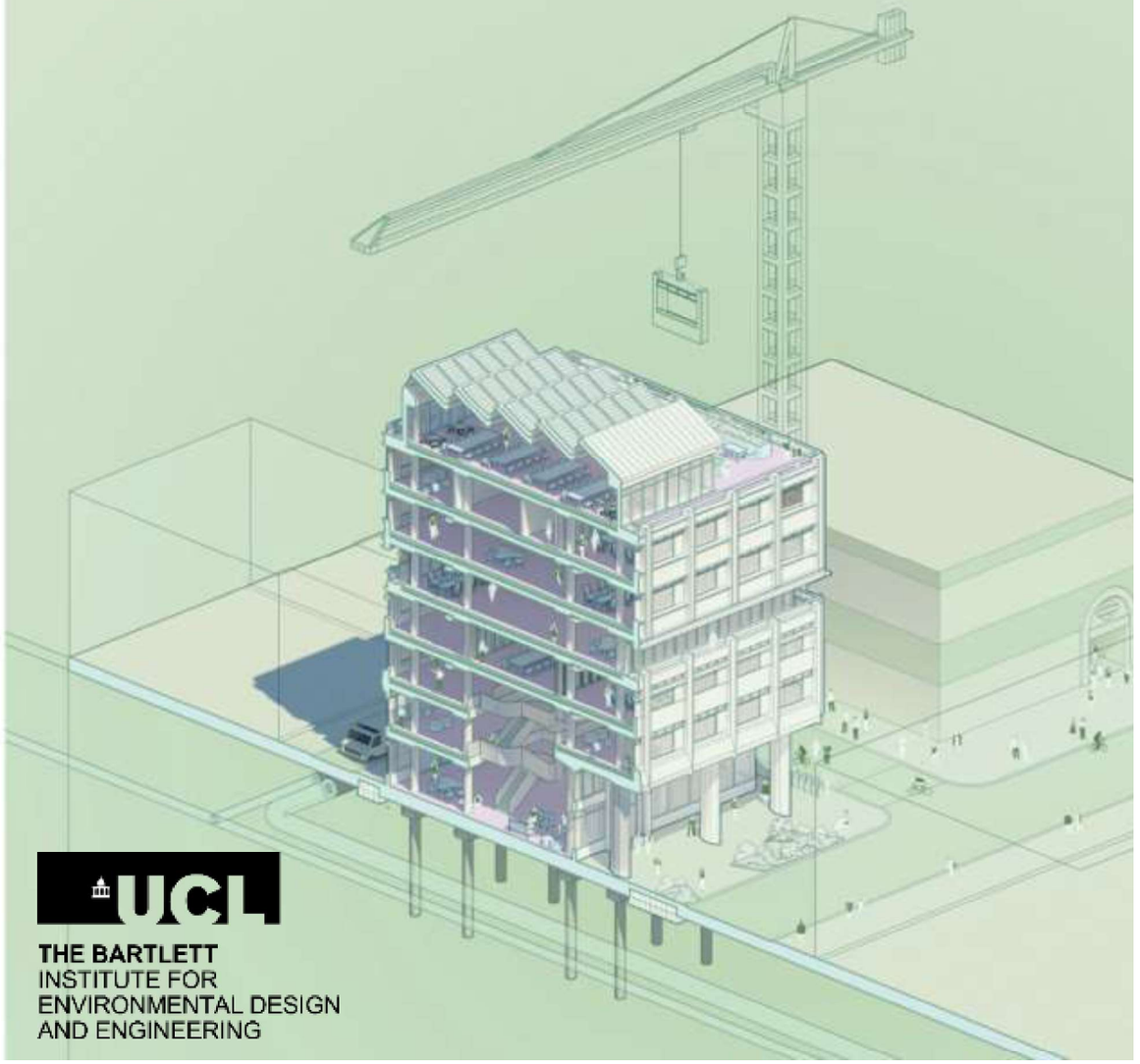
Façade Design for Net Zero Buildings

2024



UCL

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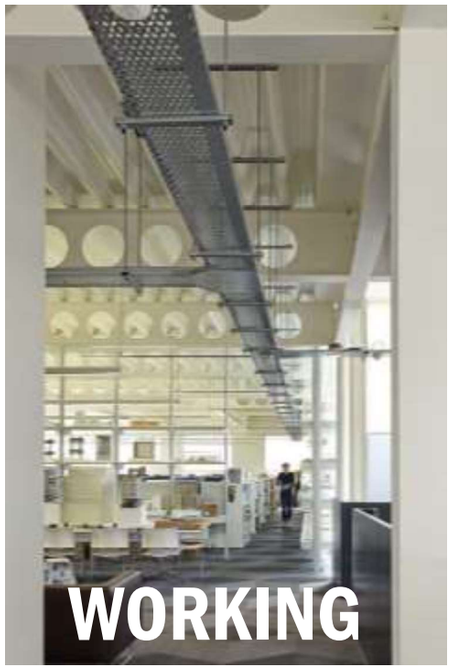
ENVIRONMENTAL DESIGN
AND ENGINEERING

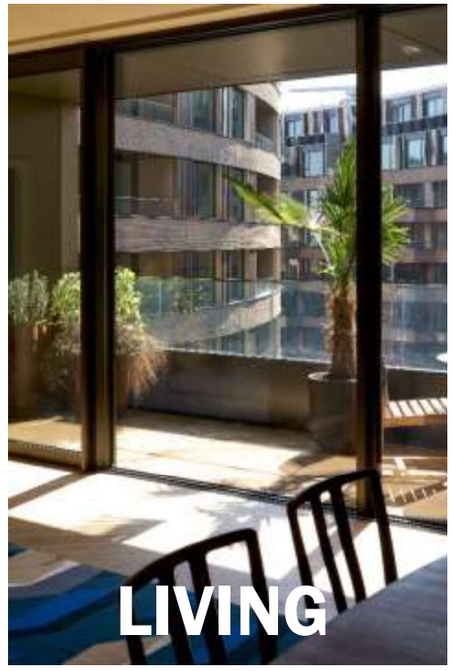

ALLFORD
HALL
MONAGHAN
MORRIS

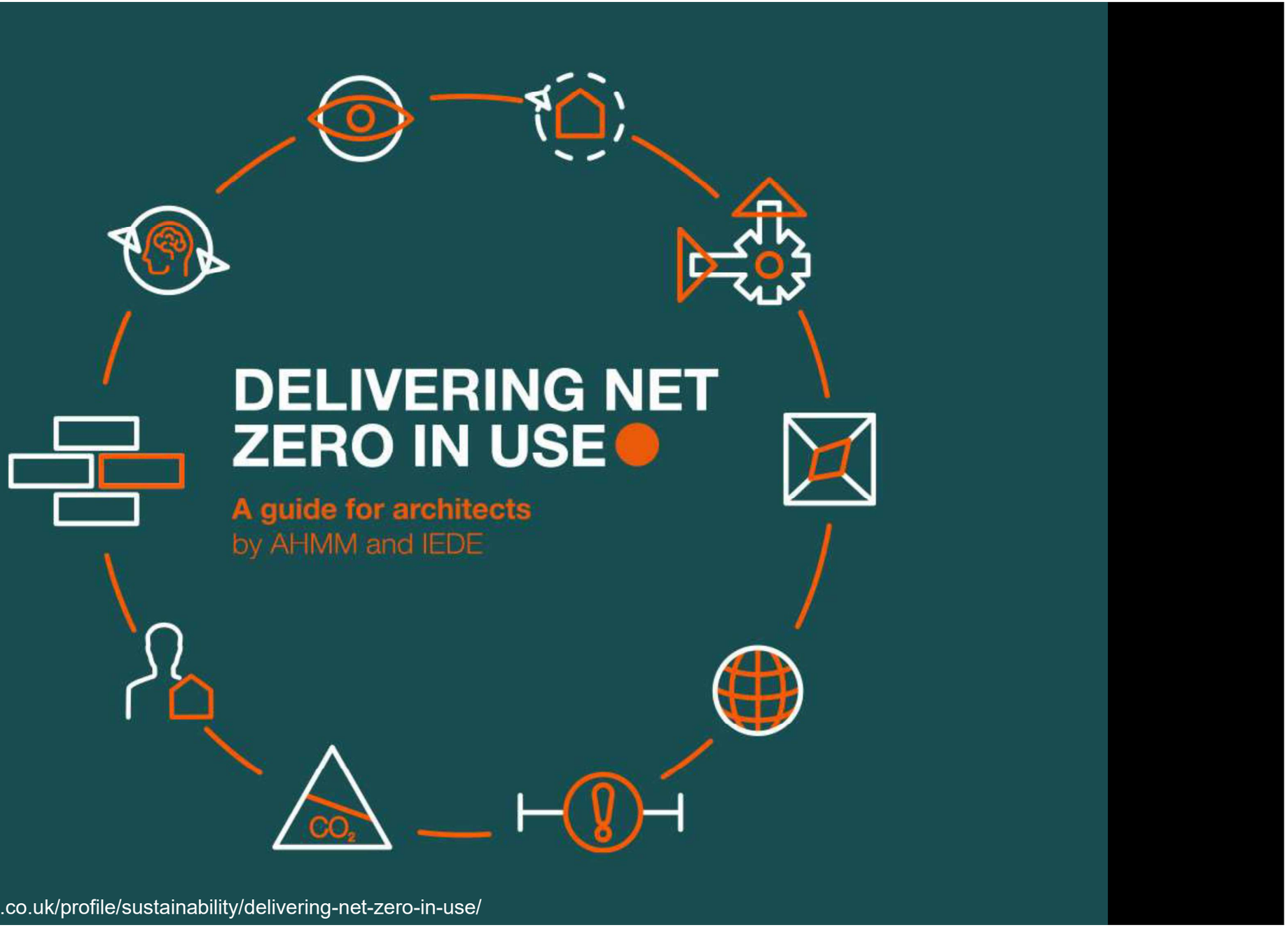

CREATING


HEALING


LEARNING


WORKING


LIVING



https://www.ahmm.co.uk/profile/sustainability/delivering-net-zero-in-use/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AND ENGINEERING

DELIVERING NET ZERO IN USE

WHOLE LIFE CARBON

UPFRONT EMBODIED CARBON

SAVE | SUBSTITUTE | SEQUESTER

OPERATIONAL CARBON

LIFETIME EMBODIED CARBON

CARBON OFFSETTING

DECARBONISATION & GRID FLEXIBILITY

ECONOMY | EFFICIENCY | ELEGANCE

BEYOND NET ZERO

ADVOCACY & INFLUENCE

WHOLE LIFE CARBON

Upfront Embodied Carbon
Generated from the extraction, processing and manufacturing of materials used to make, maintain, run and repair buildings (A1-5)

