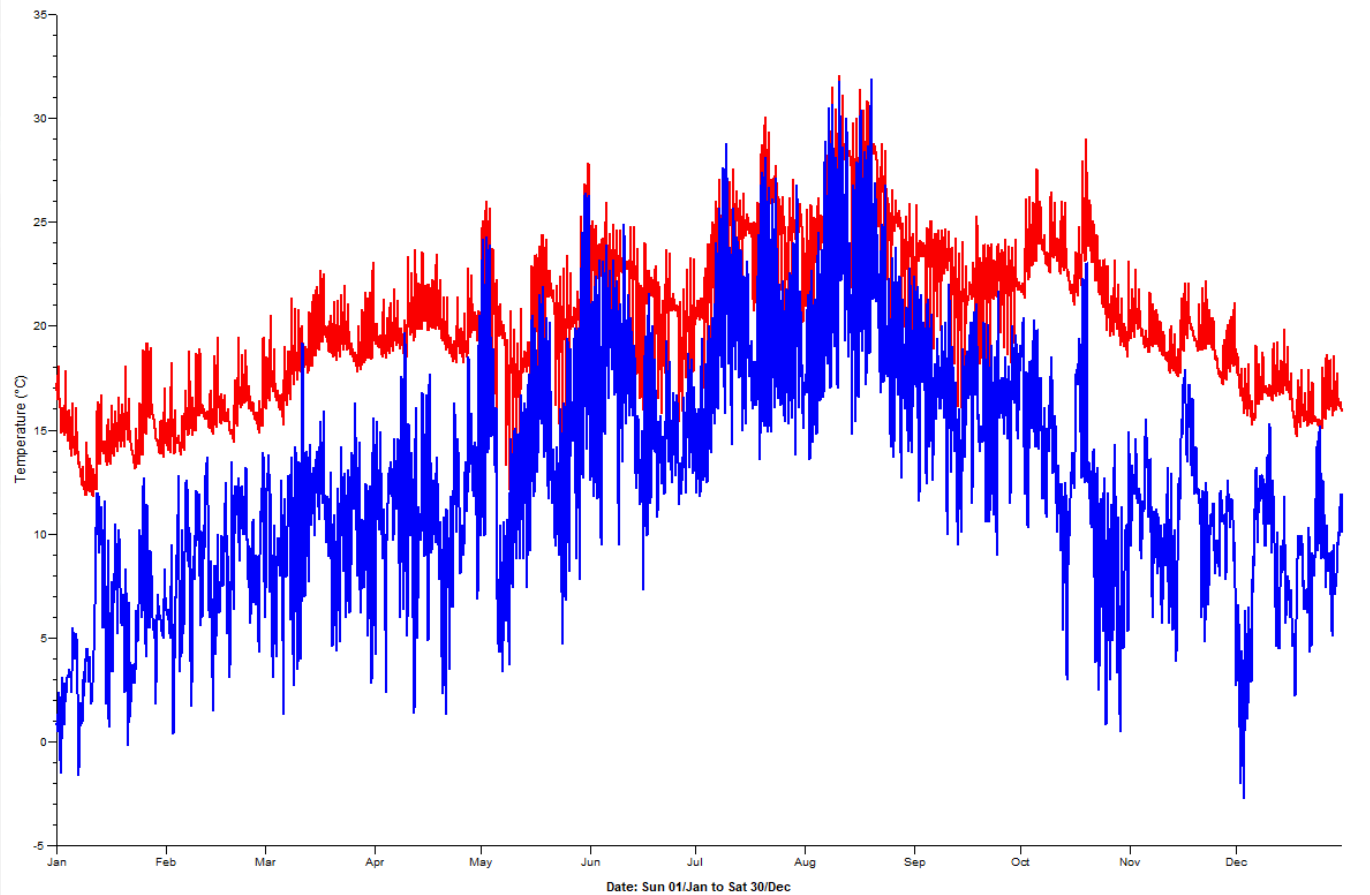
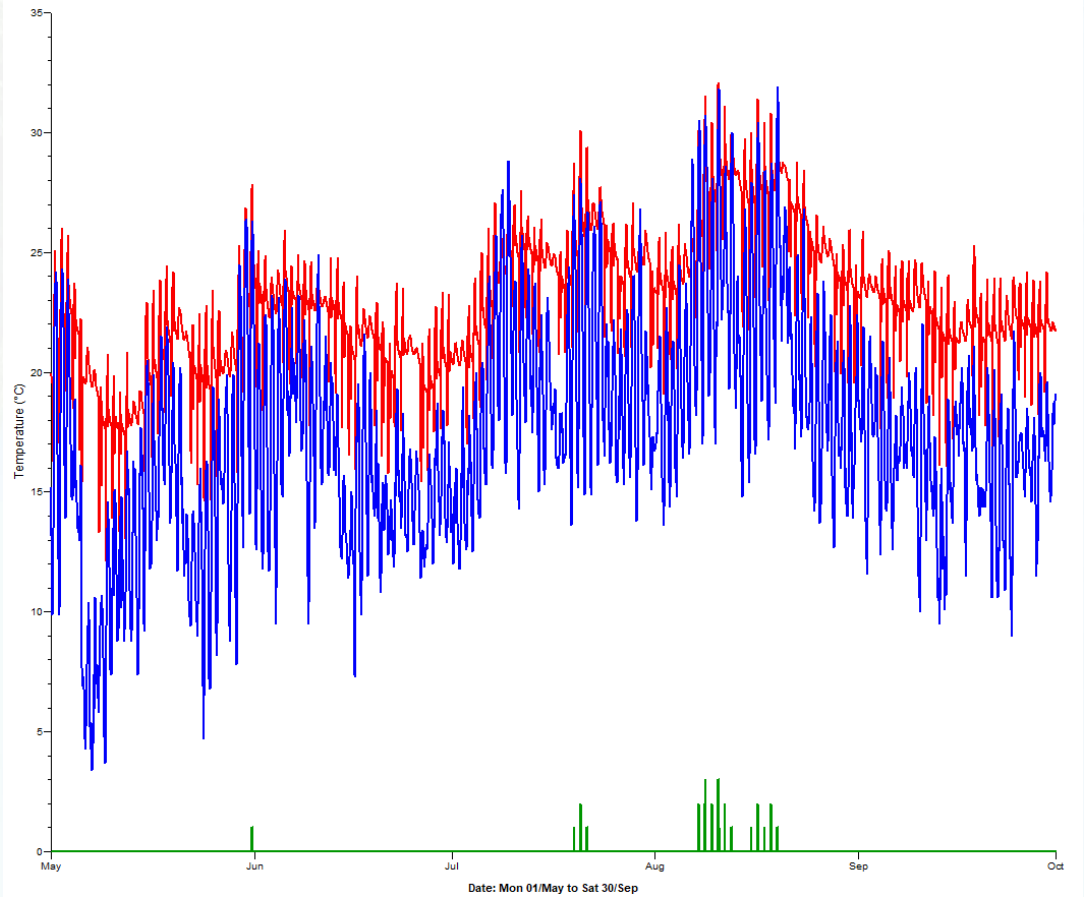
Temperature Profile





Internal Temperature (˚C)

External Temperature (˚C)

Adaptive Temperature (˚C)

