

Radically Reducing Operational Energy:



Innovation
Integrity,
Discovery

ARCHITYPE

London | Hereford | Edinburgh

Radically Reducing Operational Energy: Harris Academy Sutton



Christian Dimbleby
Associate at Architype;
Architect & Chartered Engineer

   @ArchitypeUK

ARCHITYPE/PERFORM+

Client: London Borough of Sutton

Contractor: Willmott Dixon

End user: Harris Academy

Budget: £38 million




Gross Internal Area: 10,625m²

1,275 pupils: Six form entry plus 6th form

Completed: September 2019

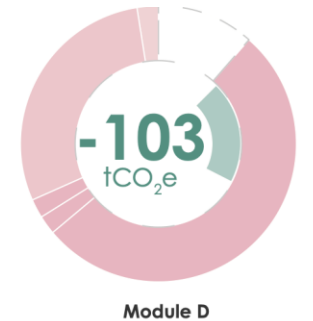
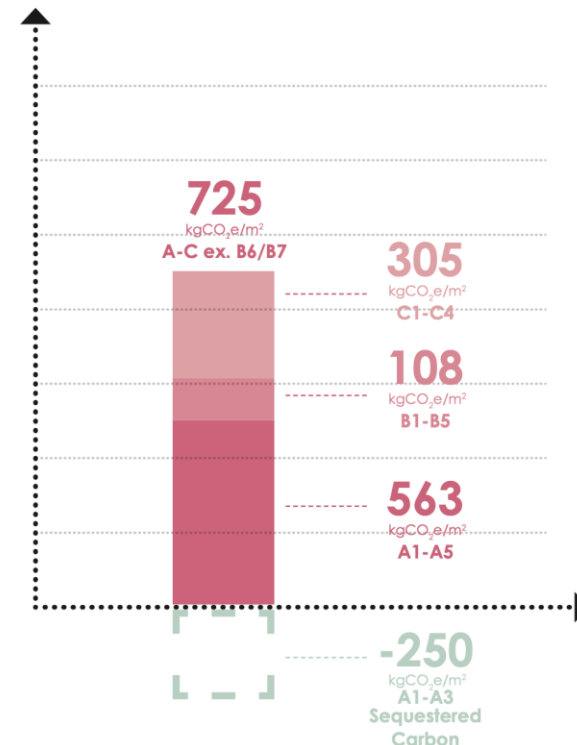
Status: First Passivhaus Secondary School in UK

RIBA 2030 Climate Challenge target metrics for non-domestic (new build schools)

RIBA Sustainable Outcome Metrics	Business as usual (new build, compliance approach)	2025 Targets	2030 Targets	Notes
Operational Energy kWh/m ² /y 	130 kWh/m ² /y	< 70 kWh/m ² /y	< 60 kWh/m ² /y 50.8 HARRIS	<p>Targets based on GIA. Figures include regulated & unregulated energy consumption irrespective of source (grid/renewables).</p> <p>Refer to Department for Education Output Specifications for schools: 2025: Primary <55 kWh/m²/y, 2030: Primary <45 kWh/m²/y</p> <ol style="list-style-type: none"> 1. Use a 'Fabric First' approach 2. Minimise energy demand. Use efficient services and low carbon heat 3. Maximise onsite renewables
Embodied Carbon kgCO ₂ e/m ² 	1400 kgCO ₂ e/m ²	< 675 kgCO ₂ e/m ²	< 540 kgCO ₂ e/m ² 725 HARRIS	<p>Use RICS Whole Life Carbon (modules A1-A5, B1-B5, C1-C4 incl sequestration). Analysis should include minimum of 95% of cost, include substructure, superstructure, finishes, fixed FF&E, building services and associated refrigerant leakage.</p> <ol style="list-style-type: none"> 1. Whole Life Carbon Analysis 2. Use circular economy strategies 3. Minimise offsetting, use UK schemes (CCC) <p>BAU aligned with LETI band E; 2025 target aligned with LETI band C and 2030 target aligned with LETI band B.</p>
Portable Water Use m ³ /pupil/year 	4.5 m ³ /pupil/y	< 1.5 m ³ /pupil/y	< 0.5 m ³ /pupil/y 1.49 HARRIS	Refer to Department for Education Output Specifications for schools.

LETI

Embodied Carbon Case Studies Set 1



Operational energy estimation method:
PHPP at design stage

Building Performance Gap

- > 40% performance gap from design to occupation
(CIBSE Carbon Bites)
- > Uncomfortable and inadequate environments
- > Difficult to control systems



“Building Systems are being oversized...

Meaning projects cost more to build and operate.

Oversizing is like an **ultra-runner** carrying a full camping backpack for a one-day race. It's not just unnecessary, but it also adds to the load, reducing the runner's efficiency and overall performance.”

Paul Paterson, Net Zero Carbon Leader

Less Equipment & Less Energy

Typical 6 form entry Secondary School Heating System



Harris Academy Secondary School Heating System:

2x 150 kW Boilers [one is Backup]





London Cancer Hub



Harris Academy
Sutton

Innovation
Gateway

Maggie's
Centre Garden

Passivhaus for a secondary school



Classrooms



Sports hall



Science laboratory



DT workshop



Canteen

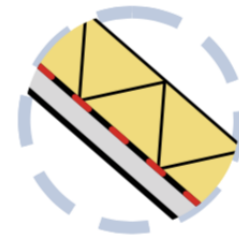


Assembly hall/ performance space

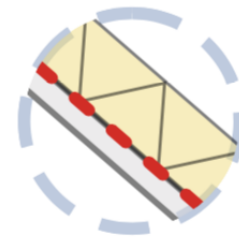
New Energy Efficient Buildings – Passivhaus



Form and Orientation



Continuous Super Insulation



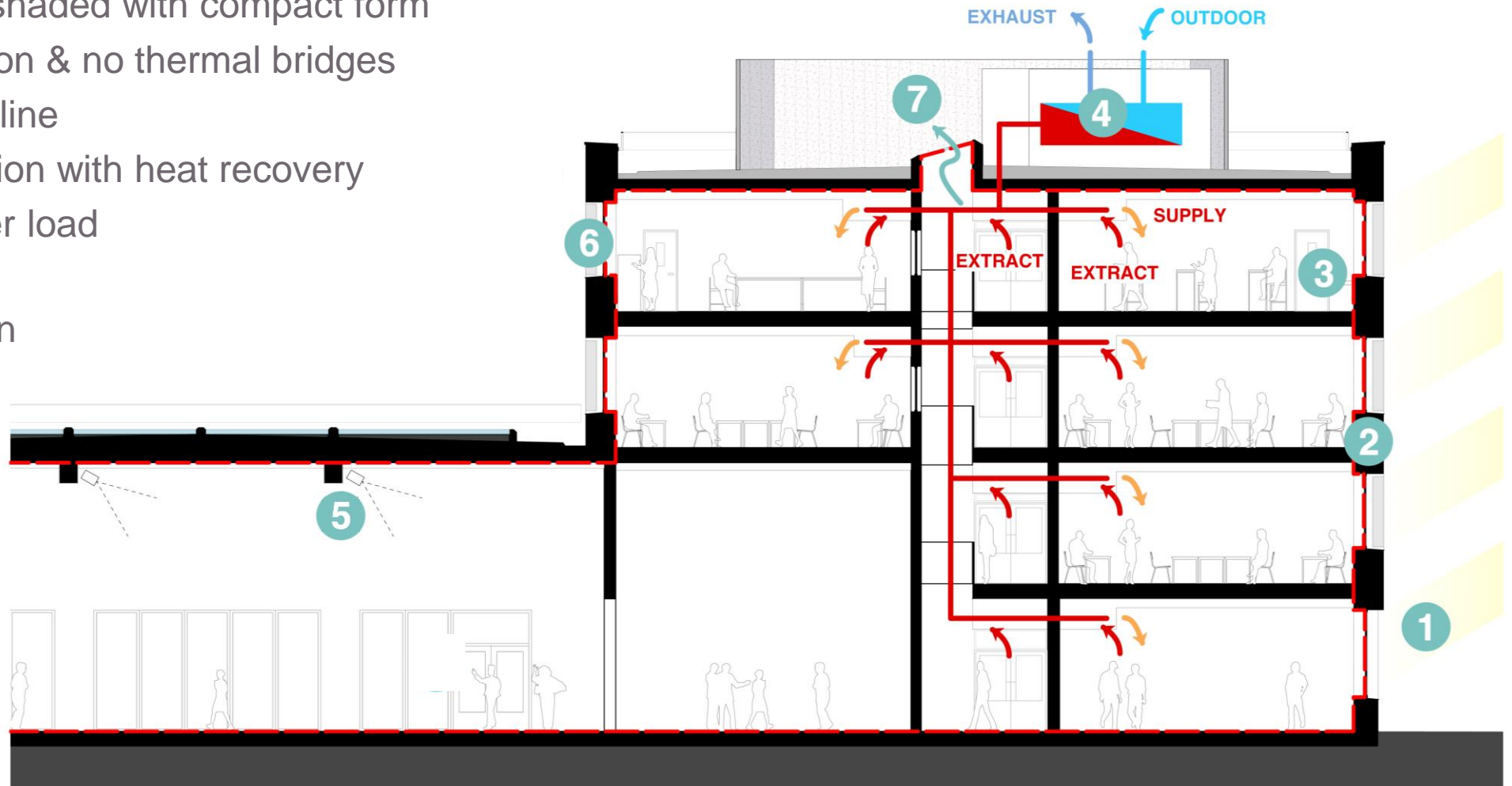
Draft Free Construction



Efficient Services

Passivhaus strategies to minimise energy

1. Solar orientated & shaded with compact form
2. Continuous insulation & no thermal bridges
3. Continuous airtight line
4. Mechanical ventilation with heat recovery
5. Reduce small power load
6. Triple glazing
7. Natural ventilation in temperate months



Design with nature at heart - Biophilia

Through the use of bringing in nature and greenery to the building it should reduce stress and increase wellbeing to all users of the building.



