Soft Landings and Lessons Learnt
3 Passivhaus Schools 1 Team

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Project Overview

Name: Bushbury Hill Primary School

Type: Mainstream Primary School

Build type: Timber frame

Location: Wolverhampton

Occupancy: Occupied since Oct 2011

Budget: £4.2 million

Project Overview

Name: Oakmeadow Primary School

Type: Mainstream Primary School

Build type: Timber frame

Location: Wolverhampton

Occupancy: Occupied since Oct 2011

Budget: £5.2 million


Bushbury Hill Primary School
Bushbury Hill
Primary School
Entrance


Soft Landings

BSRIA & Usable Building Trust: Publish first framework document in 2009 based on the previous and on-going work of Mark Way Architype featured in the initial soft landings case study school document: Published by BSRIA & Usable Building Trust in 2010, funded by Technology Strategy Board (TSB)

Used Soft Landings on the Passivhaus schools

Lighting & Ventilation Control

Light Switches:

- Each classroom has two light switches, one close to the entrance of the room, and the other nearer the whiteboard.
- The lights closest to the whiteboard can be controlled independently from the other lights. To dim the lights press the switch until the desired level is reached.
- To switch the lights on: hold the switch down until the lighting reaches the required level, then release. Repeat to increase the lighting level.
- On leaving the room switch off the lights. If they are left on for 5 minutes with no movement in the room an absence detector will switch the lights automatically.
- If the daylight inside the classroom is of a sufficient level a sensor will automatically dim or switch the lights off.
- The blinds over external windows/doors can also be used to control the lighting levels within the classrooms.

Example:
Lights close to Whiteboard
Main room lights

Lights OFF

Lights ON

Ventilation:

- Ventilation panels/doors are controlled manually by turning the handle and opening to the desired position. Ventilation panels can be left open at night.
- Windows are electrically opened and closed using the switches located close to the classroom door.
- The switches for the windows are designed for single click pushes and must not be held continuously.
  - One push to the top part of the switch, window opens to 1/3 position.
  - Two pushes, to 2/3 position,
  - Three pushes, to fully open position,
  - To close repeat as above, but pushing the bottom part of the switch.
- Remember windows and ventilation panels can be opened at any time during the school day, only vents can remain open during the night.
- The windows will automatically close after 60 minutes or at the end of the day.
- If it is very cold outside, the opening of the high level ventilation panels will reduce automatically.

Window open / close switch

Temperature sensor connected to the Building Management System

Oak Meadow Primary School

Passivhaus classroom user guide

Summer

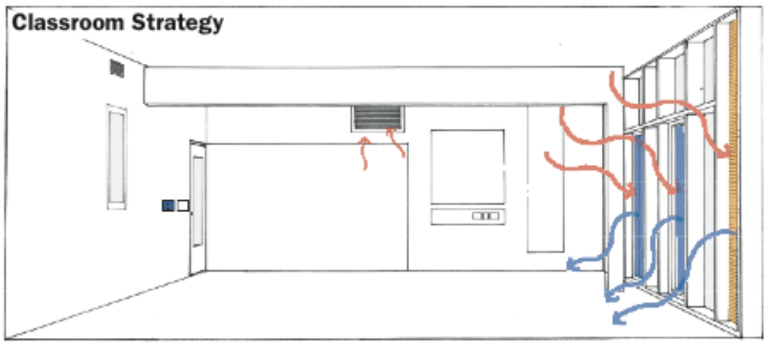
The building is naturally vented and therefore supplied by fresh air from outside, however if you are:

Feeling too cold:
Close windows (electric) and/or ventilation panels

Feeling too hot:
Open windows (electric) and/or ventilation panels
The building needs to cool down at night therefore the secure ventilation panels should be left open at night, allowing the cool night air to reduce the internal building temperature in preparation for the following next day.

All occupants using the building will have different perceptions of temperatures but if everybody is feeling too hot or too cold then please contact your caretaker who will be able to organise overall adjustments to the building services.

