LETI

Embodied Carbon CaseStudies

The LETI Embodied Carbon case studies are a selection of projects in the UK chosen to showcase 'good practice' regarding consideration of embodied carbon and whole life carbon principles in a clear, and consistent format.

The aim of their development has been to create a format, with a clear and understandable scope, to provide a useful means of sharing lessons learned to reduce embodied carbon while striking a balance of reporting robust metrics to back up the 'carbon story' behind the analysis and project procurement.

The template on which they are based has been aligned where possible to the RICS PS Whole life carbon assessment for the built environment reporting format, and the emerging GLA Whole Life Carbon Reporting template, the UKGBC Net Zero Carbon Construction Reporting Template, with input from LETI Embodied Carbon Working Groups.

This first set of case studies are a 'snapshot' in time of projects and data gathered in 2020/21 and are not limited to projects achieving a specific embodied carbon rating as they pre-dated the developments of the ratings. Being a 'LETI Embodied Carbon case study' is not part of a verification or certification process.
(See details of the case study selection in the following pages)

The LETI embodied case study group's ambition is to continue to call out for further case studies for publication over time, evolving and linking the information gathered to other emerging industry 'declaration' databases e.g the BECD (tbc) in order to bring more transparency to embodied carbon reporting and practice.

Summary process of development of case study set 1

Introduction

The initial call out for case studies was made in 2020, to which we received a great number of responses. More detailed information was requested in early 2021. Projects were selected based on a set criteria and priorities list, which included:

- Projects that aimed to consider and asses the full building
- UK based projects
- Projects that had also measured the operational energy

At the time of development of the original case study template neither the GLA Whole Life Carbon Reporting template, LETI Embodied Carbon reporting declaration template, nor the BECD consultation/upcoming reporting standards were in place. The current RIBA 2030 Climate Challenge (V2) and targets were also not yet published, nor were the LETI benchmarks, carbon alignment document or Embodied/Whole Life Carbon one pagers.

Since the creation of the template and this set of case studies there has been significant progress in the understanding of WLC/EC metrics in the industry including the alignment of LETI and RIBA benchmarks, the RIBA 2030 climate challenge update, launch of the BECD and an update to GLA WLC reporting, as well as publication of LETI/RIBA/WLCN definitions paper, the IPCC report, the UN Climate Change Conference etc. And other work is on going at pace.

In light of the above, prior to publication the LETI case study template has been reviewed and updated and further information obtained for each case study where possible. Inevitably, due to the pace of development in this area, not all sections could be completed for each project. We anticipate that further evolutions of the case study format will be necessary for future publications.

Ambition for future LETI case studies

To continue to call out for best practice case studies and share lessons learned with regards to Whole Life Carbon tracking, analysis, reporting and reduction.

To align the reporting to the latest and emerging industry guidelines e.g. the BECD.

Detailed information identified by the LETI case study working group as requiring further focus for consistent and transparent reporting of embodied carbon

A industry wide reporting template/format/place to declare any reported figures, embodied carbon targets for all the sectors/types of projects, the regulation of embodied carbon, the measurement and reporting of MEP embodied carbon wide scale, embodied carbon studies at post completion, reporting of sequestration as per industry guidelines (see note 1 at the end of the document).

LETI

Embodied Carbon
Case Studies Set 1

Acknowledgements:

LETI Embodied Carbon Case Studies Workstream:

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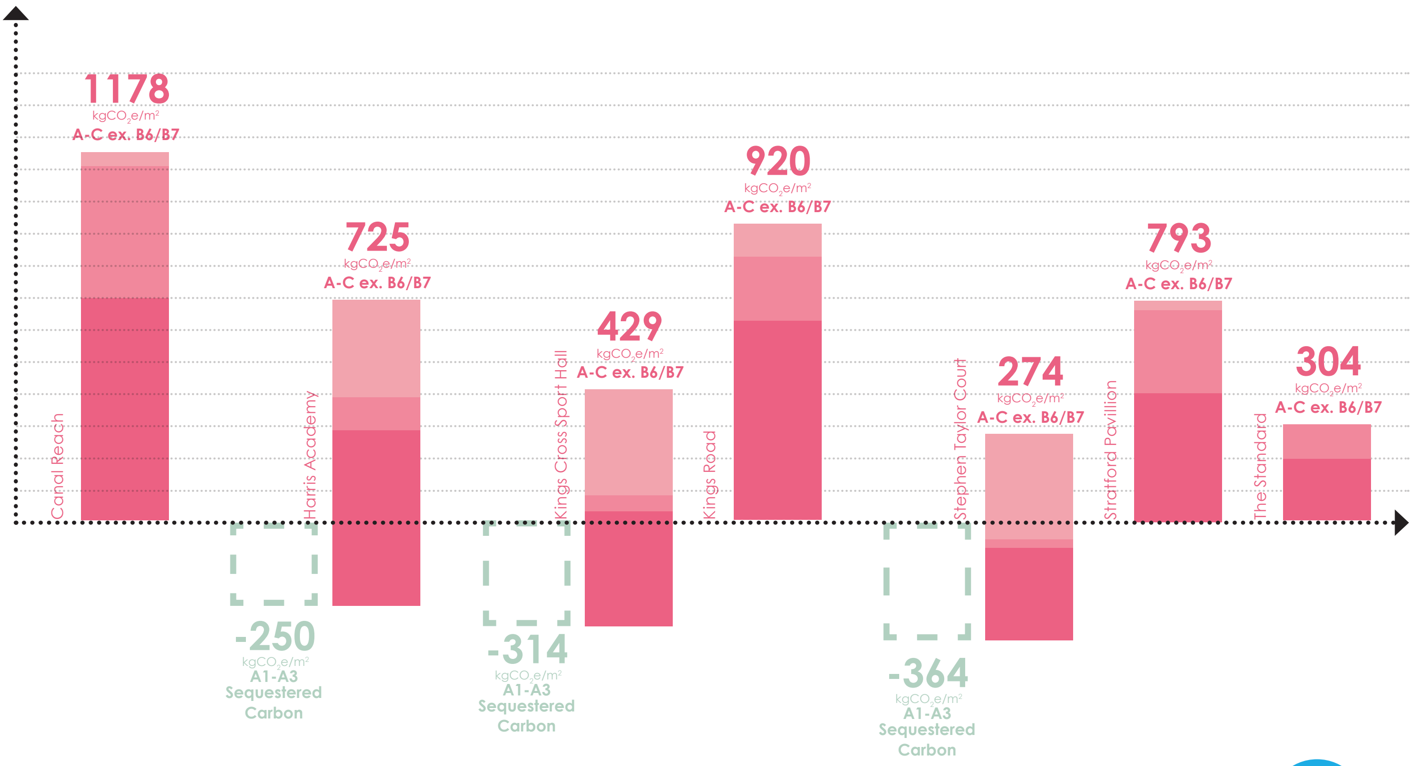
Website: Alex Johnstone

With thanks to: Bennetts Associates, BAM & Cundall, Architype , Feilden Clegg Bradley Studios , Benoy, KJ Tait Eng., Eng. HRW, Gardiner & Theobald, ACME , Orms

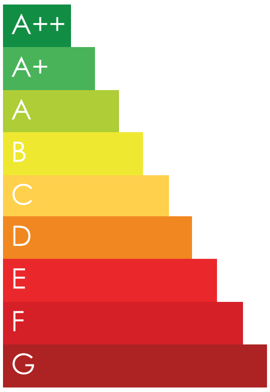
Summary of case studies:

1. Canal Reach
2. Harris Academy
3. Kings College Cambridge Stephen Taylor Court
4. Kings Cross Sports Hall
5. Kings Road
6. Stratford Pavillion
7. The Standard

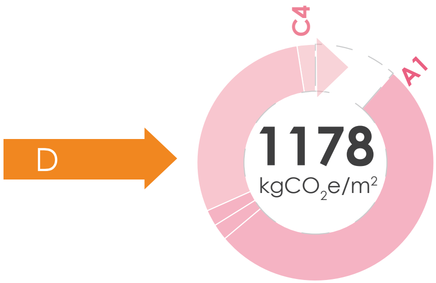
Life cycle embodied carbon reporting summary



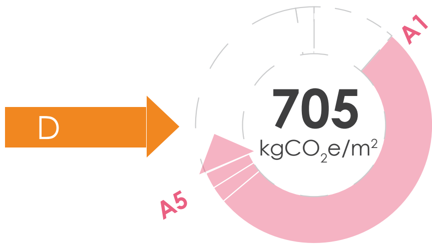
11-21 Canal Reach by Bennetts Associates, BAM & Cundall

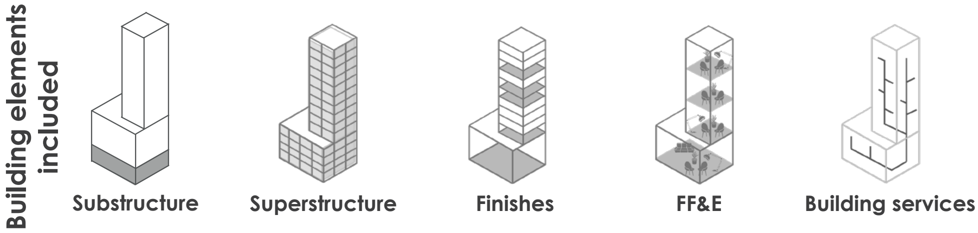


Life cycle embodied carbon
A1-C4 ex B6,B7



Upfront embodied carbon
A1-A5





Project overview
A 400,000sq ft commercial office, initially designed as two adjacent buildings capable of either being let as a single building, two buildings, or with 8 tenancies per floor.