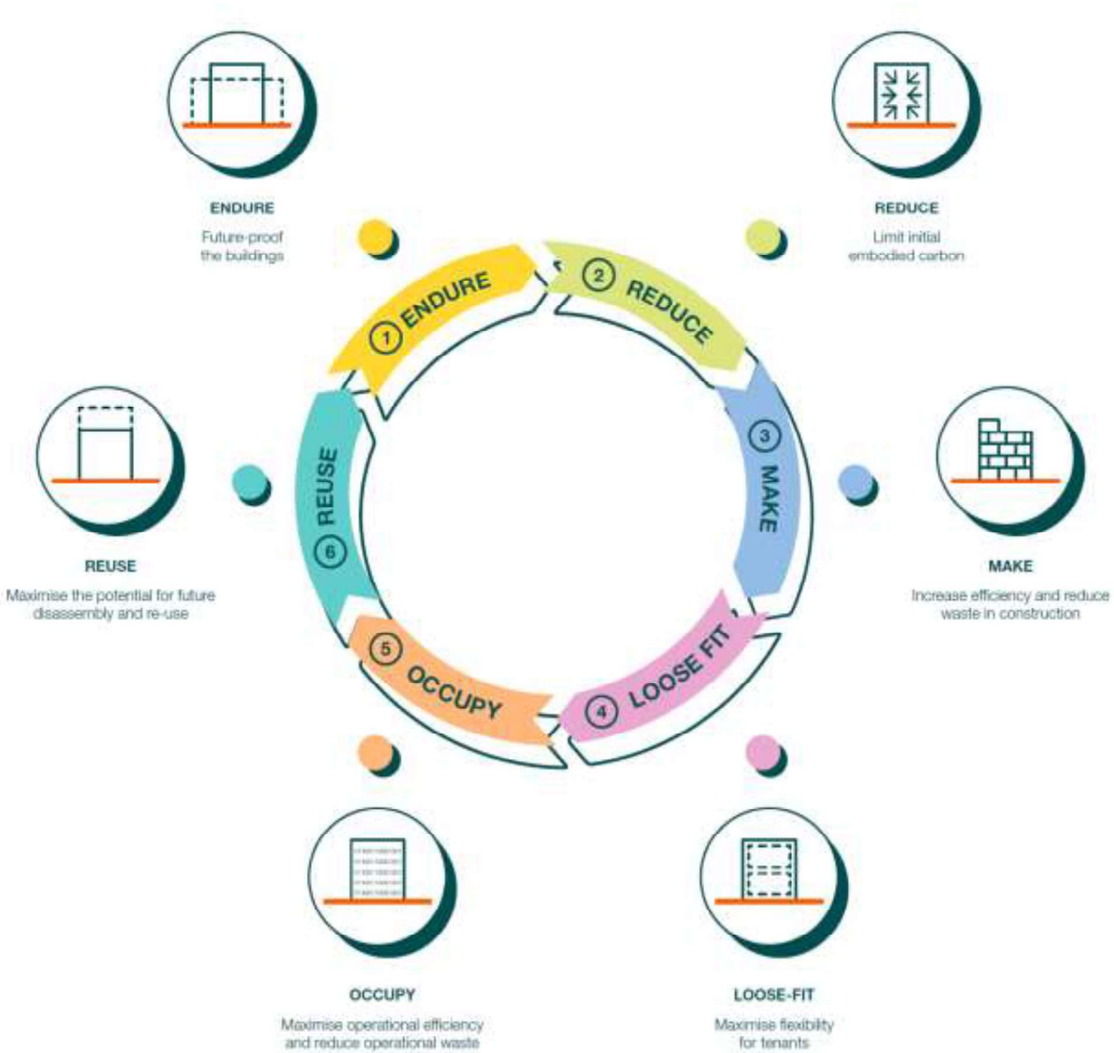
Operational Carbon
Product of energy consumed by the use of electrical power, heating and cooling systems for the benefit of a buildings' users (B6-7)

Lifetime Embodied Carbon
Maintenance and replacement of materials throughout the life of the building, and the eventual demolition and disposal of a building at the end of its life (B1-5 & C1-4)

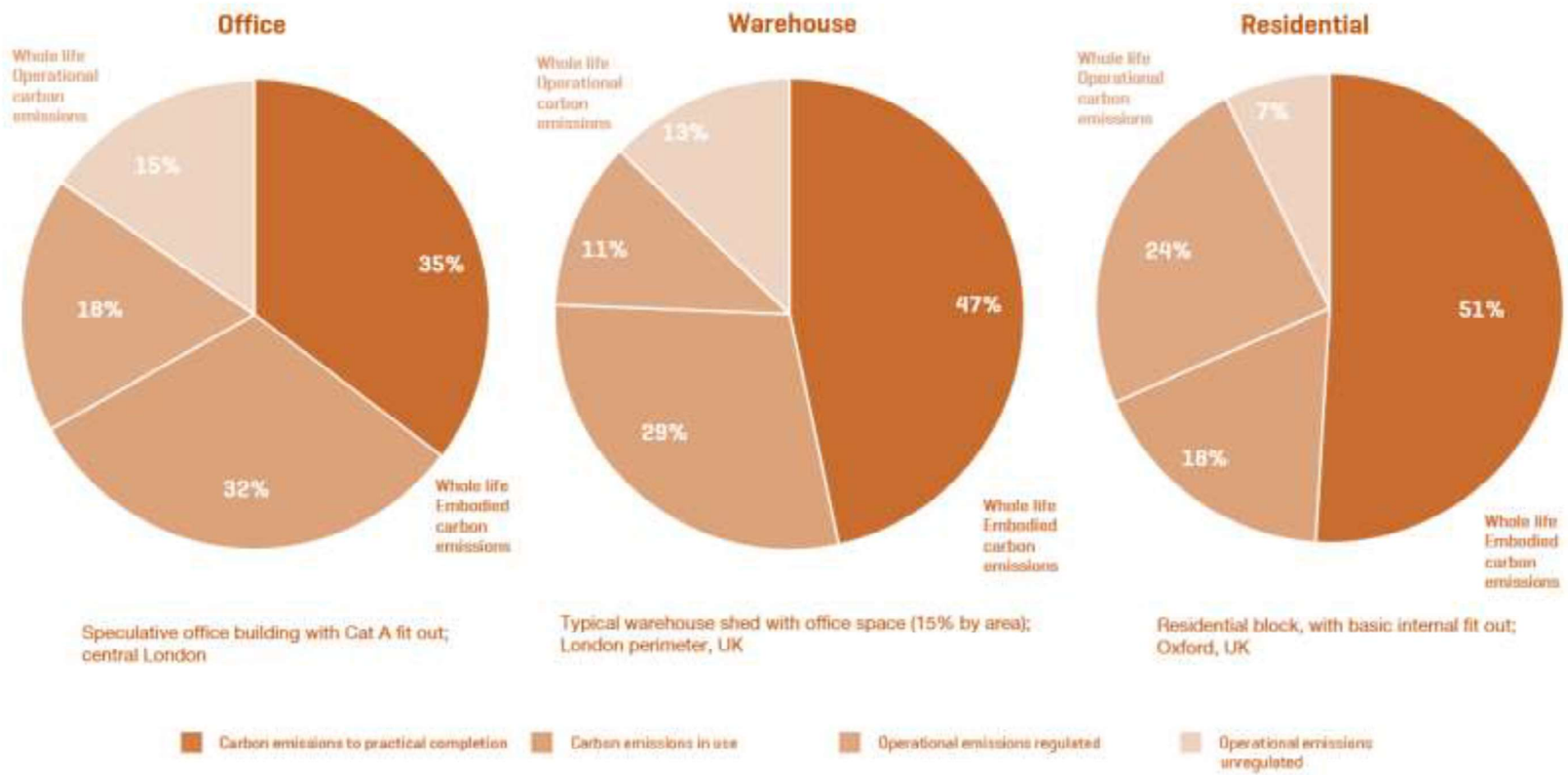
Carbon Offsetting
Required for a building project to meet net zero carbon commitments and can be delivered through carbon sequestration and financing renewables offsite

Carbon Neutral & Net Zero Carbon
A Carbon Neutral organisation delivers zero direct and indirect carbon emissions. Achieving Net Zero Carbon also accounts for indirect emissions outside of its control

Climate Positive
Actions that go beyond achieving net zero carbon emissions to create environmental benefits and reverse the harm caused to natural systems



WHOLE LIFE CARBON



https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/whole-life-carbon-assessment-for-the-built-environment

WHOLE LIFE CARBON

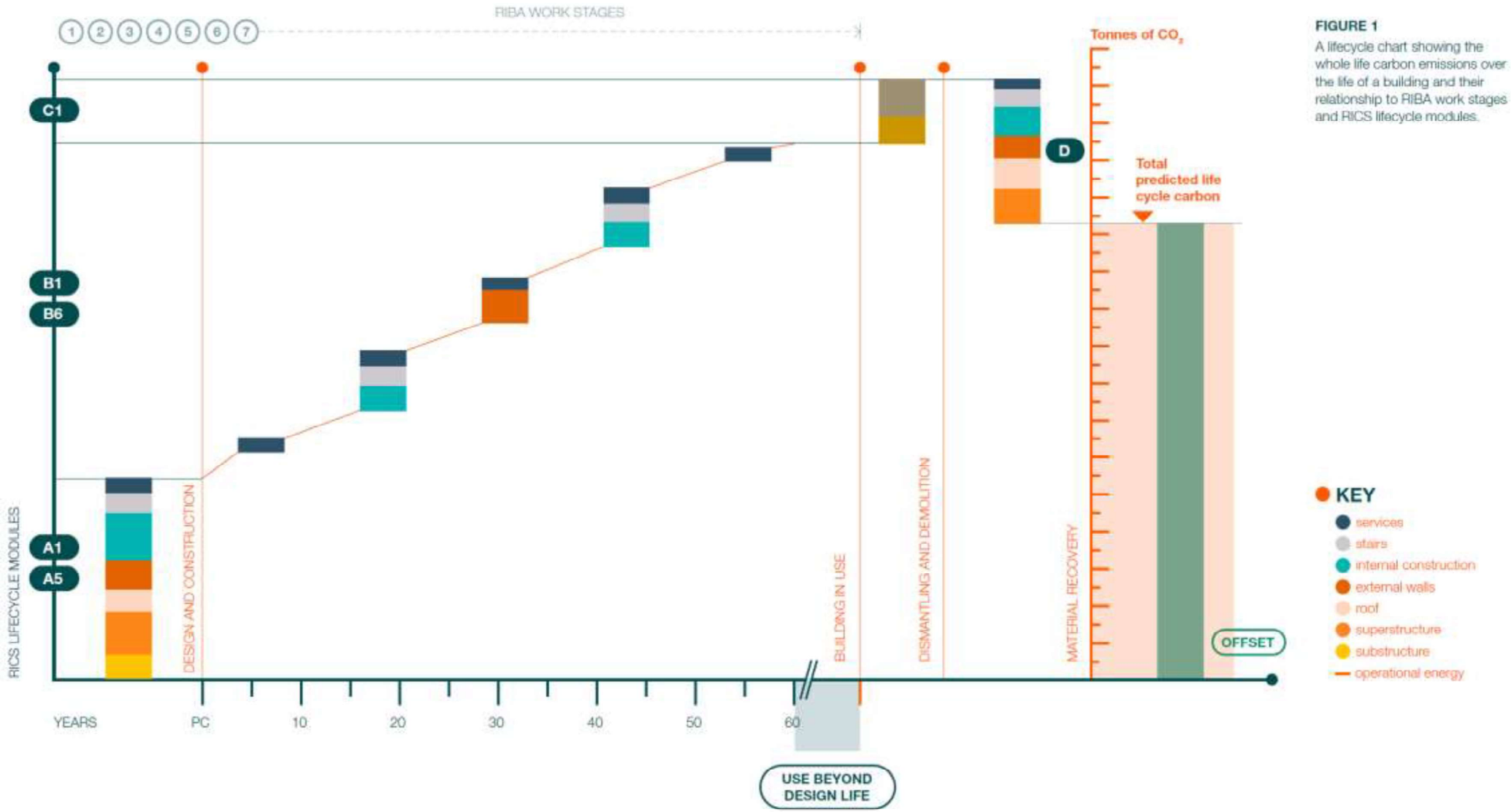


FIGURE 1
A lifecycle chart showing the whole life carbon emissions over the life of a building and their relationship to RIBA work stages and RICS lifecycle modules.

