Bennetts Associates

Innovation in Science Buildings

The UK science sector is just beginning to face up to the challenge of achieving net-zero carbon. Our research looks at the path to getting there.

Turner & Townsend alinea

HEYNE TILLETT STEEL

HOARE LEA

We are the team behind the 360,000ft2 Timber Square project in Southwark, LandSec's pioneering net-zero commercial development.

We believe that genuine sustainability supported by evidence and hard data underpins all truly long-lasting architecture. We take innovative low-carbon solutions into the mainstream, researching and up-scaling innovative ideas, using data to drive our design decisions.

Our pioneering approach to sustainability helped us to be one of the first architects to gain B Corp certification and we were named AJ100 Practice of the Year 2024.

Certified B Corporation

AJ100

The Team:

- Simon Erridge, Director, Bennetts Associates, Architect
- Hamish Summers, Director, Turner and Townsend Alinea, Cost Consultant
- Andy Heyne, Director, Heyne Tillett Steel, Structural Engineer
- Kostas Milonidis, Associate Director, Hoare Lea, MEP Engineer

BENNETTS ASSOCIATES

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We have also been working with Reef Group on the Tribeca since 2016, developing and delivering the first phase of what will become London's largest purpose-built life sciences campus. The five buildings provide 1.1m sq ft of lab-ready space and 70 homes. The 110,000ft2 Apex building will be handed over this summer to occupiers The Crick Institute and LBIC.

The UK science sector is just beginning to face up to the challenge of achieving net-zero carbon.

Science investors and occupiers are becoming more discerning, and the sector is likely to follow others in commercial property with a flight to quality led by ESG and user wellbeing. To achieve net-zero, the operational and embodied carbon performance of all buildings will need to be within the UK's built environment carbon budget.

> "...It is time for all players in the life science value chain to embrace environmental sustainability in their portfolios future proofing their assets."

Chris Walters
Head of UK Life Sciences, JLL

I2SL International Institute for Sustainable Laboratories

UK Net Zero Carbon Buildings Standard

CONSTRUCTING SCIENCE

Bennetts Associates were part of the working group involved in the development of the new UK Net Zero Carbon Building standard. Initial carbon targets for science buildings have now been published.

Science buildings are measured on shell/core + Cat A and the target will reduce year-on-year from 2025 based on the construction start date. To be able to meet the standard, a new-build lab building project starting on site in 2-3 years' time would need to meet :

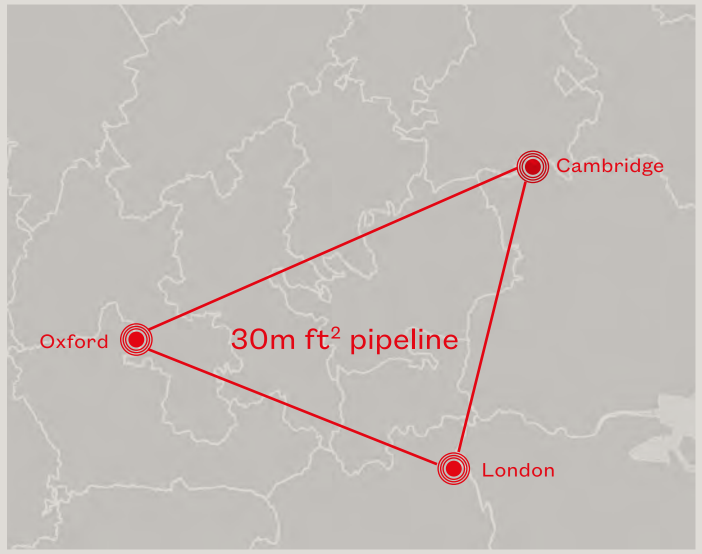
Upfront Carbon target of 640-680 kg/m² CO_2
Operational Energy Target of 280-289 kWh/m² GIA

	Science & Technology Limits			
	New Build Limits		Retrofit Limits	
	Upfront Carbon kgCO2e/m²GIA	Operational Energy kWh/m²GIA year	Upfront Carbon kgCO2e/m²GIA	Operational Energy kWh/m²GIA year
2025	755	305	605	360
2026	715	297	575	351
2027	680	289	545	341
2028	640	280	515	331
2029	605	272	485	322
2030	565	264	455	312

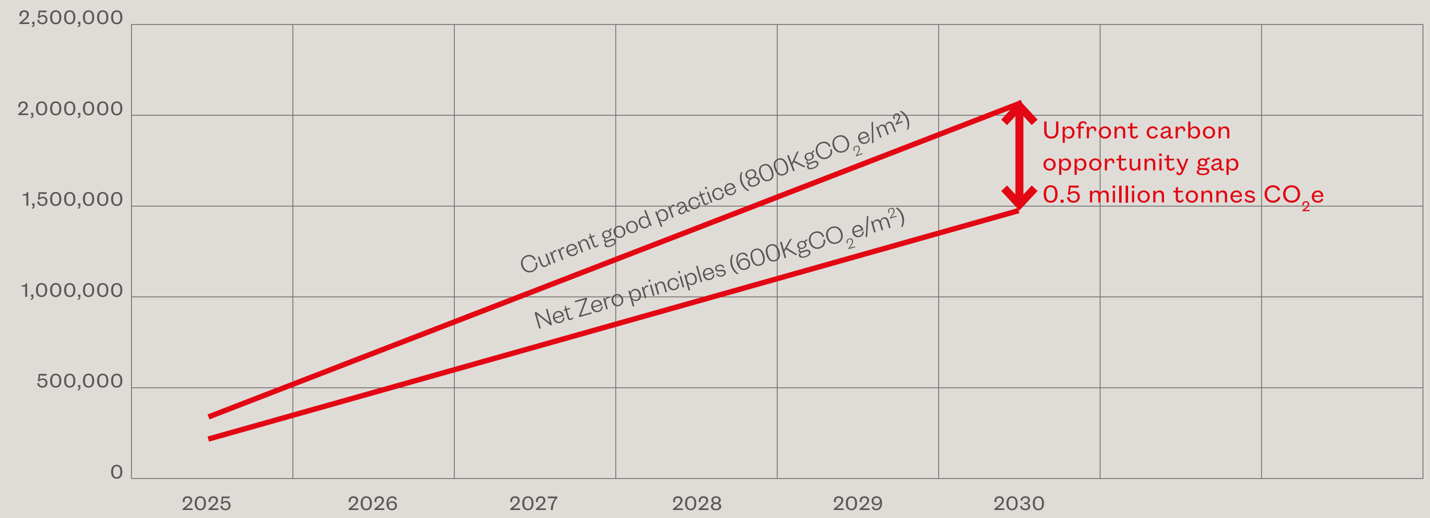
Draft UK Net Zero Carbon Building Standard targets for Science & Technology