Classroom Strategy

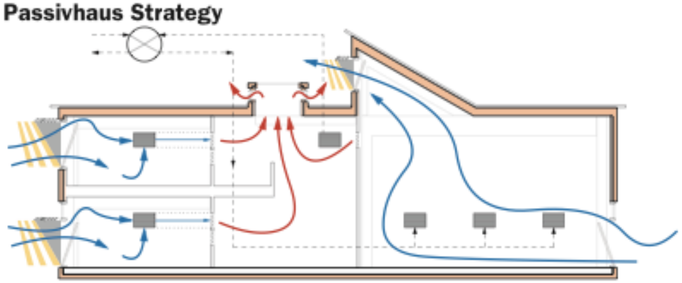


Day – Electrically operated windows hot air out cool air in

Night – Ventilation panel (opened at any time. opened automatically at night)

Night 1 – Push button operated window panel control

Passivhaus Strategy



Heating:
The highly insulated building fabric keeps the building cooler during the summer.
Solar heat gain is controlled by the brise soleil.

Ventilation:
Summer cross ventilation is controlled by opening windows and ventilation panels.
Air from outside enters the classroom and passes through them into the hub space. Air leaves the building through high level vents in the hub space.

Heat exchanger | Air transfer duct | Locally controlled radiator | Ducted air | Cooling air flow

Winter

The classrooms are supplied with a constant flow of pre-heated fresh air, which will help keep the building at a fairly constant temperature, however if you are:

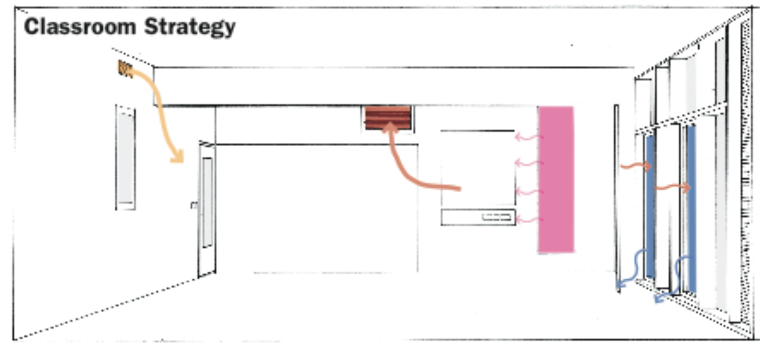
Feeling too Cold:
Turn the radiator valve (adjacent to radiator) to a higher figure

Feeling too hot:
Turn the radiator valve (adjacent to the radiator) to a lower figure

Still feeling too hot:
Windows (electric) or ventilation panels can be opened (must be closed at end of day), remember heat/ energy will be lost

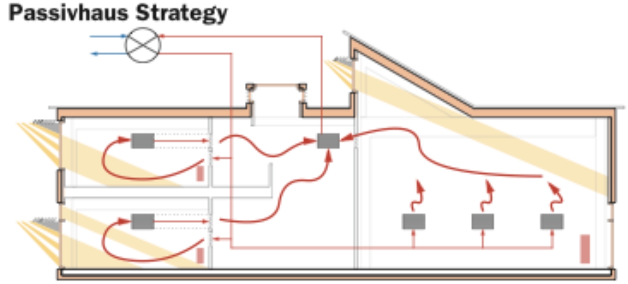
All occupants using the building will have different perceptions of temperatures but if everybody is feeling too hot or too cold then please contact your caretaker who will be able to organise overall adjustments to the building services.

Classroom Strategy



Fresh supply air | Radiator | Exhaust air | Window can be opened (when open heat will be lost)

Passivhaus Strategy



Heating:
Heat is contained within the building by the highly insulated airtight walls, and triple glazed windows. The building is heated by solar gains and radiators that can be individually controlled.

Ventilation:
A central heat recovery system supplies fresh air to classrooms via supply grilles, air is then extracted through grilles from classrooms to hub spaces.
Windows and ventilation panels can be opened to supply air direct from outside, however heat will be lost.