UPFRONT EMBODIED CARBON

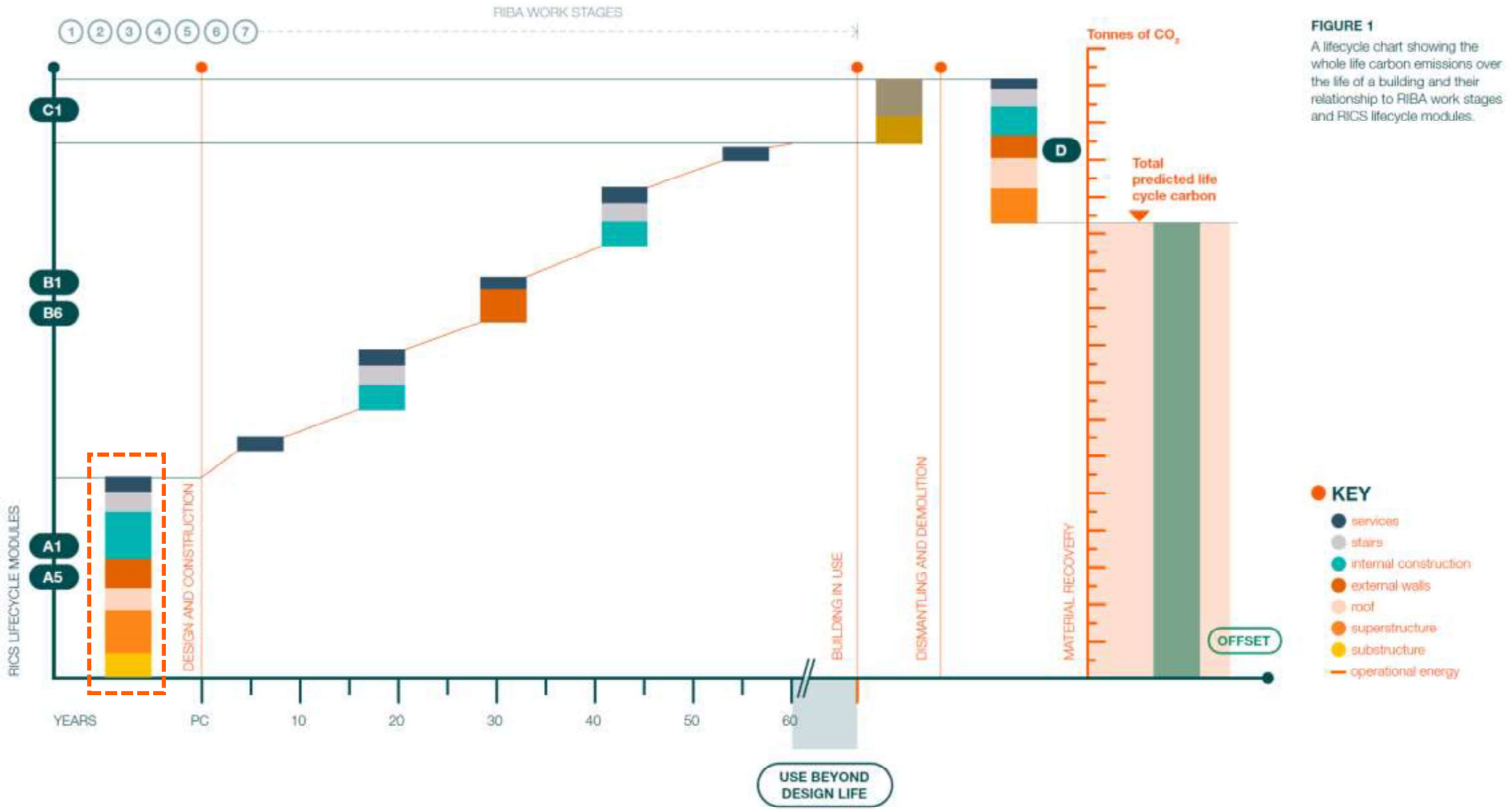


FIGURE 1
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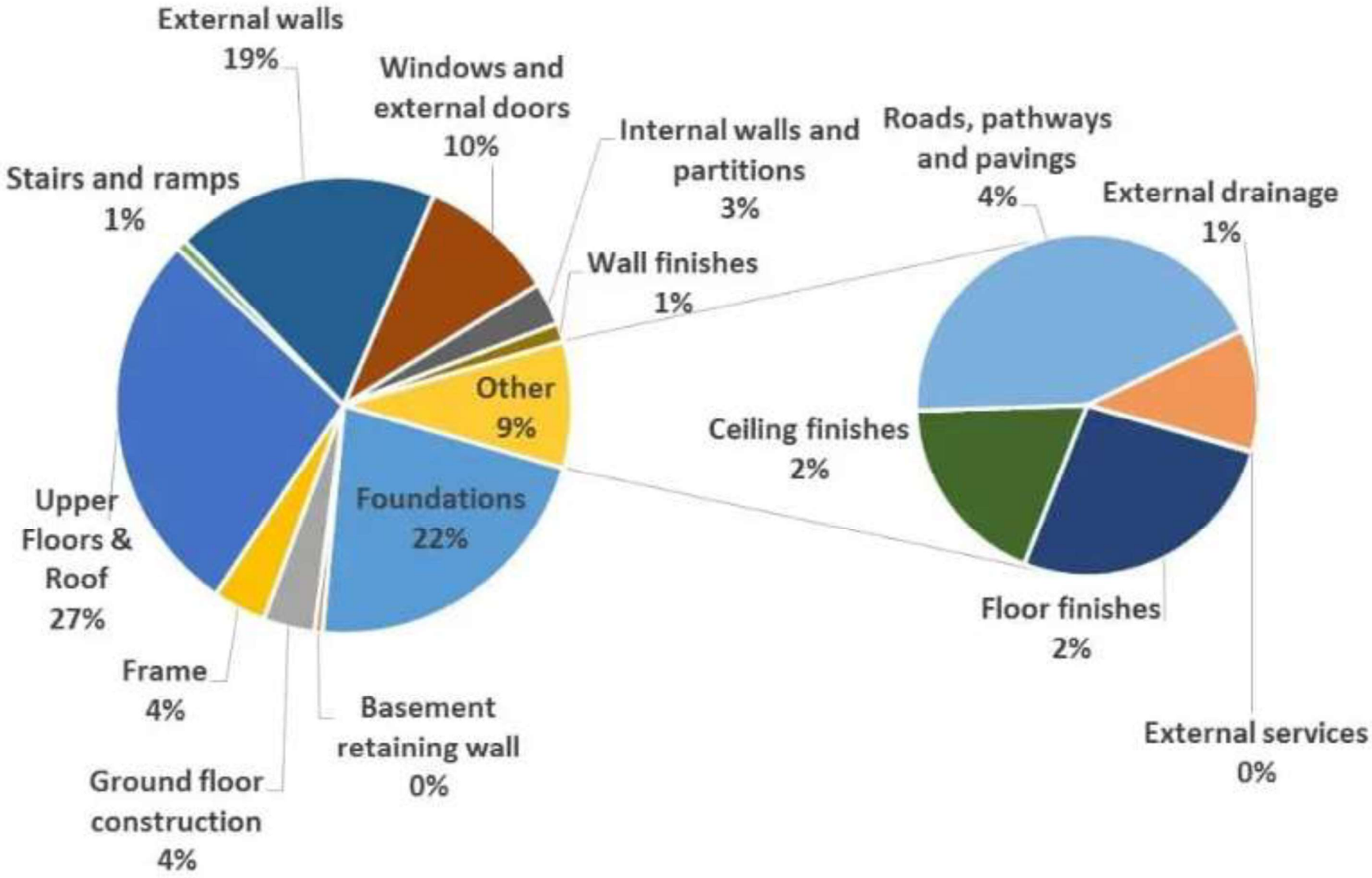
UPFRONT EMBODIED CARBON



UPFRONT EMBODIED CARBON

Structure & Substructure
Most carbon intensive component accounting for up to 65-70% of embodied carbon.

Facades
Need to balance embodied carbon (circa 15%) with key role that façade plays in improving operational energy efficiency

Services
Hard to quantify (circa 15%) but requirement for replacement over the life of building can be significant

Space and volume
Delivering efficiencies in volume and form can reduce the overall material take and hence embodied energy

SAVE | SUBSTITUTE | SEQUESTER

Save

This principle applies to the entirety of a development; specify reused materials and give precedence to saving, refurbishing and reusing existing buildings onsite over demolition and rebuild, wherever possible.

Substitute

Encourage the substitution of less carbon intensive materials, for example recycled aluminium in place of newly mined and processed aluminium

Sequester

Specify materials that have carbon locked into their physical make-up, such as timber framed curtain walling.

ONE BROADGATE

British Land | City of London

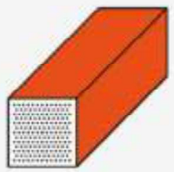
CONSIDER THE CARBON INTENSITY OF MATERIALS

BATTLE OF THE HEAVYWEIGHTS

Weighing up the pros and cons of three common structural materials

STEEL

- \+ High strength-to-weight ratio means a lighter structure and potentially less concrete in foundations
- \+ Long-lasting
- \+ Highly recyclable ...
- − ... though the embodied carbon of recycled steel is still around 50% that of new steel
- \+ Potential reassembly of simple steel buildings or reuse of many components ...
- − ... though this seldom happens currently



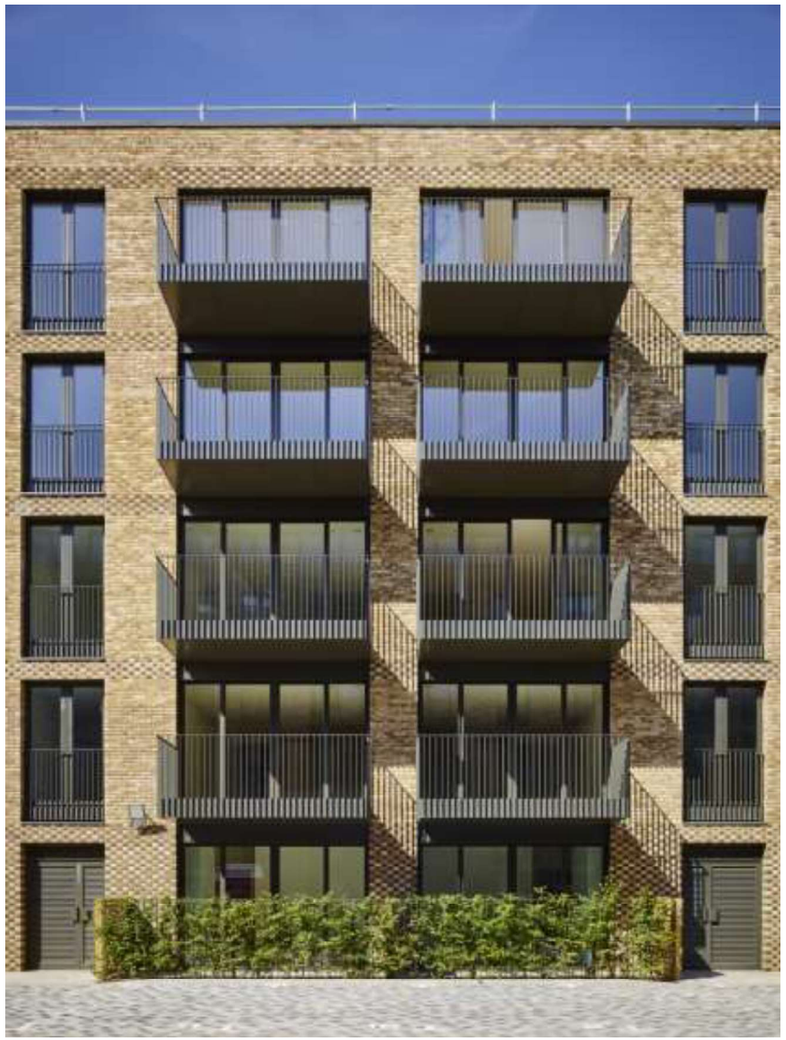
CONCRETE

- − Normally a high tonnage and embodied carbon value per building ...
- \+ ... but thermal mass can deliver operational carbon benefits ...
- − ... though only if concrete is exposed
- \+ Long-lasting
- \+ Recyclable ...
- − ... though mostly as low-grade aggregate
- − Reinforced concrete contains steel ...
- \+ ... which can be recovered at end-of-life
- \+ / − Embodied carbon varies depending on the mix and whether cement substitutes are used
- \+ Can reabsorb some of the carbon released during production over its lifetime
- \+ No alternative available for many applications, particularly foundations

TIMBER

- \+ Usually the lowest embodied carbon of any structure — the tree actually absorbs CO_2 as it grows
- \+ / − Needs to be from a sustainable source — forestry must not threaten existing habitats
- \+ With cross-laminated timber (CLT), larger spans are possible ...
- − ... but CLT has higher embodied carbon than regular timber and its limited strength-to-weight ratio still hinders use in larger, taller buildings
- − Concern over fire risks
- \+ / − End-of-life options range from rotting in landfill and creating methane (bad), to being burnt as carbon-neutral fuel (better), or being reused (best). Little end-of-life information available as few CLT structures have ever been demolished

