

Managing Ventilation in COVID Whilst Minimising Energy Use



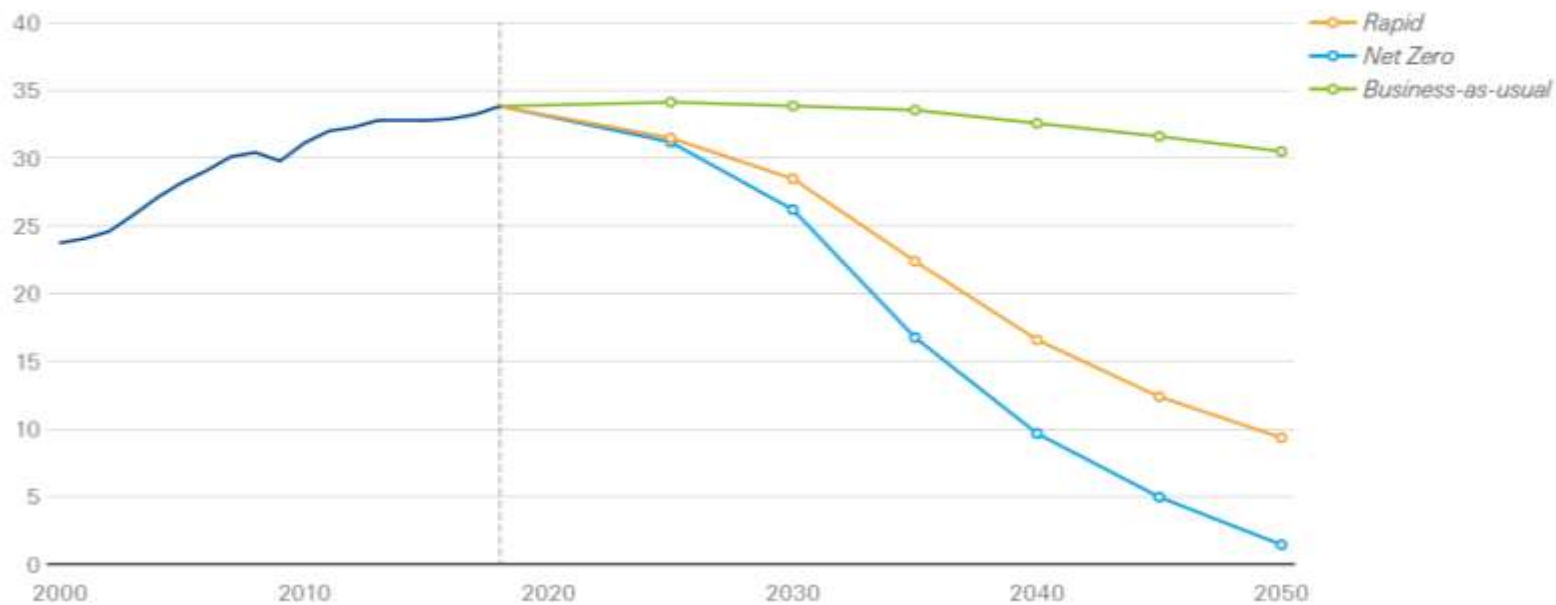
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Dr Shaun Fitzgerald FREng
Director of Centre for Climate Repair, University of Cambridge

