RICHMOND COLLEGE

ENERGY AND SUSTAINABILITY STATEMENT

April 2021 I Rev E

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Summary | Richmond College is a pilot project for Net Zero Carbon

This Energy and Sustainability Statement is submitted in support of the full planning application for the proposed Richmond College development. The site consists of 212 residential units across 6 apartment blocks and 4 terraces of houses.

The largest apartment block and one of the terraces are aiming to achieve Net Zero operational carbon on site (as indicated on the site plan to the right). The other terraces and blocks will also target very high levels of energy efficiency and environmental sustainability.

Building regulations and London Plan compliance

Based on the initial Part L1A calculations undertaken for a large sample of residential units, a 100% improvement over Part L1A 2013 is targeted (assuming the SAP 10.0 carbon factor for electricity of 233 gCO_2/kWh). **This is well in excess of the minimum planning requirement of a 35% on site improvement,** and therefore no carbon offsetting payment is required.

Net Zero Carbon* block and terrace

There are three key aspects to the Net Zero Carbon strategy:

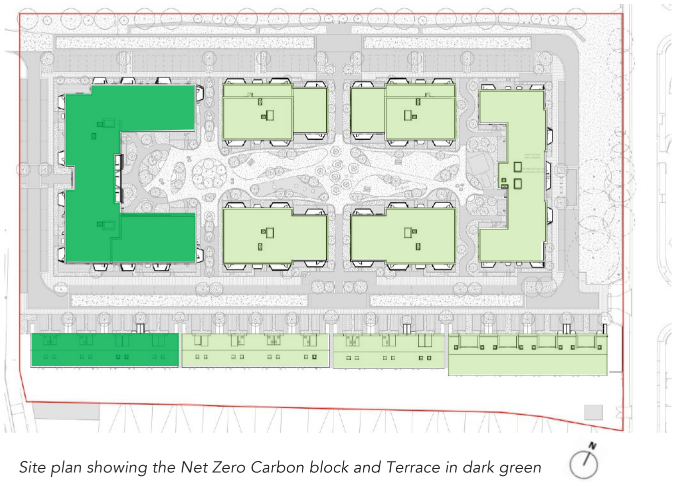
1. Minimising space heating demand
2. Supplying low carbon heat
3. Providing renewable energy on-site

The Net Zero Carbon block has been designed with Passivhaus levels of fabric and ventilation efficiency and the heat energy demand is based on the Passivhaus target in PHPP, the terrace is also likely to be close to Passivhaus levels of heating demand. The primary energy has also been assessed in PHPP alongside the renewable energy generation from photovoltaic panels (PVs). **This analysis has shown the Net Zero Carbon block is capable of meeting Passivhaus Plus standard at this stage**, which would make this an exemplar housing development in the UK and internationally.

**For clarity, reference 'Net Zero Carbon' or 'NZC' in this report refers to operational carbon only.*

Materials and circular economy

This document also includes an assessment of embodied carbon and whole life carbon. It should be read in conjunction with the separate Circular Economy Statement.



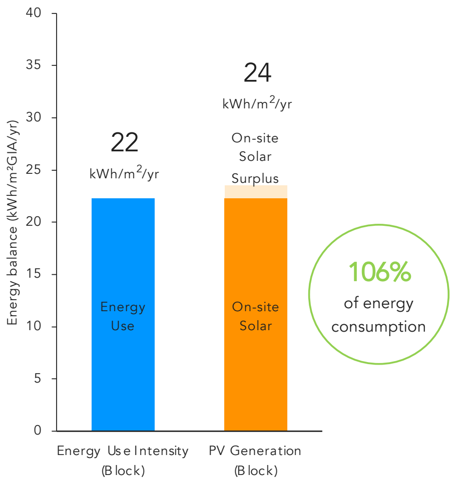
Site plan showing the Net Zero Carbon block and Terrace in dark green

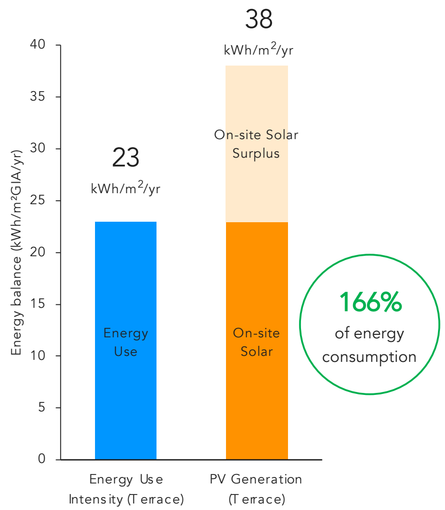
CGI of proposed scheme showing the building form

Net Zero Carbon block and terrace

Energy use intensity & Renewable energy generation

($kWh/m^2_{GIA}/yr$)





Total Energy Use Intensity of building compared to onsite generation by PVs, for the Net Zero Carbon Block and Terrace

Net Zero Carbon block and terrace

Space heating demand

($kWh/m^2_{TFA}/yr$)

The space heating demand of Richmond College Net Zero Carbon block and terrace estimated at Stage 3 is currently compliant with the Passivhaus target of 15 kWh/m²/yr

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Summary | Key energy efficiency measures – Net Zero Carbon Block and Terrace

Reducing energy demand at Richmond College

Efforts made at Stage 2 to minimise energy demand have continued at Stage 3. The adjacent icons summarise the key energy efficiency measures.

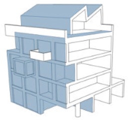
This includes review of the building envelope, component U-values and identification of thermal bridges. Workshops have been held with the architect and structural engineer to explore how to mitigate heat losses through key junctions and to evolve the insulation strategy. Further emphasis has also been placed on elevation design and the appropriate window proportions that take advantage of winter solar gains while minimising the risk of overheating

In order to reduce hot water, it is recommended that flow rates adhere to the AECB water standards.

Progressing the design post-planning

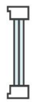
Currently the space heating demand is just under the Passivhaus levels for the block and just over for the terrace. There are some key areas of focus which will need to be considered post-planning to ensure that the Richmond College NZC Block and Terrace keep on track for these levels of heat energy demand. These include:

- Ensuring high efficiency MVHR unit is used, with a heat recovery efficiency of 90%.
- Ensuring the MVHR units are located as close to external walls as possible.
- Reducing the number and impact of thermal bridges, paying particular attention to the ground floor, parapets, balconies and junctions between heated and unheated areas.



Building form

The building form has been optimized in order to reduce heat loss areas and the number of complex junctions. **The current form factor is 1.41 for the block and 2.40 for the Terrace**.

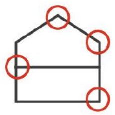


Elevation design

The proportions of windows range **between 23% and 35%** and seek to find the right balance between efficiency, overheating and daylight.

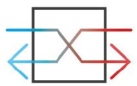
Insulation

A well insulated envelope is proposed with low U-values (e.g. **0.13 W/m².K for external walls in the NZC block and 0.1 W/m².K in the NZC terrace**). The insulation line has been clearly identified.



Detailing

A very airtight envelope is proposed (i.e. **0.6 m³/h/m² at 50Pa**) and key thermal bridges have been identified.



Mechanical ventilation

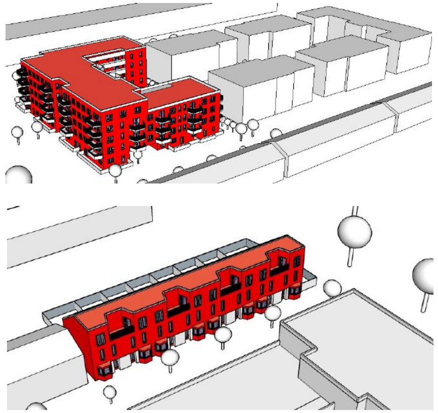
Mechanical Ventilation with Heat Recovery is provided in each unit. A **heat recovery efficiency of 90%** is targeted for each dwelling.

Space heating demand

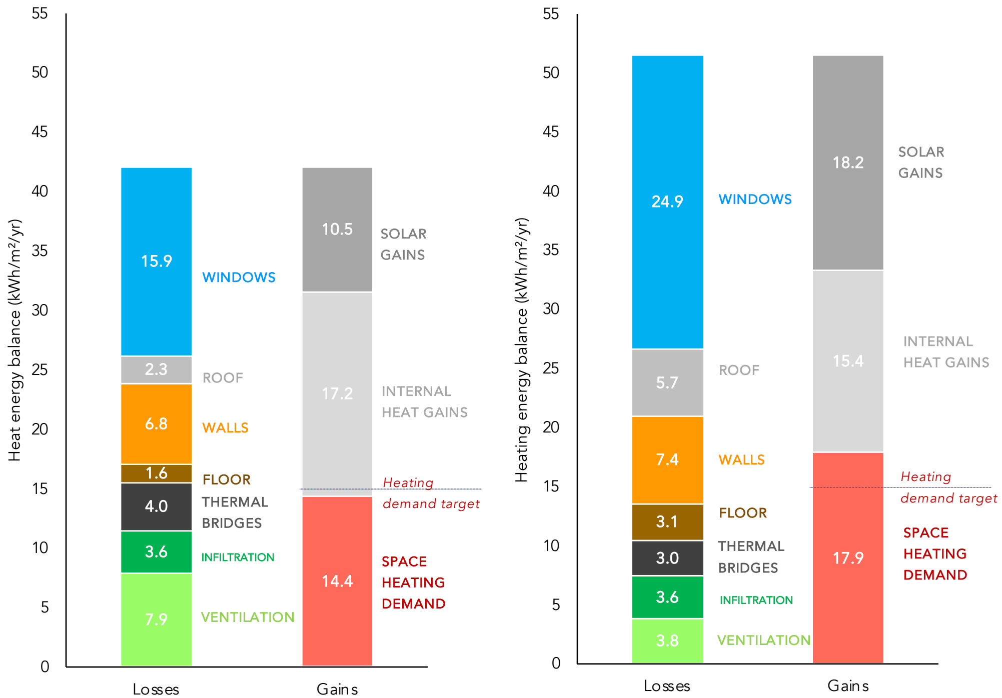
The figure below summarises the results of the Stage 3 PHPP analysis for Richmond College.

The bars on the left show heat energy lost from the building (e.g. through windows, thermal bridges, infiltration), and the bars on the right show heat gains into the building (e.g. solar gains, internal gains).

The difference is the space heating demand (shown in red), which will need to be provided by the heating system. Based on the Stage 3 PHPP analysis, this is less than the Passivhaus requirement of 15 kWh/m².yr for the block and slightly more for the terrace. The block should be able to comply with Passivhaus subject to further efforts during detailed design and construction.



3D images of Richmond College energy models for Block 5 (top) and Terrace 4 (bottom)



Bar charts showing estimated annual heating energy balance using PHPP for Richmond College Block 5 (left) and Terrace 4 (right).

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Summary | Low carbon heat and on-site renewable energy generation

Heating and hot water

The heating systems for Richmond College will not use any fossil fuels on site.

Blocks of flats: space heating and hot water will be provided in the apartments by rooftop air source heat pumps supplying heat energy via an ambient temperature (20-25°C) communal distribution system to individual heat pumps within each apartment.

Houses: space heating and domestic hot water will be provided by individual air source heat pumps with a hot water storage tank in each house. Underfloor heating will be used.

Ventilation

An efficient Mechanical Ventilation with Heat Recovery (MVHR) system will be provided in each unit. In the Net Zero Carbon elements (i.e. Block 5 and Terrace 4) it will be located close to the façade to minimise distribution losses.

Roof-mounted PVs

The team has looked at maximising the renewable energy generation at Richmond College whilst considering other services the roof space must provide for. The roof plan to the right shows a potential solar PV layout based on the current roof plan.

In summary, our assessment indicates that the potential PV design could include **1,676 solar panels** representing a total capacity of **603.3kWp**. This size of and configuration of PV array would be estimated to generate approximately **518,950kWh/yr** and provide carbon savings of **120.9 tonnes/yr** (assuming SAP10 carbon emission factors).

The PVs will enable the development to achieve 100% improvement over Part L1A 2013 on site

603.3 kWp — Nominal array power

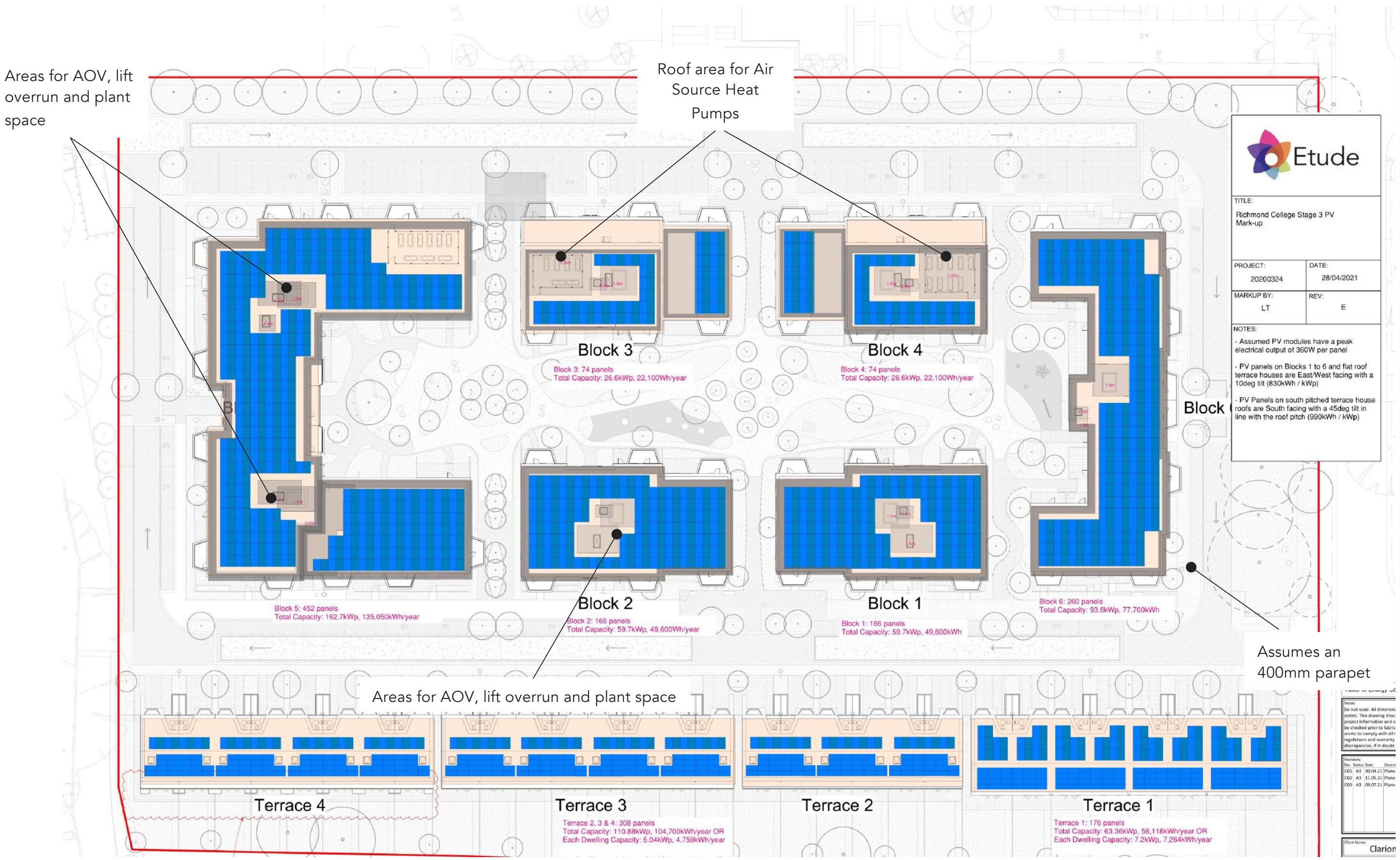
32.2 $kWh/yr/m^2_{GIA}$ — Annual energy generation (per m^2 GIA)

89.9 $kWh/yr/m^2_{fp}$ — Specific energy generation (per m^2 footprint)

Blocks 1 to 6: All panels mounted on the apartments blocks are assumed to be mounted in a concertina type arrangement, at a 10 degree tilt angle, facing to the East and West.

Terraced Houses: Panels are both mounted to the pitched South facing roof (assumed 45 degrees) and East / West at a 10 degree tilt angle on the flat roof areas.

Panels across roofs are located to avoid ventilating pipe terminals.



Potential solar PV layout

Summary | Performance against planning requirements

Energy efficiency (Be Lean)

The proposed design and building fabric specification ensures that the development will exceed the minimum requirements of Part L 2013 through energy efficiency and passive design measures alone, achieving a **26% improvement over Part L (SAP 10)** from energy efficiency alone.

Low carbon heat (Be Clean)

It is not proposed that the site will incorporate CHP or connect to a district heat network.

Heat Pumps and Roof-mounted PVs (Be Green)

Individual and communal Air Source Heat Pumps will provide heating and DHW to the Terraced Houses and Apartments, respectively.

Photovoltaic panels on the roofs are proposed to generate approximately **518,950 kWh/yr**.

Overall on-site performance

The two bar charts opposite comply with the GLA's requirement to report carbon emissions against both:

- the out-of-date carbon factor for electricity currently being used by Part L (i.e. SAP 2012 - 519 gCO_2/kWh)
- The up-to-date carbon factor for electricity determined by the GLA (i.e. SAP 10.0 - 233 gCO_2/kWh)

Based on the initial Part L1A calculations undertaken for a sample of 37 residential units:

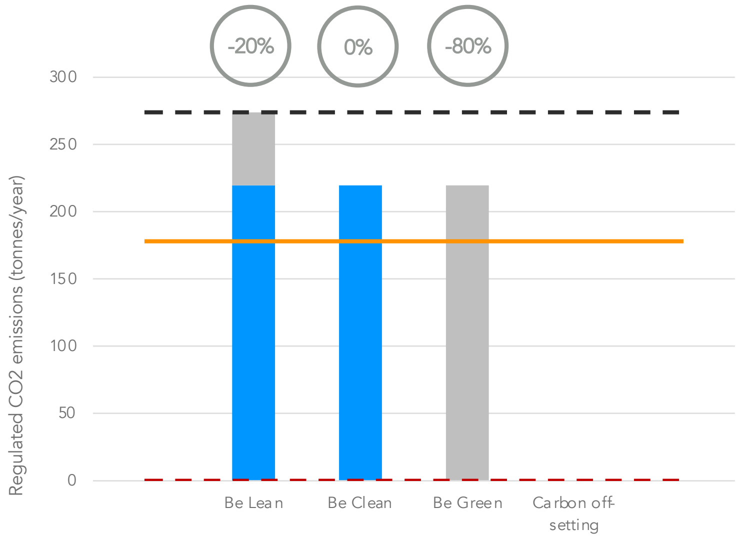
- a 100% improvement over Part L1A 2013 is targeted assuming a carbon factor for electricity of 519 gCO_2/kWh.
- a 100% improvement over Part L1A 2013 is targeted assuming the SAP 10.0 carbon factor for electricity of 233 gCO_2/kWh.

Carbon offsetting

The scheme is targeting the Zero Carbon Homes requirement, as defined by the current London Plan. All on-site carbon emissions will be offset through electricity generated by roof mounted PV arrays resulting in the scheme having net zero carbon emissions. Therefore, no carbon offsetting payment is required.

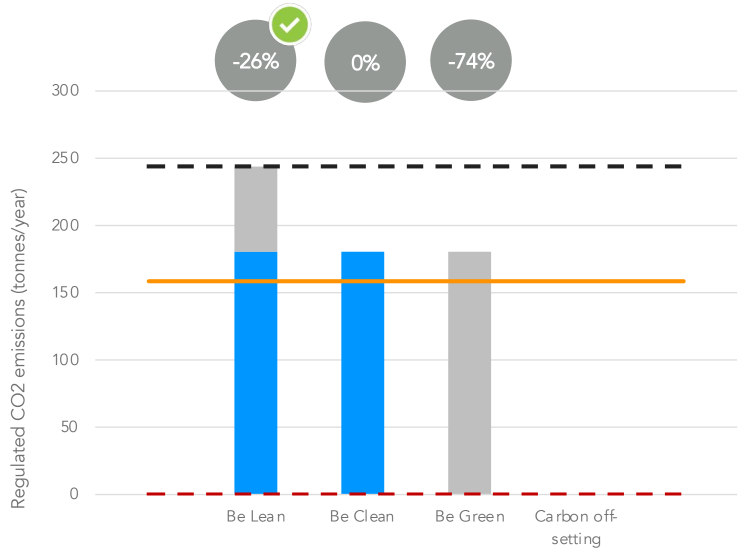
Domestic energy hierarchy and targets for Richmond College – SAP 2012 Carbon Factors

(assuming a carbon factor of electricity of 519gCO_2/kWh)



Domestic energy hierarchy and targets for Richmond College – SAP 10 Carbon Factors

(assuming a carbon factor of electricity of 233gCO_2/kWh)



Site Domestic Emissions (tonnes CO_2 / year) | **Carbon savings** (tonnes CO_2 / year) | Part L 2013 Target Emissions Rate | Minimum 35% saving on site

	Total regulated emissions (Tonnes CO_2/year)	CO_2 savings (Tonnes CO_2/year)	Percentage saving (%)
Part L 2013 baseline	274.0	-	-
Be lean	219.5	54.5	19.9%
Be clean	219.5	0.0	0.0%
Be green	0.0	219.5	80.1%

Cumulative % reduction in regulated emissions: -100%

	Total regulated emissions (Tonnes CO_2/year)	CO_2 savings (Tonnes CO_2/year)	Percentage saving (%)
Part L 2013 baseline	243.9	-	-
Be lean	180.6	63.4	26.0%
Be clean	180.6	0.0	0.0%
Be green	0.0	180.6	74.0%
Offset		0	

Cumulative % reduction in regulated emissions: -100%

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CIBSE TM59 Overheating risk assessment

An overheating risk assessment using the CIBSE TM59 methodology was undertaken for fifteen dwellings at Richmond College, from a total of 212. It was considered that the selected units provided a representative sample of the proposed mix. The tested units are highlighted on the marked-up drawings in the calculations section of this document.

EDSL Tas (version 9.5.1) has been used to undertake the CIBSE TM59 overheating risk analysis by using LHR 1989 weather data (DSY1 for the 2020s, high emissions, 50th percentile scenario). In accordance with the requirements of TM59 the model was also rerun using the DSY 2 and DSY 3 weather files. The results from these additional runs have been provided for information purposes only. It is noted that there is no expectation for these runs to fully comply with the criteria.

Key modelling inputs and assumptions

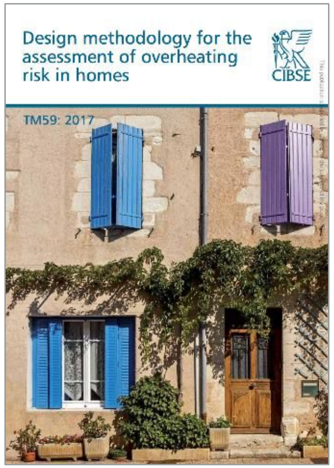
The modelling assumed that all units will be provided with opening windows to living room/kitchen areas and bedrooms. This is to provide summer purge ventilation in addition to year-round background ventilation provided by MVHR units. The modelled window opening strategy is as follows:

Room and Window Type	Openable Free Area Equivalent	Openable window schedules
Bedroom Windows	50% (day & night)	24hr
Kitchen / Living Room – Windows	30% (day) / 15% (night)	7am-11pm*

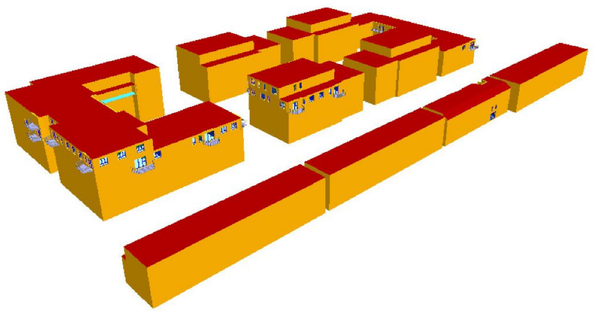
* It is assumed that the kitchen / living room openings will be left partially open on a secure restrictor on the warmest nights of the year in order to provide cross ventilation.

Conclusion

In conclusion, it was found that all tested units passed the summer thermal comfort requirements of CIBSE TM59.



CIBSE TM59 – Design methodology for the assessment of overheating risk in homes



Richmond College – Tas 3D Geometry

Summary of CIBSE TM59 Results

The tables below show the TM59 modelling results for the sample of fourteen modelled units.