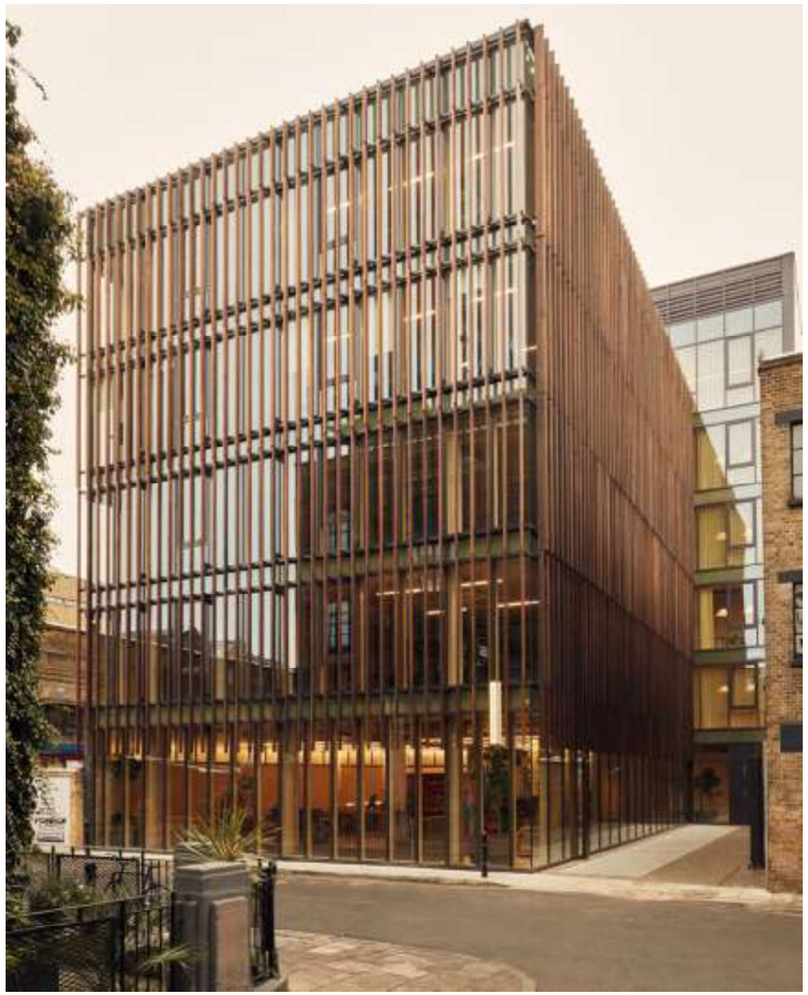
CONSIDER THE CARBON INTENSITY OF MATERIALS



SURREY LANE

Lendlease |Wandsworth

CONSIDER THE CARBON INTENSITY OF MATERIALS



THE BLACK & WHITE BUILDING

Waugh Thistleton & Eckersley O'Calloghan |Wandsworth

2 RUSKIN SQUARE

Stanhope & Lendlease | Croydon

2 RUSKIN SQUARE

Stanhope & Lendlease | Croydon

Headline Embodied Carbon Figure
558 kgCO2/sqm of GIA (42,610 sqm)
No basement
No transfer structures
Low carbon steel for structure
Low Carbon concrete for structure (70% GGBS)
Low carbon aluminium façade (recycled)

Headline Embodied Carbon Figure 558 kgCO2/sqm of GIA (42,610 sqm)

FAÇADE OPTIMISATION | COMMERCIAL

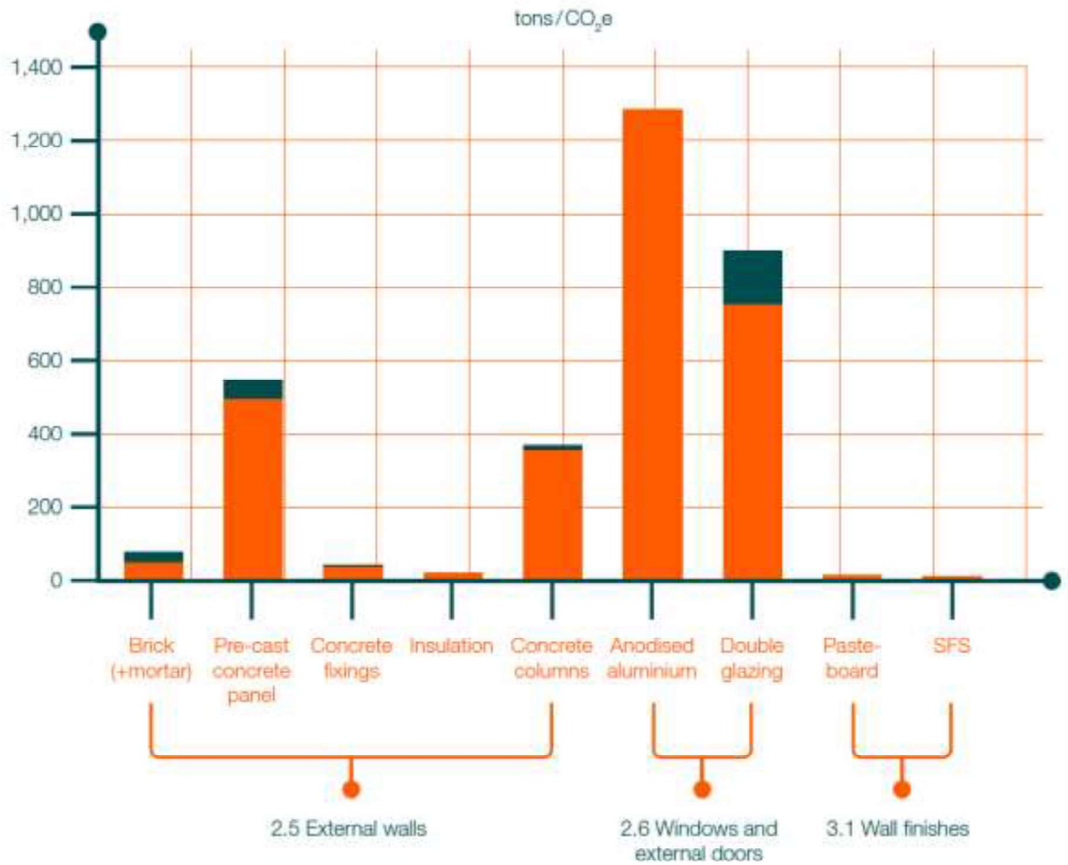
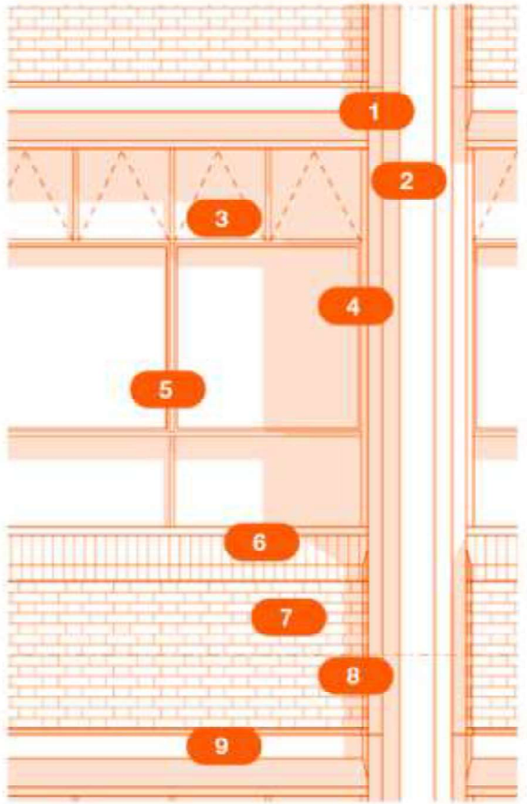


FIGURE 22
Embodied carbon comparison analysis of the carbon intensity of various elements of the commercial office façade based on a typical bay.



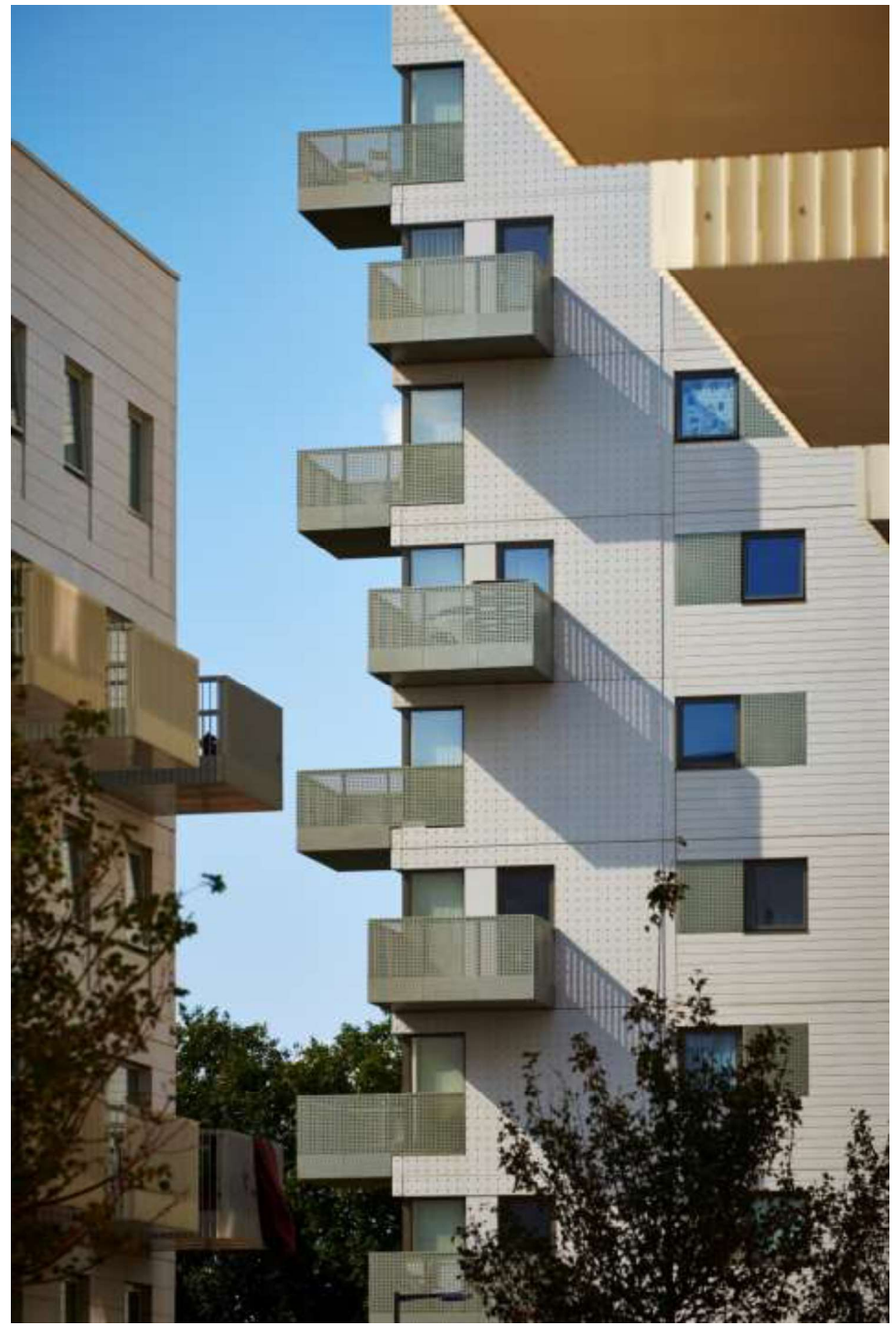
1 Expressed rebated joints between precast concrete column, location of joint illustrative only.
2 Profiled precast concrete column.
3 Outward opening, projecting top hung windows, manually operated by handle at centre of sill.
4 Aluminium window.
5 Clip-on aluminium fin.
6 Angled brick sill.
7 Precast concrete spandrel panel with brick slip or half brick facing.
8 Profiled corner to brick panel.
9 Precast concrete lintel.

EXPLORE OFFSITE EFFICIENCIES + MINIMISE ON AND OFFSITE WASTE

- As far as possible each component of the buildings are pre-manufactured offsite to allow for a compressed assembly phase on site.

- The facade is formed by self-supporting precast stone facades and steel / timber balconies.

- The fit out comprises off-site manufactured and traditional drylined walls, partitions and ceilings, timber batten acoustic floors, joinery, kitchens, sanitary ware, floor finishes and decorations.



WILLIAM STREET QUARTER

Laing O'Rourke & London Borough of Barking & Dagenham

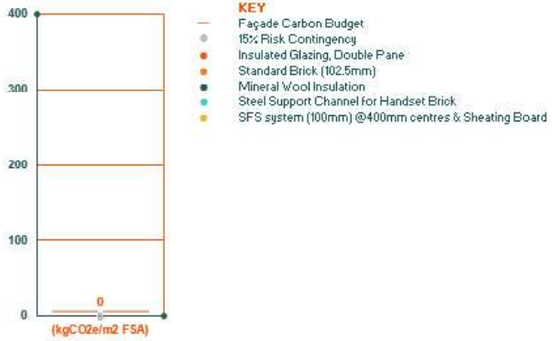
façade **DELIVERING NET ZERO IN USE**
A guide for architects
by AHMM and IEDE

Option 1

Insert title here

Carbon content of the façade panel is a sum of the carbon content of all of its components. The table below allows for a façade build up to be tested based on the area of each of its parts. Use the diagrams as a guide for required layers for each façade type at early stage.

BACK TO NAVIGATION | CONTINUE TO NEXT STEP



Input legend

There are two input types. One is numerical and another which selects from a fixed drop-down.