Science and innovation is an active sector across the UK with thirty million square feet* of science buildings under development in Oxford, Cambridge and London alone.

The delivery of this pipeline using conventional construction specifications could result in over 2m tonnes of upfront embodied carbon.



Typical schemes under delivery include the 1mft² Tribeca development in the London's King's Cross Knowledge Quarter



*Source: Savills Dec 2023

Our projects for Landsec at Timber Square, and for Related Argent at Brent Cross explore the large-scale use of mass timber to create workplace building which are ahead of the trajectory towards net zero carbon.

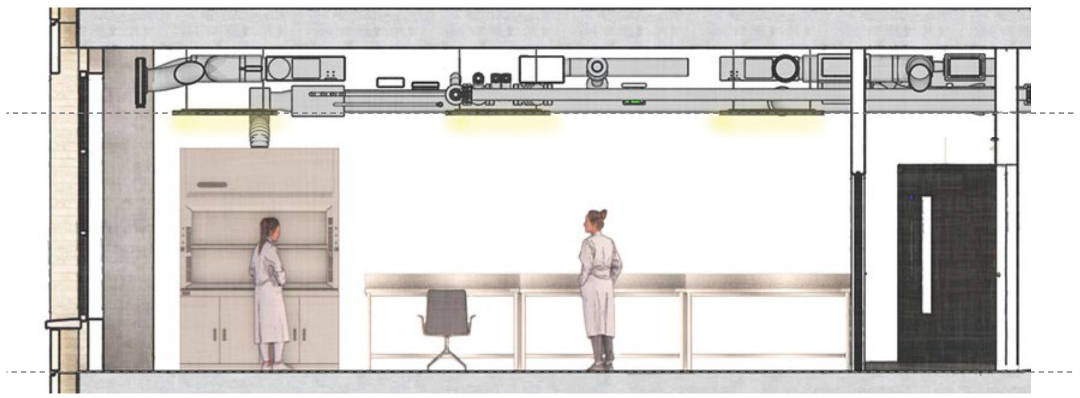
We must look at transferring approaches and technologies from the workplace sector where we are already delivering net-zero-ready buildings at scale.

We need to challenge assumptions and find mainstream solutions that can be scaled-up to meet the challenge.

Whilst they occupy similar types of space, the performance requirements of lab buildings result in heavier, more carbon intensive buildings than a typical net-zero office building.

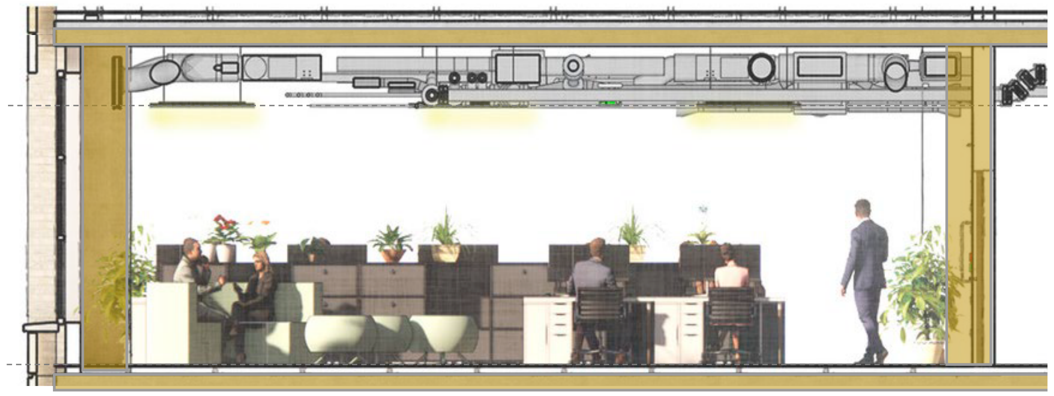
Compared to workplace buildings, labs will have significantly higher operational carbon emissions. Building systems are required to circulate large quantities of air and safely eject them at roof level, facades are sealed, and occupant comfort requires mechanical ventilation and cooling.