CO₂ emissions forecast

CO₂ emissions from energy use

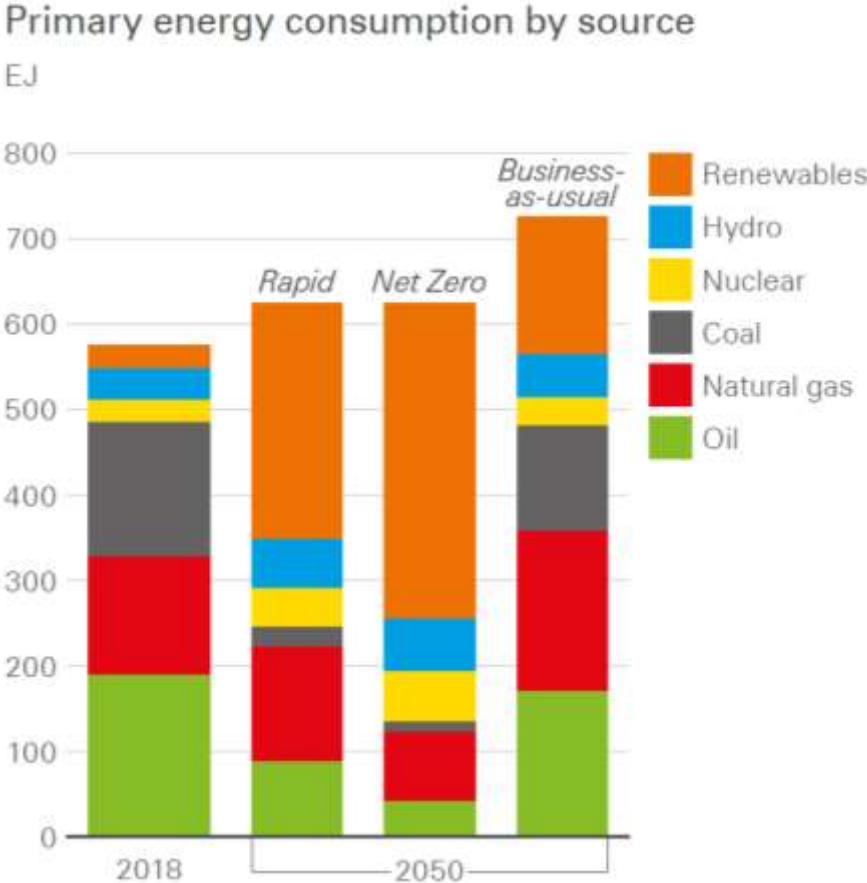
Gt of CO₂



Source: Energy Outlook 2020



Energy Supply

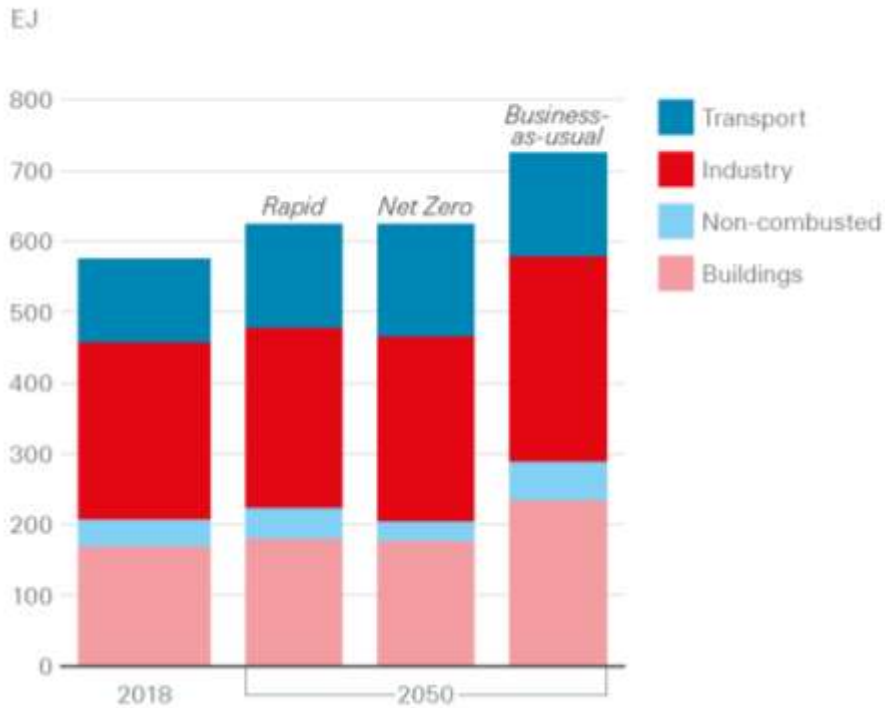


Source: Energy Outlook 2020

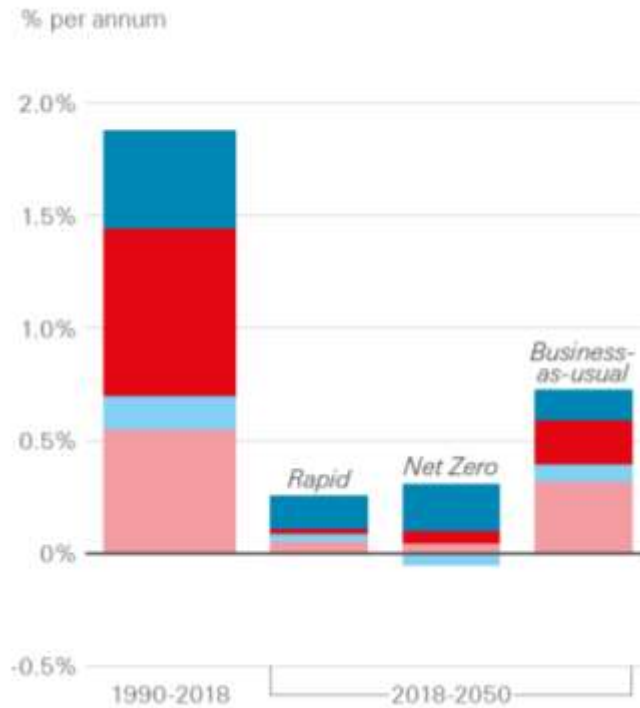


Energy Demand

Primary energy consumption by end-use sector



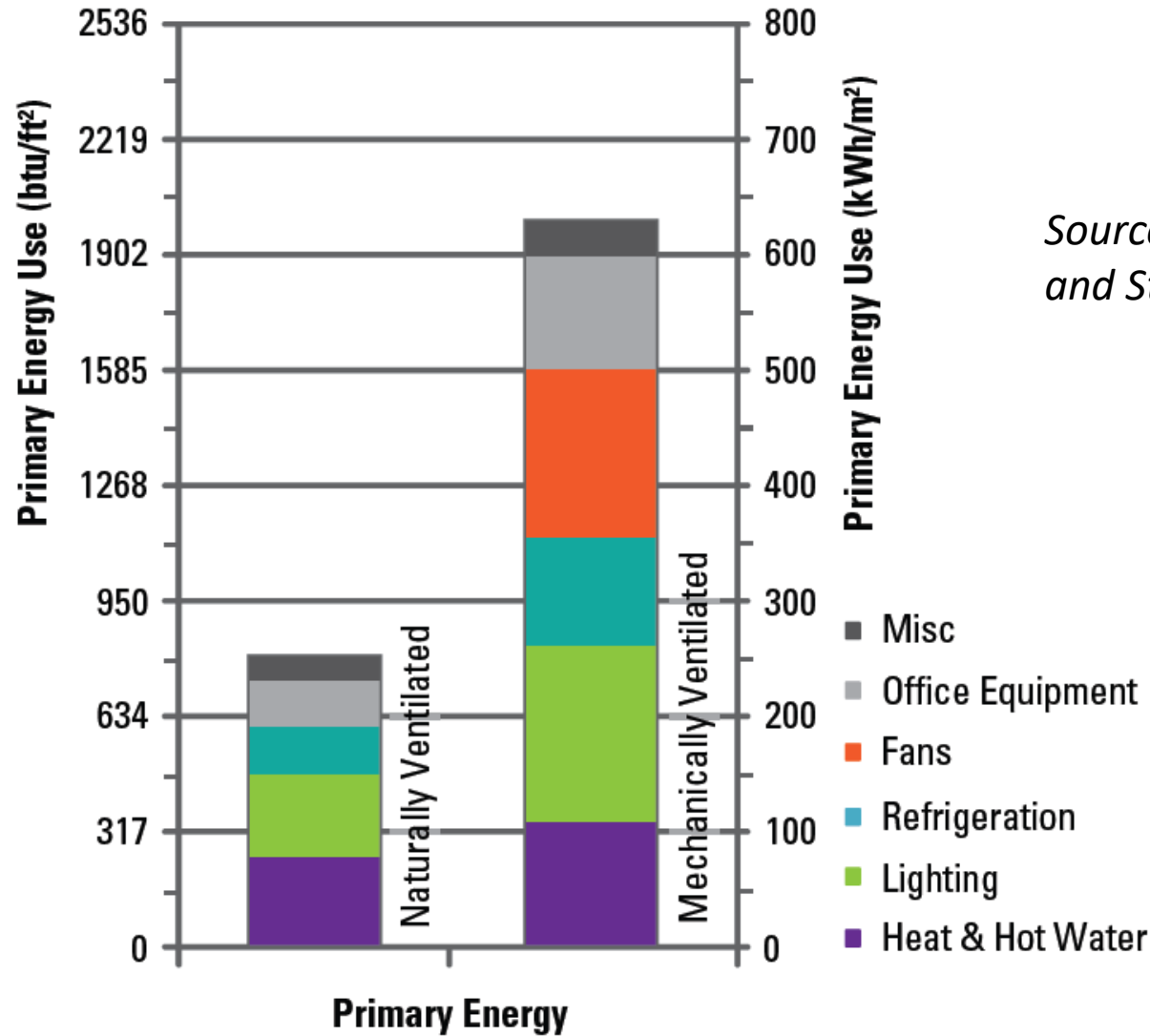
Annual demand growth and sector contributions



Source: Energy Outlook 2020

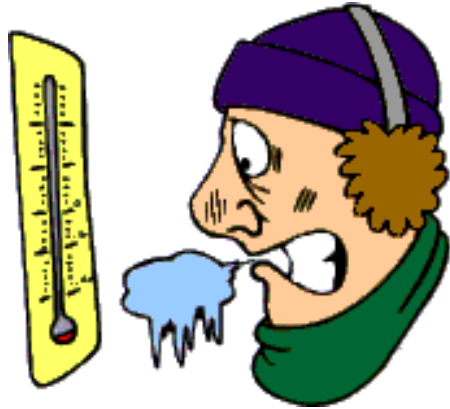


Energy Use



Source: Baker and Steemers

Fears of Natural Ventilation



Mechanical Ventilation Scheme

Significant HVAC equipment

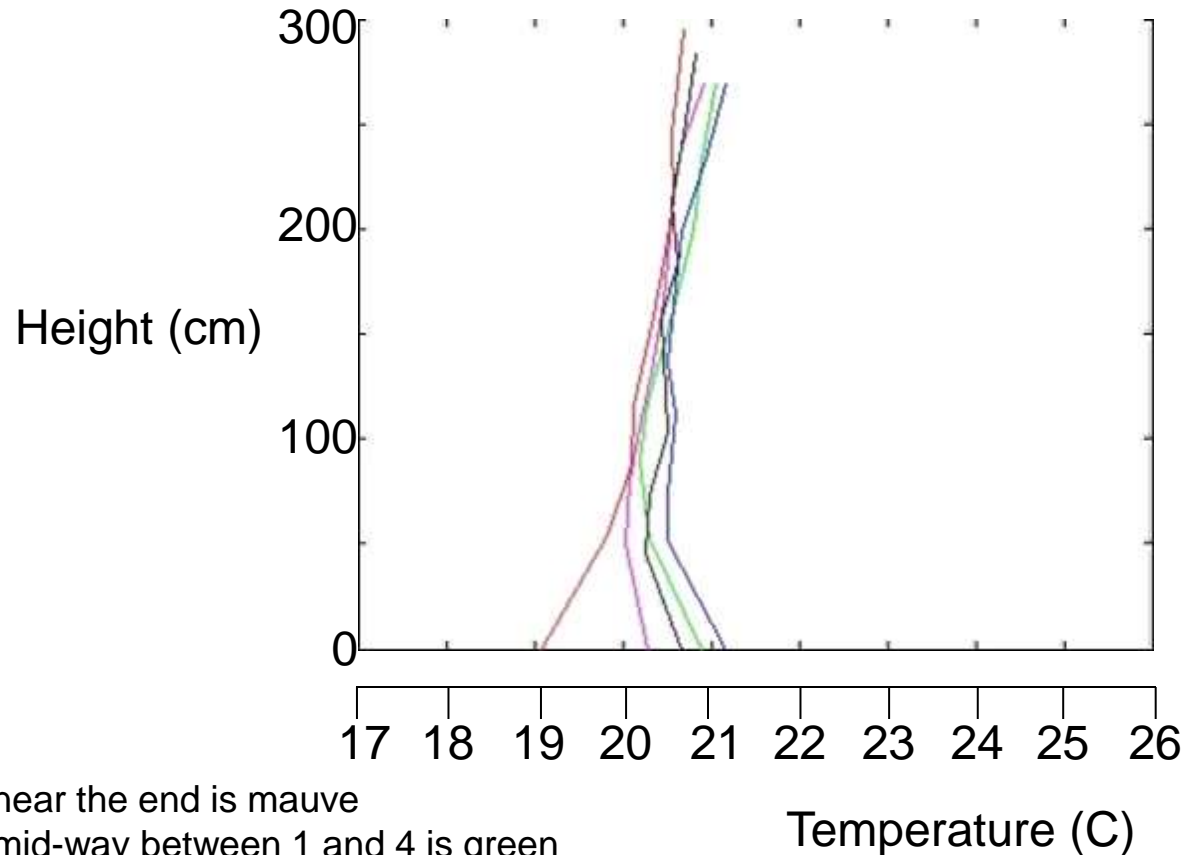
Energy consumption - heating and cooling run simultaneously



Mechanical Ventilation Scheme

1st Floor Sunbury A, Week 16/11 through 21/11

Starts at 0600 Sat 16/11, finish 1050 on Thur 21/11



#1 near the end is mauve

#2 mid-way between 1 and 4 is green

#3 Stand near window, ¼ way along the building is red

4 stand near the middle and away from the window is blue

#5 near the middle, but at the window is black

Natural Ventilation



e-stack, how natural ventilation should be.

Low Energy
Natural Ventilation

New Standards for Winter

 GOV.UK

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Guidance

BB 101: Ventilation, thermal comfort and indoor air quality 2018

This Building Bulletin provides guidance on ventilation, thermal comfort and indoor air quality in schools

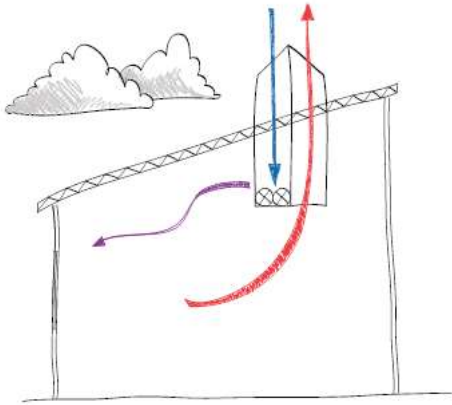
Published 11 March 2014

Last updated 23 August 2018 — [see all updates](#)

From: [Education and Skills Funding Agency](#)

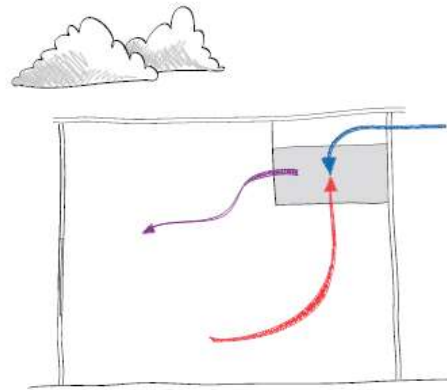
Winter Solution

Stack



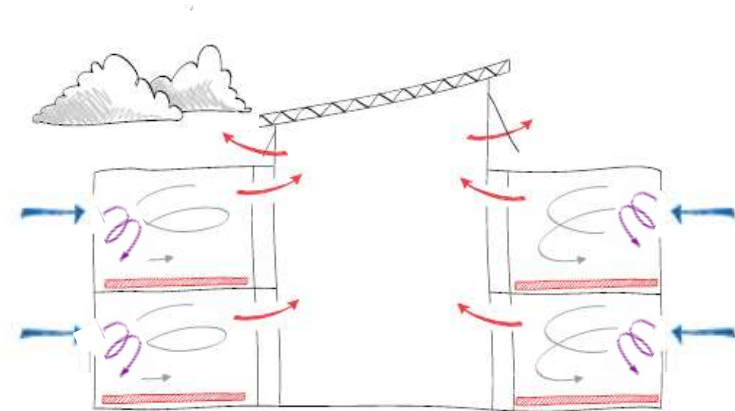
- Classrooms
- Halls (multiple units)