Input Required

Drop-down

Inputted Value is higher than total panel area

Typical Façade Bay	Total Panel (m)	Window (m)	Opaque Panel (m)
Width			
Height			
Total Area (m^2)			
Total Insulation Volume			
WWR (%)			

Façade Carbon Budget ($kgCO_2e/m^2$ FSA)	
Typical Bay Carbon Cont ($kgCO_2e/m^2$ FSA)	incl. Contingency
Typical Bay Weight (tonnes)	**0.3** incl. Contingency

Facade Build-Up

Type	Area (m^2)	Buildup	Carbon Factor ($kgCO_2e/m^2$)	Carbon Conte ($kgCO_2e$)	Carbon Conte ($kgCO_2e/m^2$ FSA)	Weight (kg)
Glazing	1	Insulated Glazing, Double Pane	20	20		24
Cladding	1	Standard Brick (102.5mm)	32	32		159
Insulation	1	Mineral Wool Insulation	43			
Cladding	1	Steel Support Channel for Handset Brick	94			
Backing	1	SFS system (100mm) @400mm centres & Sheating Board	68	68		43
Contingency			15%	18		34

Include Cladding: Steel Support Channel for Handset Brick

To remove elements, please erase the data from the input fields, do not remove rows

Explainer

The Façade Build-Up chart allows for combining different pre-defined build-up layers to create custom configurations.

The term Backing refers to a system that supports the outer layers of the build-up.

When selecting a Structural Framing System, the area input refers to the total area where SFS is the support system, the stud spacing has been accounted for.

When Insulation is selected, the calculation uses the Insulation Volume calculated in previous step. Similarly, Steel Supports for Handset Brick use width of the panel to calculate the carbon intensity.

Please see the Calculation Worksheet to query any build-ups, additionally, System Builder can be used to input custom materials or systems.

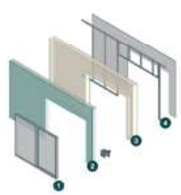
Calculation Worksheet | System Builder

RAINSCREEN SYSTEM
Uniclass Subgroup: Wall Cladding Systems / Unit Wall Structure Systems

1. Glazing
2. Cladding
3. Backing
4. Insulation
5. Drylining System

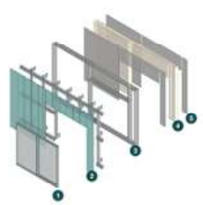
PANELISED SYSTEM
Uniclass Subgroup: Panel Wall Structure Systems

1. Glazing
2. Panelised System
3. Insulation
4. Drylining System



UNITISED SYSTEM
Uniclass Subgroup: Framed Wall Systems

1. Glazing
2. Cladding
3. Unitised System Frame
4. Insulation
5. Sandwich Panel



NABERS Embodied Carbon

Today's construction decisions cement tomorrow's environmental footprint. With embodied carbon poised to dominate Australia's building emissions in the next few years, it's vital to address this from the very first brick.

On this page

Featured downloads

- National emission factors database - v1.0.xlsx
- National emission factors database - Technical workbook - v1.0.xlsx
- National emission factors database - EPD list - v1.0.xlsx

Resources

MECLA has over 150 member organisations collaborating across 10 different Working Groups creating resources about embodied carbon. MECLA pools knowledge and expertise from across the supply chain to provide openly accessable documents for anyone in the construction sector and related industries to use to help reduce embodied carbon. You can access these documents below:

MECLA has partnered with the Supply Chain Sustainability School Limited to host their learning resources. Follow the link and create a free account to view resources and track your personal learning history for professional development or accreditation programs.

View Resources

https://mecla.org.au/resources/

REUSE EXISTING FACADE

OPERATIONAL CARBON

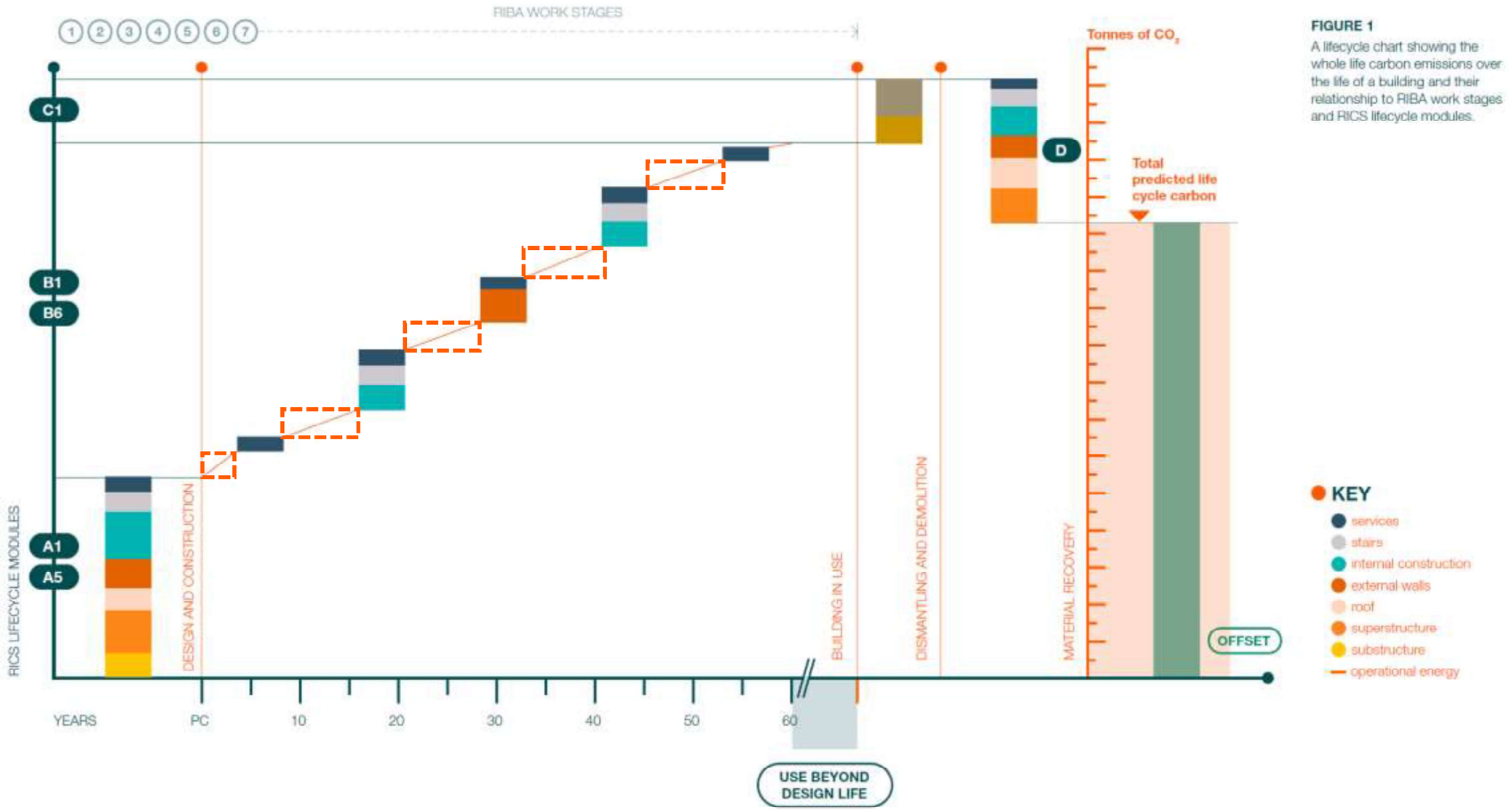


FIGURE 1
A lifecycle chart showing the whole life carbon emissions over the life of a building and their relationship to RIBA work stages and RICS lifecycle modules.

OPERATIONAL CARBON

Site Layout
How the building responds to the potential of its site

Building Form
Balancing natural air & lighting with form factor & loose fit

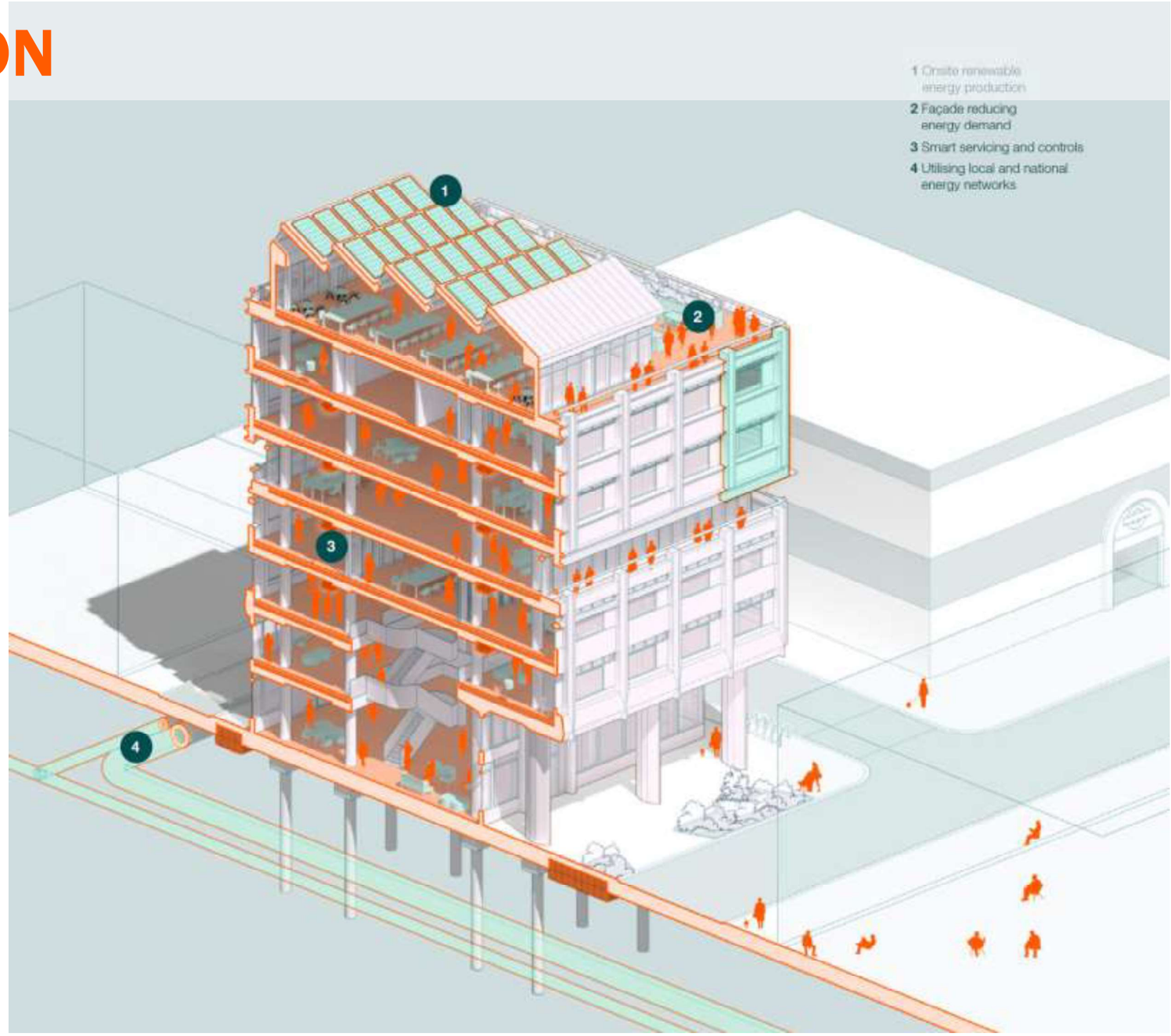
Thermal Envelope
Careful design & detailing help manage the energy balance

Ventilation Heating & Cooling
Reduce energy requirements with natural ventilation

