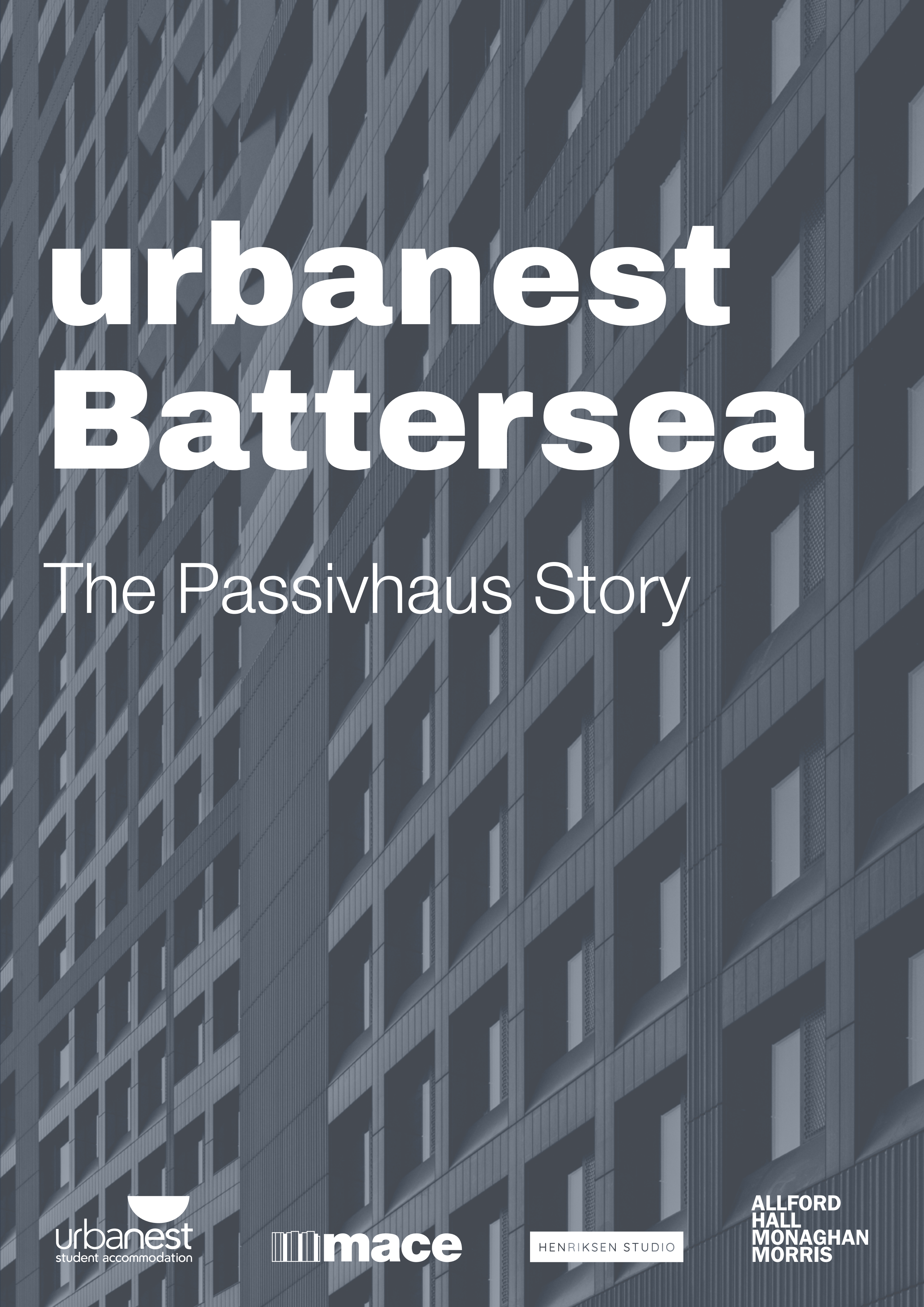

urbanest Battersea

The Passivhaus Story

urbanest
student accommodation

mace

HENRIKSEN STUDIO

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MONAGHAN
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The Passivhaus Story

ALLFORD HALL MONAGHAN MORRIS

Morelands
5-23 Old Street
London EC1V 9HL
T +44 (0)20 7251 5261
www.ahmm.co.uk
www.ahmm.co.uk/profile/sustainability

Certified Passivhaus
Passivhaus Institut
| classic | plus | premium |

Prepared by the urbanest Battersea architectural team at AHMM - Flora Genel, Kate Prudence, Tamara Baresic, Laura Gonzalez Mezquita, Joanne Chen, Rita Silva, Jane Ashe, Urim Islami, Freddy Douglas, Zipu Zhu, James Santer, and Simon Allford and Ege Savran of AHMM's Sustainability Team - on behalf of AHMM, Henriksen Studio, Mace Construct, and urbanest.

Photography credits: Tim Soar, Rob Parrish, and James Santer, with drone imagery by Rot8 UAVs.

We would like to thank urbanest for the use of urbanest Battersea as a case study, and the wider project team for providing access to their analysis. We also acknowledge the following contributors: Craig Robertson (AHMM), Ella Smith (AHMM), Katharine Storr (AHMM), Warren Stanley (Henriksen Studio), Thomas Henriksen (Henriksen Studio), and Katie Mann (Mace Construct).

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V 1.0
Apr 2026

General Information

Sector Student accommodation and commercial
Location London, UK
Address Palmerston Way, Battersea, London SW8 4AJ
Start November 2019
Completion October 2024
Contract type Design and Build

Key PHPP values

Treated floor area 17,964 m^2
Airtightness n50 = 0.28 / h
Annual heating demand 13 kWh / (m^2a)
Heating load 9 W / m^2
PER demand 113 kWh / (m^2a)*
Generation of renewable energy 30 kWh / (m^2a) based on the projected area
Cooling load 9 W / m^2
Cooling and dehumidification demand 3 kWh / (m^2a)

*Project specific

Project Team

Client urbanest
Architect Allford Hall Monaghan Morris
Project Managers CAST
CDM Coordinator JLL then Priority Risk
Structural/Civil Engineer Walsh Group
Cost Consultant Cast Consultancy
MEP/Lift Engineer AECOM, Caldwell Consulting
Planning Consultant Newmark
Fire Engineer Jensen Hughes
Landscape Architect The Urbanists
Transport Consultant Caneparo Associates
Daylighting Consultant Point 2 Surveyors
Acoustic Consultant AECOM, RBA acoustics
Environmental Consultant AECOM, BPP
Access Consultant Buro Happold Engineering
Façade Consultant Henriksen Studio
Passivhaus Consultant Henriksen Studio
Main Contractor Mace Construct Group
Building Control Socotec
Wind Consultant RWDI

AHMM Team

Simon Allford, James Santer, Flora Genel, Kate Prudence, Laura Mezquita Gonzalez, Tamara Baresic, Rita Silva, Chelo Garcia, Michal Przychodzen, Benjamin Veyrac, Joanne Chen, Stefan Florescu, Marco Marcelletti, Urim Islami, Freddy Douglas, Giuseppe Conzo, Peter Shelton, Alex Woolgar, Martina Ferrarese, Michael Cradock

Graphics by Pablo Jorge

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Contents

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The Passivhaus Story

urbanest Battersea, developed for leading London student accommodation provider urbanest, is the largest built Passivhaus certified building in Europe.

urbanest Battersea

The Passivhaus Story

As the largest built Passivhaus certified building in Europe and the eighth largest in the world at the time of certification, this achievement reflects the exceptional collaboration and expertise of the core project team - developer urbanest, architect AHMM, general contractor Mace Construct and Passivhaus consultant Henriksen Studio.

Given the growing interest in Passivhaus high-rises, we have created this storybook to share our experience in designing to this rigorous standard. Intended as an engaging and accessible read for architects, it also welcomes anyone interested in high-performance, low-energy buildings that contribute to reducing operational carbon emissions in the built environment.

The report begins with an introduction to the Passivhaus standard and its critical role in meeting Net Zero targets by 2050.

It includes an analysis (specific to urbanest Battersea compared against two other AHMM projects) demonstrating how Passivhaus design reduces whole-life carbon by reducing operational energy demand. We then explore the unique challenges of applying Passivhaus principles to high-rise buildings. Using urbanest Battersea as a case study, we examine key issues such as thermal bridging, airtightness, and the complexities of scaling up Passivhaus strategies.

Further sections delve into essential considerations, including façade design, the benefits of early-stage design optimisation, airtightness monitoring and testing, and strategies for managing thermal bridges.

The report also highlights the importance of harnessing passive energy sources such as internal heat gains, and mechanical ventilation with heat recovery - an approach that enables up to 90% energy savings for space heating and cooling compared to typical building stock, and over 75% compared to typical new builds[1].

Finally, a Lessons Learnt chapter gathers insights from key team members, reflecting on the project's successes, challenges, and the path forward for future Passivhaus high-rises.

We hope this report inspires further innovation in sustainable, low-energy building design.

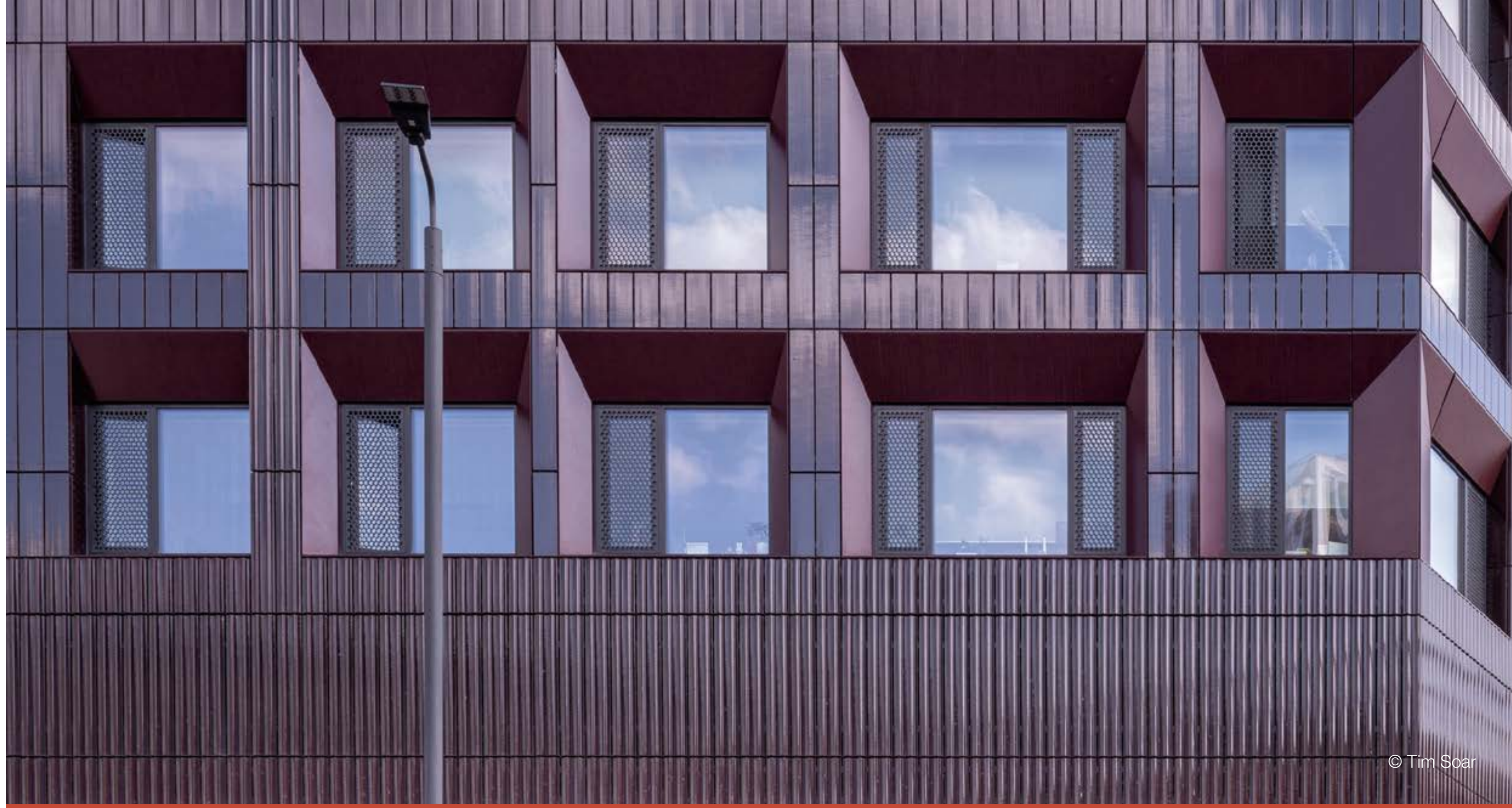
Foreword

We're delighted that urbanest Battersea has now achieved Passivhaus certification to become the largest Passivhaus building in the UK, setting the standard for sustainable student accommodation.

From the start, we wanted our Battersea development to be an exemplar for future projects not only in London, but in cities all over the world that need to respond to the net zero challenge.

This is just the beginning of our Passivhaus journey, and we look forward to continuing our work with the Passivhaus Institute to achieve accreditation at urbanest Canary Wharf, and all further urbanest schemes going forward.

Angus Kearin
Head of Development, urbanest



"urbanest Battersea stands as an industry-leading example of compelling architecture and sustainable construction, achieved through the combined expertise of urbanest, AHMM, Henriksen Studio, and Mace Construct.

Passivhaus certification highlights what's possible through collaborative ambition and a commitment to excellence; we are immensely proud of the result."

Simon Allford
Executive Director
Allford Hall Monaghan Morris

"This is a great achievement. Passivhaus accreditation is typically associated with smaller, private residential projects. urbanest Battersea, the largest building in the UK to achieve Passivhaus, not only demonstrates the potential for future applications on a much larger scale, but also showcases what can be done collectively to make our buildings more sustainable."

Ged Simmonds
Managing Director – Private Sector
Mace Construct

"At Henriksen Studio, we are proud to have brought our Passivhaus expertise and façade engineering experience to urbanest Battersea, a landmark project that sets new standards for sustainable student accommodation.

Collaborating with urbanest, a visionary partner, we delivered advanced façade and Passivhaus solutions to achieve exceptional energy efficiency and comfort at scale. This milestone highlights the power of innovation and collaboration in creating low-energy, high-performance buildings."

Dr Thomas Henriksen
Founder and Director
Henriksen Studio

Intro-duction

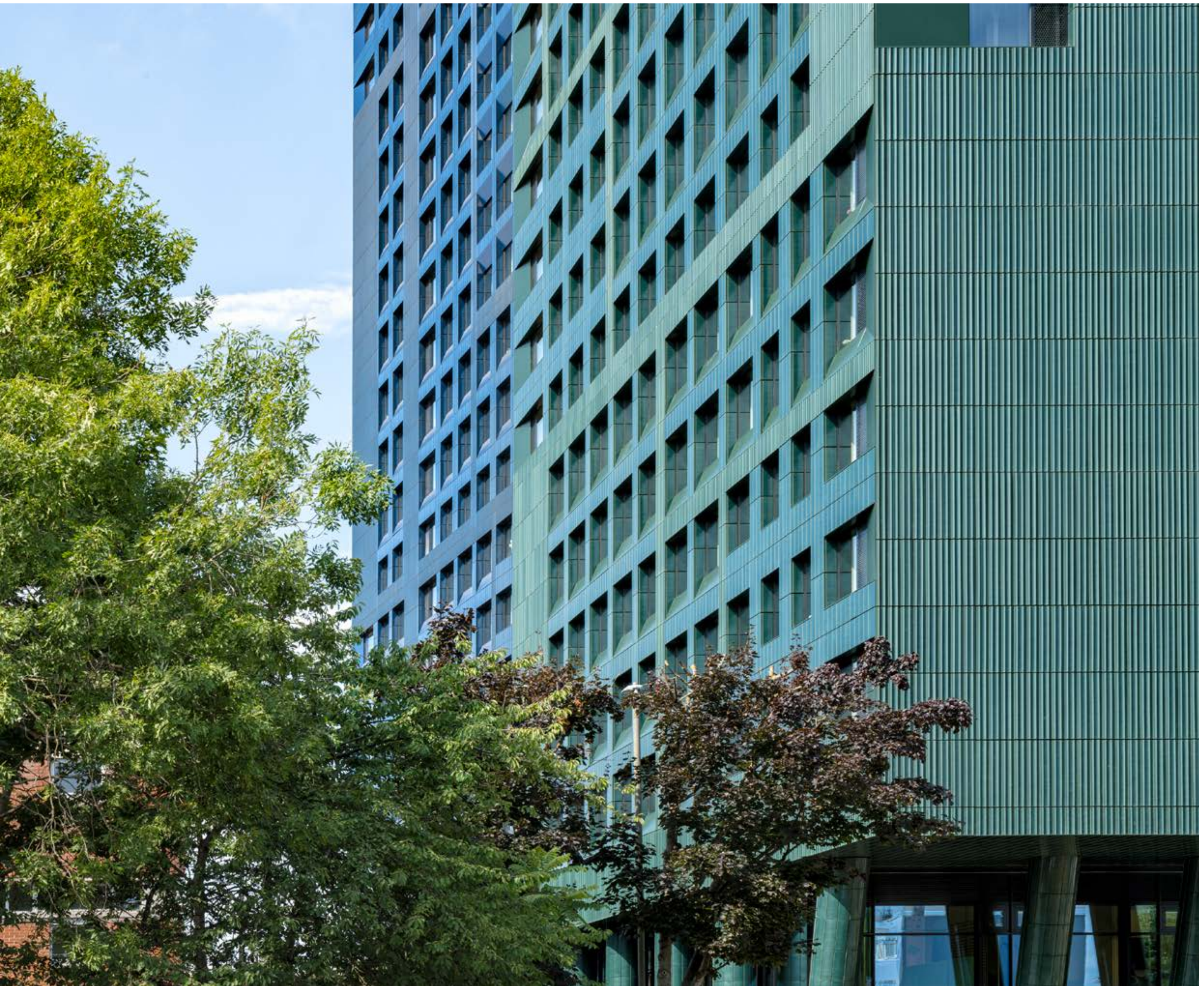
Passivhaus buildings have high insulation, high airtightness and ventilation with heat recovery to significantly reduce operational carbon and improve occupant comfort and health.

Located near Battersea Power Station, the four-block development provides energy-efficient housing for 852 students. It is also Europe's largest Passivhaus student residence and the third largest globally, following UTSC in Canada and Cornell Tower in New York at the time of writing.

Stepping up from 11 to 19 storeys, the buildings are clad with glazed terracotta façades in red, green, and blue that reference the site's industrial heritage. Opened last September, the development features ensuite and studio accommodation, a cinema room, gym, and rooftop terraces with city views.

The low-energy design harnesses solar gain, internal heat sources, and mechanical ventilation with heat recovery to achieve substantial space heating and cooling energy savings compared to conventional buildings. The building minimises thermal bridging and utilises high-performance pre-fabricated façade elements, as well as being rigorously tested for airtightness to ensure a comfortable indoor environment. The office building of the development also achieves BREEAM 2018 Outstanding.

© Tim Soar



Thermal Insulation

urbanest Battersea features high quality insulation than standard constructions to minimise heat loss in winter and reduce heat gain in summer. The target U-value for the external walls is between 0.10 and 0.15 W/m².K.

Heat Loss Form Factor

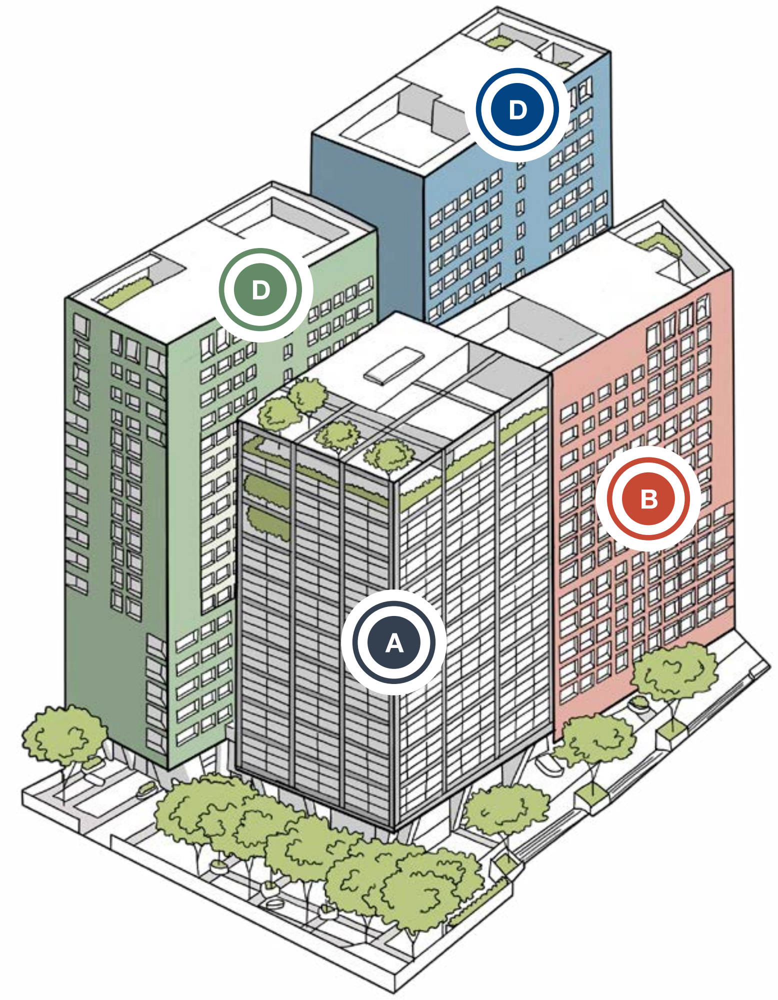
The heat loss form factor ranges from 1.04 to 1.1, which is well below the Passivhaus recommendation of 3.0 or lower. This indicates a highly efficient design relative to its treated floor area and external envelope.

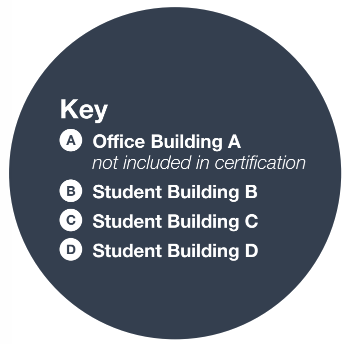
Modular Construction

Off-site fabrication of façade panels was used, allowing for a rigorous quality assurance process that ensures a continuous thermal and airtightness line.

Mechanical Ventilation with Heat Recovery (MVHR)

The low heat demand of the building allows for all heating to be delivered by fresh air through the MVHR system. Heat is then recovered from the extracted air to further maximise efficiency, and reduce energy consumption.





Minimised Thermal Bridges

Early collaboration with façade engineers was key to designing and detailing solutions that eliminate thermal bridges, optimising the building's energy performance.

High Performance Glazing

Triple-glazed units are utilised to ensure internal surfaces remain above 17ºC, avoiding cold draughts and improving occupant comfort. The glazing has a u-value between 0.517 - 0.565 W/m².K, meeting Passivhaus standards.

Solar Gains and Shading

The façade design is optimised to maximise useful solar gains during the heating period while controlling problematic solar gains during the cooling period. The PHPP model was used to assess occupant comfort and manage overheating risks.

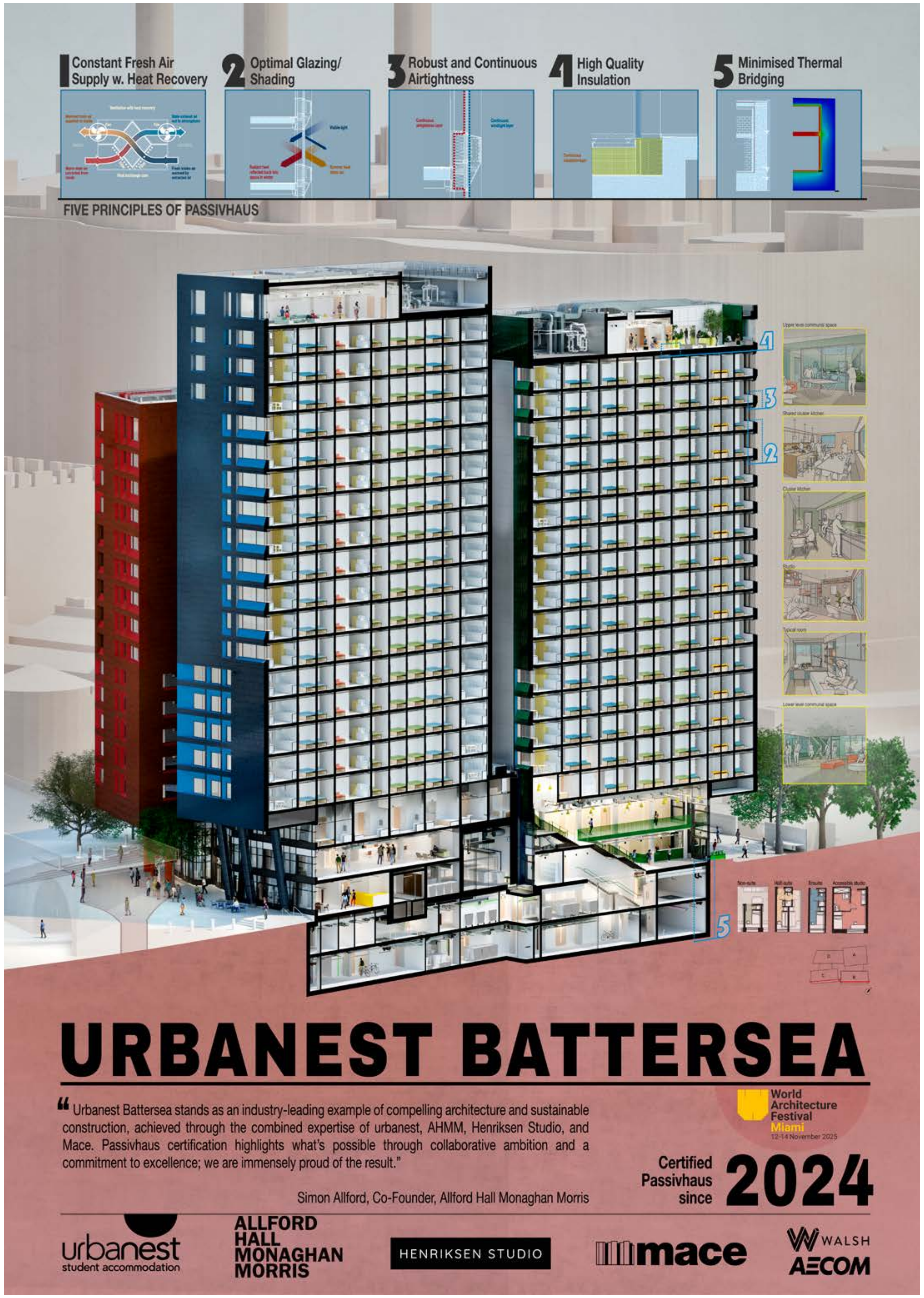
Airtightness

A continuous airtight envelope was a key focus in the design, with detailed planning and representation in all external envelope drawings from the early stages through to on-site monitoring to ensure airtightness.