Natural non-toxic materials

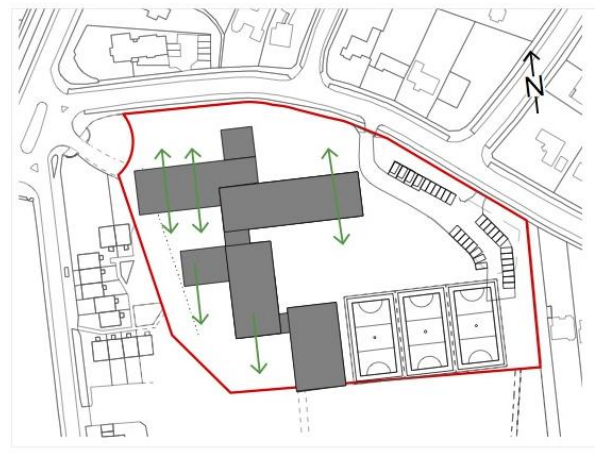
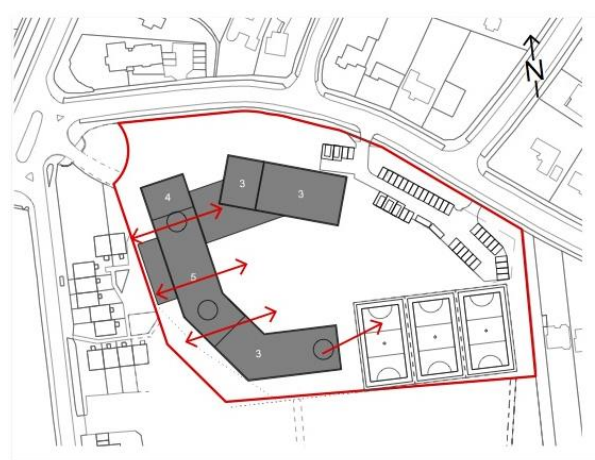


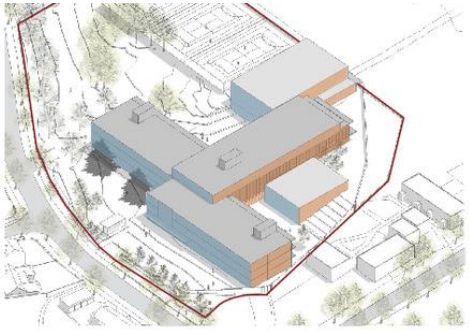
“It really is a spectacular learning environment where our students will thrive academically and develop long-life interests and talents...

A building which delivers, not only on quality and looks, but also on environmental targets...

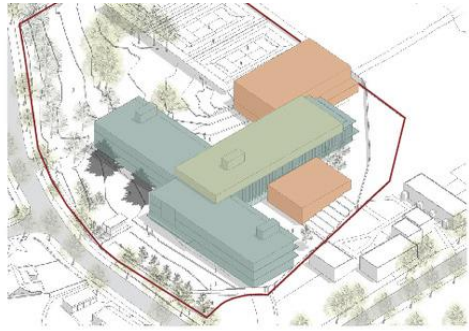
Our new school provides an inspiring new space for students and teachers alike”