Solar Gain
Location and the orientation of glazing on a building

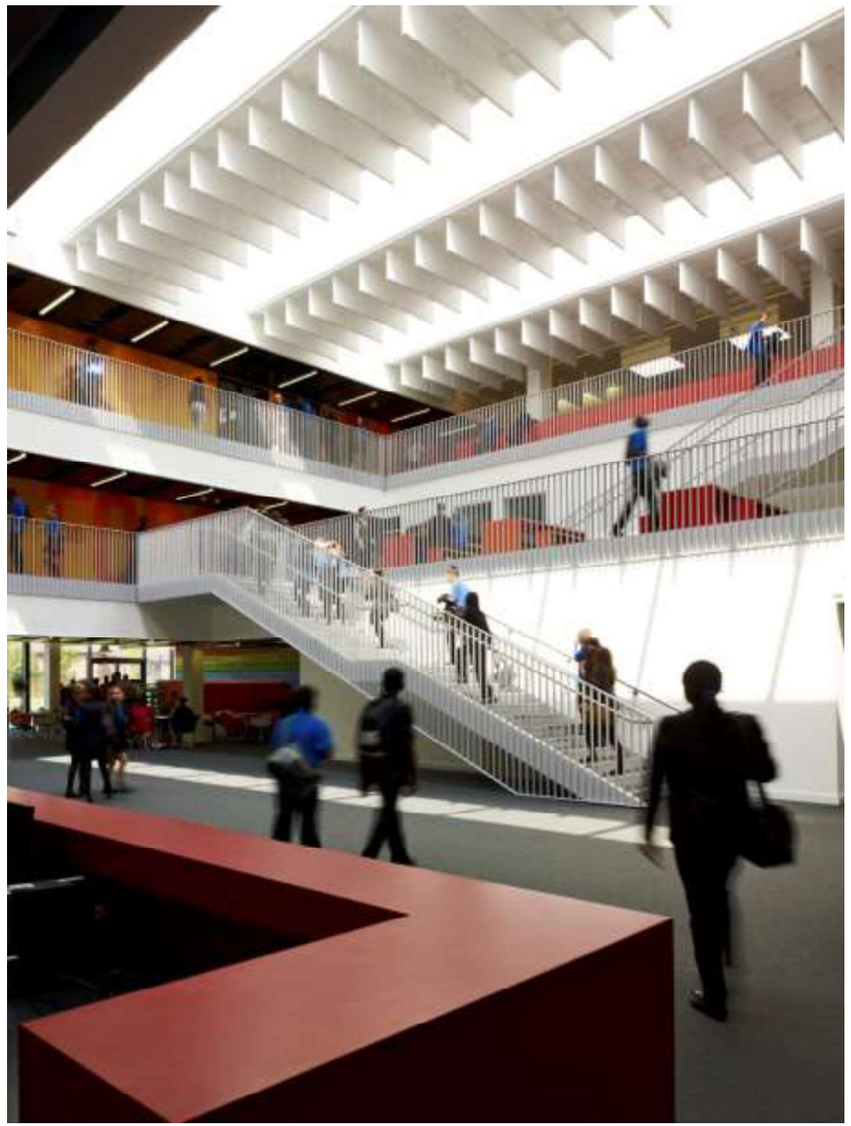
Occupant density
Number and density of people influence energy use

User Control
Giving people control over their environment and ensuring they understand how their building works



SOLAR GAIN & MIXED MODE VENTILATION

DAGENHAM PARK SCHOOL
Dagenham Park Church Of England School & Laing O'Rourke | Barking & Dagenham



OPERATIONAL ENERGY

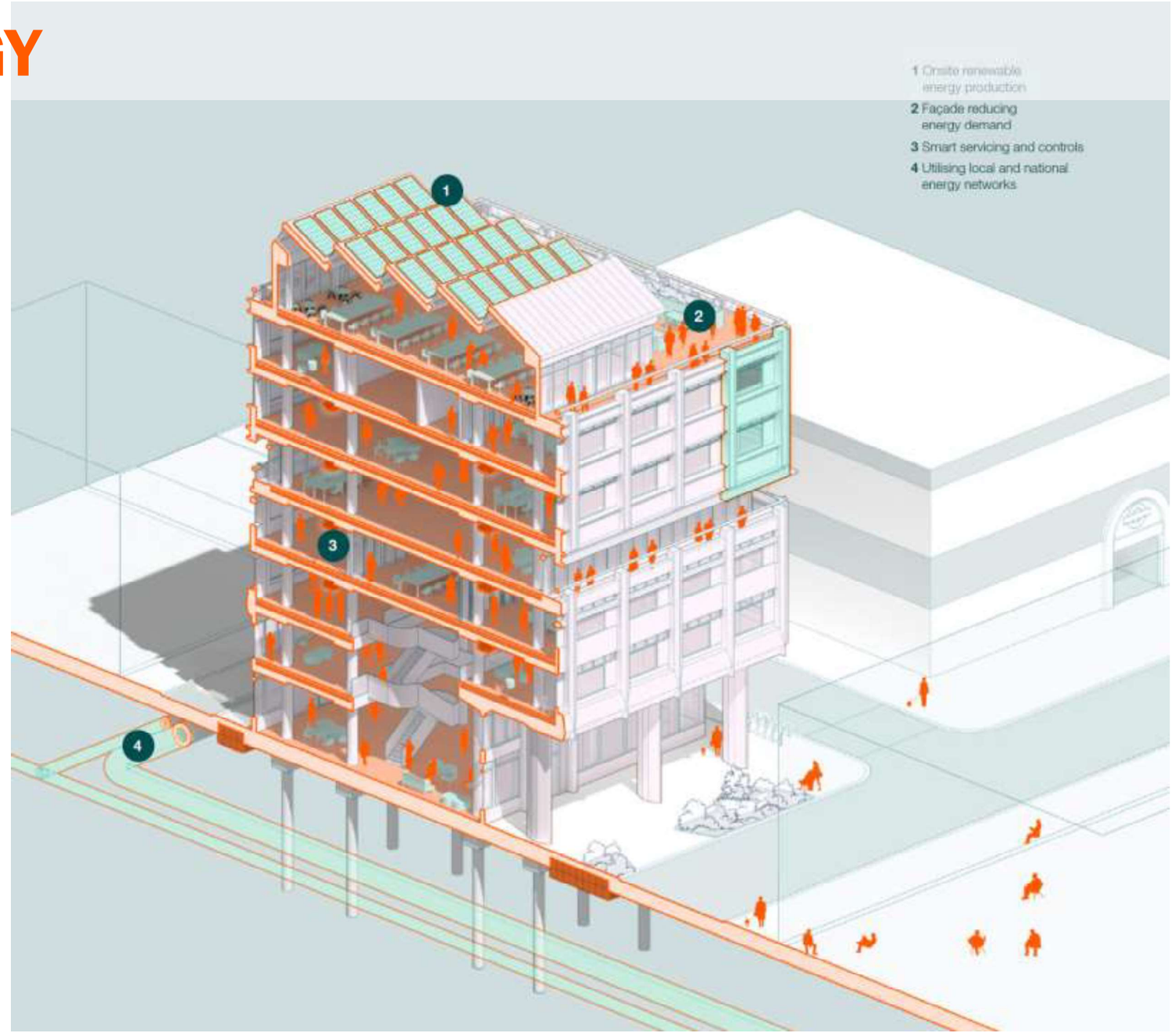
Renewable Technologies
Onsite generation where a building generates through PV and solar thermal

Energy Storage
Energy can be stored in a building passively or actively through thermal heat stores and batteries

Review of Performance
Review operational energy performance of the building in use and overall performance of the design

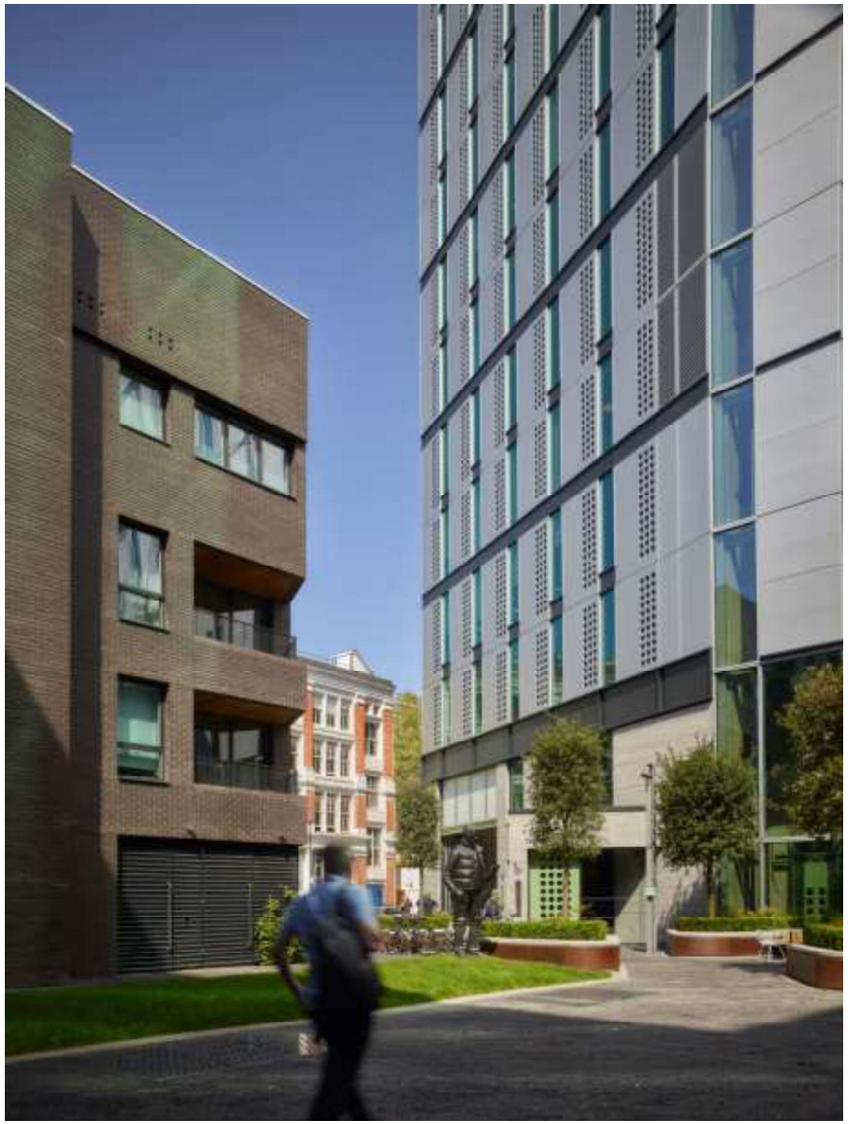
In-use optimisation
Optimisation right from handover to on-going use to minimise energy consumption

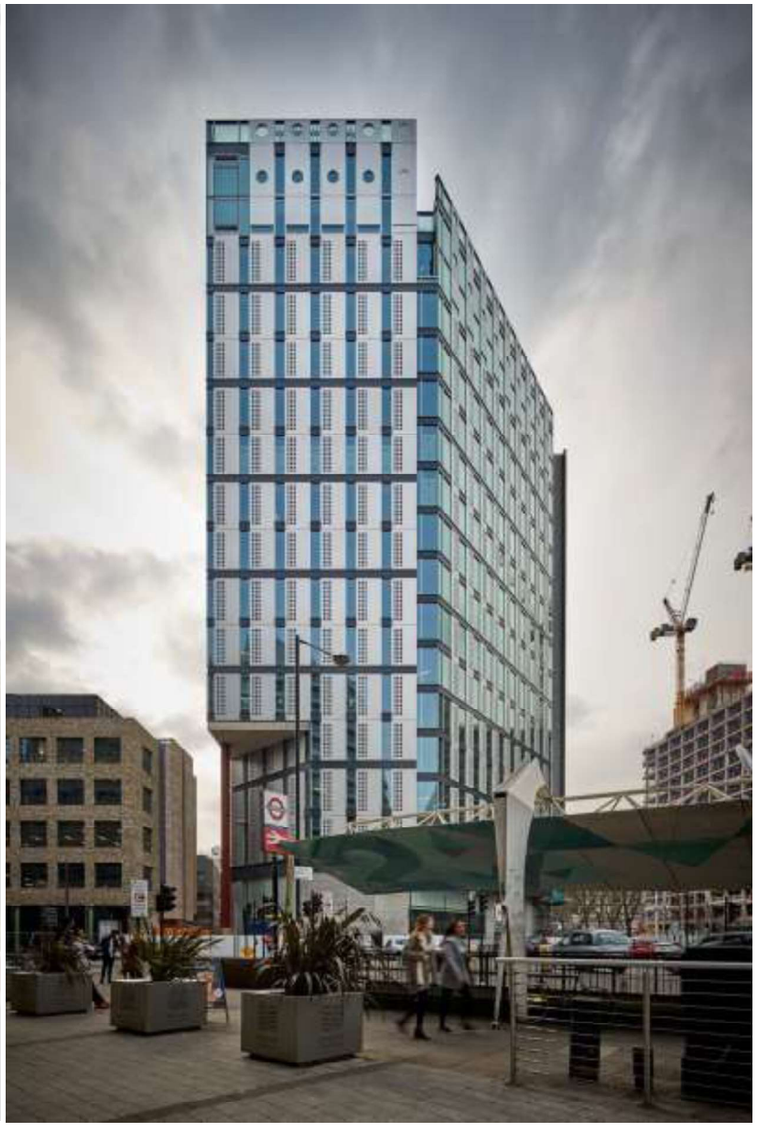
Smart Buildings
Integration of automated controls to provide efficient and targeted lighting, heating and cooling