Project sector
Commercial Office

Assessment date
2020 (at RIBA Stage 2,3,4 & PC)

RIBA work stage
6

GIA (m^2)
54921m^2

Year of project completion
2021 (Complete)

Analysis
Sturgis Carbon Calculator

Database(s) used
EPDs and data submitted by contractor

Type of building
New build

Reference study period
60 years

Location
UK

Data notes
12 Storeys
Aluminium unitised curtain wall
Post-tensioned frame

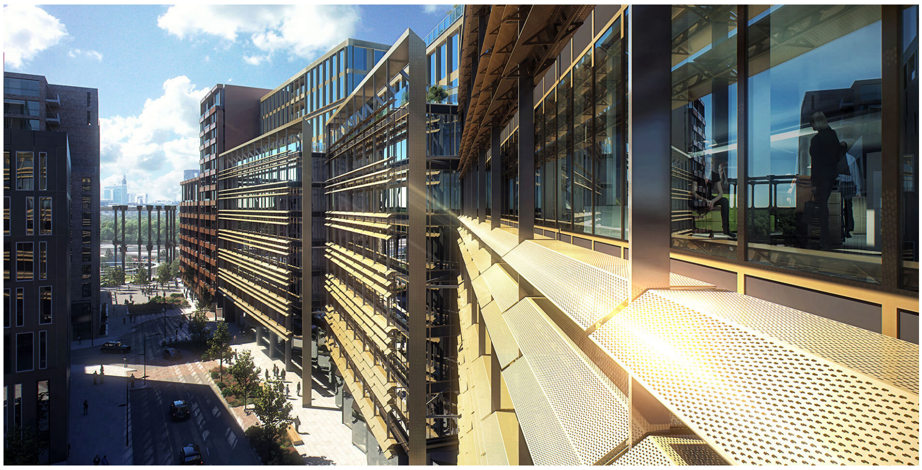


Image c. Bennetts Associates, BAM & Cundall

Assessment objective

The design team was initially briefed with designing the lowest embodied carbon building of its type, with Sturgis Carbon Profiling providing benchmarks and targets for this goal.

Key lessons learned

The massing design which allows maximised roof terraces/gardens whilst removing the need for a basement is something that could be replicated in similar situations.

Relating to procurement/measurement, we discovered the need for subcontractor contractual requirements to provide data, as obtaining as-built data for the final assessment was laborious.

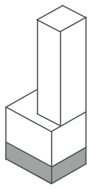
Key barriers and challenges

The project had a very difficult site, with a very long curving plot backing on to the Eurostar line and district cooling plant.

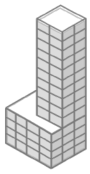
The planning requirements limited the amount of area that could be occupied, with a plot volume that required set-backs at upper levels.

The brief of an adaptable/flexible building capable of numerous configurations also provided a design challenge. Whilst moving to Post-tensioned structure allowed for a large reduction in concrete and reinforcement, it did mean retaining cement replacement levels was a big challenge.

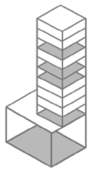
Building elements embodied carbon (A1-A5)



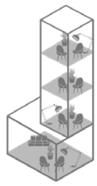
Substructure
98 kg CO_2e/m^2 (A1-A5)



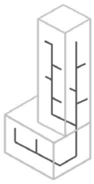
Superstructure
370 kg CO_2e/m^2 (A1-A5)



Finishes
78 kg CO_2e/m^2 (A1-A5)



FF&E
3.5 kg CO_2e/m^2 (A1-A5)



Building services
149 kg CO_2e/m^2 (A1-A5)

Client: Argent

Architect: Bennetts Associates

Structural engineer:
Ramboll until Stage 4 then BAM Design

Services engineer:
Cundall until Stage 4 then BAM Design

Cost consultant: Gardiner & Theobald

Sustainability:
Cundall until 2018 then BAM Design

Carbon consultant: Sturgis Carbon Profiling until 2018 then Cundall

Façade consultant:
FMDC until 2018 then NET Consultancy

CDM advisor: David M. Eagle. Ltd

Fire consultant:
Jeremy Gardner Associates

Acoustic consultant:
Sandy Brown Associates

Site logistics / Asset protection: Arup

Landscape architect: LDA Design

Lighting consultant: Michael Grubb Studio

BREEAM:
Cundall until Stage 4 then BAM Design

Success stories

Though the project does not meet the LETI 2020 targets, for a design from 2015 it is probably the best example of reducing a building as far as possible without any radical departures from typical construction practices.

The building is also inherently adaptable, with lifts and cores separated, and core expansion options and multiple soft-spots designed in.

Despite client aspirations, it was not possible to integrate carbon targets within the contract at the time, but regardless of this working together as a team the design team and contractor have managed to improve on carbon targets.

Particularly with the aluminium façade and Post-tensioned structure, procurement and subcontractor engagement managed to retain specification choices that are often lost on other projects.

Material selection

Though hybrid structures were considered, including Cross Laminated Timber options, this was not deemed possible due to the costs involved in 2015.

A Post-tensioned concrete frame was seen as the best way of obtaining adaptable spaces with flat slabs capable of flexible rearrangement of floor plates. The original design relied on thermal mass of the concrete which allowed the removal of large amounts of MEP equipment, though this was not taken through to completion.

Design decision justification

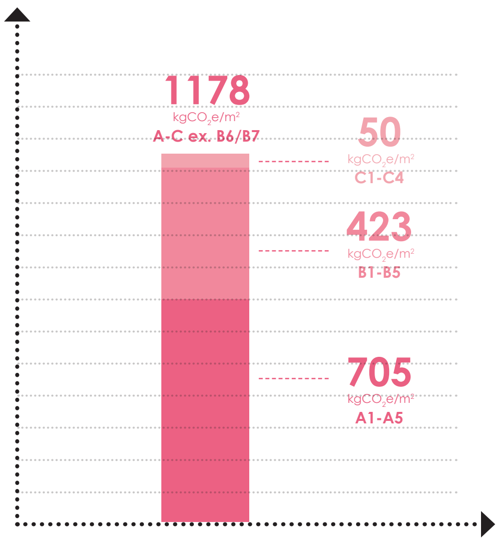
The louvred façade was designed in coordination with planner's aspirations that the project not replicate the solid/glazed patterns of adjacent buildings, providing shading to the façade and originally allowing for a low-energy displacement ventilation system to work.

The metal content of the louvres was reduced as much as possible to provide visual interest but also to dramatically reduce the upfront carbon emissions.

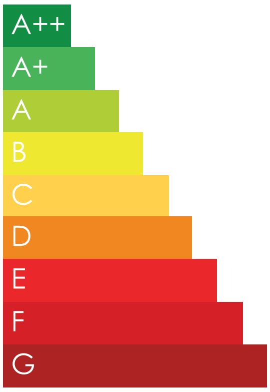
Client engagement

At appointment the client set the target of "the lowest embodied carbon building of its type".