James Fisher, Headteacher, Harris Academy Sutton

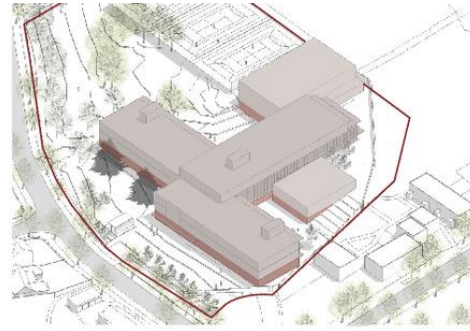




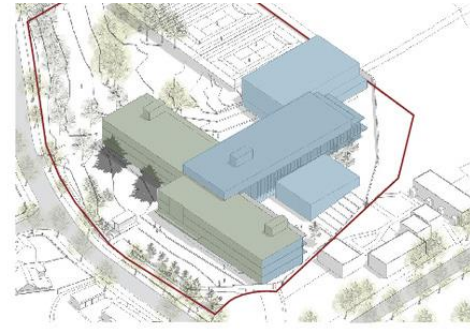
ORIENTATION & SHADING DEVICES



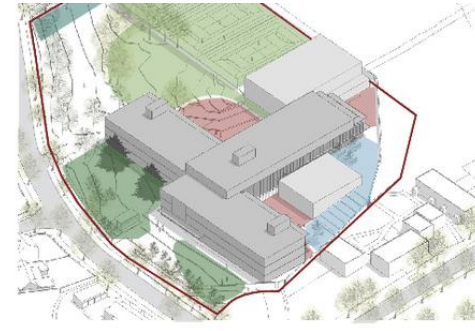
EXPRESSION OF FORMS



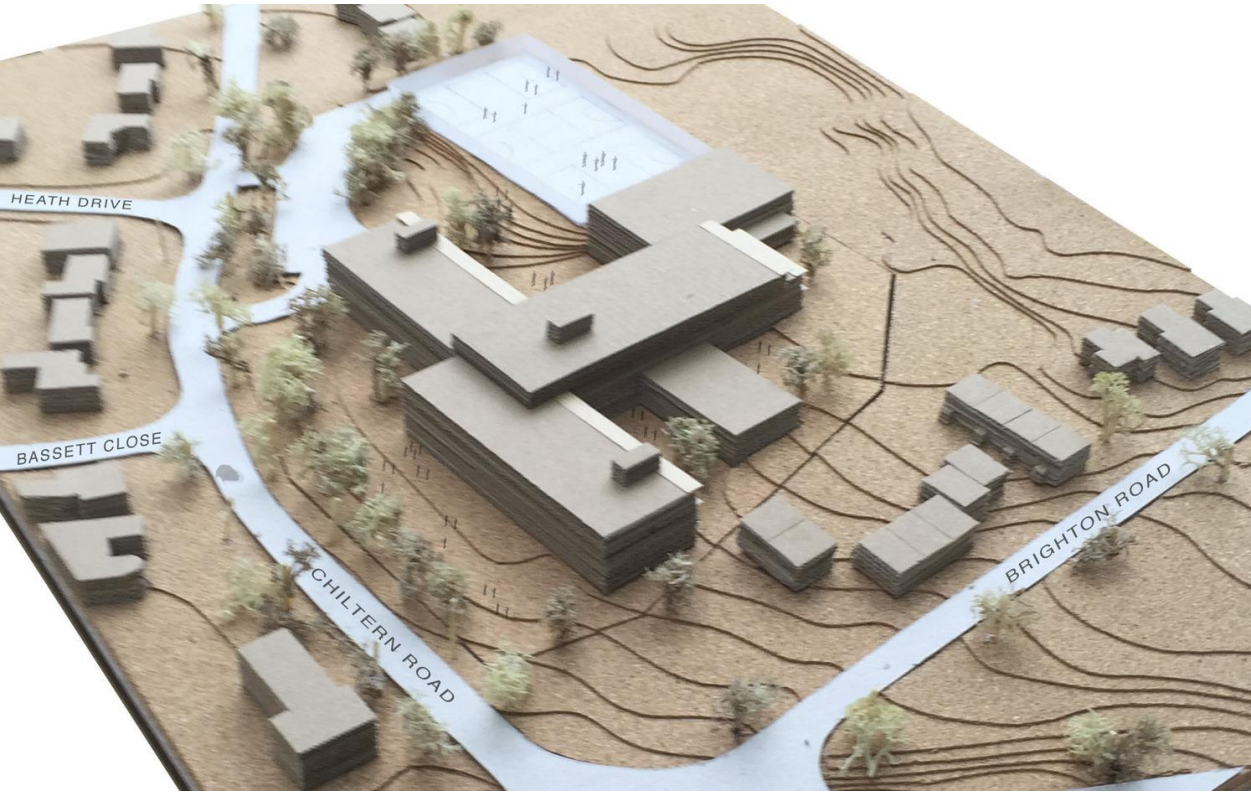
HEAVY & LIGHT



RELATING TO CONTEXT

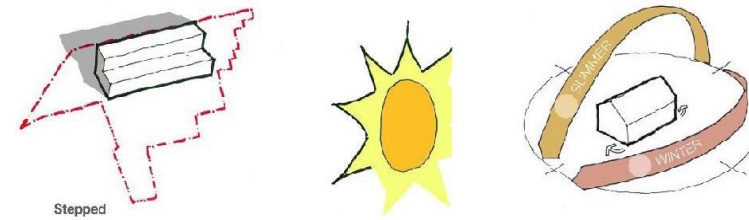


CHARACTER OF SPACES

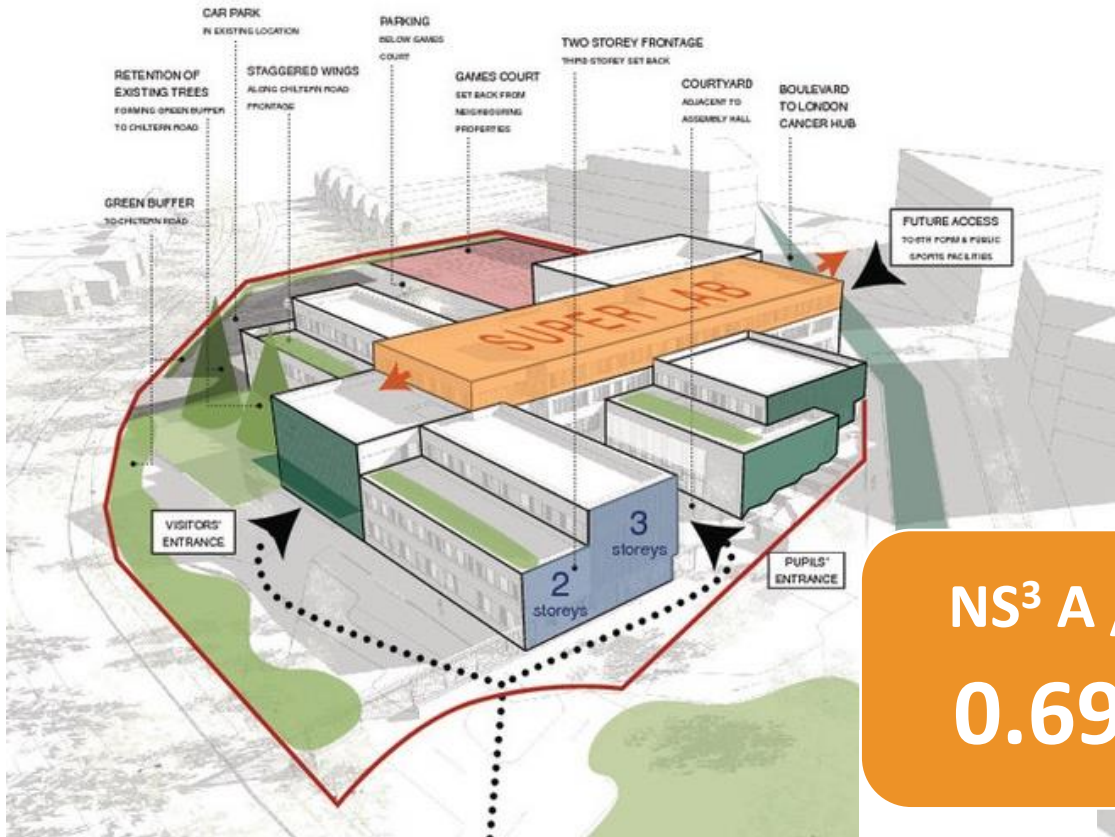


Orientation & Form

Relationship between surface area and volume of building has a major impact on its efficiency

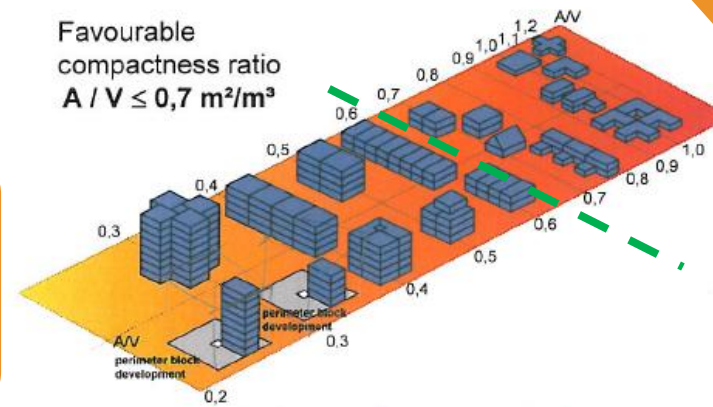


$$A / V \leq 0.7 \text{ m}^2/\text{m}^3$$



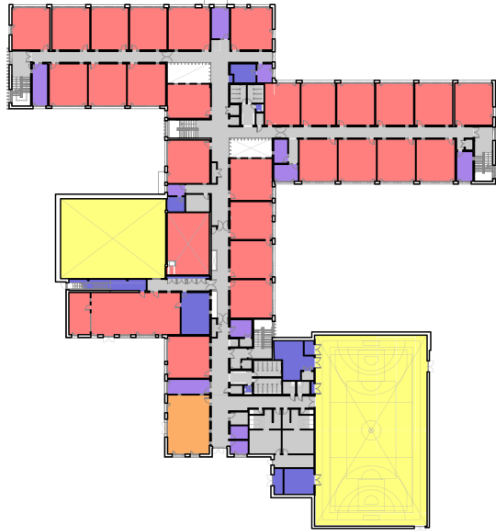
$$NS^3 A / V = 0.69 \text{ m}^2/\text{m}^3$$