Ground Floor Plan

Typical Floor Plan

Poster created for World Architecture Festival showing a cutaway section and inhabitation scenarios



The Case for Passivhaus

Proven Benefits

Operational energy/bed/month data from urbanest

Key

Energy / bed / month (kWh)

- Portfolio average
- Battersea

The graph illustrates the average Operational Energy use across urbanest's portfolio (red) against the current Battersea use (blue), which has limited annual fluctuation.

Reduction in Operational Energy

The above figure shows the operational energy use per bed for urbanest Battersea (from first occupation in September 2024), represented by the red curve, compared with urbanest's non-Passivhaus student accommodation.

The data indicates a substantial reduction in overall energy demand and a markedly lower winter peak, demonstrating strong resilience to external temperature fluctuations. This reduced peak demand aligns with the needs of a future decarbonised grid by easing pressure during high-load periods.

The performance to date provides strong confidence that these savings will be sustained over the long term. Overall, the scheme delivers a clear win-win: lower running costs for the client alongside meaningful contributions to environmental sustainability.

Costs and Long-Term Value

Modest Capex Uplift with Falling Trend

Current UK analysis based on historical Passivhaus developments (Passivhaus Trust, 2019) shows an average ~8% capex premium, forecast to fall towards ~4% as supply chains mature and industrial experience grows[2].

Reduced Operational Costs (opex savings)

UK studies show that certified Passivhaus dwellings typically achieve space-heating demands of around 10.8 kWh/m^2·yr, representing a 75–80% reduction compared with new-build homes and around a 90% reduction relative to the existing UK housing stock[3].

This substantially lower operational energy demand leads to significantly reduced running costs and greatly limits a building owner's exposure to energy-price volatility.

Over the building's lifecycle, these operational savings can offset - and in many cases exceed - the modest initial capital cost premium associated with Passivhaus construction.

Long-Term Asset Value and Resilience

Passivhaus buildings are better positioned for future regulatory changes, rising energy costs, and decarbonisation policies. Achieving Passivhaus certification enhances ESG (Environmental, Social, Governance) credentials[4], supporting investor confidence and potentially increasing future market valuations, where sustainability performance is expected to play a central role.

Marketing Appeal

Passivhaus provides better thermal comfort, air quality, and acoustic performance, which better attracts and retains tenants.

This can mean higher rental yields and lower void periods, improving net operating income.

Passivhaus construction costs analysis paper by Passivhaus Trust

Build for the Future

Renewable energy is infinite but our capacity to generate renewable energy is finite. Reducing energy demand in the first place is a key component of getting to net zero.

Where Are We Now?

Immediate steps are essential if we are to have any chance of achieving net zero by 2050.

The Target

In late 2018, the Intergovernmental Panel on Climate Change (IPCC) released a special report[5] highlighting the impacts of global warming of 1.5°C above pre-industrial levels and the pathways necessary to limit global greenhouse gas emissions to meet this target.

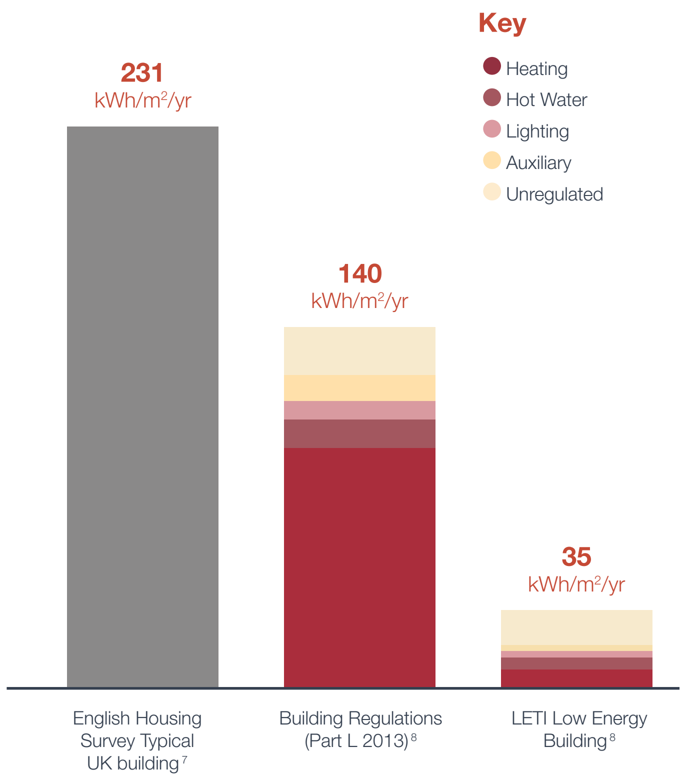
In response, the UK government set ambitious goals to reduce direct emissions of public sector buildings by 50% by 2032 and 75% by 2037, from 2017 levels. The overarching goal is to achieve net zero emissions across the entire country by 2050[6], requiring a transition to renewable energy across all sectors, with heating and transport increasingly electrified.

The Challenge

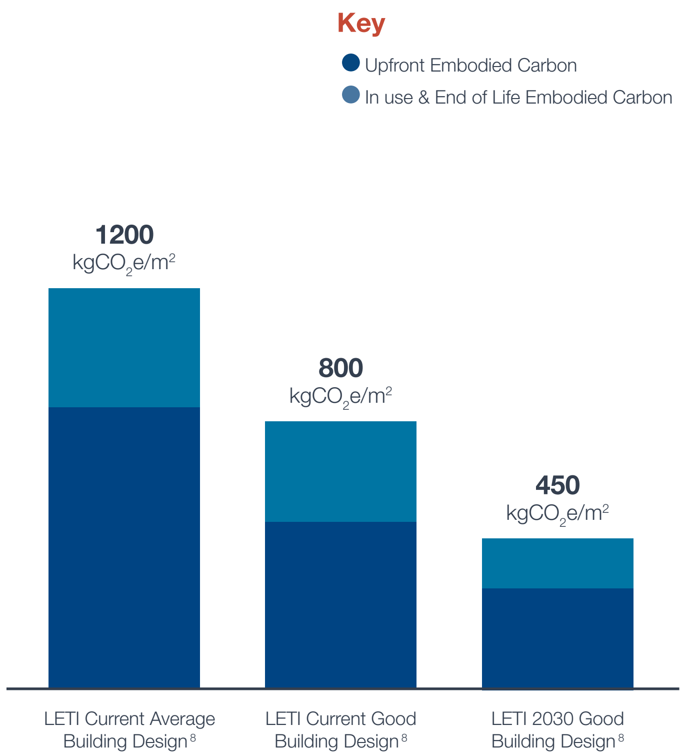
Shifting to renewable energy will increase pressure on the national grid and require major expansion of clean generation and network capacity. Maximising building-level efficiency is essential to keep electricity demand manageable and compatible with a fully decarbonised power system.

In the UK, built environment influenced emissions contribute to roughly 42% of total carbon emissions[6]. Inefficient construction such as poor insulation, inadequate airtightness, and thermal bridging, causes significant heat loss, increasing the energy required to maintain comfortable indoor conditions. Figures 6 and 7 show the current average building stock and the industry targets that need to be reached to align with 1.5°C.

Residential buildings operational energy, current building stock compared to industry targets



Residential buildings embodied carbon, current building stock compared to industry targets



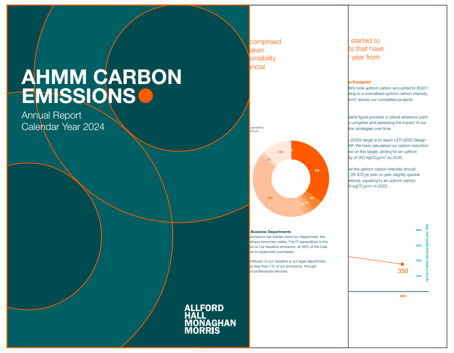
A Net Zero Future

Tackling this global challenge requires collective action to transform how we design, construct, and operate our buildings.

AHMM's Pathway to Net Zero Carbon

AHMM has set carbon reduction targets for our operational emissions, aligned with limiting global warming to 1.5 °C. The practice committed to a Science Based Target in 2021 and our reduction plan[9] was verified by the Science Based Targets Institute (SBTi)[10] in 2022.

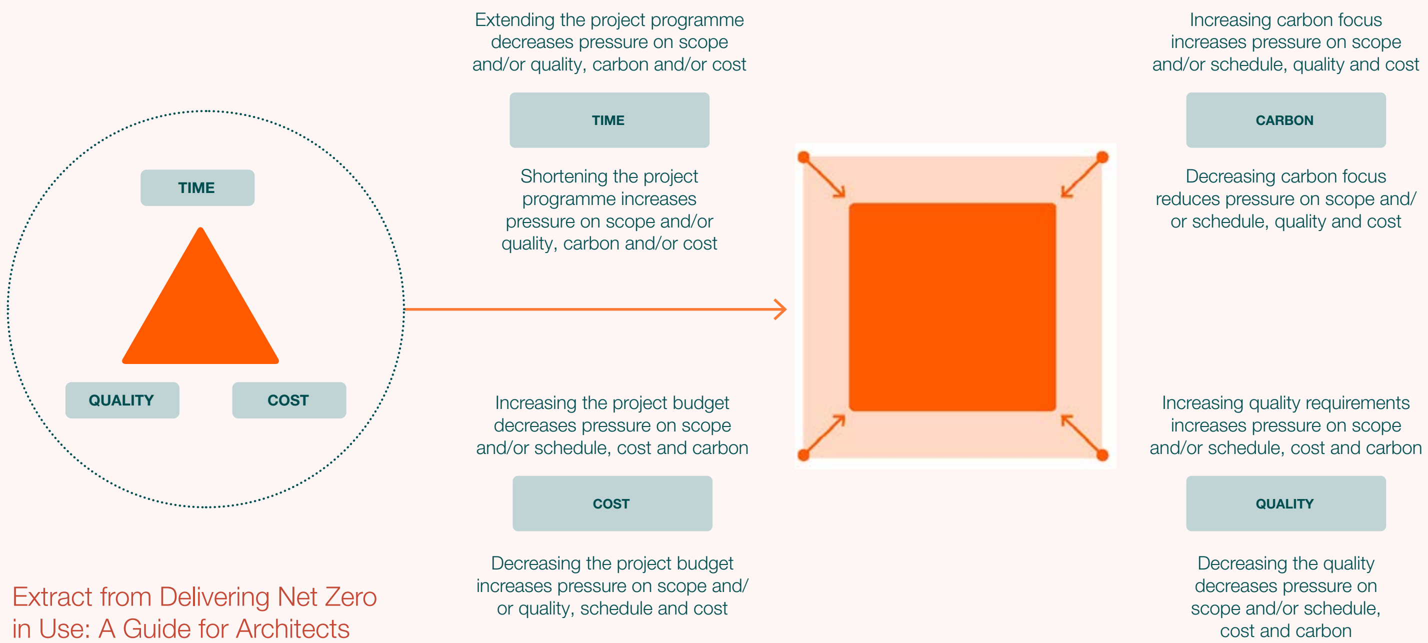
Alongside our business operations, we have also set a goal for the upfront embodied carbon emissions of our architectural projects. We have aligned a reduction trajectory for this which meets the 2030 targets set by LETI.
We are committed to transparency and continual improvement, reporting annual progress from 2022, refining our strategies, improving data quality, and focusing on high-impact actions to achieve our net zero goals. Achieving true net zero, however, requires more than operational changes - it depends on designing and delivering low-carbon buildings. Approaches such as Passivhaus design demonstrate a science-based approach to align the built environment with a net zero carbon future.



AHMM Carbon Emissions Annual Report[11]

From Golden Triangle to Carbon Square

Carbon must be viewed alongside time, cost and quality as one of the key constraints when designing buildings. The below shows the time-cost-quality triangle is re-envisioned as a time-cost-quality-carbon square to rethink the trade-offs required to deliver a net zero carbon development. Refer to our Delivering Net Zero in Use[12] guide for more details.



Extract from Delivering Net Zero in Use: A Guide for Architects

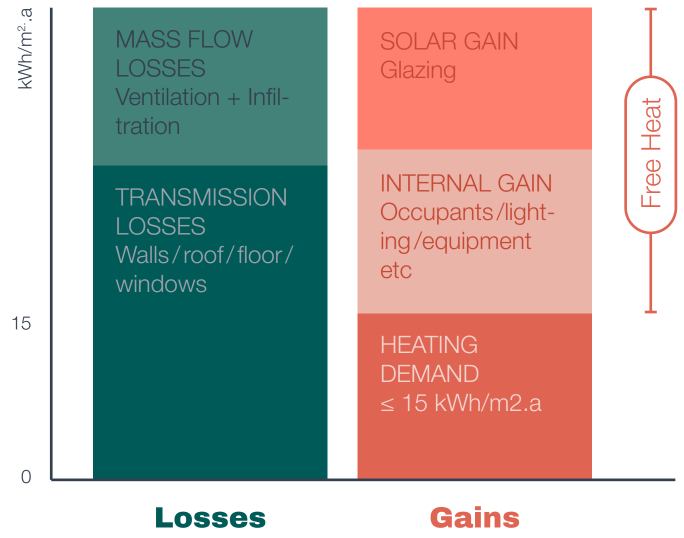
What is Passivhaus?

Passivhaus is a performance based standard focused on delivering highly energy efficient buildings, while ensuring high levels of occupant comfort.

Two fundamental principles to achieving this are a well controlled thermal envelope and airtight construction. Adopting this fabric first approach ensures heat losses are significantly reduced.

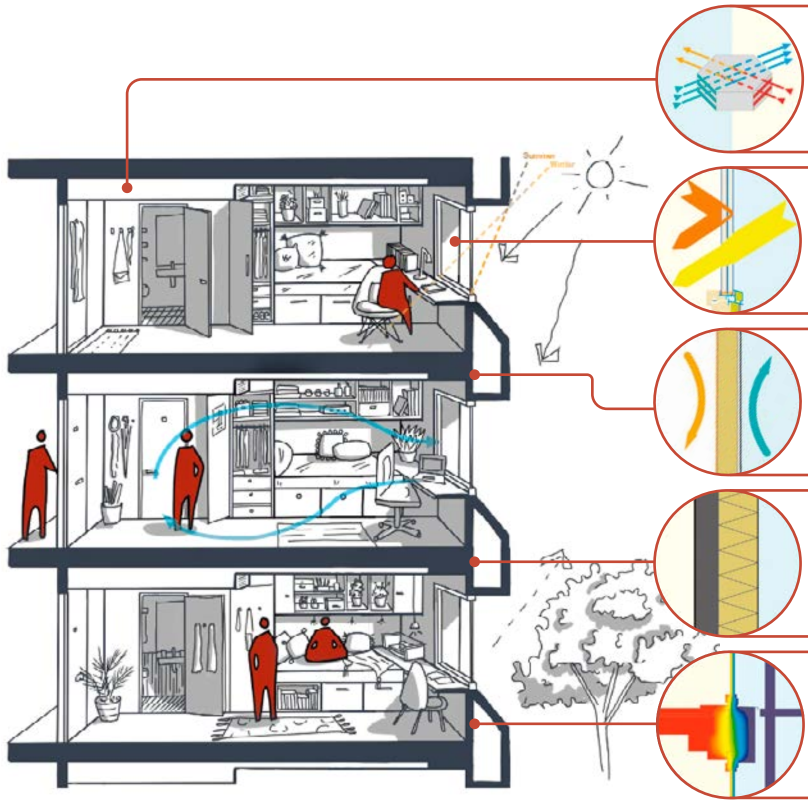
By also utilising free heat from the sun, internal heat gains and heat recovery, the building's heating demand can be reduced to within the key Passivhaus target of 15 kWh / m^2 per annum.

Energy balance diagram for a Passivhaus



5 Key Principles for a Passivhaus in a UK Climate

Sectional sketch of urbanest Battersea



	Energy	Comfort
Adequate Ventilation	Heat recovery to reduce energy inputs	Constant fresh air (temperature and humidity)
Optimal Windows/ Shade	Winter: heat loss Summer: overheating	Prevent asymmetric temperatures and condensation
Airtightness	Reduce uncontrolled heat losses	Prevent draughts
Thermal Insulation	Maintain stable internal environment	Consistent temperatures
Minimise Thermal Bridges	Maintain temperatures of building mass	Prevent condensation / mould growth

Design Criteria [12]

Requirements	Passivhaus	EnerPHit	UK Typical
Airtightness	<0.6ach*	<1ach	10 ach
Annual Heat Demand	≤15kWh/m².a	25kWh/m².a	>200 kWh/m².a
Annual Cooling Demand	≤15kWh/m².a	15kWh/m².a	0
Max Heat Load	≤10 W/m²	10W/m²	-
Primary Energy Demand	≤60kWh/m².a** *Classic* ≤45kWh/m².a *Plus* ≤30kWh/m².a *Premium*	60kWh/m²	>400kWh/m².a
Ventilation *minimum surface temp.* *overheating limit*	Typically 30m³ pp/h Typically 17°C <10% of year		

* For larger buildings, an air permeability target of 0.6m³/h.m² is recommended, which is much harder to achieve.
** These PER values are for domestic PH projects. For high occupant density a bespoke PER target may be agreed with the PHi.

The Benefits

Climate Emergency Passivhaus reduces operational energy demand by up to 90%, significantly cutting carbon emissions and supporting net-zero targets. Its focus on airtightness, insulation, and heat recovery enhances climate resilience and maximises the efficiency of renewable energy sources.

Health By maintaining high indoor air quality through MVHR, Passivhaus minimises CO_2, dust, and pollutants while preventing cold spots, damp, and mould. Stable indoor temperatures improve comfort and protect occupants from extreme weather impacts, promoting overall wellbeing.

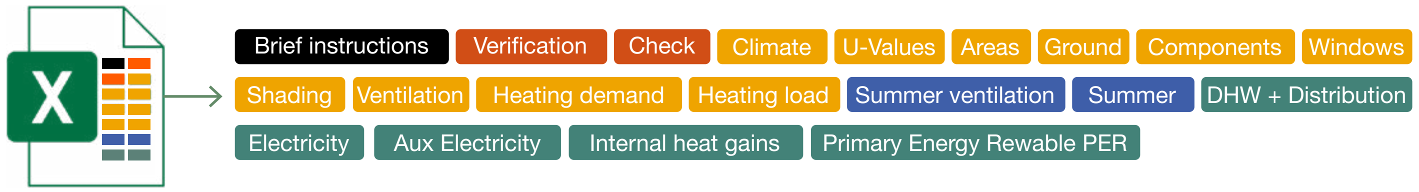
People Performance Consistent indoor conditions with fresh air and superior insulation enhance comfort, cognitive function, and productivity. The elimination of CO_2 buildup and noise pollution creates healthier and more pleasant living and working environments.

Financial With drastically reduced heating and cooling needs, Passivhaus lowers energy bills, increases property value, and reduces long-term maintenance costs. High durability and efficiency make it a cost-effective solution for sustainable development.

Social Passivhaus supports affordable housing by lowering lifetime energy costs and improving urban resilience through climate-adaptive buildings. By setting a benchmark for sustainable design, it drives industry innovation and influences policy.

Closing the performance gap Passivhaus ensures buildings perform as designed through precise energy modeling (PHPP), high-quality construction and a quality assurance process towards achieving certification by an impartial third party certifier. While initial costs may be slightly higher due to better materials and workmanship, these investments eliminate performance discrepancies, preventing costly retrofits and reducing long-term operational expenses.

Passivhaus Planning Package (PHPP)



The PHPP software sits at the heart of the Passivhaus design process. This Excel based model calculates the annual energy balance of a building, providing the detailed information required to minimise energy demands within the Passivhaus targets.

It is the heart of the Passivhaus design process. During design stage it is used to check how the criteria can be achieved. During certification it is used to check compliance once the building is constructed and final tests have been completed.

The Excel document consists of many sheets, each with a focus topics, and together the sheets calculate operational energy use.

CGI visualisation of future landscaping strategy to be completed 2026

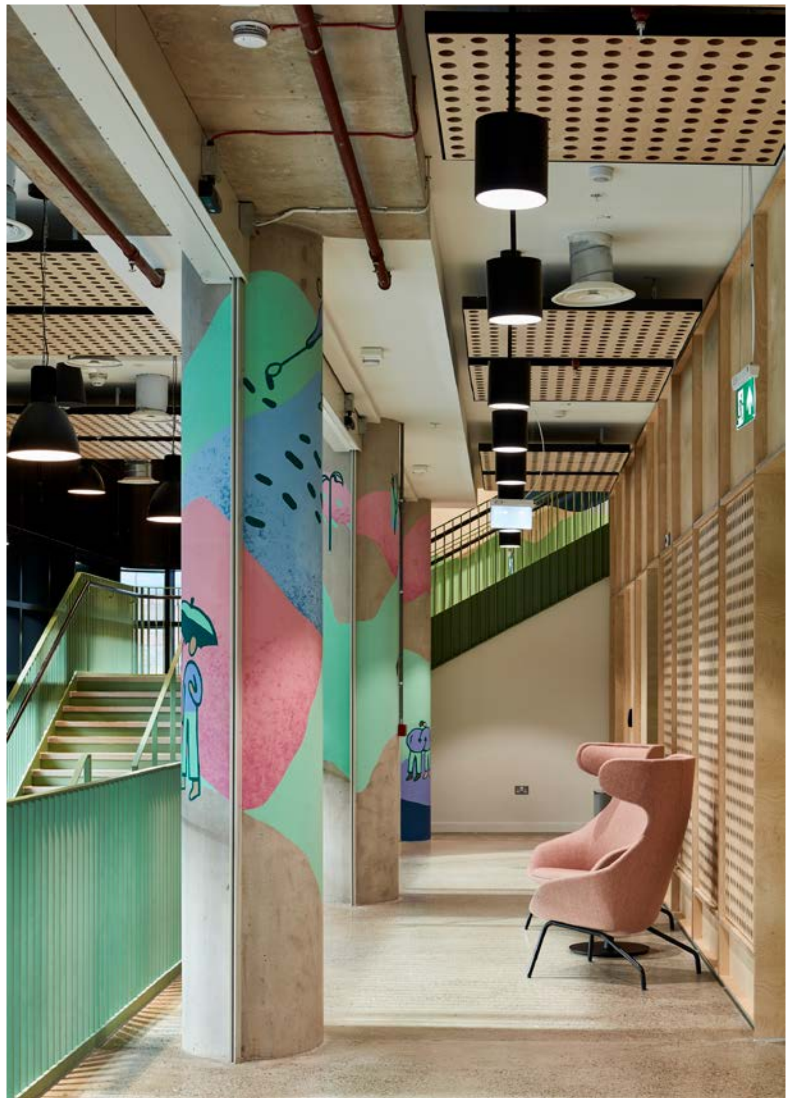
urbanest Battersea

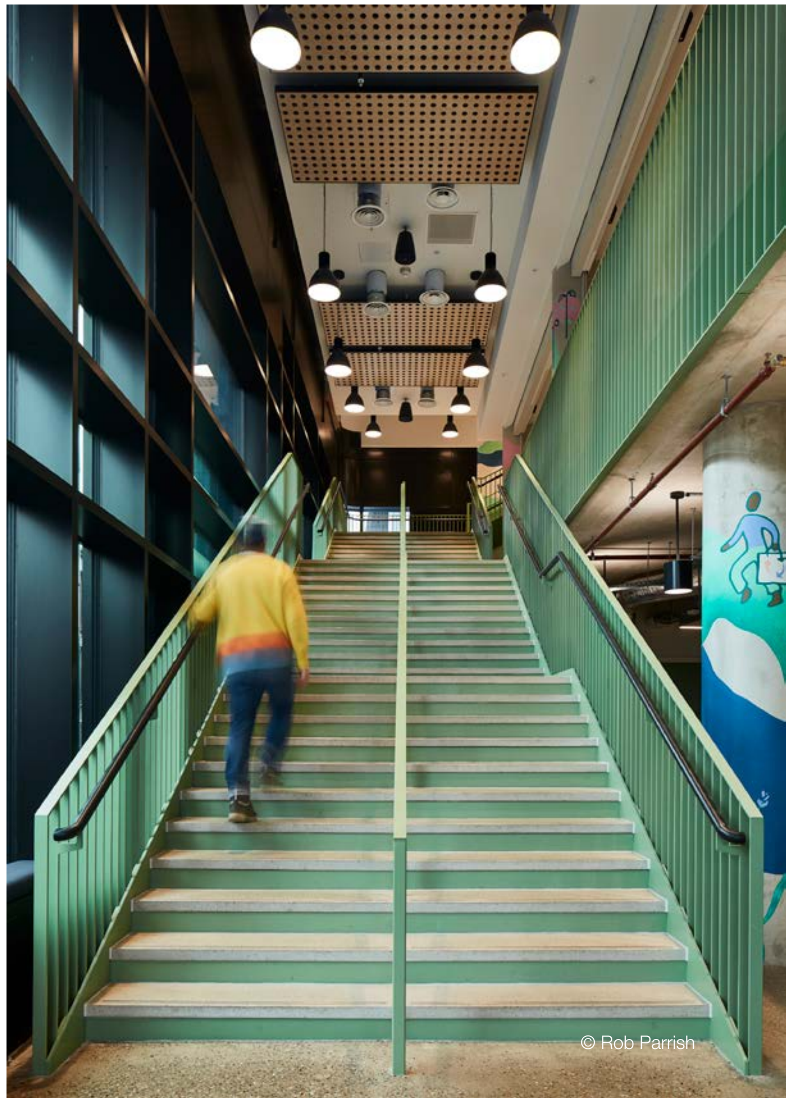
urbanest Battersea exemplifies the benefits and innovation of Passivhaus design applied to student living. Delivering unmatched energy efficiency, Passivhaus buildings maintain consistent indoor temperatures and superior air quality, reducing the need for heating and cooling systems.