Life cycle embodied carbon reporting summary

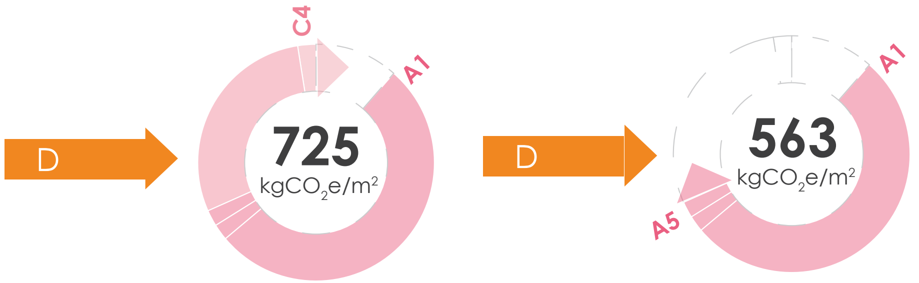


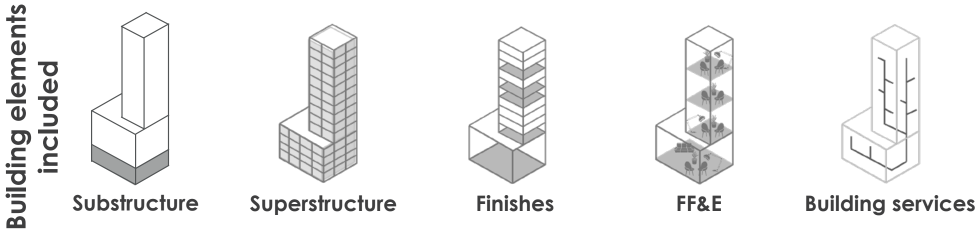
Harris Academy Sutton by Architype



Life cycle embodied carbon
A1-C4 ex B6,B7

Upfront embodied carbon
A1-A5





Project overview
Harris Academy Sutton is the first Passivhaus secondary school in the UK. The highly efficient school inspires students with exceptional facilities, flexible teaching spaces and a mature palette of materials, with a university-style feel enhanced to support transitions to higher education. As well as the significant sustainability benefits, the Passivhaus design supports a comfortable learning environment, with stable temperatures, excellent air quality and plenty of natural light.

Project sector
Education

Assessment date
2022 (at RIBA Stage 6)

RIBA work stage
6

GIA (m²)
10,625m²

Year of project completion
2019 (Complete)

Analysis
ECCOLAB export, with addition of estimated embodied carbon for MEP

Database(s) used
ECCOLAB, based on EPDs and ICE

Type of building
New build

Reference study period
60 years

Location
UK

Data notes
4 Storey, Hybrid - CLT/Glulam/timber frame/concrete/steel, copper cladding/ aluminium cladding/brick

Image c. Architype / Jack Hobhouse

Assessment objective

To understand where the building sat relative to building benchmarks, supporting our commitment to measuring genuine sustainability through the carbon impact of our buildings. Also as a pilot project for ECCOLAB, it allowed us to test and refine the software.

Key lessons learned

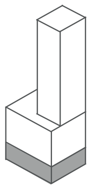
Improvements to the software have allowed us to generate more accurate and detailed reporting information for later projects and ECCOLAB has now been released for commercial use.

Key barriers and challenges

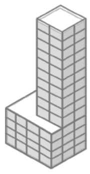
Although a Cross Laminated Timber structure lowered the embodied carbon it did present some challenges relating to connection details, services co-ordination, and fire risk mitigation. It required some secondary steel connections for the geometry which created detailing challenges and increased embodied carbon. We also faced the challenge of getting construction build-ups certified due to lack of fire certification around CLT and associated test data– resolved through a specialist fire engineers detailed calculations.

Additionally, as a high-performance building this resulted in many of the required Passivhaus components coming from Europe, resulting in higher A4 Transportation values, hopefully this will be addressed with more local supply chains shortly.

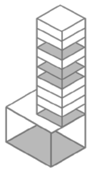
Building elements
embodied carbon (A1-A5)



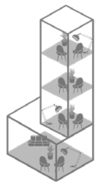
Substructure
14 kg CO_2e/m^2 (A1-A5)



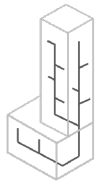
Superstructure
392 kg CO_2e/m^2 (A1-A5)



Finishes
23 kg CO_2e/m^2 (A1-A5)



FF&E
N/A kg CO_2e/m^2 (A1-A5)



Building services
90 kg CO_2e/m^2 (A1-A5)

Success stories

Embodied carbon modelling tools were used along-side Passivhaus PHPP from the outset to communicate the whole carbon story which helped influence specification decisions throughout the project. The anticipated operational savings over 60 years are greater than the total Embodied Carbon A-C of the project. The use of timber was included wherever possible and appropriate to do so - timber cladding, timber frame infill, timber batten ceiling finishes etc. The predominant external wall insulation system utilised timber I-joists with blown cellulose insulation. Substituting concrete for CLT / glulam structure where technically viable to do so resulted in over 1M kg/CO2 ended up being sequestered in the structure, with exposed elements of structure avoiding additional material finishes.

Material selection

Materials were chosen to be robust, long-life materials, which would cope in a secondary school. Concrete was chosen for critical areas, below ground and fire rated cores with 50% GGBS replacement. Dark bricks were used at low level. Timber was chosen for health and well-being as well as its carbon reduction. Natural copper cladding were chosen to distinguish the specific civic and science spaces.

Design decision justification

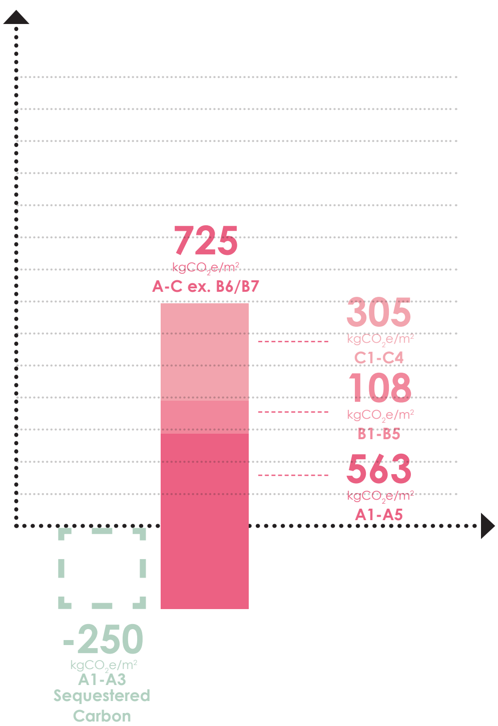
The design of the building had to achieve Passivhaus, and therefore simplification of foundations was essential on this building. Through use of timber structure above upper ground level we significantly reduced the weight of the building and were able to change from deep concrete piles to a minimal raft slab. The switch from concrete to timber alone represented a 20% saving in embodied carbon in our early-stage analysis. Cross Laminated Timber floors and roof slabs were chosen to allow future flexibility of spaces by allowing internal partitions to be adjusted and moved post completion.

Client engagement

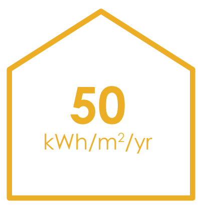
The council were committed to championing all round sustainability including a parallel target of lowering embodied carbon. The school are very pleased with the timber and daylight commenting that it is a spectacular learning environment.

Life cycle embodied carbon reporting summary

Lead consultant, architects, principal designer and passivhaus designer:
Archiltype
Contractor:
Willmott Dixon
Education consultants:
Lloyd Wilson Partnership
Services engineer:
BDP
Structural engineer:
Price & Myers
Landscape architect:
Churchman Thornhill Finch
Quantity surveyor:
Synergy
Planning consultant:
Nathaniel Lichfield & Partners
CLT supplier:
KLH UK
Passivhaus certifiers:
WARM Low Energy Building Practice



Module D

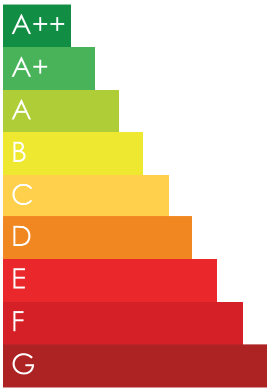


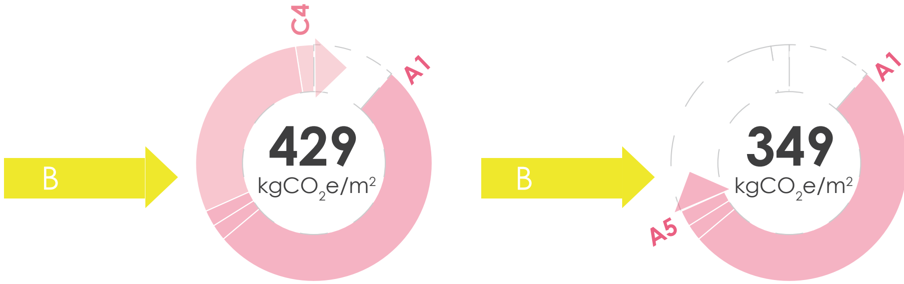
B6 Operational energy

Operational energy estimation method:

PHPP at design stage

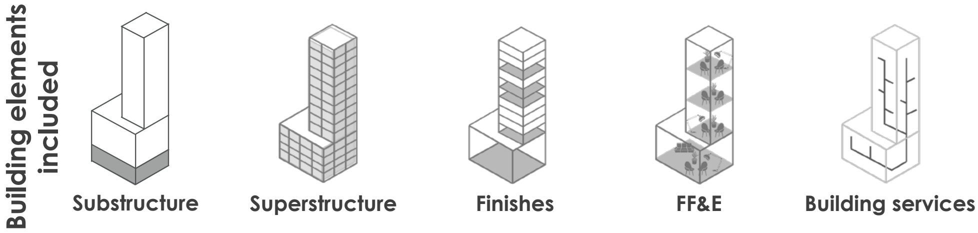
King's Cross Sports Hall by Bennetts Associates & BAM





Life cycle embodied carbon
A1-C4 ex B6,B7

Upfront embodied carbon
A1-A5



Project overview
Community sports hall in the King's Cross development, with a temporary meanwhile use as a further education venue for a constructions skills centre.

Mass timber construction with zinc façade, very few internal finishes beyond the exposed structure (and those that do exist are durable and low-carbon).

Project sector
Education

Assessment date
2021 (at RIBA Stages 3 and 6)

RIBA work stage
7

GIA (m²)
2032 m²

Year of project completion
2020 (Complete)

Analysis
OneClick (RICS Methodology)

Database(s) used
OneClick

Type of building
New build

Ref. study period
60 years

Location
UK

Data notes
2 Storeys
Mass Timber, Zinc Rain screen

Image c. Bennets Associates

Assessment objective

The project's initial target was to get embodied carbon as low as possible, and so assessment was undertaken to measure against that target.

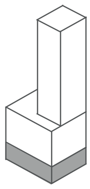
Key lessons learned

Most applicable lessons are primarily designing for future use with CLT (Cross Laminated Timber). Coordinating specifically for and with multiple end users and providing soft spots, particularly in soldier walls. Allowing for demountability via concealing panels and needing early coordination when exposing all services and service runs are also valid for other typologies.

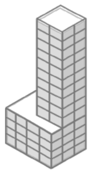
Key barriers and challenges

The Site had a number of constraints including height limitations and a tight site boundary, but most notably the project had to deal with a series of tunnels running from King's Cross station which were very close to the ground. This not only reduced the option of digging into the site or piling, but meant that weight needed to be restricted to the historic loadings and that any removal of weight had to be quickly compensated for to maintain existing loading conditions. In addition, from an operational perspective, the use of the building as a sports hall meant that whilst a mixed mode ventilation strategy is used for the sports hall in its first life, the need for controlled air movement for some sports meant that a mechanical ventilation system will be needed for its second use (though mixed mode will be available as an option).

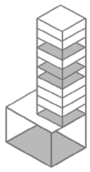
Building elements
embodied carbon (A1-A5)



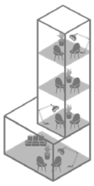
Substructure
65 kg CO_2e/m^2 (A1-A5)



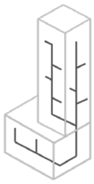
Superstructure
203 kg CO_2e/m^2 (A1-A5)



Finishes
4.3 kg CO_2e/m^2 (A1-A5)



FF&E
N/A kg CO_2e/m^2 (A1-A5)



Building services
43 kg CO_2e/m^2 (A1-A5)

Success stories

The building is unusual in that having been designed to be adaptable it is already proven to be suitable for two very divergent use types. Its first life as a construction skills centre will soon give way to a longer life as a sports hall and gym, and the flexible spaces allow future changes of use beyond this. Considering the technical challenges and limitations on where and how loading could be brought to the ground made achieving this all the more difficult. One of the other key successes is the significant reduction of upfront carbon emissions due to the ultra lightweight and material efficient design, and the removal of almost all non-essential materials whilst maintaining a robust and high quality space.

Material selection

Due to the goal of ultra low upfront embodied emissions, coupled with the need for a lightweight structure, CLT (Cross Laminated Timber) was chosen as the primary material (both for walls and roof, supported by glulam beams). The finishes palette was minimised to remove all non-essential materials, and the dark zinc façade was chosen for being both lightweight and low-carbon, but also due to it complementing the timber and being able to be used on both roof and façade to support the monolithic massing that can be seen from the many surrounding taller buildings.

Design decision justification

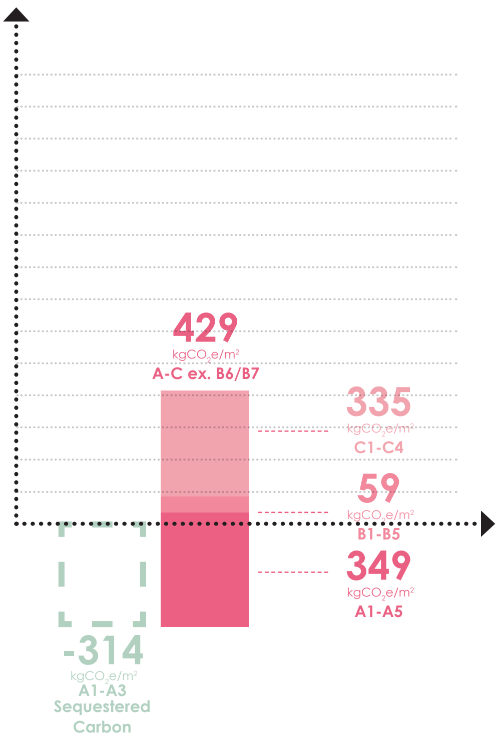
Due to the site geometry dictating where the sports hall could be placed, a structural system was selected where CLT (Cross Laminated Timber) soldier panels perpendicular to the tunnels would distributing roof loads evenly across the tunnel footprint. Height constraints, and the depth of glulams required for the desired spans meant that a monopitch design was used, providing natural light and recalling the previous buildings that had occupied the site prior to clearance in the previous century.

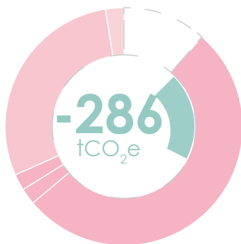
Client engagement

The client (Argent) was fully engaged in the setting of targets and vision for the project. The targets were to drive down embodied carbon as low as possible, which drove the selection of consultants and the early design.

Life cycle embodied carbon reporting summary

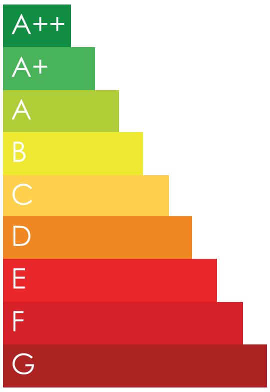
Client: Argent
Architect: Bennetts Associates Architects
Structural engineer: Arup
Ecological consultant: RPS
Acoustic engineer: Ion Acoustics
Mechanical electrical public health:
E3 Consulting Engineers
Active play area architect: Carve
Landscape architect:
Townshend Landscape Architects
CDM / health and safety advisor:
David M Eagle
Fire consultant:
Oculus Building Consultancy
Access consultant:
All Clear Designs Limited
BREEAM: SWECO
Carbon profiling:
Sturgis Carbon Profiling llp
Cost consultant: Gardiner & Theobald
Specialist timber subcontractor:
BK Structures
Delivery architect: Stride Treglown