Aim: Minimise surface area / volume

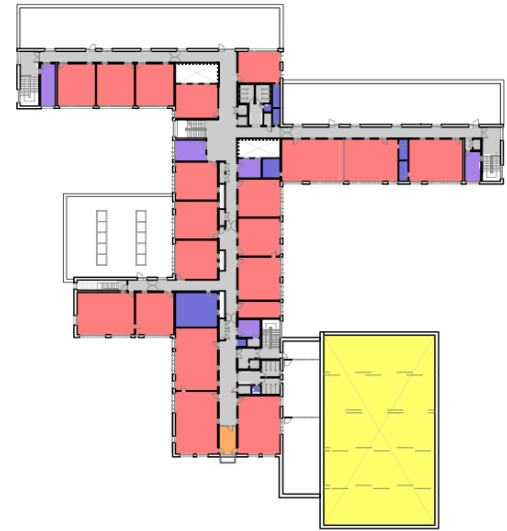




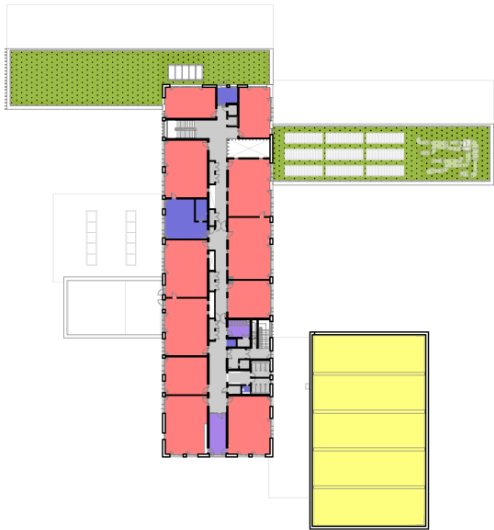
Ground Floor



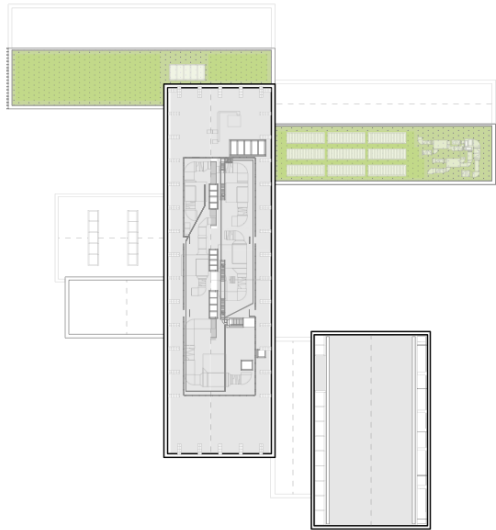
First Floor



Second Floor



Third Floor



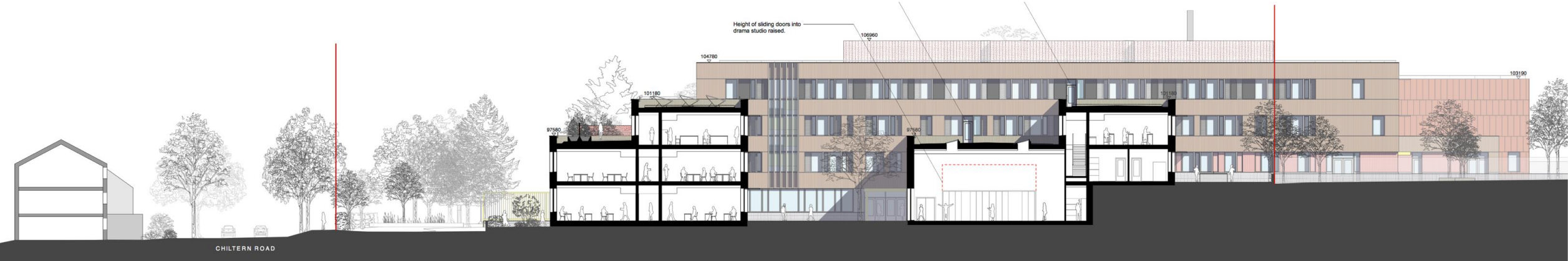
Roof Plan

KEY:

- Basic Teaching Area
- Large Space: Halls, Studios, Dining
- Learning Resource Areas
- Staff and Administration Areas
- Storage
- Circulation
- Void
- Green Roof
- Underground

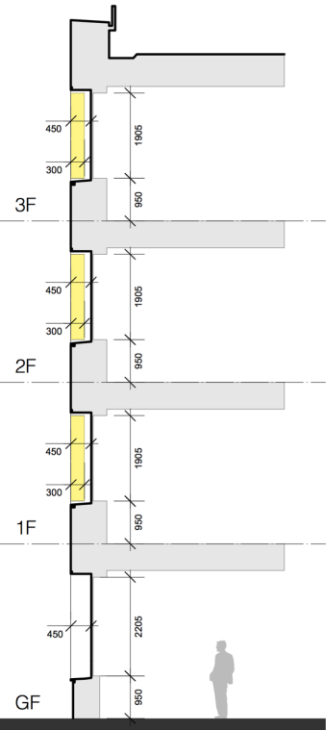
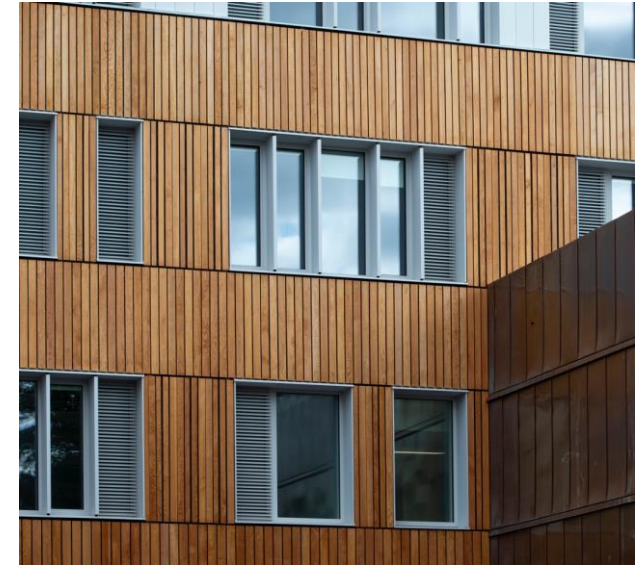
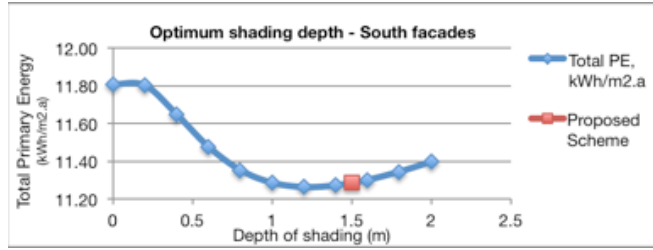


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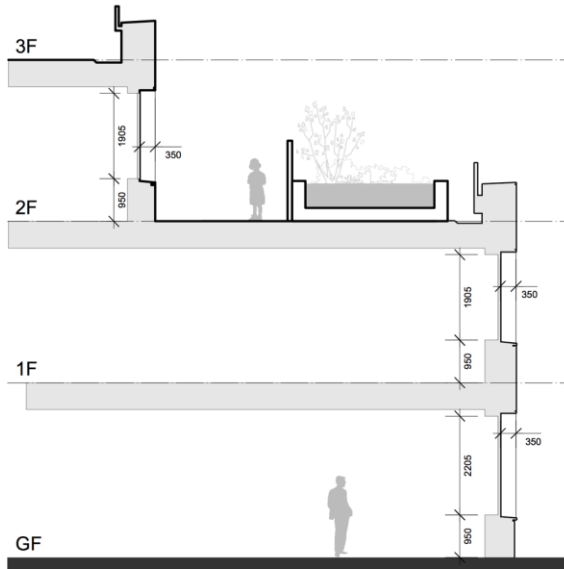


Daylight Design: Solar Gain & Shading

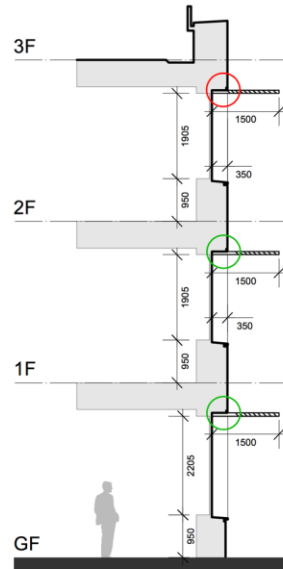
Right: Photos of East & West fins
 Middle: Brise Soleil Shading Calculation
 Below: Shading depths to façade
 Bottom Right: Brise Soleil installed