Warming air flow | Solar gains excluded | Beneficial solar gains | Sun angle

Daylight and lighting

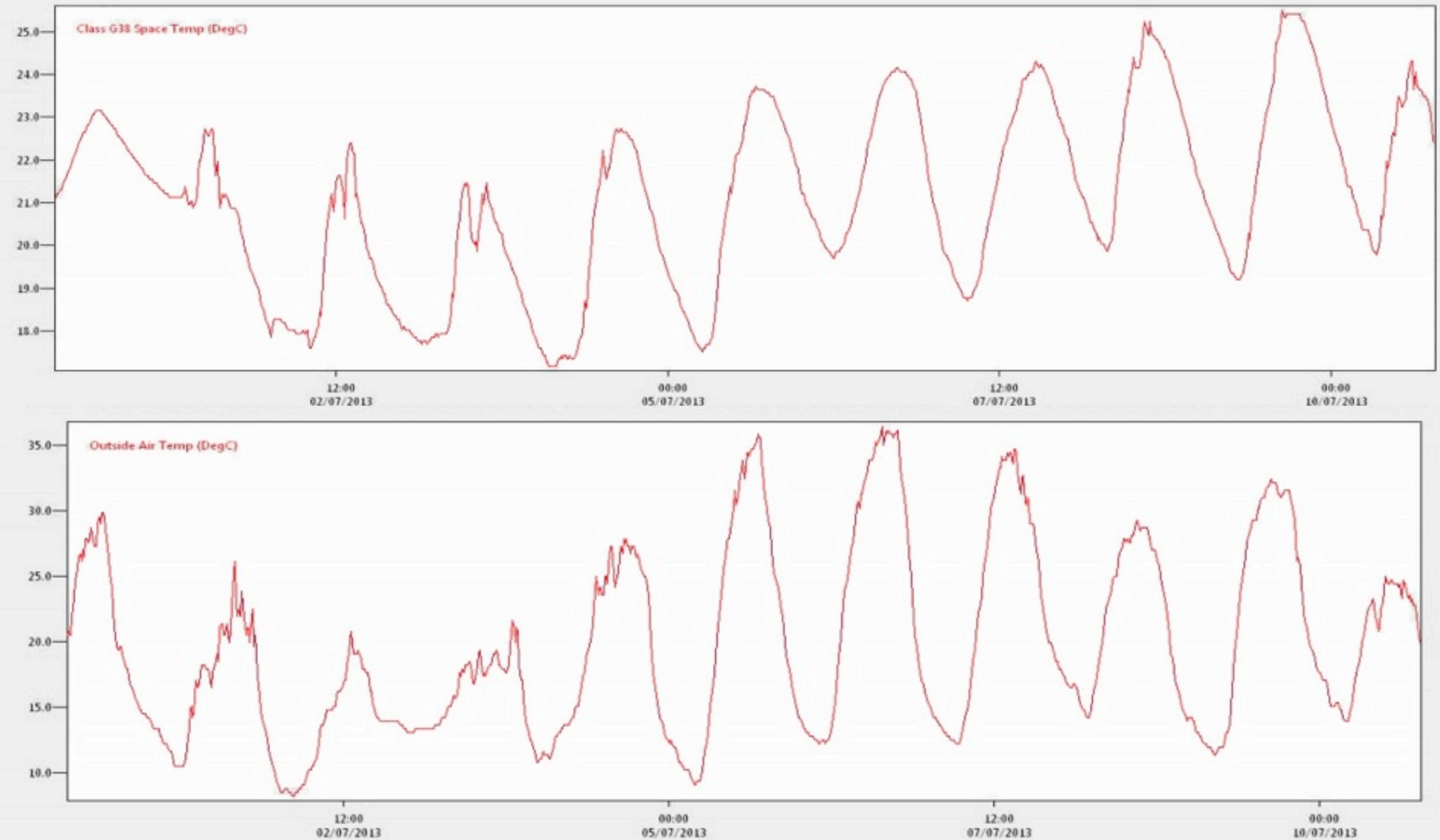
- Optimised by 3D modelling
- Consideration of localised shade for whiteboard
- State of the art energy saving lighting controls


The Rainbow Fish

Comfort

- Good air quality
- Winter comfort
- Summer comfort
- Kitchen

South classroom



KiddyWatts

Internal Heat Gains

School	Children	TFA m^2	m^2/child
Bushbury Hill (UK)	240	1707	7.1
Oakmeadow (UK)	450	2205	4.9
Montgomery (UK)	446	2367	5.3
Swillington (UK)	240	1344	5.6
Wilkinson (UK)	459	2500	5.4
LH Hannover (D)	300	3507	11.7
Gronau (D)	336	2953	8.8
Reidberg (D)	500	5540	11.1

Average for UK examples 5.7 m^2/child

Average for German examples 10.5 m^2/child

Difference +**1.32W/m^2** → + 5-6 kWh/(m^2.a) of useful heating


2 x 65kW boilers
25kW peak heat demand
5x oversized!