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Unit	Room	**Criterion 1:** #Hours Exceeding Comfort Range	**Criterion 2:** Number of Night Hours Exceeding 26 °C for Bedrooms	Result
1 - 3B5P	Bedroom 1_db	3 / 110	5 / 32	Pass
	Bedroom 2_db	0 / 110	9 / 32	Pass
	Bedroom 3_sb	0 / 110	7 / 32	Pass
	Living Room / Kitchen	19 / 59	N/A	Pass
2 - 3B5P	Bedroom 1_db	1 / 110	16 / 32	Pass
	Bedroom 2_db	1 / 110	15 / 32	Pass
	Bedroom 3_sb	0 / 110	15 / 32	Pass
	Living Room / Kitchen	27 / 59	N/A	Pass
3 - 1B2P	Bedroom 1_db	0 / 110	16 / 32	Pass
	Living Room / Kitchen	5 / 59	N/A	Pass
4 - 2B4P	Bedroom 1_db	24 / 110	32 / 32	Pass
	Bedroom 2_db	23 / 110	29 / 32	Pass
	Living Room / Kitchen	5 / 59	N/A	Pass
5 - 1B2P	Bedroom 1_db	16 / 110	17 / 32	Pass
	Living Room / Kitchen	27 / 59	N/A	Pass
6 - 2B4P	Bedroom 1_db	15 / 110	14 / 32	Pass
	Bedroom 2_db	2 / 110	16 / 32	Pass
	Living Room / Kitchen	19 / 59	N/A	Pass
7 - 3B5P	Bedroom 1_db	2 / 110	11 / 32	Pass
	Bedroom 2_db	1 / 110	12 / 32	Pass
	Bedroom 3_sb	2 / 110	6 / 32	Pass
	Living Room / Kitchen	12 / 59	N/A	Pass
8 - 2B4P	Bedroom 1_db	5 / 110	13 / 32	Pass
	Bedroom 2_db	3 / 110	14 / 32	Pass
	Living Room / Kitchen	6 / 59	N/A	Pass
9 - 1B2P	Bedroom 1_db	11 / 110	26 / 32	Pass
	Living Room / Kitchen	11 / 59	N/A	Pass
10 - 1B2	Bedroom 1_db	8 / 110	32 / 32	Pass
	Living Room / Kitchen	15 / 59	N/A	Pass
11 - 2B4	Bedroom 1_db	7 / 110	20 / 32	Pass
	Bedroom 2_db	12 / 110	20 / 32	Pass
	Living Room / Kitchen	11 / 59	N/A	Pass
12 - 3B5	Bedroom 1_db	4 / 110	17 / 32	Pass
	Bedroom 2_db	9 / 110	17 / 32	Pass
	Bedroom 3_sb	7 / 110	13 / 32	Pass
	Kitchen	1 / 59	N/A	Pass
	Living Room	21 / 59	N/A	Pass
13 - 3B5	Bedroom 1_db	19 / 110	7 / 32	Pass
	Bedroom 2_db	28 / 110	15 / 32	Pass
	Bedroom 3_sb	9 / 110	17 / 32	Pass
	Kitchen	22 / 59	N/A	Pass
	Living Room	53 / 59	N/A	Pass
14 - 3B5	Bedroom 1_db	0 / 110	10 / 32	Pass
	Bedroom 2_db	2 / 110	13 / 32	Pass
	Bedroom 3_sb	0 / 110	13 / 32	Pass
	Living Room / Kitchen	6 / 59	N/A	Pass
15 - 3B5	Bedroom 1_db	0 / 110	9 / 32	Pass
	Bedroom 2_db	0 / 110	14 / 32	Pass
	Bedroom 3_sb	0 / 110	10 / 32	Pass
	Living Room / Kitchen	0 / 59	N/A	Pass

Summary | Initiatives on materials, embodied carbon and circular economy

Materials choices

The materials chosen on a development have to fulfil many functional roles, whilst importantly, giving the place its character. However, construction plays a substantial part in the way humans consume resources and impact on the wider world.

For this reason the consumption of materials and resources is being increasingly scrutinised. It is critical that development moves away from linear, mass-consumption, wasteful models, towards favouring frugality and efficiency. How we initially conceptualise new places will play a significant part in this shift.

The design for Richmond College has considered the environmental impact of materials at the heart of its brief. From sustainable sourcing to planning for the recovery of materials when the buildings are no longer needed.

New and draft policy

Planning policy is now helping to drive a greater focus on impact of materials. Within the New London Plan two newer focus areas for policy have opened up: circular economy and whole life carbon impacts.

During the design development of Richmond college the team has both developed strategies seeking to meet the intention of the new policy, whilst also developing assessments that provide quantification of the proposals. This is summarised in the *Materials, resources & whole life impacts* section of this document. The areas of focus are:

Embodied carbon – the proposals for Richmond College are assessed in detail for the terraces and apartment blocks. The analysis examines the initial life stage for the development, looking at the sourcing and manufacturing impacts of the products and materials. The carbon associated with this life stage can be in the region of one third of a development's overall carbon footprint.

Whole life carbon – the lens shifts to a long term look at how carbon and greenhouse gases will be emitted by the development across its estimated lifetime and what will happen once the development finishes its operational life.

Circular economy – although fully explored as part of the Circular Economy Statement (submitted alongside this report), a summary of how the development will move away from linear approaches to consuming materials, and instead implement circular principles to reduce wastage and virgin material consumption as well provide material banks for the future.

Responsible sourcing of materials

In addition to ensuring materials have a low environmental impact, specifying responsibly sourced materials helps to ensure ethical labour and environmental practices in the product manufacture and supply chain.

The procurement of materials will seek to favour responsibly sourced materials. Many manufacturers provide responsible sourcing certificates for their construction products including concrete, steel, reinforcement, plasterboard and blockwork.

Timber

All timber sourced for the project will come from a certified legal source (FSC, PEFC or equivalent).

Additionally, all timber used will be sourced in accordance with the UK public procurement policy on timber.

Recycled content and reusing materials

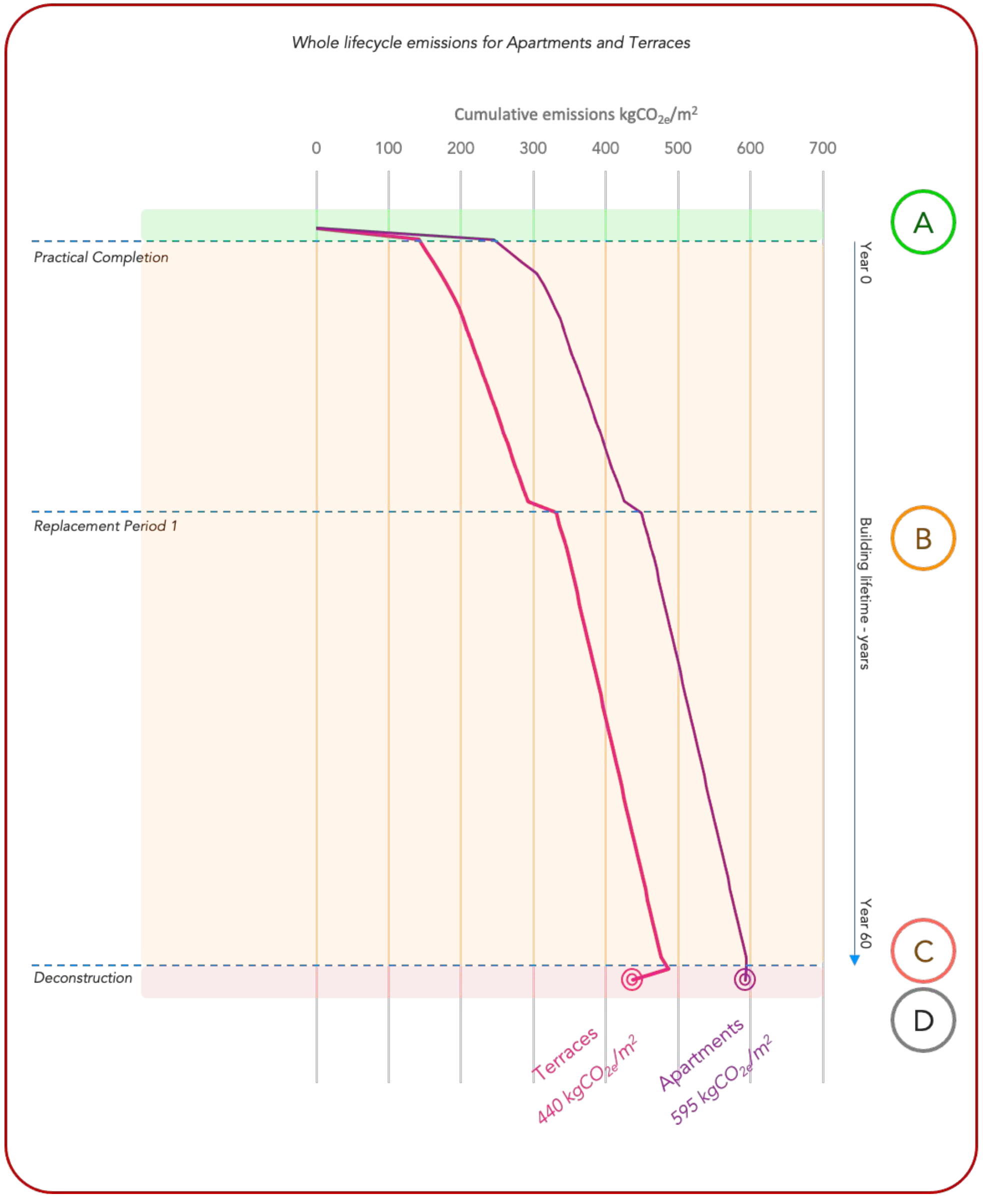
The most important element associated with reducing the embodied carbon emissions for materials, is reducing virgin resources, and either reusing existing materials or increasing the percentage of recycled content used in their manufacture.

The Greater London Authority expects all developments to aim for at least 10% of the total value of materials used, to be derived from recycled and reused sources.

Materials Strategy

There is a great opportunity to ensure that materials specified for the Richmond College site have a low environmental impact and are healthy to people and environment. The strategy includes:

1. Use of materials with reduced embodied carbon for major elements.
2. Use of products with Environmental Performance Declarations (EPDs) and Responsible Sourcing Certification – in line with the Product Environmental Information for at least 10 products will be specified at the Design Stage, installed by the Post Construction Stage and will be covered by verified EPD certificates.
3. Use of low VOC paints, varnishes and materials will be specified.
4. Limiting the material degradation effects by identifying risks of severe material degradation and incorporating appropriate measures into design and specification.



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Summary | Other sustainability measures

Water consumption

Potable water consumption will be below 105 litres/person/day through the use of low-flow fixtures and fittings. Flow rates in line with the AECB's guidance are recommended.

< 105
litres/person/day

- **Showers:** <8 litres/min
- **Hand wash taps**: <4 litres/min
- **Kitchen taps:** <6 litres/min
- **WC:** dual flush 4-6 litres
- **Washing Machine:** 6.5 litres/kg of dry load
- **Dishwasher:** 1 litre/place setting
- **Bath Capacity:** 160 litres to overflow

Transport

There will be 387 cycles spaces and 110 car parking spaces provided in total for the residents. All parking spaces have the necessary charging provision for potential future use.

There are several amenities within walking distance of the site, including an off-licence, supermarket, dentist, ATM, gym, café and bicycle store.

The site is in close vicinity to Twickenham Rail station and benefits from multiple local bus routes.

Ecology & Biodiversity

The development of Richmond College will ensure that any loss of habitat will be replaced, or enhanced, to protect local protected species. This includes bats, as confirmed by a bat survey, birds and hedgehogs.

Biodiversity will be boosted through wildlife friendly landscaping in the public area, incorporating rain gardens and ecological corridor planting including native species of trees, shrubs and introduced shrubs. There will also be provision of bird and bat boxes on-site.

Flood risk & drainage

The site has been assessed as being a low probability flood risk area from rivers and seas (Flood Zone 1) but has some risk of flooding from surface water and groundwater flooding.

Surface water can be collected via permeable paving and rainwater pipes; attenuated on-site and discharged to the existing sewer at no increased off-site flood risk.

The SuDS features proposed includes brown roofs on some of the buildings, geocellular system for temporary storage of surface water run-off and attenuation crates with approximately 730 m^3 of total attenuation volume for extreme rainfall cases.

Waste

The operational waste strategy ensures compliance with legislation while also encouraging recycling. General and recyclable waste bins will be provided in ground floor bin stores for the apartment blocks.

The terrace houses are provided with individual bin space within the front garden.

Contents

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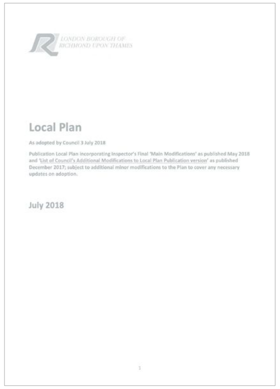
1.0

Key requirements

- London Plan and GLA guidance
- London Borough of Richmond Upon Thames



Building Regulations

The Building Regulations set out the statutory standards developments are to meet. These standards cover measures including energy efficiency, water efficiency, sound resistance and ventilation.

Part L of the Building Regulations covers energy efficiency requirements. The current version of Part L relevant to Richmond College is Part L1A 2013, which is for new dwellings. It sets the energy efficiency requirements to be demonstrated in five criteria which mainly focus on achieving better CO_2 emissions rates than target values, good practice building fabric elements and passive control measures.

A new version of Part L is due in 2021 and will use a substantially different carbon factor for electricity.

The Future Homes and Buildings Standards are due to come into force in 2025.

London Plan 2021 – Key energy requirements

The London Plan (2021) sets the key requirements for all major developments within the Greater London area.

Of particular relevance to Richmond College are the following policies:

Policy SI1 - Improving air quality

Policy SI2 - Minimising greenhouse gas emissions

Policy SI4 - Managing heat risk

Policy SI 1 – Improving air quality states that development proposals should not lead to further deterioration of existing poor air quality, create any new areas that exceed air quality limits or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits, or create unacceptable risk of high levels of exposure to poor air quality.

Development proposals should therefore:

- be at least Air Quality Neutral.
- use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality in preference to post-design or retro-fitted mitigation measures.
- If in Air Quality Focus Areas, or if they are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people, should demonstrate that design measures have been used to minimise exposure.

In order to reduce the impact on air quality during the construction and demolition phase, development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions from the demolition and construction of buildings following best practice guidance.

Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on-site. Where it can be demonstrated that emissions cannot be further reduced by on-site measures, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated within the area affected by the development.

Policy SI 2 – Minimising greenhouse gas emissions requires major developments to be net zero carbon. T§his means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

1. **be lean**: use less energy and manage demand during operation.
2. **be clean**: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.
3. **be green**: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site.
4. **be seen**: monitor, verify and report on energy performance.

Residential developments should achieve a 10% Part L improvement, and non-residential developments a 15% Part L improvement through energy efficiency measures only as a minimum.

A minimum on-site reduction of at least 35% beyond Building Regulations in total is required for major development (including renewable energy).

Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be offset.

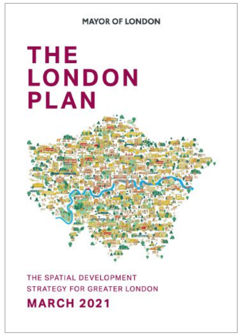
Major development proposals should also calculate and minimise carbon emissions that are not covered by Building Regulations, e.g. appliances and equipment.

Finally, development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce emissions.

Policy SI 4 – Managing heat risk requires development proposals to minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

Major development proposals should also demonstrate how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

1. reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure.
2. minimise internal heat generation through energy efficient design.
3. manage the heat within the building through exposed internal thermal mass and high ceilings.
4. provide passive ventilation.
5. provide mechanical ventilation.
6. provide active cooling systems.



London Plan (2021)

London Environment Strategy (2018)

London Plan 2021 – Key sustainability requirements

The London Plan (2021) sets the key requirements for all major developments within the Greater London area.

One of the main objectives is to improve the environment in London and tackle climate change which are mainly addressed in:

- Chapter 8 Green Infrastructure and Natural Environment
- Chapter 9 Sustainable Infrastructure
- Chapter 10 Transport

Policy G4 – Open space requires development proposals not to result in the loss of protected open space and, where possible, create areas of publicly accessible open space, particularly in areas of deficiency.

Policy G5 – Urban greening

A. Major development proposals should contribute to the greening of London by including urban greening as a fundamental element of site and building design, and by incorporating measures such as high-quality landscaping (including trees), green roofs, green walls and nature-based sustainable drainage.

B. Boroughs should develop an Urban Greening Factor (UGF) to identify the appropriate amount of urban greening required in new developments […]. In the interim, the Mayor recommends a target score of 0.4 for developments that are predominately residential, and a target score of 0.3 for predominately commercial development (excluding B2 and B8 uses).

C. Existing green cover retained on site should count towards developments meeting the interim target scores set out in (B) based on the factors set out in the associated table.

Policy G6 – Biodiversity and access to nature requires development proposals to manage impacts on biodiversity and aim to secure net biodiversity gain. This should be informed by the best available ecological information and addressed from the start of the development process. Proposals which reduce deficiencies in access to nature should be considered positively.

Policy SI 5 – Water infrastructure states that Development proposals should:

- through the use of Planning Conditions minimise the use of mains water in line with the Optional Requirement of the Building Regulations (residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption).
- achieve at least the BREEAM excellent standard for the 'Wat 01' water category or equivalent (commercial development).
- incorporate measures such as smart metering, water saving and recycling measures, including retrofitting, to help to achieve lower water consumption rates and to maximise future-proofing.

Policy SI 7 – Reducing waste and supporting the circular economy

Referable applications should promote circular economy outcomes and aim to be net zero-waste. A Circular Economy Statement should be submitted, to demonstrate:

1. how all materials arising from demolition and remediation works will be re-used and/or recycled.
2. how the proposal's design and construction will reduce material demands and enable building materials, components and products to be disassembled and re-used at the end of their useful life.
3. opportunities for managing as much waste as possible on site.
4. adequate and easily accessible storage space and collection systems to support recycling and re-use.
5. how much waste the proposal is expected to generate, and how and where the waste will be managed in accordance with the waste hierarchy.
6. how performance will be monitored and reported.

Policy SI 12 – Flood risk management

Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.

Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.

Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

Policy SI 13 – Sustainable drainage

Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

1. rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
2. rainwater infiltration to ground at or close to source
3. rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
4. rainwater discharge direct to a watercourse (unless not appropriate)
5. controlled rainwater discharge to a surface water sewer or drain
6. controlled rainwater discharge to a combined sewer.

Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, enhanced biodiversity, urban greening, amenity and recreation.

Policy T2 – Healthy Streets

Development proposals and Development Plans should deliver patterns of land use that facilitate residents making shorter, regular trips by walking or cycling.

Development Plans should:

1. promote and demonstrate the application of the Mayor's Healthy Streets Approach to: improve health and reduce health inequalities; reduce car dominance, ownership and use, road danger, severance, vehicle emissions and noise; increase walking, cycling and public transport use; improve street safety, comfort, convenience and amenity; and support these outcomes through sensitively designed freight facilities.
2. identify opportunities to improve the balance of space given to people to dwell, walk, cycle, and travel on public transport and in essential vehicles, so space is used more efficiently and streets are greener and more pleasant.

Development proposals should:

1. demonstrate how they will deliver improvements that support the ten Healthy Streets Indicators in line with Transport for London guidance
2. reduce the dominance of vehicles on London's streets whether stationary or moving
3. be permeable by foot and cycle and connect to local walking and cycling networks as well as public transport.

Policy T5 – Cycling

Development Plans and development proposals should help remove barriers to cycling and create a healthy environment in which people choose to cycle. This will be achieved through:

1. supporting the delivery of a London-wide network of cycle routes, with new routes and improved infrastructure
2. securing the provision of appropriate levels of cycle parking which should be fit for purpose, secure and well-located. Developments should provide cycle parking at least in accordance with the minimum standards set out in Table 10.2 and Figure 10.3, ensuring that a minimum of two short- stay and two long-stay cycle parking spaces are provided where the application of the minimum standards would result in a lower provision.

Cycle parking should be designed and laid out in accordance with the guidance contained in the London Cycling Design Standards. Development proposals should demonstrate how cycle parking facilities will cater for larger cycles, including adapted cycles for disabled people.

Local Plan (2018)

The key environmental policies in the Local Plan are:

Policy LP 10
Policy LP 12
Policy LP 15
Policy LP 17
Policy LP 20
Policy LP 21
Policy LP 22
Policy LP 23
Policy LP 24

Policy LP 10 includes requirements on:

- Local Environmental Impacts, Pollution and Land Contamination
- Air quality
- Noise and Vibration
- Light pollution
- Land contamination
- Construction and demolition

Policy LP 12 includes requirements on green infrastructure and public open space.

Policy LP 15 deals with biodiversity.

Policy LP 17 includes requirements on green roofs and walls.

Policy LP 20 addresses climate change adaptation.

Policy LP 21 includes requirements in terms of flood risk and sustainable drainage.

Policy LP 22 provides the requirements in terms sustainable design and construction.

Policy LP 23 deals with water resources and infrastructure.

Policy LP 24 includes requirements for waste management.

Richmond Climate Emergency Strategy 2020-2024

The Strategy is divided into six chapters highlighting key areas of focus, each chapter sets out the headline ambition, the key drivers and the Richmond context, legislation and policy related to that specific area, and where Richmond is now around performance and progress. A brief summary of each chapter is given below:

Our council: *Becoming carbon neutral as an organisation by 2030 – It is proposed that the Council embarks on a radical change programme that encompasses its buildings, services and staff, ensuring it becomes carbon neutral as an organisation by 2030. The Council would reduce the energy demands from its estate, generate its own renewable energy, minimise waste and eliminate single use plastics from its operations.*

Our legacy: *Climate Change Mitigation and Energy Efficiency – It is proposed that the Council work with residents, communities, businesses and partners to engage, involve and support them in tackling the climate emergency. The Council would share knowledge and approaches with them, ensure that the built environment is sustainable and can support them as climate change occurs and that they can live their lives in ways that reduce carbon emissions. The Council would ensure Richmond is able to plan, measure and respond proactively to the effects of climate change and the implications of resource scarcity.*

Our waste: *Waste and Plastics and the Circular Economy – It is proposed that the Council embed reduce, reuse, recycle into everything Richmond does around waste, working with our residents, businesses and schools to reduce the overall amount of waste generated in the Borough, with the aim to be one of the top performing boroughs in London for recycling.*

Our air: *Improving Air Quality – It is proposed that the Council develop and deliver an ambitious air quality plan that will make a meaningful change to air quality in the Borough with an emphasis on reducing air pollution around schools and town centres. By 2024, the Council aim to have less polluting traffic on the Borough's roads, contributing to an improvement in air quality across the Borough.*

Our nature: *Green Infrastructure and Biodiversity – The Strategy proposes improving and protecting the biodiversity and ecology of the Borough's green spaces and protecting them against the negative impacts of climate change.*

Our water: *Water Management and Flood Abatement – It is proposed that the Council ensure that development across Richmond addresses flood risks and promotes sustainable drainage.*

Local Plan Direction of Travel Consultation (2021)

The first reason set out in the document for requiring a new local plan is that the Council declared a climate emergency in summer 2019 and that it is committed to taking robust action to tackle the local and global threat of climate change, both internally and in partnership with local organisations and residents.

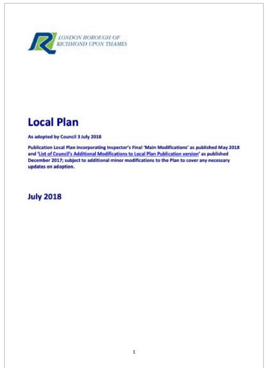
The document states that:

'Climate change is now the greatest challenge facing our society. The scientific evidence of climate change is overwhelming, and the global impacts of climate change will be severe.

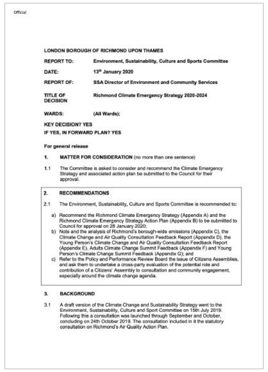
Delivering a sustainable built environment is crucial for Richmond's long-term sustainability and prosperity. We need to ensure that the borough is prepared for the adverse impacts of climate change, particularly those resulting from extreme weather events such as heat waves, droughts and flooding. The entire borough falls within an Air Quality Management Area (AQMA) designated since 2000, and we have an ageing building stock in the borough.

The borough also has a relatively high probability of flooding from many sources, including from the River Thames (both tidal and fluvial), as well as from surface water, groundwater, sewers and blocked culverts, and this risk will rise with climate change.

The majority of London, including Richmond borough, is at particular risk from surface water flooding, mainly due to the large extent of impermeable surfaces. The likelihood of surface water flooding is increased as more frequent and heavy intense rainfall during extreme weather events is unable to permeate through paved and hard surfaces.'



Local Plan (2018)



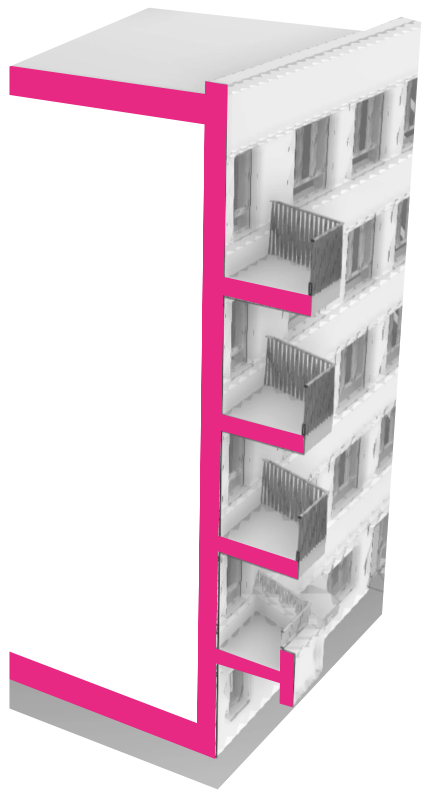
Richmond Climate Emergency Strategy 2020-2024 (2020)

Local Plan Direction of Travel Consultation (2021)

2.0

Building envelope and insulation

- Insulation line
- U-values and insulation thicknesses
- Accurate assessment of external wall U-value
- Wall types
- Floors, roofs and terraces



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Thermal envelope

The adjacent diagrams are based on the Stage 3 layouts and indicate where the main insulation layer is to be installed throughout the building for Block 5. The thermal envelope identifies which areas are considered to be 'warm' and which 'cold'.

- Not all the spaces within the envelope have to be actively heated. However, they do **need to meet the airtightness requirements**.
- All **walls** and **doors** along the insulation line, separating 'warm' from 'cold' spaces must be insulated.
- If a unit has an exposed floor to an 'cold' space such as an unheated bicycle storage, this **floor must be insulated**.
- **Structure going through the insulation line generally needs to be thermally broken**.

All stairs, lifts and access corridors are within the thermal envelope for Blocks 1 to 4, and outside the thermal envelope for Block 6. Block 5 has stairs, lifts and some access corridors within the thermal envelop and some external access decks.

Blocks 1 - 6

Building fabric I U-values and insulation thickness (Walls)

Envelope performance

The U-value is a measure of how effective a construction is at providing thermal insulation. It is a single number representing the complex heat transfer through a building element. The quality of insulation install will be assessed on site.

Wall build-ups

The proposed wall construction is a fully filled cavity wall with blown mineral wool insulation. This helps achieve the required U-values with a slimmer build-up, and makes installation easier, especially at junctions (e.g. masonry support system connection to the slab).

The construction also includes an internal 40mm service cavity to allow for the first fix works to take place without interfering with the fabric and/or the airtightness layer, which will be located on the inside face of the blockwork layer.

The alternative wall type for the apartment blocks are SFS infill panels between a concrete frame, and a facing brick façade.

The wall build ups for the Net Zero Carbon Terrace and Block are shown at the top and the reduced insulation thickness for the non-Net Zero Carbon Terraces and Blocks are shown underneath.