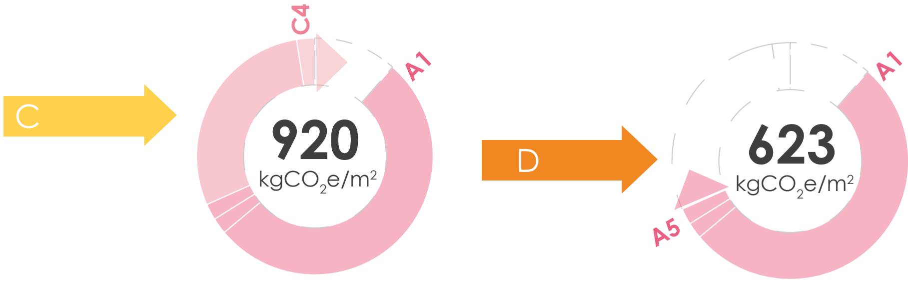
Module D

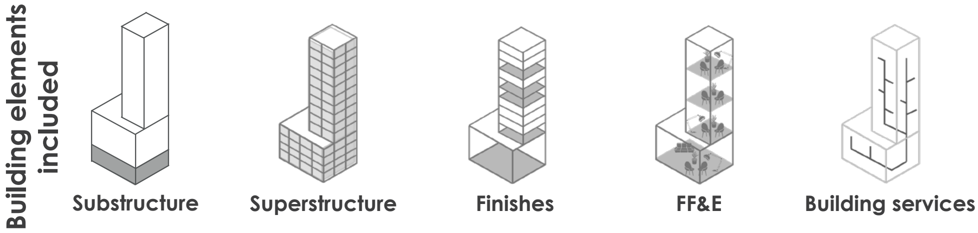
81-103 Kings Road by Benoy, KJ Tait Eng., Eng. HRW, Gardiner & Theobald



Life cycle embodied carbon
A1-C4 ex B6,B7

Upfront embodied carbon
A1-A5





Project overview
Demolition of existing office and retail building. Proposed building is a mixed used development of retail units on the ground floor and offices on the upper floors. The proposal is for a 4s storey development with district wings that look onto the below retail courtyard. This makes the building ideal for mixed mode ventilation.

Project sector
Mixed Use (Office/Retail)

Assessment date
2020 (at RIBA Stage 2)

RIBA work stage
2

GIA (m²)
17,177 m²

Year of project completion
N/A

Analysis
OneClick LCA

Database(s) used
Ecoinvent, GABi, FDES, BRE

Type of building
New build

Ref. study period
60 years

Location
UK

Data notes
4 Storeys
Concrete frame

Image c. Bennetts Associates, BAM & Cundall

Assessment objective

We were instructed to complete the assessment by the GLA as the Publication London Plan was a material consideration for referable schemes. Although there is no target to meet for the London Plan, the Design Team felt it would be good to target module A1-A3 figures in line with the GLA aspirational benchmarks.

Key lessons learned

Key lessons learned is that we need to have the embodied carbon specialist on board from the start of the process. As the new building is to replace the existing building on site there may have been further opportunities to save carbon through use of less materials.

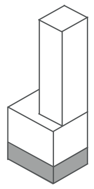
That being said, there has been good lessons learned on the sort of materials that we should be specifying such as replacement cement concrete, CLT (Cross Laminated Timber) floor slabs and recycled steel.

Key barriers and challenges

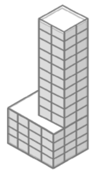
Key challenge was starting the assessment later than what we would have liked. This resulted in the mass of materials being generally fixed. Main barrier appears to be availability of systems data, and estimating aspects such as pipework using previous projects as a baseline.

It is accepted that, the more WLCs (Whole Life Carbon) completed, the more systems information will be gathered.

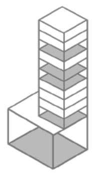
Building elements embodied carbon (A1-A5)



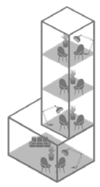
Substructure
145 kg CO_2e/m^2 (A1-A5)



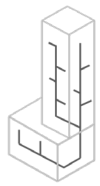
Superstructure
393 kg CO_2e/m^2 (A1-A5)



Finishes
N/A kg CO_2e/m^2 (A1-A5)



FF&E
0.9 kg CO_2e/m^2 (A1-A5)



Building services
83 kg CO_2e/m^2 (A1-A5)

Success stories

From the baseline scheme, we managed to save approximately 100kgCO2e. Data for the baseline scheme was taken from RICS WLC (Whole Life Carbon) guide.

Together with this, we managed to save 134kgCO2e by making the building mixed mode which contributed to lowering the B6 module figure.

Design decision justification

For example, was a particular foundation solution sought, were savings found from using a specific frame or MEP system.

Design benchmarks

We aimed to better the GLA Aspirational benchmarks for an office development.

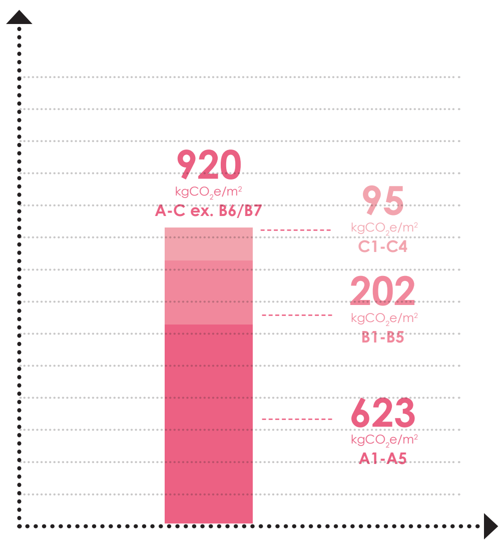
Offsetting incentive

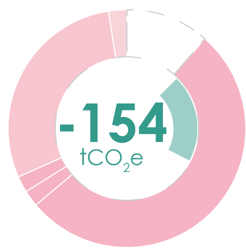
There is an objective in line with planning obligations for the development to be Net Zero in operation.

Savings from Part L were 53% therefore the offset payment for the scheme was calculated at £192,747.

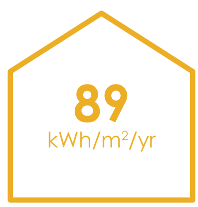
Client: Kings Road Properties Ltd
Architect: Benoy
Structures: Engineers HRW
Quantity surveyor: Gardiner & Theobald
M&E/sustainability: KJ Tait Engineers

Life cycle embodied carbon reporting summary





Module D

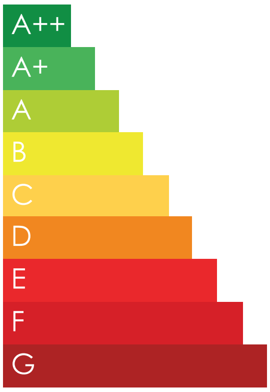


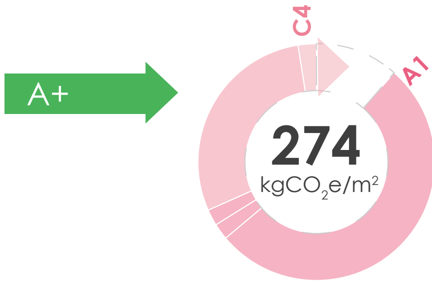
B6 Operational energy

Operational energy estimation method:

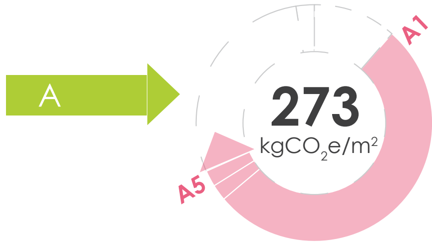
PHPP at design stage

Stephen Taylor Court by Feilden Clegg Bradley Studios



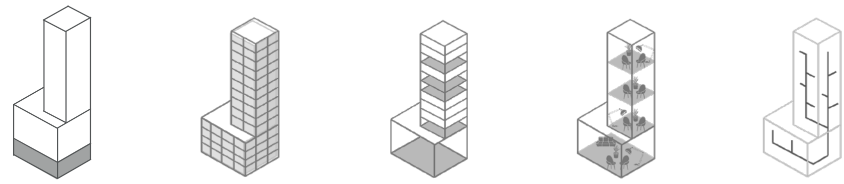


Life cycle embodied carbon
A1-C4 ex B6,B7



Upfront embodied carbon
A1-A5

Building elements included



Substructure **Superstructure** **Finishes** **FF&E** **Building services**

Project overview
As a new community for Kings College, Cambridge, the Stephen Taylor Court's scheme creates 60 new graduate study rooms and 24 1 and 2 bed apartments for Fellows and their families. Built to achieve Passivhaus standards the buildings are typically 3 storey, with 4 new residential buildings and refurnished and extended existing building providing communal spaces, laundry and library.

Project sector
Higher Education & Student Resi

Assessment date
2022 (at RIBA Stage 4,5)

RIBA work stage
5

GIA (m²)
4400m²

Year of project completion
2022 (Complete)

Analysis method (e.g. software)
FCB Carbon

Database(s) used
EICE database, V3

Type of building
New build & refurbishment

Ref. study period
60 years

Location
UK

Data notes
3 Storeys, CLT, Brick facing walls, Aluminium triple-glazed windows, No Basement

Image c. Feilden Clegg Bradley Studios

Assessment objective

Client objectives were for a low-energy project, achieving Passivhaus standards and with a 100 year design life. Broader sustainability objectives were managed through a bespoke, client-led, matrix.