Facade



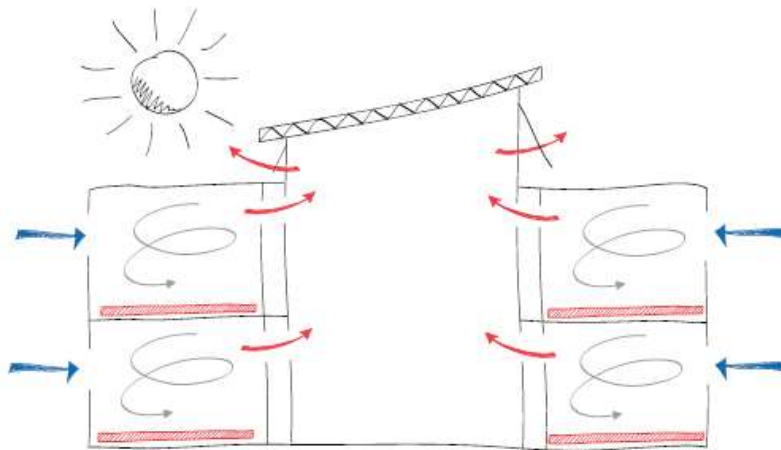
- Spaces with clerestory

Atrium

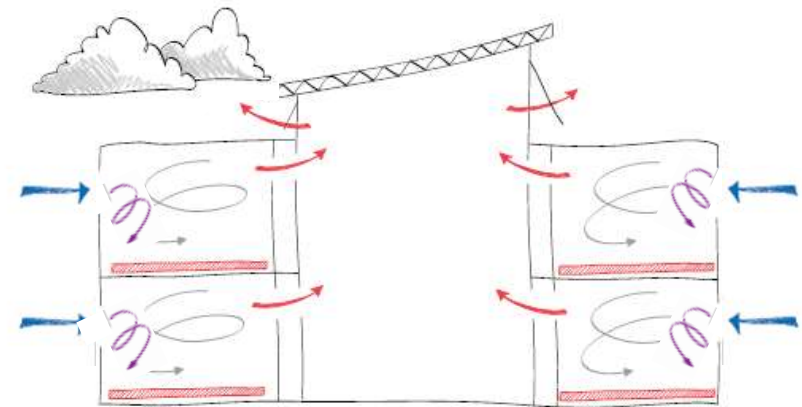


- Spaces onto an Atrium with attenuators

Façade mixing



Summer Strategy
Upwards Displacement Ventilation



Winter Strategy
Winter Mixing Ventilation

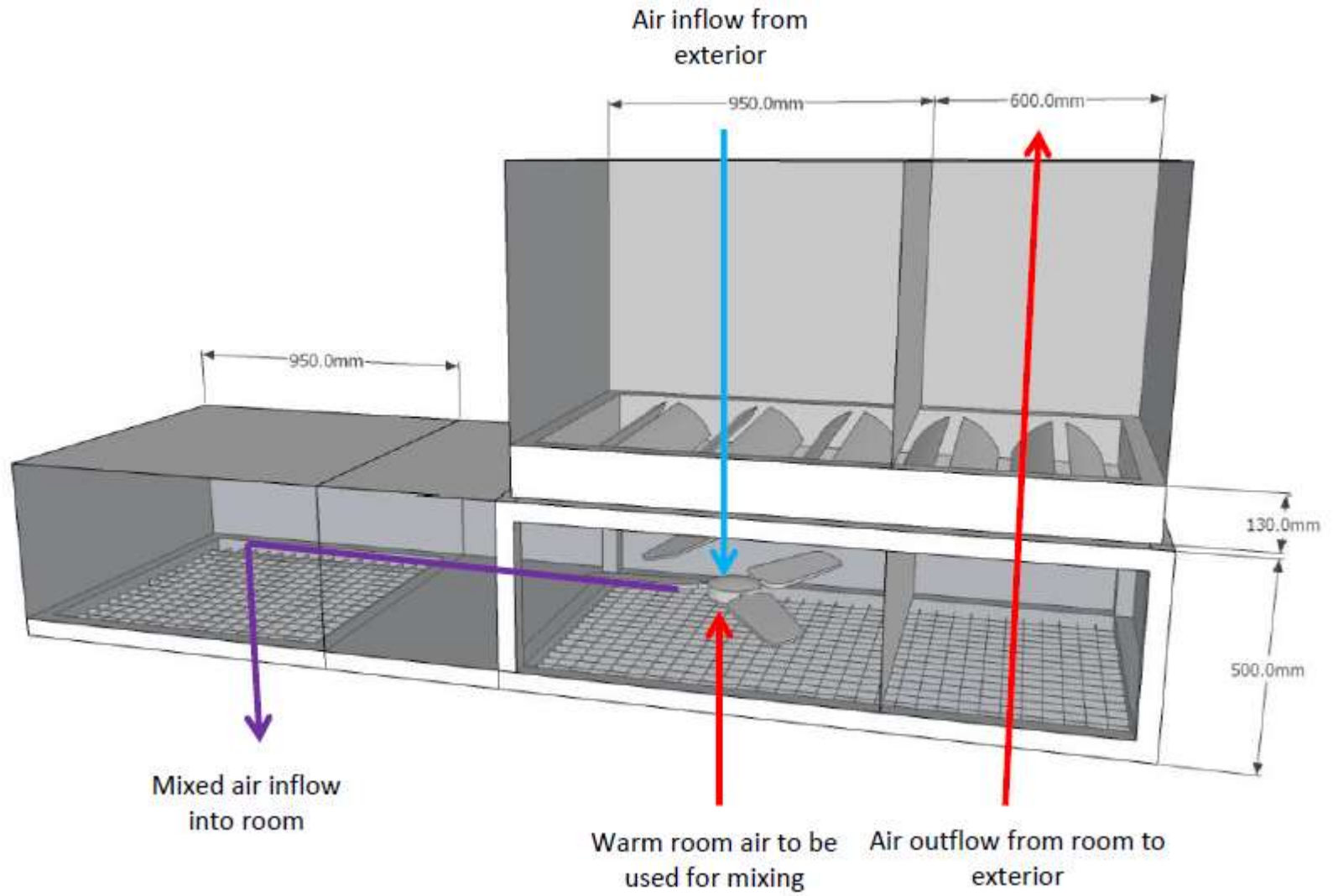
Exhaust via

- 1) Atrium (as shown) or
- 2) Passive stack dedicated to a classroom