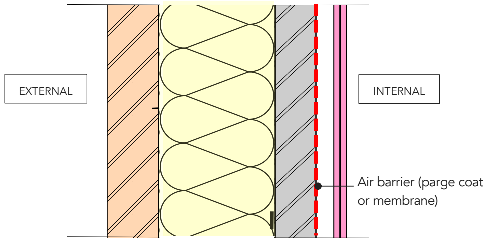
The U-value must incorporate all the individual heat flows through different parts of a surface including:

- Linear repeating thermal bridging within the construction
- Point repeating thermal bridging within the construction such as fixings and wall ties.

It should be noted that this page shows the 'uncorrected' U-values for the external walls. It excludes the effect of concrete slabs, brick supports, etc. which will need to be considered.

Construction types provided on this page are indicative and for the purpose of showing insulation thickness and conductivity.

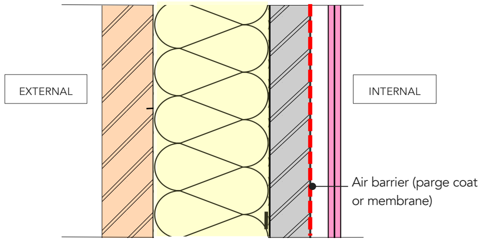
Indicative wall build-ups for Net Zero Carbon Terrace



External Wall, NZC Houses–
Mineral Wool with blockwork

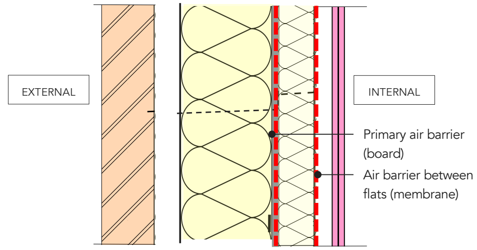
Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
2 layers plaster board	25	0.250	
Service cavity	40	0.22	
Membrane or parge coat	1-15	0.56	
Insulating blockwork (Thermalite or equivalent)	100	0.15**	0.10*
Blown fibre / wool insulation with Teplo ties	**300**	**0.034**	
Brick	103	0.770	

Indicative wall build-ups for Net Zero Carbon Block



External Wall, NZC Block –
Mineral Wool with blockwork

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
2 layers plaster board	25	0.250	
Service cavity	40	0.22	
Membrane or parge coat	1-15	0.56	
Insulating blockwork (Thermalite or equivalent)	100	0.15**	0.13*
Blown fibre / wool insulation with Teplo ties	**250**	**0.034**	
Brick	103	0.770	

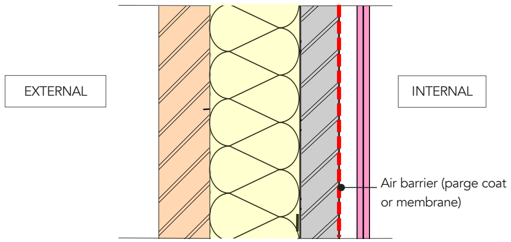


External Wall, NZC Block (alternative) –
Mineral wool with SFS

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
2 layers plaster board	25	0.250	
Service cavity	40	0.22	
Membrane	1-15	-	
SFS system with mineral wool infill	100	0.045	
Cement board panel or similar	15	0.2	0.13*
Cavity mineral wool insulation with brackets	**200**	**0.040**	
Cavity	50	-	
Brick	103	-	

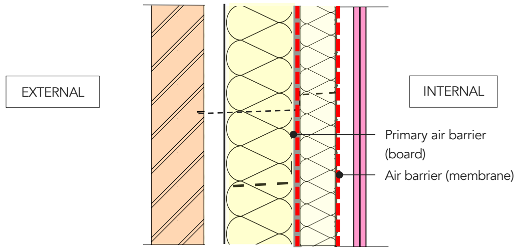
** Un-corrected U-value excluding: concrete columns, brick shelves and brick return to window jamb. Please note, the corrected value on the following page is the priority requirement*
The external wall to the ***unheated area*** *(bike/bin store) is considered to have the same build up with block finish on both sides instead of brick.*
*** Average conductivity of Aircrete type blocks of average compressive strength, based on architect's description of 'insulating blockwork'. Final conductivity may vary based on final specification.*

Wall build-up adjustments for Non-Net Zero Carbon Terraces and Blocks



External Wall, Non-NZC Houses and Blocks –
Mineral Wool with blockwork

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
Internal layers as per NZC wall			
Blown fibre / wool insulation with Teplo ties	**200**	**0.034**	0.15*
External layers as per NZC wall			



External Wall, Non-NZC Blocks (alternative) –
Mineral wool with SFS

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
Internal layers as per NZC wall			
Cavity mineral wool insulation with brackets	**160**	**0.040**	0.15*
External layers as per NZC wall			

Etude

Building fabric | U-values and insulation thickness (Roofs and Floors)

Floor and roof build-ups

The floor and roof build-ups will be the same for both the Net Zero Carbon and Non-Net Zero Carbon buildings.

The proposed floor constructions are screed over insulation on a concrete slab, for both the houses and apartment blocks.

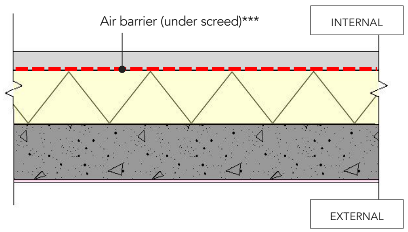
The proposed roof constructions are similar to the floor build ups with a roof finish over the insulation on a concrete structure. For the houses the insulation is within and over the timber frame structure.

The U-value must incorporate all the individual heat flows through different parts of a surface including:

- Linear repeating thermal bridging within the construction
- Point repeating thermal bridging within the construction such as fixings

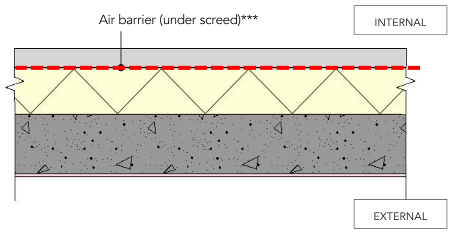
Construction types provided on this page are indicative and for the purpose of showing insulation thickness and conductivity.

Indicative floor build-ups for NZC and Non-NZC blocks



Lower Ground floor (slab to ground)

Layer	Thickness mm	Conductivity W/mK	U-value ground W/m²K
Screed	75	1.400	
Rigid insulation – PIR*	230	0.023	0.10**
Concrete slab	250	2.300	

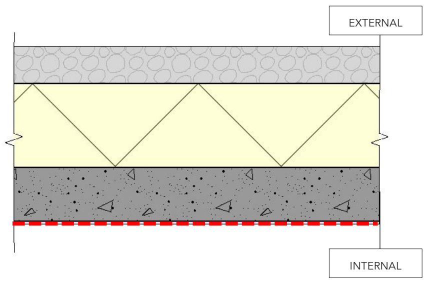


Exposed ground and first floors
(slab above unheated areas)

Layer	Thickness mm	Conductivity W/mK	U-value exposed floor W/m²K
Screed	75	1.140	
Floor insulation – PIR	150	0.023	0.15
Concrete slab	250	2.300	

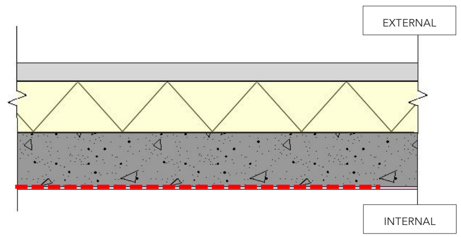
** Insulation above slab takes into account a pile/foundation solution. With raft foundation it would be easier to insulate under the slab.*
*** U-value takes into account the ground effect. P/A ratio assumed: 0.21*
**** Air tightness strategy to be examined in detail at Stage 4 so as to avoid condensation risk*

Indicative roof build-ups for NZC and Non-NZC blocks



Roof, Block 5 – Type 1 (main)

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
Roof finish	tbc	-	
Insulation board - EPS	400	0.040	0.10
Concrete slab	250	2.300	



Roof, Block 5 – Type 2 (roof terrace)

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
Terrace finish	tbc	-	
Rigid insulation – EPS	250	0.038	0.15
Concrete slab	250	2.300	

Etude

Actual external wall U-value

This page explains the effect of the slab edges and brick shelves on the actual U-value of the external wall.

The main cavity width is 250mm and achieves an uncorrected U-value of 0.13 W/m^{2}K. However the actual U-value is slightly higher as the thermal performance is affected by the masonry support system (and the slab edge behind it) introducing a repeating thermal bridge (indicated on the adjacent elevation)*.

It is understood that there are no recessed brick surfaces on the external façades, therefore, the cavity width remains the same in the rest of the building.

The area of these different wall conditions and a breakdown of the actual achieved U-value for the Block 5 is shown to the right.

An area weighted average external wall U-value of 0.145 W/m^{2}K (corrected) is estimated. This corrected U-value is what is used in all SAP calculations.

Average U-value: 0.145 W/m^{2}K

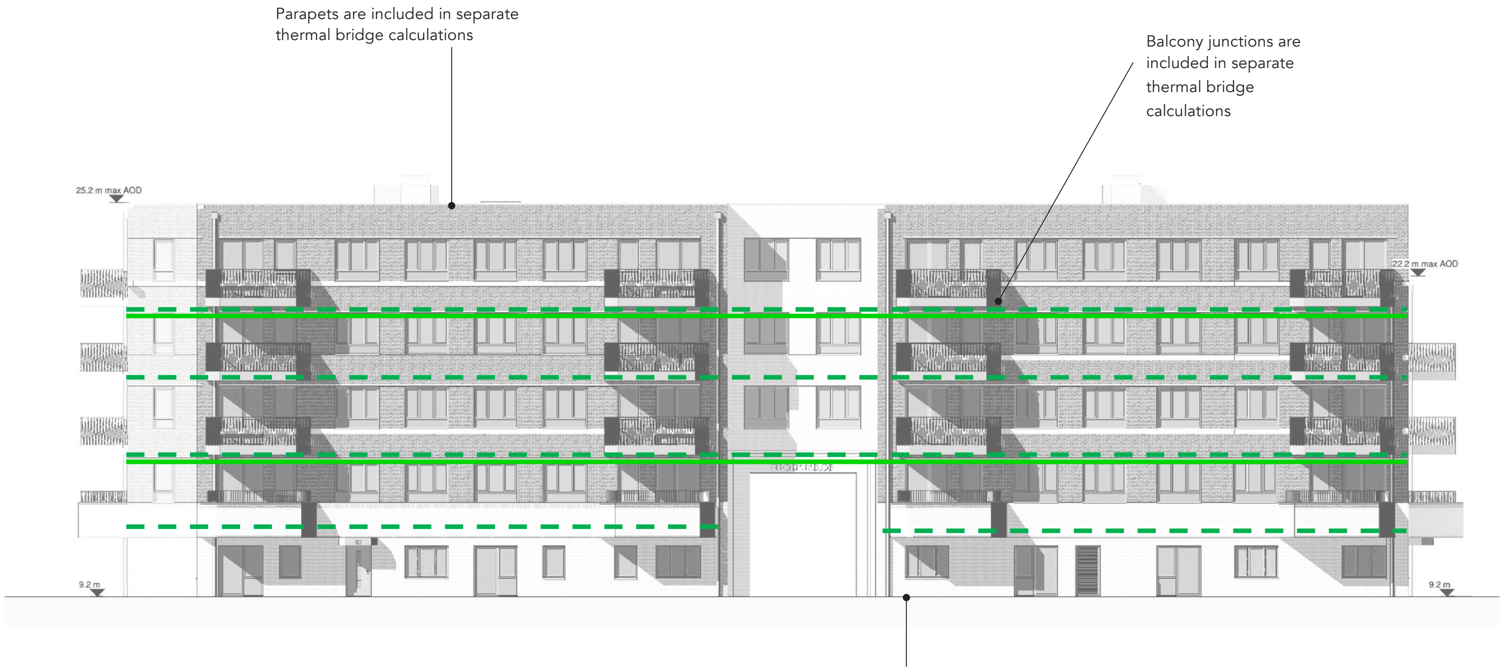
Main Insulation thickness: 250 mm

Target performance

The external walls should achieve an overall area weighted average U-value of 0.14 W/m^{2}K. This is a priority.

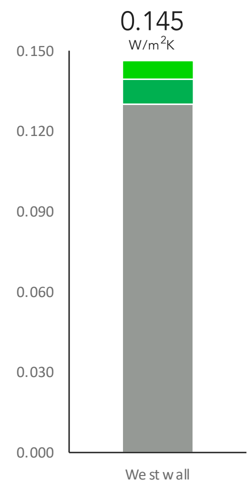
For the residents the U-value of the wall to the individual flats is what matters. Although trading off performance between parts of the building is acceptable in energy terms, it should consider the effect on individual flats to ensure they have a similar level of performance and fuel bills in one flat are not much higher than elsewhere.

** Note: It has been assumed that the brick supports will be located at every other level and that in these locations the slab edge will be pushed out to reduce the cavity to 100mm.* ***If this changes, the U-value shall be corrected accordingly.***



Heat losses via perimeter slab are included in separate thermal bridge calculations

Actual wall U-value: the West Elevation of the Block 5 showing the areas with masonry supports (in green), and slab edges (in dark green) . It has been assumed that the supports are at every other storey, starting from the ground floor.



Key

- Main wall structure (cavity 250 mm)
- Masonry support point thermal bridge
- Slab edge extending within insulation (cavity 100 mm)

Corrected U-value chart showing the effect of the extended slab edge and the brick masonry support in the overall U-value calculation.

Etude

Building fabric | Walls

External walls

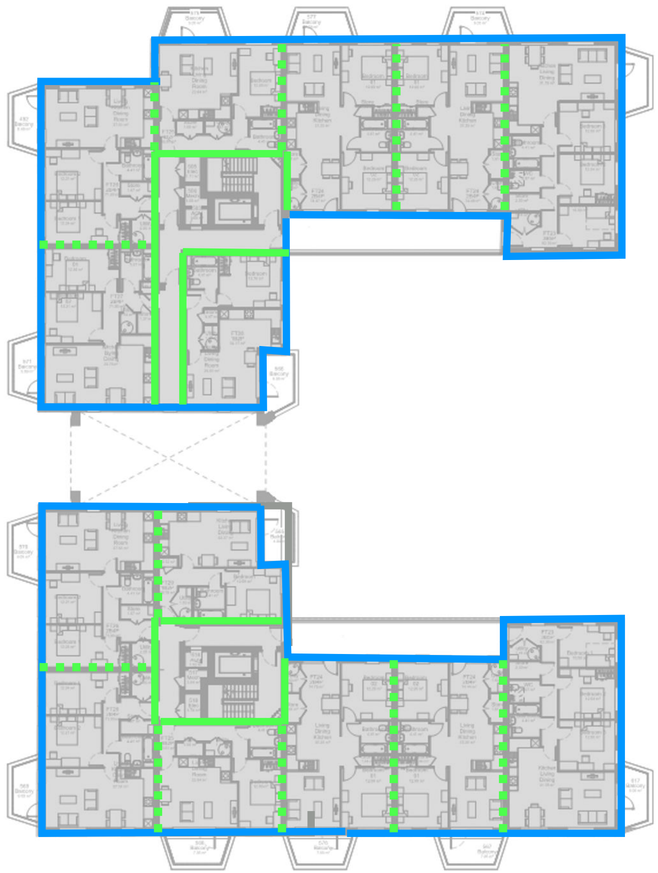
The adjacent drawings indicate where each wall type has been assumed in the energy calculations for Richmond College.

Key to wall types

	ID	Description	Uncorrected U-value NZC (W/m²K)	Uncorrected U-value Non-NZC (W/m²K)
(solid blue line)	EW 01	Main cavity brick wall (or SFS alternative)	0.13	0.15
(solid purple line)	EW 02	External wall to unheated areas	0.15	0.18
(solid green line)	IW 01	Party walls between flats & communal circulation (within thermal envelope)		
(dashed green line)	IW 02	Party walls between flats – acoustic insulation only (within thermal envelope)		
(grey box)		Insulation line boundary. area enclosed by insulation		

The ground floor space outside the thermal envelope is assumed to have the same build up as the main building and the floor above to minimise thermal bridges at the junctions

GF layout



Typical upper floor

Etude

Building fabric | Floors, roofs and terraces

Floors, roofs and terraces

The adjacent drawing indicates where each floor and roof type has been assumed in the energy calculations.

The main ground floor build up has 230 mm of PIR insulation.

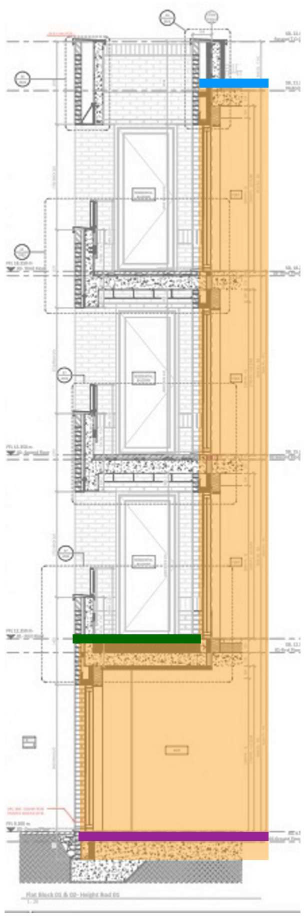
The exposed floor build up has 150 mm of PIR insulation.

The primary roof build up has 400 mm of EPS insulation in an inverted (warm) roof approach.

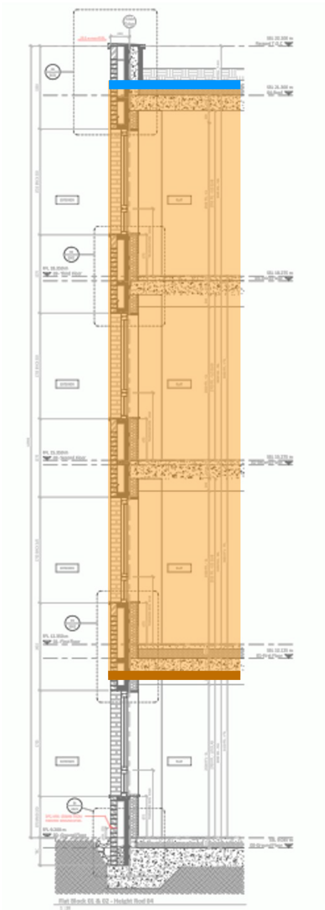
The secondary roof build up (terrace) has 250 mm of EPS insulation in an inverted (warm) roof approach.

Key to roof and floor types

	ID	Description	Calculated U-value
Purple line	FL 01	Main ground bearing slab	0.10
Orange line	FL 02	Floor above unheated space	0.15
Blue line	RF 01	Main roof	0.10
Green line	RF 02	Terrace	0.15
Light orange area		Insulation line boundary. Area enclosed by insulation	



Typical section incl. lower ground heated spaces and recessed balconies.



Typical section with no balcony recess and unheated areas in the lower ground floor (indicative only).

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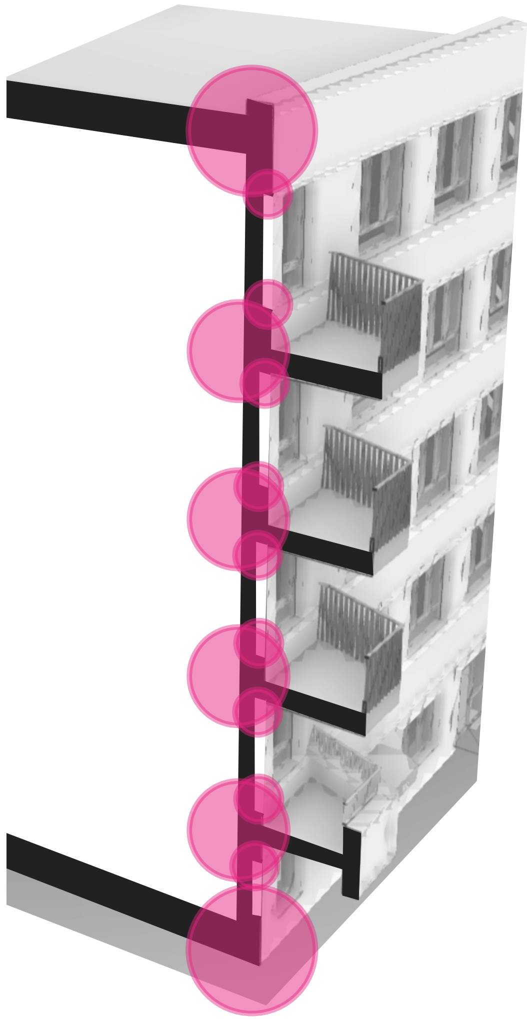
3.0

Junctions and thermal bridges

- Location of key junctions
- Schedule of key junctions



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Building fabric | Location of key junctions (Block 5)

Thermal bridges

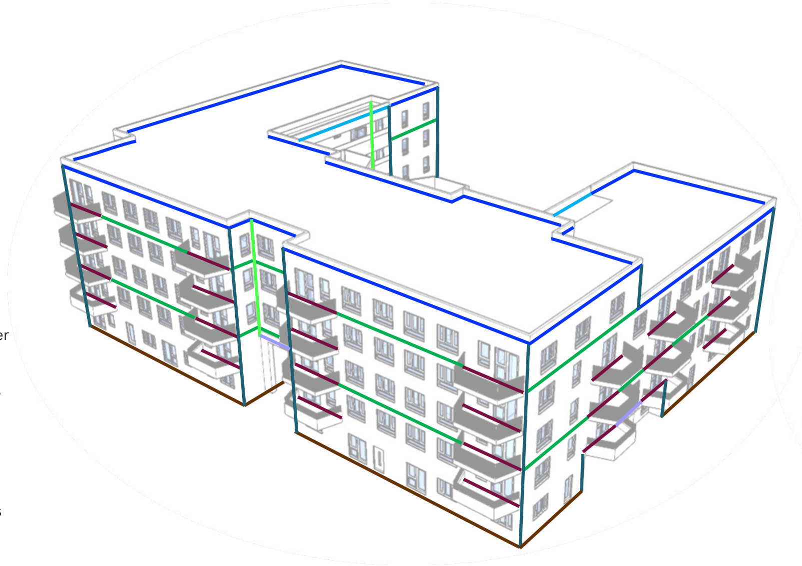
The additional heat loss through junctions and structural connections in the insulation layer has a significant effect on the total heating energy consumption of the building. This extra heat loss is referred to as thermal or cold bridging.

Thermal bridges occur wherever there is a reduction in insulation compared to the main heat loss envelope. The effect on building performance depends on their heat loss rate (Psi-value) together with their length.

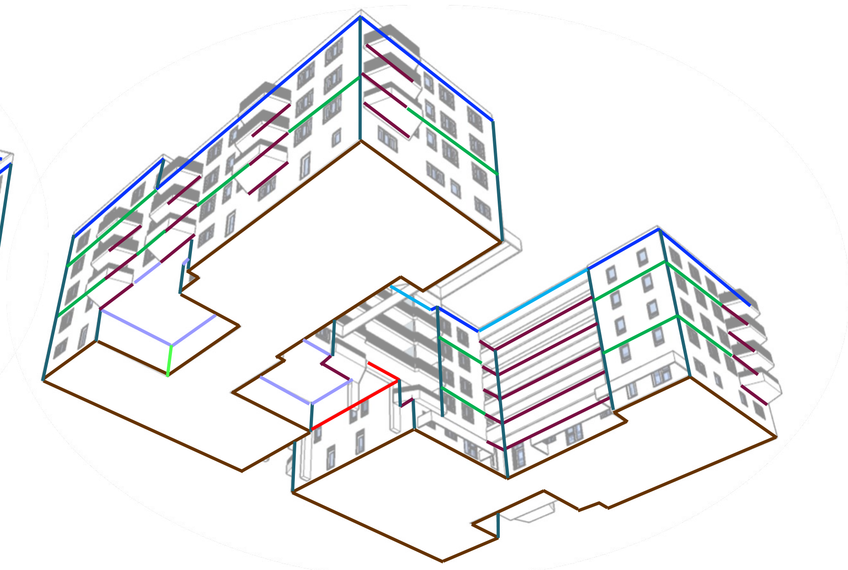
Roof parapets or other perimeter junctions that are usually quite long can have a bigger effect on the building's energy consumption even if they have a better Psi-value than another junction with a much smaller length.

The longest junctions identified at Richmond College are the **parapets** (roof and terraces), **the brick masonry support** and the **balconies.** Other significant thermal bridging will include junctions between heated and unheated spaces on the ground floor. It is also important to note that any **soil vent pipe connections** will create significant thermal bridge points and their number should be kept to the minimum possible. Bellow is a list of typical types of thermal bridge on a project of this scale.

The images on this page show the location of the key junctions at Richmond College.



Southwest view of the Block 5 main volume from above.



Southeast view of the Block 5 main volume from below.

Key categories of thermal bridges

- Balcony/canopy-wall junction
- Parapet junction
- Cantilevered parapet junction
- Masonry brick support + slab edge junction
- Window junctions (sill or threshold, jamb, head)
- Door installations (threshold, jamb, head)
- Ground floor-wall junction (Perimeter)
- Corner (external wall)
- Inverted corner (external wall)
- Terrace access junction
- Exposed floor-wall junction
- Floor above sheltered space to wall junction
- Party wall to unheated space
- Party wall to ground
- Wall from unheated space to insulated floor above
- Column to slab point thermal bridge

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Building fabric | Key junction psi-value summary

Thermal bridge Ps-value summary

The table on the right summarises the key thermal bridge categories at Richmond College and the assumptions made at this stage about their performance, which will have to be confirmed at Stage 4.

They are divided into 17 categories which include different junctions types amounting to at least 25 different non-repeating thermal bridge details. Some of those thermal bridges are particularly important, e.g. parapets or the 'column to ground slab' junction type.

The Contractor will have to develop all these details (and more if required) and calculate their performance through a thermal bridge calculation at Stage 4.

Beyond the calculations, it is important for the impact of thermal bridges to be reduced.

Key strategies to minimise thermal bridging

- ✓ Trying to maintain insulation continuity. Ensure all insulation layers are continuous and fill all small gaps.
- ✓ Using a structural thermal break at the base of parapets, balcony junctions, etc. in line with wall/roof insulation layer (eg. Schöck, Foamglass Perinsul, etc.)
- ✓ Introducing thermal blocks e.g. Marmox Thermoblock where internal walls pass through insulation under blockwork..
- ✓ Where insulation needs to be interrupted, consider wrapping the 'breaking' element in insulation for approx. 1 m length.