Lab, Current Best Practice



Floor to Floor	4,200
Loading	5+1
Vibration	R=1 or 2
Ventilation	6 ac/hr
Structure	Concrete
Upfront Embodied Carbon	800kgCO_2e/m^2
EUI (Base Build)	98kWh/m^2/y

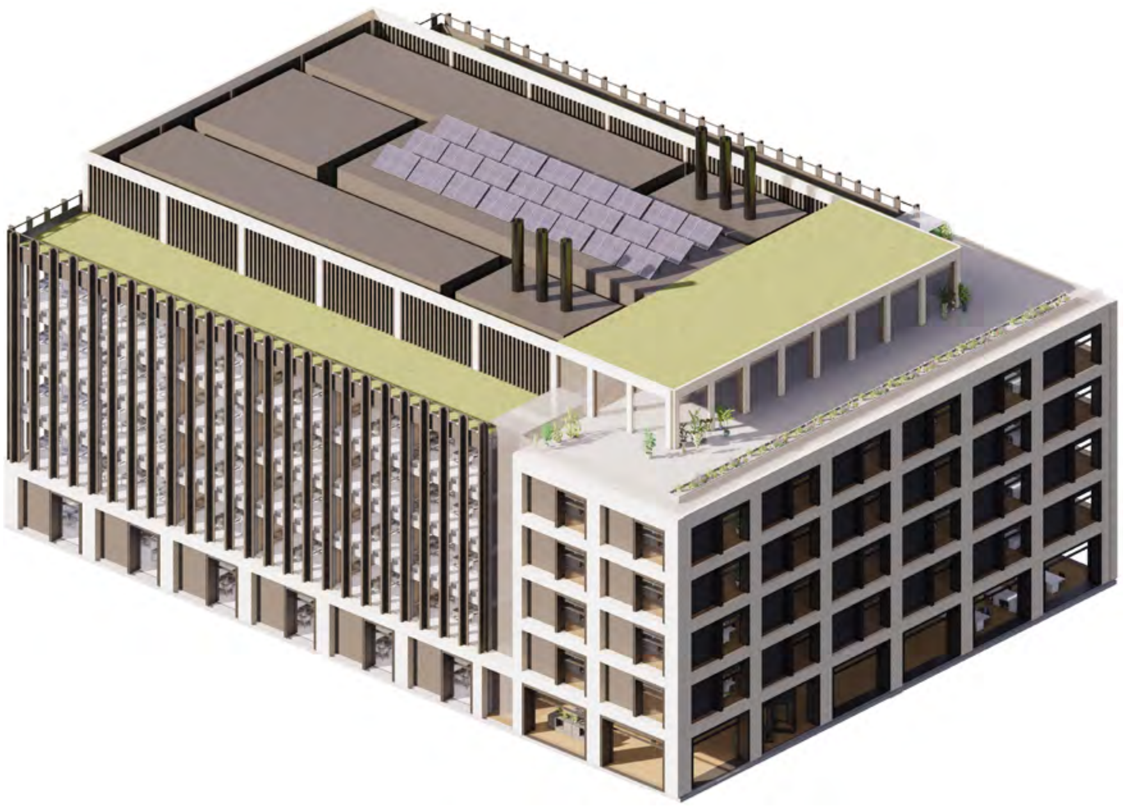
Typical Net Zero Office



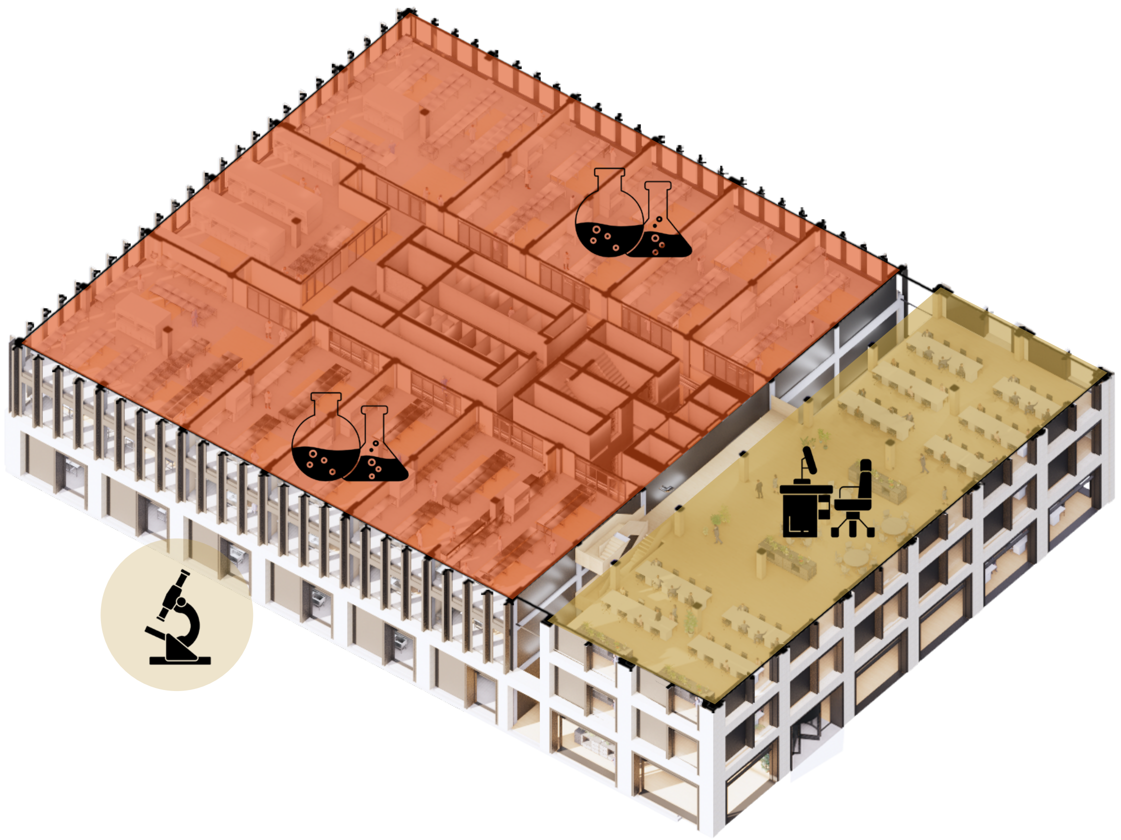
Floor to Floor	3,800
Loading	2.5+1
Vibration	R=8
Ventilation	14l/s/person
Structure	Timber or timber hybrid
Upfront Embodied Carbon	LETI Target 475kgCO_2e/m^2
EUI (Base Build)	Target 60kWh/m^2/y

We have created a prototype building to test our ideas and to understand the carbon benefits of taking a holistic approach. It represents a typical speculative lab building with a net area of around 115,000ft².