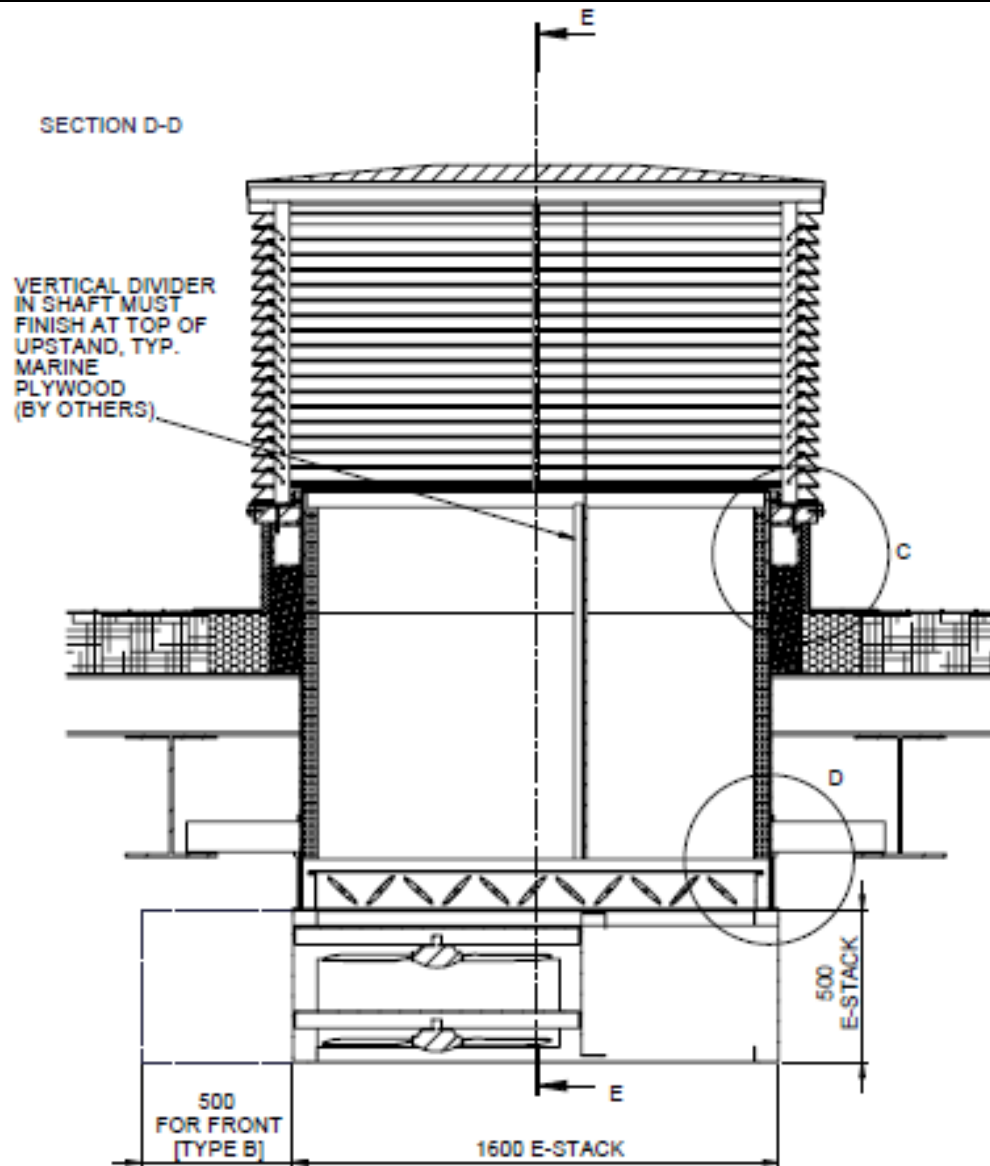
Façade mixing



Roof-based mixing



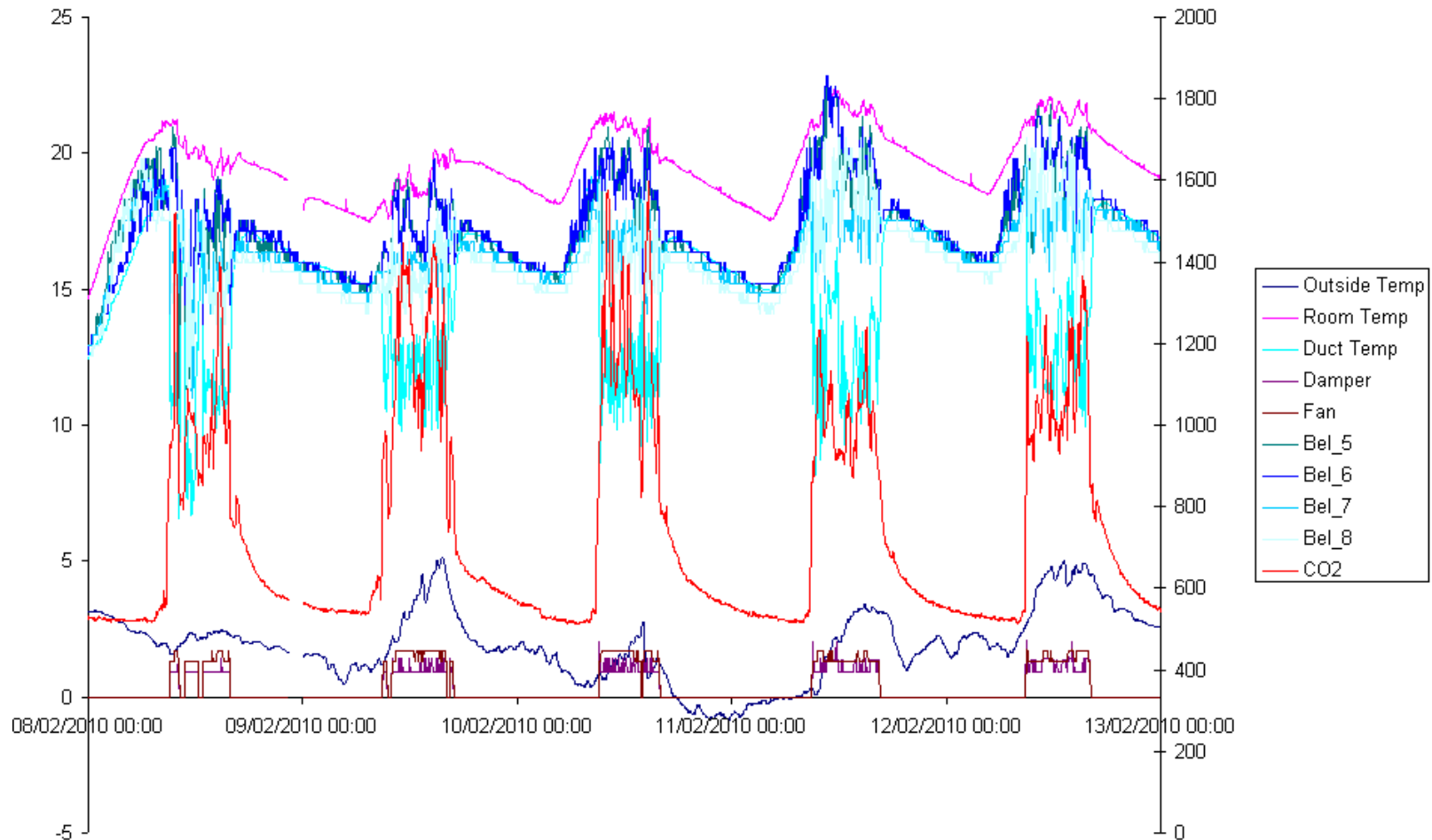
Roof-based mixing



Roof terminals

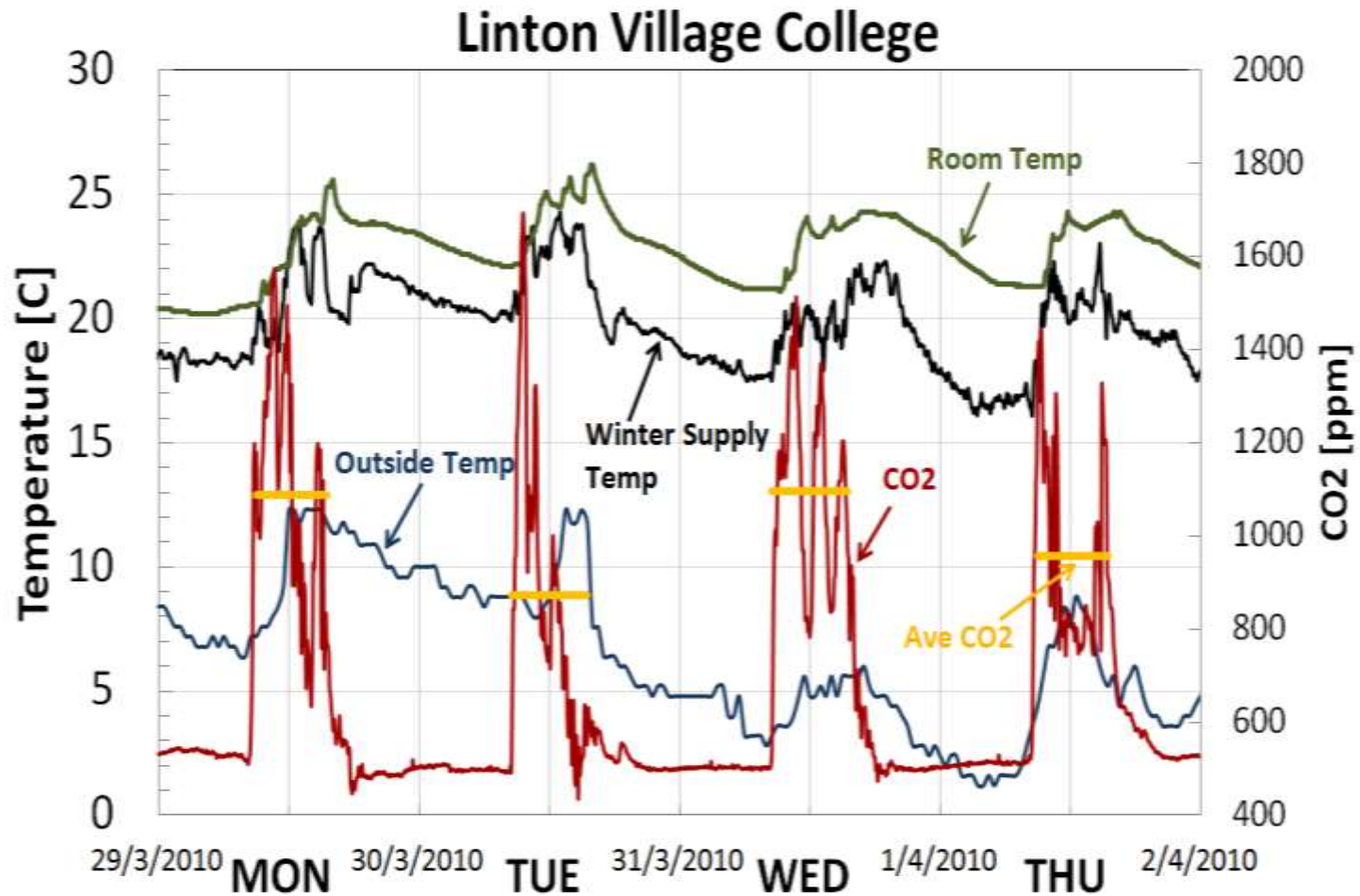


Temperatures in Winter



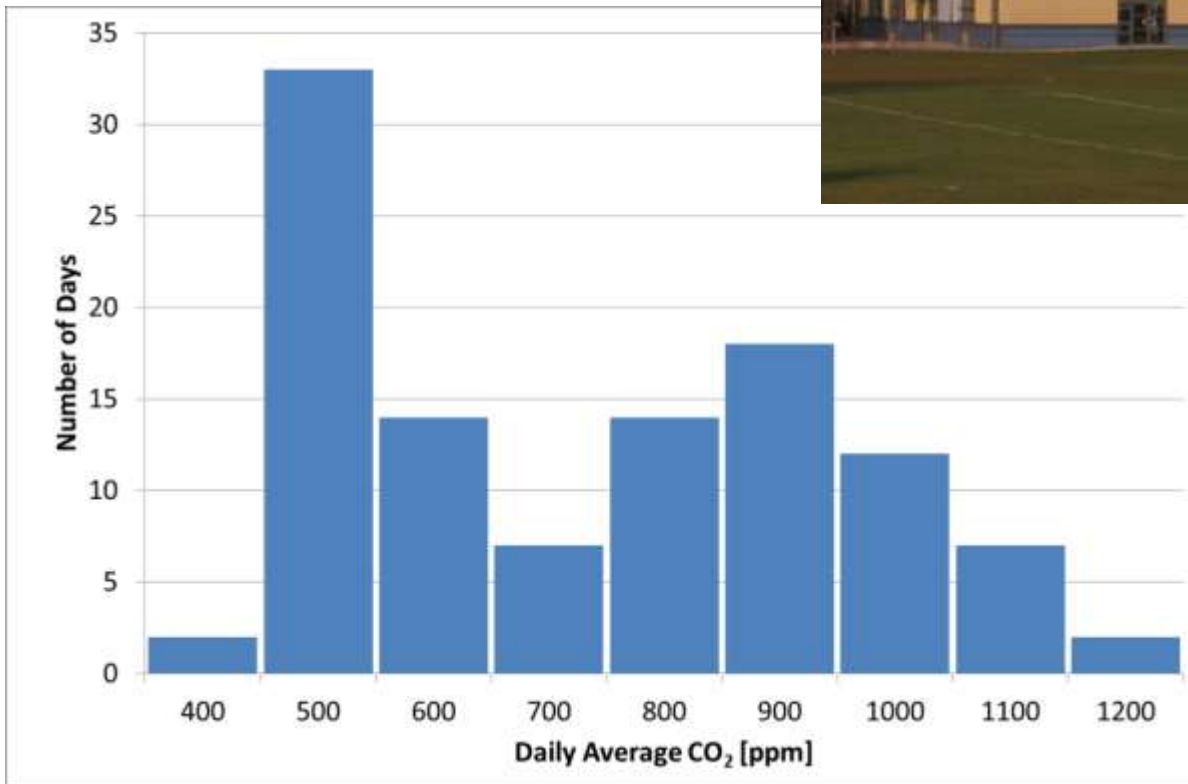
- During development site experiments revealed cold draughts ...
- 9C air introduced to space when interior is 22C