Requirements for thermal bridge calculations

Thermal bridge calculations submitted must be to BR497 2nd edition and ISO 10211:2017. Values must be calculated based on the actual construction details and materials proposed.

Colour code	Junction category	General junction category (as per SAP)	SAP ID	Type 1	Target Ψ-Value for SAP (W/mK)
	Balcony-wall junction	Balcony / deck	E23	Balcony/Canopy	0.20
	Parapet junction	Flat roof with parapet (main) / external wall junction	E15	Main roof parapet	0.01
	Brick support + slab edge	Intermediate floor between dwellings / external wall junction	E7	Masonry support	0.05
	Window / door - Lintel	Lintel	E2	Standard lintel	0.05
	Window / door – Jamb	Jamb	E4	Standard jamb	0.05
	Window/door – Sill - Threshold	Sill	E3	Standard sill	0.10
	Ground floor-wall junction (Perimeter)	Ground	E5	General wall to ground junction	0.16
	Corner (external wall) – vertical	Corner (normal)	E16	90° corners	0.07
	Inverted Corner (external wall) - vertical	Corner (inverted)	E17	Inverted 90° corners	-0.07
	Terrace access junction	Insulation at ceiling level (inverted)	E24	Third floor recessed fourth floor wall	0.12
	Exposed floor-wall junction	Exposed Floor (normal)	E20	Exposed floor to external wall	0.06
	Floor above sheltered space to wall inverted corner junction	Wall between heated and sheltered space	P8	Standard wall to sheltered space detail	0.24
	Folding slab point bridge*	Not in general SAP categories	-	*Project specific thermal bridge at terrace access	0.30
	Party wall to unheated space	Party Wall to exposed floor	P7	Walls between dwellings and corridors above unheated space	0.08
	Party wall to ground	Party Wall to Ground Floor	P1	Walls between dwellings and corridors on ground bearing slab	0.08
	Wall from unheated space to insulated floor above	Floor above unheated to external wall junction	P4 or P5	Walls from plant rooms to above floors	0.24
	Column to slab point thermal bridge	Concrete/steel column through exposed floor	-	Concrete column to ground concrete slab	0.40

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4.0

Airtightness

- Air tightness strategy for Richmond College
- Key material suggestions

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Airtightness | Airtightness target and strategy

Designing and constructing an airtight building

The energy strategy and Passivhaus approach rely on achieving an excellent level of airtightness. The airtightness test is also a good check on general construction quality and has many knock-on benefits to the client and occupants.

A low air permeability rate is targeted for Richmond College.

This is a **challenging,** but **achievable** target:

Air permeability requirement (measured at 50 Pa)

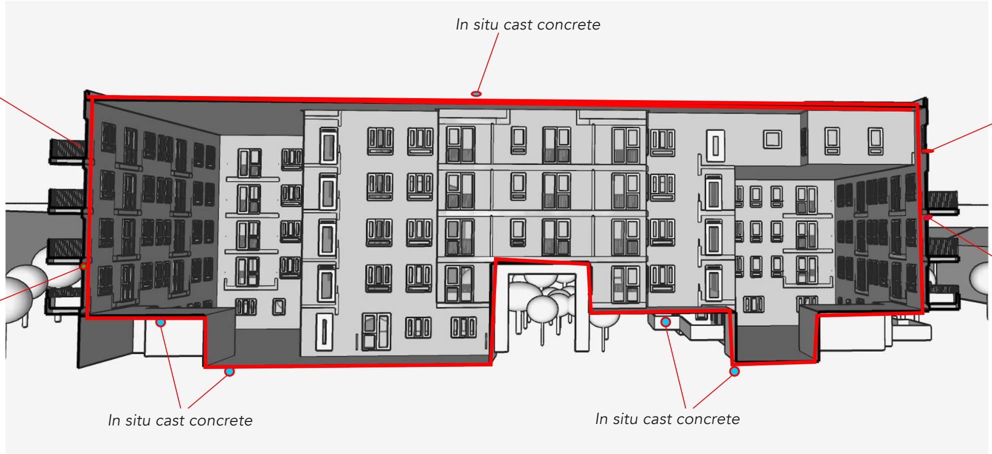
0.60 m³/h/m²	3.0 m³/h/m²
Net Zero elements	Other houses and blocks of flats

Buildings of a similar scale in the UK have achieved an air permeability of <0.5m^3/m^{2}h reliably.

Identifying and specifying materials forming the airtight layer

To achieve this level of airtightness it is imperative to have **one** single and continuous layer that completely wraps the heated volume. The materials acting as the airtightness layer are identified on the adjacent sections. Each of these materials is connected together using specialist airtightness products to achieve a continuous airtightness line. The Contractor can suggest an alternative strategy for approval to the client.

- A membrane or a parge coat plaster will provide the airtightness layer to the external walls. The wall build up includes a 40 mm service cavity to protect it. Services should not penetrate the airtightness layer unless they are incoming connections.
- The alternative wall type for the NZC apartment blocks incorporates SFS infill panels between a concrete frame and facing brick façade. A cement board panel on the external face of the SFS system will provide the primary airtightness layer.
- The concrete slabs on ground/lower ground floors and roof can work as the airtightness layer. Airtightness strategy to be examined in detail at Stage 4 to avoid condensation risk
- All service penetrations must be sealed.



Sections cut through Richmond College Block 5 and 6 showing the air tightness barrier as a red line and the materials forming it. The exact route of the airtightness layer is shown on the architect's drawings.

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Connections

Assuming all key materials forming the airtightness layer are airtight (see previous page), it is crucial to ensure that the connections between all these materials are also airtight. The main materials used for sealing junctions are mainly sealants and tapes, detailed in the adjacent table.

These specialist tapes and adhesives can have a life span of more than 100 years and are specifically designed for reducing air leaks in buildings.

There is a range of systems available for achieving excellent levels of airtightness and major manufacturers are listed here:

- Isover (Saint Gobain)
- Siga
- Pro-clima
- Isocell

Note: Products that are not designed for achieving air tightness should be avoided; they usually lack the flexibility and durability that is required and fail soon after their installation.

The image above shows an example window frame being taped to a masonry wall before the sill and window reveal are installed.

Material	*Application*	*Example specification*	
Air-tightness tape **Multi purpose**	Flexible tape for junctions, corners, and services not using a rubber gland	**Isover Multitape SL, Isocell Airstop Flex, SIGA Rissan, Partel Conexo, Proclima Tescon** Single sided flexible adhesive tape with a split release strip.	
Air-tightness tape **Joints**	Butt joints between flat boards or membranes. Flexible tapes can be used here instead	**Proclima Vana, Isover Vario KB1, SIGA Sicrall, Isocell Airstop** or equal**.** Single sided adhesive tape for sealing overlap seams in membranes and rigid boards.	
Air-tightness tape **Below ground**	Concrete slab edge to fibre cement board or membrane	Proclima Extoseal, alternatively multi-purpose tapes with primer may be used.	
Flexible sealant	As an adhesive for tape or membrane connecting to a rough or porous substrate.	**Isover Vario DS, Proclima Orcon F, SIGA Meltell** or equal. Durable elastic air tight sealant	
EPDM services seal or gland	A rubber gland that seals mid size ducts and pipes passing through the air-barrier that need further adjustment. E.g. SVPs	**Isover Vario Stos, Proclima Roflex**, (or equal) Self-adhesive flexible membrane profile for durable airtightness junction around service penetrations	
Concrete sealant	A durable and permanent primer or sealant that provides a robust surface to take an adhesive tape	**Pro Clima Tescon Primer RP, SIGA Docksill,**or equal. Priming coat suitable for use blockwork, brick, concrete	
~~Aluminium foil tape, Expanding foam sealant, silicon sealant~~	Foil tapes do not have the flexibility or durability of specialist products and should not be used. Site applied expanding foam is not suitable for achieving Passivhaus levels of air-tightness. The foam is rigid and cracks away from surfaces as the building settles. Air passages are often formed that are near impossible to trace and repair. Foam is a good solution for filling construction junctions and ensuring insulation continuity for example around windows, but must be taped over to create an air-tight seal. Silicon sealant is not a permanent airtightness connection unless installed between a butt joint. 90deg beads will pull away from one surface.		

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Services

Service penetrations are one of the most common causes of failure in terms of building airtightness.

Key services penetrations through the airtightness barrier of the building must therefore also be identified, minimised where possible and effectively sealed.

There are specialist airtight products particularly designed for services' penetrations such as grommets or socket boxes.

Electrical services

There will be multiple cable penetrations through the building fabric. The number of connection cables should be minimised and each of the remaining cables will need to be individually sealed to ensure a completely airtight building.

EPDM airtight seals or taped connections to each cable should be used.

Bunching cables together through an air tight seal is not acceptable. Individual grommets or seals are needed for each cable.

Mechanical services

Incoming services through the ground floor concrete slabs that can be cast in situ will be airtight with no further treatment.

Utilities running through a duct or penetrating a wall will require secondary sealing either with tape or with a dedicated rubber seal such as the Isover Vario Stos (or equivalent).

Category	Examples	Recommendations
Cables	• Incoming data cables • Fire alarm connections • Solar PV connections • Connections to roof plant rooms • External lights	1. Bring all cables in at same location. 2. Taped or rubber gland joint to individual cables. 3. Each cable must be separate and have 50mm clear all round.
Ducts	Plant room duct connections	Taped joint connection to duct and insulation.
Water mains	• Water mains to the building • Roof top chiller • Sump pump and access hatches	1. Taped or rubber gland joint to individual pipes. 2. Each pipe must be separate and have 100mm clear all round.
Pipe	Drainage rodding access points	Cast in and drain covers should be self sealing.

Example window reveal, MVHR duct and incoming cable penetrations through an airtight zone.

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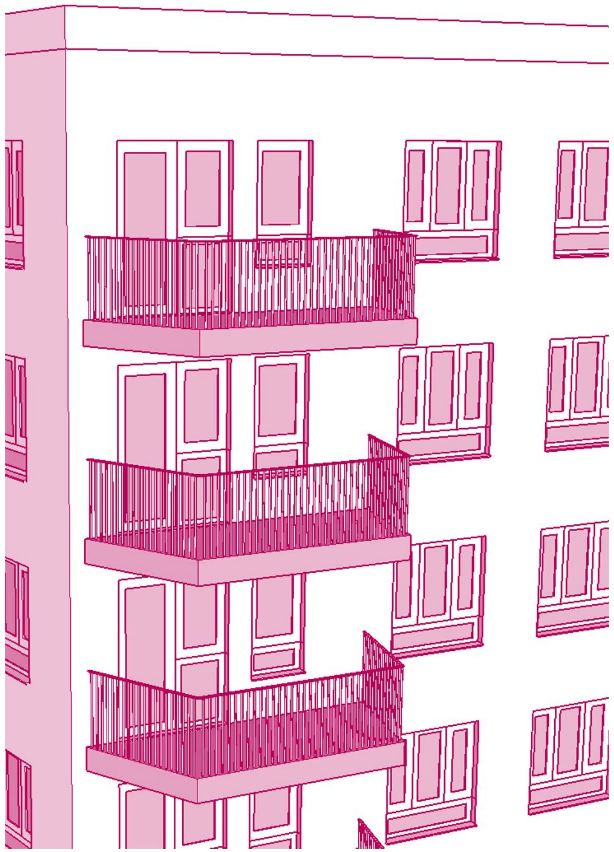
5.0

Windows and doors

- Elevations
- Energy performance requirements for windows
- Energy performance requirements for doors



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Windows and doors | Elevations (Block 5 – Net Zero Carbon)

Windows and doors

The window and door performance has a very large impact on the internal conditions and is extremely important for the future energy consumption of residents at Richmond College. The design of elevations and specification of windows affects heat losses (U-values, junction details around the window) and solar gains (g-value and frame dimension). A balance needs to be achieved between the energy and other considerations such as daylight, views and the overheating risk.

All windows, doors and access panels forming part of the thermal line must comply with agreed upon performance specifications.

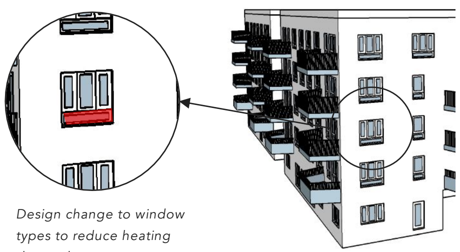
Indicative target proportions

Low energy buildings tend to require modest levels of glazing. The Climate Emergency Design Guide available at www.leti.london provides indicative window proportions per elevation for housing of this scale:

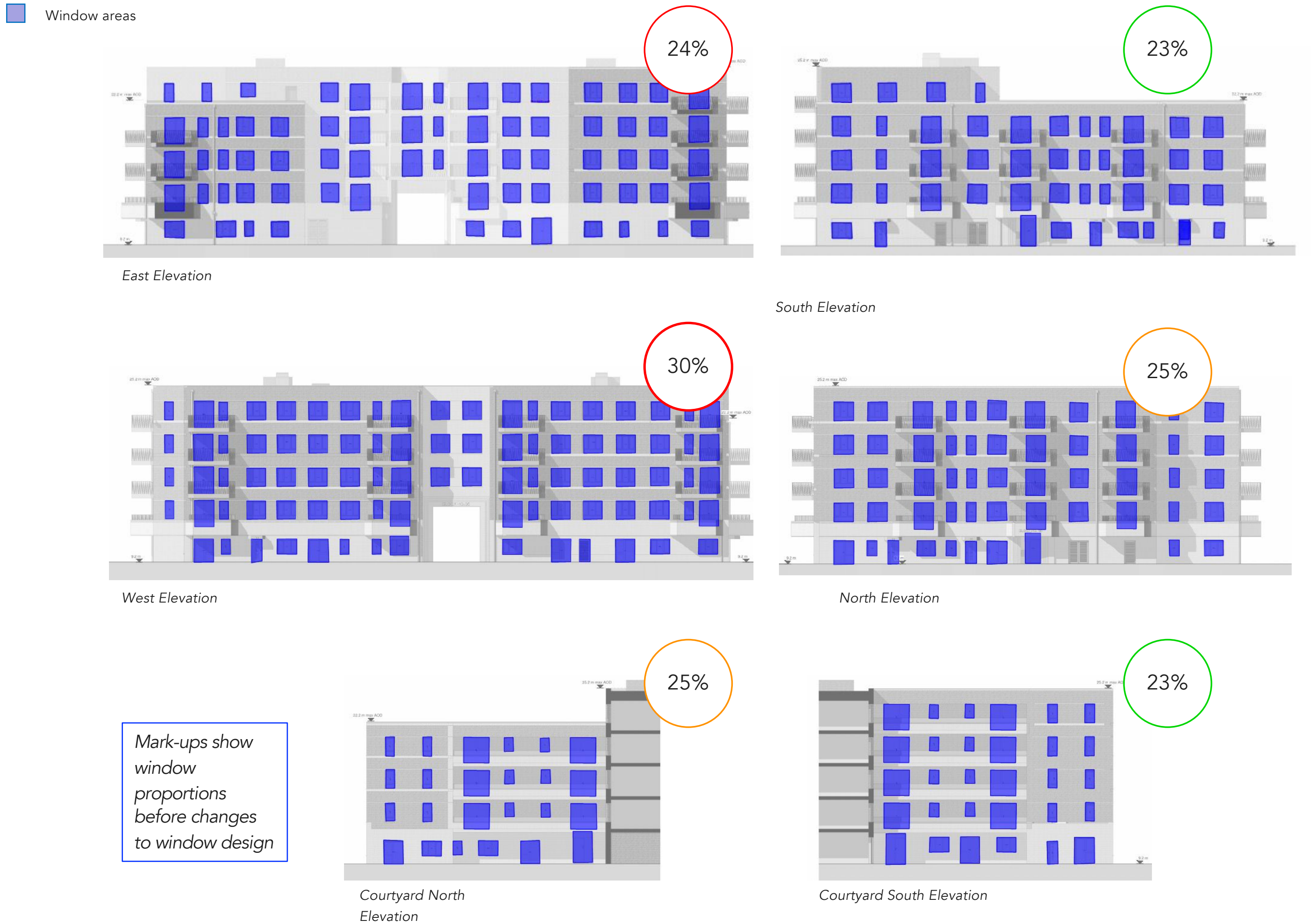
North: 10-20%
East: 10-15%
South: 20-25%
West: 10-15%

Current design

The mark-ups of the elevations on this page show the window and door areas along with the glazed proportion of each elevation during early Stage 3 design. In response to this work, the window proportions have since been reduced by removing the short lower windows as shown in the image below.



Design change to window types to reduce heating demand



Mark-up of Richmond College Stage 3 facades with window proportions – Block 5

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Windows and doors | Elevations (Terrace 4 – Net Zero Carbon houses)

Windows and doors

The window and door performance has a very large impact on the internal conditions and is extremely important for the future energy consumption of residents at Richmond College. The design of elevations and specification of windows affects heat losses (U-values, junction details around the window) and solar gains (g-value and frame dimension). A balance needs to be achieved between the energy and other considerations such as daylight, views and the overheating risk.

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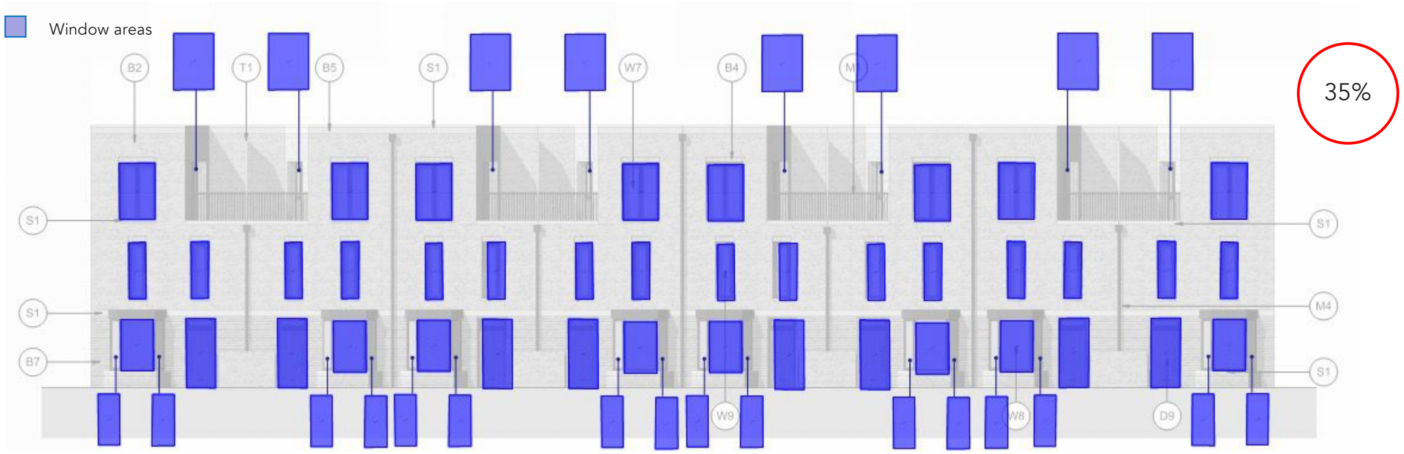
East: 10-15%
South: 20-25%
West: 10-15%

Current design

The mark-ups of the elevations on this page show the window and door areas along with the glazed proportion of each elevation for the Stage 3 design.

The window proportions have been significantly reduced since early Stage 2, although they remain significantly higher than the indicative target proportions on the north elevation.

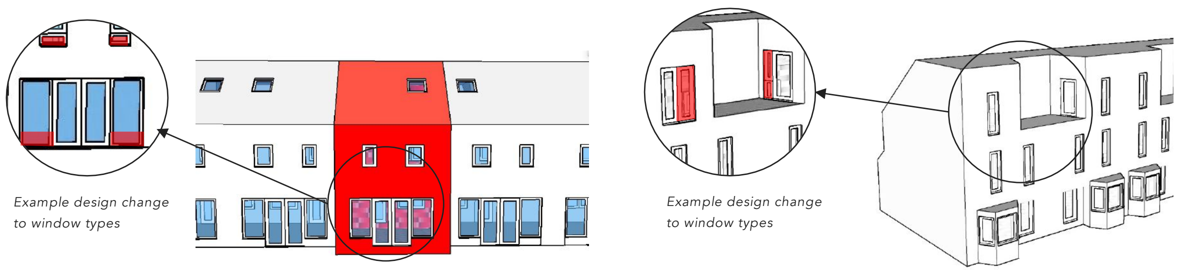
The images to the right give suggestions on how to reduce the window proportions to improve the heat balance.



North Elevation

South Elevation

Mark-up of Richmond College Stage north and South facades with window proportions – Terrace 4



Suggested *window proportions on North and South elevations (note that shading should be considered for the south façade to prevent overheating)*

Window performance

All windows should be triple-glazed.

The main parameters that impact window performance are:

1. **Area of frame proportional to glass area.** The window frame has higher heat loss than the glass, and reduces the transmission of solar gain and light into the room. Less frame improves the window performance. Additional frame may be required to provide practical openings for ventilation though.
2. **Thickness of glazing unit.** The thermal performance of the glass is mainly dependent on the thickness of the entire glazing unit. The optimum cavity width in triple glazing is 16 or 18 mm, giving an ideal glazing thickness range of approximately 44-50 mm. Warm edge plastic spacers further reduce heat loss.
3. **Gas and coatings in glazing unit.** The gas used between the glass panes affects heat transmission. Argon gas is standard practice, Krypton and Vacuum panel glass are both more expensive options that allow thinner glass panes. All options should include low emissivity coatings.
4. **Frame material and thermal performance.** Less conductive materials such as timber reduce heat loss and are preferred, however, solutions available include thermally broken aluminium frames which can also suit a variety of designs as their profiles are much thinner than their timber equivalents.
5. **Thermal and light transmission of glass.** Improved transparency of the glass means more daylight and solar energy is transmitted into the room. Special glass types are available that are clear but limit the solar gain (to control overheating) while allowing high light transmission. Over reliance on glass coatings to control solar gain can affect the visual tint of the glass.

The importance of installation junctions around doors and windows

The thermal performance of window-to-wall junctions and more generally the quality of installation of windows and doors are very important from an energy point of view.

The location of the window frame in the wall section in relation to the insulation is very important for reducing heat loss.

An installation thermal bridge of 0.04 W/mK has been assumed for windows and doors generally, and 0.10 W/mK for door thresholds. These values should be achieved or bettered.

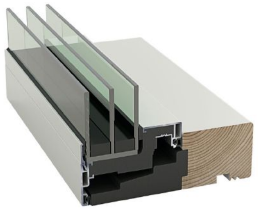
Thermal Performance Requirements

Glass U-value	Glass g-value
< 0.55 W/m²K	> 0.5*

Window frame U-value	Area-weighted window U-value**
< 0.85 W/m²K	< 0.8 W/m²K

*The g-value of a small number of windows on the lower ground floor may have to be reduced to 0.3-0.4. This will be confirmed at Stage 4.

**The U-value of windows always refers to the whole system (e.g. including frame).



e.g. Idealcombi futura+ or equivalent

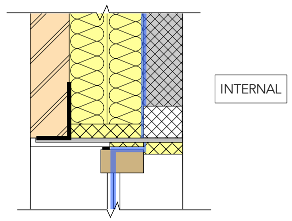
Each component of the window should achieve a high thermal performance to ensure that the window system as a whole is energy efficient.

General principles

The purpose of this page is to outline the principles that should be applied to achieve good quality junctions with high thermal performance (and low thermal bridge Psi-values):

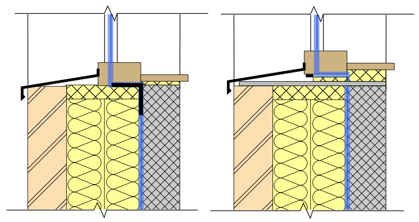
- ✓ The window glass pane should be as close to the centre line of the insulation as feasible.
- ✓ Wrapping window frames internally (or externally) with an additional piece of insulation reduces heat loss.
- ✓ Steel connections to the windows have a very high impact on the performance of the detail. Windows and doors should be supported by small straps or fixings through the frame. Angle brackets at the sill should be minimised and should only be specified on larger openings. These should be hit and miss or replaced with a structural block, e.g. Compacfoam or ArmathermPET.
- ✓ Full fill any air gaps surrounding windows with insulation, using expanding foam where required and an EPDM gasket, with particular attention around brick returns and other details.

Window head



- ✓ Maintaining the full depth of wall insulation as close as possible to the edge of the window frame
- ✓ Using split or thermally broken lintels.
- ✓ Wrapping insulation around the window frame.

Window cill

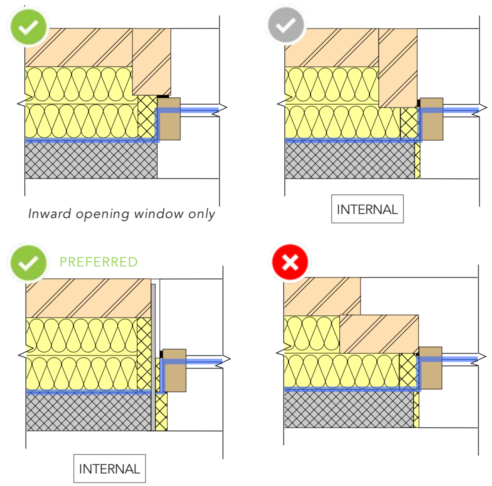


Window jamb options

The length of jambs is at least twice that of either sills or lintels, however this junction has the potential for the lowest thermal bridging if carefully designed.

Key strategies to minimise thermal bridging include:

- ✓ Maintaining the full depth of wall insulation as close as possible to the edge of the window frame
- ✓ Positioning the window frame in line with the insulation layer.
- ✓ Using low-conductivity and/or intermittent rather than continuous connections between window frame and supporting structure.
- ✓ Fully filling any air gaps surrounding windows with insulation, with particular attention around brick returns and other details.



Doors | Energy performance requirements for Net Zero Carbon block and terrace

Door performance

Doors in the insulation line should be insulated framesets and should include rubber seals to achieve airtightness. It is likely that a thicker doorset will need to be specified to provide the appropriate level of thermal performance.