WHITE COLLAR FACTORY

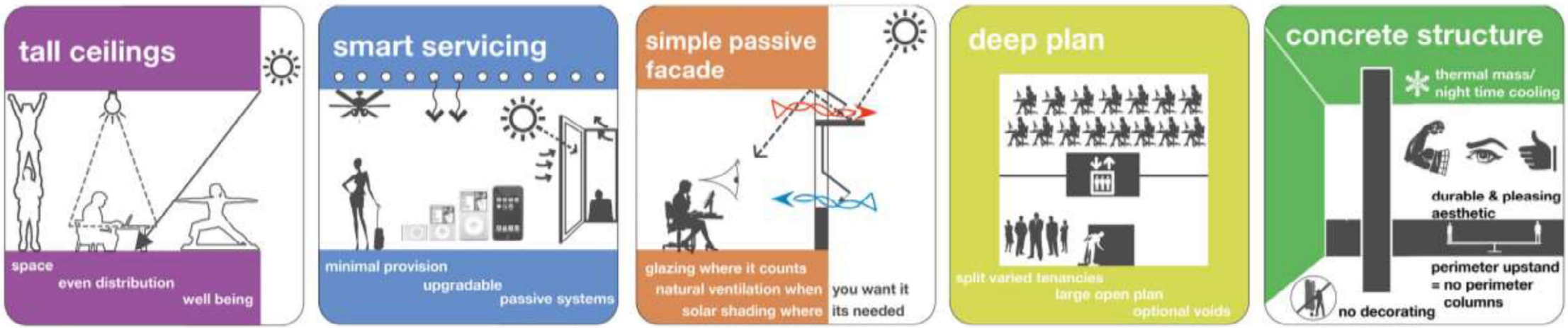
2017 Derwent London | Islington



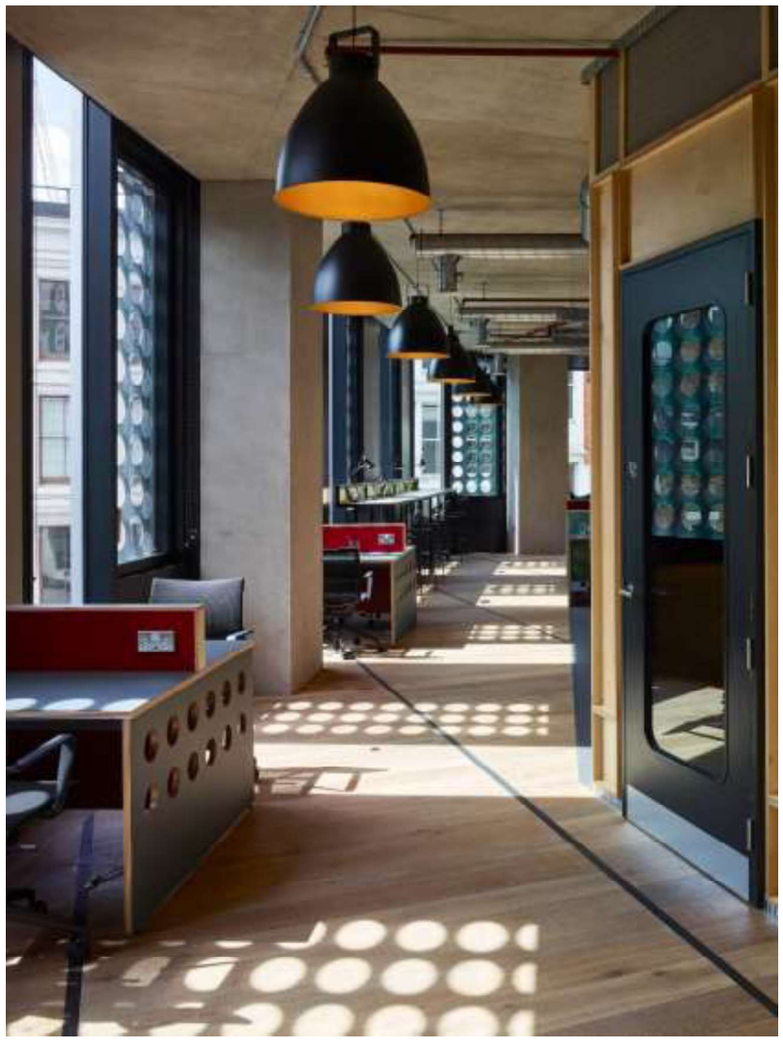


INTEGRATED SYSTEMS

1. tall ceilings
2. smart servicing
3. simple passive facade
4. deep plan
5. concrete structure

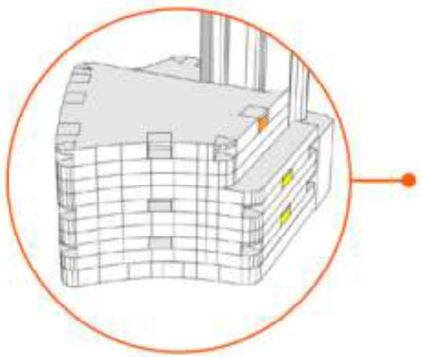


USER CONTROL



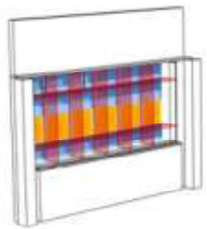
FAÇADE OPTIMISATION| COMMERCIAL

EAST FAÇADE



L09 E2 façade

- Recess 400mm
- 5 x vertical shades
- Increase depth of vertical and horizontal shades

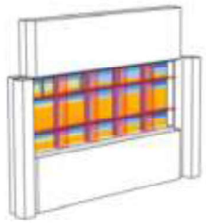


Level 09 E2

- Internal solar gain - 30w/m²
- G-value - 0.3
- Vertical shade depth - 675mm
- Horizontal shade depth - 800mm

L05 E2 façade

- 4 x vertical shade, rotate 45 deg
- Increase depth of vertical and horizontal shades



Level 05 E2

- Internal solar gain - 29.2w/m²
- G-value - 0.3
- Vertical shade depth - 400mm, 45deg acw
- Horizontal shade depth - 400mm

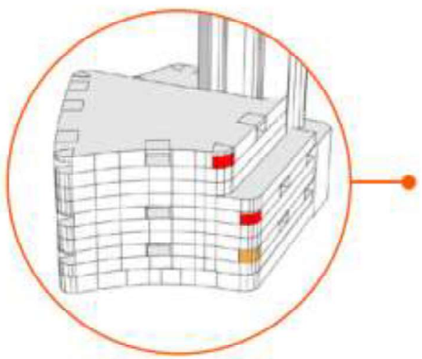
L02 E2 façade

- 2 x vertical shade, rotate 45deg
- Increase depth of vertical and horizontal shades

Level 02 E2

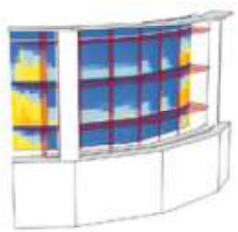
- Internal solar gain - 29.2w/m²
- G-value - 0.3
- Vertical shade depth - 275mm, 45deg acw
- Horizontal shade depth - 275mm

SOUTH EAST FAÇADE



L09 SE corner façade

- Recess 400mm
- 6 x vertical shades, rotate 45deg
- 3 x horizontal shades
- Increase depth of vertical and horizontal shades

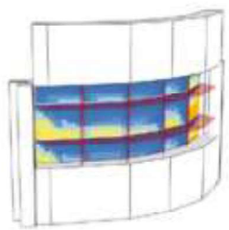


Level 09 SE corner

- Internal solar gain - 30w/m²
- G-value - 0.3
- Vertical shade depth - 800mm, 45deg acw
- Horizontal shade depth - 750mm

L05 SE corner façade

- 4 x vertical shade, rotate 45deg
- Increase depth of vertical and horizontal shades

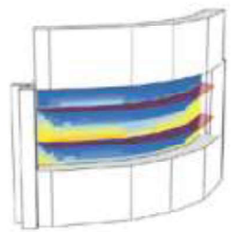


Level 05 SE corner

- Internal solar gain - 29.8w/m²
- G-value - 0.3
- Vertical shade depth - 650mm, 45deg acw
- Horizontal shade depth - 775mm

L02 SE corner façade

- Increase depth of horizontal shades



Level 02 SE corner

- Internal solar gain - 29.1w/m²
- G-value - 0.3
- Vertical shade depth - 0mm, 0deg
- Horizontal shade depth - 650mm

LIFETIME EMBODIED CARBON

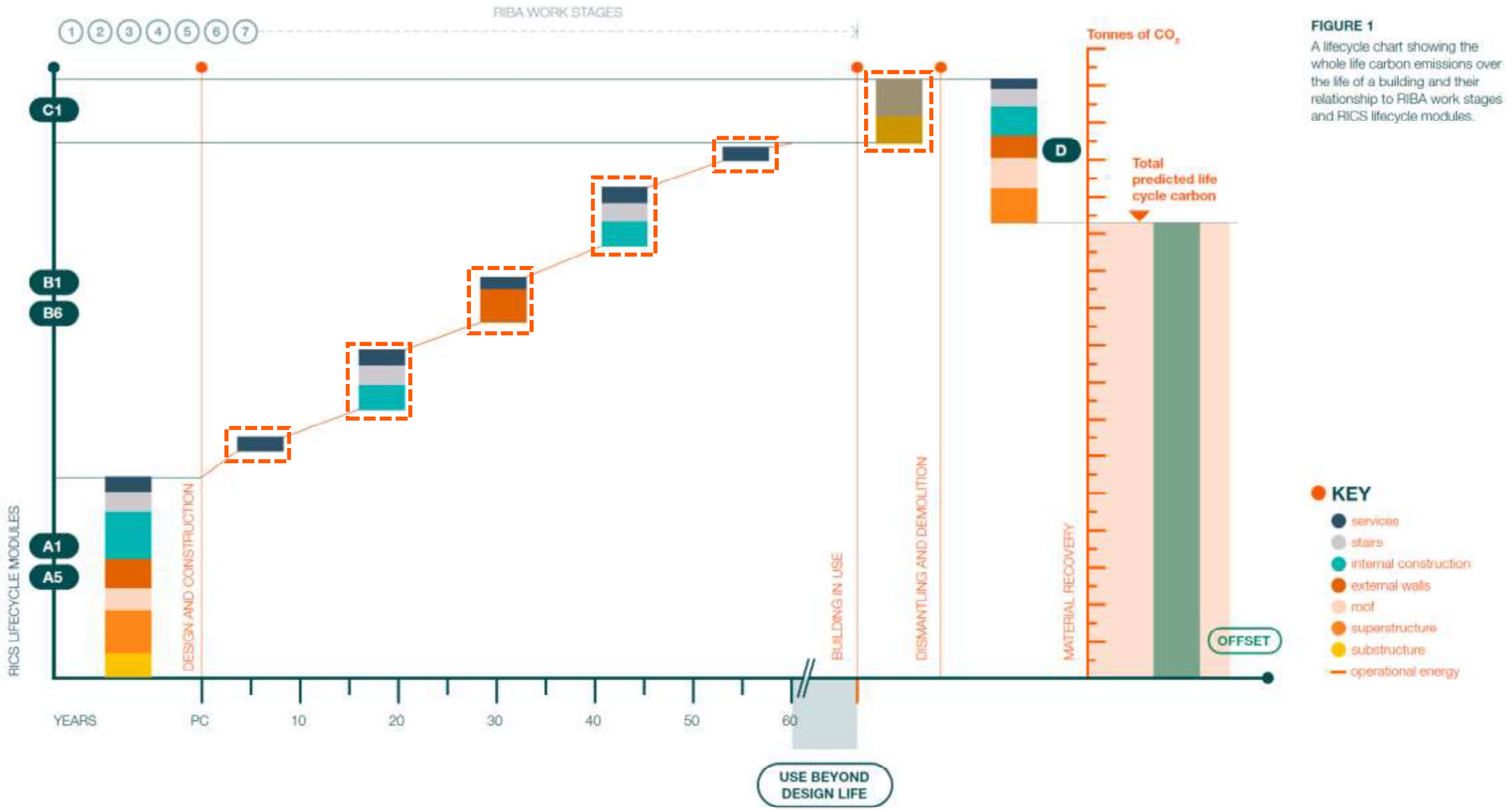


FIGURE 1
A lifecycle chart showing the whole life carbon emissions over the life of a building and their relationship to RIBA work stages and RICS lifecycle modules.