Temperatures in Winter



- Draught mitigation software used to overcome problem
 - detect and adjust fan speeds & damper position

Winter Air Quality



The daily average CO₂ never exceeds 1500ppm

Air Quality and Covid-19



World Health
Organization

Health Topics ▾

Countries ▾

Newsroom ▾

Emergencies ▾

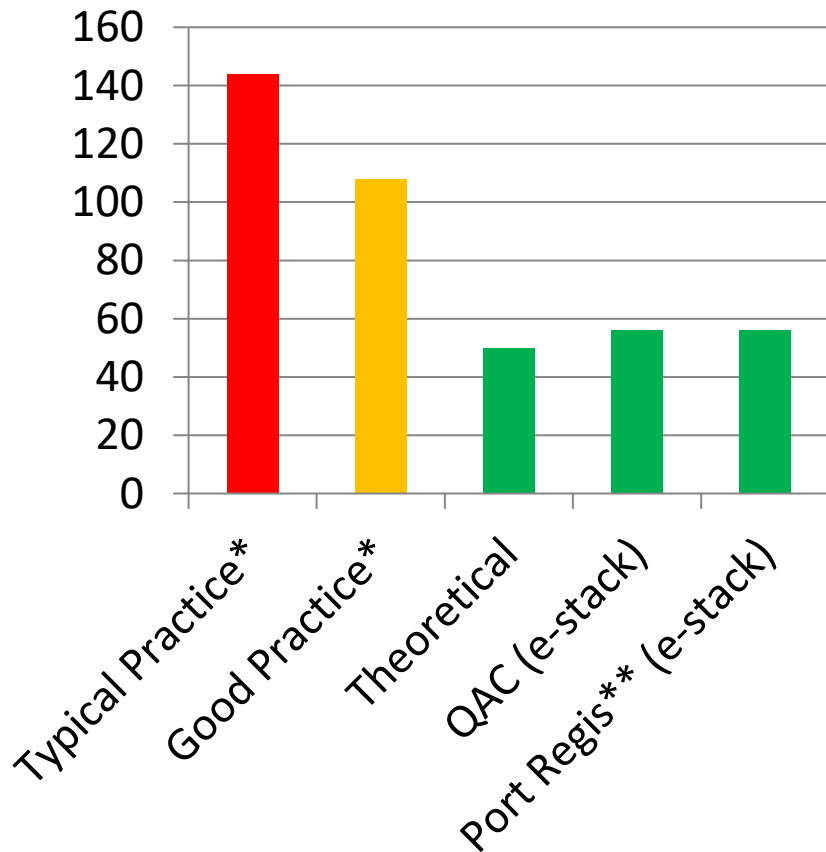
What steps can be undertaken to improve the ventilation in indoor public spaces and buildings?

Ventilation is an important factor in preventing the virus that causes COVID-19 from spreading indoors. Below are steps to consider which can improve indoor ventilation. These steps should be considered in consultation with a heating, ventilation and air conditioning (HVAC) professional.

- Consider using natural ventilation, opening windows if possible and safe to do so.
- For mechanical systems, increase the percentage of outdoor air, using economizer modes of HVAC operations and potentially as high as 100%. Before increasing outdoor air percentage, verify compatibility with HVAC system capabilities for both temperature and humidity control as well as compatibility with outdoor/indoor air quality considerations.
- Increase total airflow supply to occupied spaces, if possible.
- Disable demand-control ventilation controls that reduce air supply based on temperature or occupancy.
- Improve central air filtration:
 - [Increase air filtration](#) to as high as possible without significantly diminishing design airflow.
 - Inspect filter housing and racks to ensure appropriate filter fit and check for ways to minimize filter bypass.