Although specifying a Passivhaus certified door is not mandatory, there is a large range of door solutions that are certified, including opaque entrance doors and doors with an element of transparency (triple glazing). Products include the following:

Urban Front: E98Passiv (U-value= 0.78 W/m²K)

Aluprof: Passive SI+ (U-value= 0.72 W/m²K)

Moralt: Ferro Passiv (U-value= 0.71 W/m²K)

Rehau: Haustur Geneo PHZ (U-value= 0.67 W/m²K).

Current design

The following 17 doors have been identified as crossing the insulation line on the ground floor:

- **10 flat 'external' entrance doors**
- **4 communal access doors** on ground floor, including the main entrance and fire exits
- **1 entry door to water store** from internal corridor
- **2 external entrance doors to services corridors**

On a typical upper floor there are:

- **8 flat 'external' entrance doors**

Note this does not include fully glazed balcony doors that are included under window specifications.

Approximately half of the apartment entrance doors on the upper floors are accessed via internal corridors within the thermal envelope. These do not need to be insulated to the same level as the doors on the insulation boundary.

Ground floor plan and Typical floor plan with external doors to be fully insulated highlighted

Thermal Performance Requirements

Entrance / access door U-value*

<0.9 W/m²K

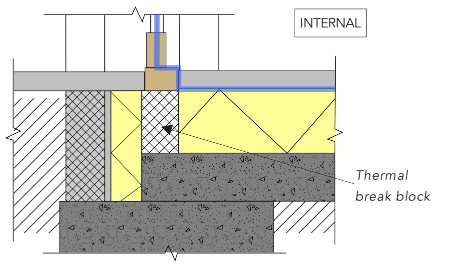
*The U-value of doors always refers to the whole system (e.g. area weighted value including frame and any proportion of glazing).

Door thresholds

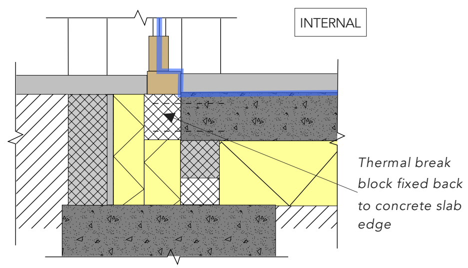
Door thresholds can be one of the largest thermal bridges in a project. The door and threshold need to be well supported which can bridge the insulation layer.

Key strategies to minimise thermal bridging include:

- ✓ Supporting the door frame outside of the main building slab edge. In this example the slab has been extended underneath the door.
- ✓ Supporting the threshold on a thermal break block material that can take fixings. For example Compacfoam or ArmathermPET.
- ✓ Fully filling any air gaps surrounding windows with insulation, with particular attention around brick returns and other details.



Floor insulation above slab



Floor insulation below slab

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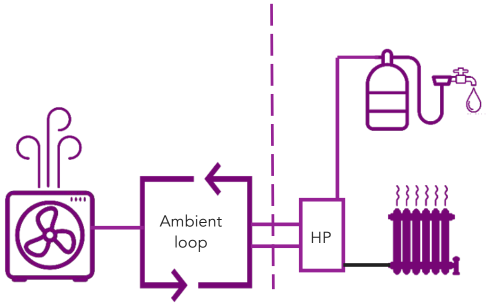
Low carbon heating, hot water & ventilation

- Low carbon heating system
- Mechanical ventilation with heat recovery



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Low carbon heating system

The heating systems for Richmond College will not use any fossil fuels on site.

Blocks of flats

Space heating and hot water will be provided in the apartments by rooftop **air source heat pumps** supplying heat energy via an **ambient temperature** (20-25°C) communal distribution system to individual heat pumps within each apartment. Since there is little difference in the temperature of the loop and the surrounding air, there is little heat loss and the system does not contribute to overheating in communal areas.

Within each dwelling, a heat pump unit (HP) uses electricity to upgrade the heat from the communal ambient loop to a higher temperature – typically 45°C for space heating and 60°C for hot water. Hot water is stored in an individual hot water tank in each flat.

Radiators or underfloor heating must be sized for low flow temperature as heat pumps are most efficient when operating at low temperatures.

Houses

Space heating and domestic hot water will be provided by individual air source heat pumps with a hot water storage tank in each house. Underfloor heating will be used.

The standing heat loss of the hot water tanks should be mnimised at Stage 4 and during procurement.

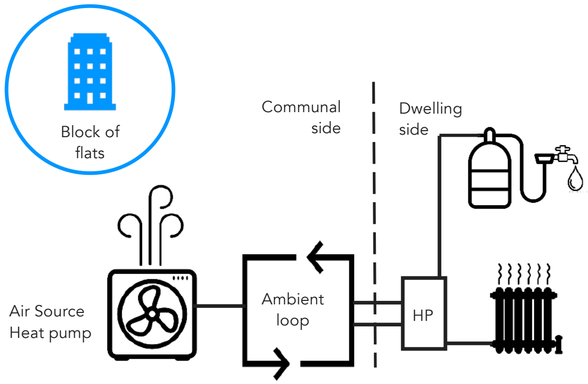
Reducing Domestic Hot Water demand

In very low energy buildings, the energy required for hot water can meet or exceed the amount of energy required for space heating. Optimisation of hot water systems is therefore important to ensure overall energy use remains low.

The AECB water standards provide clear guidance on sensible flow rates for water fittings, which are consistent with what is required to achieve net zero carbon buildings. Showerhead flow rates generally have the greatest impact and should be limited to a maximum of 8 litres/min.

Reducing distribution losses in each unit

The volume of distribution pipework has a significant effect on overall system losses. It should be minimised by clustering tapping points as close as possible to the heat pump or the hot water tank. Floor to ceiling pipe drops should be kept to a minimum and use of small diameter piping, 15mm or less, is an effective way to reduce losses.

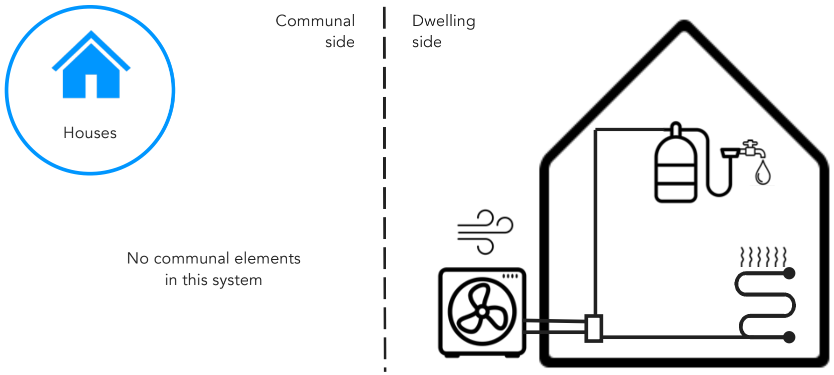


1. Air source heat pumps located on roof gather heat from surrounding air.

2. Heat pumps deliver heat to a communal loop, which flows at a similar temperature to the inside of the building.

3. A heat pump in each dwelling upgrades heat from the communal loop for use as space heating and hot water in the dwelling.

Simplified diagram of the system for the blocks of flats



1. Air source heat pump located on external wall gathers heat from surrounding air

2. The heat pump alternates between providing space heating, via underfloor pipework or low temperature radiators, and hot water in the dwelling.

Simplified diagram of the system for houses

Communal rooftop air source heat pumps (Source: Daikin)

Domestic water source heat pump, Daikin Altherma 3 Geo–Model currently selected for Carlton Dene. (Source: Daikin)

Domestic scale air source heat pump, ground mounted (Source: Vaillant)

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Ventilation system | Mechanical Ventilation with Heat Recovery (MVHR)

Benefits of MVHR

A Mechanical Ventilation system with Heat Recovery (MVHR) is specified for each flat as part of the compact unit. Its benefits include:

1. Continuous year-round ventilation
2. Reduced condensation and mould risk, reducing potential damage to building fabric
3. Less noise from outside and from intermittent fans
4. Excellent air quality with filtered air

An energy efficient MVHR system

The actual energy performance of an MVHR system will be significantly affected by the following factors:

- **Heat losses through the intake and exhaust air duct:** they both carry cold air through the heated apartment. This could reduce the MVHR in-use efficiency by more than 30%. The external duct connection lengths should therefore be minimised as much as possible, e.g. by locating the MVHR as close as possible to external wall.
- **Considering the system as a whole:** an efficient system needs to be designed, installed and commissioned as a whole system. The unit should be a Passivhaus certified energy efficient unit with 100% summer bypass, less than 3% air leakage at average airflow, and achieve a device sound level of <45dB(A). Supply filters should be F7, extract G4.
- **Installation and commissioning quality:** Adopting the requirements on this page will ensure that the MVHR systems in each apartment will perform well in-use.

Design – General

- MVHR should be designed as a complete system, including ducting, attenuators, frost protection, supply/extract and intake/exhaust valves and any auxiliary components.
- Sufficient room should be provided to carry out routine maintenance on the MVHR unit; typically 1m of clear space is required in front of the unit to change the filters or heat exchange core.
- Control systems should be simple and conveniently located for building occupants to access. Ideally near the ventilation unit.
- Filters must be accessible to building occupants and easily replaceable without tools.
- The kitchen extract terminal must have a separate terminal filter.
- Visual indicators are recommended to display the MVHR system status, including any maintenance requirements. Ideally a control panel should be visible on the face of the MVHR unit.
- Any fire stops should clearly indicate their status (tripped or stand-by) and be easy to reset by hand without special tools.
- Any boost function should be timed and system set to return to standard ventilation rate automatically.
- External intake terminals should be located to minimise exposure to air pollutants and the extract air. e.g. away from bin storage.
- Ducting layout should ensure any condensation does not reach the MVHR unit or accumulate in the ducts.
- It is essential that MVHR ducting is treated as a key component of the system, as it has a significant effect on overall system performance and energy efficiency.

Design – Air flow rates, ducting & comfort

- Intake and exhaust duct lengths should be as short as possible. Less than 1.5m per duct is good practice.
- Intake/exhaust ducts should have 25mm minimum thickness of vapour sealed insulation with a minimum design thermal conductivity of 0.04 W/(m.K)
- Supply air terminals should be located away from internal doors, transfer grilles and at least 1m from walls to ensure proper air flow across rooms.
- Ducts should be sized to achieve <2m/s and air speeds associated with supply air terminals should be low enough to avoid excessive noise and thermal discomfort:
  - ✓ Rigid or semi-rigid ducting should be used. Never flexible ducting.
  - ✓ Extract terminals should not be located above cooking appliances in kitchens, and grease filters used if necessary.
  - ✓ Acoustic attenuators should be positioned to reduce noise from the unit, and between rooms.

Installation

- The system designer, or a suitably experienced representative, should meet with the installation team to confirm system layout before installation, or visit site while ducting is still exposed to identify any issues.
- No flexible ductwork is permitted. This includes final connections to terminals.
- Kinks or crushing ductwork must be avoided.
- Ducts should be kept clean and ends covered during installation to prevent dust entering the system.
- A method statement for installing duct insulation highlighting key risk areas is required before start on site. This will summarise the key areas that require insulating before installation, and the installation order.
- Insulation must have no air gaps larger than 2mm between or behind the insulation layer. The vapour barrier shall be a robust and weatherproof (where required) complete sealed jacket to the duct.
- Any design changes should be approved by the system designer.

Commissioning

- Ensure ductwork is clean at terminals.
- Ensure all filters are clean so system is balanced with clear air flow.
- Set fan speed according to dwelling-specific design specification.
- Balance total supply and extract flow rates within at most 10% of one another, and within 5% of design values (or better if required by mechanical spec).
- Individual rooms supply and extract terminals to be measured at standard/commissioning operating flow, these should be within 5% or better of the design air flow.
- Lock air valves in position once balanced.
- Investigate and resolve deviations from the design specification when they occur.
- Submit commissioning reports for each MVHR system/unit to the client.
- Transfer grills, low level floor supply grills, and door undercuts should have supply air speed not exceeding 1m/s. Door undercuts must have more than 10mm clear opening after finishes are installed.

Handover & Operation

- Provide simple operation & maintenance instructions to occupants, which should include:
  - ✓ System overview
  - ✓ Schedule and explanation of routine maintenance procedures
  - ✓ Parts numbers for replacement filters
  - ✓ Contact information for filter suppliers
  - ✓ Contact information for inspection/servicing/repairs
  - ✓ Explanation of boost and summer bypass modes
- Provide three years supply of spare filters to encourage building occupants to change them regularly.

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Ventilation performance | Location of the MVHR units

Location of MVHR units

The location of a MVHR unit is critical to the performance of the ventilation system.

Ducts from/to outside must be insulated as they will be at or near external temperature. These external duct lengths should be minimised as much as possible during detailed design. This means the unit should ideally be located against an outside wall.

Based on the layouts prepared by BPTW, the average intake and exhaust duct length has been estimated **at 4.1 m for Block 5** with a potential to reduce to **2.2m** with some modifications.

This is satisfactory for Block 5 but will need to be considered further during detailed design development, particularly due to the 'U' routes that the ducts follow. More direct connections to the outside would improve energy efficiency further.

Best practice intake and exhaust duct length	Estimated average external duct length Block 5 worst case	Estimated average external duct length Block B best case
<2.0 m	4.1 m	2.2 m

** All above calculated lengths include vertical rises.*

Ideally the MVHR units should also be installed close to the 'noisiest' part of the flat or within a dedicated service room/cupboard. Service cupboards within living areas should be provided with sufficient sound-proofing. They should not be located in bedrooms.

All intake and exhaust ducts are assumed to be insulated with at least 25 mm of vapour sealed insulation with a design thermal conductivity of less than 0.04 W/mK. Inlets and outlets have been also assumed to be spaced at approximately 1 m.

Key

Assumed MVHR location

Horizontal duct length to external wall:

- poor for thermal performance
- acceptable for thermal performance
- good for thermal performance

Ground floor plan, 1st floor plan and 4th floor plans for Richmond College Block 5 showing location of the MVHR units and lengths of intake and exhaust ductwork to external wall. Lengths have been calculated based on drawings issued April 2021

Etude

8.0

Appliances, white goods and lighting

Appliances, white goods and lighting

Energy efficient appliances

Appliances and white goods can use significant amounts of energy in a building. High efficiency appliances are recommended to limit total energy consumption and minimise overheating risk from waste energy given off as heat (i.e. A++ or A+++).

It is also proposed that the scheme is fitted with drying clothes lines in order to avoid the use of tumble dryers.

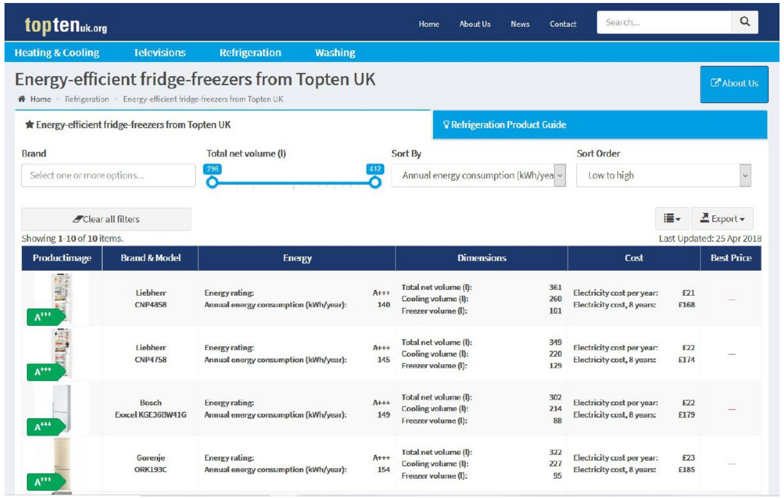
Generally, free-standing appliances can achieve better performance than integrated devices and their use is encouraged wherever this is possible although their compliance with the overall design needs also to be considered.

Lighting

All the light fittings in both apartments and houses should be efficient warm white LEDs. Occupancy sensors and daylight dimming should be specified in communal areas where appropriate.

Lifts

The lift must be of a high energy efficiency rating with low stand-by energy consumption.



The Energy Saving Trust's www.toptenuk.org website is an excellent resource for finding the most energy efficient appliances available on the market. While it is unlikely to be the contractor's responsibility to specify which appliances will be used, it is included here for reference and can be a useful resource to help inform future occupants of New City Road.

Appliance efficiency	Lighting efficacy	Lift efficiency
A+	80lm/W (LED)	A

Typical electrical efficiencies assumed at Richmond College

These generally represent good but not best practice and are easily achievable. Best practice efficiencies are recommended where possible.

Retractable clothes drying lines – could be located in the bathroom or a designated drying cupboard fitted with an extract

High-rated (A+++) washing machine model from Bosch

High-rated (A+++) free standing fridge-freezer model from Bosch

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Be seen/metering

Purpose of energy metering

Energy metering and monitoring of the new homes provides valuable information for this development and future schemes, as well as contributing to the development of the industry. The purpose of metering and storing energy data for these buildings is:

- Monitor homes to spot potential set up and commissioning issues by comparing measured energy consumption to predictions.
- Identify faulty equipment that goes wrong in the future by comparing year on year or monthly billing.
- Help tenants understand their use patterns and diagnose high bills, e.g. at energy clinics.
- Report aggregated or average home energy consumption to justify the design approach taken here, and feedback into design calculations on future schemes.
- Report energy consumption, generation and carbon emissions as demonstration of meeting Climate change objectives.
- Report to GLA to show case the project and to help inform the industry on what works.

Data that should be collected

Any data that is stored must adhere to GDPR and other relevant legislation. For home energy monitoring it is generally accepted that averaging or aggregating (adding together) more than 6 homes means that individual permission is not required, as it is not possible to glean individual habits. For Richmond College, aggregating each block would meet this requirement. For data stored by the landlord it might be possible to store information on each property, as there is an interest for both parties.

The minimum metering would be the annual energy consumption of each home and communal lighting, and the generation by block for PV.

For each meter the **monthly energy consumption** should be stored. This can be via a central web based datalogger, or manually collected. The datalogger or system should ensure that there is enough storage for at least 5 years of data.

Submetering recommendations

Useful metering to help diagnose potential issues would be:

- Submetering the heating and hot water energy consumption for each home. This could be electrical consumption only. For more detailed diagnosis a heat meter would be beneficial, but is not critical for all homes.
- Submetering any electric vehicle charging.
- Submetering generation from PV before the consumer unit, so that total generation can be reported (and doesn't offset consumption)
- Internal temperature and humidity. Switchee offers a smart thermostat integrated solution that could be used: https://www.switchee.co/

Industry data disclosure

This can be published via the new CIBSE and RIBA tool (in development) or on the Low Energy Buildings database.

London Plan requirements for 'Be Seen'

The New London Plan has a requirement for all major developments to report at least three years of data post occupancy. Richmond College will need to report:

- A planning stage 'be seen' submission on the GLA webform using the Be Seen spreadsheet will be needed at the end of RIBA Stage 3
- Aggregated data by block for the first three years of occupancy.

Data disclosure after the first years is voluntary and would contribute to industry knowledge.

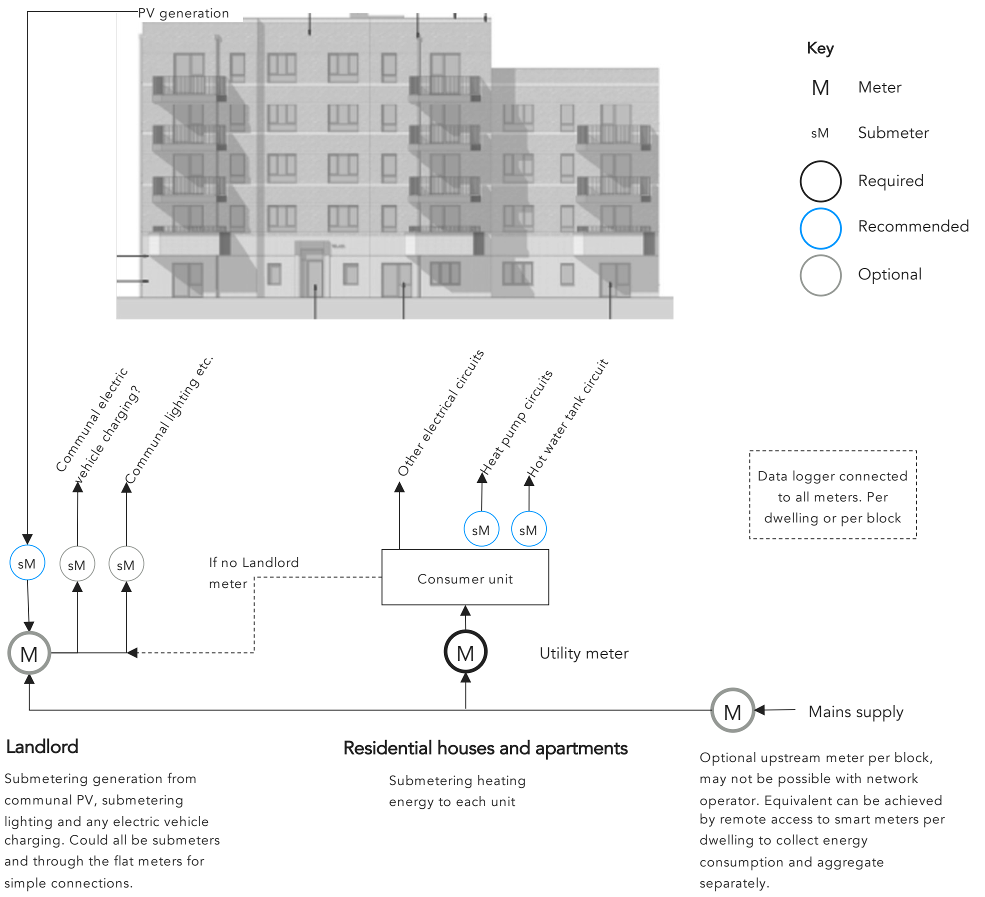
Other building performance monitoring

It is highly recommended that energy monitoring is carried out alongside a more comprehensive building performance evaluation. This can be relatively light touch and would include user surveys and more developed internal air quality monitoring.

Very good guidance on building performance evaluation is available in these freely available publications:

RIBA Plan for use guide 2021

Wood Knowledge Wales – Building Performance Evaluation Guide



Outline schematic showing potential metering arrangements for Richmond College

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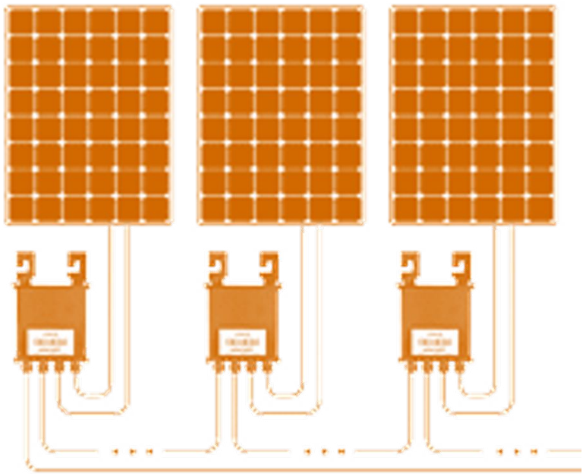
9.0

Renewable energy: roof-mounted PVs

- Best practice specifications for PVs
- Richmond College PV potential



Best practice specification of solar PV technology

Specification matters

The energy generated over the lifetime of a solar PV system based on the latest solar technology could be **twice as high** as the energy generated by a poorly specified system.

Fortunately, the cost differences associated with specifying higher performance components are often marginal. Higher performing systems are frequently able to achieve similar costs per unit of energy produced as the higher energy production reduces fixed costs per unit of energy.

Three three key elements of solar system specification should particularly be optimised:

- Solar panel selection
- Power output warranty
- Module Level Power Electronics (MLPE).

A – High efficiency solar panel selection

The solar PV panel is the core component of any system. While different panels may appear to be similar, the best products have been built on decades of development in materials technology.

High efficiency monocrystalline silicon solar panels can deliver excellent levels of efficiency while maintaining their performance over several decades. Bifacial panels are able to absorb light on both sides of the panel, which can boost energy generation. It is recommended to specify high efficiency panel with an output of at least 360 W, though panels are available with outputs up to 400 W in a typical 1700mm x 1100mm size.

LG Neon² solar panels are one of many options that deliver an impressive 360W of power (© LG)

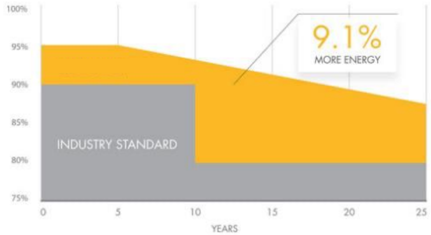
Well established solar manufacturers include:

JA Solar | Jinko Solar | Canadian Solar | Sunpower | LG | Trina | First Solar | BYD | Sharp | Panasonic | SolarWatt | REC | BENQ | Hanwha Qcells | LONGi | Risen Energy | GCL-SI | Talesun

B - Power output warranty

The power output warranty for a solar panel provides an indication of how it will perform over time. Lower performing solar panels have 'stepped' warranties that usually guarantee a percentage of the original power production at 10 and 25 years.

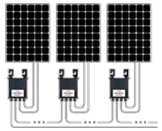
Higher performing solar panels have **'linear' warranties** that guarantee higher levels of power production throughout the lifetime of the panel. Some manufacturers now offer 30-year warranties, though 25 years is the industry standard.



A typical linear power output warranty from a Tier 1 manufacturer (© Sunpower)

C - Module Level Power Electronics (MLPE)

Module Level Power Electronics (MLPE) refer to technologies that manage power production individually for each solar panel. The main benefit is achieved through maximum power point tracking. This is a feature that ensures each solar panel operates at its peak power output. There are two main MLPE options: **Microinverters** or **DC Optimisers**.



Typical MLPE layout - power control for each solar panel

Microinverters

In this system, a single tiny inverter is provided for every solar panel. It converts the electricity from the solar panel into a suitable form for the building's electrical system and ensures each panel constantly operates at its peak performance.

Advantages include a typical 5-15% increase in energy production, lack of high voltage DC wiring (which can be more prone to arcing), a high level of redundancy, and a 25 year warranty compared to around 10 for a central inverter.

Enphase IQ7 microinverter (© Enphase)

DC Optimisers

DC Optimisers split the two main functions of a microinverter into two groups of hardware: a single central inverter that conditions the solar power so it can be used by the building, and several smaller power optimisers that provide maximum power point tracking for each panel.