East & West Facade
 > Recessed glazing
 > Vertical Fins on mullion lines



North Facade
 > Recessed glazing



South Facade
 > Recess glazing
 > 1.5m horizontal brise-soleil









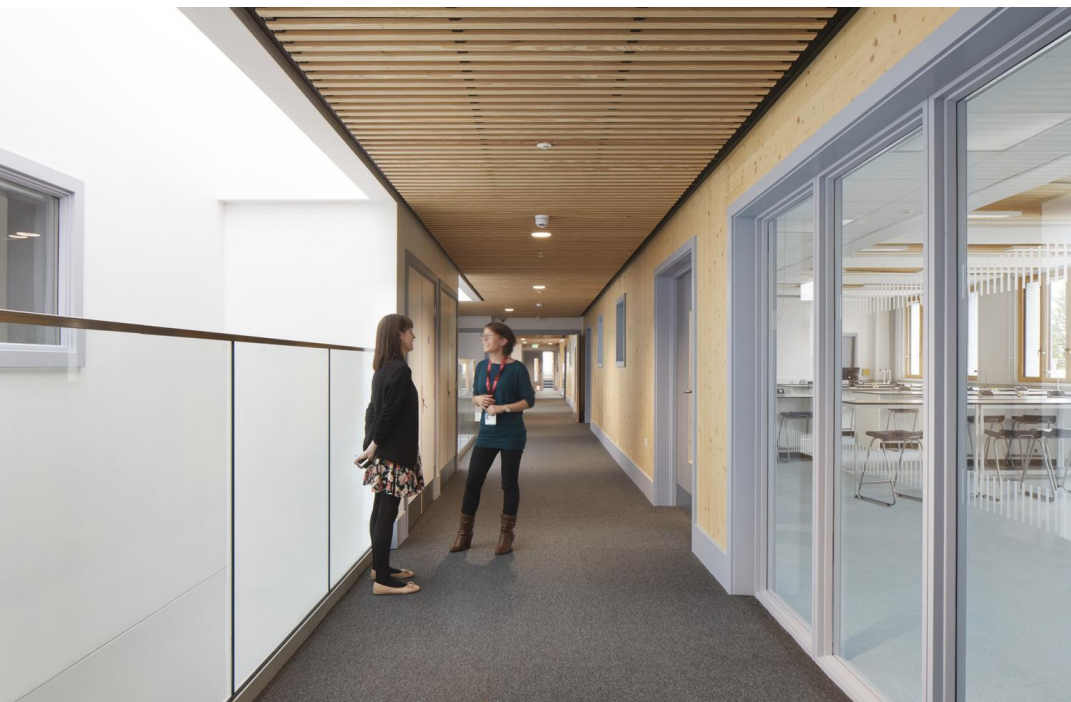


Easy to use

Classroom Guide Summer Daytime

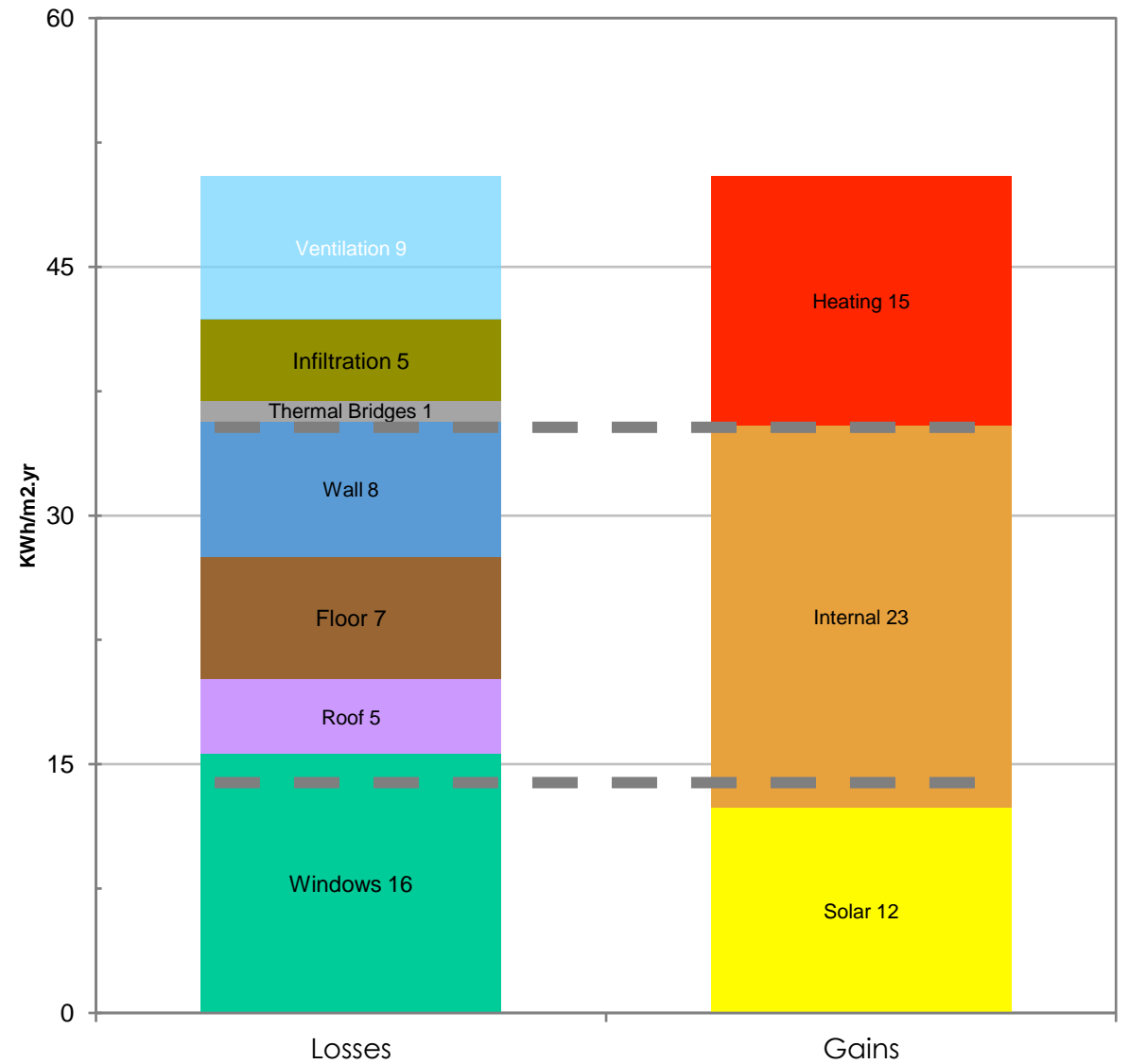
- Warm air escapes through the open ventilation panels.
- Warm air escapes through the grilles to the hub space.





Heating Balance

- Optimise window design: Gains balance losses.
- Optimise your ventilation to reduce heat loss.
- Focus on reducing small power demand in key areas.
- Do detailed calculations for actual equipment and occupants to determine exact internal heat gain.
- Match the external fabric losses to roughly internal gains.
- Then you can meet the Passivhaus requirements of Heating Demand $\leq 15\text{kWh/m}^2$

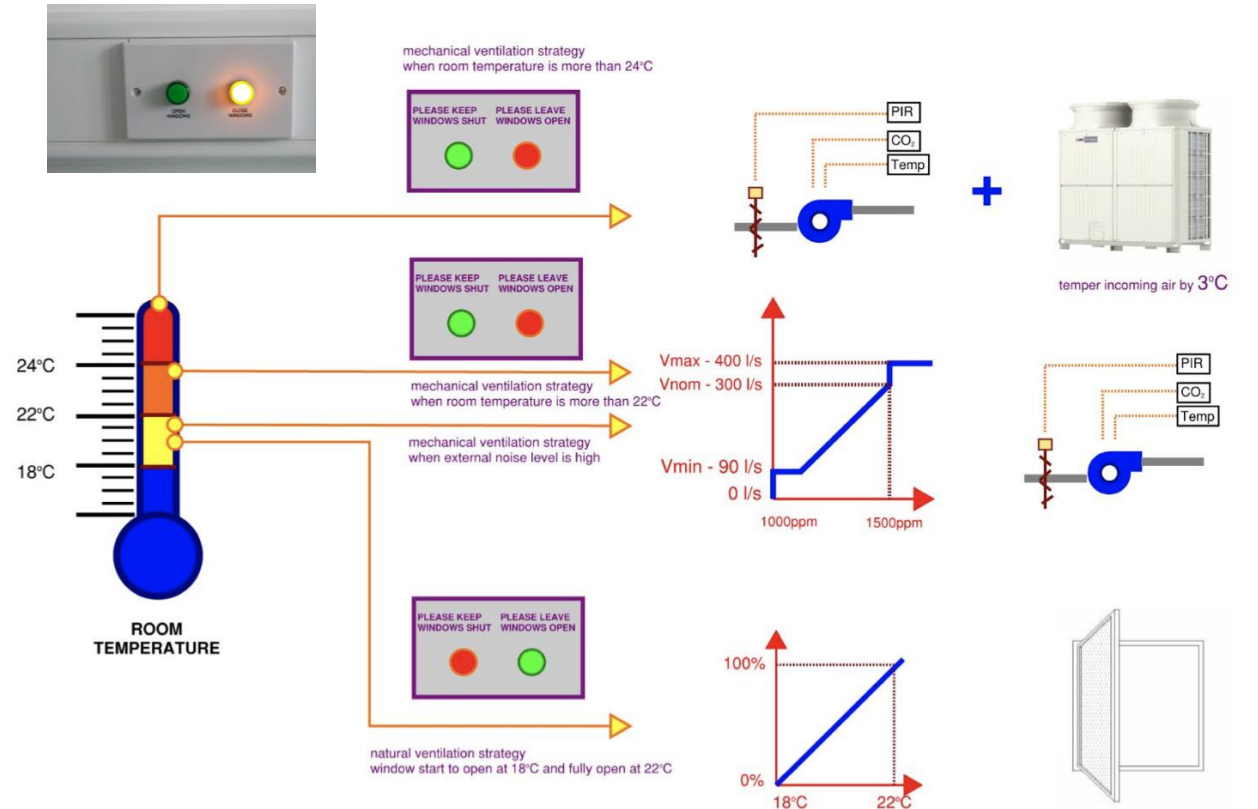
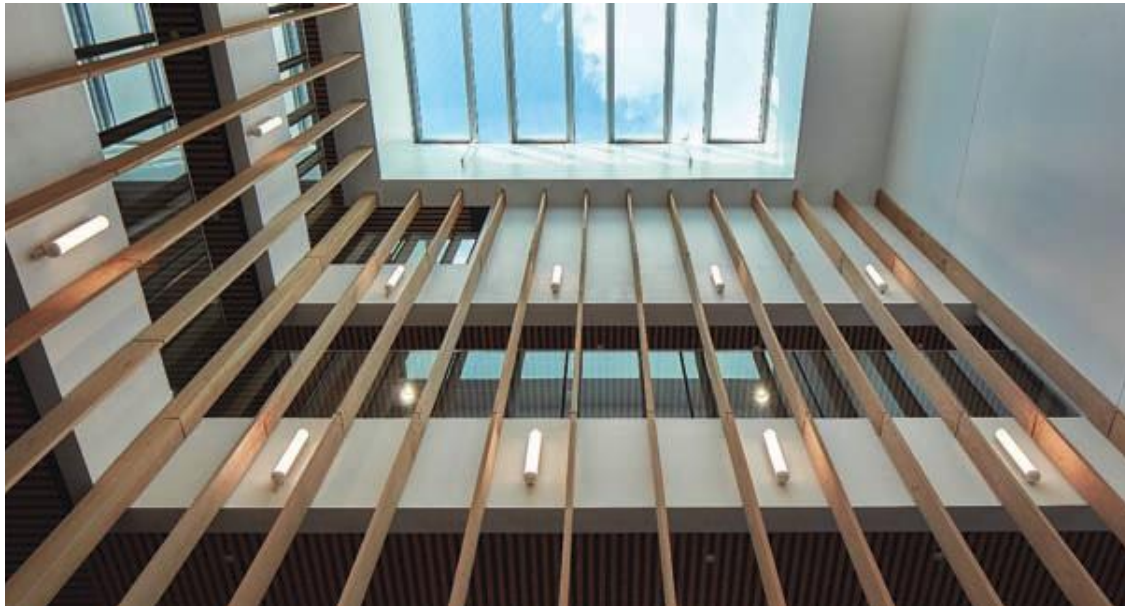