A simple centre-core design creates the most efficient floorplate of around 20,000ft2 and maximises perimeter space for the occupier. Regular grids of 7.5m or less suit lab layouts and create efficiencies in structure and foundation design.



The building extends to ground plus four storeys with rooftop amenity and plant areas.



The prototype 20,000 ft² floorplate with centre core and defined entrance/write-up zone, shown here with hybrid concrete/timber structure

A great place to work, equally at home in urban or science-park settings.

Cafe and events space at ground floor

Rooftop hospitality pavillion and roof terrace

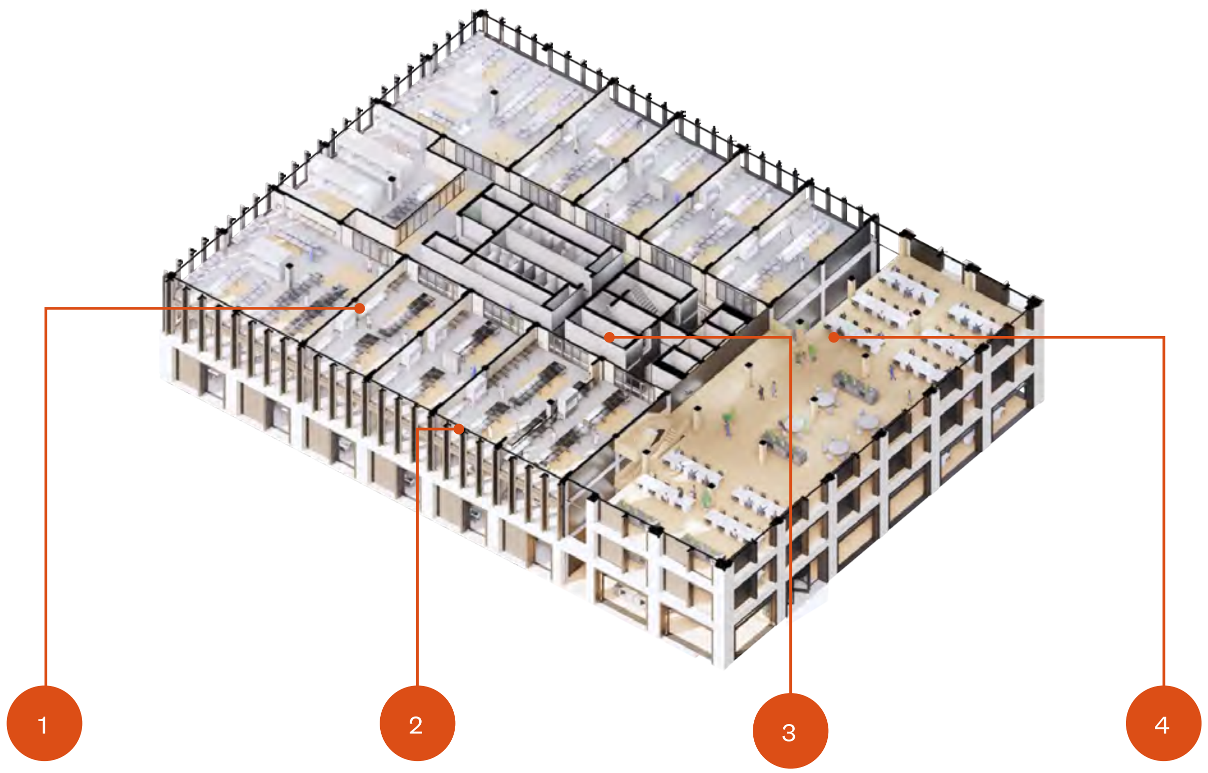
End of trip facilities

Open circulation stair

Our study focuses on embodied carbon emissions in the first instance, then considers approaches to improve operational energy performance.

We are seeking a reduction of around 20-25% of the upfront embodied carbon emissions compared to current best practice.

We are taking a holistic approach which covers the whole building by looking at four areas of impact:



Structure: Containing half of the total embodied carbon, the lean design of the superstructure offers the biggest potential to decarbonise. Mixing materials allows the use of structural timber where possible, adding the stiffness and mass of concrete where this is required.

MEP: Applying lean thinking to MEP systems reduces the risk of over-engineering. Adding smart controls, and heat recovery units on the fume extract also significantly reduces operational energy demands.

Enclosure: Put together, facades and finishes contain around a quarter of the embodied carbon in a typical building. Carbon metrics can be used to optimise the design of these elements.

Finishes: Looking at alternatives to standard interior elements like blockwork and metal studding that are available could offer substantial carbon savings. Modular partition systems with timber frames and components would help to further reduce embodied carbon.