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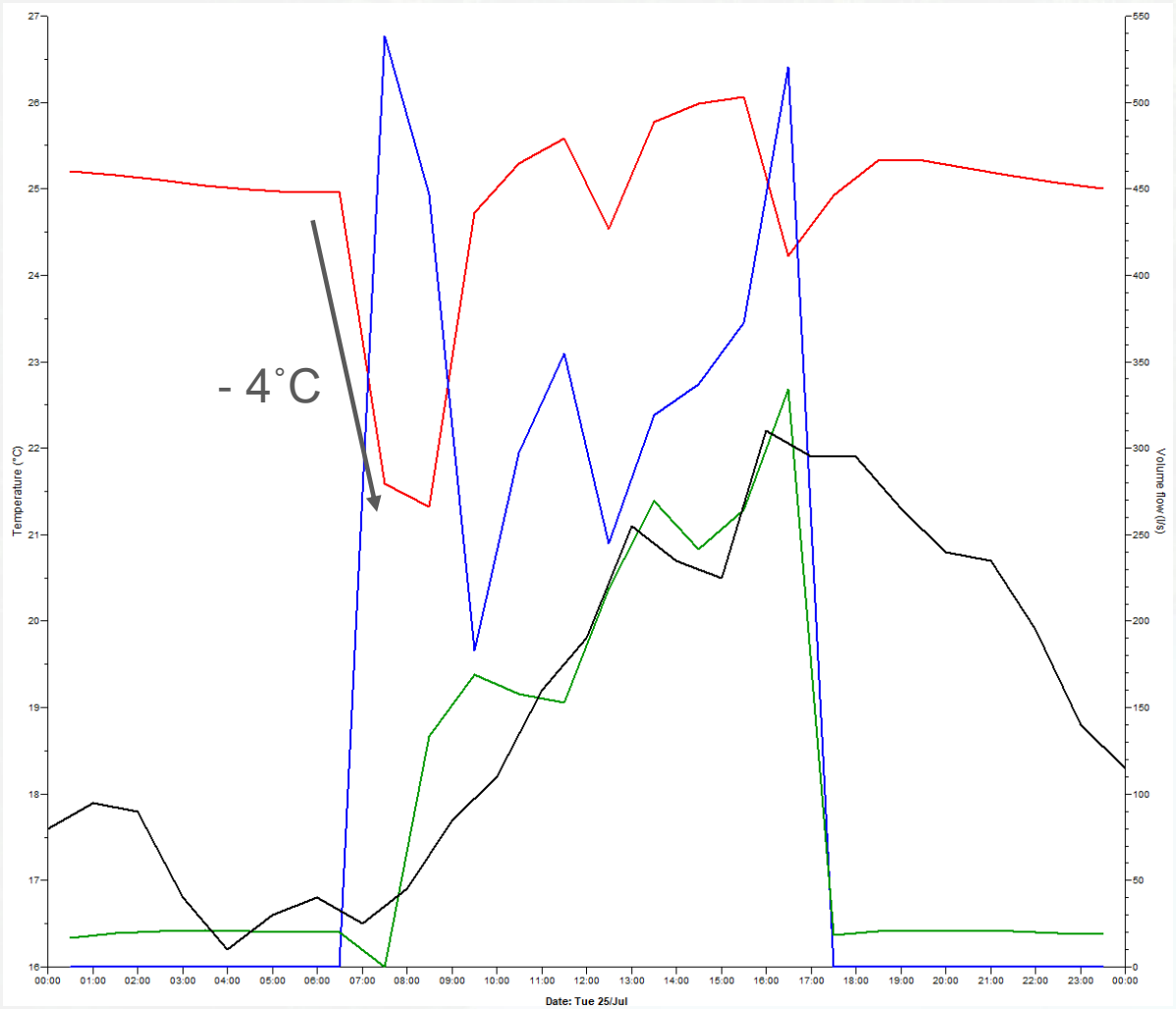
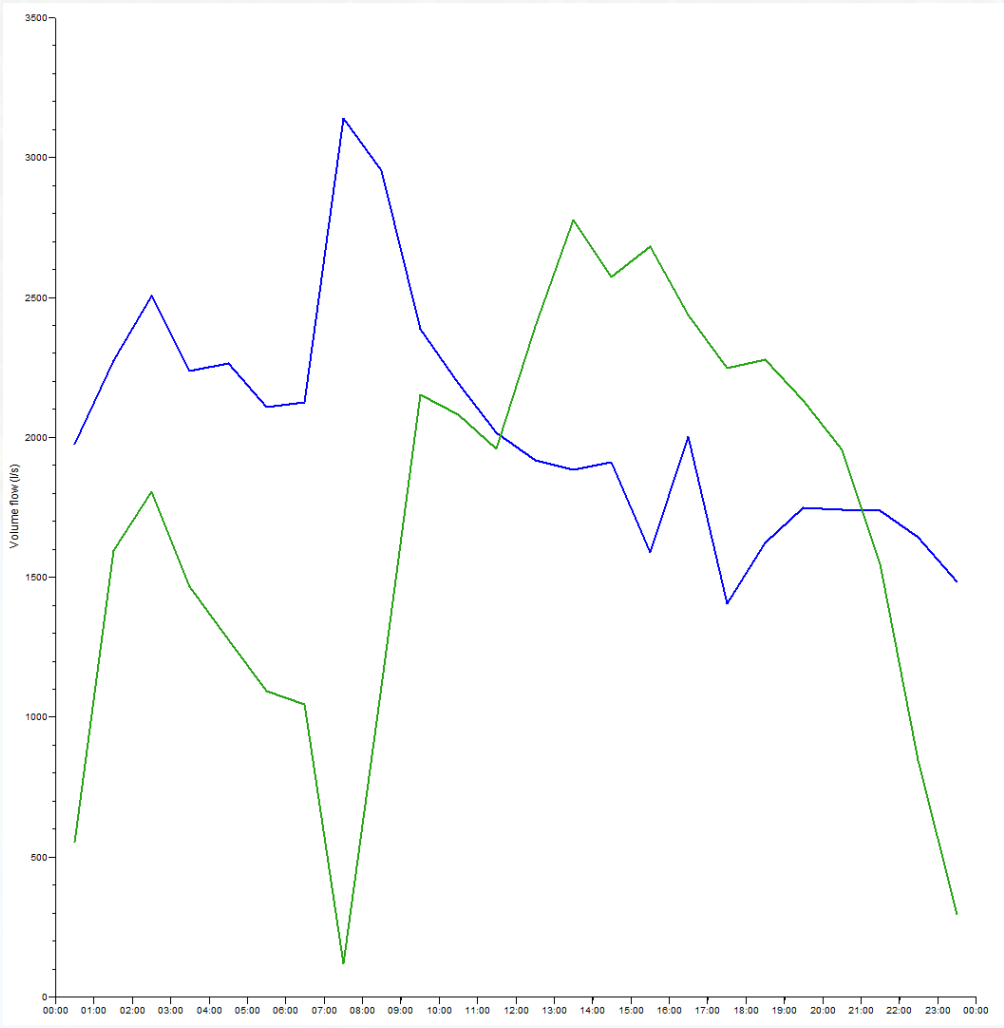
Classroom



Stack Vent



Internal Temperature (˚C)

External Flow Rate (l/s)

External Temperature (˚C)

Internal Flow Rate (l/s)

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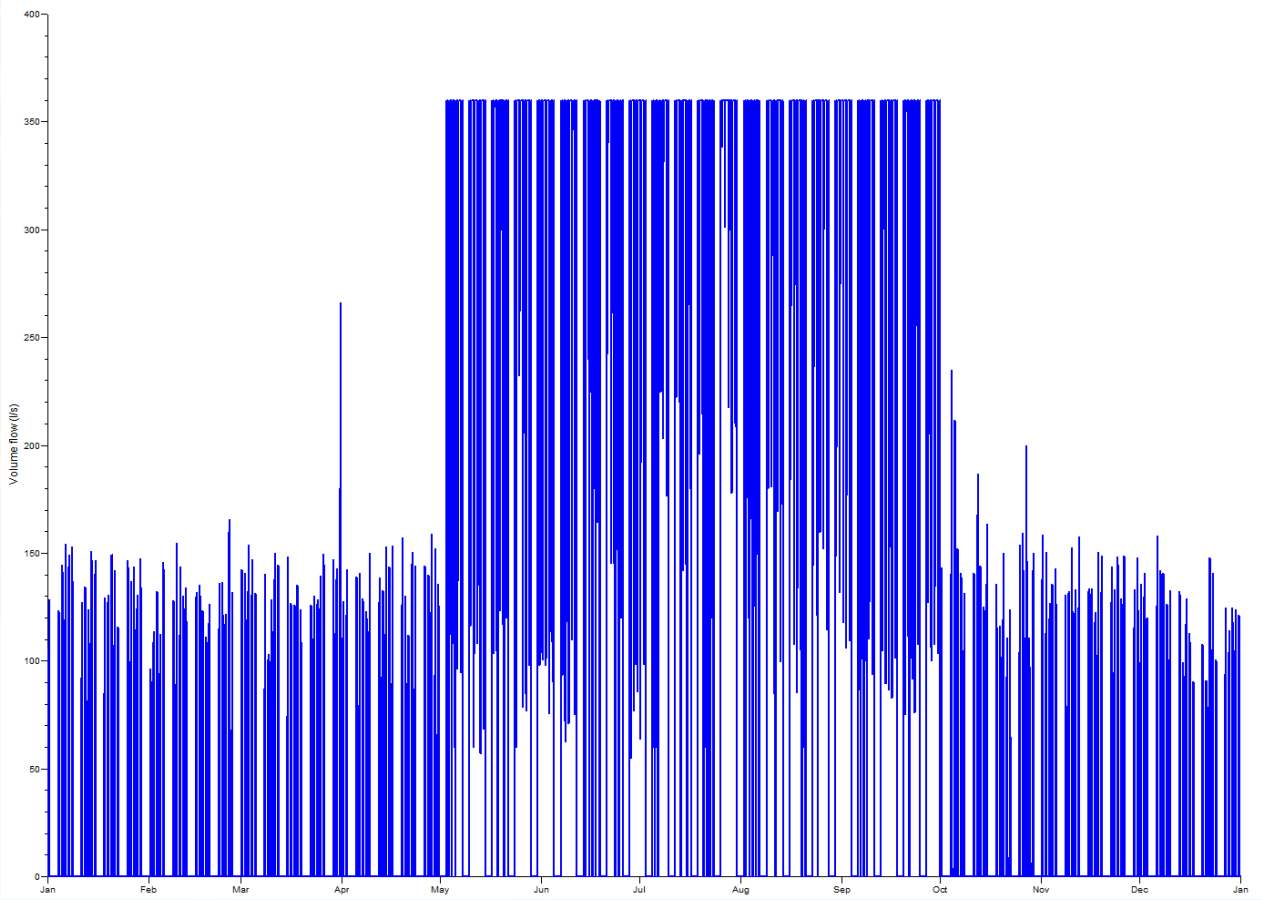
Upfront Cost