Students benefit from a thermally stable space conducive to focus and relaxation, while the integration of renewable energy sources aligns with broader climate goals.

This building also stands out for prioritising community and modern amenities, offering a holistic lifestyle that balances sustainability with urban convenience.

Dragos Arnautu
Building Certifier, Passivhaus Institute





© Rob Parrish

Passivhaus High-Rise

A taller building offers a favourable form factor, but scaling up amplifies challenges with airtightness, thermal bridge control and ventilation. Overcoming these requires meticulous planning, innovative design, skilled labour, and unwavering commitment to quality.

Form Factor Efficiency

High-rise buildings often have a more efficient external surface area to treated internal floor area ratio, requiring less insulation to meet Passivhaus standards. However, as the building scales up, careful design and execution in the following areas are needed to maintain this efficiency.

Thermal Bridging

High-rise buildings often involve complex structural elements like terraces, columns, and cantilevers, which can create thermal bridges - areas where heat can escape. Balancing the significant structural requirements while designing out thermal bridging in the façade zone is a significant challenge.

Airtightness

Achieving the airtightness required by Passivhaus standards is difficult in high-rises because of the sheer number of joints, windows, doors, and penetrations by mechanical systems. Small gaps or construction errors can accumulate to significantly impact the building's energy performance.

Mechanical Ventilation

Passivhaus buildings rely on mechanical ventilation with heat recovery (MVHR) systems to supply fresh air while minimising energy loss. Designing and implementing an effective MVHR system in a high-rise is complex due to the vertical distribution of air, pressure differences, and ensuring airtightness and high performance insulation around all the façade penetrations.

Comparing urbanest Battersea with established Passivhaus projects over time

The world's first Passivhaus, Darmstadt-Kranichstein, Germany, 1990. Designed by architects Bott, Ridder and Westermeyer

UK's first certified Passivhaus student accommodation, Carnegie Village, Leeds Metropolitan University, 2009. Designed by GWP Architecture Ltd.

urbanest Battersea, London, UK, 2024. Designed by AHMM Architects

Window Design and Solar Shading

High-rise buildings can be more exposed to solar gain, which requires thoughtful design to avoid unwanted overheating. This involves optimising window placement, size, and shading devices, which is more complex when dealing with the varying orientations and exposures of a high-rise.

Energy Modelling and Simulation

Accurately modelling energy performance in high-rises to meet Passivhaus standards is complex, requiring advanced tools to account for scale, pressure variation, and system interactions.

Material Selection and Procurement

Procuring specialised materials at scale, such as high-performing windows and airtight membranes, is challenging due to longer lead times, higher costs, and the need for reliable suppliers. Ensuring that all components meet Passivhaus standards while maintaining the construction schedule requires careful coordination with the supply chains.

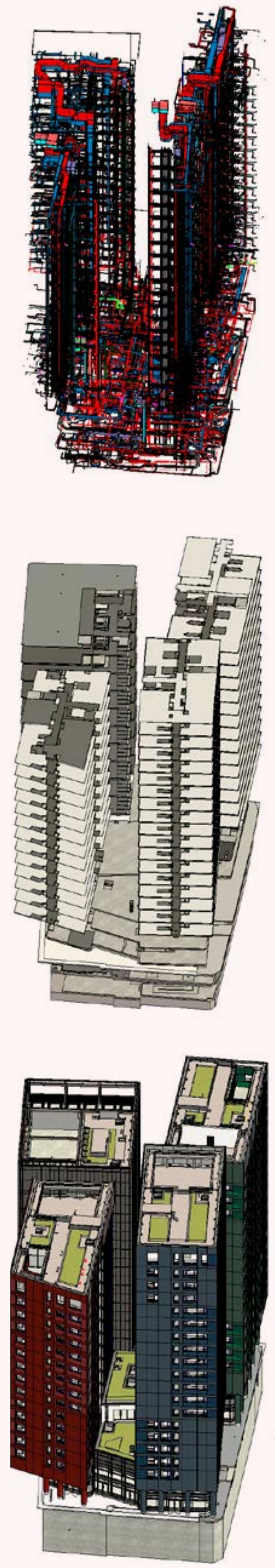
Construction Quality Control

Ensuring that the high standards of workmanship required for Passivhaus certification are maintained throughout the construction process is more difficult in a high-rise due to the scale and number of workers involved. Any lapse in quality can compromise the building's performance.

The following section explores how the project team implemented innovative solutions to overcome these challenges, from conceptualisation to construction, and details the quality assurance processes in place to ensure the Passivhaus standard is achieved.

urbanest Battersea
As a Passivhaus High-Rise

Exploded axonometric diagrams of urbanest Battersea: services, treated floors and building envelope.



53,976 m³
Building volume

18,480 m²
Building envelope

4,226 m²
Glazing area

17,964 m²
Treated floor area

865 m
of airtight, vapour sealed and thermally insulated ductwork

18,328 m
of DHW pipework

11,791 m
of ambient loop pipework

852
Rooms

Sustainability Targets

A key consideration from design to construction

Why Passivhaus?

"Like many things, it started with a couple of problems. Reports surfaced that London would experience temperatures as high as Barcelona in the next ten years, while air quality in the city continued to decline due to increasing sand, dust, and pollution.

We knew we needed to address the heat gains in our building, but after considering traditional air conditioning systems, we realised they weren't sustainable. We didn't want to burden the building with such poor sustainability credentials. Plus, these systems take up a lot of space and often just release excess energy into the atmosphere.

I searched for ways to repurpose waste heat within the building, and that's when I came across water-to-water heat pumps. I visited two manufacturers, and since we were also collaborating with Mitsubishi on another project, they helped me understand how the system worked as they were developing their own heat pump.

It became clear that we could convert the heat energy in the building into usable energy for our hot water. After all, student accommodation requires a massive amount of hot water.

Instead of simply discarding the heat, we decided to save it. That's when Thomas [Henriksen] came into the picture. I asked him how we could stop the energy leakage from the building and he pointed out, "What you're trying to do is essentially what the Passivhaus Institute is all about." Thomas then wrote a paper on Passivhaus, and we realised that not only would we save energy and therefore operation carbon but also by shutting the façade and incorporating high-quality air filtration throughout that building it would help address London's air quality issues. Win, win, win.

Passivhaus principles are all about improving comfort and wellbeing for our students, which aligns perfectly with our goals at urbanest."

Angus Kearin
Head of Development, urbanest

Key Sustainability Goals

- **90% REDUCTION IN ENERGY NEEDED FOR OPERATIONS** — Compared to a standard residential building
- **PASSIVHAUS** — Comfortably cool, Comfortably warm
- **TARGETING BREEAM OUTSTANDING**
- **COMFORT AND WELLBEING**

- Ambient loop with waste energy recovery
- Reduced carbon emissions due to adoption of Passivhaus principles
- 100% of electrical supply from renewable sources
- Ready for a net zero energy system

Key Passivhaus targets for urbanest Battersea

≤15 kWh/m².a
Space Heating / Cooling Demand

OR

≤10 kWh/m².a
Peak Heating / Cooling Load

≤120* kWh/m²
Primary Energy Renewable

urbanest Battersea is using adjusted project-specific PER limits

≤ 0.6 ACH @ 50Pa
Airtightness n_{50} (required)

AND

≤ 0.6 m³/h/m² @ 50Pa
Air permeability q_{50} (recommended)

20 °C
Operative room temperatures

Reduced temperatures in non-residential, non-continuously areas acceptable if within 5 °C of adjacent spaces

max 10% time >25°C
Summer Overheating

≤ 30 m³/hr.person
Ventilation

Key Passivhaus ↔ BREEAM Outstanding Crosswalk

BREEAM Category and goals	How Passivhaus Supports Credit Achievement
ENE 01 **Reduction of energy use and carbon emissions**	PHPP model provides robust evidence of energy efficiency and carbon reduction; delivers a 76% reduction in space heating requirements compared with current building regulations
ENE 04 **Low carbon design**	Fulfils Passive Design credits automatically; supports Low/Zero Carbon readiness
HEA 02 **Indoor air quality**	Passivhaus Mechanical Ventilation with Heat Recovery provides filtered, fresh air, ensuring excellent IAQ and stable CO_2 concentrations
HEA 04 **Thermal comfort**	Maintains comfort 20–25°C year-round; supports seasonal comfort credits
MAN 04 **Commissioning and handover**	Passivhaus verification includes commissioning of MVHR, airtightness testing, and PHPP validation, with clear evidence for commissioning documentation
INN 01 **Innovation**	Achieving Passivhaus certification can be recognised as an Innovation Credit (especially in energy efficiency or occupant wellbeing)

Passivhaus & Whole Life Carbon

The relationship between Passivhaus and WLC

AHMM's Building Performance Team undertook a study to understand how the Passivhaus standard influences whole life carbon. We compared urbanest Battersea PBSA with two comparable AHMM buildings of the same typology that meet building regulations (Part L 2021, incorporating 2023 amendments)[13] but were not designed to Passivhaus. By focusing on façade design and energy use intensity, we assessed both embodied and operational carbon to understand the whole life carbon implications of adopting Passivhaus principles.

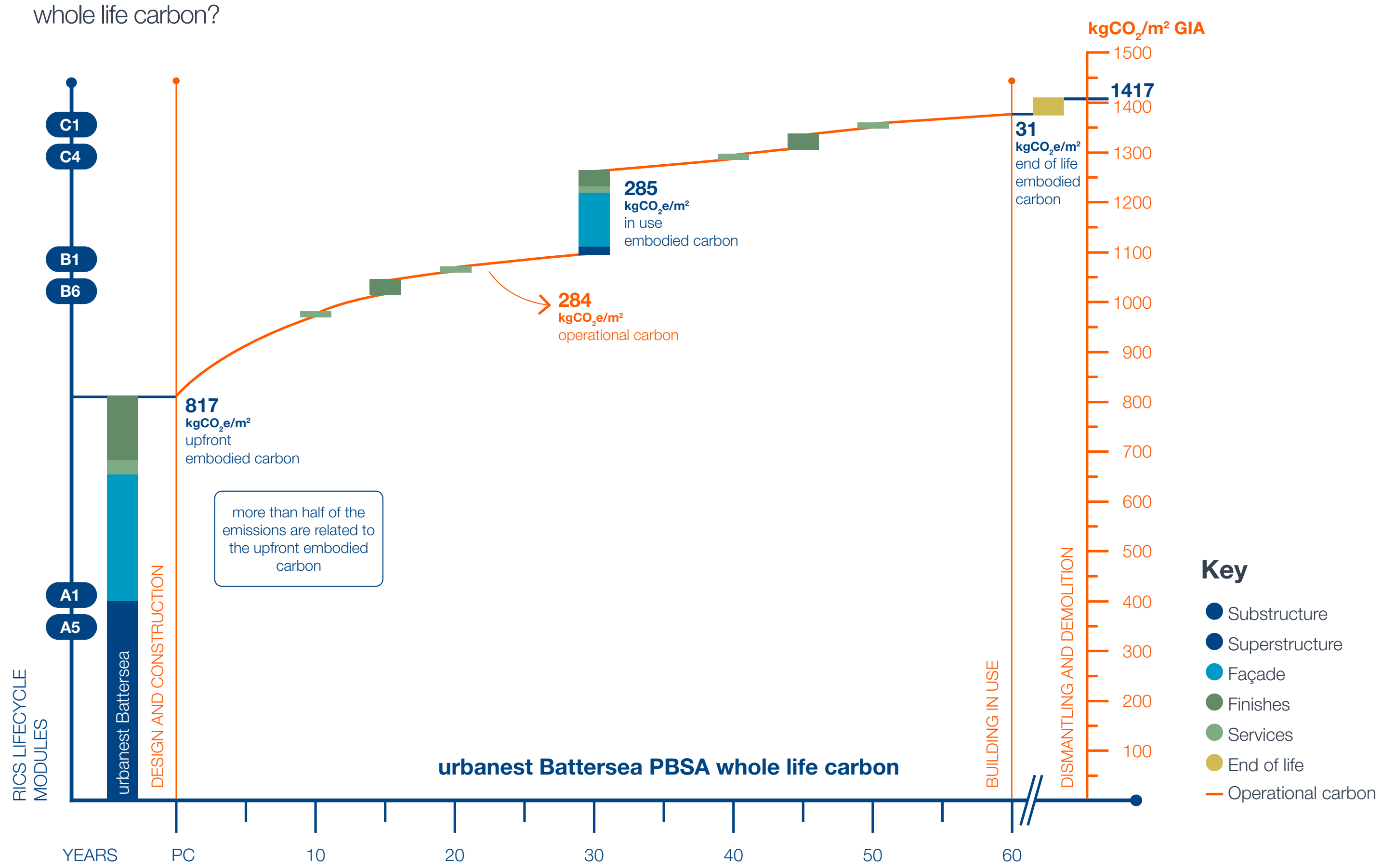
We Set Out to Answer:

- What is the upfront embodied carbon uplift associated with the Passivhaus standard?
- When actual performance is factored in, does the uplift pay back through reduced operational carbon over the life cycle and which (minimum compliance or Passivhaus) delivers lower whole life carbon?

Methodology

We have used the RICS whole life carbon methodology[14] for calculations, focusing on project emissions over the 60 year life cycle (Modules A-C) using AHMM's Delivering Net Zero in Use Toolkit[15]. To test minimum Building Regulations compliance, we adapted the urbanest Battersea whole life carbon model using parameters from the case studies. Substructure, superstructure, finishes and services were held constant across all variants; only the façade specification and energy use intensity were adjusted to enable a like for like comparison.

Replacement over the life cycle was modelled on a like for like basis in all scenarios. In the Part L compliant scenarios, the façade may require more substantial upgrades over the life cycle than in the Passivhaus scenario to meet future performance standards. These additional interventions could increase life cycle impacts and are not reflected in this analysis.

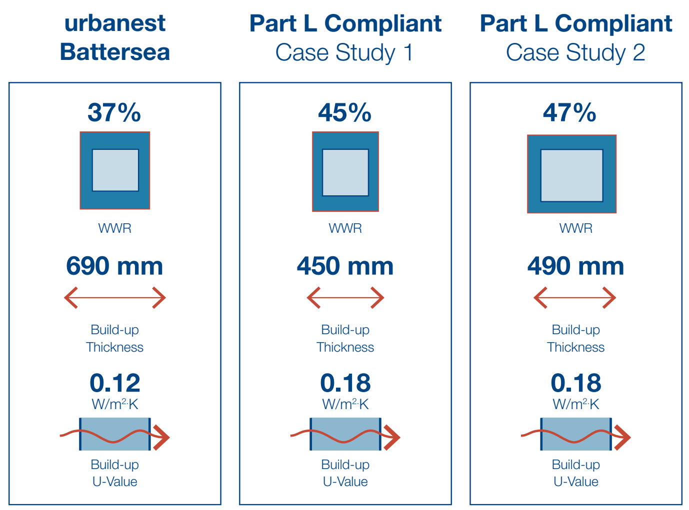


Façade Embodied Carbon

While building regulations set minimum requirements, Passivhaus façade design demands higher energy efficiency and performance. To evaluate this, the typical façade bay of urbanest Battersea was analysed. Adjustments were then made based on case studies to meet only the building regulations.

Insulation thickness was reduced, leading to a decrease in the unitised system frame thickness and support structure. The windows, originally triple glazed, were downgraded to double glazing in Part L compliant designs. Window to wall ratios and reveal depths were adjusted to align with the case studies.

Comparing the product stage embodied carbon (modules A1–A3) shows the Passivhaus façade has higher embodied carbon per m² of façade, but the building's lower façade form factor decreases the difference when expressed per m² GIA. Most of the difference in the compliant variants comes from the decrease in the amount of aluminium and steel used in the façade components.

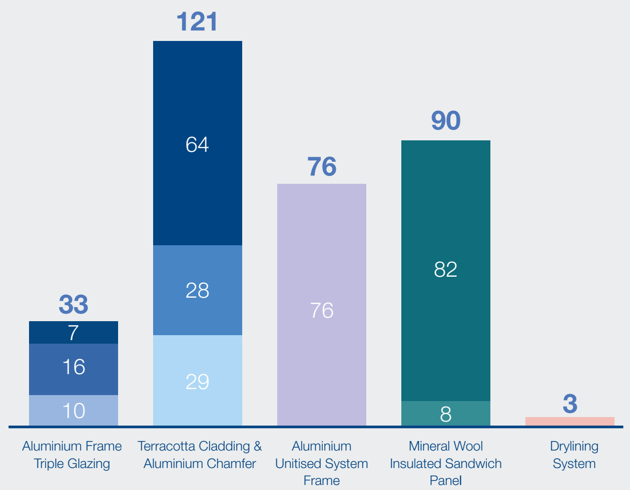


Left: urbanest Battersea lifecycle chart showing the whole life carbon emissions over the life of the building and their relationship with RICS lifecycle modules.

Right: comparing the product stage façade embodied carbon (modules A1 - A3).

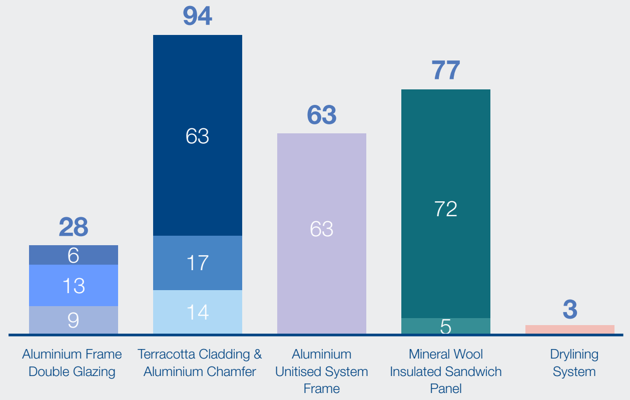
urbanest Battersea

323 kgCO$_2$/m² FSA (A1-A3)
223 kgCOO$_2$/m² GIA (A1-A3)



Part L Compliant (Case Study 1)

266 kgCO$_2$/m² FSA (A1-A3)
189 kgCO$_2$/m² GIA (A1-A3)



Part L Compliant (Case Study 2)

259 kgCO$_2$/m² FSA (A1-A3)
189 kgCO$_2$/m² GIA (A1-A3)

Key

- triple pane insulated glazing
- double pane insulated glazing
- aluminium frame triple glazed window system
- aluminium frame double glazed window system
- ppc aluminium perforated panel on aluminium support system
- glazed terracotta tiles on aluminium support system
- glazed terracotta reveals
- ppc aluminium chamfer on aluminium support system
- aluminium unitised system frame
- mill finish aluminium sheet for sandwich panel
- mineral wool insulation
- drylining system

Operational Carbon

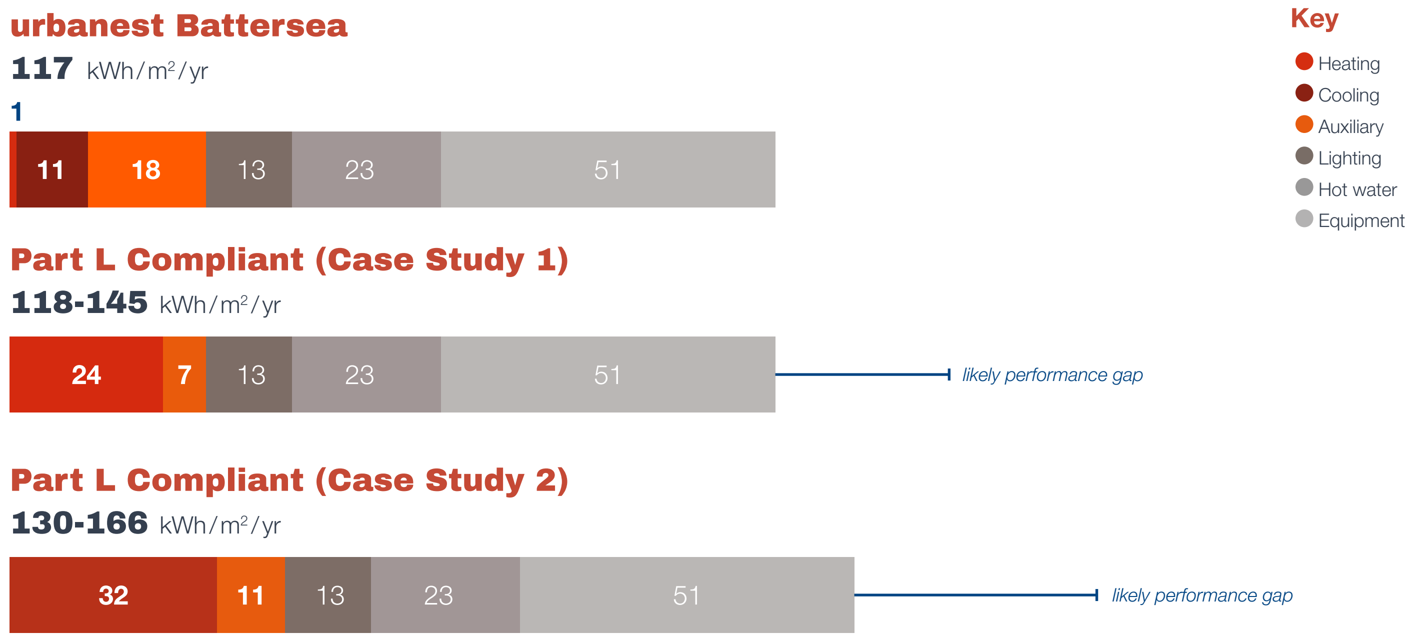
The predicted operational energy data was taken from urbanest Battersea's As Built TM54 model, keeping lighting, hot water and equipment constant. Heating, cooling and auxiliary energy were adjusted based on the Part L models from two other Part L compliant student residential projects. The non-Passivhaus buildings show higher heating demand and lower cooling and auxiliary consumption.

Annual energy use (kWh) was converted to carbon emissions using National Grid Future Energy Scenarios (FES) "Falling Short" carbon factors, in line with RICS 2023[13].

Likely Operational Performance Gap Consistent with Innovate UK's Building Performance Evaluation findings[16] of a significant gap between predicted and actual operational energy use, we applied an average 87% operational performance gap uplift (although this is likely to be conservative) across the non-Passivhaus scenarios.