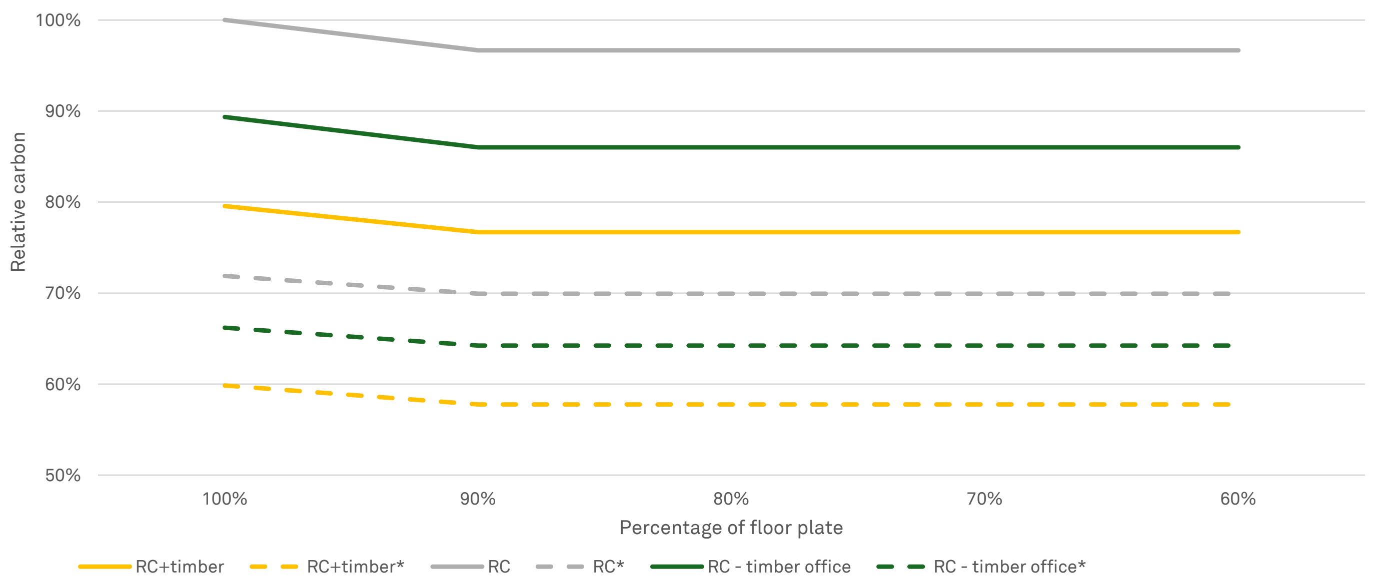
We carried out a large meta study of 1,000,000+ options, comparing like for like performance. A realistic solution providing a 20% structural carbon saving, with further optimisation options achieving upward of 40% saving.

Also evaluating the carbon cost of increasing performance for the options, with the timber infills allowing for 20% reduction in carbon cost per performance enhancement.

Future studies on performance criteria and local stiffening optimisation would yield further value.

Optimised with hybrid RC/timber lab frame and all-timber office

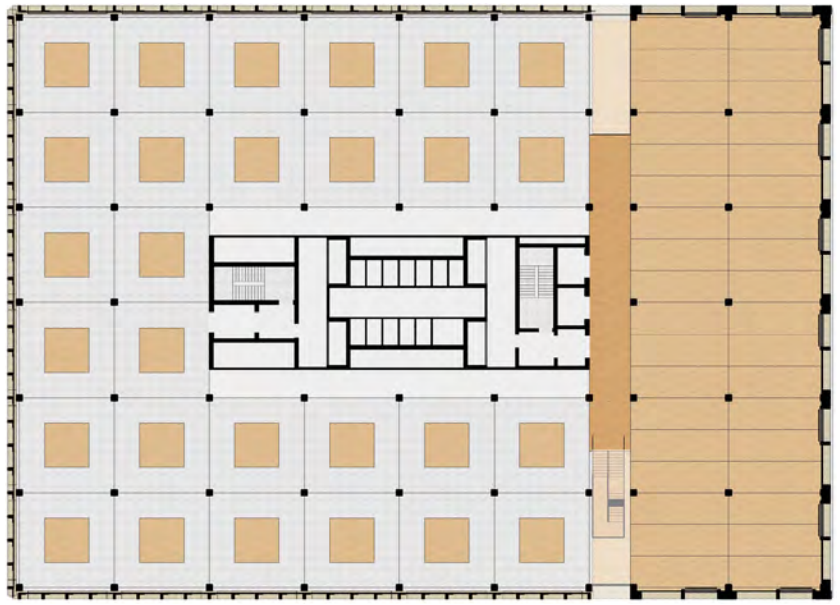
Baseline RC frame for labs and offices



Analysis of different structural options to show relative carbon-intensity of each option to achieve a response factor of 2 for varying percentages of the floorplate

Initial results of structural carbon analysis show an optimised scheme with mass timber write-up area results in a 20% upfront carbon saving. Timber cassettes in lab areas save an additional 5% upfront carbon but at a significant cost and additional complexity.

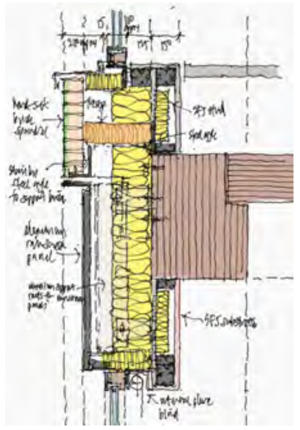
	Upfront Carbon $kgCO_2e/m^2$	Carbon Saving $kgCO_2e/m^2$	Carbon Saving %
Baseline Scheme (RC, 0% GGBS)	341	0	0%
Optimised (Timber Office + 20% GGBS)	272	69	20%
Timber Office + 20% GGBS + Timber Infills	257	84	25%
Timber Office + 50% GGBS + Timber Infills	199	142	42%



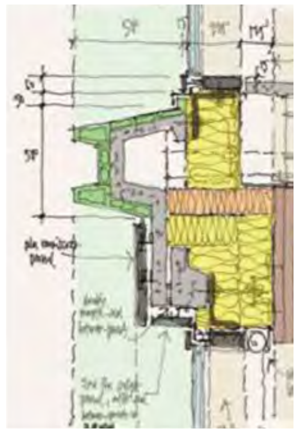
Prototype Structural Floorplate with timber office and infills

Cladding and roofing account for over 20% of the embodied carbon in our baseline proposal, the second highest element in the building after the superstructure.