Energy Savings

Fossil Fuels Energy Consumption kWh/m²/yr



* CIBSE Guide F Table 20.1 Fossil fuel use in secondary schools

** Total energy consumption of building



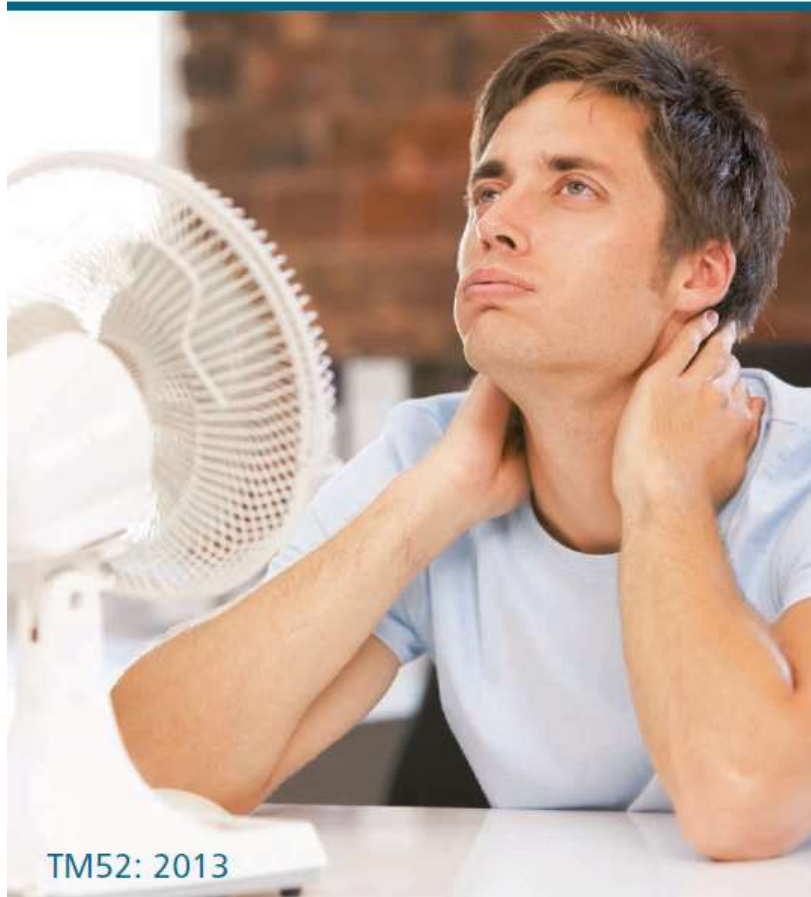
QAC, Birmingham



Port Regis School

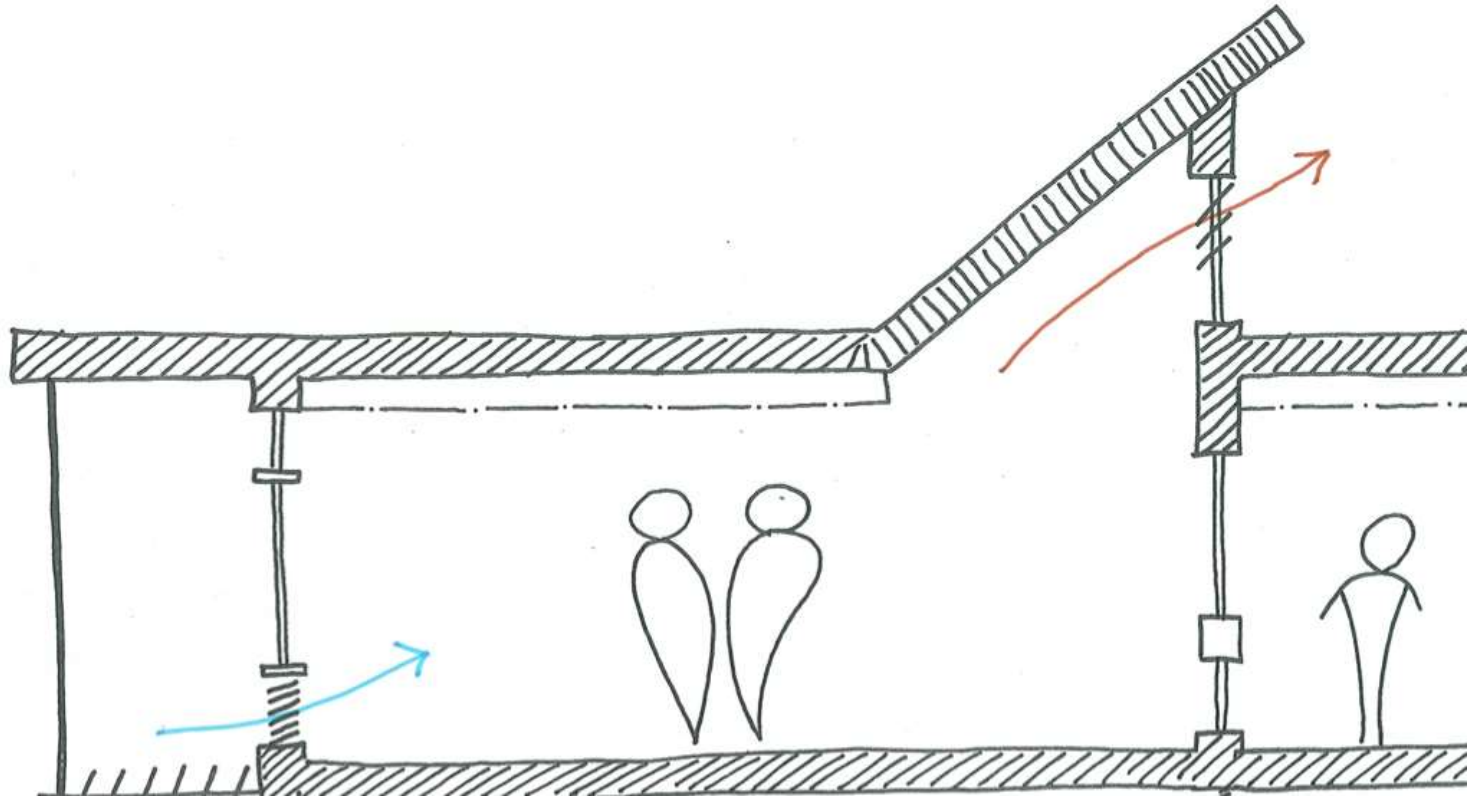
New Standards for Summer

The limits of thermal comfort:
avoiding overheating in
European buildings



TM52: 2013

Air Flow Modelling



No longer sufficient to assess overheating risk

Dynamic Thermal Modelling



Project: ST Mark's RC School
Description: Performance Theatre Hounslow

Date: 30/01/2015
Designer: CE

Input

Solver: PSBP

General parameters:

Room area: 264 sq.m
 Room height: 5.25 m
 Occupancy gain: 70 W/per

Initial Unit Size

Type: S-1500
 Opening Levels: High Level Only
 Number of Units: 5
 Type of Terminal: S1500-Mushroom
 A*estack (m2): 1.72

Results

Minimum Low Level Effective A*

1.73 sq.m

Maximum Flow Rate

8.4497 cu.m/s

PSBP

(1) No hours>Tacc: 21 hours
 (2) Weighted Exceedence: 19.50
 (3) Maximum T exceeded?: 0 hours
 (4) Delta T: 3.18 °C

Glazing

Solar Model	Orientated								
Solar Orientation	East	South East	South	South West	West	North West	North	North East	Horizontal
Glazing area (m ²)	0.0	0.0	21.0	0.0	0.0	0.0	21.0	0.0	0.0
Same transmissivity glass used on all sides?	Yes								
Glazing transmissivity (%)	40								

Occupation & Night cool

Occupied days per week: 5
 Night Cool Stop: 900
 Night Cool Start: 1600
 Min night cool temp (degC): 17
 Min day temp (degC): 18
 Threshold T for vent outside occ. hours: 21

Ventilation

wind factor (k): 0.2
 A* (m²): 2.38
 Min vent (l/s/per): 10
 Vertical stratification: Yes
 Occupied Height (m): 1.6

Location

Closest weather file: Heathrow
 CIBSE Type: DSY

Thermal Mass

	PCM Ceiling Tiles	Ceiling	Wall	Floor
Area (m ²)	0.0	264.0	341.2	264.0
Thickness (m)	0.025	0.120	0.024	0.050
Material	PCM Ceiling Tiles	Concrete block (heavyweight)	Plasterboard	Timber flooring
H (W/sq.m/K)	4.3	4.3	3	1.5
Density (kg/cu.m)	1000	2300	950	650
Cp (l/Kg/K)		1000	840	1200

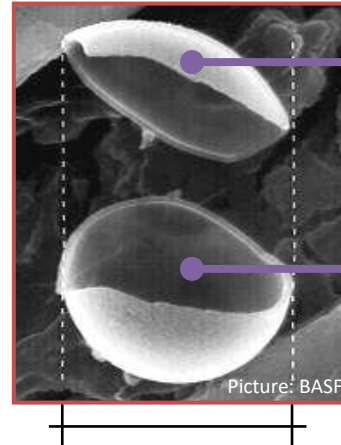
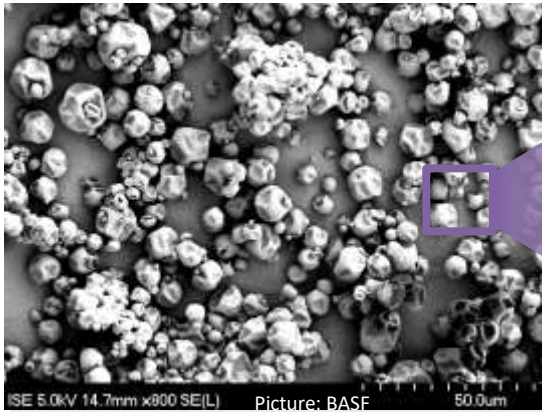
Heat Load Profile

Time	People (ppl)	Lighting (W/sq.m)	Additional (W)
00:00-00:59	0	0	0
01:00-01:59	0	0	0
02:00-02:59	0	0	0
03:00-03:59	0	0	0
04:00-04:59	0	0	0
05:00-05:59	0	0	0
06:00-06:59	0	0	0
07:00-07:59	0	0	0
08:00-08:59	0	0	0
09:00-09:59	40	8	180
10:00-10:59	40	8	180
11:00-11:59	40	8	180
12:00-12:59	1	8	0
13:00-13:59	40	8	180
14:00-14:59	40	8	180
15:00-15:59	40	8	180
16:00-16:59	10	0	0
17:00-17:59	10	0	0
18:00-18:59	10	0	0
19:00-19:59	200	0	4000
20:00-20:59	200	0	4000
21:00-21:59	200	0	4000
22:00-22:59	0	0	0
23:00-23:59	0	0	0