Solaredge P370 power optimiser (© Solaredge)

Recommendations for PV specifications

- Specify high efficiency monocrystalline silicon solar panels from a reputable manufacturer
- Choose a panel with a linear power output warranty
- Specify microinverters or DC optimisers

PV Assessment and Net Zero Carbon feasibility

Good practice design for Richmond College

The team has looked at maximising the renewable energy generation at Richmond College whilst considering other services the roof space must provide for. The roof plan to the right shows a potential solar PV layout based on the current roof plan.

In summary, our assessment indicates that the potential PV design could include **1,676 solar panels** representing a total capacity of **603.3kWp**. This size of and configuration of PV array would be estimated to generate approximately **518,950kWh/yr** and provide carbon savings of **120.9 tonnes/yr** (assuming SAP10 carbon emission factors).

Solar array design and specification

For flat roofs we have assumed that the solar array is oriented East / West at a 10 degree tilt angle. Although each panel may not quite have the same yield as a south facing panel, the total impact on annual energy generation is quite modest and this configuration allows for a much higher density of PV panel placement.

It is assumed that a low parapet, of 400 mm height is used to reduce the area rendered unusable due to shading.

Best practice solar technology is also assumed: 360W high efficiency monocrystalline silicone solar panels with microinverters or DC optimisers.

Concertina panels are assumed for the recommended PV design (image © K2 Systems)

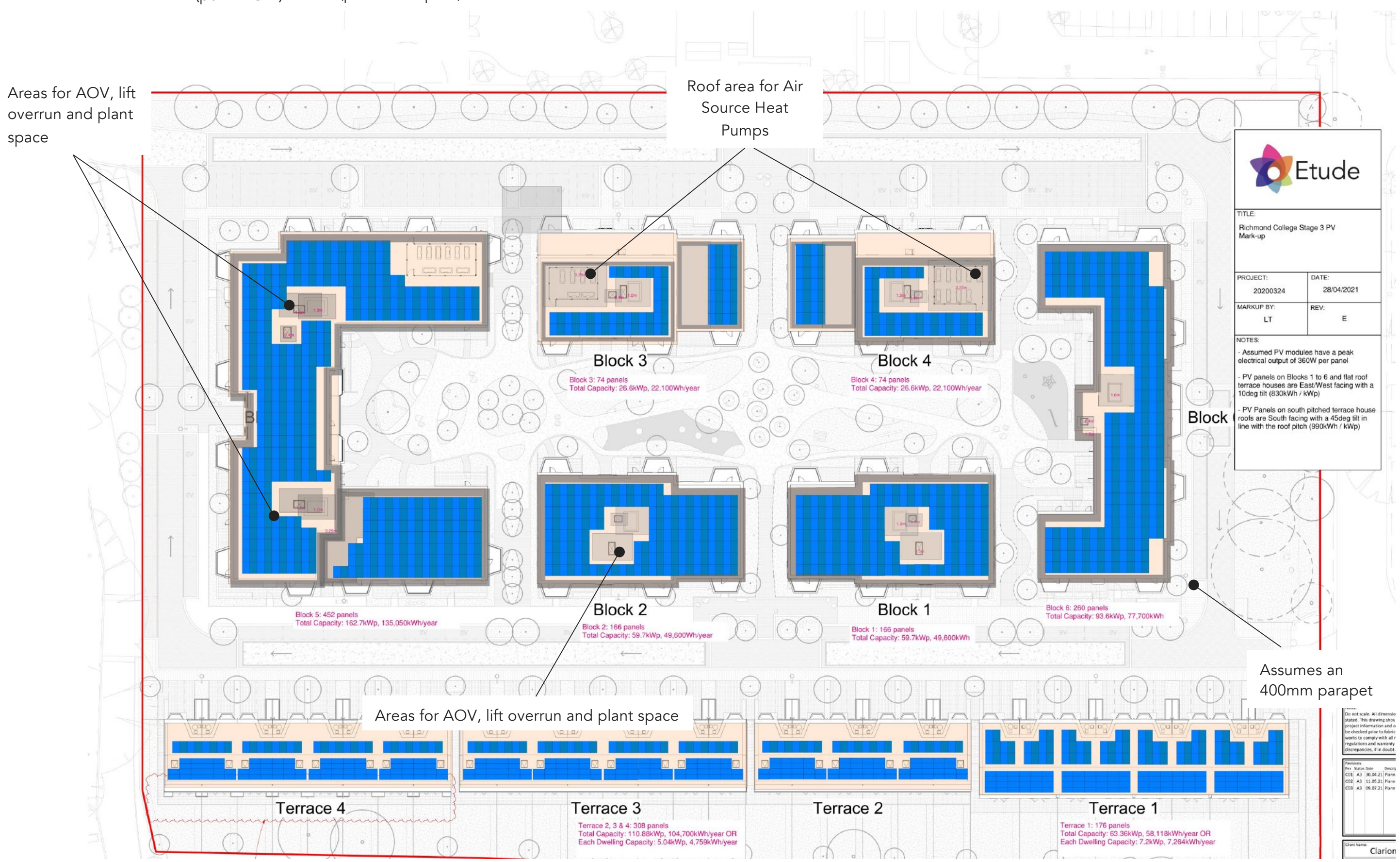
Richmond College has a total building footprint of 5,768m² with a total GIA of 16,106m².

603.3 kWp	32.2 $kWh/yr/m^2_{GIA}$	89.9 $kWh/yr/m^2_{fp}$
Nominal array power	Annual energy generation (per m² GIA)	Specific energy generation (per m² footprint)

Blocks 1 to 6: All panels mounted on the apartments blocks are assumed to be mounted in a concertina type arrangement, at a 10 degree tilt angle, facing to the East and West.

Terraced Houses: Panels are both mounted to the pitched South facing roof (assumed 45 degrees) and East / West at a 10 degree tilt angle on the flat roof areas.

Panels across roofs are located to avoid ventilating pipe terminals.



Potential solar PV layout

10.0

Summary of calculations

- Capability of meeting heating demand criteria
- Predicting operational energy calculations (PHPP)
- Preliminary Part L compliance assessment (SAP)
- Overheating risk assessment

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PHPP calculations | Compliance with Passivhaus levels of heating demand – Block 5

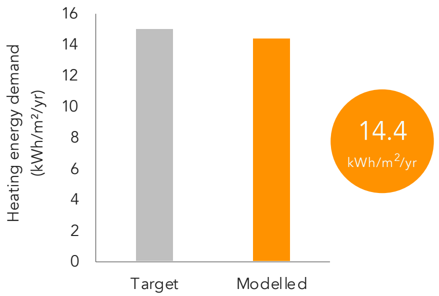
The predicted heating demand and energy use of Richmond College have been calculated using PHPP v9.6 and are summarised on the adjacent image and following pages. Although the full Passivhaus standard is not a specific target, the criteria and methodology are used as a route to Net Zero Carbon.

Space heating demand

The largest energy consumer in a standard residential building is heating. The annual heating demand (ignoring system efficiency and losses) in kWh/m²/yr treated floor area gives a good measure of the fabric performance of the building and is the metric used in Passivhaus.

It must be less than 15 kWh/ m²$_{TFA}$/yr.

The calculated annual heating demand for Richmond College Block 5 at Stage 3 design is 14.9 kWh/m2/y. This is just below the target demand, which means that it is possible to achieve the Passivhaus levels of heating demand. As it is close to the threshold, the scheme will need very careful further development in the next Stages in order to keep on track. Some of the key assumptions are described on this page.



Total heating energy demand of building compared to the Passivhaus target of 15 kWh/m²/yr

Airtightness

The Passivhaus target of a maximum 0.6 air changes per hour at 50 Pascals pressure. This is verified with an onsite pressure test. Having a good strategy put in place during design will help achieve such a level of airtightness, but ultimately it will depend on the quality of construction.

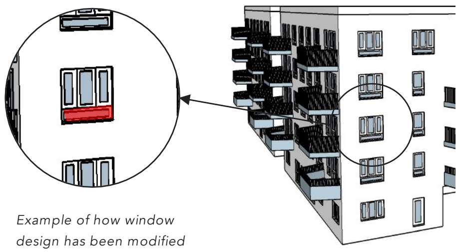
<0.6 ach — **Airtightness target** (at 50 Pa)

The predicted heating demand relies on some important assumptions as shown below, the complete list of assumptions are included in the appendix.

	Current assumption	*Potential Improvements*	
MVHR duct length	4.1 m	2.2 m	*Best and worst case figures, based on the Stage 3 drawings.*
MVHR efficiency	90%		*It is critical to use very high efficiency MVHR units to achieve the targeted heating demand*
Heat demand due to thermal bridges	4 kWh/m²/yr		*This allowance assumes excellent thermal bridge detail, as described earlier in this document. This will need further development in Stage 4.*

Further improvements have been made to the elevation design to reduce the overall window proportion of the block. This reduces the space heating demand significantly to make the target easier to achieve.

Heat demand reduction from reducing window area	-0.6 kWh/m²/yr



Example of how window design has been modified to improve energy performance of the block

Passive House Verification

Photo or Drawing

Building:	Block 5, Richmond College		
Street:	Marsh Farm Lane		
Postcode/City:	TW2	London	
Province/Country:		GB-United Kingdom/ Britain	
Building type:			
Climate data set:	GB0002a-Silsoe		
Climate zone:	3: Cool-temperate	Altitude of location:	13 m
Home owner / Client:	Clarion Housing Group		
Street:	Level 6, 6 More London Place, Tooley Street		
Postcode/City:	SE1 2DA	London	
Province/Country:		GB-United Kingdom/ Britain	

Architecture:	BPTW		**Mechanical engineer:**		
Street:	40 Norman Rd		Street:		
Postcode/City:	SE10 9QX	London	Postcode/City:		
Province/Country:		GB-United Kingdom/ Britain	Province/Country:		
Energy consultancy:	Etude		**Certification:**		
Street:	3 Dufferin Avenue		Street:		
Postcode/City:	EC1Y 8PQ	London	Postcode/City:		
Province/Country:		GB-United Kingdom/ Britain	Province/Country:		

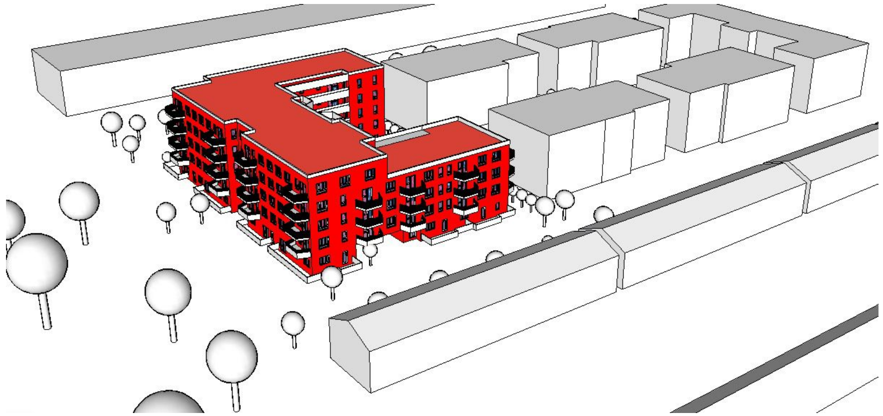
Year of construction:	2021	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	65	Internal heat gains (IHG) heating case [W/m²]:	2.8	IHG cooling case [W/m²]:	2.8
No. of occupants:	121.2	Specific capacity [Wh/K per m² TFA]:	84	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	4643.0				
Space heating	Heating demand	kWh/(m²a)	14	≤	15	-	yes
	Heating load	W/m²	10	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	5	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	27	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	34	≤	60	60	yes
	Generation of renewable energy (in relation to pro-jected building footprint area)	kWh/(m²a)	92	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

Output summary sheet for Stage 3 from PHPP



3D image of Richmond College Block 5 energy model

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PHPP calculations | Prediction of energy use and Net Zero Carbon capability – Block 5

Estimating the energy use of the building

PHPP software was developed specifically for modern low energy buildings and Passivhaus. The software has been shown to give a more realistic estimate of heating energy demand and total operational energy consumption than dynamic simulation or SAP calculations.

Richmond College Block 5 has been modelled in PHPP 9.6 software to assess the predicted heating energy demand. This demand equalises the annual heating energy balance which is shown in an image to the right. The estimated breakdown of total operational energy consumption is also shown. Due to space heating demand being minimsed through passive design measures other energy consumption, such as that relating to hot water, equipment and appliances, become more significant.

Total operational energy consumption

An estimate of the total building operational energy consumption is shown below. This assumes that performance is in line with the current PHPP modelling, with a mean internal temperature of 20°C.

With ASHP	With GSHP	
126 MWh/yr	98 MWh/yr	Total estimated annual energy consumption

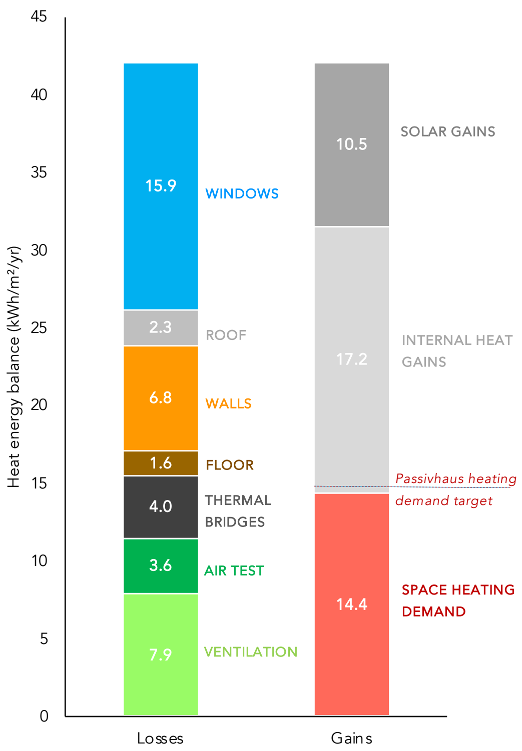
This figure can be used to estimate the mean energy consumption per unit and could possibly be compared to meter readings post occupancy. This will allow the actual performance of the construction and systems to be compared to the design and facilitate improvement of future builds.

In practice there will be considerable variation between flats due to use, occupancy and annual weather patterns.

Significant assumptions – WWHR 50%, best practice appliances

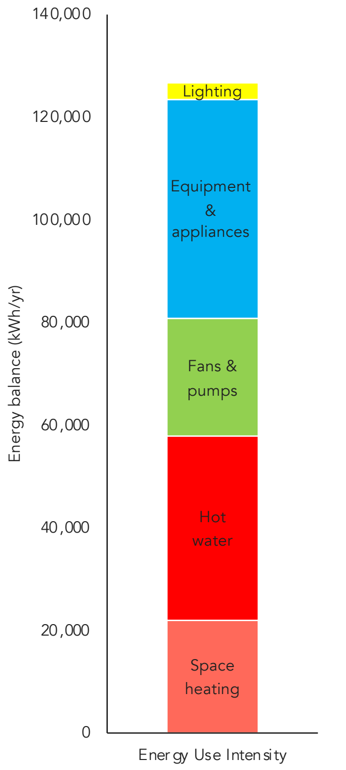
Energy Use Intensity

The Energy Use Intensity (EUI) has been calculated by dividing the sites total energy consumption by the Gross Internal Area (assumed to be 6,036 m²). This determines compliance with the Net Zero Operational Carbon criterion (i.e. less than 35 $kWh/m^2_{GIA}/yr$ for a multi-residential building). It is an estimate at this stage and assumes use of PKOM 4 exhaust air source heat pumps in each unit for heating and ventilation.



Graph showing PHPP annual heating energy balance

The column on the left shows heat energy lost from the building, and the column on the right heat gains into the building, including from the heating system.

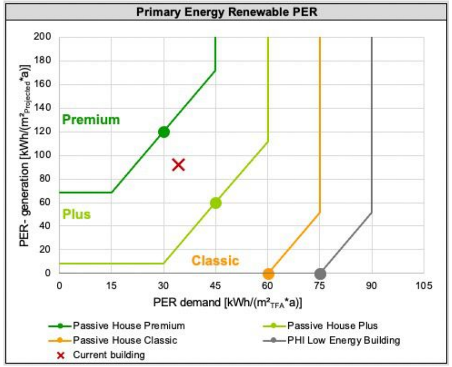


Graph showing breakdown of total annual energy consumption for Richmond College, as estimated using PHPP.

Primary Energy Renewable consumption

The Passivhaus criterion associated with total energy use is expressed in terms of Primary Energy Renewable (PER) consumption, this refers to the primary energy associated with the energy demand in a future grid dominated by renewables.

Primary Energy Renewable targets. The diagram below shows the targets for renewable energy generation (y-axis) and PER demand (x-axis) for three standards of Passivhaus: Classic, Plus and Premium, which vary according to the footprint to TFA ratio. The red X shows that the block achieves a PER of **35kWh/m²a** (treated floor area), and a PV generation of **92kWh/m²a** (projected footprint - different to the GIA figure shown later), and indicates that block 5 could comply with the Passivhaus Plus criteria, assuming the heating demand targets were also met.



Performance of current design against Passivhaus Classic, Plus, and Premium standards.

The current design of Richmond College Block 5 has the potential to comply with the Passivhaus plus criteria.

Energy Use Intensity ($kWh/m^2_{GIA}/yr$)		WITH	PV energy generation ($kWh/m^2_{GIA}/yr$)	→	Energy generation as a % of consumption
22.3 $kWh/m^2/yr$	ASHP		23.5 $kWh/m^2/yr$		106%
17.2 $kWh/m^2/yr$	GSHP				

An estimate of the Energy Use Intensity has been calculated. This indicates the designs potential to be net zero carbon in operation.

The potential on-site renewable energy generation is based on a 216 panel PV array.

Comparing PHPP calculations of predicted energy use to potential generation from roof mounted PV indicates that *Richmond College Block 5* is capable of generating 100% of its annual energy consumption onsite.

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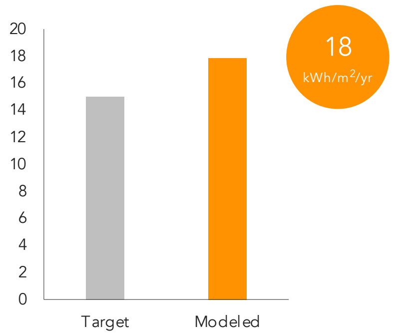
PHPP calculations I Compliance with Passivhaus levels of heating demand – Terrace 4

Space heating demand

The calculated annual heating demand for Richmond College Terrace 4 at Stage 3 design is 17.9 kWh/m2/y, which is just above the Passivhaus heating demand target. However, this is still a low heating demand, and the scheme will need very careful further development in the next Stages in order to keep on track to this. Some of the key assumptions are described on this page.



Total heating energy demand of building compared to the Passivhaus target of 15 kWh/m²/yr

Airtightness

The Passivhaus target of a maximum 0.6 air changes per hour at 50 Pascals pressure. This is verified with an onsite pressure test. Having a good strategy put in place during design will help achieve such a level of airtightness, but ultimately it will depend on the quality of construction.

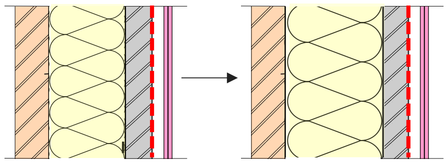
<0.6 ach — Airtightness target (at 50 Pa)

The predicted heating demand relies on some important assumptions as shown below, the complete list of assumptions are included in the appendix.

	Current assumption	*Potential Improvements*	
MVHR duct length	2 m		*This analysis relies on the MVHR being located adjacent to an external wall.*
MVHR efficiency	90%		*It is critical to use very high efficiency MVHR units to achieve the targeted heating demand*
Heat demand due to thermal bridges	3 kWh/m²/yr	2 kWh/m²/yr	*This allowance assumes good thermal bridge detailing, but with scope for improvement.*

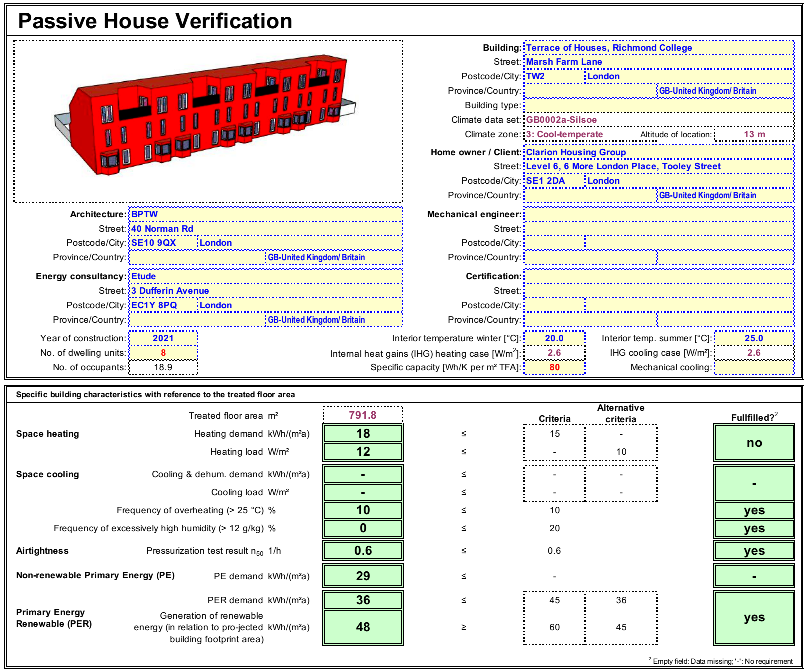
Further improvements have been made to the wall U-value, which has reduced the space heating demand significantly.

		Revised assumption
Wall U-value improvement	0.13 W/m²K	0.1 kW/m²K



External Wall, NZC Houses –
Mineral Wool with blockwork

Layer	Thickness mm	Conductivity W/mK	U-value W/m²K
2 layers plaster board	25	0.250	
Service cavity	40	0.22	
Membrane or parge coat	1-15	0.56	0.10*
Insulating blockwork	100	0.15**	
Insulation with Teplo ties	**330**	**0.034**	
Brick	103	0.770	



Passive House Verification

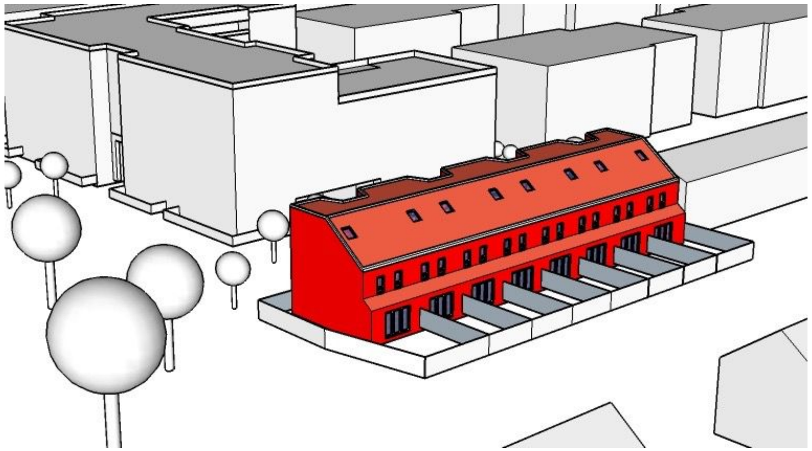
Building:	Terrace of Houses, Richmond College
Street:	Marsh Farm Lane
Postcode/City:	TW2 London
Province/Country:	GB-United Kingdom/ Britain
Building type:	
Climate data set:	GB0002a-Silsoe
Climate zone:	3: Cool-temperate; Altitude of location: 13 m
Home owner / Client:	Clarion Housing Group
Street:	Level 6, 6 More London Place, Tooley Street
Postcode/City:	SE1 2DA London
Province/Country:	GB-United Kingdom/ Britain
Architecture:	BPTW
Street:	40 Norman Rd
Postcode/City:	SE10 9QX London
Province/Country:	GB-United Kingdom/ Britain
Mechanical engineer:	
Street:	
Postcode/City:	
Province/Country:	
Energy consultancy:	Etude
Street:	3 Dufferin Avenue
Postcode/City:	EC1Y 8PQ London
Province/Country:	GB-United Kingdom/ Britain
Certification:	
Street:	
Postcode/City:	
Province/Country:	
Year of construction:	2021
No. of dwelling units:	8
No. of occupants:	18.9
Interior temperature winter [°C]:	20.0
Internal heat gains (IHG) heating case [W/m²]:	2.6
Specific capacity [Wh/K per m² TFA]:	80
Interior temp. summer [°C]:	25.0
IHG cooling case [W/m²]:	2.6
Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	791.8				
Space heating	Heating demand	kWh/(m²a)	18	≤	15	-	no
	Heating load	W/m²	12	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	10	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	29	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	36	≤	45	36	yes
	Generation of renewable energy (in relation to pro-jected building footprint area)	kWh/(m²a)	48	≥	60	45	

[2] Empty field: Data missing; '-': No requirement

Output summary sheet for Stage 3 from PHPP



3D image of Richmond College Terrace 4 energy model

Etude

Estimating the energy use of the building

PHPP software was developed specifically for modern low energy buildings and Passivhaus. The software has been shown to give a more realistic estimate of heating energy demand and total operational energy consumption than dynamic simulation or SAP calculations.

Richmond College Block 5 has been modelled in PHPP 9.6 software to assess the predicted heating energy demand. This demand equalises the annual heating energy balance which is shown in an image to the right. The estimated breakdown of total operational energy consumption is also shown. Due to space heating demand being minimsed through passive design measures other energy consumption, such as that relating to hot water, equipment and appliances, become more significant.

Total operational energy consumption

An estimate of the total building operational energy consumption is shown below. This assumes that performance is in line with the current PHPP modelling, with a mean internal temperature of 20°C.