Key lessons learned

The 100 year design life led to a depth of technical work on material life, replacement and how to maintain fabric performance. Design team focussed on material sourcing, recycled content and approach to building end of life.

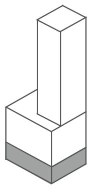
Key barriers and challenges

Key issues faced included developing a brick clad, passivhaus detailing with a Cross-laminated timber frame (CLT) and addressing replacement cycles of windows. Further challenges included the use of Ground source heat pump system (GSHP) and Air source heat pumps system (ASHP), and how to use reversed underfloor heating to cool internal spaces where opening windows can't be relied on. Design team used a process where they developed written technical summaries of their decision making process to show the evaluation of key criteria, including material choice.

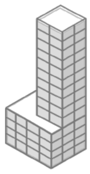
Success stories

Re-use of existing roof tiles into the landscape elements of the scheme. Use of Cross-laminated timber frame (CLT) allowed for reduction in substructure and use of raft foundation (no piling, thinner slab, use of 70% GGBS.

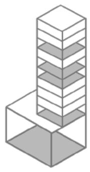
Building elements
embodied carbon (A1-A5)



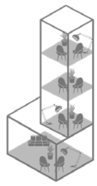
Substructure
34 kg CO_2e/m^2 (A1-A5)



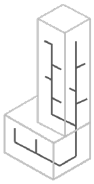
Superstructure
202 kg CO_2e/m^2 (A1-A5)



Finishes
6 kg CO_2e/m^2 (A1-A5)



FF&E
N/A kg CO_2e/m^2 (A1-A5)



Building services
N/A kg CO_2e/m^2 (A1-A5)

Material selection

Material selection was driven by the 100 year design life, and understanding the balance of material choice with longevity and carbon footprint. This has lead to using higher carbon materials where replacement is not intended, such as brick and tile roofs, use of lead for gutters.

Internally there is a simple palette of hard wearing materials with an appreciation for simple maintenance. There was an imperative to specify materials sourced within 50 km if possible.

Design decision justification

The design team tracked all decisions relating to materials and detail design through trackers and technical evaluation notes. This allowed the team to understand the benefits of CLT on reduced substructures / slabs, minimising thermal bridging in external wall and roof constructions. Robust practical solutions were explored with the aim of maintaining quality in construction.

Client engagement

Client was continually engaged in the process, through reporting and reviewing the design team progress, and commenting on proposals or potential future options.

Embodied carbon and scope of services

Embodied carbon not included within scope of services, however 100 year design life was in the brief and was regularly prompted by client and team.

Procurement

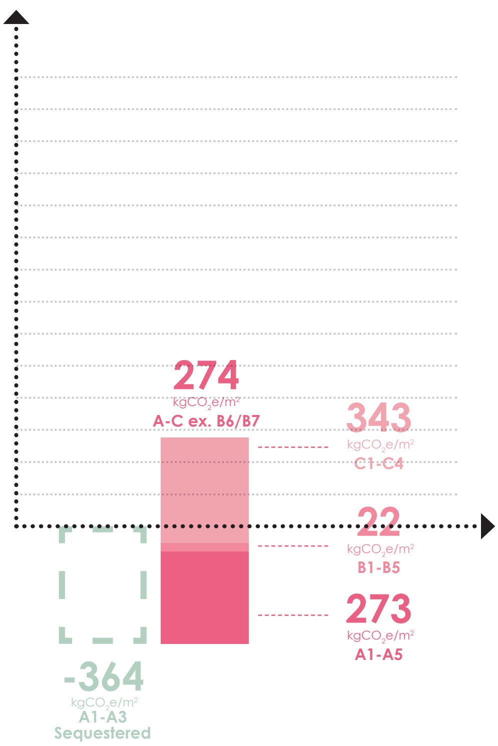
Contractors were asked for a specific response on sustainability including proposing alternative low-carbon materials.

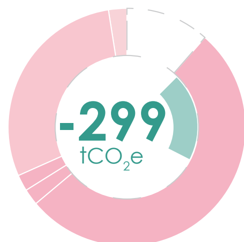
Design benchmarks

Passivhaus certification was the key benchmark, but also targeted - <25% material by value from certified responsible sources (eg BES 6001, FCS Forest Stewardship Council certified), <3% material by value from within 50km of site, and up to 10% material by value with recycled content, water consumption levels also set at 40% reduction against standard Code for water use.

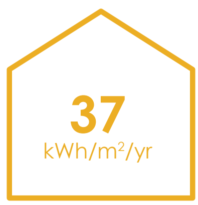
Life cycle embodied carbon reporting summary

Client:
King's College, Cambridge
Architect:
FCBStudios
(Hugo Marrack, Nick Hodges, Heidi Day, Charlotte Walker, Joe Jack Williams)
MEP, Acoustics and PH:
Max Fordham
Cost, PM and Principal designer:
Faithful and Gould
Landscape:
Robert Myers Associates
Civils and Structural engineers:
Smith and Wallwork
Planning:
Turley
Approved inspector:
Salus AI





Module D

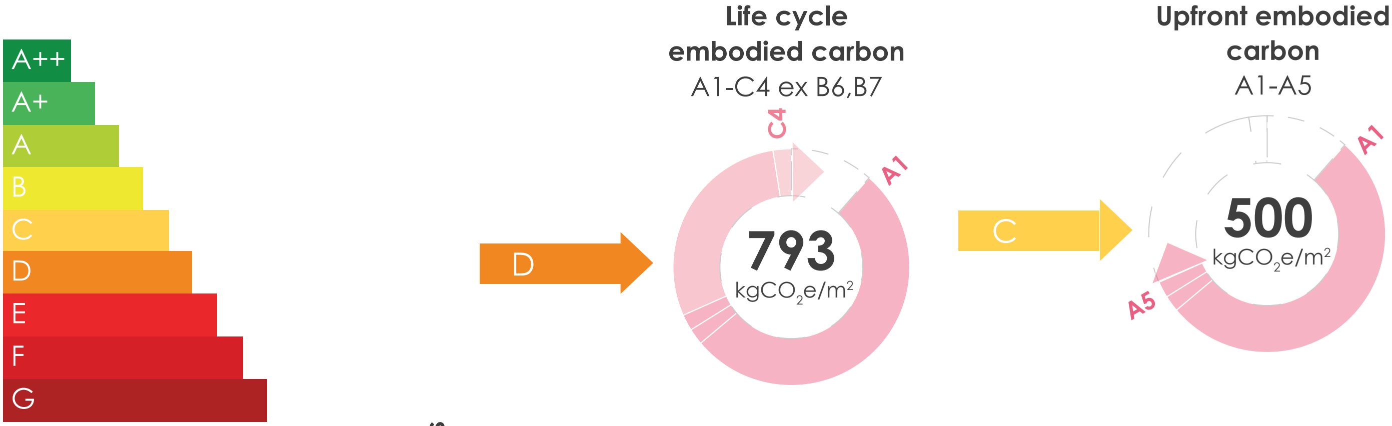


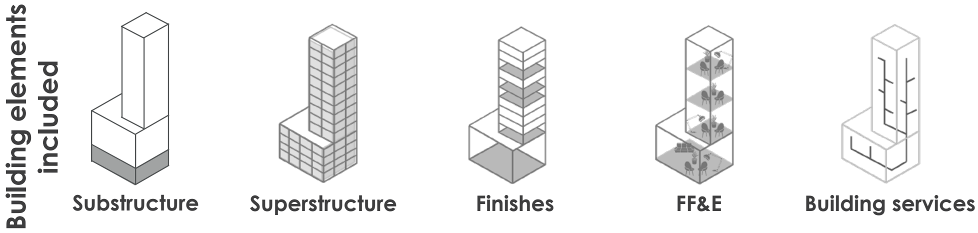
B6 Operational energy

Operational energy estimation method:

PHPP at design stage

Stratford Pavilion by ACME





Project overview
The Pavilion is a new landmark building in Endeavour Square,Stratford. The Pavilion is conceived as a folded public space, a 'vertical piazza'. Stairs, balconies and amphitheatres invite exploration; a place to gather, relax and enjoy views of the East Bank and the Olympic Park from the rooftop. The ground and first floor of the building provide space for D&D's Haugen café, restaurant and deli; and a new visitor centre for the Olympic Park.