2,200m² school


before
200mm
after

German Primary School


Nester aus

Lessons learnt: school kitchens

Use of induction hobs and low energy appliances to reduce surplus heat and primary energy

(These papers showed for instance that when cooking the heat lost to the kitchen from a gas hob is around 100% of the heat used, whereas the heat to the kitchen with an induction hob is only 25% of the useful heat. At idle the heat gain to the kitchen from some hobs, such as an iron range or gas left burning can actually be higher than when in use, but is close to zero for an induction hob.)

The model assumes a percentage of maximum cooking power, with around 15% radiant heat to the kitchen, and 15% convective heat extracted via the hood. 100% of other heat gains of lighting, refrigeration, occupants and hot cupboard go to the general kitchen area. (Note that a large fraction the cooking heat input is retained in the food and some goes to generating vapour in addition to convection.) Ventilation rate is also variable, from design maximum down to a minimum set by the fan characteristics. The air supply temperature of 12°C is considered the minimum for comfort below supply air terminals.

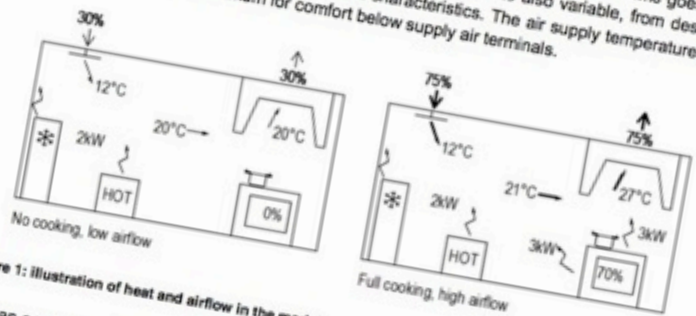


Figure 1: illustration of heat and airflow in the model

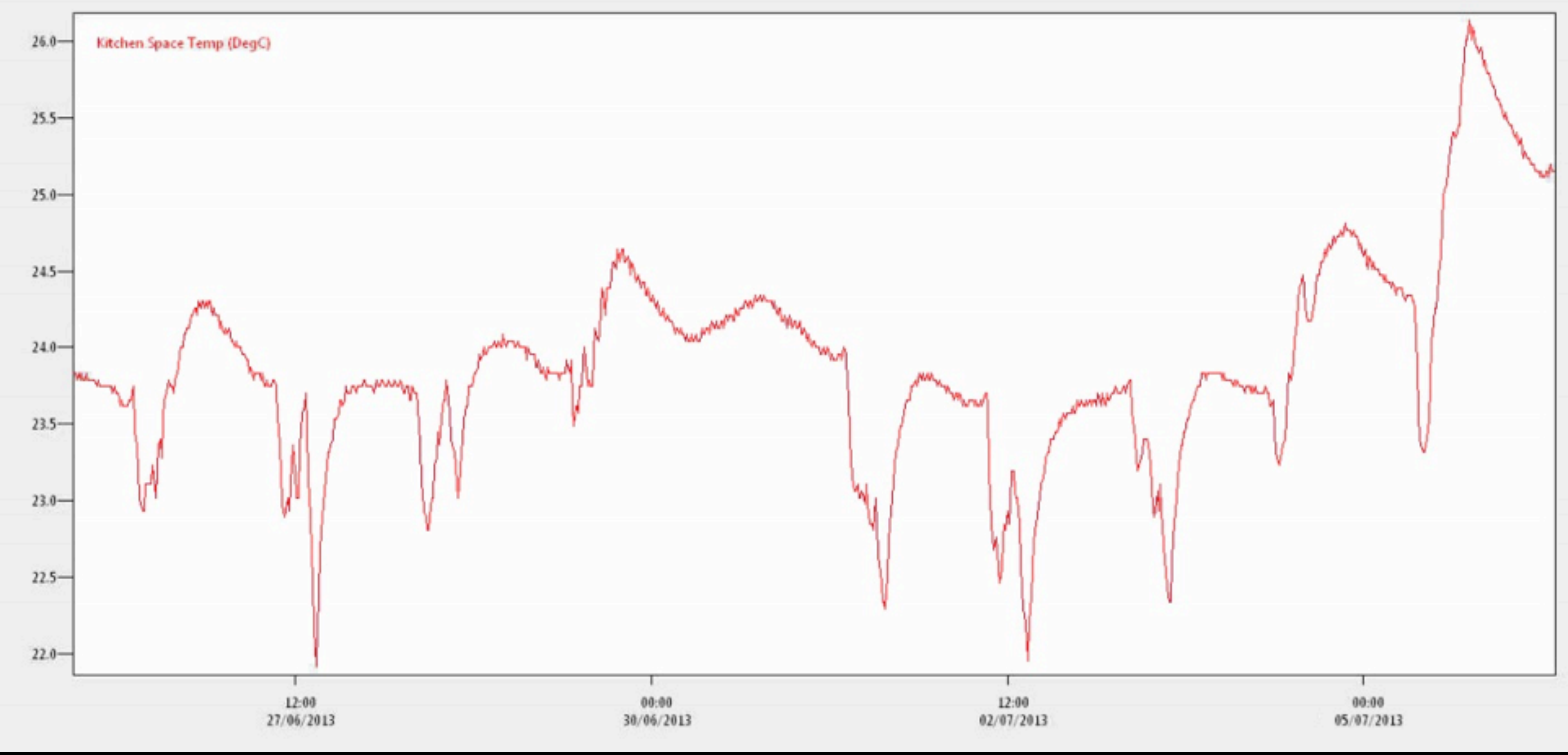
We can see that at full cooking load (70% diversity assumed for school kitchens) the gains to the kitchen are such that a 12°C supply air temperature will lead to comfortable working conditions, and with 20°C outside (summer mornings in Wolverhampton) and maximum airflow the room should be limited to 28°C – acceptable for kitchens. When there is no cooking a minimum ventilation flow rate of 50% leads to a requirement for supply temperature higher than 12°C, but not if air flowrate can be reduced to around 30%.