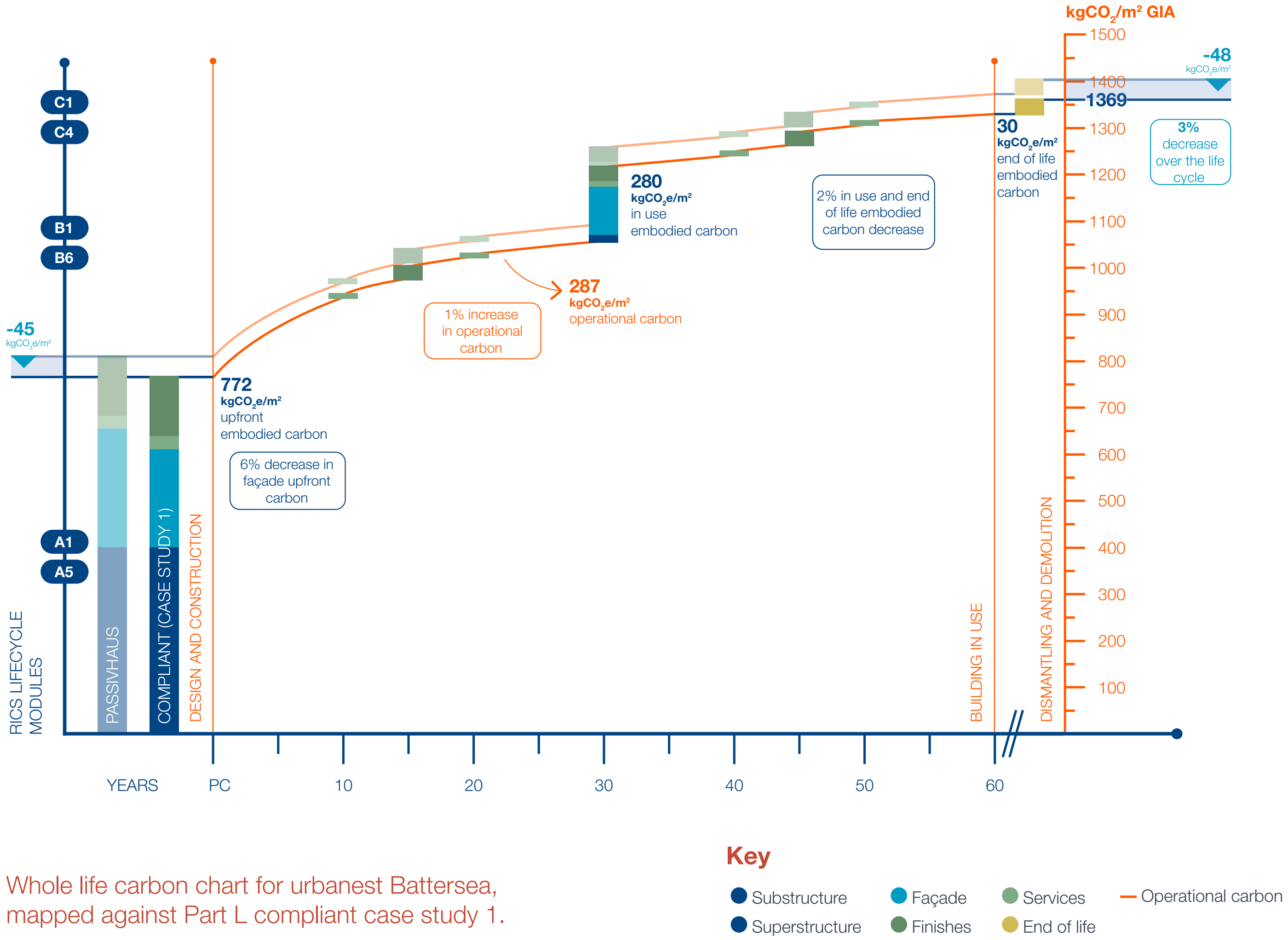
Projects designed only to comply with building regulations tend to use more energy than calculated by SBEM, while Passivhaus buildings typically align with design intent. Early metered data for urbanest Battersea (c.100 kWh/m²/yr) outperform the TM54 estimate (117 kWh/m²/yr), supporting this assumption.

On the right is the energy use comparison between urbanest Battersea and two Part L compliant case study projects.



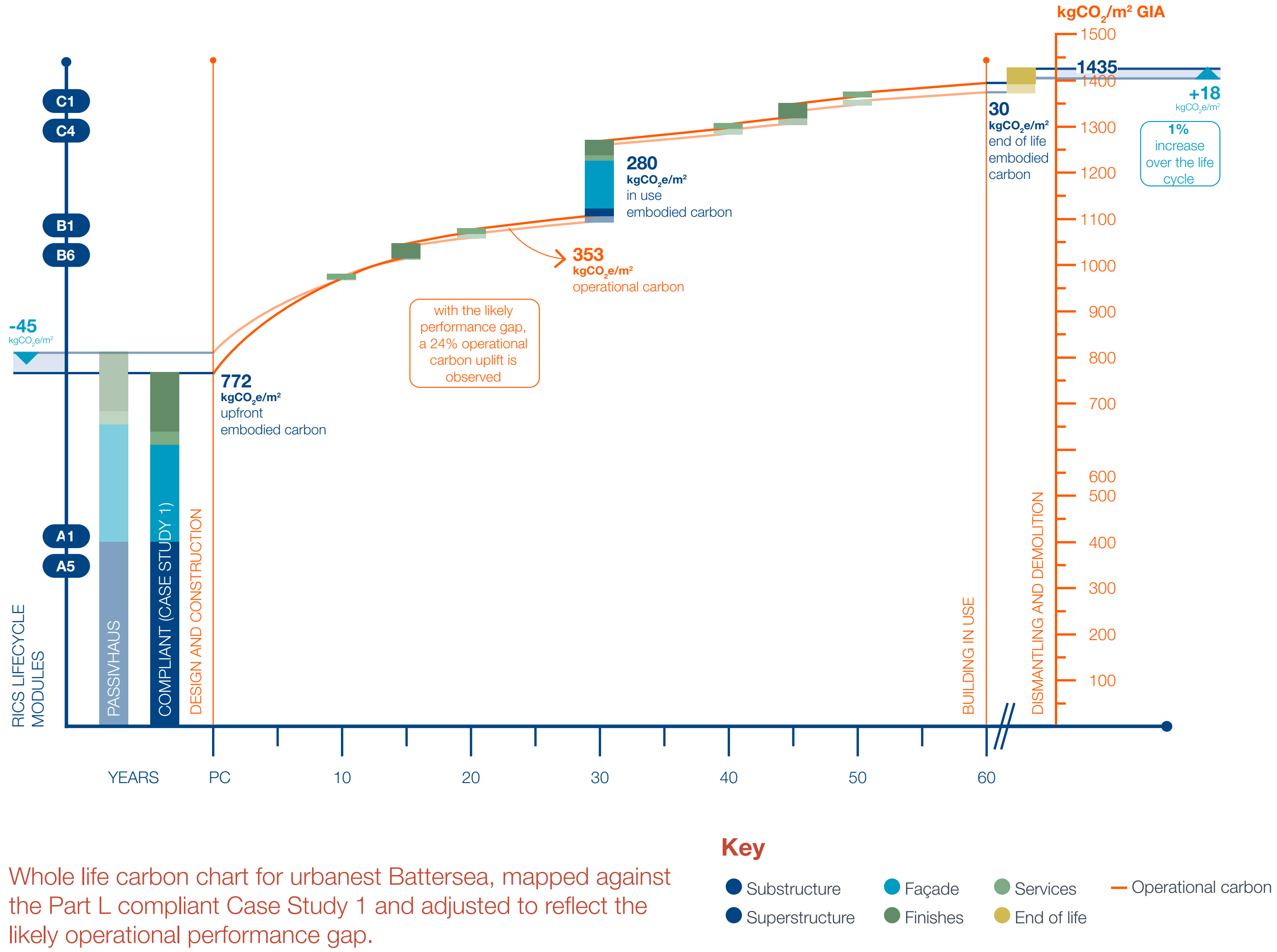
urbanest Battersea vs Part L Compliant (Case Study 1)

Comparison over the 60 year life cycle



Whole life carbon chart for urbanest Battersea, mapped against Part L compliant case study 1.

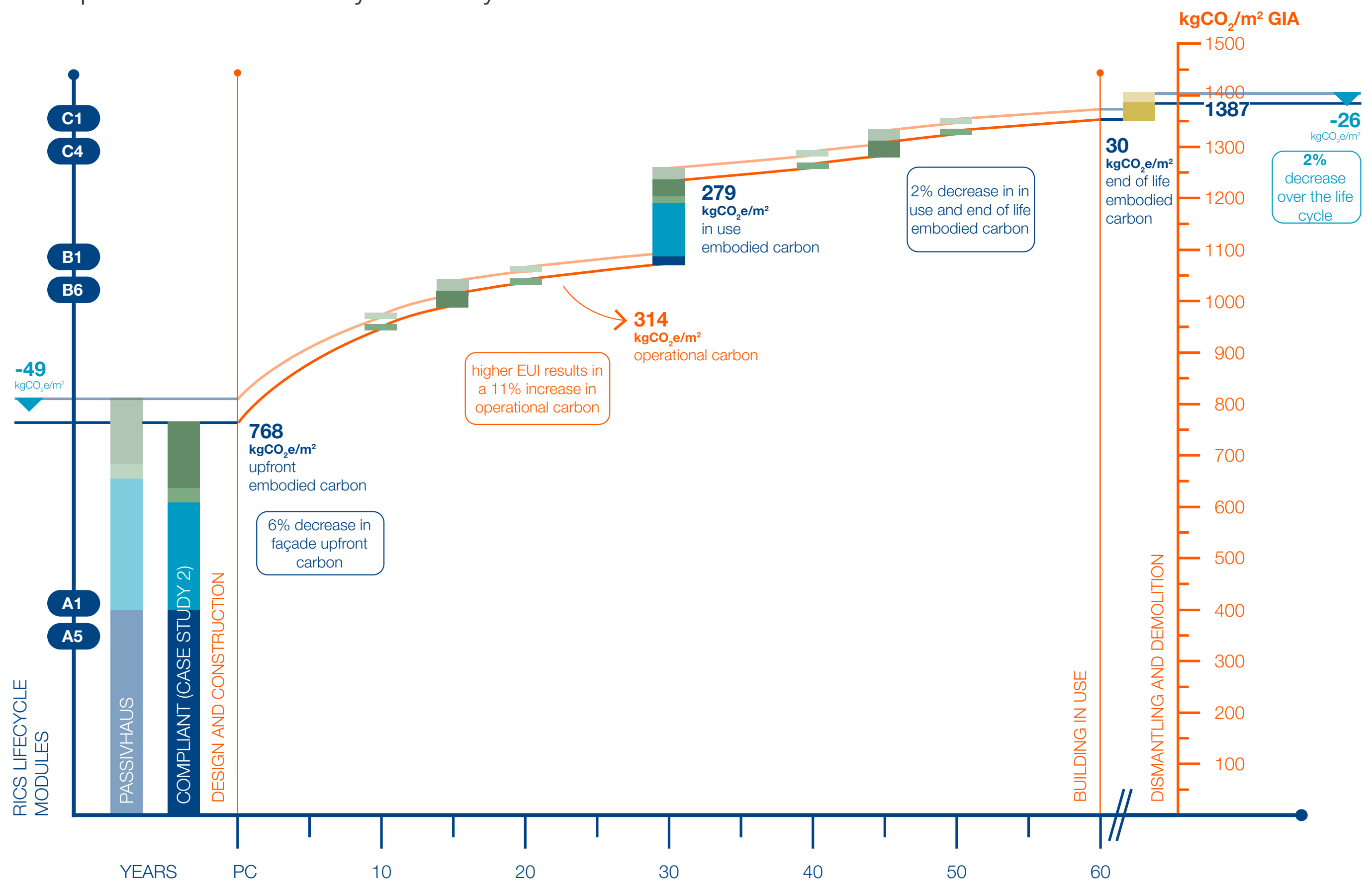
Results with the likely performance gap



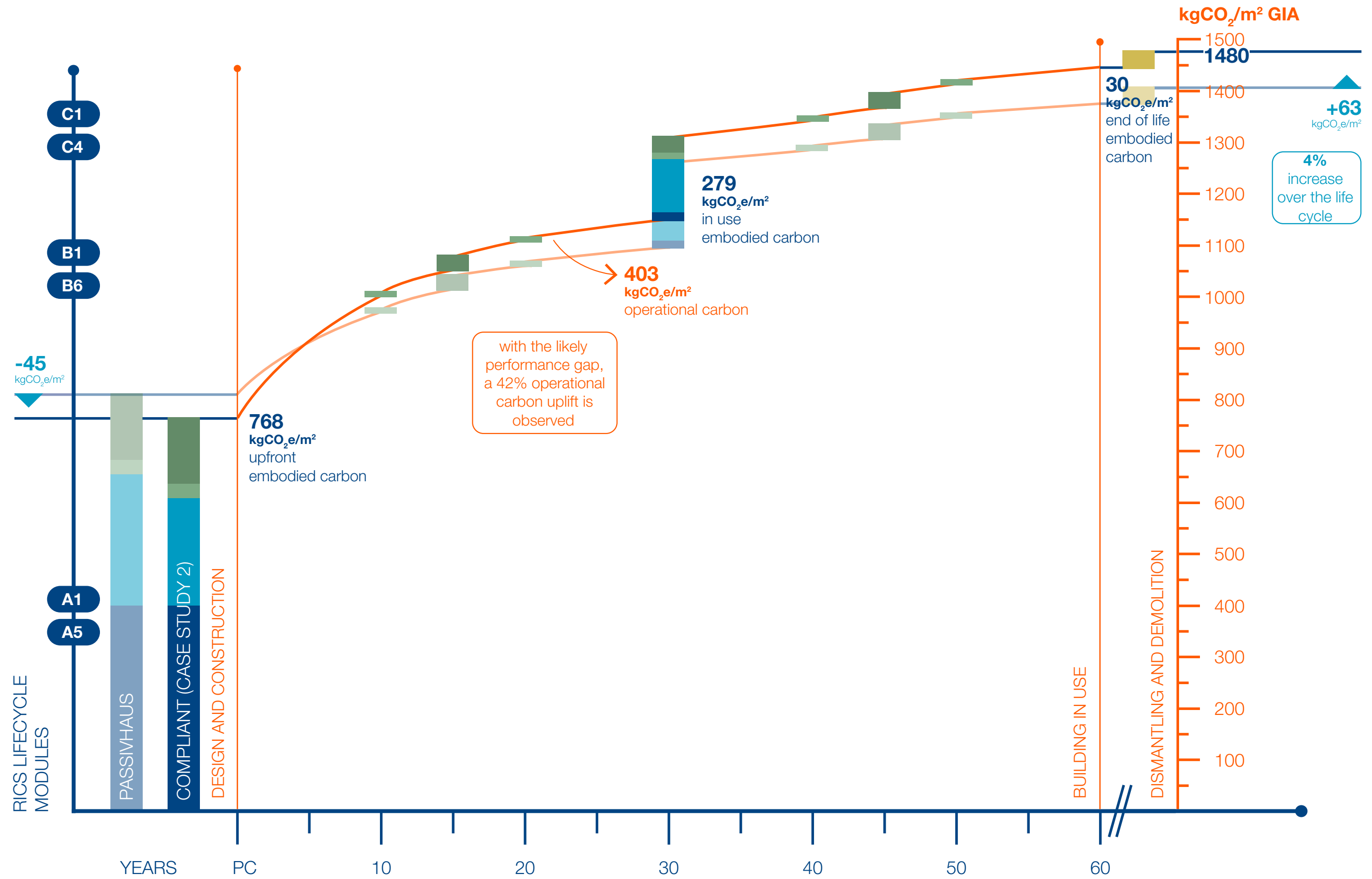
Whole life carbon chart for urbanest Battersea, mapped against the Part L compliant Case Study 1 and adjusted to reflect the likely operational performance gap.

urbanest Battersea vs Part L Compliant (Case Study 2)

Comparison over the 60 year life cycle



Results with the likely performance gap



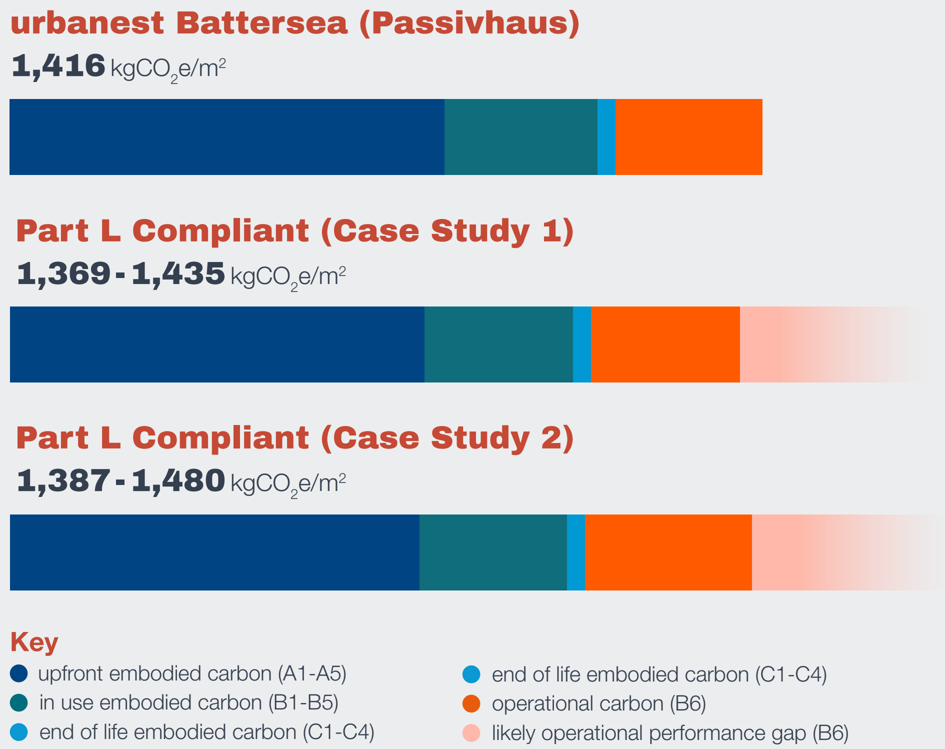
Key

- Substructure
- Superstructure
- Façade
- Finishes
- Services
- End of life
- Operational carbon

urbanest Battersea as a Passivhaus High-Rise

While urbanest Battersea has slightly higher embodied carbon emissions compared to Part L compliant variations, it achieves lower operational carbon emissions in reality.

Factoring in the likely operational performance gap, Passivhaus buildings like urbanest Battersea demonstrate a more favourable whole life carbon position, supporting its viability as a sustainable building design strategy.



Top left: Whole life carbon chart for urbanest Battersea, mapped against the Part L compliant Case Study 2 and adjusted to reflect the comparison over the 60 year life cycle

Bottom left: Whole life carbon chart for urbanest Battersea, mapped against the Part L compliant Case Study 2 and adjusted to reflect the likely operational performance gap.

© Tim Soar

Project Timeline

urbanest Battersea's RIBA stages with Passivhaus Overlay

	0	1	2	3	4	5	6	7
	Strategic Definition	Preparation and Briefing	Concept Design	Developed Design	Technical Design	Manufacturing and Construction	Handover	Use

Key dates: AUG 2020 (end of Stage 2); MAR 2021 (end of Stage 3; TENDER); SEP 2024 (end of Stage 5); DEC 2024 (end of Stage 6)

Client
urbanest

- Stage 0: Supported by Passivhaus Consultant, undertook Research and Development, prepared Case Studies, Site Appraisals etc.
- Stage 1: Appointed Design Team
- Stage 2: Appointed Passivhaus Certifier to support the project between Stage 2 and 7
- Stages 3–6: Appointed Main Contractor
- Stage 7: POST OCCUPANCY EVALUATION

Design Team

Architecture and Engineering
AHMM, Walsh, etc.

- Stage 1: Appointed by urbanest to develop design scenarios, in discussion with Passivhaus Consultant
- Stage 2: **Design Development** Developed and refined design liaising with Passivhaus Consultant. Developed BIM output core data for export to PHPP
- Stage 3: Liaised with Passivhaus Consultant and Design team to ensure design was spatially and technically coordinated and aligned with Passivhaus performance specification
- Stages 5–6: **Design Development** Liaised with Passivhaus Consultant. Visited site to review progress and quality of the works relevant to their scope
- Stage 7: POST OCCUPANCY EVALUATION

Passivhaus Consultant
Henriksen Studio

- Stage 0: Developed Passivhaus strategy and helped Client set up initial sustainability target
- Stage 2: **PHPP setup / Testing**
- Stage 3: **Technical details / Spec**
- Stage 5: **Monitor / advise** Liaised with Passivhaus Certifier
- Stage 6: Submitted Passivhaus evidence to Passivhaus Certifier
- Stage 7: POST OCCUPANCY EVALUATION

Main Contractor
Mace Construct

- Stages 5–6: **Novated to contractor Review / detail / coordinate**
  - Construction Programme taking into account Passivhaus actions. Liaised with Passivhaus Consultant. Airtightness Management Team to conduct interim tests
  - Conducted final airtightness test. Arranged MVHR/ ventilation commissioning. Collated evidence of compliance

Passivhaus Certifier
Independent evaluators

- Stages 3–6: Liaised with Passivhaus Consultant / project team
- Stage 3: INITIAL CHECK
- TENDER
- Stage 4: DESIGN CHECK
- Stage 6: FINAL ASSESSMENT
- Stage 7: PASSIVHAUS CERTIFICATION AWARDED

Zoning Strategy

Multiple Passivhaus models

Subdiving into multiple thermal and airtightness zones can help overcome the complications associated with building a Passivhaus standard high-rise.

Tailored Solutions

urbanest Battersea includes cafe and EBU spaces alongside student accommodation rooms. These areas have varying energy, ventilation, and occupancy needs. By dividing the project into several PHPP models, each use can be assessed and optimised according to its specific criteria.

Data Management

Large buildings involve vast amounts of data related to energy performance, materials, and systems. Subdividing breaks down complex data into smaller, focused sections, simplifying analysis.

Enhanced Accuracy

Different sections of a building might have varying exposure to the sun, shading, wind, or internal loads. By dividing into multiple PHPP packages, each section can be analysed more precisely, leading to more accurate energy performance predictions.

Flexibility in Design and Planning

If changes are needed in one part of the building, only the relevant PHPP package needs to be updated. This avoids the need to rework the entire building model, saving time and reducing the risk of errors.

Risk Management

By dividing the building into separate PHPP models, potential design or performance issues can be isolated and addressed within a specific section. This reduces the risk of a single problem preventing the entire project from passing the certification and makes troubleshooting more straightforward.

The Balancing Act

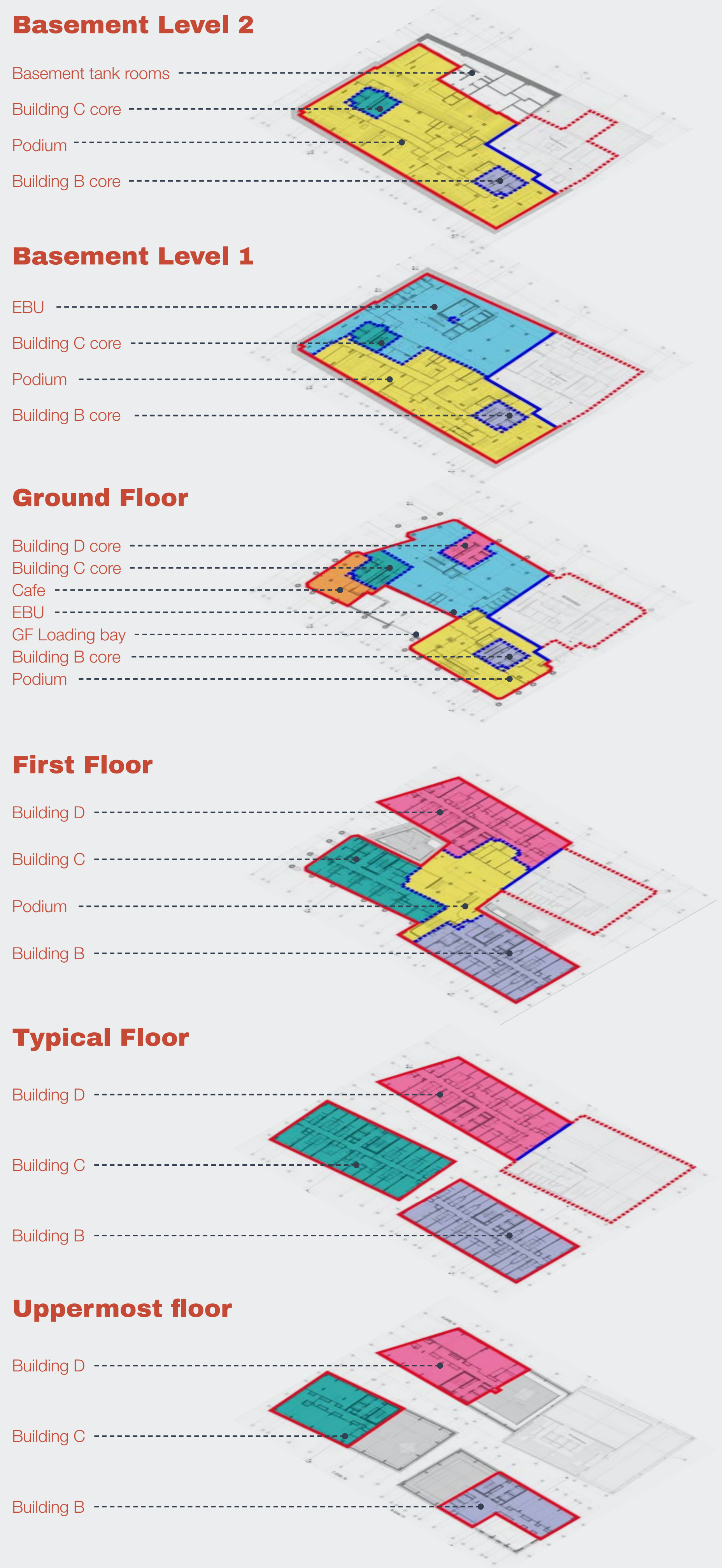
Dividing the project into individual models streamlined the design validation process and supported timely delivery. At urbanest Battersea, Building B was established as a benchmark; once approved by the certifier, its principles and methodologies were replicated across all PHPP models.