£2,000 – £2,500 per unit

£224,000 - £280,000

Operational Cost



5.36 MWh x 56 = 300 MWh

£32,000 x 50 = **£1.6m**

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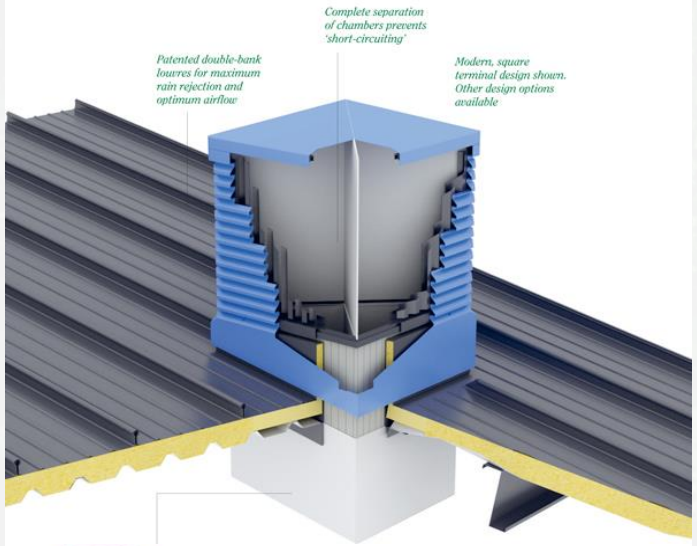
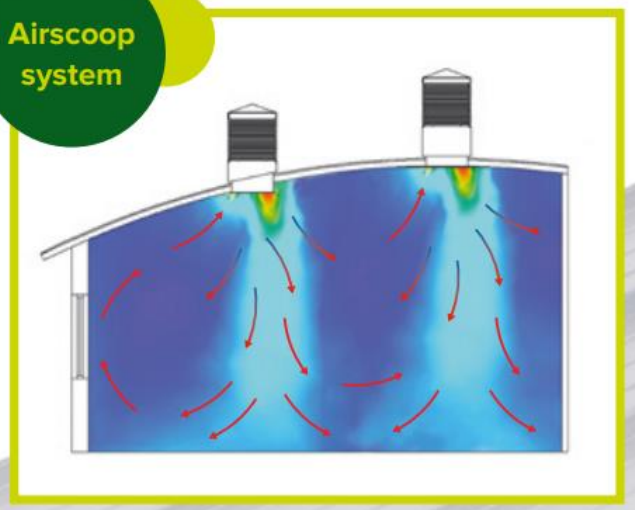
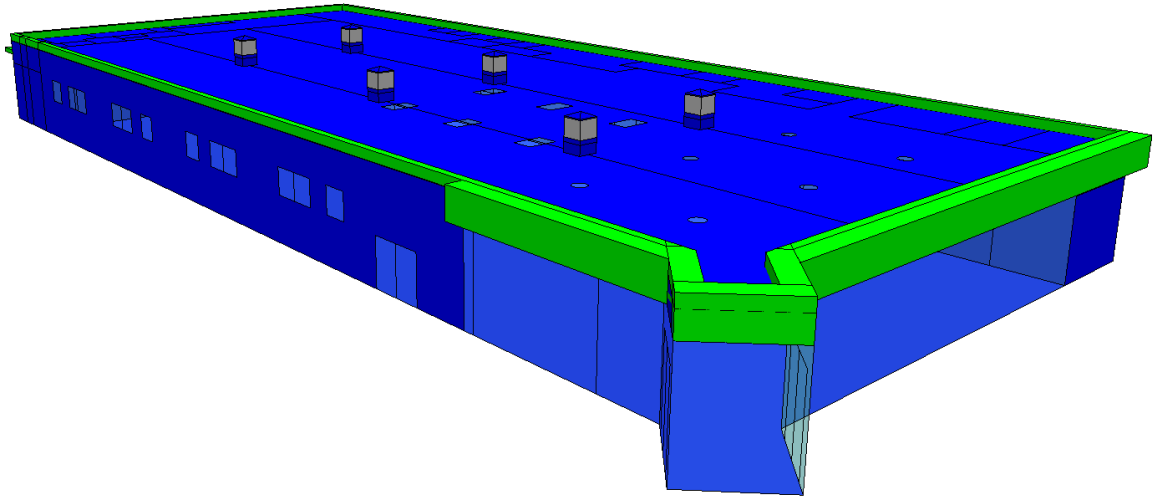
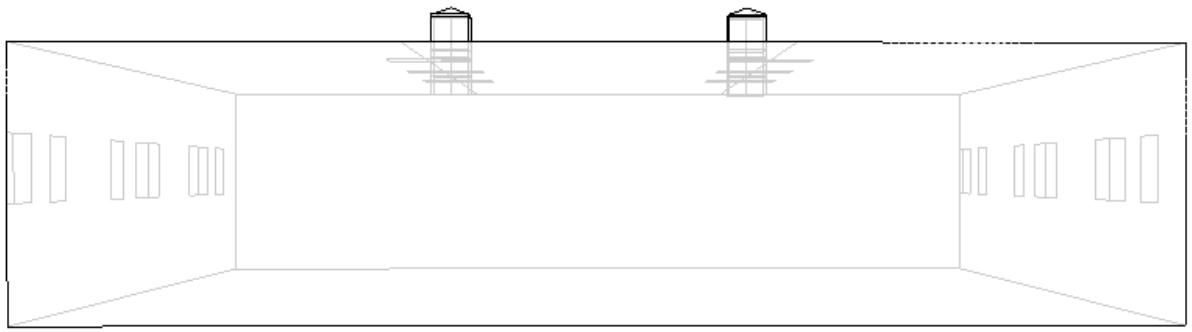
passivent