Space heating requirement

The level of building insulation in Passivhaus indicates there is no requirement for background heating in the kitchen so all heat input is via the supply air to maintain a minimum comfort temperature in the kitchen during use. The requirement for a minimum supply temperature of 12°C clearly indicates a requirement for heating as external daytime temperatures drop to -2°C here. However by establishing that we only need to heat the supply air to 12°C does mean the heat demand can be calculated for a much lower heating degree hours than for general space heating.

simple automatic control on temperature could be good for kitchen vent.

Kitchen comfort proven



Energy

- 1 year data
- issues with faulty gas meter (Bushbury)
- issues with incorrect calibration of BMS data collection
- over 1 year to get remote access to BMS
- electrical sub-metering does not follow the the specification

Measured Energy Performance

Oakmeadow Primary School

Figures are based on first year readings.

Gas (x 1.1 for PE):	
Space heating:	16kWh/(m^2.a)
Hot water:	11.5kWh/(m^2.a)
Electric (x 2.7 for PE):	
Lighting:	15kWh/(m^2.a)
Power & plant*:	21kWh/(m^2.a)
Kitchen:	6kWh/(m^2.a)
Sprinklers:	10kWh/(m^2.a)
Total primary energy:	182kWh/(m^2.a)

Comment:

Primary energy is significantly higher than the target 120 kWh/m^2. Sprinklers = 27kWh/(m^2.a) PE

Main success:

Kitchen energy & comfort

Main lessons:

Issues with automatic lighting controls and sprinkler ‘frost protection’ systems.

* MVHR left running in summer because of passive cooling problems.

Measured Energy Performance

Bushbury Primary School

Figures are based first year readings.