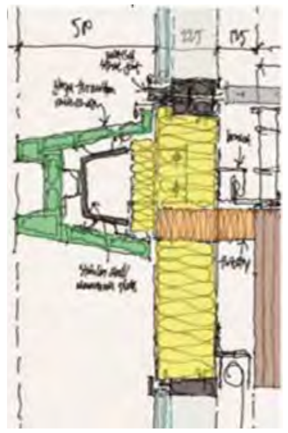
The format of the building allows a choice of cladding systems which can move away from higher-carbon solutions such as curtain walling. Simpler solutions such as hand-set facing brickwork, timber cassettes and timber-framed windows offer lower carbon alternatives. Aluminium framed curtain walling is commonly used on buildings of this scale with upfront embodied carbon of around $250kgCO_2e/m^2$ of façade.



Hand-set Brick/SFS
83 $KgCO_2/m^2$



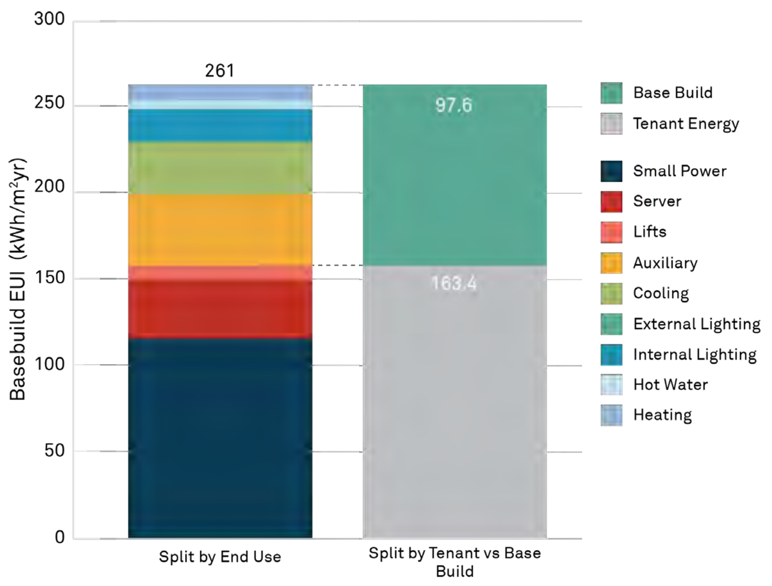
Terracotta on UHPC
110 $KgCO_2/m^2$



Terracotta on Curtain Wall
160 $KgCO_2/m^2$

MEP systems can be designed to reflect the zoned floorplate layout, reducing overall plant requirements with radically simplified solutions in the write-up areas.

In the lab areas, the impact of reduced air-change rates can be tested. In this section we discuss the baselines for operational energy and embodied carbon and address a series of optimisation options.



MEP Carbon	$kgCO2e/m^2$
Base build upfront carbon	65.2
Typical range	100-130

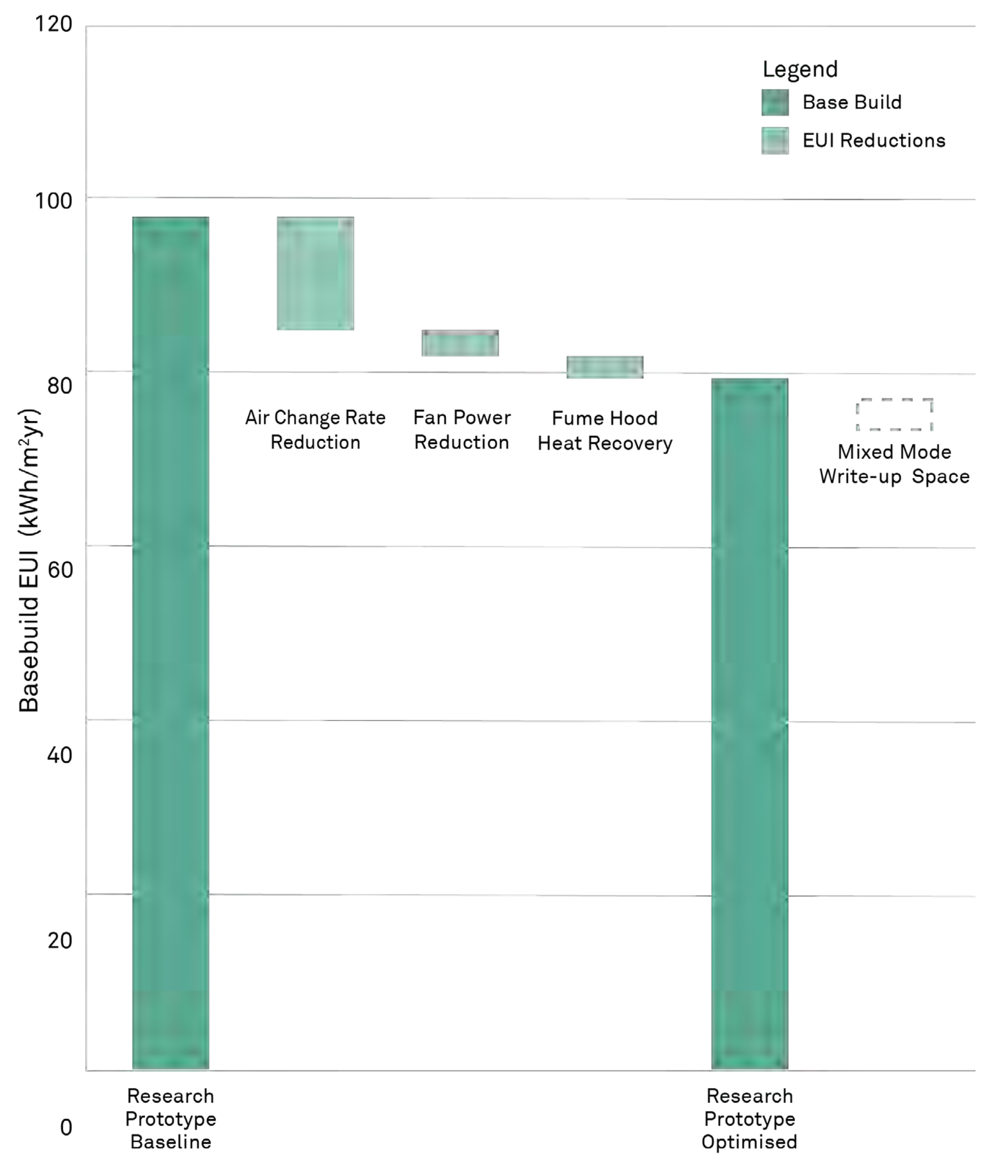
Base Build and Tenant Energy

At present a suitable target for new design labs would be ~260 kWh/m2/yr GIA ±10%. This has been benchmarked from a range of Stage 3-4 operational energy models for CL2 labs. The split of base build and tenant energy, with 63% of the total energy forecast relating to tenant energy use and 38% down to base build energy use.