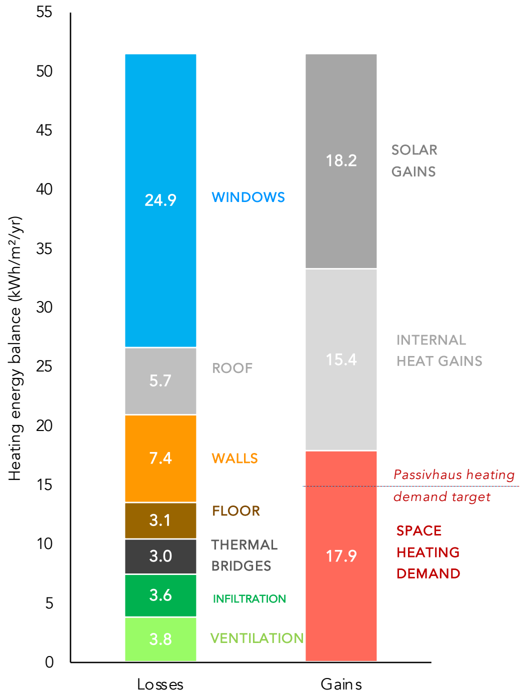
22.9 MWh/yr — Total estimated annual energy consumption

This figure can be used to estimate the mean energy consumption per unit and could possibly be compared to meter readings post occupancy. This will allow the actual performance of the construction and systems to be compared to the design and facilitate improvement of future builds.

In practice there will be considerable variation between flats due to use, occupancy and annual weather patterns.

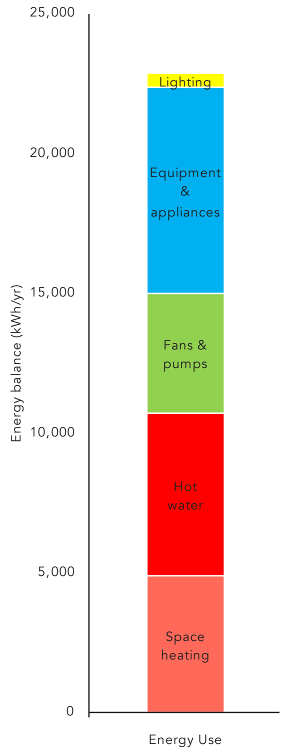
Energy Use Intensity

The Energy Use Intensity (EUI) has been calculated by dividing the sites total energy consumption by the Gross Internal Area (assumed to be 6,036 m²). This determines compliance with the Net Zero Operational Carbon criterion (i.e. less than 35 kWh/m²$_{GIA}$/yr for a multi-residential building). It is an estimate at this stage and assumes use of PKOM 4 exhaust air source heat pumps in each unit for heating and ventilation.



Graph showing PHPP annual heating energy balance

The column on the left shows heat energy lost from the building, and the column on the right heat gains into the building, including from the heating system.

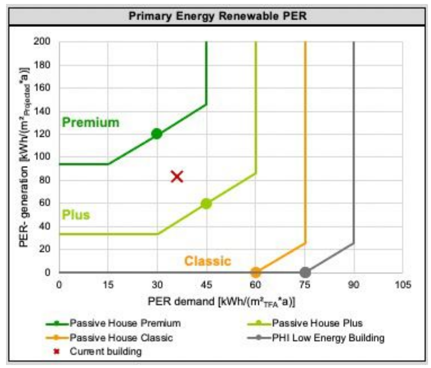


Graph showing breakdown of total annual energy consumption for Richmond College, as estimated using PHPP.

Primary Energy Renewable consumption

The Passivhaus criterion associated with total energy use is expressed in terms of Primary Energy Renewable (PER) consumption, this refers to the primary energy associated with the energy demand in a future grid dominated by renewables.

Primary Energy Renewable targets. The diagram below shows the targets for renewable energy generation (y-axis) and PER demand (x-axis) for three standards of Passivhaus: Classic, Plus and Premium, which vary according to the footprint to TFA ratio. The red X shows that the block achieves a PER of **34kWh/m²a** (treated floor area), and a PV generation of **47kWh/m²a** (projected footprint - different to the GIA figure shown later). This indicates that Terrace 4 could comply with the Passivhaus Plus criteria, if it were possible to meet the heating demand target.



Performance of current design against Passivhaus Classic, Plus, and Premium standards.

The current design of Richmond College Terrace 4 has the potential to comply with the Passivhaus plus criteria.

Energy Use Intensity (kWh/m²$_{GIA}$/yr): 22.9 kWh/m²/yr

WITH

PV energy generation (kWh/m²$_{GIA}$/yr): 38.2 kWh/m²/yr

→ **Energy generation as a % of consumption**: 166%

An estimate of the Energy Use Intensity has been calculated. This indicates the designs potential to be net zero carbon in operation.

The potential on-site renewable energy generation is based on a 216 panel PV array.

Comparing PHPP calculations of predicted energy use to potential generation from roof mounted PV indicates that *Richmond College Block 5* is capable of generating 167% of its annual energy consumption onsite.

Etude

Part L calculations | Summary of SAP analysis

Summary

This section summarises the preliminary assessment of a large sample of units at Richmond College against Part L 2013 compliance and the carbon emission targets required by the London Plan (policies 5.2 & 5.3) and the Richmond Planning Policy.

The units modelled at this stage are indicated on the adjacent floor plans.

Targets

As a minimum the site must achieve a 35% onsite reduction in CO_2 emissions over Part L 2013 and offset the remaining regulated CO_2 emissions.

The design must also achieve Part L compliance from energy efficiency measures only, i.e. before the incorporation of any low or zero carbon technology.

Methodology

The calculations were undertaken using the Government approved STROMA fSAP 2012 software (version 1.0.4.26) to assess the development against Criterion 1 Part L 2013 of the building regulations in terms of:

- CO_2 emission rates for new buildings
- Fabric energy efficiency

Ground Floor

1st Floor

2nd Floor

4th Floor

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Performance against planning requirements

Energy efficiency (Be Lean). The proposed design and building fabric specification ensures that the development will exceed the minimum requirements of Part L 2013 through energy efficiency and passive design measures alone, achieving a 26% improvement over Part L (SAP 10) from energy efficiency alone.

Low carbon heat (Be Clean). It is not proposed that the site will incorporate CHP or connect to a district heat network.

Heat Pumps and Roof-mounted PVs (Be Green). Individual and communal Air Source Heat Pumps will provide heating and DHW to the Terraced Houses and Apartments, respectively.

Photovoltaic panels on the roofs are proposed to generate approximately **518,950 kWh/yr**.

The two bar charts opposite comply with the GLA's requirement to report carbon emissions against both:

- the out-of-date carbon factor for electricity currently being used by Part L (i.e. SAP 2012 - 519 gCO_2/kWh)
- The up-to-date carbon factor for electricity determined by the GLA (i.e. SAP 10.0 - 233 gCO_2/kWh)

Based on the initial Part L1A calculations undertaken for a sample of 37 residential units:

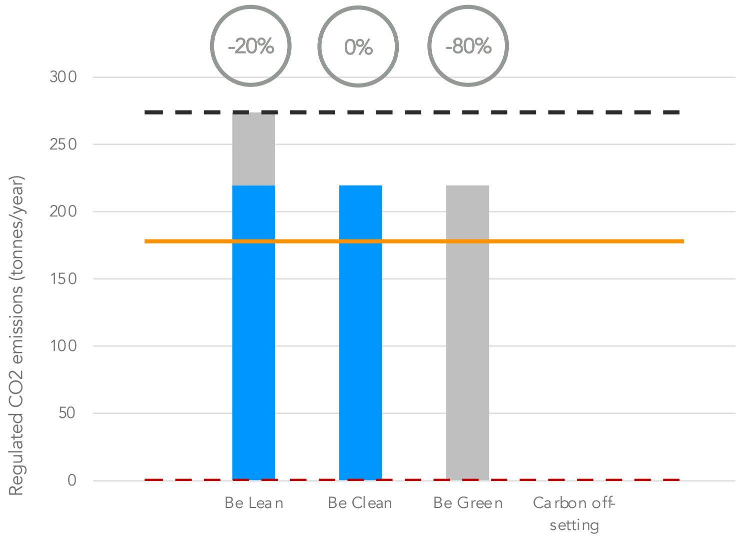
- a 100% improvement over Part L1A 2013 is targeted assuming a carbon factor for electricity of 519 gCO_2/kWh.
- a 100% improvement over Part L1A 2013 is targeted assuming the SAP 10.0 carbon factor for electricity of 233 gCO_2/kWh.

Carbon offsetting

The scheme is targeting the Zero Carbon Homes requirement, as defined by the current London Plan. All on-site carbon emissions will be offset through electricity generated by roof mounted PV arrays resulting in the scheme having net zero carbon emissions. Therefore, no carbon offsetting payment is required.

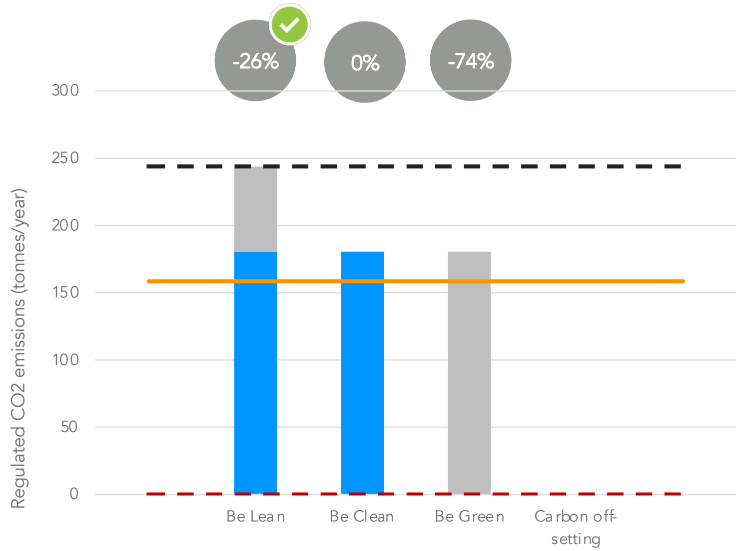
Domestic energy hierarchy and targets for Richmond College – SAP 2012 Carbon Factors

(assuming a carbon factor of electricity of 519gCO_2/kWh)



Domestic energy hierarchy and targets for Richmond College – SAP 10 Carbon Factors

(assuming a carbon factor of electricity of 233gCO_2/kWh)



Site Domestic Emissions (tonnes CO_2 / year) | **Carbon savings** (tonnes CO_2 / year) | Part L 2013 Target Emissions Rate | Minimum 35% saving on site

	Total regulated emissions (Tonnes CO2/year)	CO2 savings (Tonnes CO2/year)	Percentage saving (%)
Part L 2013 baseline	274.0	-	-
Be lean	219.5	54.5	19.9%
Be clean	219.5	0.0	0.0%
Be green	0.0	219.5	80.1%

Cumulative % reduction in regulated emissions: -100%

	Total regulated emissions (Tonnes CO2/year)	CO2 savings (Tonnes CO2/year)	Percentage saving (%)
Part L 2013 baseline	243.9	-	-
Be lean	180.6	63.4	26.0%
Be clean	180.6	0.0	0.0%
Be green	0.0	180.6	74.0%
Offset		0	

Cumulative % reduction in regulated emissions: -100%

Net Zero Operational Carbon Assessment (Block 5 example)

Why are Block 5 and Terrace 4 exemplar?

Crucially, all buildings at Richmond College will not use any fossil fuels on site. Significant progress has also been made by the Net Zero Carbon pilots (Block 5 and Terrace 4) against the all core requirements of net zero operational carbon buildings. The paragraphs below explain the project performance against these core requirements in more detail:

1. Energy efficiency

Space heating demand: The Climate Change Committee recommend a range of 15-20 kWh/m^2/yr for new buildings if the UK is to achieve net zero. Space heating demand for Block 5 and Terrace 4 will be less than 15kWh/m^2/yr.

Final energy use: LETI, RIBA and the UKGBC all recommend that final energy use is less than 35 kWh/m^2/yr for net zero buildings, to ensure the UK has enough renewable energy to power them. Block 5 and Terrace 4 will require 22 kWh/m^2/yr.

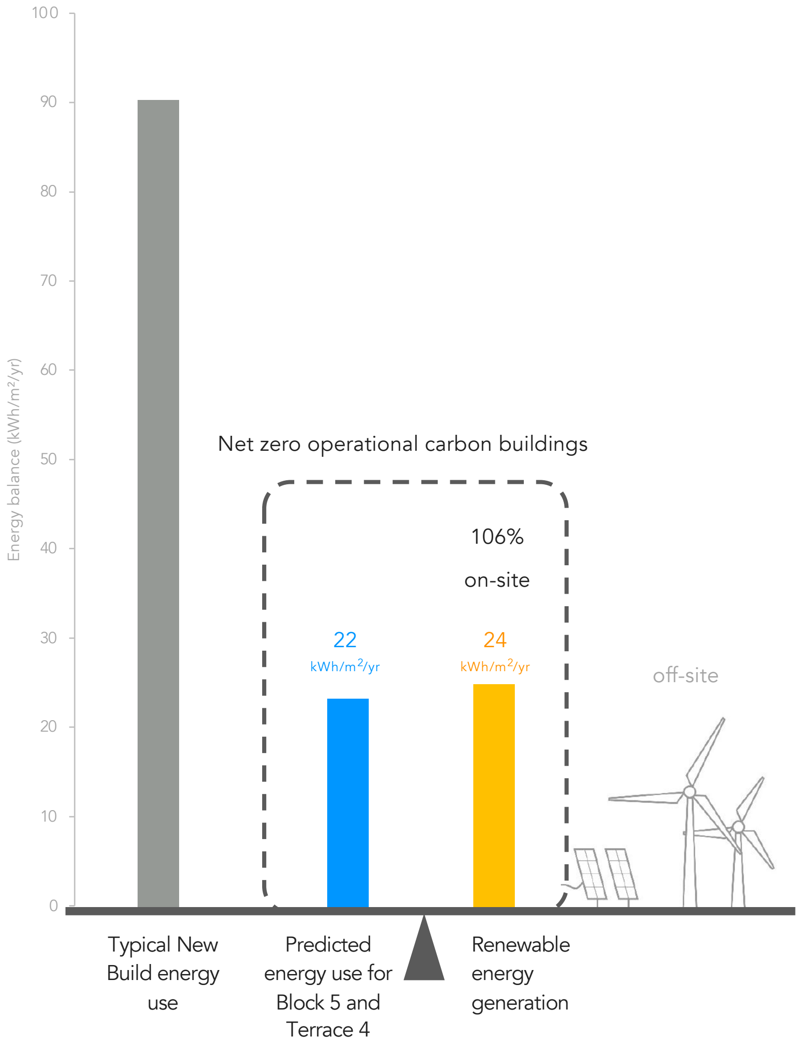
2. Low carbon heating

There will be no combustion of fossil fuels at Richmond College and the buildings will not be connected to a gas supply. Low carbon heat will be provided by a combination of communal air source heat pumps (Blocks of flats) and individual air source heat pump (houses).

As the electricity grid decarbonises, the carbon content of heat will also decarbonise.

3. Renewable energy

The proposed PV arrays on Block 5 and Terrace 4 are estimated to generate around 100% of the dwellings' annual energy requirements, based on PHPP modelling.



PHPP modelling suggests the equivalent of 100% of the energy required by the dwellings annually can be provided on-site by the rooftop solar arrays on Block 5 and Terrace 4.

Additional features

Flexible energy demand is becoming increasingly important as more renewable energy flows into the electricity grid. Buildings with the ability to flex the times at which they need to use grid electricity will be better able to take advantage of cheap clean electricity when it is available. All buildings at Richmond College (but particularly Building 5 and Terrace 4) are well positioned to do this in several ways:

The buildings have a medium level of thermal mass and excellent fabric efficiency. This means it should be possible for residents to turn off their heating systems for many hours at a time when electricity is expensive and high carbon, and their homes will stay warm. When electricity is clean and cheap they can take advantage of this by turning their heating systems back on.

Both the houses and the apartments have hot water storage tanks. This significantly reduces peak power demands on the electricity grid and offers another way for residents to take advantage of clean cheap energy when it is available.

Many heat pumps and smart thermostats are already able to do this automatically, integrating with services such as IFTTT (If This Then That) to seamlessly use the cheapest cleanest energy available.

Etude

Why should we worry about overheating?

There were over 2,000 excess deaths during the ten-day heat wave in August 2003 across England and Wales and it is widely predicted that climate change will lead to more frequent and intense heat waves, as well as increases in average temperatures in the summer.

Combined with increased urbanisation and an ageing population, thousands more people are expected to be affected by heat-related ill health by 2050, particularly elderly and vulnerable people.

Overheating can also cause less critical health problems (sleep deprivation for example) and research indicates that heat-related sleep loss is a cause for concern.

Why should the risk be carefully assessed?

The impact of overestimating the overheating risk can also have unintended negative consequences: it can lead to the reduction of window sizes when not required, which would reduce daylight and can reduce energy efficiency through the unnecessary reduction of the glazing g-value.

This Overheating Risk Assessment seeks to provide an appropriate indication on the risk of overheating from modelling a sample of ten typical units.

What are the key thresholds for overheating?

Research suggests that normally people can cope with a resting temperature of 37°C (World Health Organization 2004a). However, there is only limited and indirect epidemiological evidence about the indoor temperature exposure conditions which would cause adverse health impacts. There is therefore currently no formal cross-sectoral agreement on the temperature thresholds for 'overheating' in homes above which adverse health impacts occur.

Most definitions and thresholds have been developed with thermal comfort in mind rather than specific health impact trigger points.

CIBSE's Environmental Design Guide A (2006) definition for dwellings stated that operative temperatures:

- should not exceed 28°C for 1% of annual occupied hours in living areas;
- should not exceed 26°C for 1% of annual occupied hours in bedrooms.

However, this definition was considered insufficient by researchers. CIBSE Technical Memorandum 59: Design methodology for the assessment of overheating risk in homes has been published more recently. An important difference between CIBSE Guide A and TM59 is that the latter is based on the concept of 'adaptive comfort': instead of setting an absolute 'maximum' temperature throughout the summer, it sets a dynamic limiting temperature which varies depending on the external temperature, as it is acknowledged that an occupant's sense of comfort varies.

The TM59 methodology also proposes a methodology for assessing dwellings where windows are assumed to be closed, or cannot be opened. In this instance, the adaptive comfort methodology is not used, and all occupied rooms are expected to not exceed an operative temperature of 26°C for more than 3% of the annual occupied annual hours.

CIBSE TM59 Overheating risk assessment

An overheating risk assessment using the CIBSE TM59 methodology was undertaken for fourteen units at Richmond College. The results on the following pages show the overheating analysis for selected units, under various conditions.

The TM59 methodology has been used to assess the proposed development using the adaptive comfort criteria. This has been selected for the analysis as it is more applicable for this type of development.

All habitable rooms must meet the following criterion:

Criterion 1: Hours of Exceedance (H_e)
For living rooms, kitchens and bedrooms: the number of hours during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).

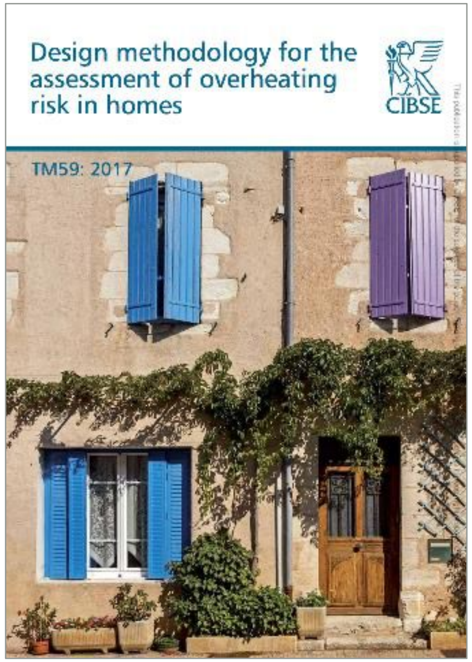
3 per cent of occupied hours is 110 hours for bedrooms and 59 hours for living rooms.

All bedrooms must also meet the following criterion:

Criterion 2: Comfort during the sleeping hours
The resultant temperature in the bedroom from 10pm to 7am cannot exceed 26°C for more than 1% of hours.

1% of hours between 2200-0700 for bedrooms is 32 hours annually.

The weather file used in this assessment is the London Heathrow 1989 weather data (DSY1 for the 2020s, high emissions, 50th percentile scenario), which represents a moderately warm summer, selected from a 30 year baseline 1984-2013.



Intend to Publish London Plan (2019)

Two key policies on the mitigation of overheating are Policy D6 and Policy SI4.

Policy D6 – Housing quality and standards

c. Housing developments should maximise the provision of dual aspect dwellings and normally avoid the provision of single aspect dwellings. A single aspect dwelling should only be provided where it is considered to a more appropriate design solution to meet the requirements of Part B in Policy D3 Optimising site capacity through the design-led approach than a dual aspect dwelling, and it can be demonstrated that it will have adequate passive ventilation, ventilation, daylight and privacy, and avoid overheating.

d. The design of development should provide sufficient daylight and sunlight to new and surrounding housing that is appropriate for its context, whilst avoiding overheating, minimising overshadowing and maximising the usability of outside amenity space.

Policy SI4 - Managing heat risk requires development proposals to minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

Major development proposals should also demonstrate how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

1. reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure.
2. minimise internal heat generation through energy efficient design.
3. manage the heat within the building through exposed internal thermal mass and high ceilings.
4. provide passive ventilation.
5. provide mechanical ventilation.
6. provide active cooling systems.

GLA Energy Assessment Guidance (2020 draft)

The relevant sections:

1.7 Each application is considered on its merits, taking into account the individual characteristics of the development. For all strategic planning applications case specific energy comments for each development are provided at Stage 1 and 2 of the GLA planning process by GLA energy officers to ensure applications comply with London Plan policy. However, for the avoidance of doubt, energy assessments must:

- include information demonstrating that the risk of overheating has been mitigated through the incorporation of passive design measures

Overheating risk analysis

8.3 All development are required to undertake a detailed analysis of the risk of overheating. See the requirements set out in Table 5.

8.4 It is important to identify potential overheating risk in residential accommodation early on in the design process and then incorporate suitable passive measures within the building envelope and services design to mitigate overheating and reduce cooling in line with the London Plan Policy SI 4.

Domestic developments	Non-domestic developments
Pre-application stage	
Complete the Good Homes Alliance (GHA) Early Stage Overheating Risk Tool and submit it to the GLA as part of the preliminary energy information for the development. More information on the GHA tool can be found in Appendix 1.	Outline in the preliminary strategy information submitted to the GLA how the overheating risk will be minimised.
Stage 1	
Include the GHA Early Stage Overheating Risk Tool in the energy assessment.	N/A
Undertake dynamic overheating modelling in line with the guidance and data sets in CIBSE TM59 and TM49 respectively	Undertake dynamic overheating modelling in line with the guidance and data sets in CIBSE TM52 and TM49 respectively
Provide evidence of how the development performs against the overheating criteria along with an outline of the assumptions made in the energy assessment.	
Stage 2 onwards	
Ensure that the results of the overheating analysis continue to be incorporated into the building design discussions as the design evolves. Any substantive changes from Stage 1 proposals will require revised overheating analysis.	

Table 5: GLA overheating requirements

Acoustics Ventilation and Overheating, Residential Design Guide (2020)

The AVO Guide recommends an approach to acoustic assessments for new residential development that take due regard of the interdependence of provisions for acoustics, ventilation and overheating. Application of the AVO Guide is intended to demonstrate good acoustic design as described in the ProPG: Planning & Noise, May 2017, when considering internal noise guidelines.

The AVO Guide seeks to:

- Encourage an assessment of noise that recognises the interdependence between the acoustics, ventilation and overheating designs;
- Provide a means of assessment to satisfy the need to consider acoustics, ventilation and overheating at the planning stage;
- Assist in educating clients, environmental health/planning officers and other stakeholders of the interdependence of design for acoustics, ventilation and overheating.

Table 4 from BS 8233:2014 is reproduced in Table 2-4, some local authorities have used these values to represent LOAEL as far as applying the policy in the NPPF and NPSE is concerned for that situation.

These levels are accompanied by various notes including:

- The levels are based on existing guidelines issued by the World Health Organisation and assume normal diurnal fluctuations in external noise;
- The levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events such as fireworks night and New Year's Eve;
- If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or resulting noise level. If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment;

Acoustics Ventilation and Overheating, Residential Design Guide (2020)

Table 2-4 Desirable indoor ambient noise levels for dwellings (reproduced from Table 4 of BS 8233:2014)

Activity	Location	07:00 to 23:00 ($L_{Aeq,16hr}$)	23:00 to 07:00 ($L_{Aeq,8h}$)
Resting	Living room	35 dB	
Dining	Dining room/area	40 dB	
Sleeping (daytime resting)	Bedroom	35 dB	30 dB

Etude

TM59 Overheating assessment

An overheating risk assessment using the CIBSE TM59 methodology was undertaken for fifteen dwellings at Richmond College, from a total of 212. It was considered that the selected units provided a representative sample of the proposed mix. The tested units are highlighted on the adjacent marked-up drawings.

EDSL Tas (version 9.5.1) has been used to undertake the CIBSE TM59 overheating risk analysis by using LHR 1989 weather data (DSY1 for the 2020s, high emissions, 50th percentile scenario).

TM59 Baseline Inputs and Assumptions

Building envelope parameters

- Glazing g-value: 0.50 on all elevations

Ventilation and Window Openings

- MVHR supply/extract vent rate: **0.55 ach – all times**
- MVHR to provide a continuous **3 l/s extract** to the HIU cupboard

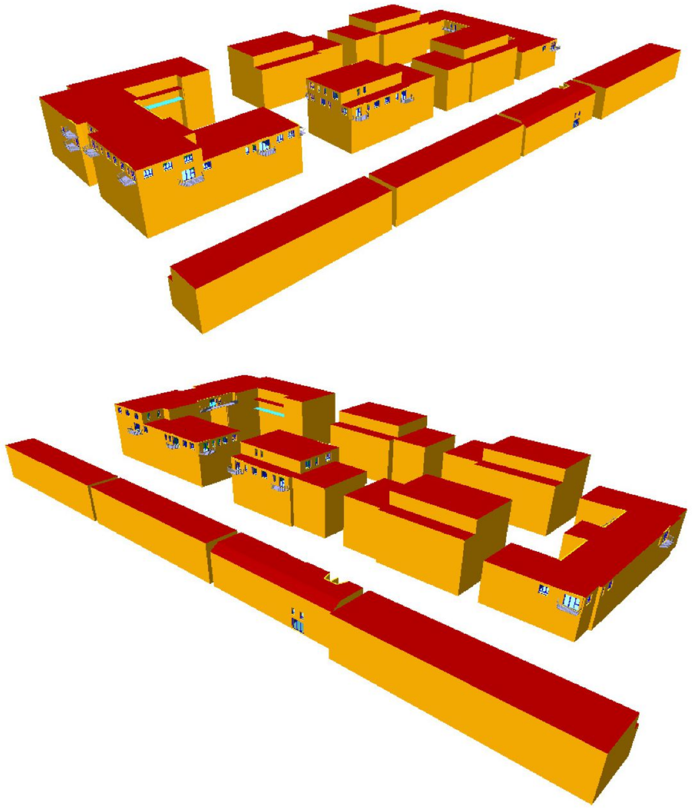
To mitigate the risk of summer overheating, the proportion of openable and free window area is critical for natural ventilation. The below table provides a summary of the openable window schedules used in the model. The MVHR provides a level of background ventilation. However, during hot weather, the schedules indicate the times at which occupants have the choice to open windows, if the outside air temperature is cooler than the inside air temperature.