Gas(x 1.1 for PE):

Space heating*:	14kWh/(m^2.a)
Hot water*:	7kWh/(m^2.a)
Electric (x 2.7 for PE):	
Lighting:	12kWh/(m^2.a)
Power & plant**:	22kWh/(m^2.a)
Kitchen:	7kWh/(m^2.a)
Sprinklers:	14kWh/(m^2.a)
Total primary energy:	169kWh/(m^2.a)

Comment:

Again Primary energy is higher than the target 120 kWh/(m^2.a)

Sprinklers = 38kWh/(m^2.a) PE

Main success:

Kitchen energy & comfort

Main lessons:

Issues with automatic lighting controls and sprinkler systems.

* Provisional gas figures due to meter fault and missing reading.
** MVHR left running in summer because of passive cooling problem.

Wilkinson Ground floor plan

Classrooms clustered around two hub spaces, school also includes community use facilities

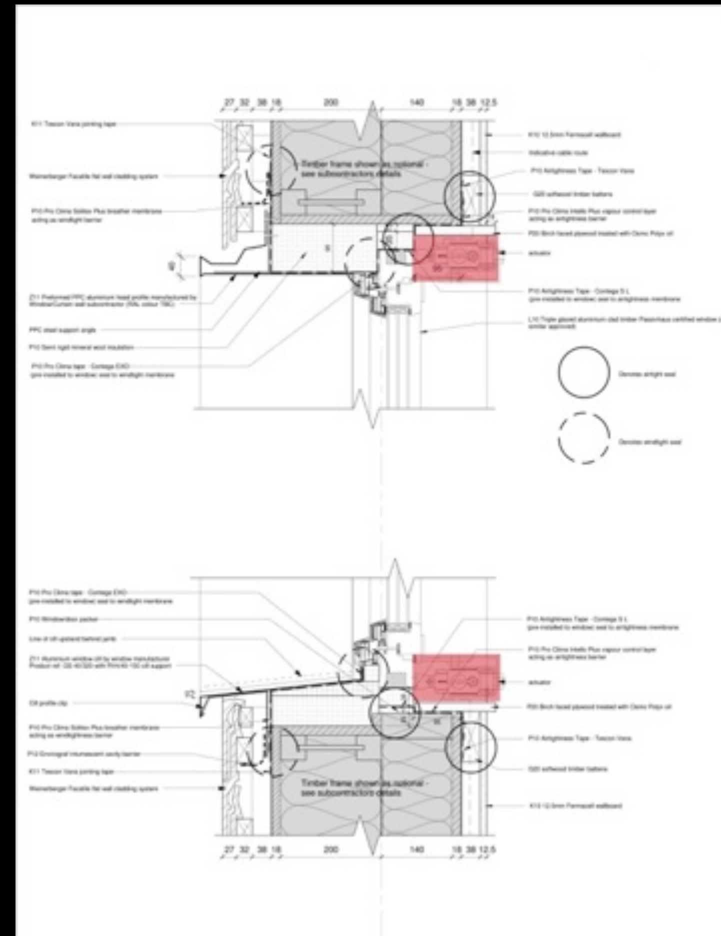
Wilkinson First floor plan

Natural light allowed to penetrate first floor via voids, MVHR externally located on roof