New Sutton Secondary School Heat Balance

Natural Ventilation Summer Cooling

The diagram below illustrates the overall control strategy for the mixed mode ventilation system proposed for the building, following the cooling hierarchy as below;

1. Natural ventilation
2. Mechanical ventilation
3. Mechanical ventilation + peak lop of 3 °C





“We’re delighted with the performance. As well as the energy and carbon being saved, we’ve had a lot of feedback about how comfortable the school is.

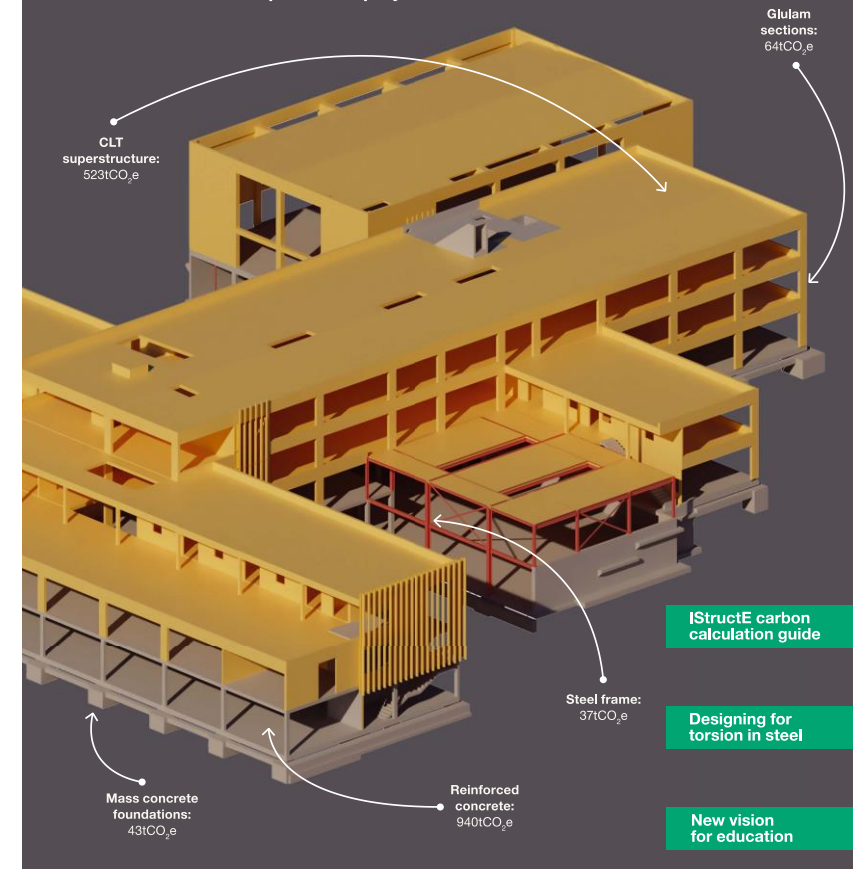
That was important to us because there’s been a lot of poor-quality school construction over the past two decades.... they’re either overheating, or too cold. It has a negative impact on children’s education, whereas we think the comfort of passive house will benefit them.”

Adam Whiteley, Senior Project Manager, LBoS



Carbon counts

How did Price & Myers set about building a carbon database for the practice's projects?