Upfront Embodied Carbon

An upfront carbon estimate has been made based on the high-level MEP servicing provision estimates for site. This has included the proposed reduced overall air change rate. The extent of the Cat A fit could have significant impact on this result. Tenant fit-out is excluded.

Potential energy reductions can be achieved by different optimisation options when compared to our initial assessment.



Base build operational energy (EUI) reductions

Air Change Rate

Typical briefing for UK buildings is to operate laboratory ventilation at 6ACH. This is typically applied on 60% of the NIA to allow maximum flexibility at development. However, if we were to consider corridors, stores and rooms that do not require 6ACH this can be reduced. Furthermore, CL2 laboratories do not require 6ACH from design guides and this could be reduced to 4ACH throughout the floorplate.

Fan Power Reduction

Building regulations limits fan energy to 1.6w/l/s and therefore, all selections should be below this value. As a matter of course we design all mechanically ventilated buildings (not just laboratories) to at least a 10% improvement on this figure.

Fume Hood Heat Recovery

Fume cupboard heat recovery is not normally utilised due to the complexities of installing heat exchangers in potentially corrosive air streams. Plastic heat exchangers can be utilised and if maintained properly are an effective method of recovering 40- 50% wasted heat or coolth from the exhaust stream.

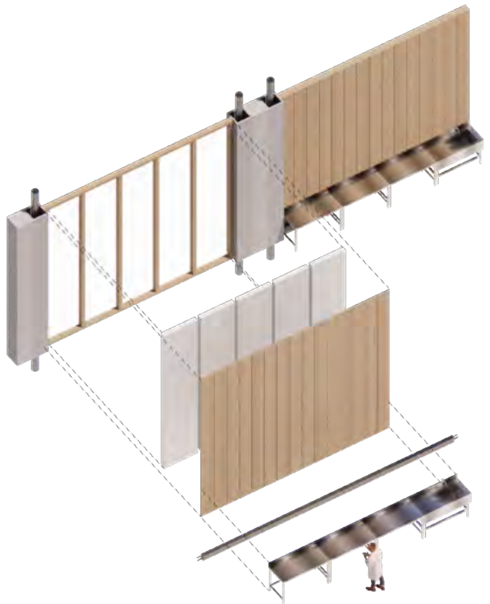
Mixed-mode to write-up space

Natural ventilation gives a potential opportunity for reduction in embodied carbon in the write-up spaces by removing all ventilation systems. However, if we consider that there is only a small portion of the year that the outside air is at a suitable temperature to ventilate the space, we often find the spaces are either not ventilated or at worst still ventilated whilst heating or cooling systems are operating giving a significant rise in operational energy.

Lab buildings already perform relatively well in his area compared to a typical workplace spec because there aren't always ceilings or raised access floors in lab areas. Finishes in the shell/core building account for around 5% of the total upfront embodied carbon in our baseline assessment.

Whilst it is currently outside the scope of this study, the CAT B fitout is a significant contributor to upfront embodied carbon, with dividing walls and corridors creating the CL2 lab layouts. Building operators have reported high churn rates amongst some types of lab occupiers resulting in multiple layout changes and consequent wastage.

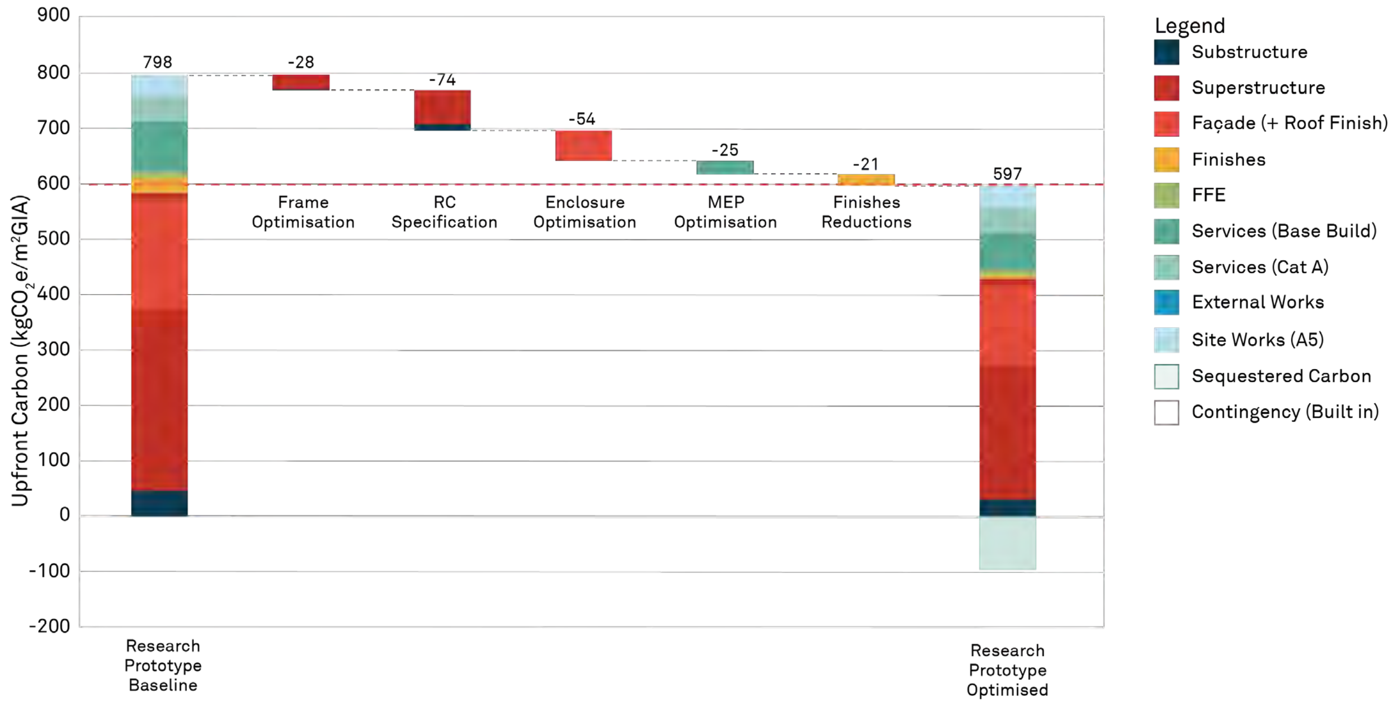
Lean finishes and exposed timber framing create characterful and carbon-efficient interiors