While this approach enhanced design efficiency, it required a dedicated team to develop and refine airtightness strategies at internal boundaries to meet the stringent Passivhaus criteria. This resulted in increased costs due to higher demands on materials and workmanship.

The compartmentalised testing approach also led to a few interim airtightness test failures - issues that might have been mitigated through a more integrated testing strategy.

However, the decision to zone the building was ultimately necessary, reflecting the varied uses across the scheme and providing a contingency: had the podium zone (considered high-risk) failed testing, the remaining blocks could still achieve certification. This reflects a strategic balancing act between performance, risk management, and certification success.

Diagrams showing different PHPP zones across the floors



Key

PHPP Zone	Area of building
PHPP 01	Building B
PHPP 02	Building C
PHPP 03	Building D
PHPP 04	Podium
PHPP 05	EBU (Enterprise business unit)
PHPP 06	Cafe

- Thermal & Airtightness Line
- Thermal Line to non-certified zones (insulation only)
- Airtightness Line between certified and uncertified zones
- Airtightness Line between certified zones (internal boundaries)

Excluded

Building A
Basement tank rooms
GF Loading bay and Electrical transformer
Top floor plant rooms

Form and Orientation

Key principles

Heat loss form factor plays a crucial role in the energy efficiency of a Passivhaus building. It is defined as the ratio between the building's envelope surface area (heat loss area) and its treated floor area. A lower form factor indicates a more compact and efficient shape, reducing heat loss and improving overall performance.

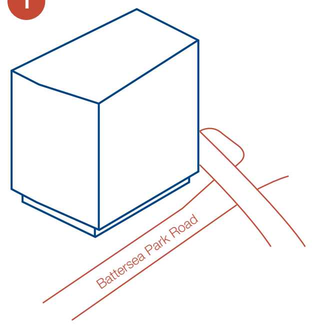
Thanks to its large scale and compact geometry, urbanest Battersea achieves a highly favourable form factor, with Buildings B, C and D scoring 1.04, 1.04 and 1.1 respectively.

A form factor close to or below 3.0 is typically ideal for achieving Passivhaus standards. A favourable form factor also eases the pressure on U-value requirements, allowing simpler detailing and reducing the need for very high insulation levels while still meeting stringent performance targets.

This helps minimise complexity, avoid performance gaps, and support a more robust and efficient building outcome.

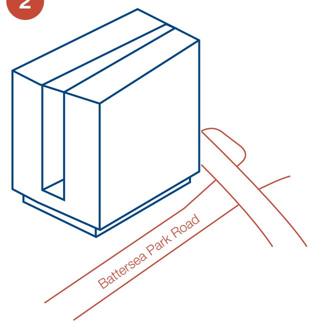
Massing strategy diagrams

1



Base Massing

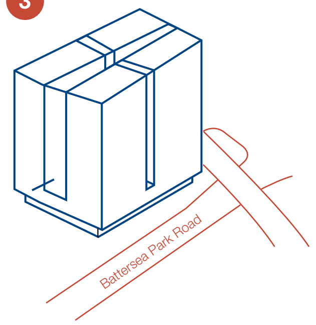
2



East-West Cut

Allows for southern light and views through the site from prominent views (including views looking east and west on Battersea Park Road)

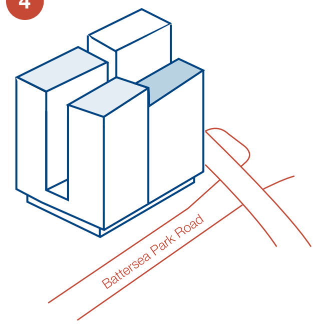
3



North-South Separation

Creates separation between different uses and brings light into the courtyard

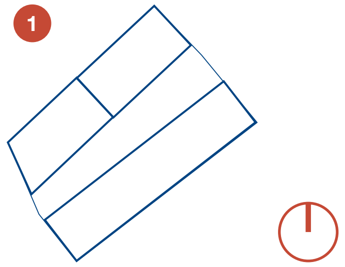
4



Stepping, Shifting and Twisting

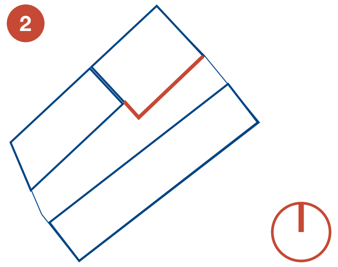
Adds variety and identity to the different elements. Twisting in plan gives each building its own orientation and outlook.

1



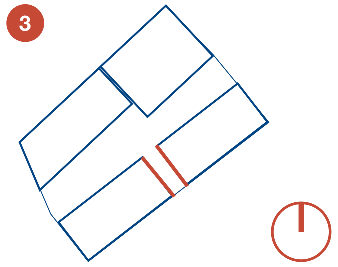
Two linear blocks

2



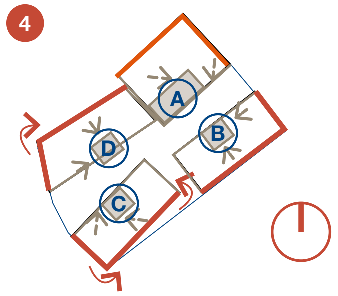
Stepping the north block

3



Cutting to the south for improved daylight

4



Twisting the blocks cores facing the courtyard

The buildings are near optimally oriented, with the long side of the buildings facing NNE. This allows the majority of glazing on the south-facing façade to capture winter sunlight, reducing heating demand. Meanwhile, the shorter east- and west-facing sides help mitigate excessive summer heat gain.

The building massing has been carefully curated to optimise daylight intake, city views, and outdoor amenities, enhancing the experience of the building and occupant comfort while maintaining a balanced energy performance and preventing excessive heat gain.

1: 1000 scale model by AHMM Modelshop

Façade U-Value Performance Requirements

Location	Building B	Building C	Building D	Podium/EBU GF+1F	Building B Roof terrace	Building D Roof terrace
Construction system	Unitised	Unitised	Unitised	Stick curtain wall	Stick curtain wall	Stick curtain wall
Required u-values (glazing + framing)	0.65 W/m²K	0.65 W/m²K	0.65 W/m²K	0.55 W/m²K	0.65 W/m²K	0.65 W/m²K

Façade Design

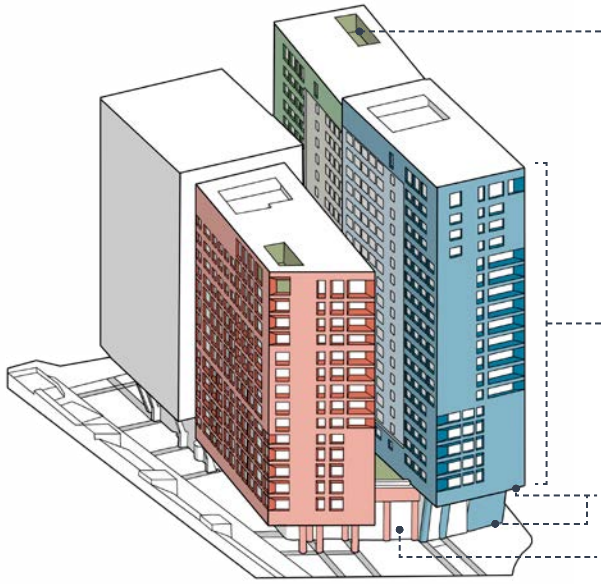
Design strategy and development

Strategic Overview

The façades of the student accommodation blocks are designed in line with Passivhaus principles. Chamfered recesses provide tailored shading to reduce summer solar gain, minimising cooling demand while maximising daylight.

This approach responds to each façade's orientation, adding variety and visual interest within the urban context.

A shared glazed ceramic façade system unites the three buildings, while distinct colour palettes give each block its own identity.

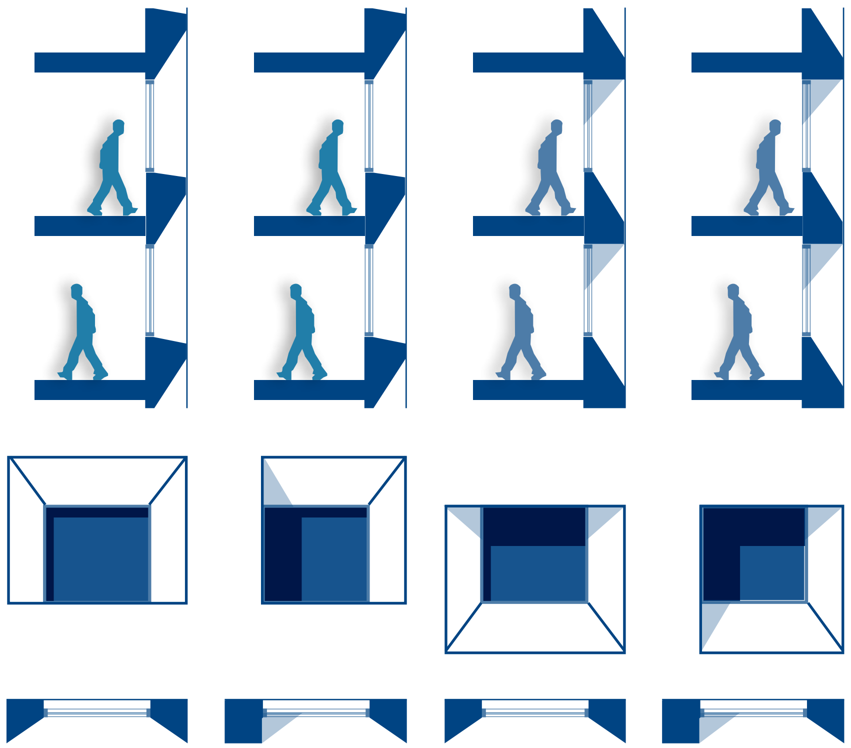


Designing to Orientation

The external façade combines solid panels with recessed, chamfered doughnut panels. The chamfer geometry varies to optimise daylight and views or to increase shading. Chamfers providing greater shading are concentrated on the southern façades, while those allowing more daylight are positioned to the north.

Window types range from fully chamfered openings admitting maximum light to unchamfered ones offering deeper shading and framed views. Within each façade, chamfer types are arranged in clusters to articulate the design and break up the elevation, creating subtle variations in pier width and solid-to-void proportions.

Additional refinement occurs at corners and upper levels, where modified chamfer types are introduced. Further variation results from differing window sizes that correspond to the range of room types and functions.



Max. daylight | **Vertical Shading** | **Horizontal Shading** | **Max. Shading**

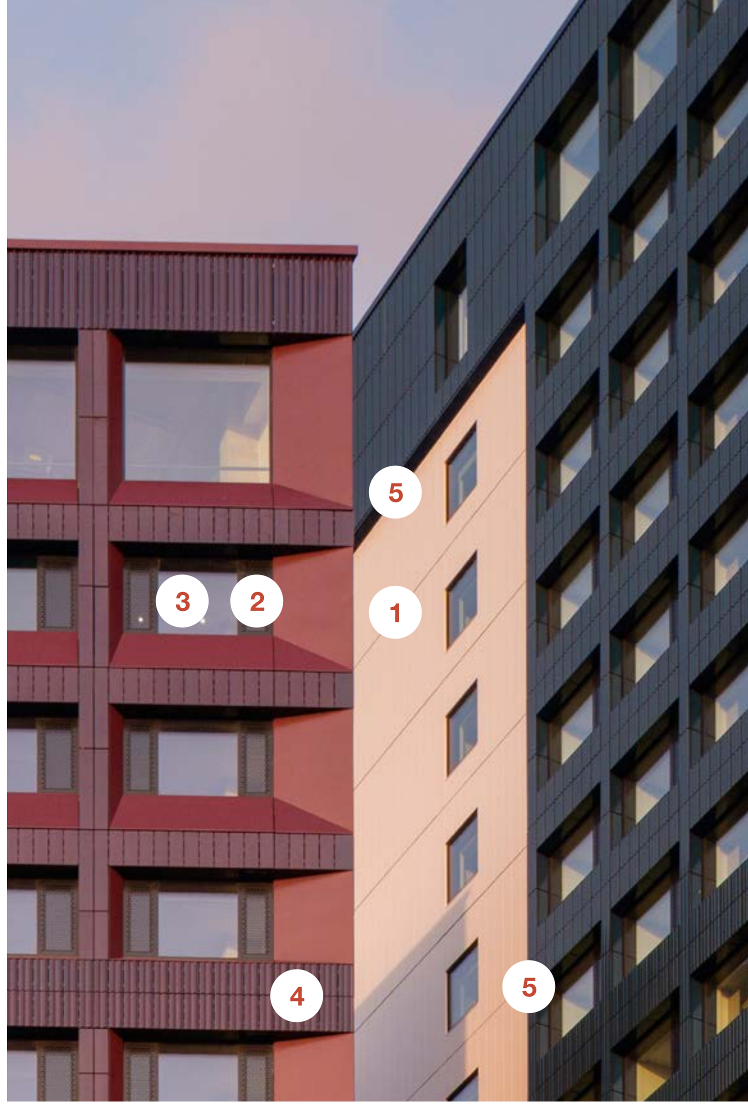
Articulation of chamfered geometries and window typologies

Articulation between Solar Gain and Daylight

The triple-glazed, high performance windows used in the towers have a light transmittance of 70%, with the overall window to wall glazing ratio being approximately between 23%-30%, while the G-value of the glazing varies between 0.27 and 0.49, depending on the façade typology and orientation. To further enhance daylighting, two façade types were introduced for the inner courtyard-facing elevations. The outer deeper façade wraps around the corners and upper zones, where sun exposure is higher. Its increased depth provides natural shading, significantly reducing overheating risk.

A simple glossy, reflective metal panel façade was proposed to maximise daylight in courtyard-facing rooms. Since no additional shading is required, this façade is thinner, with the glazing line brought forward to create variation and optimise daylight and sky views. Additionally, windows facing internal courtyards are larger than those on external elevations, spanning the full width of the rooms.

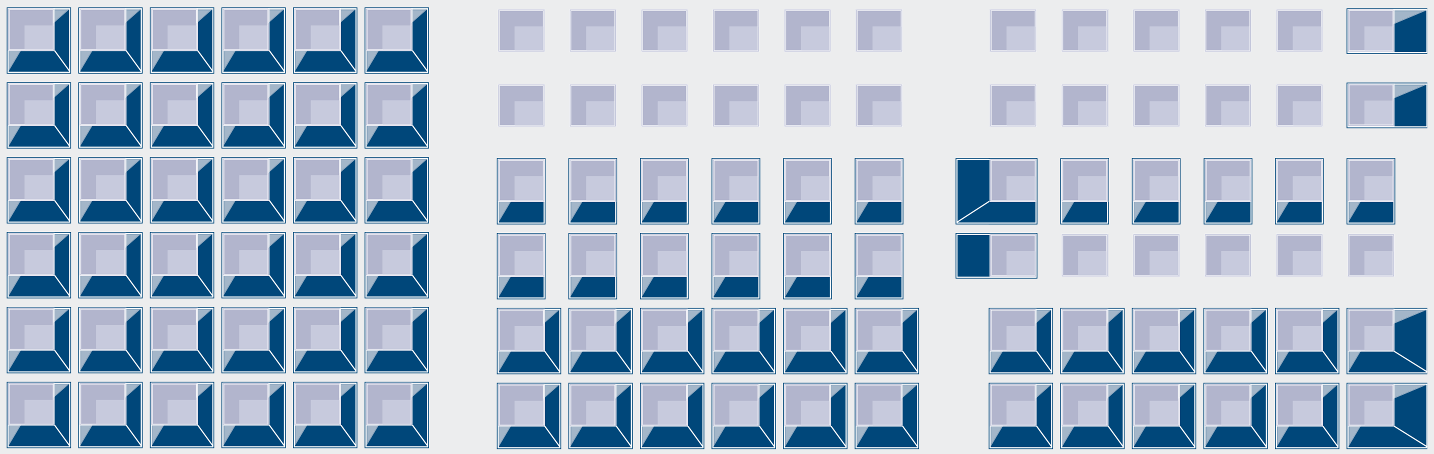
This design strategy enhances natural light, openness, and visual connection to the sky, improving the overall spatial quality and occupant experience.



Key

1. Reflective metal façade toward the inner courtyard
2. Glazed openable vent with fixed perforated panel
3. Fixed glazing
4. Coloured glazed tiled façade
5. Chamfered façade transition

Layered façade logic: Orientation response and spatial field shifts



Shading and Orientation

A single façade type was used to provide the necessary shading according to each elevation's orientation.

Banding and Increased Pier Widths

The solidity and pier widths were increased vertically up the façades. to create a series of bands that wrap around the building façades. The tops of the buildings become the most solid.

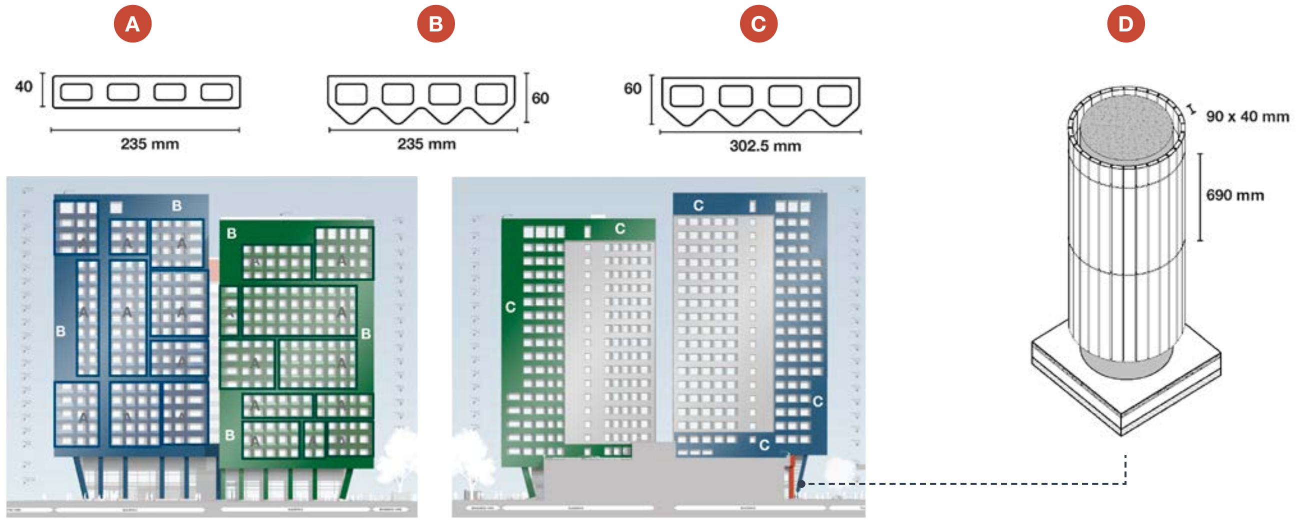
Shifting Fields

These bands were further emphasised by shifting the chamfers to the edges of the building. Fields within the bands further break up the elevations and provide variety within the townscape.

Unitised system - detailed design and construction

Standardised Tiling System

Rationalisation of tiling system across the elevations

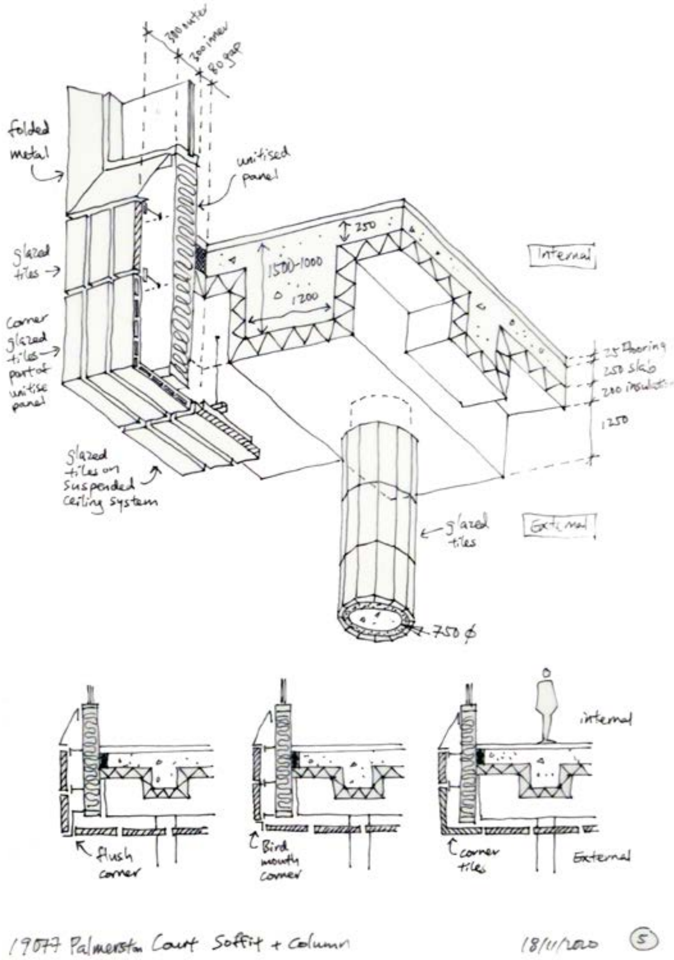


Chosen colour palette following an extensive selection process

The use of glazed tiles and aluminium reveals draws inspiration from the site's industrial heritage while aligning with London Borough of Wandsworth's emerging aspirations for the Battersea Design and Technology Quarter. The reflective, glossy tiles capture and abstract the surrounding context, creating dynamic façades that respond to light and shadow both from afar and at close range.

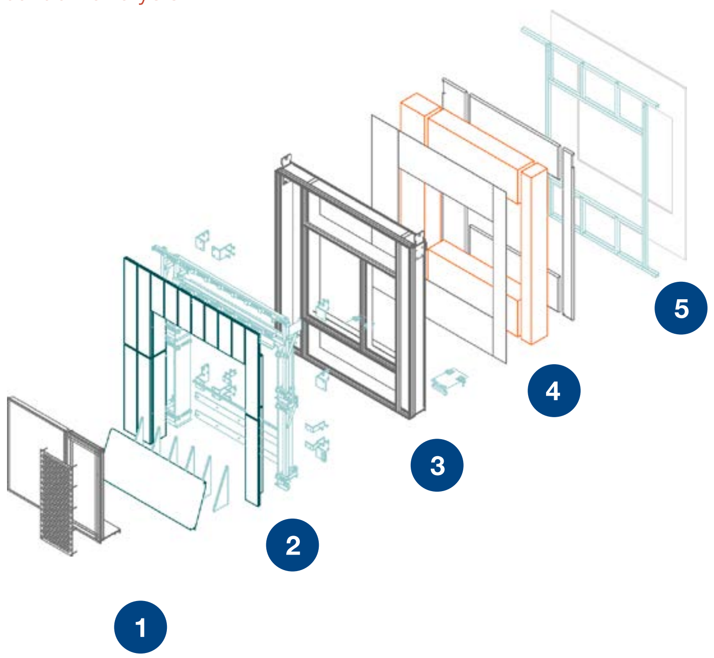
Variations in tile texture also contribute to glare control, while tiles are organised into standardised systems to streamline design detailing and fabrication.

Axonometric sketch to communicate material compatibility, detailing and buildability with contractors



Standardised Façade Panel

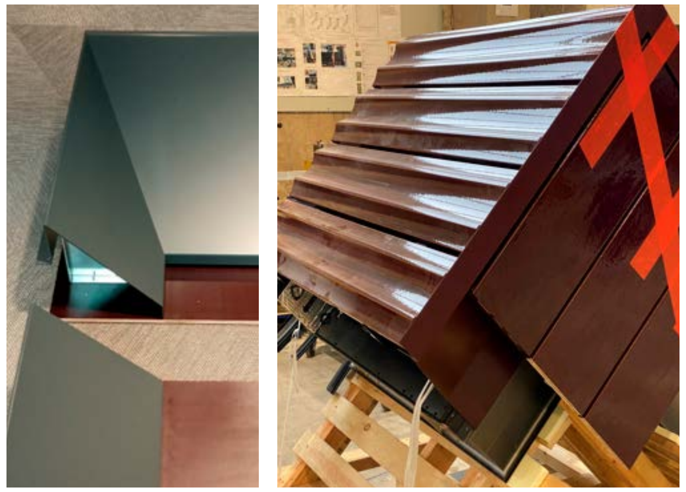
Standardised panels were developed based on façade typologies. Illustrated by AHMM's Sustainability Team for carbon analysis.