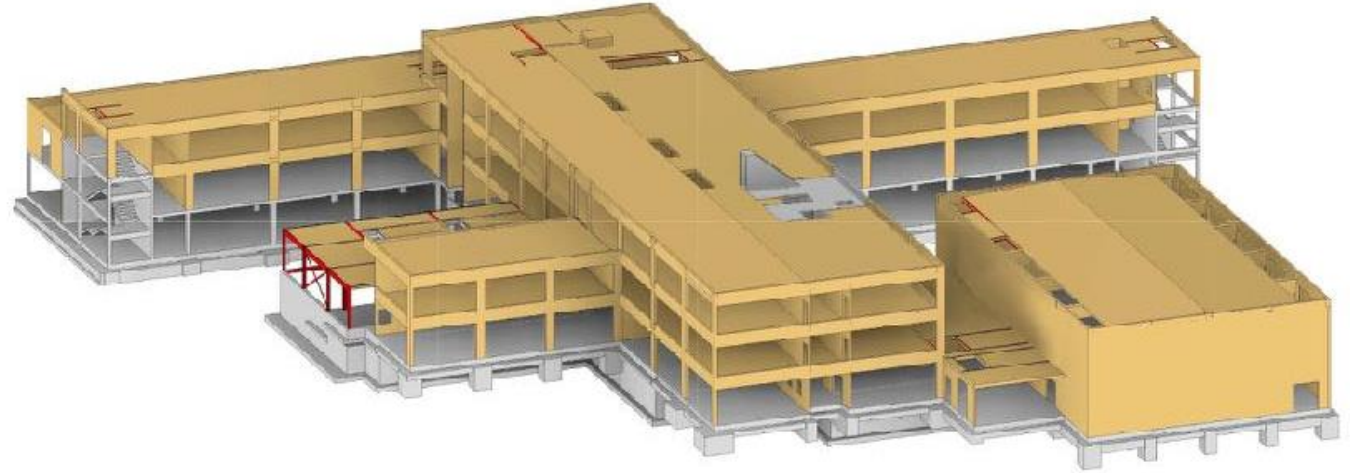


Structural Overview

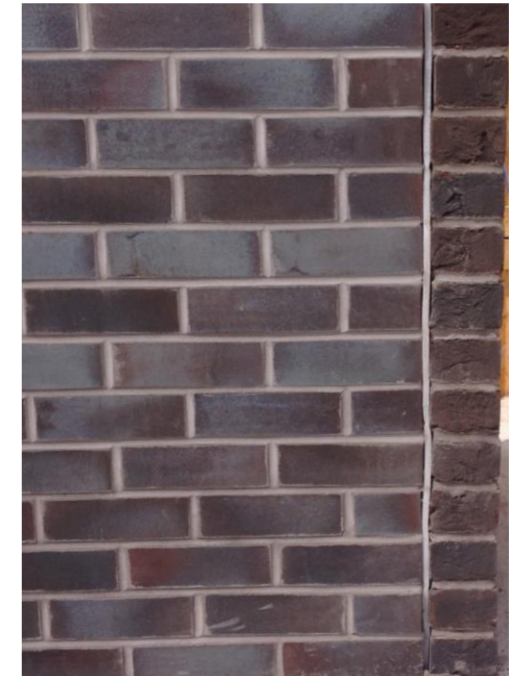
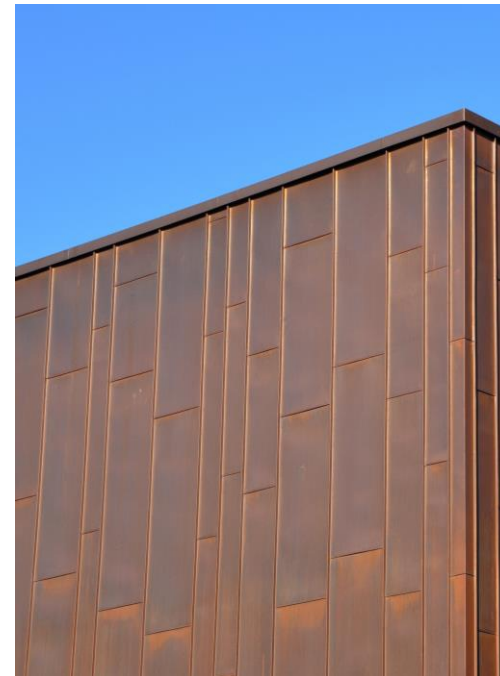
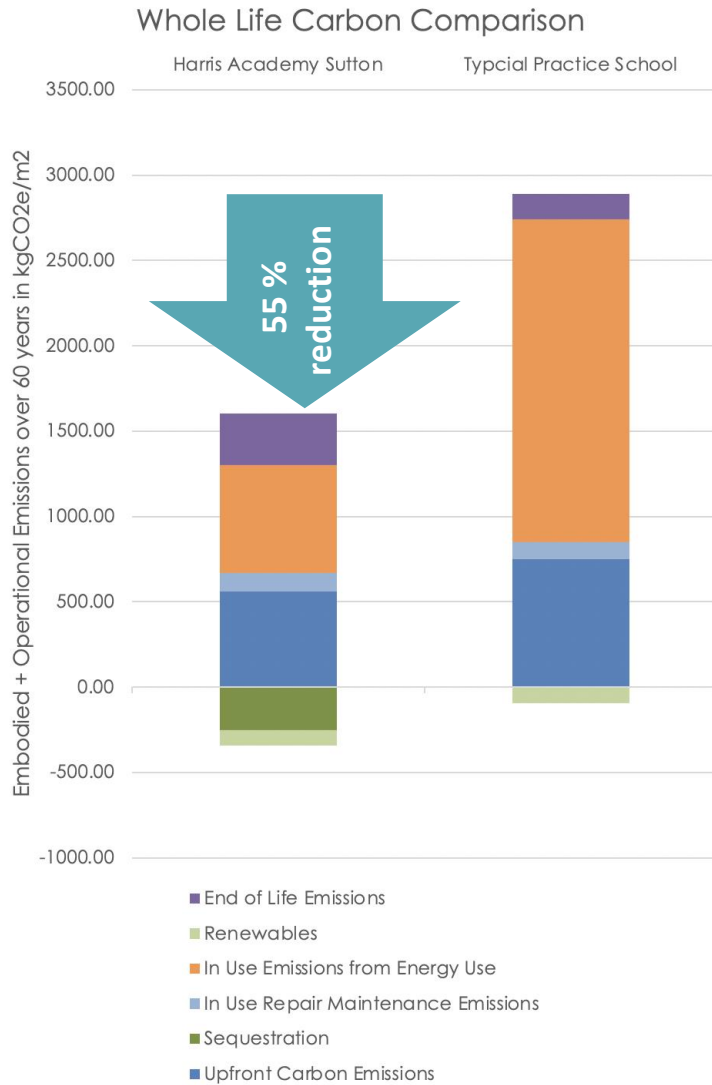
Ground & 1st floor slab, plus stair cores: Concrete (50% GGBS cement replacement)

Above ground: Cross Laminated Timber (CLT) walls and floor slabs, and Glulam external frame

Assembly hall walls: Steel columns



Materials















“We were learning about how eco-friendly the school is as we watched it being built. This is much less stuffy than our classrooms last year”

Year 8 student

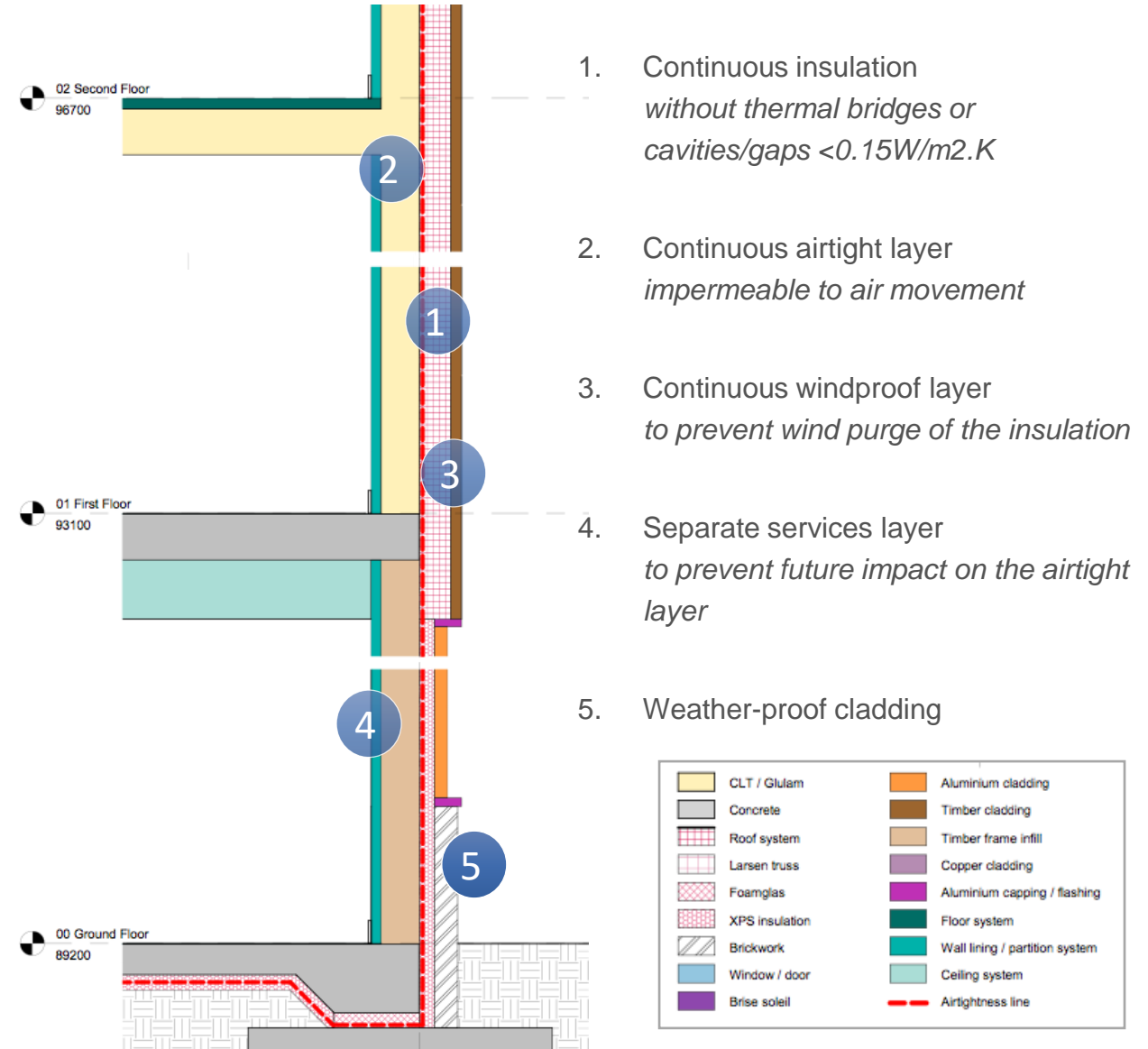
“My favourite places are the outdoor spaces and the bright classrooms”

Year 7 student

Get It Right On Site



Simply - High Performance



Skills, training & mock-ups

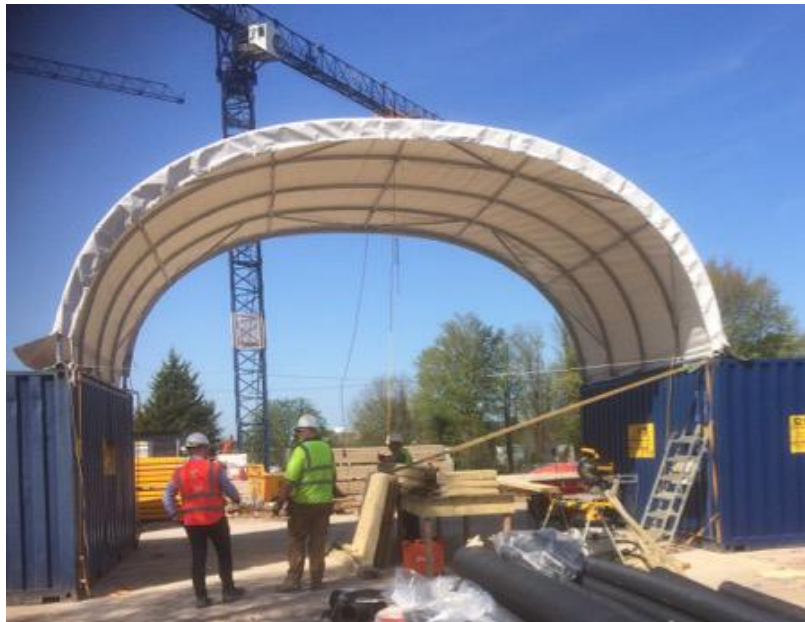


- Lessons learnt workshops
- Trades person training
- Passivhaus induction for operatives
- Setting the expectations on quality