Airscoop system

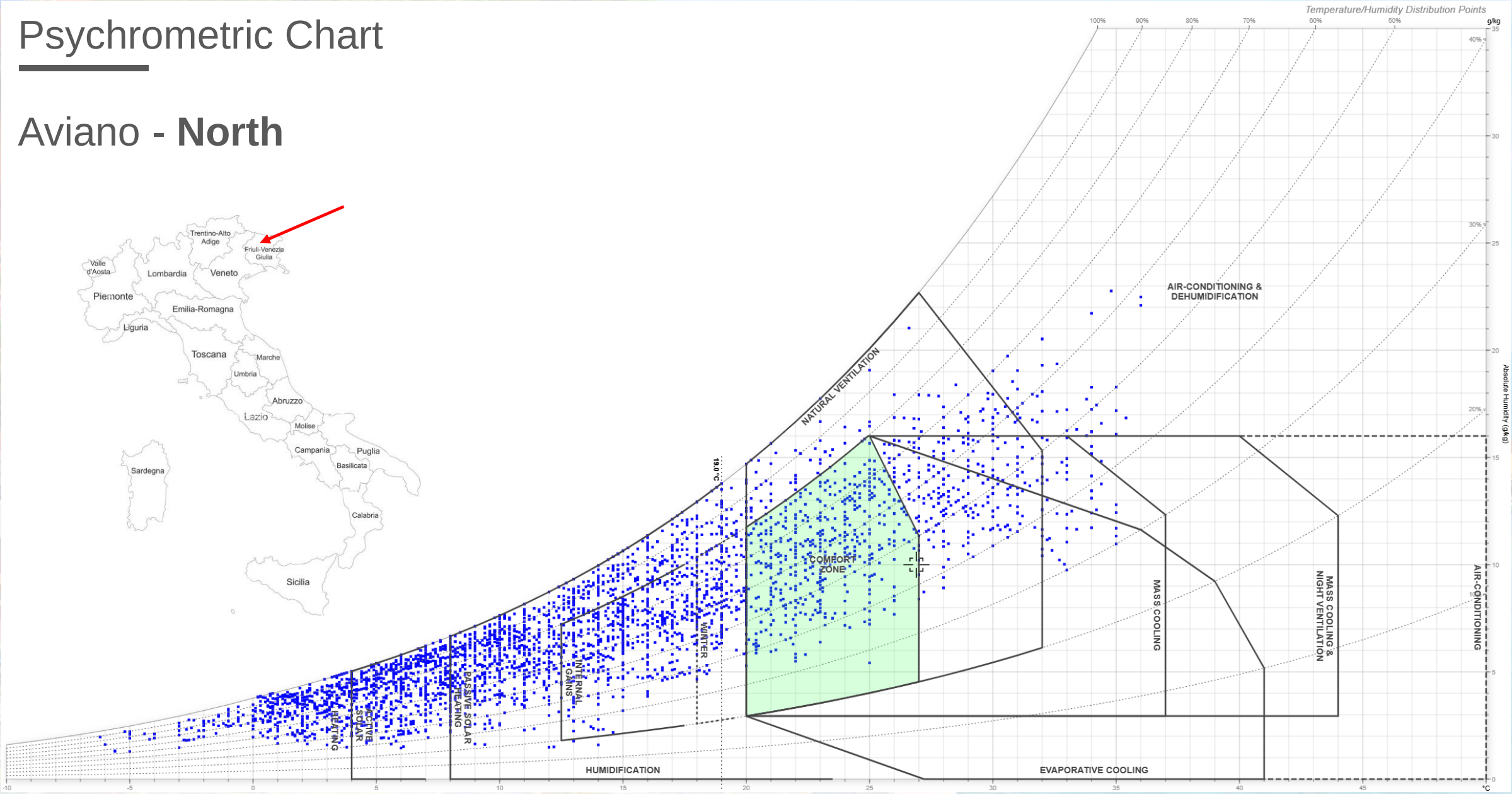






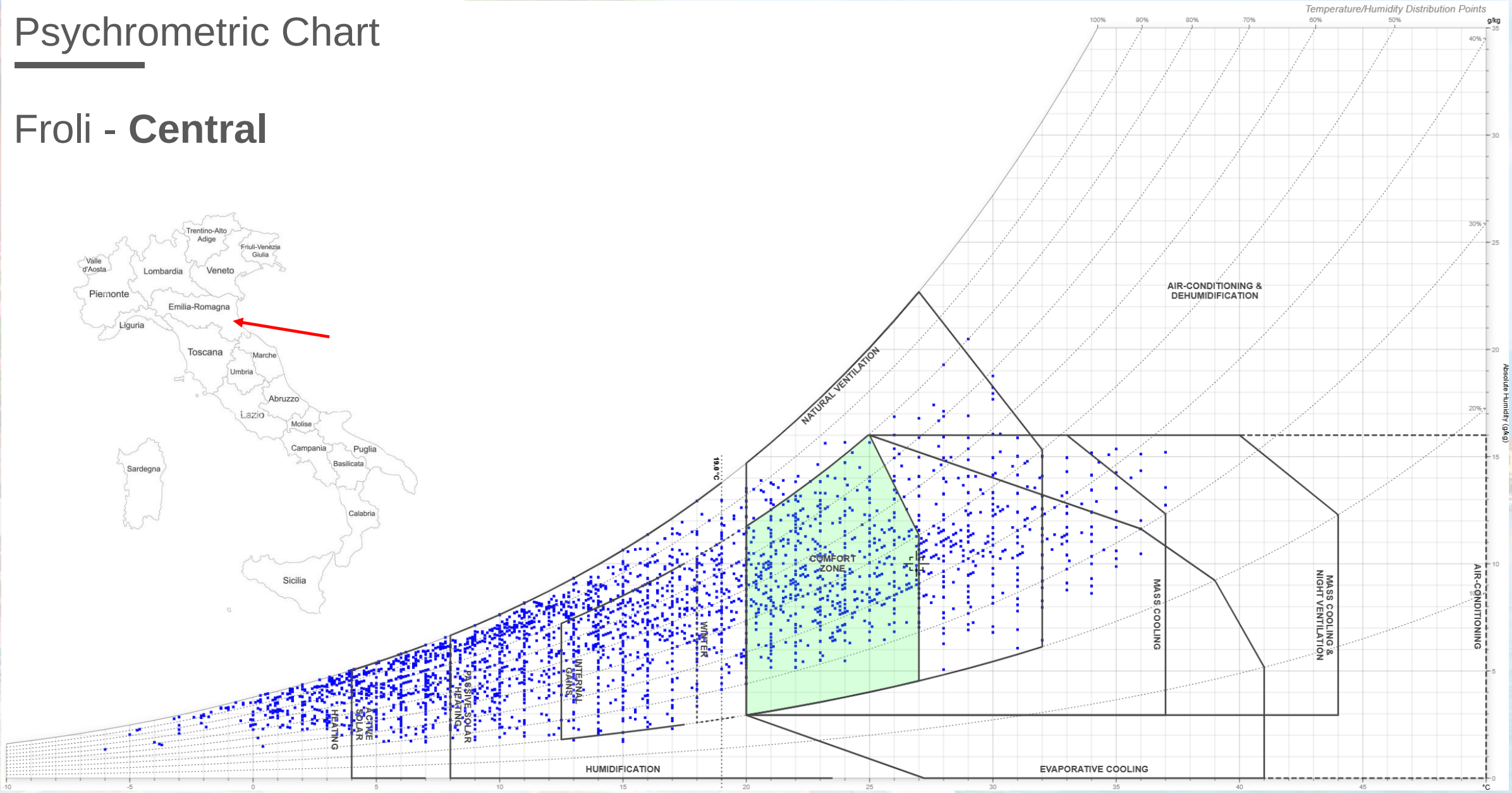
Psychrometric Chart

Aviano - **North**



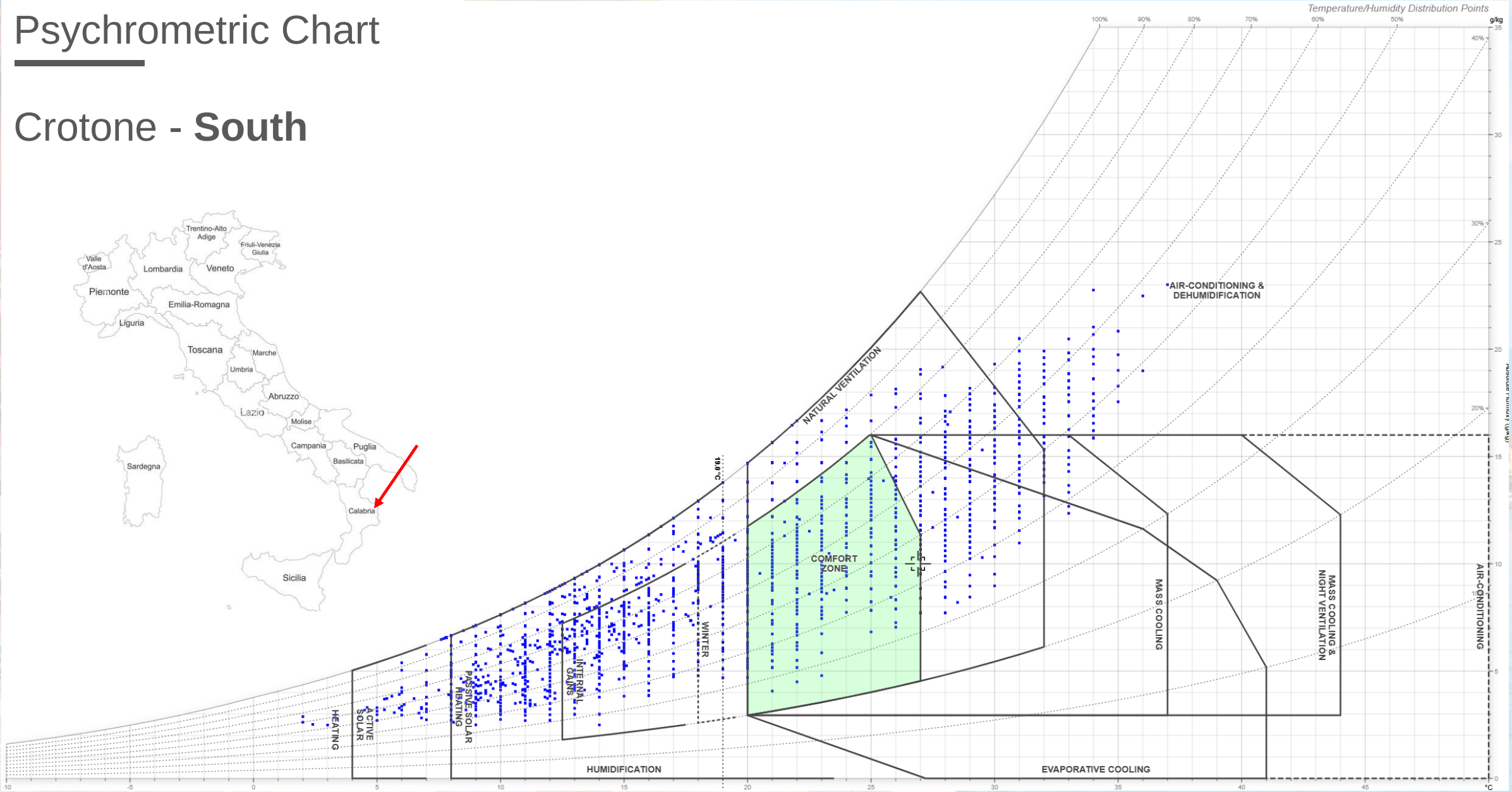
Psychrometric Chart

Froli - **Central**