1. **Aluminium Frame Triple Glazing**
   - Triple Glazed Unit
   - Aluminium Frame Triple Glazed Window System
   - PPC Aluminium Perforated Panels
2. **Terracotta Cladding and Aluminium Chamfer**
   - Glazed Terracotta Tiles
   - 300mm deep PPC Aluminium Chamfer
   - PPC Aluminium Support System
   - Stainless Steel Brackets
3. **Aluminium Unitised System Frame**
   - 300mm Aluminium Unitised System Frame
   - Galvanised Steel Brackets
4. **Mineral Wool Insulated Sandwich Panel**
   - 2mm Mill Finish Aluminium
   - 300mm Mineral Wool Insulation
   - 3mm Mill Finish Aluminium
5. **Drylining System**
   - 50mm SFS for Drylining
   - Double Lined Plasterboard

Samples, Mock-Ups, Benchmarks and On-Site Assembly

Mock-ups to review material compatibility and buildability



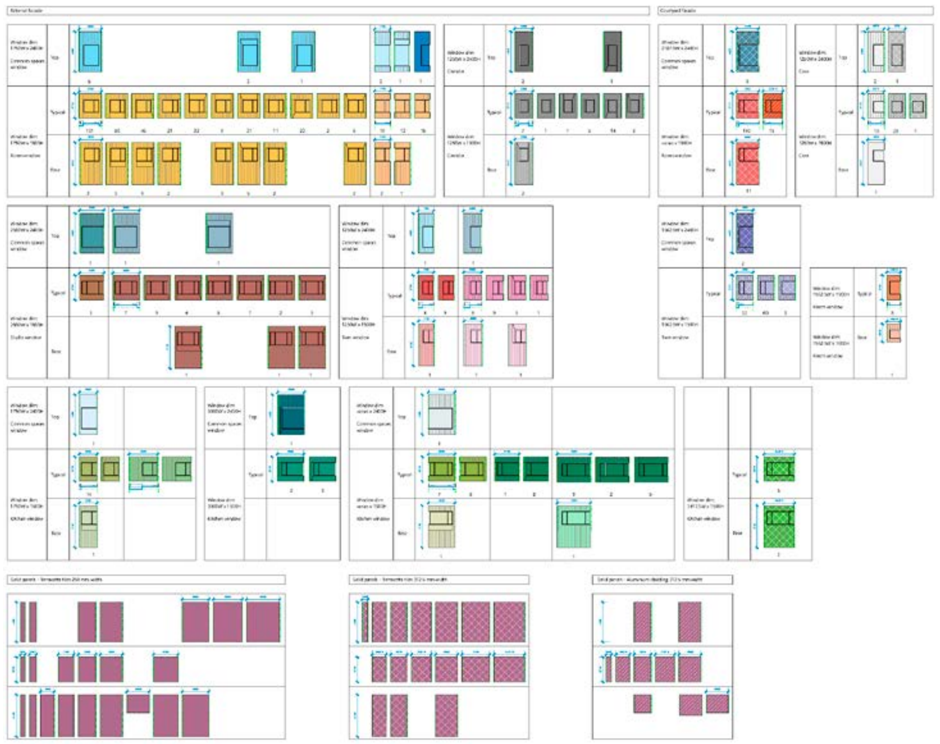
Façade mock-up for a dual review on visual and performance due to tight project programme

Unitised system - detailed design and construction

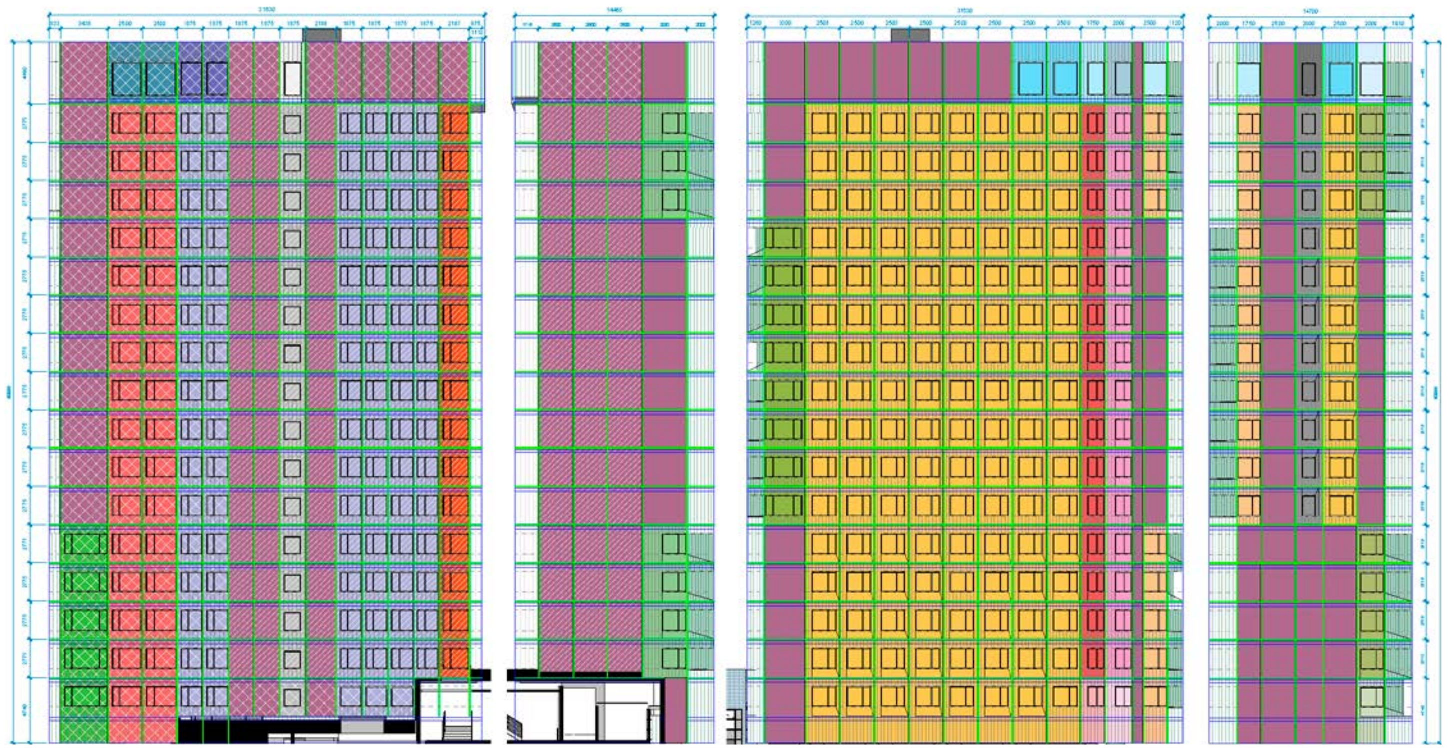
Design Optimisation

Heat loss through the building fabric significantly affects specific heating demand, making early-stage design optimisation essential. AHMM and Henriksen Studio collaborated to streamline the cladding system with standardised assemblies and repeatable details, which not only streamlined the calculation process for the area weighted u value per building, but also enhanced construction quality and cost efficiency.

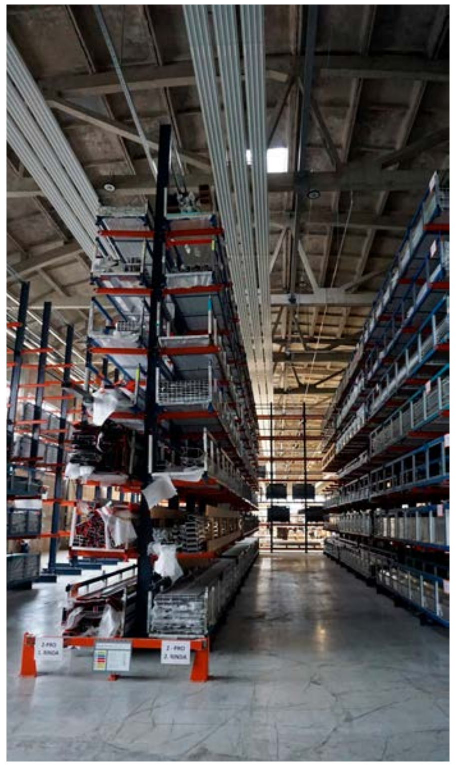
This approach made it easier to design out thermal bridging, ensures consistent airtightness, and allows for precise control of insulation continuity.



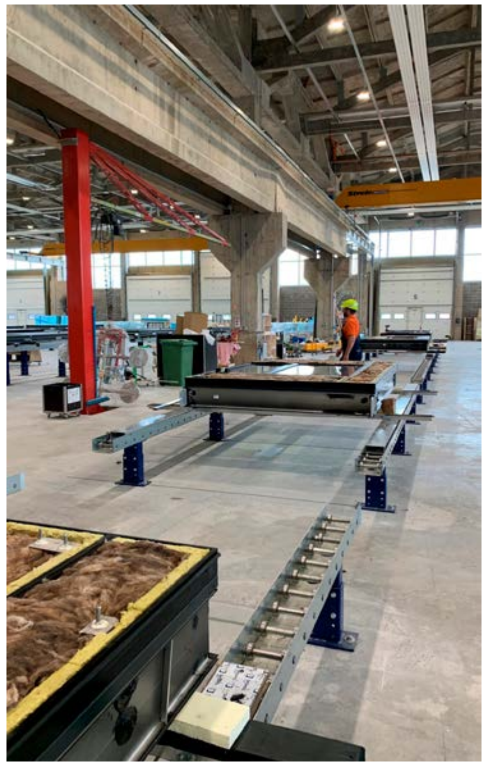
Schedule of façade panel types



Façade setting out for Building B

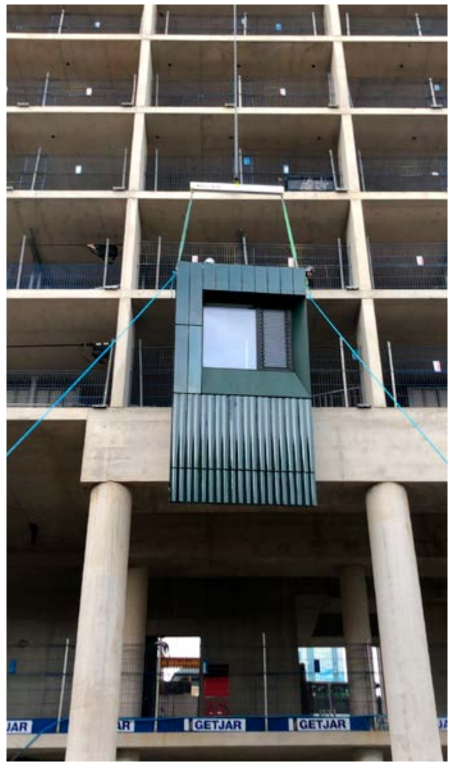


Components for the unitised panels in the warehouse

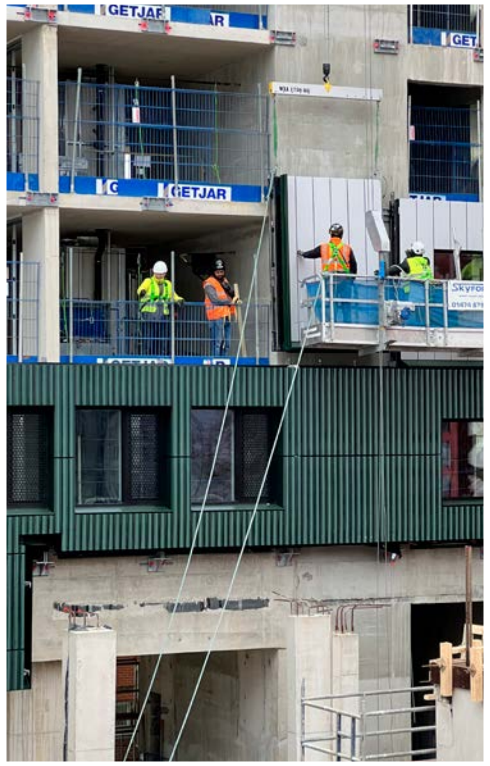


Unitised panels being assembled in the factory

Unitised panels arriving in London



First unitised panel being installed



Panel installation requiring 4-5 builders for accurate fitting

Unitised panel assembly in progress

Unitised system - detailed design and construction

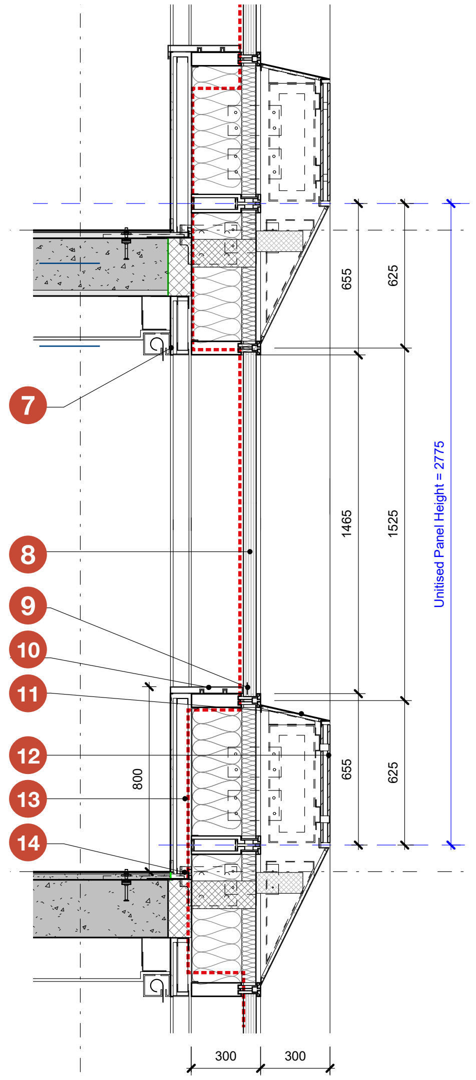
The unitised system offers multiple advantages. From a Passivhaus perspective, its precision fabrication and controlled panel assembly reduce thermal bridging and ensure consistent airtightness and wind barrier performance are achieved through aluminium sheets on either side of the unitised panels, with horizontal and vertical gaskets ensuring continuous airtight junctions.

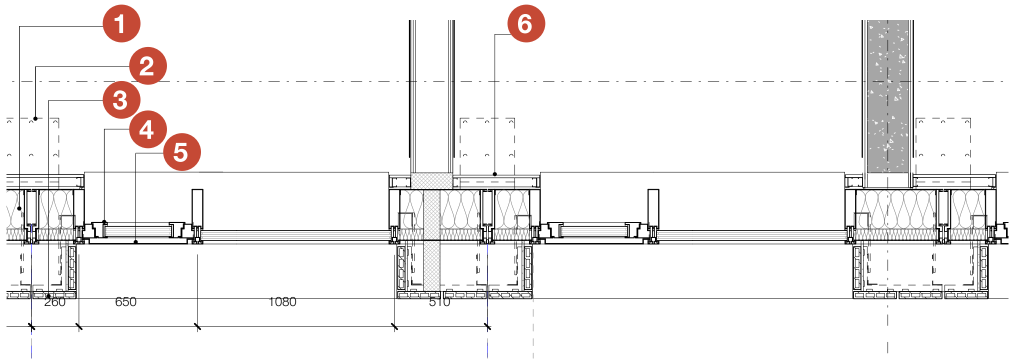
Coordination with façade subcontractors ensured airtightness around all penetrations, while on-site testing of selected sample areas confirmed the installed sections meet the required permeability standards.

From a cost and construction perspective, off-site fabrication improves quality control, reduces installation time and labour, and lowers the risk of on-site rework. Additional benefits include faster installation, simplified maintenance or replacement of individual panels, and reduced on-site waste and disruption.

Typical bay plan and section

© James Santer





Key

1. Unitised Façade Panel
2. Façade Steel Support below
3. Smooth Terracotta Cladding
4. Openable Vent
5. Fixed Perforated Metal Panel
6. Plasterboard Internal Lining
7. Indicative blind box
8. Fixed glazing
9. Silk screen print to internal face of glass to conceal internal cill edge
10. Internal Cill (concealed fixings & removable for glass replacement)
11. External Cill
12. Terracotta Cladding
13. Plasterboard Internal Lining
14. Steel Support Bracket

© James Santer

MEP Strategy

Detailed design, construction, monitoring and testing

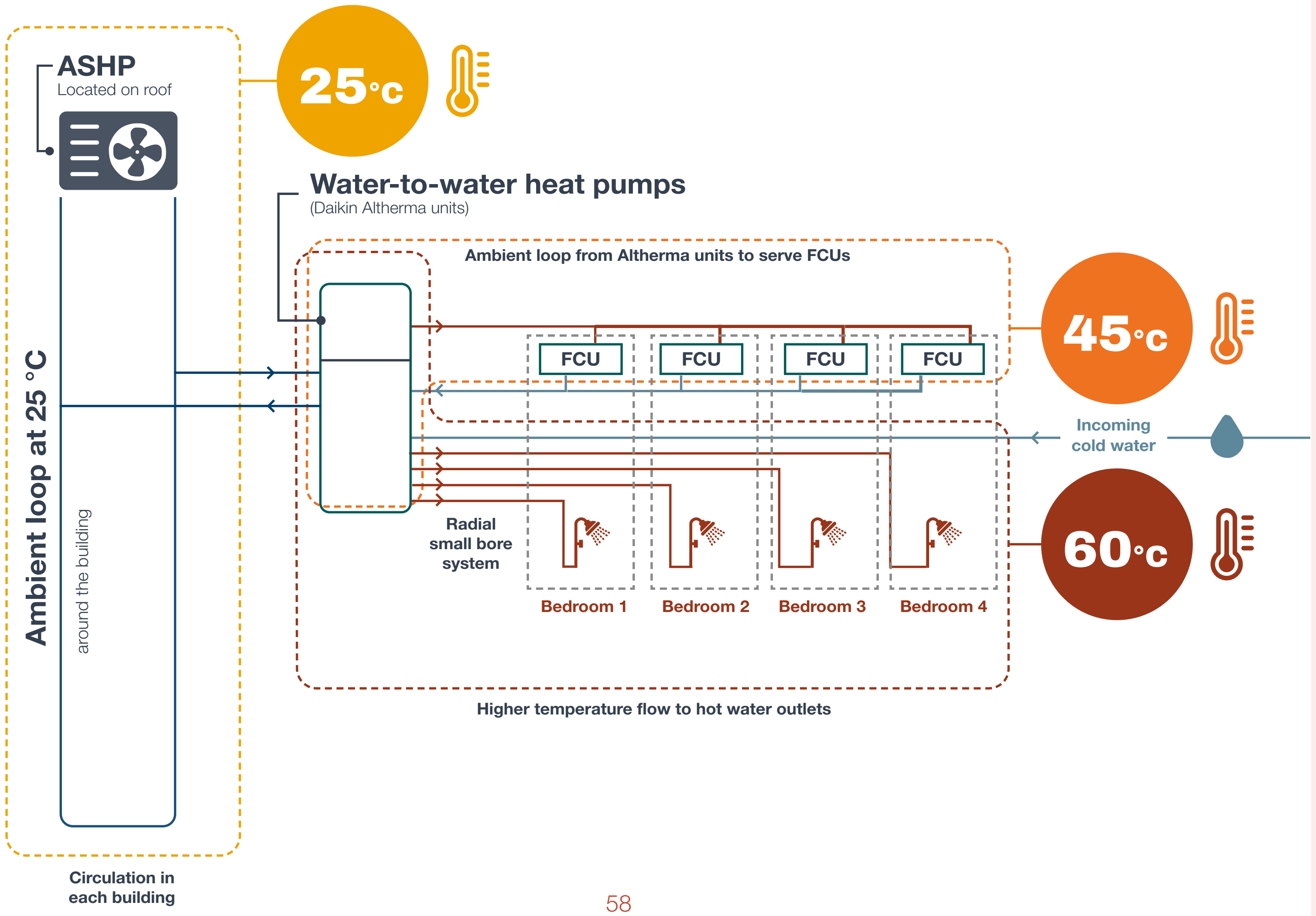
Ambient Loop-Heating and Cooling Strategy

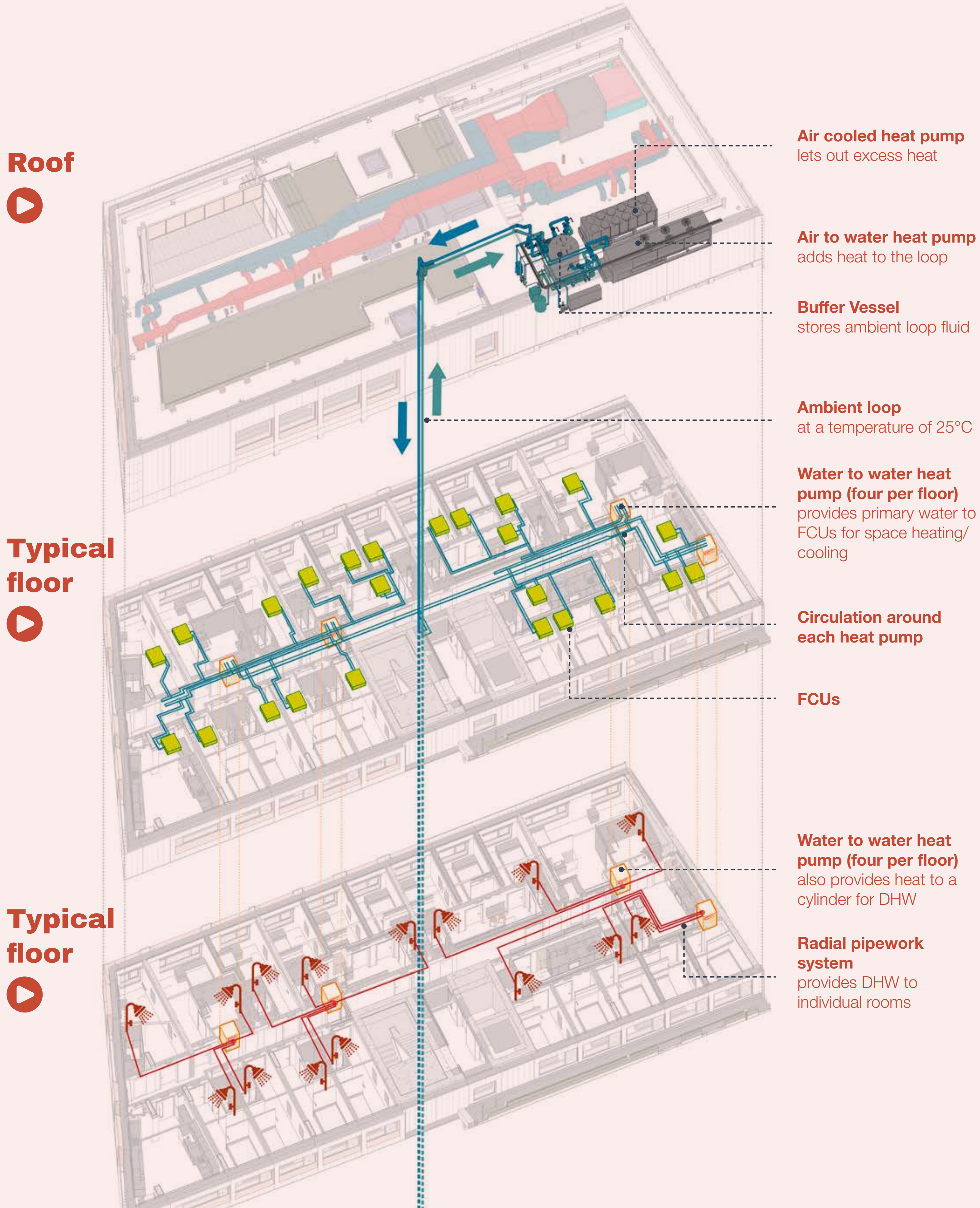
An air source heat pump (ASHP) located on the roof of each building serves an ambient loop that pumps water around the building at an ambient temperature of around 25°C. There are four water-to-water heat pumps on each floor, which draw water from the ambient loop and upgrade this to a usable temperature to provide domestic hot water, cooling and heating via the fan coil units within the space.

The ambient loop system, combined with radial pipework distribution, minimises heat loss, reduces overheating risk, and lowers operational energy demand compared to maintaining a higher loop temperature in a traditional system. It is especially efficient when some heat pumps operate in cooling mode while others operate in heating mode, as often occurs in student accommodation due to varying occupant needs.

The system will be able to reclaim "waste heat" whilst in the cooling mode which further mitigates the energy use in the building as the heat is rejected into the ambient loop. The system's reduced insulation requirements also enable a leaner MEP installation, lowering embodied carbon and costs.

Schematic diagram of the ambient-loop system in operation





Axonometric diagram of the ambient-loop system in operation

Detailed design, construction, monitoring and testing

Ventilation Strategy

The performance of the ventilation system is key to the success of maintaining a low specific heating demand. Passivhaus ventilation relies on mechanical ventilation with heat recovery (MVHR) to ensure energy efficiency and a constant supply of fresh indoor air while minimising heat loss.

At urbanest Battersea, each student unit is served by centralised air handling units that recover heat from exhaust air and return it to the building. These units can also bypass heat recovery to provide “free cooling” during cooler nights following hot days. A further advantage of the centralised system is its ability to reclaim waste heat for domestic hot water production, which represents the largest energy load in student accommodation. This integrated approach significantly reduces operational carbon emissions compared with conventional building systems.

In addition to heat recovery, the system supplies filtered air, reducing dust and pollen ingress and maintaining low CO_2 levels, which enhances indoor air quality and supports occupant wellbeing.