Houghton Hall

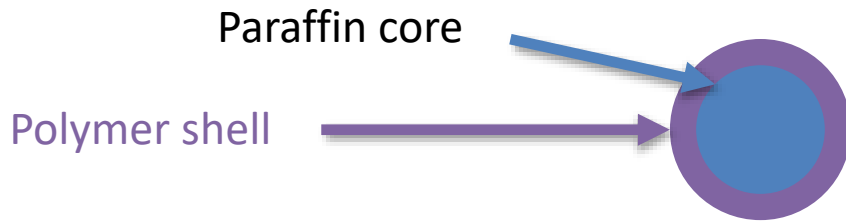


Exposed PCM Tiles



Polymer coating

Wax
Melting Point:
23C / 26C



PCM
Cassette

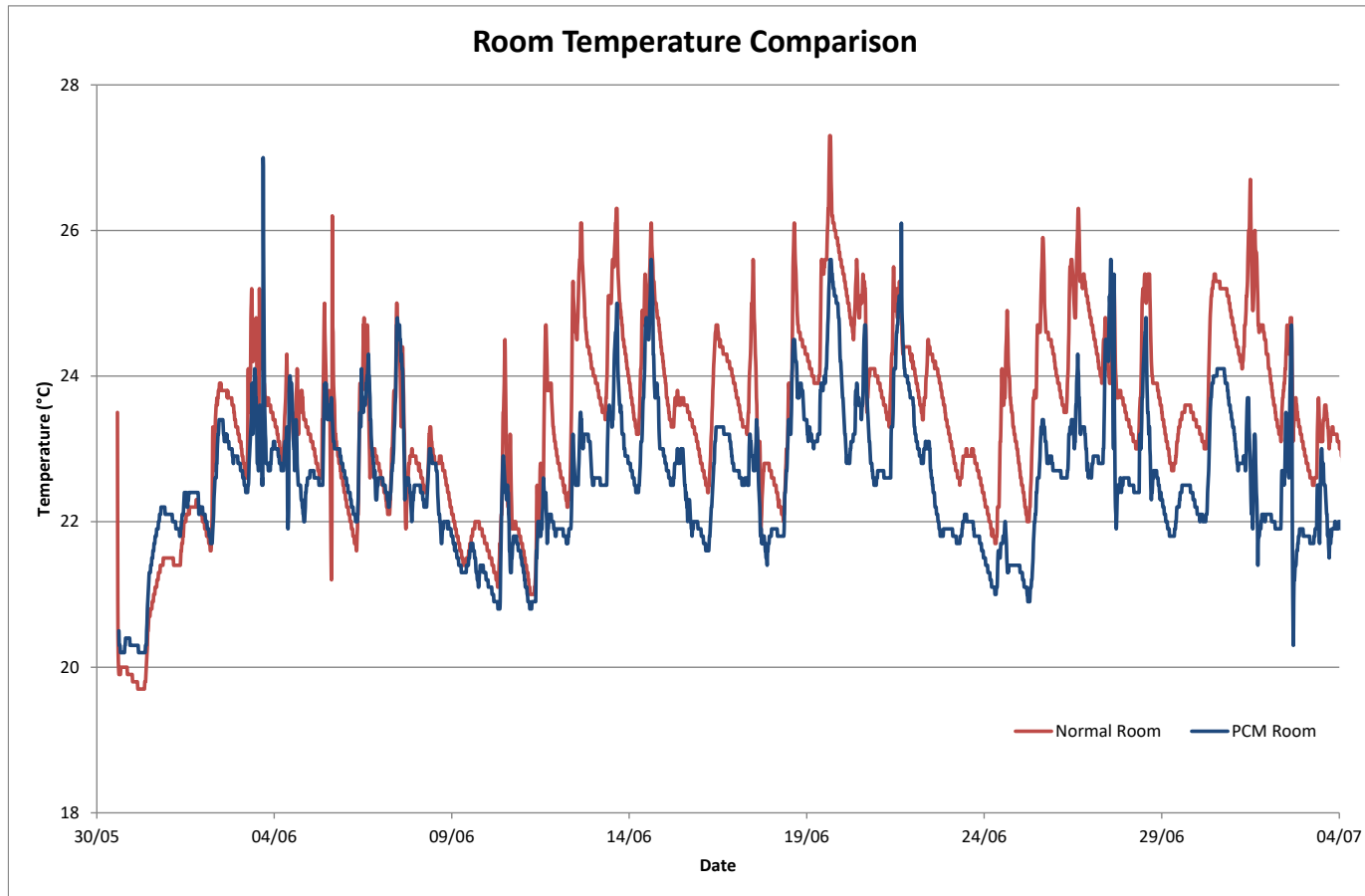
Acoustic
tile



Belvoir High School

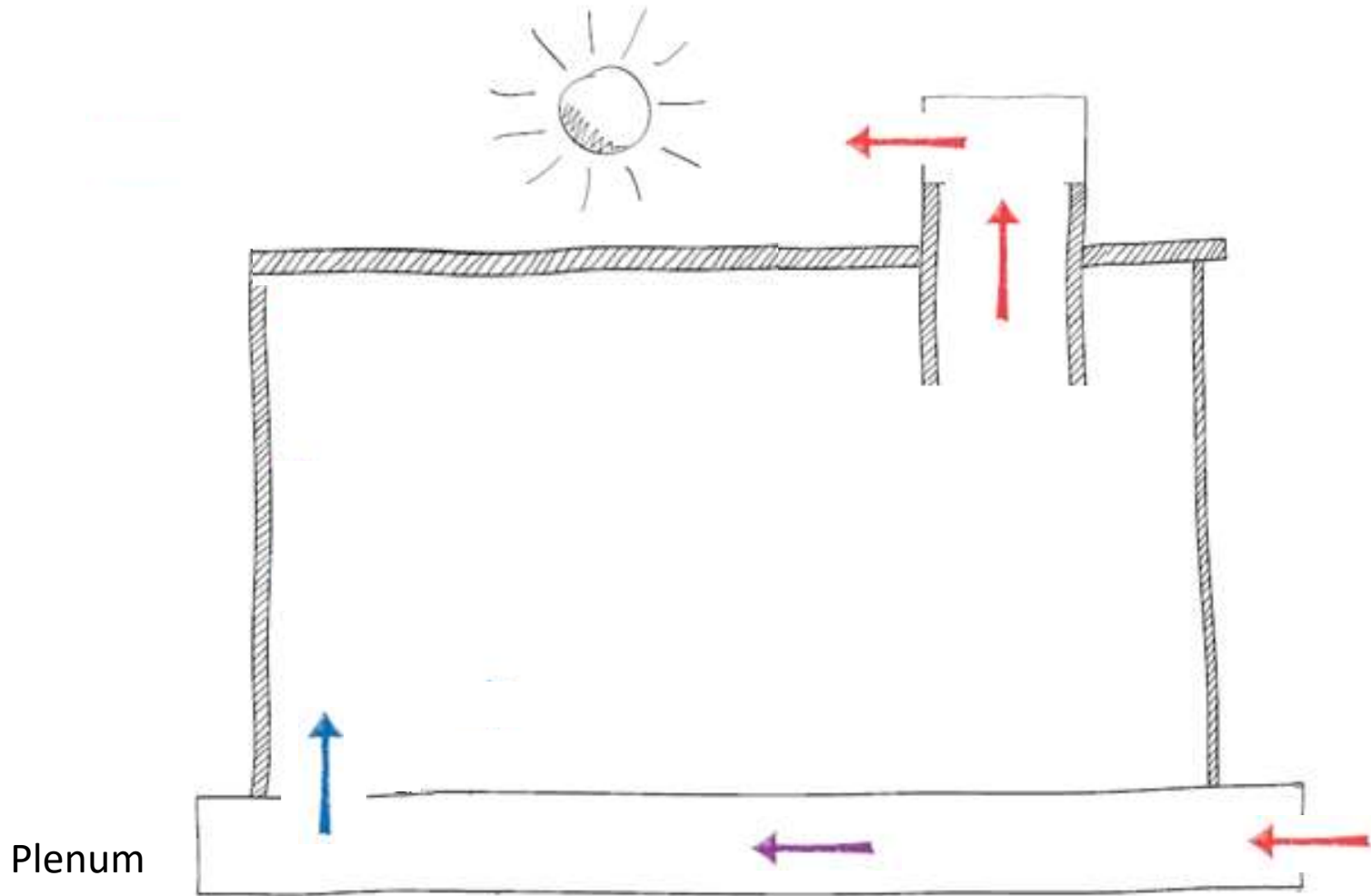


Belvoir High School

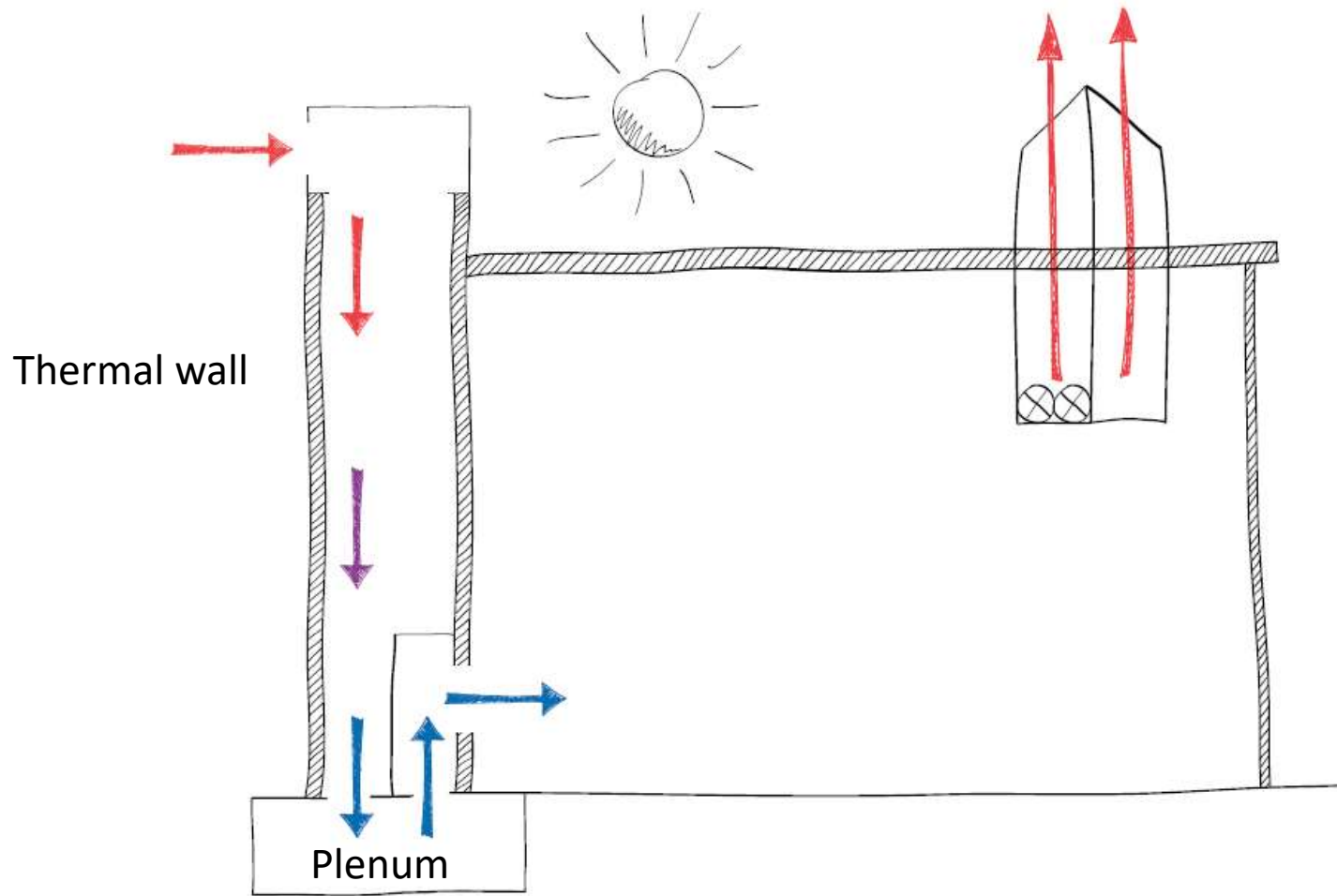


- Data collected summer 2013 (**R Series in classrooms** + opening windows)
- Two classrooms studied, **one with PCM CoolZone** ceiling tiles and **the other without**
- Temperature data below ceilings (hottest part of the room) shows **consistently lower peak temperatures in room with PCM**