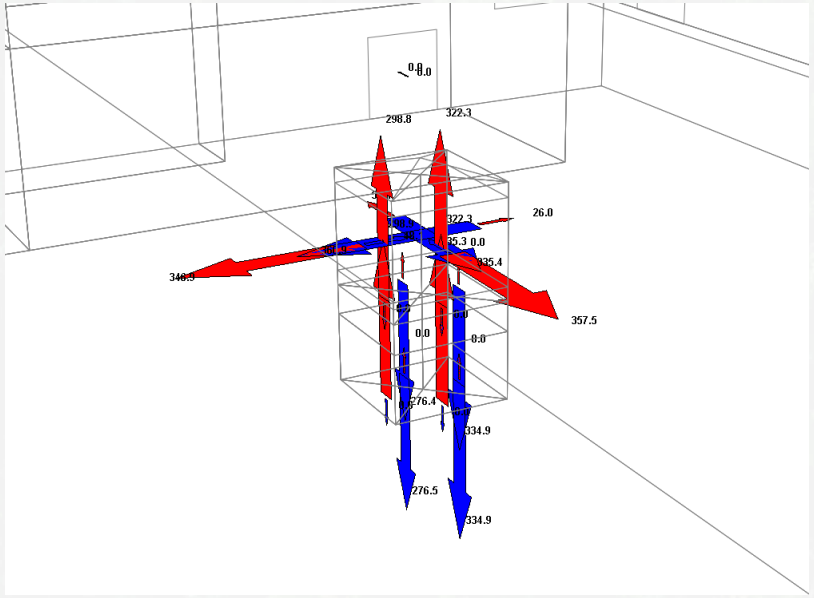


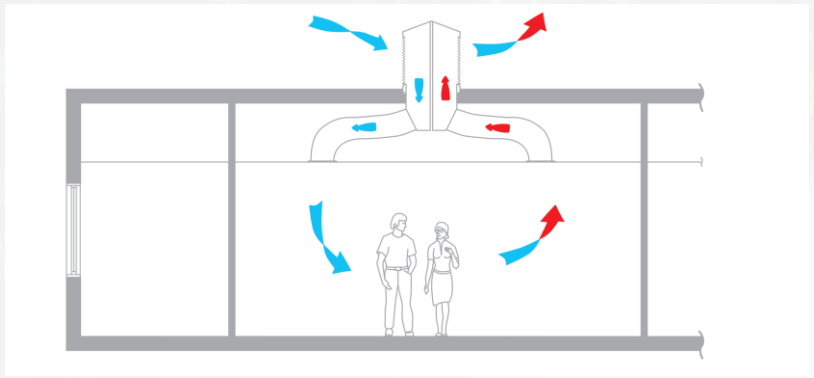
Psychrometric Chart

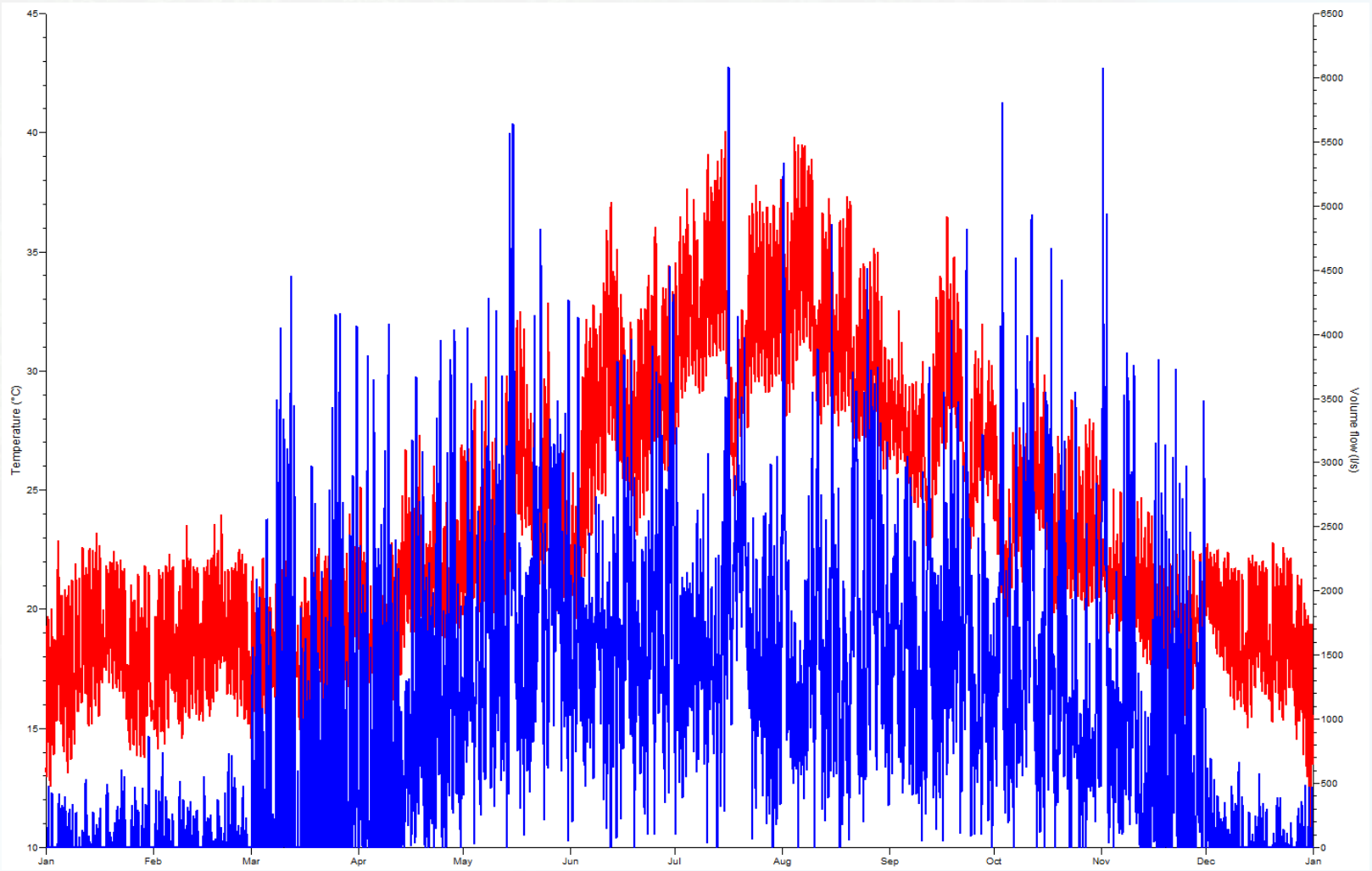
Crotone - **South**



Winter/Mid-Season Performance



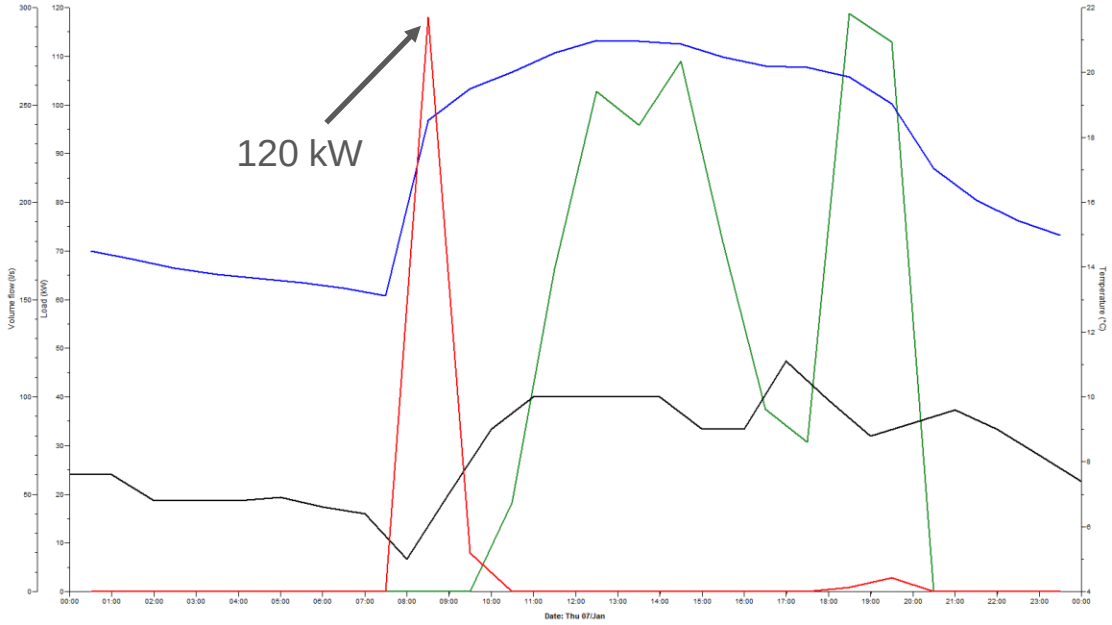




Internal Temperature (˚C)