Spaces not served by the central AHU are equipped with local MVHR units. Communal kitchens use local MVHR systems with supply grilles in suspended ceilings and façade-integrated intake and exhaust points positioned around kitchen windows.

For assured performance and compliance, Passivhaus certified MVHR units are recommended, as they meet PHI requirements for heat recovery efficiency, specific fan power, acoustic performance, and overall reliability. Non-certified units typically incur a 12% heat-recovery penalty and require additional verification to demonstrate compliance. The MVHR unit selected for the student accommodation areas is PHI-certified, ensuring full compliance without further analysis.

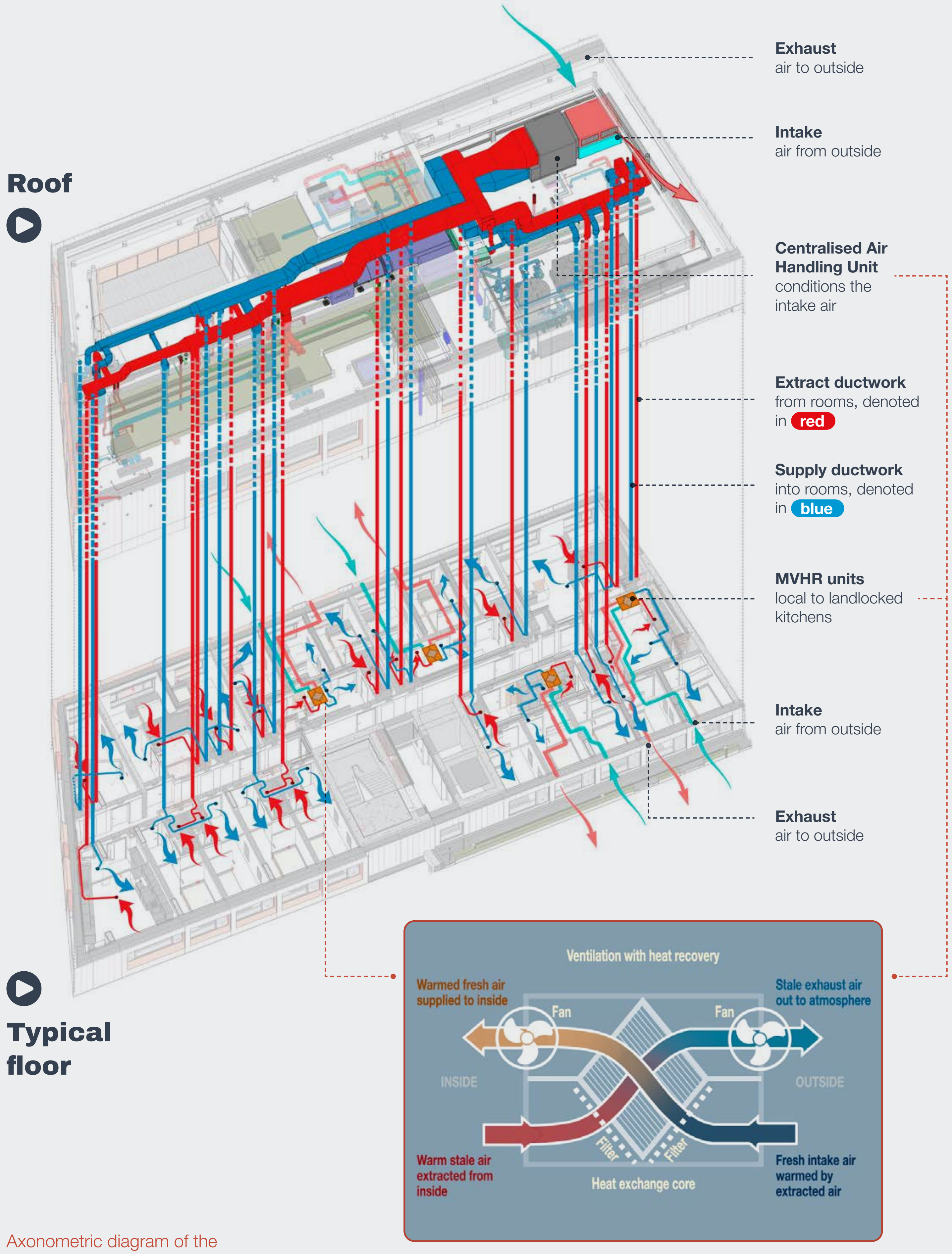
Balanced Air Flows

The Passivhaus standard requires supply air flow and extract air flow to be equal - within a 10% overall system imbalance tolerance. Too much extracted air or too much supply air would lead to heat loss due to infiltration or exfiltration, compromising the energy balance of the building.

For tall buildings, achieving this balance becomes more challenging. The stack effect intensifies with height, creating strong upward or downward pressure differentials that vary between lower and upper floors. Wind pressures also increase at higher elevations, causing fluctuating façade loads that can disrupt carefully calibrated airflow rates.

These forces mean that even small imbalances in the mechanical ventilation system can be amplified across the height of the building. As a result, tall Passivhaus projects require more sophisticated controls and highly coordinated commissioning to maintain the required pressure neutrality throughout the entire building.

Intake and exhaust grills integrated into the façade design



Axonometric diagram of the MVHR system in operation

Airtightness

Design and construction

Why is it important?

Airtightness is essential in Passivhaus buildings because it reduces heat loss, improves comfort, and protects the building fabric. A well-sealed envelope limits uncontrolled infiltration, lowering the energy needed to reach and maintain a comfortable internal environment. As shown below, poor airtightness can significantly increase heat losses through ventilation and infiltration [17], undermining the benefits of high-performance fabric.

urbanest Battersea has an internal volume of 53,976 m^3 and an envelope area of 18,480 m^2. Larger buildings often meet the ≤ 0.6 ACH @ 50 Pa Passivhaus target more easily due to their favourable surface-to-volume ratio, but they can still experience localised draughts.
Air permeability testing therefore remains an important check on construction quality, helping to identify weaknesses in the airtightness layer before completion.

The Requirement

Airtightness and air permeability are assessed using a Blower Door test, which pressurises and depressurises the building to 50 Pa. To achieve Passivhaus certification, urbanest Battersea must meet two performance thresholds:

Air change rate (N50)

≤ 0.6 ACH@50 Pa

Air permeability (Q50)

≤ 0.6 m^3/h/m^2@50 Pa

for buildings with an internal volume greater than 4,500 m^3

Understanding the difference between these metrics is essential:
Air Change Rate (ACH): A Passivhaus metric calculated by dividing the measured airflow (m^3/h) by the building's internal volume (m^3). It indicates how much air is unintentionally exchanged with the outside and directly relates to heat loss.

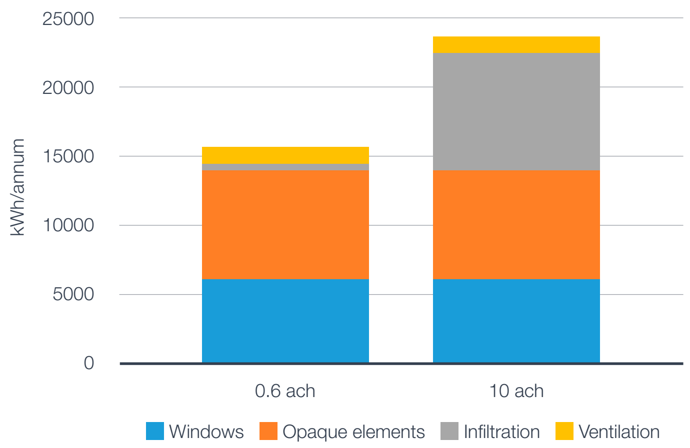
Air Permeability (m^3/h/m^2): Calculated by dividing the measured airflow (m^3/h) by the envelope area (m^2). It is widely used in UK construction as an indicator of build quality and airtightness integrity.

These metrics are not interchangeable; their relationship depends on the building's surface-to-volume ratio, meaning form and scale strongly influence results. In a building the size of urbanest Battersea, the 0.6 m^3/h/m^2 air permeability target corresponds to roughly 0.23 ACH.

The Strategy

A clear, continuous airtightness line must be established from the outset in both plan and section, along with the sealing products and construction processes needed to achieve the target performance. As described in the previous chapter, the building was divided into six airtightness zones, with boundary conditions defined through a coordinated set of drawings.

Developing these boundaries required careful attention to detailing, specification, and sequencing by both the design team and contractors.



Heat losses in a Passivhaus dwelling with high and low airtightness (Courtesy of Passivhaus Trust)

List of Airtightness Materials

Cut-away section showing different airtightness zones

Inverted Roof System
- Inherently airtight concrete with hot melt system on top

Services Penetrations
- Fire stopping products tested to have satisfactory level of airtightness
- Grommets
- Airtightness tapes

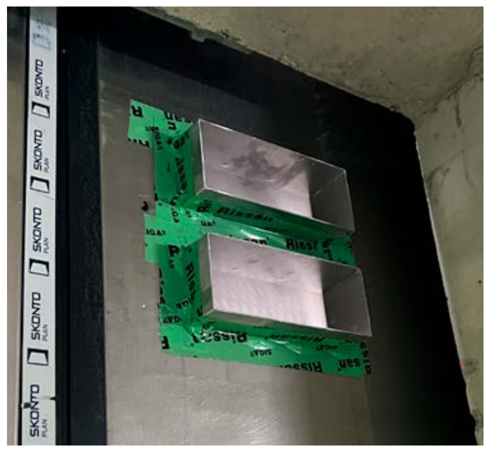
External envelope
- Cladding system airtightness achieved by aluminium sheets on front and back of the unitised panel
- Junctions sealed by gaskets

Floors
- Concrete (inherently airtight)

Internal Walls
- Dry lining with 5mm skim plaster: a thicker skimming will provide an adequate airtightness barrier
- Blockwork with acrylic sprayed membrane
- Concrete (inherently airtight)
- High performing doors as internal airtight doors at internal boundaries

Examples of Air Barrier Applications

Blockwork with acrylic sprayed menbrane



Airtightness tape around services penetrations

Fire stopping product around incoming cables

Monitoring and testing

Management and Process

Extensive planning is required for a large building to pass the final airtightness test. Given the scale of the task, effective teamwork is essential. Mace Construct established an on-site airtightness management team dedicated to overseeing and monitoring the process. This team worked closely with testers and subcontractors to coordinate works required for each type of testing.

Interim Tests

To ensure compliance and a smooth process, it is essential to integrate interim airtightness testing into the overall construction programme. This greatly mitigates the risk of failing the final airtightness test. As shown overleaf, Henriksen Studio advised the following tests to be carried out as construction proceeded:

- **Component tests (offsite)** to be conducted if no prior test evidence available for existing products or assemblies
- **Prototype tests (offsite)** Partial assembly of components and/or bespoke elements using final materials
- **Benchmark tests (onsite)** Areas of permanent installation intended as a point of reference for quality
- **Area checks (onsite)** Progressive checks of construction.
- **Zone tests (onsite)** Sectional and full areas of the building:
  Stage 1 Pre-tests to assess key junctions and penetrations to identify weaknesses before major works progress.
  Stage 2 Sectional tests to be carried out on specific building sections as they were near completion, ensuring airtightness measures are applied consistently
  Stage 3 Final test on the completed building and retests (as required)

The total number of tests was estimated to be around 70, excluding any retests required in the event of failure.

Benchmarks onsite

Extract of Airtightness testing schedule. Courtesy of Henriksen Studio

No	Benchmark Description	Locat. Type	Extent	Airtight-ness Test Target	Airtightness Test Body	Smoke & Thermography Test Required
B1	Unitised curtain wall - Block B	Façade	2nd installed floor incl. corner 2 vertical & 2 horizonal joints	≤0.2 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B2	Unitised curtain wall - Block C	Façade	2nd installed floor incl. corner 2 vertical & 2 horizonal joints	≤0.2 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B3	Unitised curtain wall - Block D	Façade	2nd installed floor incl. corner 2 vertical & 2 horizonal joints	≤0.2 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B4	Stick-built curtain wall system - Podium	Façade	2 vertical & 2 horizonal joints incl. corner	≤0.2 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B5	Kitchen and vent extractors	Façade	First installed extractor for each type	≤0.45 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B6	Parapet; interface between roof and façade	Non-façade	First completed section	≤0.45 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B7	Roof hatch/Access hatch - junction to upstand/slab	Non-façade	First installed hatch	≤0.45 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B8	Internal partition (Drylining) including: door frame junction, head detail, base detail	Non-façade	First completed section	≤0.45 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes
B9	Blockwork wall including: door frame junction, head detail, base detail, wall junction	Non-façade	First completed section	≤0.45 m^3/hr/ m^2 @ 50 Pa	Indep. Recognised Accredited body	Yes

Off site façade mock up to ensure performance requirements were met before sign-off for construction.

Onsite façade panels testing involved setting up testing rigs around 8 selected areas to measure the as-built leakage, ensuring delivery and installation did not compromise the airtightness performance of the design.

Off Site

Component Tests

by accredited bodies
e.g. roof access hatch/ rooflights/ metal doors/ services penetration products if no prior evidence available

Prototype Tests

by accredited bodies
e.g. unitised curtain wall panels, internal partitions including various junctions

On Site

Benchmark Tests

by accredited bodies
e.g. selected areas of unitised curtain wall, selected area of stick-built curtain wall in the podium, first completed section of parapet

Area Checks

by trained personnel
localised leakage checking ahead of the pre-test

On Site - Building Zones

Stage 1 Pre-Test

by accredited body groups of floors after airtight barriers were installed and remained mostly visible/accessible

Stage 2 Sectional Test

by accredited body groups of floors near completion

Stage 3 - Final test

Airtightness timeline

Monitoring and testing

The Final Test

Although the final test was conducted on a much larger scale, lessons learned from the interim tests were invaluable in identifying high-risk areas, refining remedial methods, and optimising time management.

These tests also required resource planning and manpower allocation across the test areas. In the event of a failed test, the cause of the leak would be identified using diagnostic tools such as smoke machines and thermographic cameras. The responsible subcontractor would then be contacted for rectification.

The initial plan was to test the individual building blocks and podium area separately, as suggested by the zoning strategy. However, through the learnings of the Podium pre-test, upon agreement with Henriksen Studio and BSRIA, Mace Construct decided that the best way to get the most accurate test result for the project was to test the entire building as one area.

Testing in this way would avoid the need to manage or monitor the leakage between the internal boundaries, which would have compromised area test results. Moreover, this also negated the need to work out an average result across the areas.

As illustrated on the next page, at final test, four blower doors were placed on ground floor and three on the uppermost level, with smoke machines placed across the floors of the final building test area for discovery of leakages.

Initial whole building airtightness result was 0.28 air changes per hour (ACH) and 0.815 $m^3/hr/m^2$ for air permeability, which fell short of the 0.6 $m^3/hr/m^2$ target. Henriksen Studio felt that this was not a true reflection of the air permeability, as some areas/interfaces/systems compromised the result unfairly. The programme, however, did not allow retesting to improve the results.

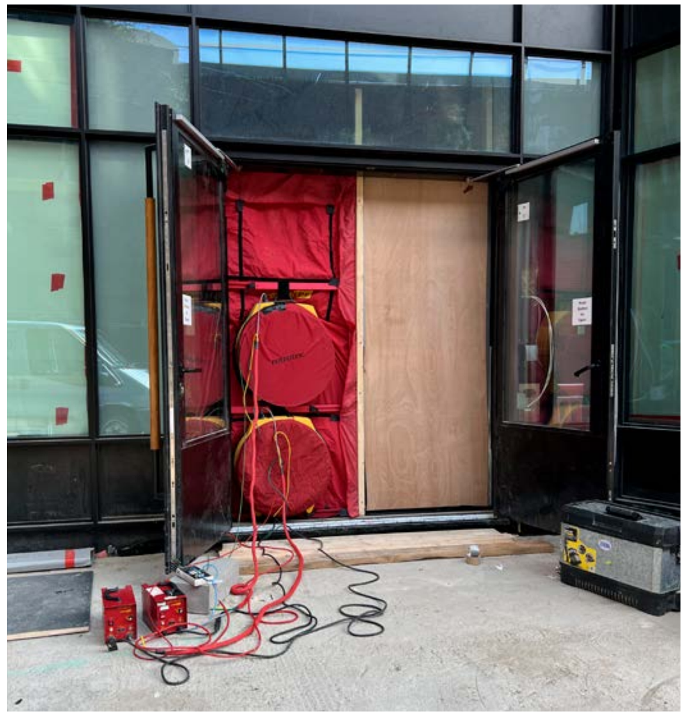
The measured air leakage had a low impact on the overall modelled performance of the building, and therefore the overall certification criteria were still achieved even with the negative impact of the higher than desired air permeability.

Final test area on Ground Floor

Final test area on Uppermost Floor

Team briefing prior to test commencement

Setting up blower door



Smoke machines in action

Observation of leakage through louvres at podium level

Thermal Bridging

Strategy to tackle heat loss associated with thermal bridges

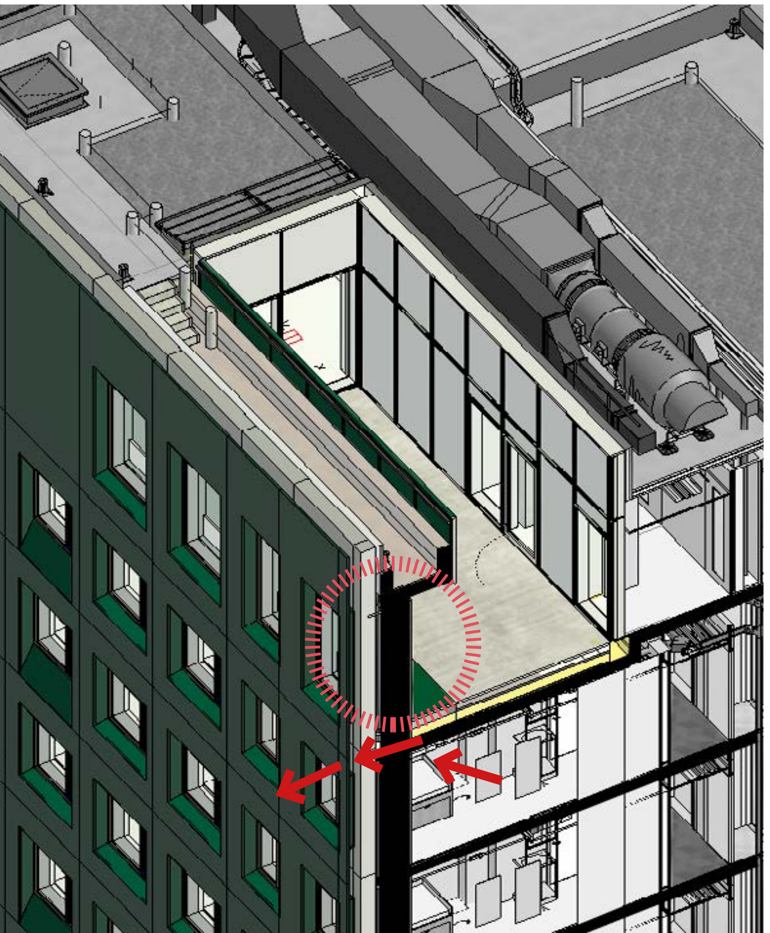
Why is it important?

Thermal bridges are areas in a building where heat transfer occurs at a higher rate than in surrounding materials, leading to increased energy loss, reduced thermal comfort, and potential condensation and mould risks due to low surface temperatures.

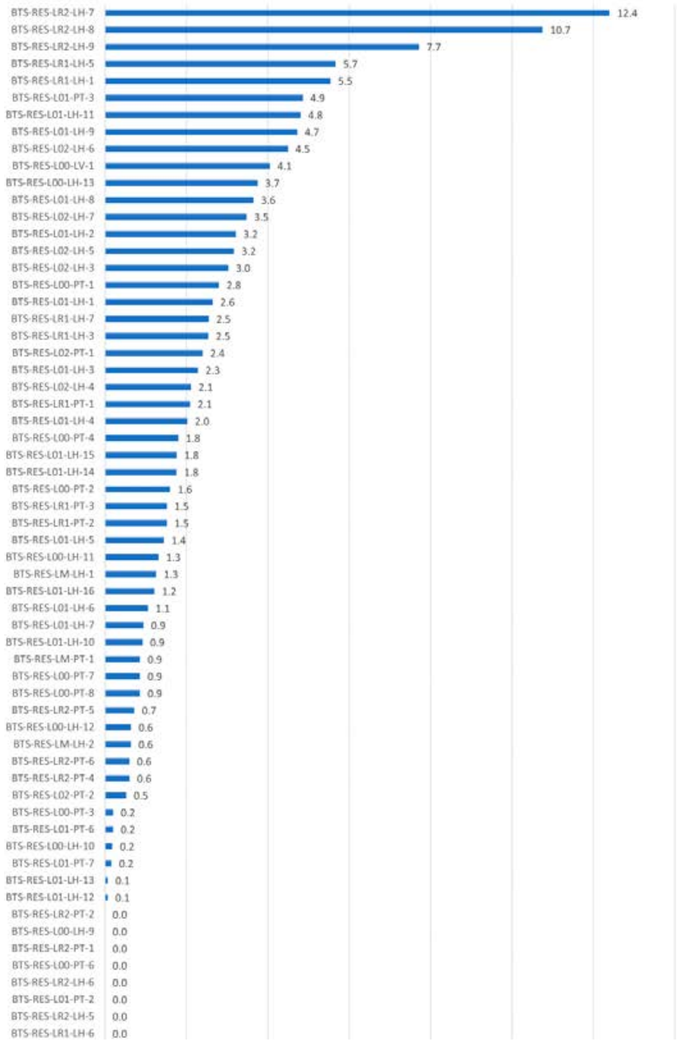
In high-rise buildings, unaddressed thermal bridges, especially when they are repetitive, can cause significant heat loss, impacting overall energy performance.

Passivhaus design principles emphasise eliminating or minimising thermal bridges through careful detailing and high-performance materials from conceptual design stage. Where thermal bridges cannot be fully designed out, their impact must be quantified and mitigated to minimise heat loss.

Thermal bridges formed by penetrating structural columns



Thermal bridges formed by penetrating structural columns *Courtesy of Henriksen Studio*



Stage 5 summary table for thermal losses per area due to non-façade thermal bridges *Courtesy of Henriksen Studio*

PH area	In contact with external air [W/K]	In contact with ground [W/K]	In contact with unheated areas [W/K]	MEP repeating penetrations [W/K]
Block B	36.3	11.3	0	14.8
Block C	29.3	11.3	0	20.6
Block D	26.9	0	0	37.3
Podium	26.9	111.9	18.8	10.8
EBU	8.4	0	20.1	7.4
Cafe	2.8	0	0	0.4
Total	130.6	134.5	38.9	91.2

Calculation Methodology

The Passivhaus standard adopts a conservative approach to calculate thermal bridges. In contrast to some national building regulations that use internal dimensions, Passivhaus calculations take into account the external surface area of the thermal envelope.

At urbanest Battersea, all façade thermal bridges are included in the area-weighted u-values and it was the responsibility of the façade subcontractor to submit detailed calculations demonstrating that the maximum allowable thermal transmission was not exceeded for each building as set out in the façade specifications written by Henriksen Studio.

Henriksen Studio adopted a stringent monitor and control process for the non-façade thermal bridges to be identified, quantified in length (as linear thermal bridges) or number (as point thermal bridges), and the total thermal losses were determined for each PH area.

Examples of non-façade thermal bridges include penetrations of columns in the roof terrace, retaining walls against the ground and interface between curtain walls and roofs.

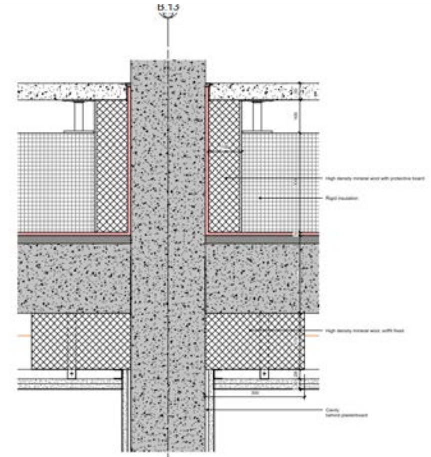
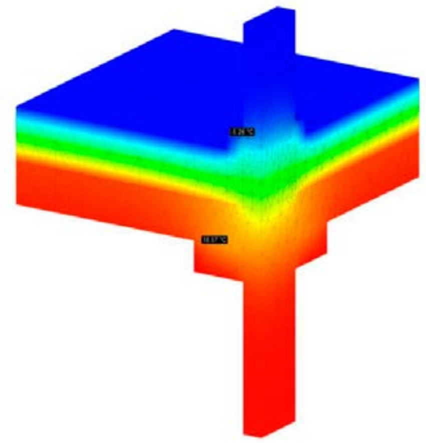
The thermal bridges were identified using architect's drawings, each then given a name and code to reflect the location and characteristics of the thermal bridge.

When a detail was available, a 2D or 3D Finite Element Method (FEM) analysis was perfomed to simulate heat flow and temperature distribution, in order to assess energy efficiency.

By the end of Stage 5, the impact of the total non-façade related thermal bridges on the heating energy was estimated to be approximately 5.5% of the total heat loss, making it a relatively insignificant contributor to the specific heating demand.