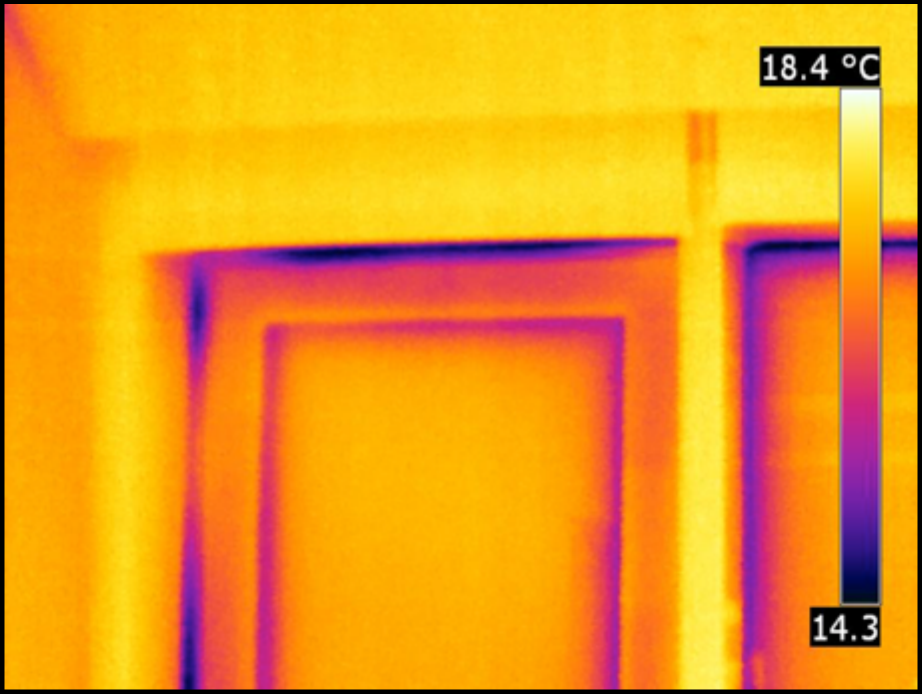
Key Lessons

- Get the basics right early on
- Keep it simple
- Have confidence in Passivhaus performance
- Be proactive with snagging