Airscoop Flow Rate (l/s)

Winter/Mid-Season Performance using CO_2 controlled Ventilation

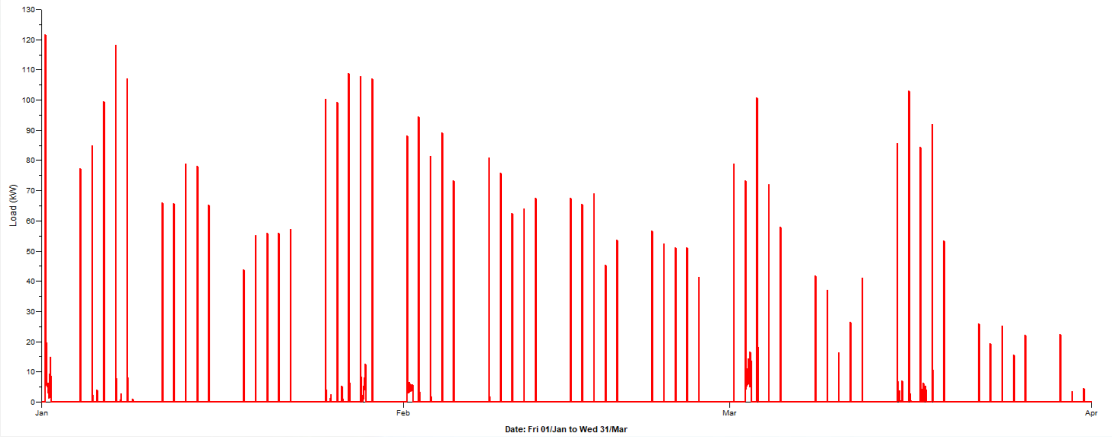


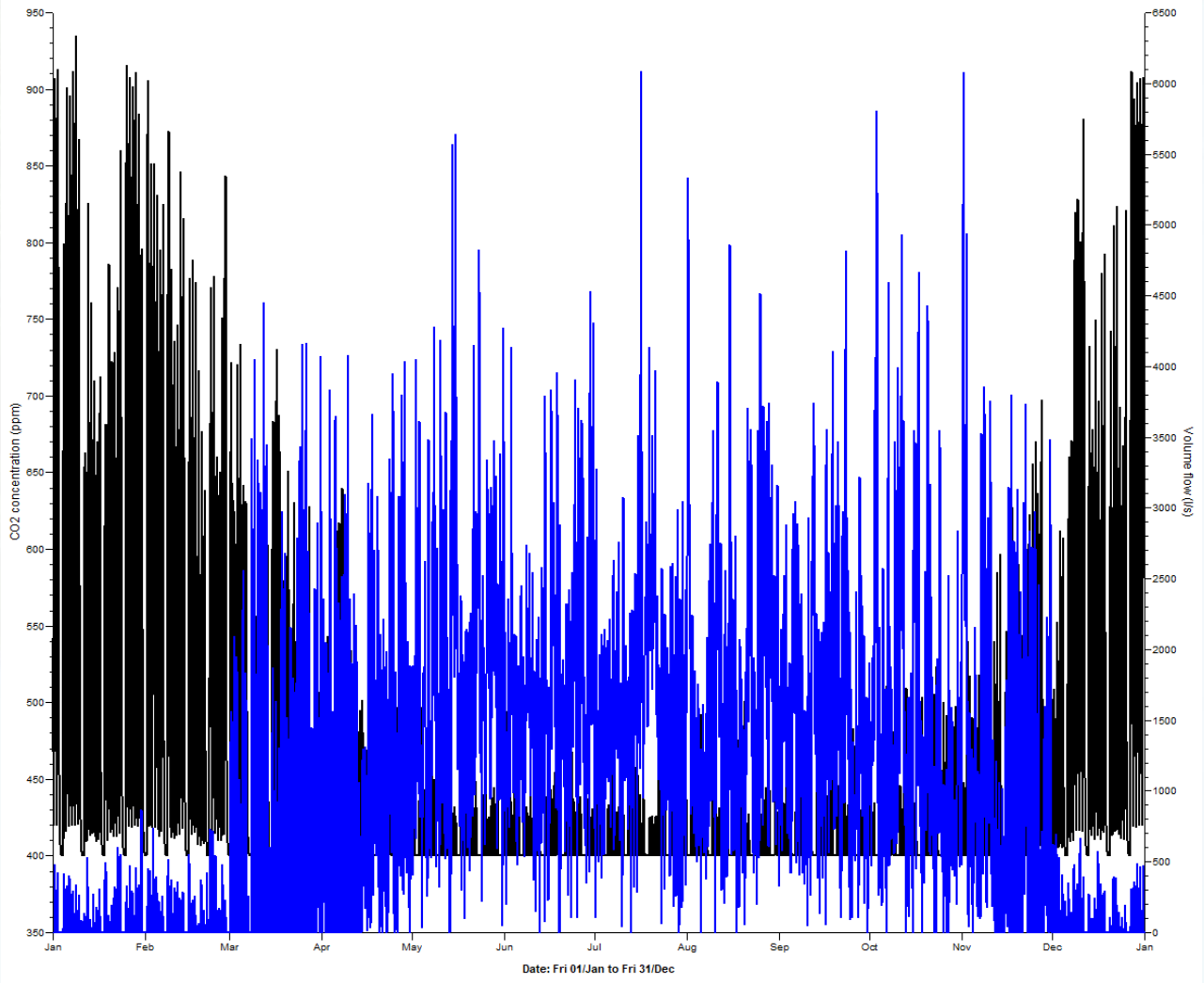
Heating Load (kW)

Internal Temperature (˚C)

External Temperature (˚C)

Airscoop Flow Rate (l/s)