It is worth noting although PHPP makes an allowance for thermal bridges, their impact cannot be fully determined until constructed, as the build quality also contributes to the thermal performance of the building fabric.

FEM analysis on the insulation around the terrace columns *Courtesy of Henriksen Studio*

Current detail	FEM Model snapshot
	
Detail ref:	19077_SK078_Insulation around student terrace columns
Calculated χ value (W/K):	0.19
Notes	N/A

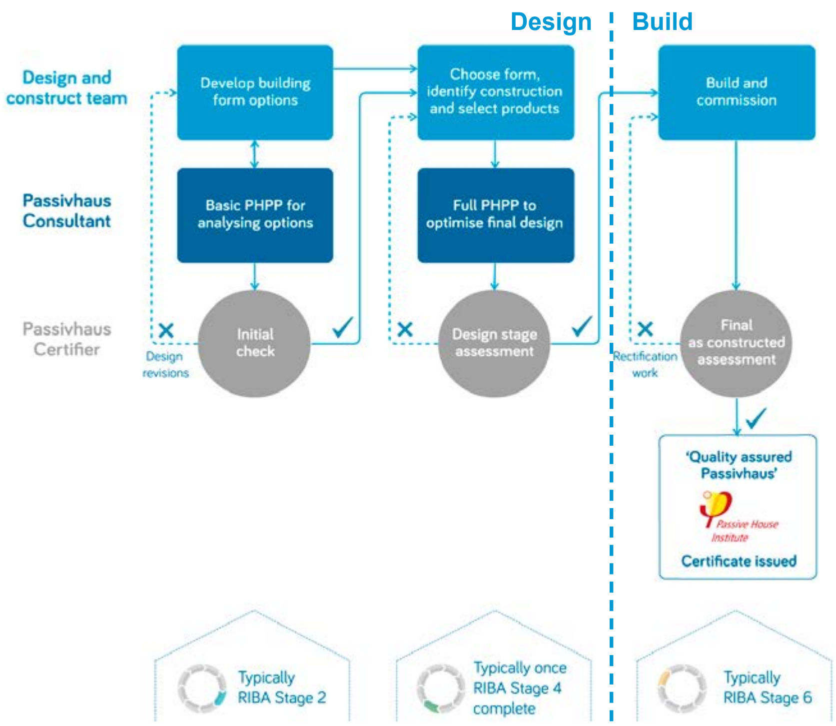
Certification

En route to certification

The Process

Henriksen Studio and Mace Construct maintained close engagement with the Certifier from the early design stages of the project, defining the project goals and certification targets, and establishing the workflow for the certification process - notably, agreeing on the project-specific PER limit. The Certifier carried out interim assessments and provided feedback, which supported the project through both the design development and quality assurance phases during construction.

As only completed buildings are eligible for certification, Henriksen Studio submitted a Passivhaus Planning Package (PHPP) modeling pack and Mace Construct submitted an as-built construction evidence pack. After confirming that all requirements were met, the Certifier awarded the building an official Passivhaus Classic Certificate from the Passivhaus Institute.

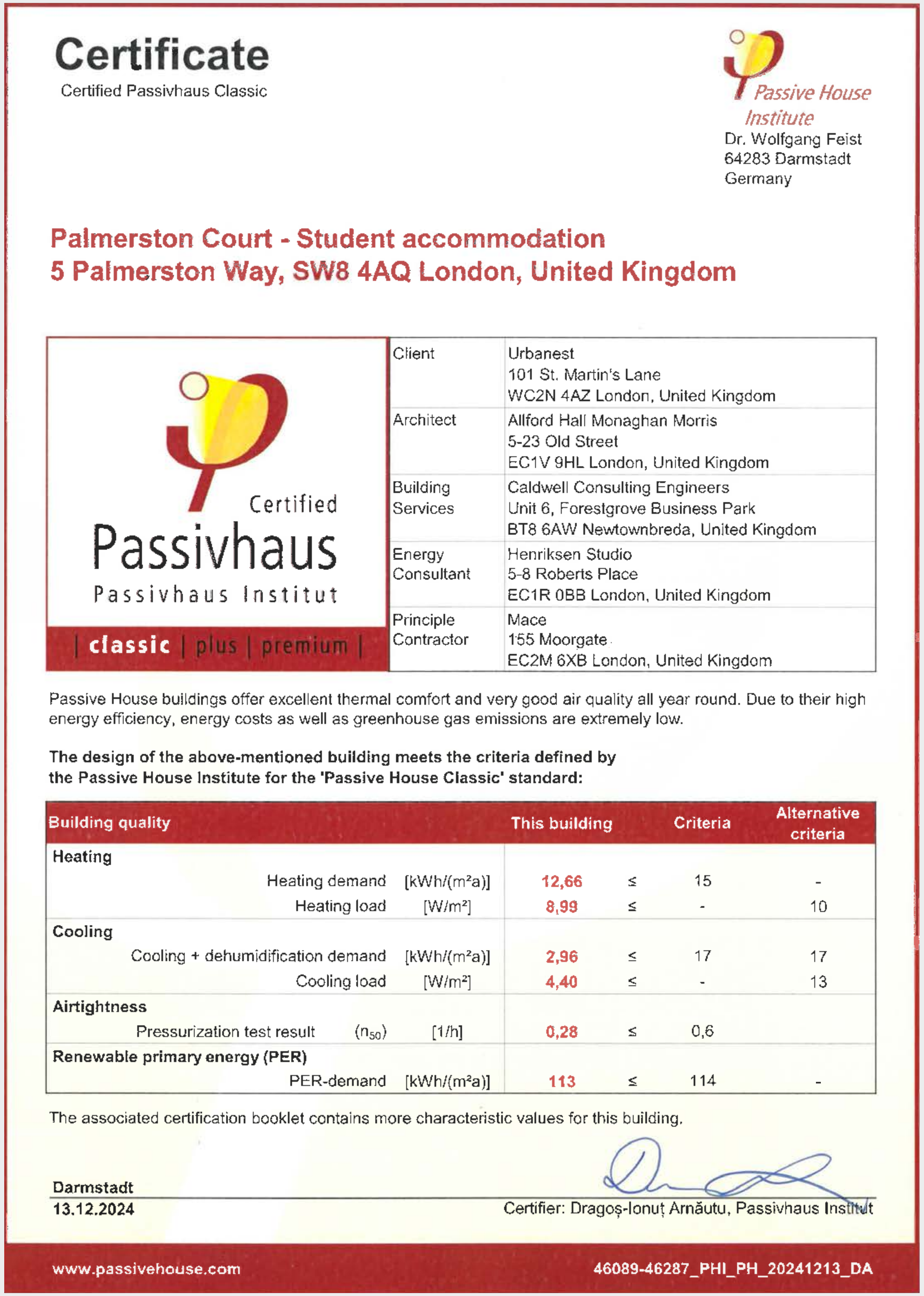


Passivhaus certification process workflow.
Image source: Passivhaus Institute

Final Submission for Certification

1. **Planning Package (PHPP)** To be signed off by the certifier if approved
2. **Design and Planning Docs** Site and construction drawings, treated floor area, envelope reference drawings
3. **Details - Standard/Connections** Thermal bridges, connection details, loss coefficients, insulation, radiation properties (hot climates), moisture protection
4. **Windows and Doors** Drawings, manufacturer, fitting and install details, U-value frames and glass
5. **Shading - Movable/Fixed** Sections and product detail
6. **Ventilation** Drawings and spec, heat recovery (efficiency, humidity, energy, operating settings and times, exhaust), components, sub-soil heat exchangers, pressure loss calc, HVR commissioning report
7. **Heating/Cooling and Water (DHW and Waste)** Drawings and spec, description/schematics, photos of installed insulation and suspension, strategy for summer thermal comfort
8. **Electrical Devices/Lighting** Planning/concept (resi), details/spec (non-resi)
9. **Renewable Energy** Proof of ownership (solar thermal, PV or other)
10. **Airtightness and Envelope** Independent testing (positive and negative testing), extensive leak detection (EnerPHit)
11. **Photographs** Documentation of construction
12. **Minimum requirements verification**
13. **Construction Manager's Declaration** Statement noting variations/deviations

Figure Passivhaus Classic certificate issued by Passivhaus Institute



Certificate

Certified Passivhaus Classic

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Palmerston Court - Student accommodation
5 Palmerston Way, SW8 4AQ London, United Kingdom

Certified Passivhaus
Passivhaus Institut
| classic | plus | premium |

Client	Urbanest 101 St. Martin's Lane WC2N 4AZ London, United Kingdom
Architect	Allford Hall Monaghan Morris 5-23 Old Street EC1V 9HL London, United Kingdom
Building Services	Caldwell Consulting Engineers Unit 6, Forestgrove Business Park BT8 6AW Newtownbreda, United Kingdom
Energy Consultant	Henriksen Studio 5-8 Roberts Place EC1R 0BB London, United Kingdom
Principle Contractor	Mace 155 Moorgate EC2M 6XB London, United Kingdom

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/(m²a)]	12,66	≤	15	-
	Heating load	[W/m²]	8,99	≤	-	10
Cooling						
	Cooling + dehumidification demand	[kWh/(m²a)]	2,96	≤	17	17
	Cooling load	[W/m²]	4,40	≤	-	13
Airtightness						
	Pressurization test result (n_{50})	[1/h]	0,28	≤	0,6	
Renewable primary energy (PER)						
	PER-demand	[kWh/(m²a)]	113	≤	114	-

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

Darmstadt
13.12.2024

Certifier: Dragoș-Ionuț Arnăutu, Passivhaus Institut

www.passivehouse.com
46089-46287_PHI_PH_20241213_DA

Post-Occupancy Evaluation

Building management and user experience

Why it Matters

Post-occupancy evaluation is not required for Passivhaus certification; however, the project team believes it is vital to understand how the building performs in reality. It verifies whether energy use, comfort, and indoor air quality match design expectations. POE captures how occupants actually live in and respond to the building, which often uncovers insights that no model or certification process can fully anticipate.

A structured approach to monitoring and feedback therefore strengthens the evidence base, confirms whether design intentions have been achieved, and informs continuous improvement for future projects.

Proposed Methodology

Building Walk Around An informal method of getting a high level understanding of how a building performs, and witnessing the building in use.

Energy Consumption Analysis of utility bills, meter readings, and sub-metered data to understand when, where, and in which systems energy is used. Comparing this with design predictions reveals actual performance.

Occupant Satisfaction Survey A structured survey capturing feedback from a broad sample of users. It provides statistically robust insights into comfort, usability, and overall experience, and allows benchmarking against other buildings

Monitored environmental conditions Using unobtrusive environmental data loggers to record quantitative temperature, relative humidity and lux levels

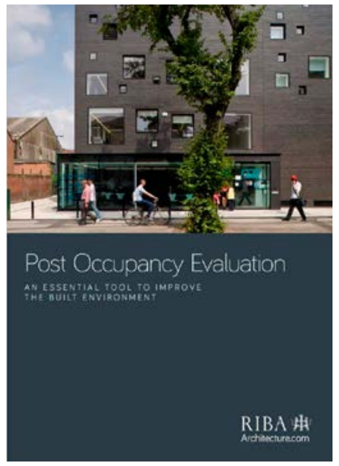
Interviews Semi structured interviews with a selection of building occupants and operators

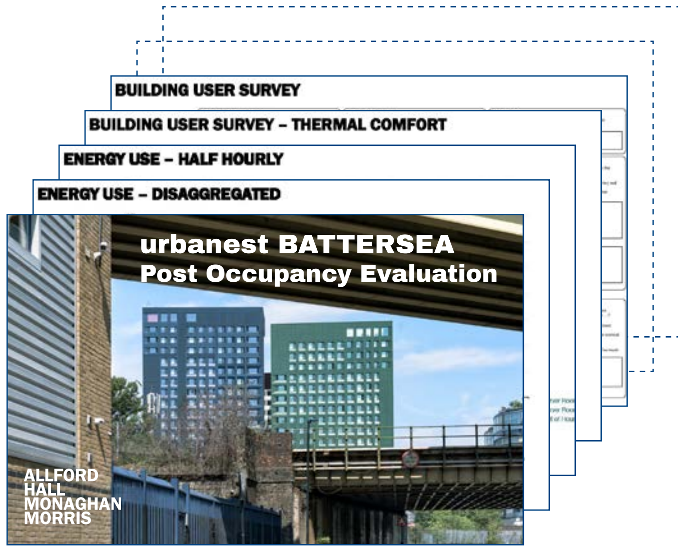
Focus Groups Facilitated discussions with user groups - such as FM teams, reception, security staff, general occupants or ED&I representatives - to uncover operational complexities and shared experiences.

Water Consumption Water use is a key indicator of environmental impact

Thermal imaging Using a thermal imaging camera to understand fabric performance quickly shows where heat loss occurs in a building.

Post Occupancy Evaluation Guidance by RIBA





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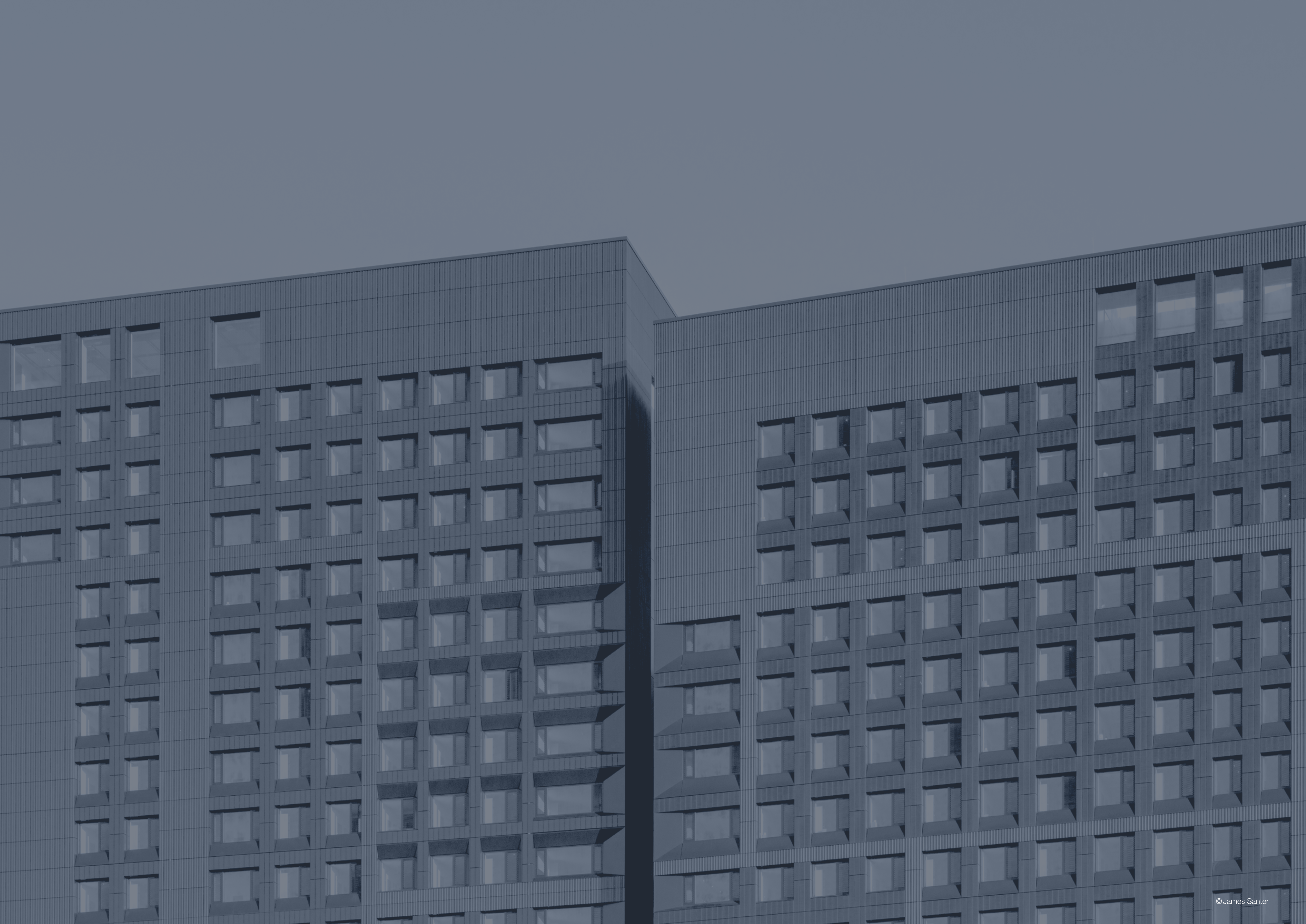
De-risking Passivhaus Delivery

Key risks and how we have addressed them

	Risk	Mitigation
Programme	Critical requirements (airtightness, façade, MEP) not fixed early, leading to redesigns. Additional QA (e.g. airtightness testing, mock-ups, certification admin) perceived as slowing delivery.	Early decision to target Passivhaus. Early decisions on façade, MVHR, and airtightness are critical to avoid redesign. Built into the programme from the outset so QA/testing doesn't add time. Prefabrication or unitised façades can reduce programme risk by improving quality and speed.
Cost Clarity	Perception that PH has significant capex premium, risking QS pushback.	Benchmark against UK/EU PH high-rise projects; highlight operational savings (esp. if retaining the asset); present lifecycle cost analysis (capex vs opex).
Certification	Documentation burden for large, multi-unit projects. Failing to pass certain PH criteria.	Appoint PH certifier early for ongoing feedback establish evidence log system (e.g. BIM-linked) Allocate resource for certification admin. Where appropriate, define multiple airtightness zones so that the majority of the building can still achieve certification even if a high-risk zone underperforms.
Post-Occupancy User Behaviour	Large tenant base creates variability in user behaviour and comfort outcomes.	Provide clear tenant guides; Staff training for building management; Intuitive controls; POE surveys after Year 1.
Façade Complexity	Larger façade areas means higher risk of thermal bridges and air leakage.	Early façade modelling in PHPP; Standardised panels and junction details; Stringent airtightness schedule throughout construction.
Airtightness at scale	Multiple penetrations (risers, MEP, fire-stopping) across multiple storeys means compounded leak-age risk.	Define airtightness strategy from the outset; Set up multiple airtightness zones if required; co-ordinate MEP to reduce unnecessary penetrations; strict QA on penetrations; Incremental airtightness testing; targeted training on site.
Thermal Bridge Risks	More complex structural elements like terraces, columns, and cantilevers can increase heat loss through thermal bridges	Design out where possible from the outset; Early modelling and analysis. Quantify, refine and monitor the thermal bridge details from design through to construction to minimise heat loss.
MEP Strategy for Tall Buildings	MVHR system (centralised or decentralised) may lead to complex duct runs, pressure imbalance, or excessive noise. Inadequate space for insulated ductwork or clashes with other services. Penetrations through airtight layer risk undermining building performance.	Decide MEP strategy at concept stage; coordinate services zones early; Select PH certified MEP kits. simplify duct runs; Minimise number of penetrations; use airtight grommets/sleeves; QA/testing of penetrations. robust commissioning; ensure access for future maintenance.
Overheating Risk	Solar gain can cause overheating in upper floors.	Assessment integrated into design process; Different treatment on different orientations carefully balanced glazing ratios and g-values.



Key Lessons

Project team reflections on the challenges and learnings

Architect

Delivering this project was not, in itself, a process that went far beyond what we would normally do as architects, but it demanded an exceptional level of attention to detail at every stage. Collaboration proved absolutely key, from the earliest feasibility studies through to practical completion.

Furthermore, working through the COVID-19 pandemic and to a tight programme required close coordination and clear communication.

A fundamental part of the project was integrating passive design strategies within a robust, fabric-first approach.

Early engagement with Henriksen Studio helped us develop innovative solutions that met strict Passivhaus criteria without compromising the project's aesthetic and social values.

Coordination, particularly with building services, was critical to achieving performance targets while protecting the design intent.

Every team member - from consultants to subcontractors, guided by Mace Construct (main contractor) - needed to fully understand and commit to the project's goals. As lead designer, we ensured that meeting Passivhaus standards did not conflict with other requirements and regulations. This process has deepened our expertise and strengthened our commitment to designing buildings that are resilient to climate change, able to withstand extreme temperatures while remaining energy efficient and comfortable to occupy.

Led by urbanest's clear and ambitious vision, this project demonstrates that with care, collaboration, and determination, it is possible to deliver a beautiful building that performs exceptionally well.

Flora Genel
Associate Director

ALLFORD HALL MONAGHAN MORRIS

Main Contractor

Achieving a Passivhaus building is a challenging concept to quantify, especially on large scale complex developments. That said, as a project team, we embraced the challenge and worked tirelessly over the last two to three years to make this project a successful Passivhaus building.

There have been many lessons learnt along the way for all involved. Understanding the requirements of Passivhaus and ensuring these are delivered is a key requirement and our leadership team recognised early on that dedicated resource would be required to manage the process and ensure the deliverables were met.

For any team embarking on Passivhaus certification for a large sale project, dedicated resourcing is essential. It is also vital that the whole team understands and assists in the delivery of the Passivhaus requirements. Passivhaus certification demands huge emphasis on the design management, the quality of the products and materials used and how they are installed on site. It is therefore crucial to have the whole team on board, working together to achieve the certification.

Site wide Passivhaus training was essential and helped us to engage with the workforce, setting the standard of quality expected. As we developed the training, we found it was important to split the content across the work packages, ensuring the relevant information was delivered to each trade. This allowed us to provide targeted training relating to the specific elements of work onsite to those that needed it.

The design validation process was far more lengthy and complex than anyone had anticipated. The CDP element and subsequent co-ordination with other trades added an extra dimension to the process, along with the sheer volume of façade and M&E information needed and the format it was required in.

We learnt that for a Passivhaus building, if there is an approved Passivhaus product, it's worth specifying in order to avoid the extent of additional information required for non-certified products.

The initial estimate was that the design validation would take approximately one month to complete. It actually took over a year to finalise this part of the certification process.

Achieving the required airtightness target for Passivhaus is not to be underestimated. It's an extremely difficult target to achieve. If you are embarking on a large development, it's important to know that the certifier will expect the target to be in relation to air permeability rather than air changes per hour. We learnt this early on in our testing process.

There is an important balance to hit when you are pre-testing – the tests need to add value and de-risk final testing, but they also must be sympathetic to the build process. This is a challenging balance to achieve and once you get to the final test there is very little that can be done to get to leakage points if they are not caught early on. It is also important to get a temporary sealing contractor on board and make the necessary allowance for temporary sealing.

Planning in contingency and back-up test dates are also important elements to consider. Never expect a test to pass first time, even the simple ones! For final testing, I cannot emphasise enough how important it is to meticulously plan the test, engage with the workforce and ensure you have all make ready needs complete and resource allocated for the test day.

It has been a long journey, with many lessons learnt, all made worthwhile by achieving our Passivhaus certification.

Katie Mann
Project Manager

mace

Passivhaus Consultant

Success in large Passivhaus projects requires early commitment to the standard and an integrated design approach. As dedicated Passivhaus consultant embedded in the design team, it is important to ensure all stakeholders were aligned with performance objectives from day one - essential for coordinating airtightness, thermal envelope continuity, and HVAC efficiency across multiple construction packages.

Maintaining thermal continuity at this scale demands meticulous detailing and robust QA systems. All airtightness junctions must be comprehensively detailed and monitored on site, as validated by component and sectional testing.

ubanest Battersea exemplifies an "envelope first" strategy. By integrating façade engineering with the Passivhaus consulting role, we bridged the AHMM's aesthetics with structural, and performance requirements without compromising architectural intent. Buildability detailing preserved airtightness across interfaces between façade systems and structural elements, reducing coordination risks, simplifying certification documentation, and achieving Passivhaus certification at unprecedented scale.

Delivering at this scale exposed supply chain gaps in certified components - particularly around airtightness products and certified MVHR/AHU units. Strategic manufacturer engagement to verify components under PHI protocols is vital to ensure delivery continuity and performance compliance.

A dedicated Passivhaus quality champion embedded in the project team proved essential. This role maintained clarity on performance requirements, coordinated detailing consistency, reviewed on-site execution, and bridged design intent and site realities - upskilling trades and resolving issues in real time.

The building's centralised air handling strategy required meticulous ductwork design, pressure balancing across diverse occupancy zones, and a robust BMS. PHI-approved AHU components and careful commissioning were critical to achieving heat recovery efficiency and low specific fan power targets. A soft-landing commissioning phase and ongoing post-occupancy evaluation aligned operational performance with design intent.

A zoned airtightness testing approach with continuous QA, proactive subcontractor training, and mock-up testing ensured consistent workmanship. Balancing test frequency against risk and programme was a key lesson.

Certification requires disciplined documentation - photographic records, as-built thermal bridge calculations, airtightness data, and commissioning reports - to ensure the quality of final product.

urbanest Battersea demonstrates that scale is no barrier to the world's most rigorous energy standard.

Warren Stanley
Associate Passivhaus Designer

HENRIKSEN STUDIO

urbanest Battersea demonstrates a commitment to designing sustainable buildings that are resilient, adaptable and valued over time.

By adopting the Passivhaus standard, the project integrates environmental performance, cost efficiency and occupant wellbeing to deliver lasting benefit for residents, the client and the wider community.

Click to see the project

ahmm.co.uk

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The Passivhaus Story

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