Project sector
Retail

Assessment date
2020 (at RIBA Stage 4)

RIBA work stage
5

GIA (m²)
1500m²

Year of project completion
2021 (Complete)

Analysis
OneClickLCA

Database(s) used
RICS

Type of building
New build

Ref. study period
60 years

Location
UK

Data notes
3 Storeys, lightweight timber structure, cross-laminated and glue-laminated timber panels and beams, district heating network, BREEAM Outstanding, EPC A rating.

Image c. ©Hufton+Crow

Assessment objective

A life cycle assessment and a whole life carbon study has been undertaken by the services engineer at stage 4. An IMPACT compliant LCA was first produced in support of the two exemplary credits under BREEAM NC 2014 Mat01 - Life cycle impacts. An additional Whole Life Cycle assessment was also undertaken in accordance with the RICS methodology, this taking in consideration the operational energy and water.

Key lessons learned

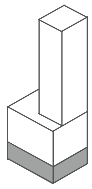
Timber frame buildings perform better than full concrete or steel frames, however, only with an appropriate offsetting strategy and definition of the building 'end of life' stage can the full potential be unlocked. Recycling & circular economy strategies should also be embedded within design development.

Key barriers and challenges

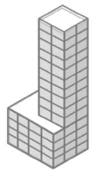
The building geometry was complex and required close coordination between design team members using BIM. In some locations cantilever length exceeded the capacity of timber so a few steel beams had to be introduced.

A concrete core was required to achieve the structural performances and a concrete ground floor slab/basement to avoid timber in direct contact with ground. A general lack of products which have been certified for compatibility with timber, eg. fire stopping or waterproofing, was a major challenge.

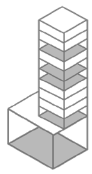
Building elements embodied carbon (A1-A5)



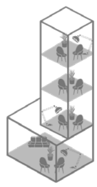
Substructure
91 kg CO_2e/m^2 (A1-A5)



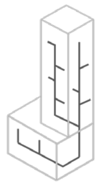
Superstructure
362 kg CO_2e/m^2 (A1-A5)



Finishes
4 kg CO_2e/m^2 (A1-A5)



FF&E
N/A kg CO_2e/m^2 (A1-A5)



Building services
44 kg CO_2e/m^2 (A1-A5)

Client:
Stratford City Business District Ltd
Architecture:
ACME
Structural engineering: Arup
MEP, sustainability:
Norman Disney & Young
Civil engineering: Buro Happold
Facade consultant: Meinhardt
Access consultant: Lord Consultants
Planning consultant: QUOD
Cost consultant: Gardiner & Theobald
Fire consultant: The Fire Surgery
Landscape architecture:
Gustafson Porter + Bowman
Acoustics: Hoare Lea
Wind consultant: FD Global
Ecology: Green Infrastructure
Waste, security, traffic: WSP
Public artwork: Troika
Construction manager:
Lendlease Construction

Success stories

In addition to the impact on reduction of carbon footprint, the adoption of a timber frame was highly beneficial to the programme given the speed of erection. Use of digital modelling and fabrication processes for the frame and also the feature timber fins drove quality and minimised waste. The use of BIM in coordination reduced clashes and site issues. Thanks to the timber's thermal properties, less insulation material was required to meet fabric performance targets, further reducing the carbon footprint. Exposing the naturally beautiful timber frame internally enabled a reduction in the quantity of materials used in the fit-out.

Material selection

The timber frame solution was driven initially by the requirement for a lightweight solution given the location over a tunnel. The building was thus conceived as a series of timber slabs, with timber decking and cladding on terraces, and full height glazing to maximise daylight and views in and out to suit the building use. As a "building in the round" without a true rear facade, solid areas of facade were design to mimic the reflective properties of glass.

Design decision justification

As noted above the decision to pursue a timber frame solution was initially driven by the requirement to minimise loads on the DLR tunnel beneath the building. This in turn enabled a reduction in the size / depth of the foundation solution.

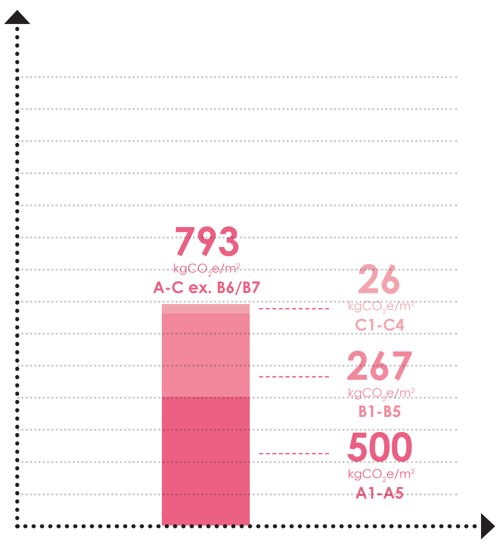
Client engagement

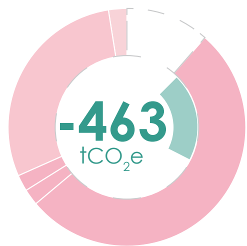
Lendlease's latest carbon targets published in August 2020 are aiming for Net Zero Carbon by 2025 for direct and indirect emissions (scopes 1 & 2) and absolute zero carbon by 2040 including other indirect emissions (scope 3).

Embodied carbon and scope of services

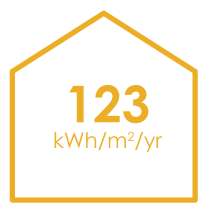
For this building the embodied carbon reporting was not integrated into the scope of services. However, the client started reporting embodied carbon metrics internally and launching new minimum sustainability standards for future projects. Additionally, the whole life carbon impact and opportunity to meet industry targets, such as the LETI targets, will be requested and introduced in future design briefs.

Life cycle embodied carbon reporting summary





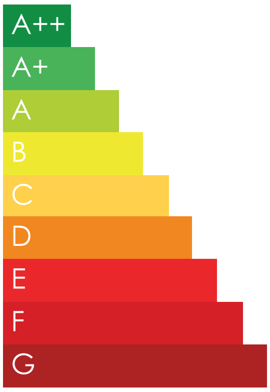
Module D

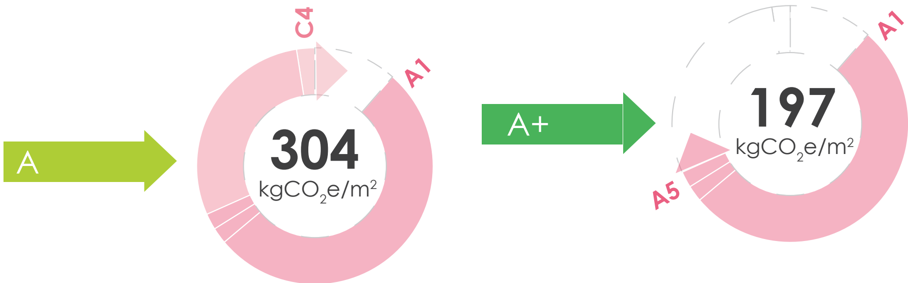


B6 Operational energy

Operational energy estimation method:
PHPP at design stage

The Standard by Orms

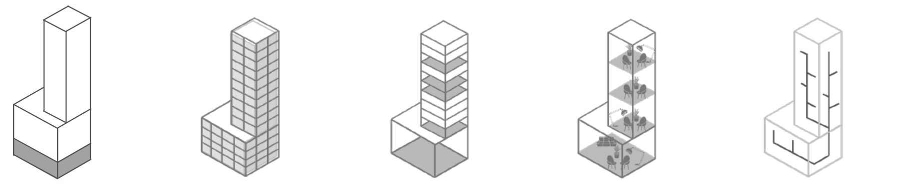




Life cycle embodied carbon
A1-C4 ex B6,B7

Upfront embodied carbon
A1-A5

Building elements included



Substructure | Superstructure | Finishes | FF&E | Building services

Project overview
Housed in the former Camden Town Hall Annexe, a 1974 Brutalist structure overlooking King's Cross, the 266-room hotel marks the first in The Standard's global growth ambitions. As lead consultant, Orms was responsible for the exterior architecture / shell and core on behalf of Crosstree Real Estate Partners and The Standard.