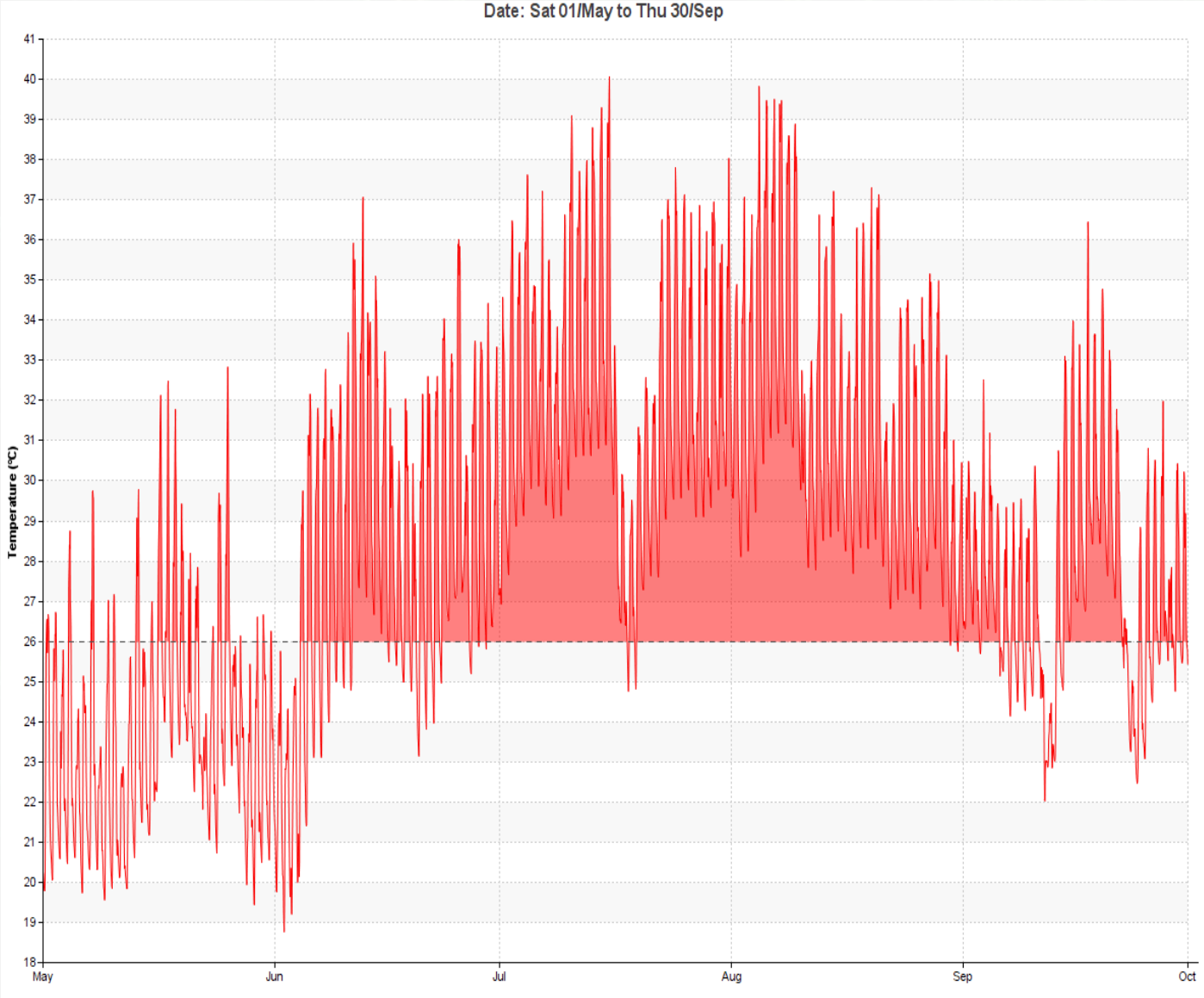


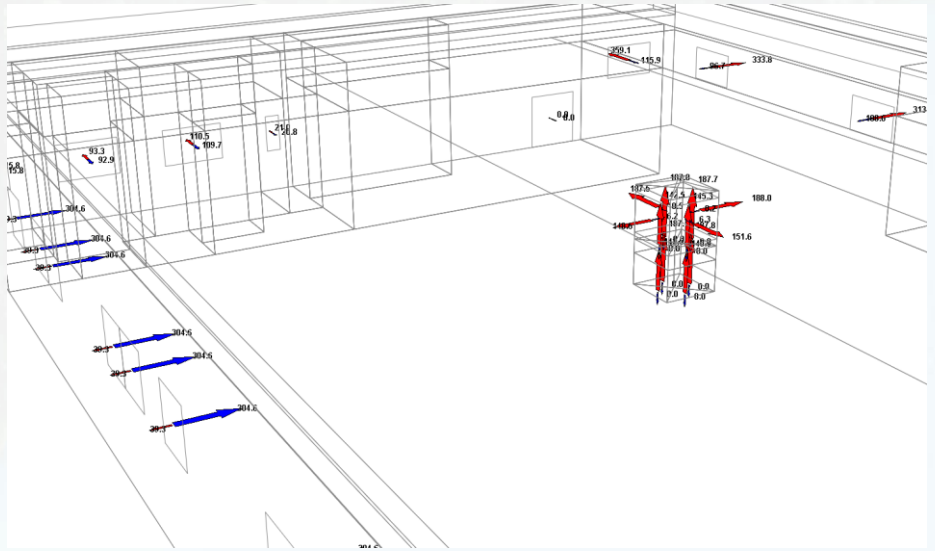


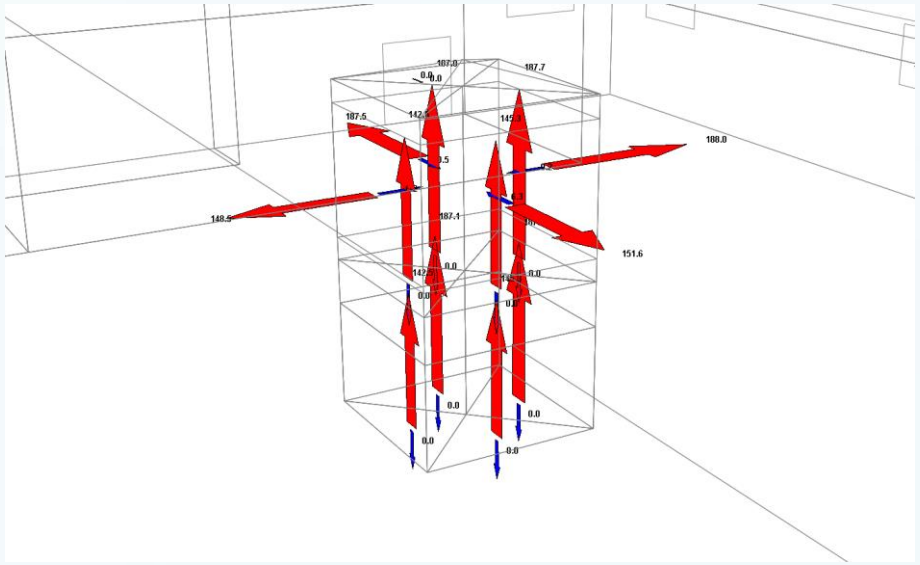
Room CO_2 Concentration (ppm)

Airscoop Flow Rate (l/s)