Windows/curtain walls

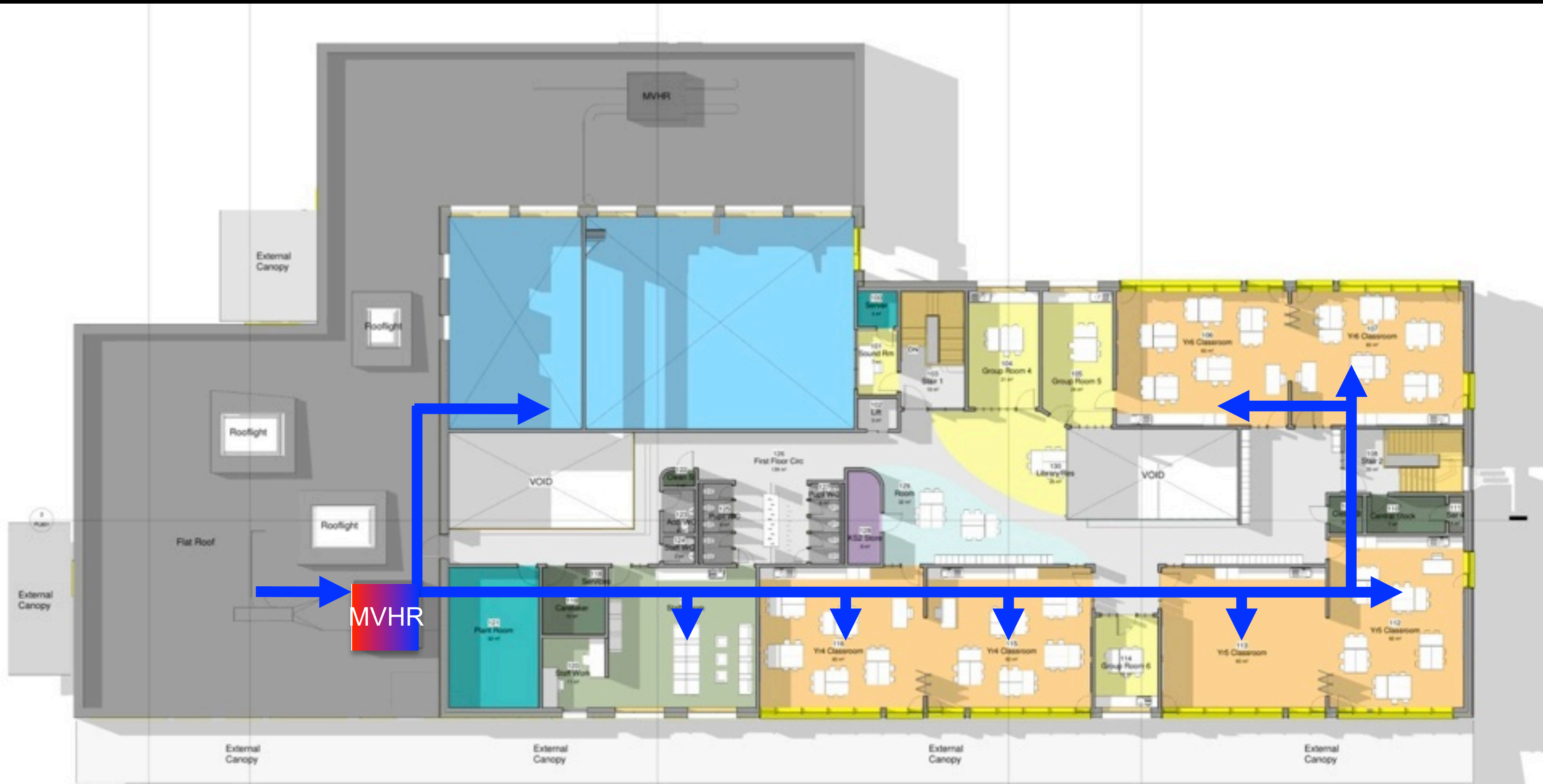


Improved operation of actuator by repositioning on window also reducing total number by increasing manual operated windows and night vents


18.4 °C
14.3


GOLD

Optimised MVHR ducts



Optimised MVHR ducts

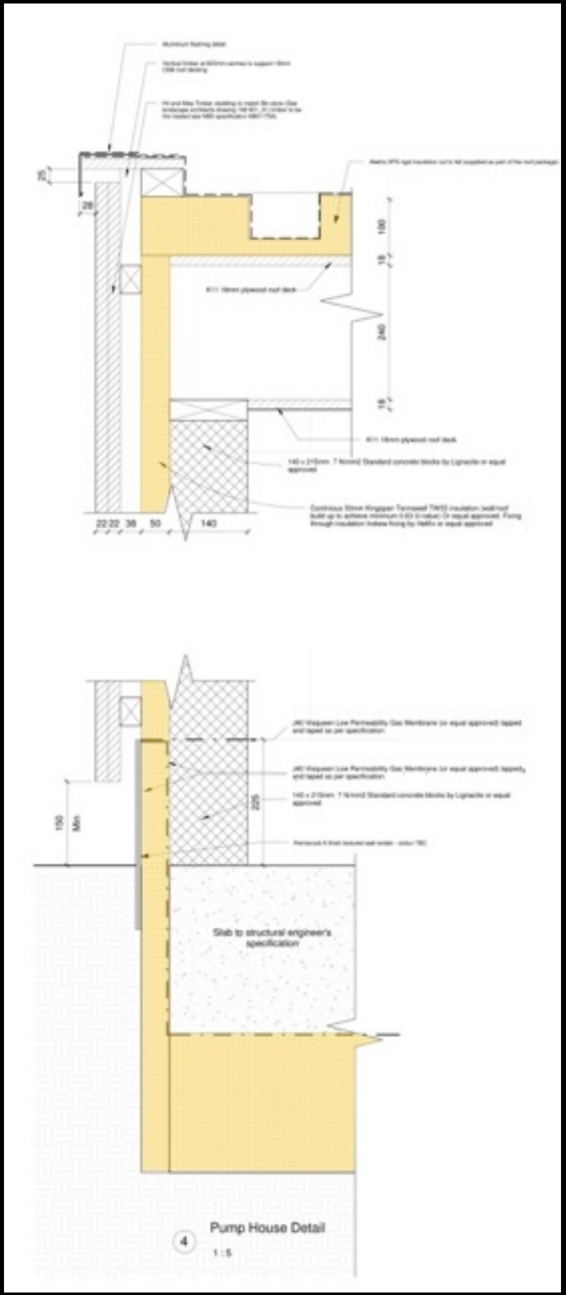
Air-tightness detailing

Design team, contractor & sub-contractors learn how to over come previous construction issues

Air-tightness detailing (cont..)

Contractor & sub-contractors pro-actively improve detailing

Sprinkler tank



Improvement on standard sprinkler tank housing by detailing highly insulated container

Thanks for listening

"We feel that our children are more alert and attentive in lessons due to the amount of daylight in classrooms and the fresh air throughout the school. The fact that the new school is built to passivhaus standards means that learning has been enhanced; our pupils love coming to school and enjoy their impressive surroundings. They are comfortable, secure and stimulated by their new environment; hence they learn very well!"

Sara Morris: Head Teacher, Oak Meadow Primary School