Project sector
Hotel

Assessment date
2020 (at RIBA Stage 7 - In Use)

RIBA work stage
6

GIA (m^2)
17,317 m^2

Year of project completion
2019 (Complete)

Analysis
Sturgis Carbon Calculator

Database(s) used
RICS professional Statement

Type of building
Retrofit of an existing building and new addition

Ref. study period
60 years

Location
UK

Data notes
Storeys 3 New, 8 Existing, Existing Pre-cast Concrete, New PVD Stainless Steel Cladding and Double Glazed Curtain Walling System

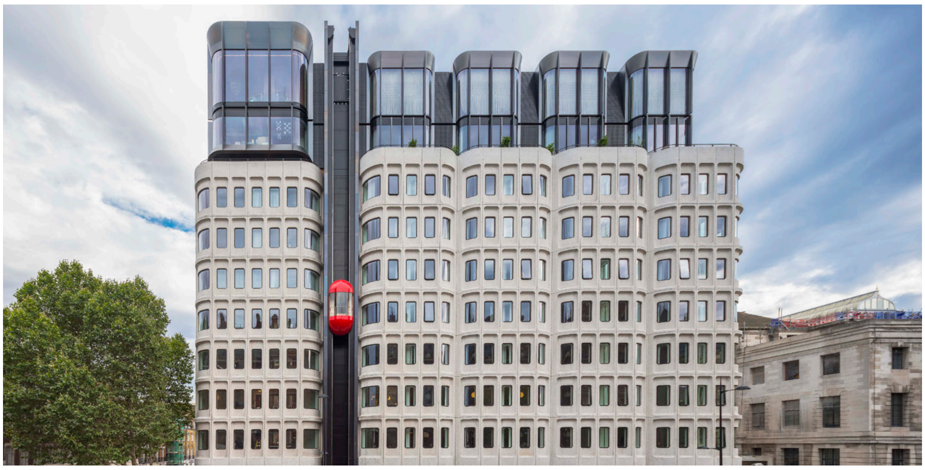


Image c. Timothy Soar

Assessment objective

The assessment was undertaken to understand the benefits of reusing and adapting an existing structure, using stage 3 design information, by a sub consultant.

Key lessons learned

The assessment demonstrates that through Orms's long practiced strategy of maximum retention of existing building fabric the embodied carbon impact of a project may be reduced significantly.

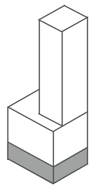
By using clever design solutions the character of our existing urban fabric can be preserved and enhanced while repurposing buildings which are innovative and exciting as well as sustainable.

Key barriers and challenges

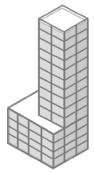
The existing structure is unusual in that the characteristic precast façade supports the frame. The depth of the plan and the low floor to ceiling heights combined with structural complexities led the former owner to vacate and sell the building in 2011. As such most of the other bids for the site involved demolition and rebuilding.

Archive drawings and BIM were used in collaboration with Heyne Tillet Steel at an early stage to understand the potential and limitations of the existing fabric and inform the persuasive initial design proposal.

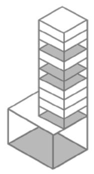
Building elements
embodied carbon (A1-A5)



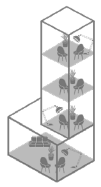
Substructure
5 kg CO_2e/m^2 (A1-A5)



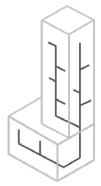
Superstructure
182 kg CO_2e/m^2 (A1-A5)



Finishes
9 kg CO_2e/m^2 (A1-A5)



FF&E
N/A kg CO_2e/m^2 (A1-A5)



Building services
N/A kg CO_2e/m^2 (A1-A5)

Success stories

The team sought to work with the existing building as much as possible. This required the team to first understand the existing building, identify and realise the opportunities it presented. This approach minimised the amount of demolition and maximised the amount of reuse of the structure in situ. Risers, lift shafts and most of the staircases were reused.

Material selection

The PVD (Physical Vapor Deposition) stainless steel cladding to the new extension was chosen for its durability and is also recyclable at end of life. Timber was also used to clad the facade around eighth floor terraces and the ground floor. For other materials and products, local sourcing was an important consideration.

Design decision justification

The façade's existing precast concrete panels formed an integral part of the building's structure and so could not be removed or altered without significant structural remodelling to accommodate the additional weight of the three new floors, Orms collaborated with Structural engineers Heyne Tillett Steel to add new steel columns to the existing structure. These were threaded like needles down through the existing waffle slabs to the first floor transfer slab and concrete columns below and incorporated into the build-up of the new dividing walls between bedrooms. A lightweight steel frame solution was developed for the roof extension to minimise the impact on the overall loadings to the existing concrete frame and foundations.

Client engagement

The existing building was not listed and had been previously identified as one which detracted from the character and appearance of the local conservation area. However, the design team felt that it was under-appreciated and, along with the client, Crosstree Real Estate Partners, developed ideas to retain it.

Design benchmarks

Embodied carbon targets/benchmarks did not exist at the time of design, however a BREEAM Very Good rating was achieved (BREEAM 2014 Non-Domestic Refurbishment).

Client:
Crosstree Real Estate Partners and The Standard

Lead consultant, envelope and shell and core architect:
Orms, Director John McRae and Associate Director Simon Whittaker

Structural engineer:
Heyne Tillett Steel

M&E consultant:
Arup

Quantity surveyor:
Gardiner & Theobald

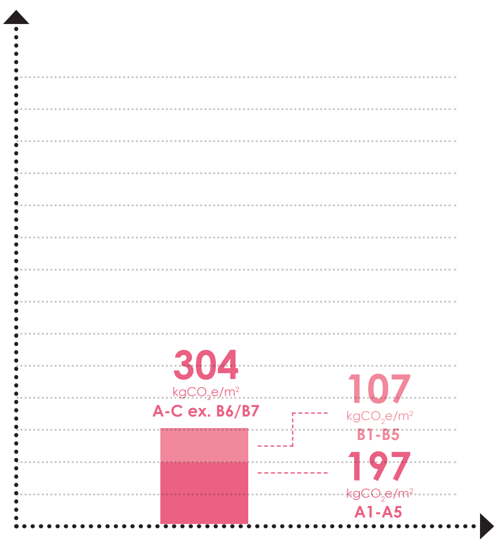
Project manager:
Tower Eight

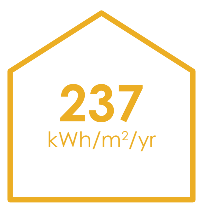
Main contractor:
McLaren

Interior architect:
Archer Humphryes

Interior designer:
Shawn Hausman Design

Life cycle embodied carbon reporting summary





B6 Operational energy
Operational energy estimation method:
PHPP at design stage

Note 1

Current LETI template requires:

- clarification that sequestered figures are relating to sustainably sourced timber e.g. FSC/PEFC certified.
- Where possible to provide the end of life scenario for the bio-based material/ timber, if reuse is one of the scenarios;
- To submit a module D figure to capture the benefit of the re-use of timber beyond the system boundaries of the building study
- To follow the below guidance:

    The negative figure from A1-A3 (the sequestered carbon) has still got to be 're released' and added back into the calculation within the end of life stage, even in the case for the reuse of the timber/bio based products. Please see excerpt from the Timber Development UK Technical Paper to help explain this.

"When any timber is recovered at the end-of-life, then its sequestered carbon is transferred to the recovered product. This is reported as an 'emission' of the sequestered carbon in C3 and as a removal of the sequestered carbon in the recovered product in Module D.

Of course, the carbon is not emitted as it stays in the timber throughout the recovery process, but it is necessary to consider it as an emission to ensure:

- *There is a biogenic carbon balance for the original product*
- *There is no double counting of the benefit of sequestration in both the original and recovered product*
- *That the recovered product has sequestered carbon that will balance the emission of carbon if it is burnt at the end-of-life.*

When the timber leaves the building, it is assumed to be waste. Any transport and processing which is needed to allow it to reach the "end of waste state" and become a product again is reported in the Modules C1 (deconstruction and demolition), C2 (transport) and C3 (waste processing)."

Note 2

Notes on the figures

A degree of standardisation has been achieved by asking all the submitters to provide their results using the LETI Embodied Carbon Declaration Template, a method we'd encourage all practitioners to use. However, a challenge regularly met when carrying out and attempting to draw conclusions from embodied carbon analyses is the fact that the results can be highly dependant on the methods and assumptions used. These can include aspects such as: which building elements are chosen for inclusion or exclusion, how quantities are estimated, the embodied carbon coefficients used and the assumed end of life scenarios. We have not interrogated or verified these type of assumptions or the resulting embodied carbon figures in detail. The work is that of the case study teams. It is likely that different teams used different methods and assumptions (even if they followed the RICS Whole Life Carbon Professional Statement). Another way of describing the above is that the uncertainly on any building embodied carbon analysis result is likely to be high. This should be considered when comparing projects to benchmark figures and to each other.