Modular partitioning and furniture systems allow re- configuration whilst minimising waste

We have carried out an assessment of upfront carbon on the prototype to compare the 'current good practice' baseline with the adoption of our chosen optimisation strategies.

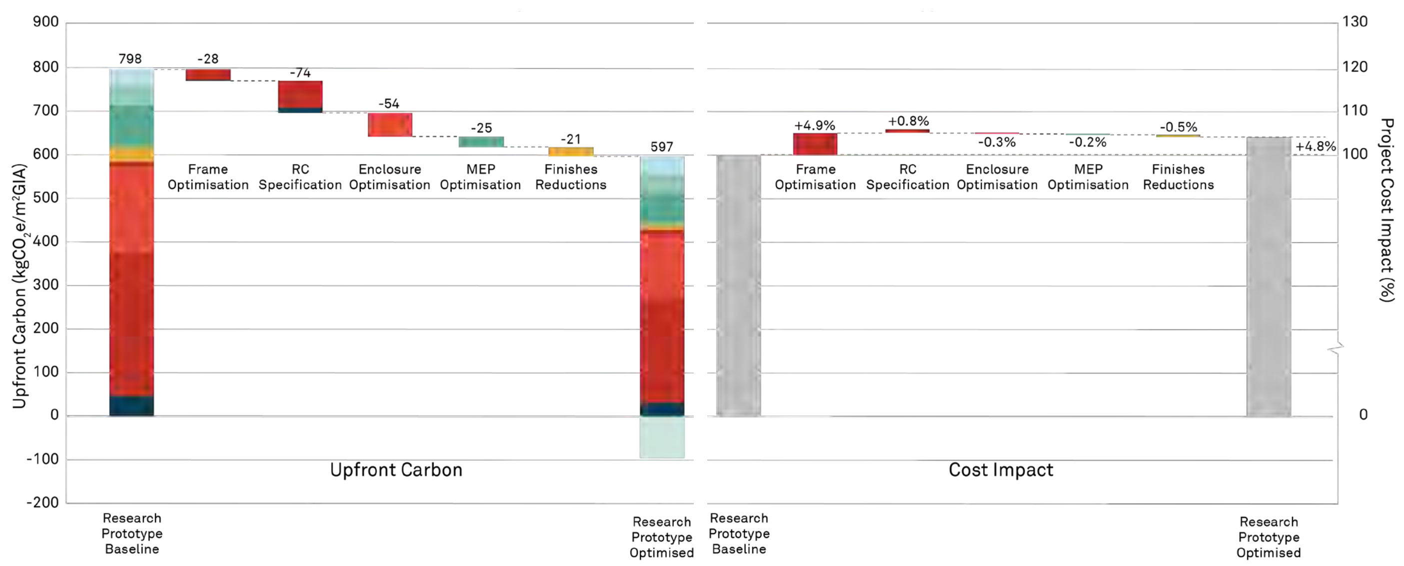
Preliminary results show that it is possible to optimise the building to achieve a reduction in upfront carbon emissions by around 25%. This meets the Net Zero Carbon Building Standard target for 2029.



Upfront carbon reductions from the baseline prototype (A1-A5) indicate that a 25% reduction compared to current good practice is possible

Setting out a notional building enabled us to cost model a baseline position and then study the cost impact of each individual optimization.

The graph shows a cost waterfall aligned to the optimizations made to reduce embodied and operational carbon. It is sometimes the case the cost and carbon reductions come hand in hand but often bigger carbon savings can come with a price. That said, the study has demonstrated that it is possible to achieve an embodied carbon reduction approaching 25% for an overall cost increase (Shell and Core & Cat A) of 4.8%.



Cost Impacts vs Carbon Reductions from the Baseline Prototype

- We have been able to identify around 25% of reductions in upfront embodied carbon when compared to current best practice.
- The starting point is to design lean and flexible buildings which have inherent efficiency.
- A holistic approach is needed which looks at each contributor to lifetime carbon emissions.
- Identifying zones for write-up in the floorplate is beneficial because it allows structural optimisation
- Structural timber is an essential component in the de-carbonisation of labs.
- We have also been able to reduce base build operational energy by 20%.
- Most operational energy interventions will have an impact on embodied carbon or brief so we must always look at these holistically for the lifetime of the building.
- The small cost uplift is driven by the very carbon-efficient structural changes. However, some other carbon reduction measures are achieved with minimal uplift or even with cost savings.

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