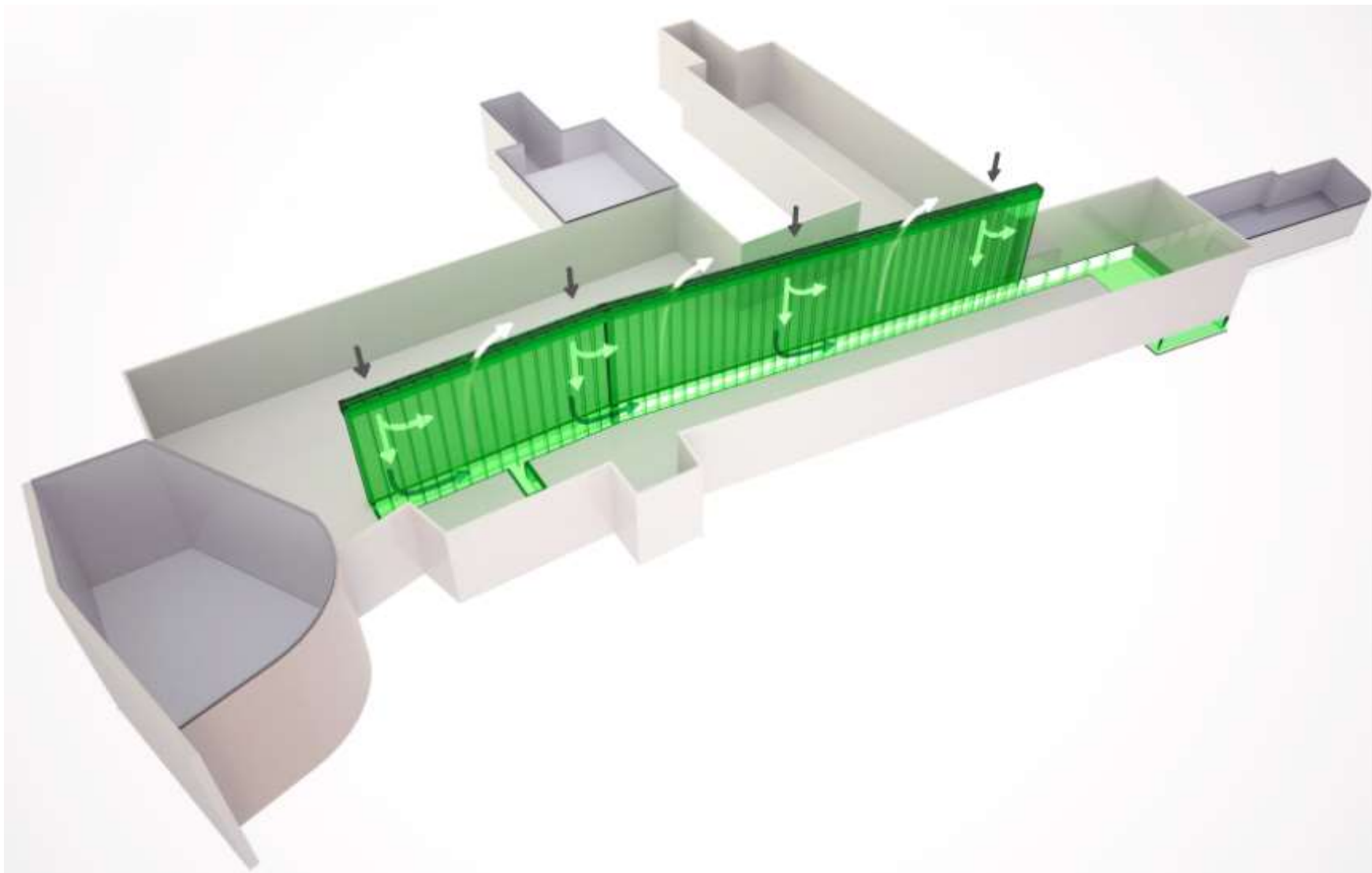
Pre-cooling Challenge



Houghton PCC



Houghton PCC



Waiting Area and Plenum



Shaft in Thermal Wall



BREEAM Outstanding



Hybrid Designs



Hybrid Designs



Hybrid Designs



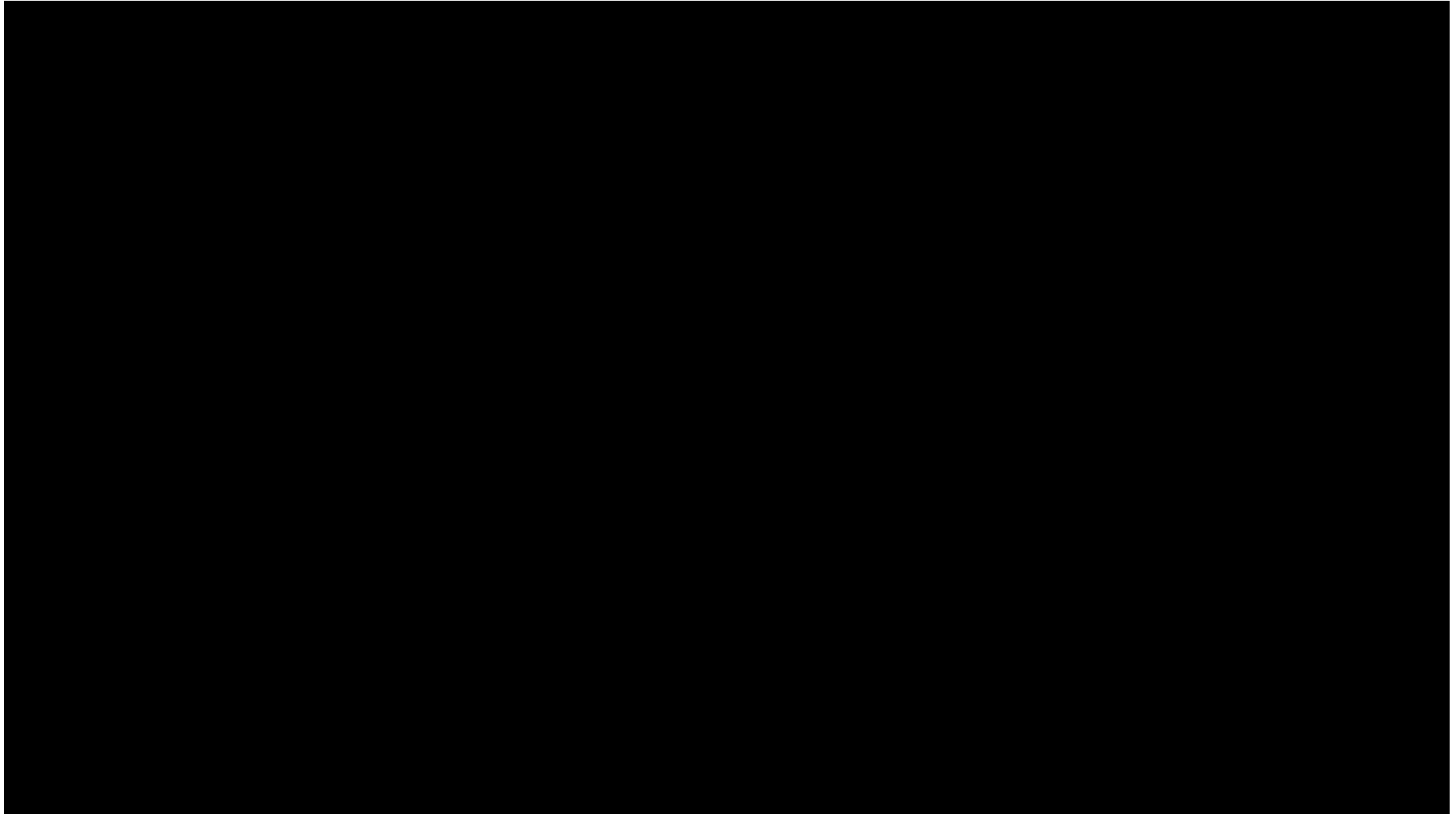
Hybrid Designs



Hybrid Designs



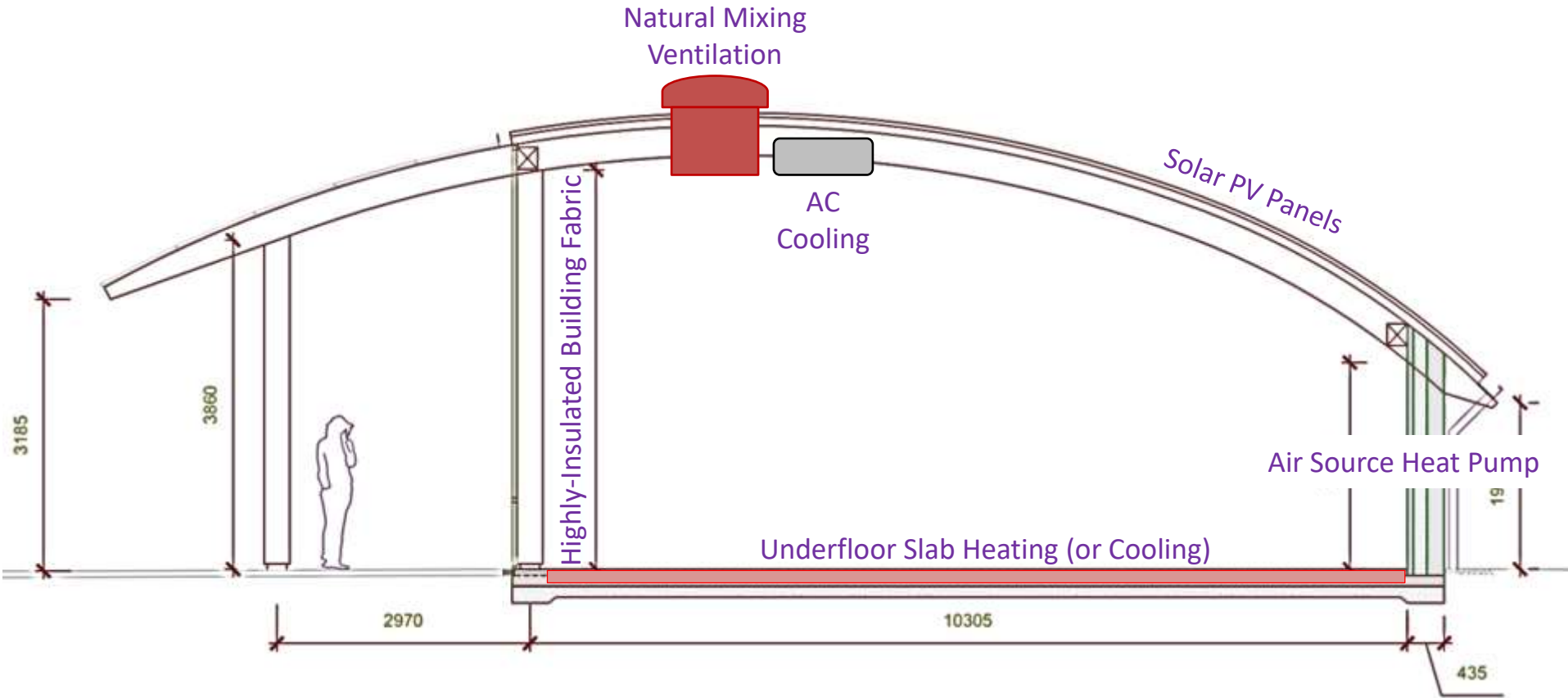
Hybrid Designs



Hybrid Designs



Hybrid Designs



Hybrid Designs



Summary

- Natural ventilation low energy
- Resultant/operative temperature
- Hybrid
- More to learn

Acknowledgements

- Breathing Buildings Team
- DfE
- CIBSE NVG
- Academic colleagues