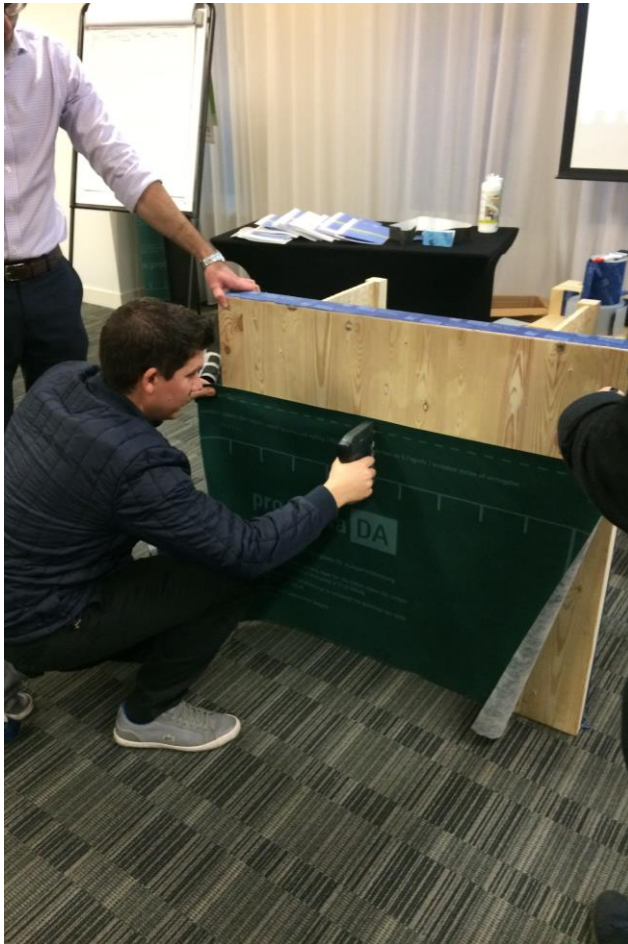
Prefabrication

- Prefabrication speeds up site activities
- Enhances quality which helps meeting Passivhaus requirements
- Flying factory used on site



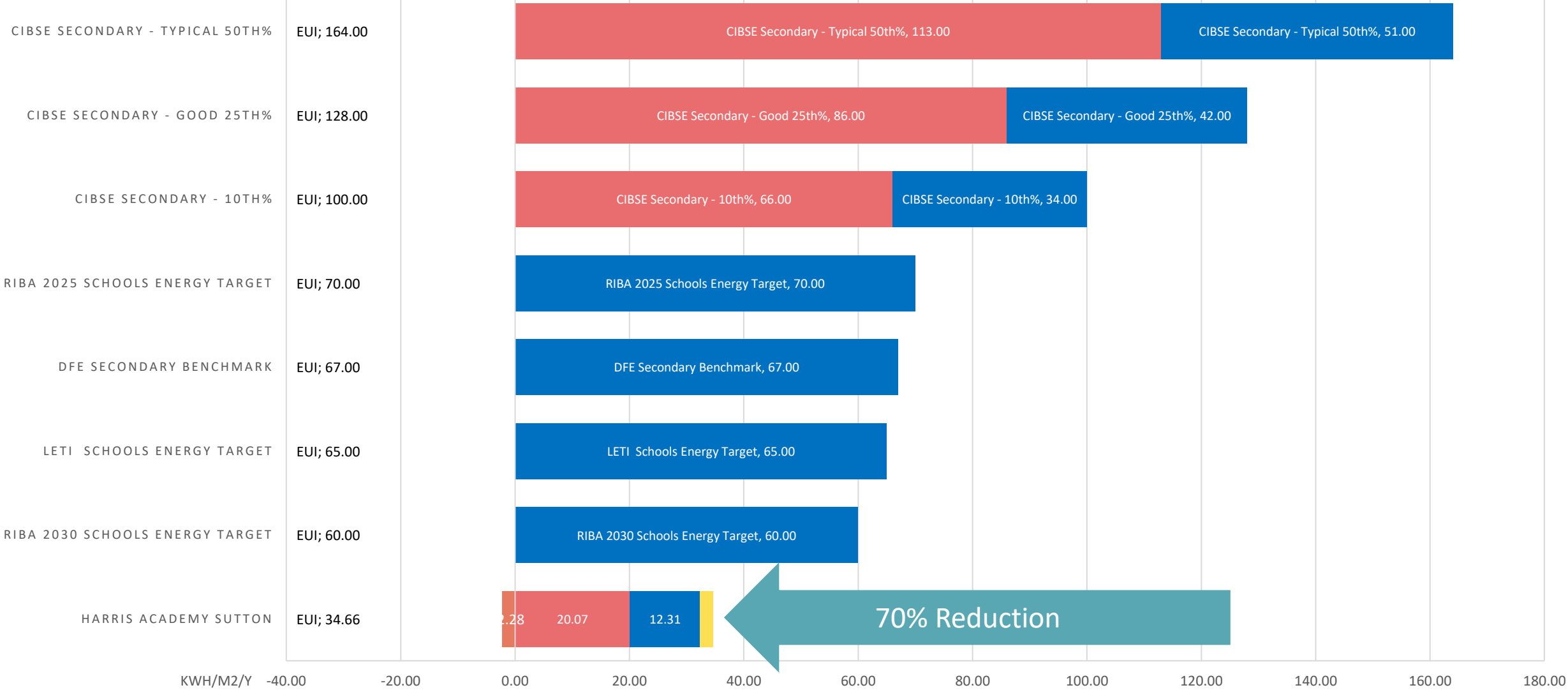
Quality Control - Airtightness

- Test - do early stage mock-ups off site
- Test - review first installation to check for quality and performance
- Test again - larger scale sectional air-tests



SECONDARY SCHOOL BENCHMARKS COMPARISON

ENERGY USE INTENSITY (EUI) IN KWH/M2/Y



Display energy certificate (DEC)

Harris Academy Sutton 2 Chiltern Road SUTTON SM2 5RD	Operational rating A	Certificate number: 2534-3212-6852-5398-9606
		Valid until: 29 September 2023
		Total useful floor area: 10746 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO₂) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.

Score	Operational rating	This building	Typical
0-25	A	22 A	
26-50	B		
51-75	C		
76-100	D		100
101-125	E		
126-150	F		
150+	G		

This building's energy use		
Energy use	Electricity	Other fuels
Annual energy use (kWh/m ² /year)	12.31	20.07
Typical energy use (kWh/m ² /year)	40	131.96
Energy from renewables	0%	0%

Previous operational ratings

Date	Operational rating
September 2022	22 A
September 2021	18 A

Total carbon dioxide (CO₂) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO₂.

Date	Electricity	Heating	Renewables
September 2022	73	42	0
September 2021	50	49	0

Assessment details

Assessor's name	Nick Taylor
Employer/Trading name	DEC Associates Ltd
Employer/Trading address	02380 982 472
Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	ECMK
Issue date	15 August 2022
Nominated date	30 September 2022

Harris Academy Sutton 2 Chiltern Road, SM2 5RD Sutton, United Kingdom/ Britain



Client	London Borough of Sutton 24 Denmark Road SM5 2JG Carshalton, United Kingdom/ Britain
Architect	Archtype Ltd 13 Mill Street SE1 2BH London, United Kingdom/ Britain
Building Services	CMB / DES / Jones King
Main Contractor	Willmott Dixon Suite 201 The Spirella Building, Bridge Road SG6 4ET Letchworth Garden City, United Kingdom
Energy Consultant	Archtype Ltd 13 Mill Street SE1 2BH London, United Kingdom/ Britain

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the 'Passive House Classic' standard:

Building quality		This building	Criteria	Alternative criteria
Heating	Heating demand [kWh/(m ² a)]	15	≤ 15	-
	Heating load [W/m ²]	9	≤ -	10
Cooling	Cooling + dehumidification demand [kWh/(m ² a)]	0	≤ 15	15
	Cooling load [W/m ²]	0	≤ -	11
Airtightness	Pressurization test result (n ₅₀) [1/h]	0.3	≤ 0.6	-
Non-renewable primary energy (PE)				
	PE demand [kWh/(m ² a)]	120	≤ 120	-

The associated certification booklet contains more characteristic values for this building.

Plymouth, 17 December 2021

Certifier: Sally Godber, WARM: Low Energy Building Practice

You have Passivhaus!
You have a radically lower energy building!



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Photo Credit: Jack Hobhouse / Architype