Room and Window Type	Openable Free Area Equivalent	Openable window schedules
Bedroom Windows	50% (day & night)	24hr
Kitchen / Living Room – Windows	30% (day) / 15% (night)	7am-11pm*

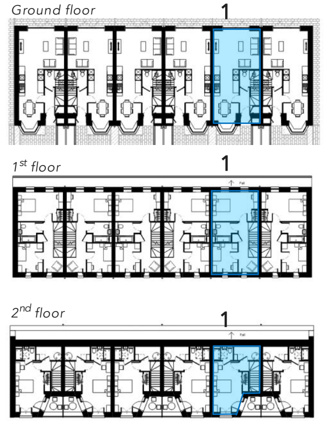
** It is assumed that the kitchen / living room openings will be left partially open on a secure restrictor on the warmest nights of the year in order to provide cross ventilation.*

Internal heat gains

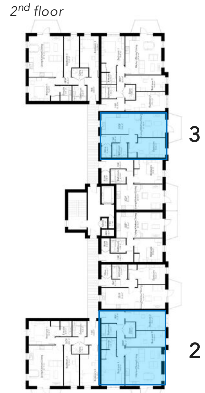
- Occupancy, equipment and lighting gains and profiles all as required by TM59



Richmond College – Tas 3D Geometry

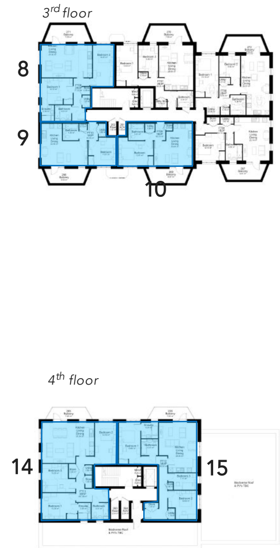


Terrace House - modelled units



Block 6 - modelled units

Block 5 - modelled units



Block 2 - modelled units

Etude

TM59 Openable Window Assumptions

The adjacent images show the assumptions that have been made for the equivalent window openable free area and opening durations on several of the key elevations that have been modelled.

Bedroom window
Openable free area equivalent: 50% day / 40% night over 24 hours

Kitchen / living room / bathroom window
Openable free area equivalent: 30% 7am-11pm* / 15% night

** It is assumed that the kitchen / living room openings will be left partially open on a secure restrictor on the warmest nights of the year in order to provide cross ventilation.*

Room and Window Type	Openable Free Area Equivalent	Openable window schedules
Bedroom Windows	50% (day & night)	24hr
Kitchen / Living Room – Windows	30% (day) / 15% (night)	7am-11pm*

** It is assumed that the kitchen / living room openings will be left partially open on a secure restrictor on the warmest nights of the year in order to provide cross ventilation.*

North West Elevation – Block 2

South West Elevation – Block 2

South West Elevation – Block 5

Etude

Overheating risk assessment | CIBSE TM59 results

Summary of CIBSE TM59 Results

The tables below show the TM59 modelling results for the sample of fifteen modelled units.

The results indicate that all units are expected to pass. To mitigate the risk of summer overheating, the proportion of openable and free window area is critical for natural ventilation.

Conclusion

This Overheating Risk Assessment provides a summary of how the scheme addresses the relevant summer overheating and thermal comfort policies from the London Plan and GLA's Energy Assessment Guidance.

The sample of modelled residential units have demonstrated compliance with the overheating criteria of CIBSE TM59 and therefore complies with the relevant policy requirements.

Unit	Room	**Criterion 1:** #Hours Exceeding Comfort Range	**Criterion 2:** Number of Night Hours Exceeding 26 °C for Bedrooms	Result
1 - 3B5P	Bedroom 1_db	3 / 110	5 / 32	Pass
	Bedroom 2_db	0 / 110	9 / 32	Pass
	Bedroom 3_sb	0 / 110	7 / 32	Pass
	Living Room / Kitchen	19 / 59	N/A	Pass
2 - 3B5P	Bedroom 1_db	1 / 110	16 / 32	Pass
	Bedroom 2_db	1 / 110	15 / 32	Pass
	Bedroom 3_sb	0 / 110	15 / 32	Pass
	Living Room / Kitchen	27 / 59	N/A	Pass
3 - 1B2P	Bedroom 1_db	0 / 110	16 / 32	Pass
	Living Room / Kitchen	5 / 59	N/A	Pass
4 - 2B4P	Bedroom 1_db	24 / 110	32 / 32	Pass
	Bedroom 2_db	23 / 110	29 / 32	Pass
	Living Room / Kitchen	5 / 59	N/A	Pass
5 - 1B2P	Bedroom 1_db	16 / 110	17 / 32	Pass
	Living Room / Kitchen	27 / 59	N/A	Pass
6 - 2B4P	Bedroom 1_db	15 / 110	14 / 32	Pass
	Bedroom 2_db	2 / 110	16 / 32	Pass
	Living Room / Kitchen	19 / 59	N/A	Pass
7 - 3B5P	Bedroom 1_db	2 / 110	11 / 32	Pass
	Bedroom 2_db	1 / 110	12 / 32	Pass
	Bedroom 3_sb	2 / 110	6 / 32	Pass
	Living Room / Kitchen	12 / 59	N/A	Pass
8 - 2B4P	Bedroom 1_db	5 / 110	13 / 32	Pass
	Bedroom 2_db	3 / 110	14 / 32	Pass
	Living Room / Kitchen	6 / 59	N/A	Pass
9 - 1B2P	Bedroom 1_db	11 / 110	26 / 32	Pass
	Living Room / Kitchen	11 / 59	N/A	Pass
10 - 1B2	Bedroom 1_db	8 / 110	32 / 32	Pass
	Living Room / Kitchen	15 / 59	N/A	Pass
11 - 2B4	Bedroom 1_db	7 / 110	20 / 32	Pass
	Bedroom 2_db	12 / 110	20 / 32	Pass
	Living Room / Kitchen	11 / 59	N/A	Pass
12 - 3B5	Bedroom 1_db	4 / 110	17 / 32	Pass
	Bedroom 2_db	9 / 110	17 / 32	Pass
	Bedroom 3_sb	7 / 110	13 / 32	Pass
	Kitchen	1 / 59	N/A	Pass
	Living Room	21 / 59	N/A	Pass
13 - 3B5	Bedroom 1_db	19 / 110	7 / 32	Pass
	Bedroom 2_db	28 / 110	15 / 32	Pass
	Bedroom 3_sb	9 / 110	17 / 32	Pass
	Kitchen	22 / 59	N/A	Pass
	Living Room	53 / 59	N/A	Pass
14 - 3B5	Bedroom 1_db	0 / 110	10 / 32	Pass
	Bedroom 2_db	2 / 110	13 / 32	Pass
	Bedroom 3_sb	0 / 110	13 / 32	Pass
	Living Room / Kitchen	6 / 59	N/A	Pass
15 - 3B5	Bedroom 1_db	0 / 110	9 / 32	Pass
	Bedroom 2_db	0 / 110	14 / 32	Pass
	Bedroom 3_sb	0 / 110	10 / 32	Pass
	Living Room / Kitchen	0 / 59	N/A	Pass

CIBSE TM59 Overheating Risk Results - London_LHR_DSY1_2020High50

Etude

Additional weather files

The TM59 assessment was also run using the DSY2 and DSY3 weather files for information purposes only. In accordance with the guidance there are no expectations for the units to pass the criteria under these weather files.

Unit	Room	**Criterion 1:** #Hours Exceeding Comfort Range	**Criterion 2:** Number of Night Hours Exceeding 26 °C for Bedrooms	Result
1 - 3B5P	Bedroom 1_db	10 / 110	18 / 32	Pass
	Bedroom 2_db	7 / 110	32 / 32	Pass
	Bedroom 3_sb	3 / 110	18 / 32	Pass
	Living Room / Kitchen	45 / 59	N/A	Pass
2 - 3B5P	Bedroom 1_db	28 / 110	49 / 32	Fail
	Bedroom 2_db	21 / 110	34 / 32	Fail
	Bedroom 3_sb	21 / 110	34 / 32	Fail
	Living Room / Kitchen	70 / 59	N/A	Fail
3 - 1B2P	Bedroom 1_db	6 / 110	39 / 32	Fail
	Living Room / Kitchen	28 / 59	N/A	Pass
4 - 2B4P	Bedroom 1_db	53 / 110	69 / 32	Fail
	Bedroom 2_db	54 / 110	63 / 32	Fail
	Living Room / Kitchen	27 / 59	N/A	Pass
5 - 1B2P	Bedroom 1_db	51 / 110	56 / 32	Fail
	Living Room / Kitchen	63 / 59	N/A	Fail
6 - 2B4P	Bedroom 1_db	31 / 110	41 / 32	Fail
	Bedroom 2_db	16 / 110	32 / 32	Pass
	Living Room / Kitchen	37 / 59	N/A	Pass
7 - 3B5P	Bedroom 1_db	22 / 110	30 / 32	Pass
	Bedroom 2_db	14 / 110	29 / 32	Pass
	Bedroom 3_sb	13 / 110	12 / 32	Pass
	Living Room / Kitchen	42 / 59	N/A	Pass
8 - 2B4P	Bedroom 1_db	22 / 110	35 / 32	Fail
	Bedroom 2_db	11 / 110	29 / 32	Pass
	Living Room / Kitchen	26 / 59	N/A	Pass
9 - 1B2P	Bedroom 1_db	48 / 110	64 / 32	Fail
	Living Room / Kitchen	45 / 59	N/A	Pass
10 - 1B2	Bedroom 1_db	53 / 110	80 / 32	Fail
	Living Room / Kitchen	55 / 59	N/A	Pass
11 - 2B4	Bedroom 1_db	30 / 110	51 / 32	Fail
	Bedroom 2_db	39 / 110	51 / 32	Fail
	Living Room / Kitchen	32 / 59	N/A	Pass
12 - 3B5	Bedroom 1_db	25 / 110	45 / 32	Fail
	Bedroom 2_db	33 / 110	43 / 32	Fail
	Bedroom 3_sb	33 / 110	39 / 32	Fail
	Kitchen	9 / 59	N/A	Pass
	Living Room	47 / 59	N/A	Pass
13 - 3B5	Bedroom 1_db	30 / 110	20 / 32	Pass
	Bedroom 2_db	40 / 110	46 / 32	Fail
	Bedroom 3_sb	22 / 110	31 / 32	Pass
	Kitchen	38 / 59	N/A	Pass
	Living Room	75 / 59	N/A	Fail
14 - 3B5	Bedroom 1_db	18 / 110	35 / 32	Fail
	Bedroom 2_db	12 / 110	28 / 32	Pass
	Bedroom 3_sb	12 / 110	34 / 32	Fail
	Living Room / Kitchen	27 / 59	N/A	Pass
15 - 3B5	Bedroom 1_db	2 / 110	22 / 32	Pass
	Bedroom 2_db	6 / 110	36 / 32	Fail
	Bedroom 3_sb	7 / 110	26 / 32	Pass
	Living Room / Kitchen	10 / 59	N/A	Pass

CIBSE TM59 Overheating Risk Results - London_LHR_DSY2_2020High50

Unit	Room	**Criterion 1:** #Hours Exceeding Comfort Range	**Criterion 2:** Number of Night Hours Exceeding 26 °C for Bedrooms	Result
1 - 3B5P	Bedroom 1_db	21 / 110	27 / 32	Pass
	Bedroom 2_db	7 / 110	40 / 32	Fail
	Bedroom 3_sb	5 / 110	30 / 32	Pass
	Living Room / Kitchen	48 / 59	N/A	Pass
2 - 3B5P	Bedroom 1_db	41 / 110	60 / 32	Fail
	Bedroom 2_db	42 / 110	44 / 32	Fail
	Bedroom 3_sb	42 / 110	42 / 32	Fail
	Living Room / Kitchen	88 / 59	N/A	Fail
3 - 1B2P	Bedroom 1_db	25 / 110	40 / 32	Fail
	Living Room / Kitchen	46 / 59	N/A	Pass
4 - 2B4P	Bedroom 1_db	98 / 110	101 / 32	Fail
	Bedroom 2_db	99 / 110	96 / 32	Fail
	Living Room / Kitchen	32 / 59	N/A	Pass
5 - 1B2P	Bedroom 1_db	50 / 110	73 / 32	Fail
	Living Room / Kitchen	72 / 59	N/A	Fail
6 - 2B4P	Bedroom 1_db	51 / 110	51 / 32	Fail
	Bedroom 2_db	13 / 110	49 / 32	Fail
	Living Room / Kitchen	50 / 59	N/A	Pass
7 - 3B5P	Bedroom 1_db	45 / 110	37 / 32	Fail
	Bedroom 2_db	39 / 110	37 / 32	Fail
	Bedroom 3_sb	36 / 110	20 / 32	Pass
	Living Room / Kitchen	64 / 59	N/A	Fail
8 - 2B4P	Bedroom 1_db	36 / 110	58 / 32	Fail
	Bedroom 2_db	21 / 110	49 / 32	Fail
	Living Room / Kitchen	37 / 59	N/A	Pass
9 - 1B2P	Bedroom 1_db	62 / 110	86 / 32	Fail
	Living Room / Kitchen	54 / 59	N/A	Pass
10 - 1B2	Bedroom 1_db	70 / 110	104 / 32	Fail
	Living Room / Kitchen	68 / 59	N/A	Fail
11 - 2B4	Bedroom 1_db	53 / 110	83 / 32	Fail
	Bedroom 2_db	64 / 110	83 / 32	Fail
	Living Room / Kitchen	59 / 59	N/A	Pass
12 - 3B5	Bedroom 1_db	54 / 110	70 / 32	Fail
	Bedroom 2_db	72 / 110	69 / 32	Fail
	Bedroom 3_sb	68 / 110	64 / 32	Fail
	Kitchen	16 / 59	N/A	Pass
	Living Room	82 / 59	N/A	Fail
13 - 3B5	Bedroom 1_db	51 / 110	28 / 32	Pass
	Bedroom 2_db	61 / 110	56 / 32	Fail
	Bedroom 3_sb	36 / 110	36 / 32	Fail
	Kitchen	55 / 59	N/A	Pass
	Living Room	112 / 59	N/A	Fail
14 - 3B5	Bedroom 1_db	31 / 110	55 / 32	Fail
	Bedroom 2_db	25 / 110	45 / 32	Fail
	Bedroom 3_sb	24 / 110	60 / 32	Fail
	Living Room / Kitchen	52 / 59	N/A	Pass
15 - 3B5	Bedroom 1_db	10 / 110	34 / 32	Fail
	Bedroom 2_db	20 / 110	39 / 32	Fail
	Bedroom 3_sb	26 / 110	31 / 32	Pass
	Living Room / Kitchen	25 / 59	N/A	Pass

CIBSE TM59 Overheating Risk Results - London_LHR_DSY3_2020High50

11.0

Materials, resources & whole life impacts

- Materials
- Embodied carbon
- Whole life carbon
- Circular economy

Etude

Materials and resource use

Materials choices

The materials chosen on a development have to fulfil many functional roles, whilst importantly giving the place its character. However, construction plays a substantial part in the way humans consume resources and impact on the wider world.

For this reason the consumption of materials and resources is being increasingly scrutinised. It is critical that development moves away from linear, mass-consumption, wasteful models, towards favouring frugality and efficiency. How we initially conceptualise new places will play a significant part in this shift.

The design for Richmond College has considered the environmental impact of materials at the heart of its brief. From sustainable sourcing to looking at recovering materials when the buildings are no longer needed.

New and draft policy

Alongside this greater focus on impact of materials has come planning policy to steer change. Within the New London Plan two newer focus areas for policy have opened up: circular economy and whole life carbon impacts.

During the design development of Richmond College the team has both developed strategies seeking to meet the intention of the new policy, whilst also developing assessments that provide quantification of the proposals. The following pages of this Sustainability Statement present this summary and assessment. The areas of focus are:

Embodied carbon – the proposals for Richmond College are assessed in detail for the terraces and apartments. The analysis on these pages examines the initial life stage for the development, looking at the sourcing and manufacturing impacts of the products and materials. The carbon associated with this life stage can be in the region of one third of a development's overall carbon footprint.

Whole life carbon – the lens shifts to a long term look at how carbon and greenhouse gases will be emitted by the development across its estimated lifetime and what will happen once the development finished its operational life.

Circular economy – although fully explored as part of the Circular Economy Statement (submitted alongside this report), a summary of how the development will move away from linear approaches to consuming materials, and instead implement circular principles to reduce wastage and virgin material consumption as well provide material banks for the future.

The table across details the scope for each of these assessments.

Responsible sourcing of materials

In addition to ensuring materials have a low environmental impact, specifying responsibly sourced materials helps to ensure ethical labour and environmental practices in the product manufacture and supply chain.

The procurement of materials will seek to favour responsibly sourced materials. Many manufacturers provide responsible sourcing certificates for their construction products including concrete, steel, reinforcement, plasterboard and blockwork.

Timber

All timber sourced for the project will come from a certified legal source (FSC, PEFC or equivalent).

Additionally, all timber used will be sourced in accordance with the UK public procurement policy on timber.

Recycled content and reusing materials

The most important element associated with reducing the embodied carbon emissions for materials, is reducing virgin resources, and either reusing existing materials or increasing the percentage of recycled content used in their manufacture.

The Greater London Authority expects all developments to aim for at least 10% of the total value of materials used, to be derived from recycled and reused sources.

Materials Strategy

There is a great opportunity to ensure that materials specified for the Richmond College site have a low environmental impact and are healthy to people and environment. The strategy includes:

1. Use of materials with reduced embodied carbon for major elements.
2. Use of products with Environmental Performance Declarations (EPDs) and Responsible Sourcing Certification – in line with the Product Environmental Information for at least 10 products will be specified at the Design Stage, installed by the Post Construction Stage and will be covered by verified EPD certificates.
3. Use of low VOC paints, varnishes and materials will be specified.
4. Limiting the material degradation effects by identifying risks of severe material degradation and incorporating appropriate measures into design and specification.

Whole life and embodied carbon: ✓ Included   ✗ Excluded   ○ Guestimate /Partial

Circular Economy: ✓ Included   ✗ Excluded   ○ Guestimate /Partial

Which part of the development	Elements involved	Life stages: Upfront	Operation	End of life	Beyond the system boundary
Substructure	Foundations, ground floor	✓ ✓	✓ ✓	✓ ✓	✗ ✓
Core structure	Concrete frame	✓ ✓	✓ ✓	✓ ✓	✗ ✓
External walls	Façade, insulation, blockwork, infill material	✓ ✓	✓ ✓	✓ ✓	✗ ✓
External doors/windows	Glazing components	✓ ✓	✓ ✓	✓ ✓	✗ ✓
Internal partitions	Walls and doors separating rooms and dwellings	✓ ✓	✓ ✓	✓ ✓	✗ ✓
Roofs	Roof components and weatherproofing	✓ ✓	✓ ✓	✓ ✓	✗ ✓
Finishes	Internal plasterboard and skim	✓ ✓	✓ ✓	✓ ✓	✗ ✓
Services	Equipment to supply heating, hot water, ventilation and lighting	✗ ✗	○ ✓	✗ ✓	✗ ✓
Fittings, furnishings and equipment	-	✗ ✗	✗ ✗	✗ ✗	✗ ✗
Demolition	Demolition and removal of material	○ ✓		✗ ✓	✗ ✓
External Works	Landscaping and site infrastructure	✗ ✓	✗ ✗	✗ ✓	✗ ✓

A breakdown of how materials and resources have been assessed across the lifetime of Richmond College through the embodied carbon, whole life carbon and circular economy assessments

Terrace 4 "Be Lean"

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.41
Printed on 02 August 2021 at 20:12:56

Project Information:

Assessed By: () **Building Type:** End-terrace House

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 115.9m²
Site Reference : RC-T2 **Plot Reference:** Unit1
Address :

Client Details:

Name:
Address :

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating system: Mains gas (c)		
Fuel factor: 1.00 (mains gas (c))		
Target Carbon Dioxide Emission Rate (TER)	18.74 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	13.12 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	65.2 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	42.1 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.10 (max. 0.30)	0.10 (max. 0.70)	OK
Floor	0.10 (max. 0.25)	0.10 (max. 0.70)	OK
Roof	0.10 (max. 0.20)	0.10 (max. 0.35)	OK
Openings	0.81 (max. 2.00)	0.90 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	0.60 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Community heating schemes - mains gas	
Secondary heating system:	None	

5 Cylinder insulation

Hot water Storage:	Measured cylinder loss: 1.61 kWh/day	
	Permitted by DBSCG: 2.56 kWh/day	OK
Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls	Charging system linked to use of community heating, programmer and TRVs	OK
Hot water controls:	Cylinderstat	OK

Regulations Compliance Report

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.6	
Maximum	1.5	OK
MVHR efficiency:	96%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South England):	Slight	OK
Based on:		
Overshading:	Average or unknown	
Windows facing: North West	4.8m²	
Windows facing: South East	7.2m²	
Windows facing: North West	2.94m²	
Windows facing: South East	2.88m²	
Windows facing: North West	2.94m²	
Windows facing: North West	3.15m²	
Ventilation rate:	4.00	
Blinds/curtains:	Dark-coloured curtain or roller blind Closed 100% of daylight hours	

10 Key features

Air permeablility	0.6 m³/m²h
Windows U-value	0.8 W/m²K
Doors U-value	0.9 W/m²K
Roofs U-value	0.1 W/m²K
External Walls U-value	0.1 W/m²K
Floors U-value	0.1 W/m²K
Community heating, heat from boilers – mains gas	
Community heating, heat from boilers – biomass	

Etude

Terrace 4 “Be Clean”

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.41
Printed on 28 July 2021 at 15:36:52

Project Information:

Assessed By: () **Building Type:** End-terrace House

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 115.9m²
Site Reference : RC-T2 **Plot Reference:** Unit1
Address :

Client Details:

Name:
Address :

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating system: Electricity (c)		
Fuel factor: 1.55 (electricity (c))		
Target Carbon Dioxide Emission Rate (TER)	27.78 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	11.49 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	65.2 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	42.1 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.10 (max. 0.30)	0.10 (max. 0.70)	OK
Floor	0.10 (max. 0.25)	0.10 (max. 0.70)	OK
Roof	0.10 (max. 0.20)	0.10 (max. 0.35)	OK
Openings	0.81 (max. 2.00)	0.90 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	0.60 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Community heating schemes - Heat pump	
Secondary heating system:	None	

5 Cylinder insulation

Hot water Storage:	Measured cylinder loss: 1.61 kWh/day	
	Permitted by DBSCG: 2.56 kWh/day	OK
Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls	Charging system linked to use of community heating, programmer and TRVs	OK
Hot water controls:	Cylinderstat	OK

Regulations Compliance Report

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.6	
Maximum	1.5	OK
MVHR efficiency:	96%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South England):	Slight	OK
Based on:		
Overshading:	Average or unknown	
Windows facing: North West	4.8m²	
Windows facing: South East	7.2m²	
Windows facing: North West	2.94m²	
Windows facing: South East	2.88m²	
Windows facing: North West	2.94m²	
Windows facing: North West	3.15m²	
Ventilation rate:	4.00	
Blinds/curtains:	Dark-coloured curtain or roller blind	
	Closed 100% of daylight hours	

10 Key features

Air permeablility	0.6 m³/m²h
Windows U-value	0.8 W/m²K
Doors U-value	0.9 W/m²K
Roofs U-value	0.1 W/m²K
External Walls U-value	0.1 W/m²K
Floors U-value	0.1 W/m²K
Community heating, heat from electric heat pump	
Community heating, heat from boilers – biomass	

Terrace 4 “Be Green”

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.41
Printed on 28 July 2021 at 15:39:34

Project Information:

Assessed By: () **Building Type:** End-terrace House

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 115.9m²
Site Reference : RC-T2 **Plot Reference:** Unit1
Address :

Client Details:

Name:
Address :

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating system: Electricity (c)
Fuel factor: 1.55 (electricity (c))

Target Carbon Dioxide Emission Rate (TER)	27.78 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	-9.22 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	65.2 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	44.8 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.10 (max. 0.25)	0.10 (max. 0.70)	OK
Roof	0.10 (max. 0.20)	0.10 (max. 0.35)	OK
Openings	0.81 (max. 2.00)	0.90 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	0.60 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Community heating schemes - Heat pump	
Secondary heating system:	None	

5 Cylinder insulation

Hot water Storage:	Measured cylinder loss: 1.61 kWh/day	
	Permitted by DBSCG: 2.56 kWh/day	OK
Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls	Charging system linked to use of community heating, programmer and TRVs	OK
Hot water controls:	Cylinderstat	OK

Regulations Compliance Report

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.6	
Maximum	1.5	OK
MVHR efficiency:	96%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South England):	Slight	OK
Based on:		
Overshading:	Average or unknown	
Windows facing: North West	4.8m²	
Windows facing: South East	7.2m²	
Windows facing: North West	2.94m²	
Windows facing: South East	2.88m²	
Windows facing: North West	2.94m²	
Windows facing: North West	3.15m²	
Ventilation rate:	4.00	
Blinds/curtains:	Dark-coloured curtain or roller blind Closed 100% of daylight hours	

10 Key features

Air permeablility	0.6 m³/m²h
Windows U-value	0.8 W/m²K
Doors U-value	0.9 W/m²K
Roofs U-value	0.1 W/m²K
Floors U-value	0.1 W/m²K
Community heating, heat from electric heat pump	
Community heating, heat from boilers – biomass	
Photovoltaic array	

Etude