The Real Challenge - Summer Performance

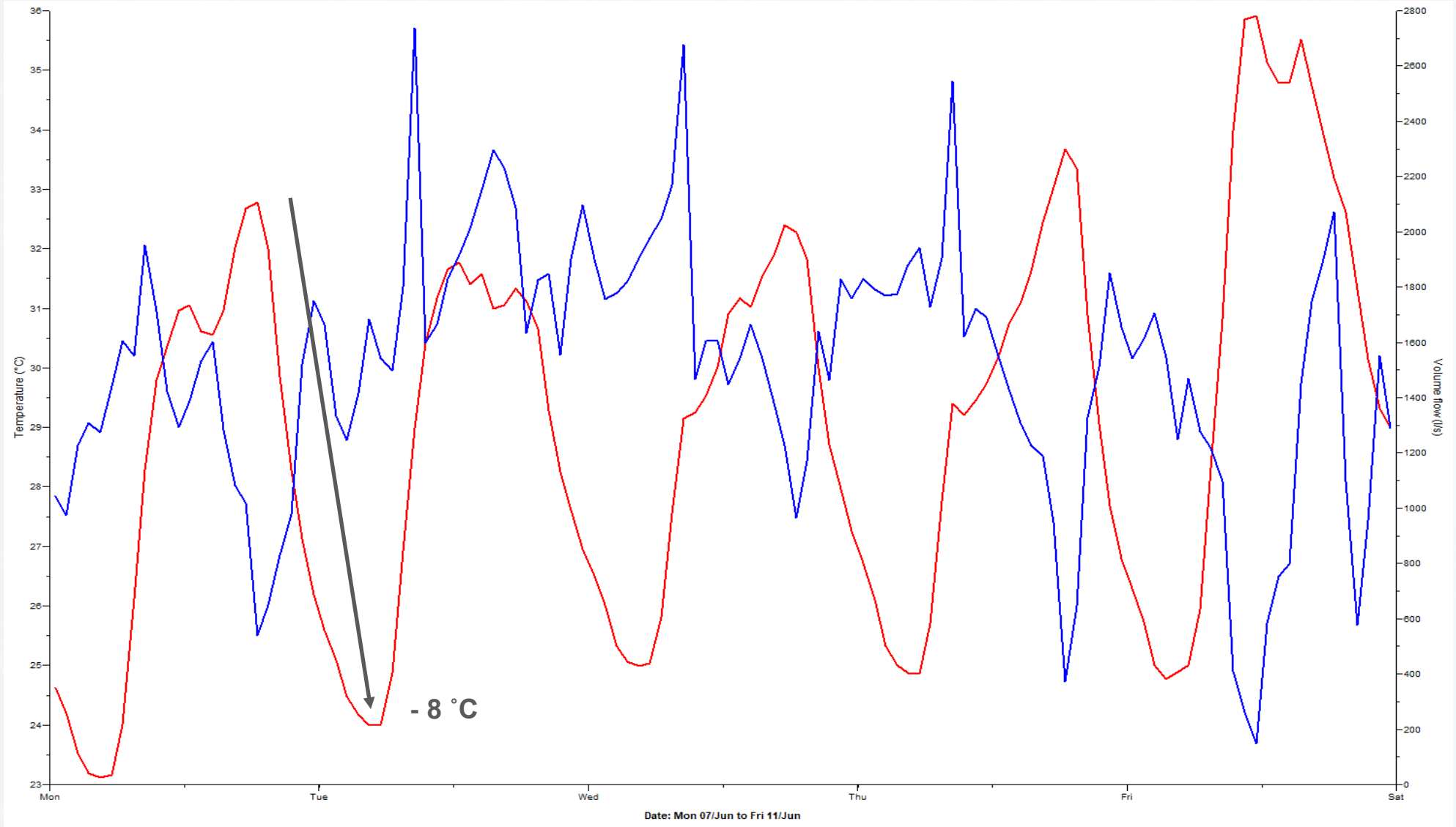






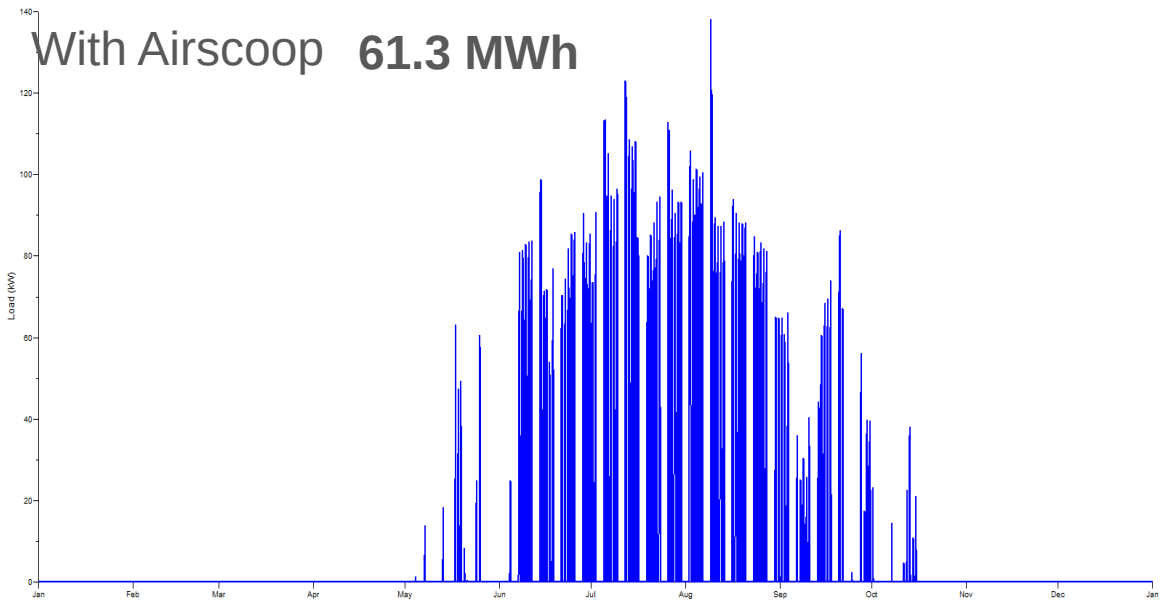
Internal Temperature (˚C)

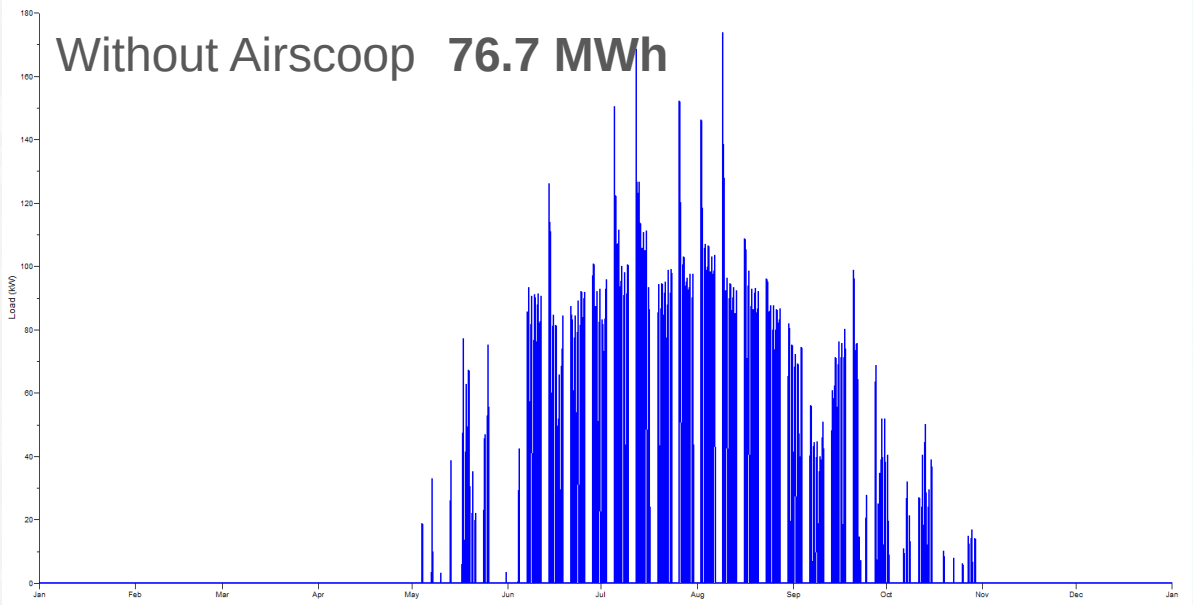
Summer Nighttime Purge

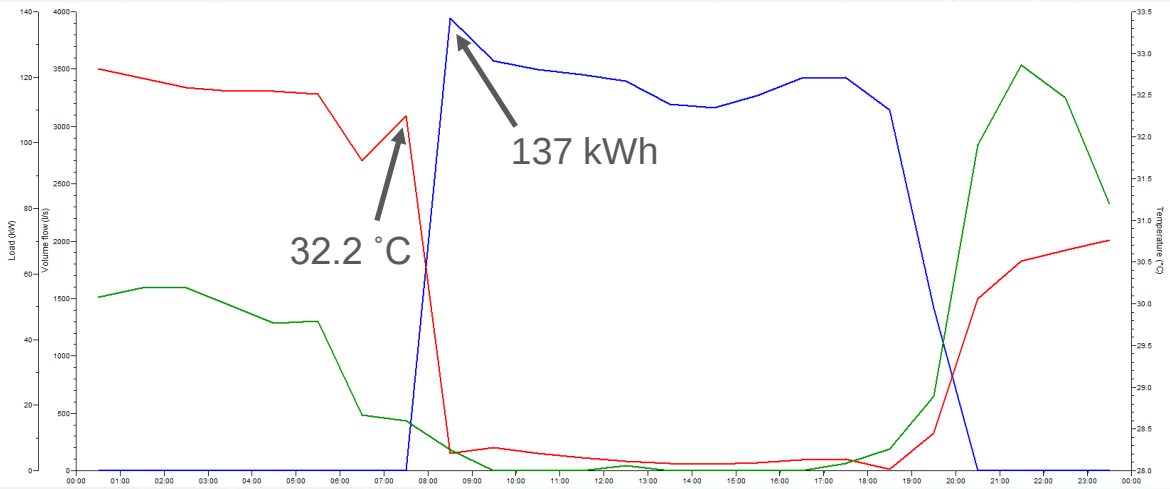


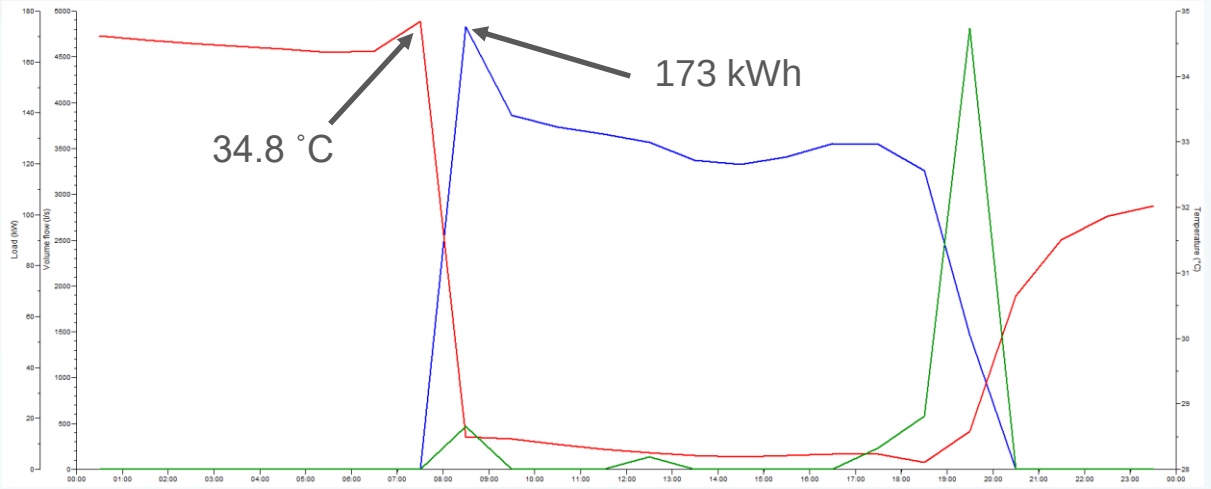
Internal Temperature (˚C) Airscoop Flow Rate (l/s)

Peak summer Cooling Load Reduction









Internal Temperature (˚C) Cooling Load (kW) Natural Ventilation Flow Rate(l/s)

So what does this all mean?