LIFETIME EMBODIED CARBON

Defining Lifetime Embodied Carbon
Carbon associated with changes over time, climate and emerging technology based on assumptions for the replacement and maintenance rates of building elements and components

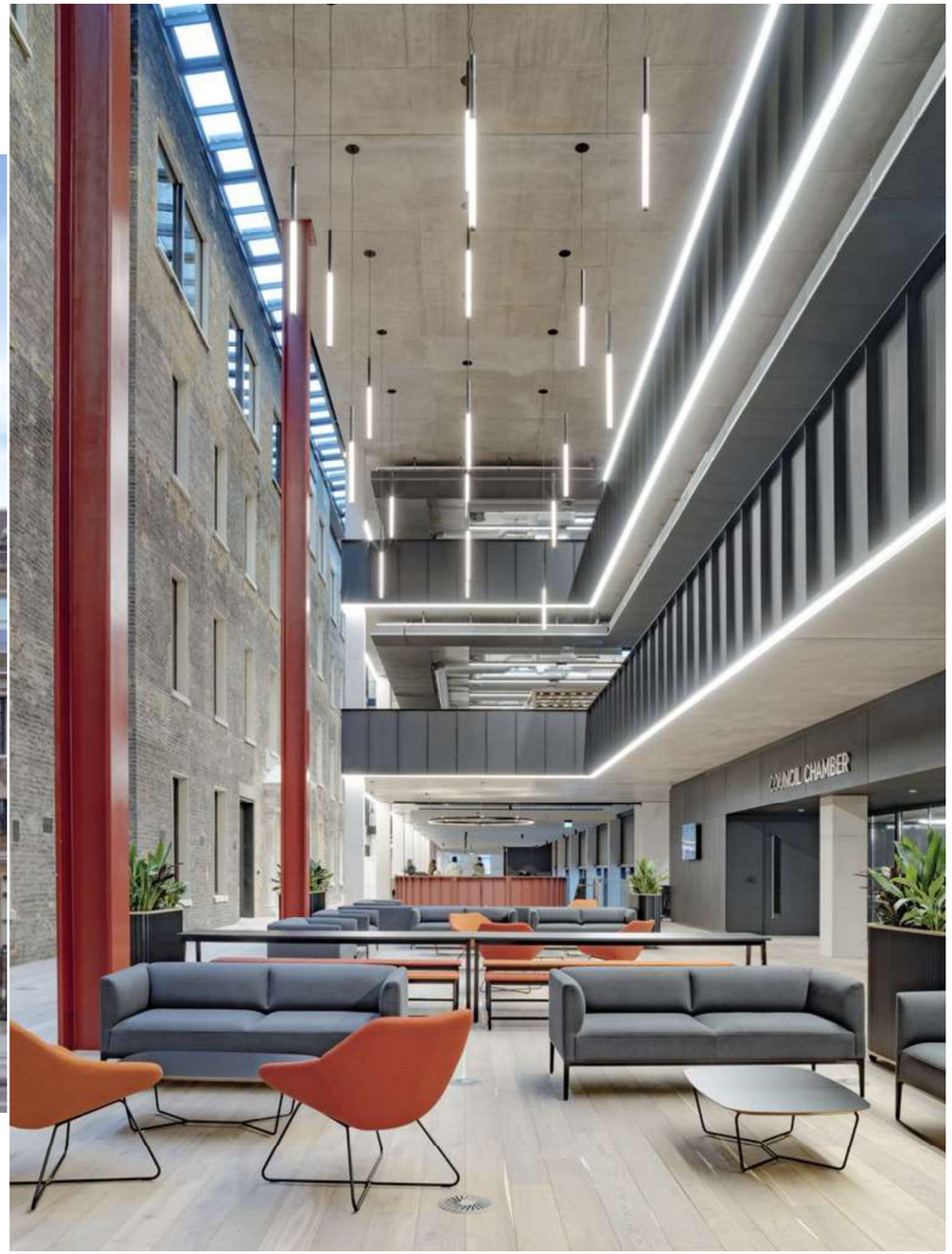
Replacement Repair & Maintenance
Materials, components and building elements, need to be maintained and/or replaced a building's life

Adaptation & Reuse
Ensure that buildings can accommodate changes of use by designing for future flexibility

Design for Disassembly
Investment of embodied carbon should be treated as a future resource bank such that every component can be recycled or reused at the end of the building's lifespan

Lifespan
Components are designed so that their embodied carbon can be given a useful life for as long as possible with material passports to capture this information

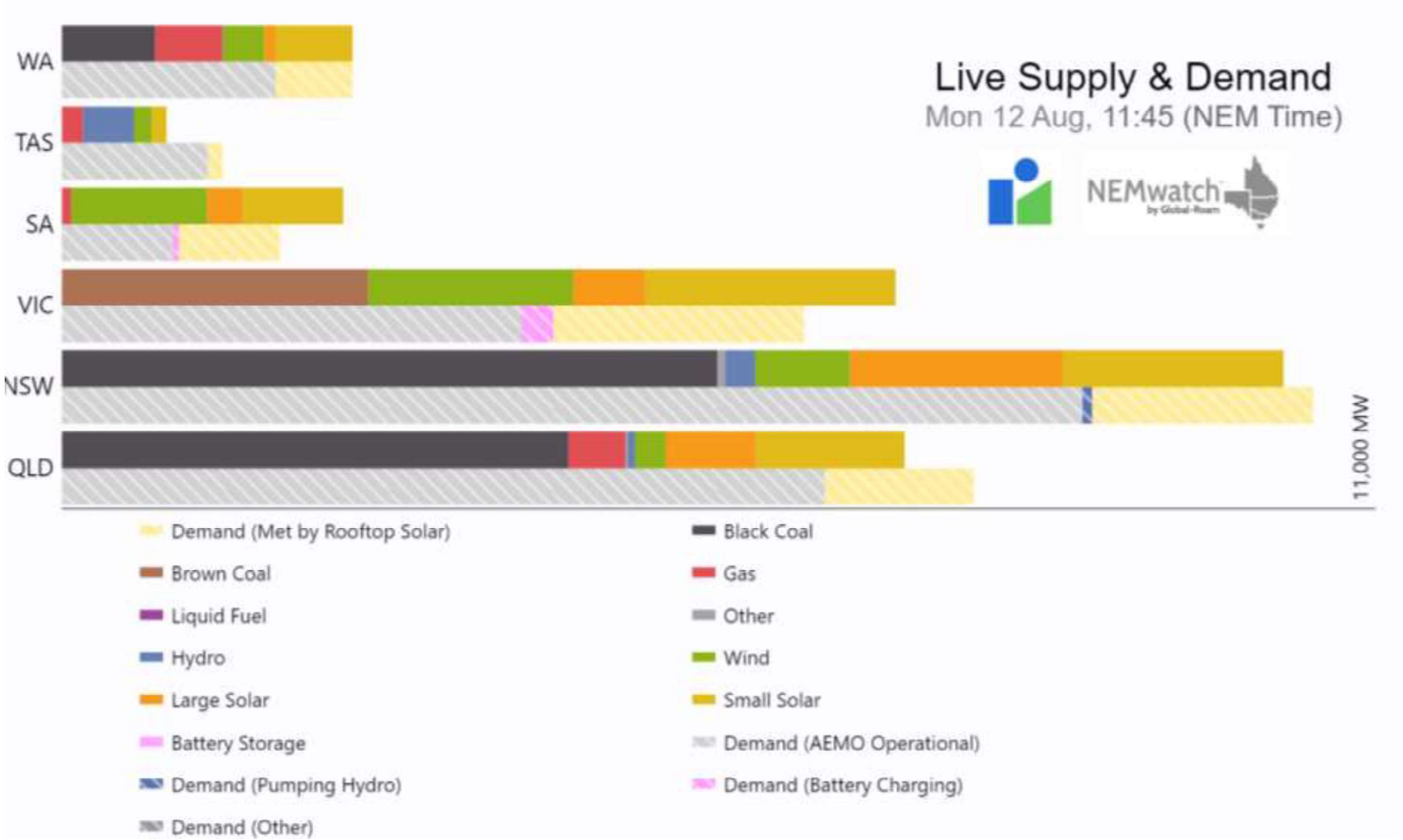
HIGH QUALITY | LONG LIFE



TOWER HAMLETS TOWN HALL | ADAPTIVE REUSE & CIVIC

London Borough of Tower Hamlets | Whitechapel

DECARBONISATION & GRID FLEXIBILITY

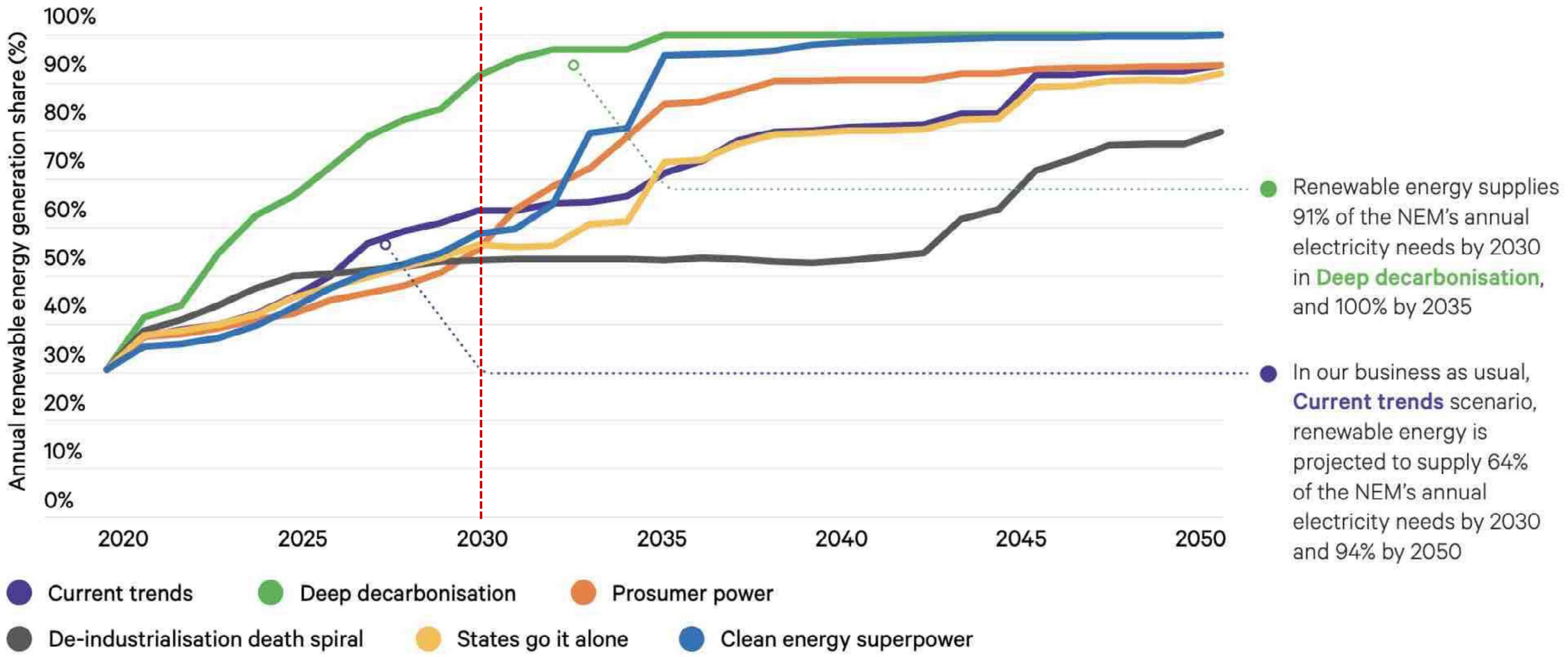


http://reneweconomy.com.au/nem-watch/

National Energy Market

DECARBONISATION & GRID FLEXIBILITY

Figure 6: Annual share of renewable energy generation to total generation in the NEM, inclusive of largescale wind and solar PV, rooftop solar, hydro and biomass



https://reneweconomy.com.au/unstoppable-transition-australia-can-hit-91-renewables-by-2030/

GOLDEN TRIANGLE > CARBON SQUARE

Extending the project programme decreases pressure on scope and/or quality, carbon and/or cost

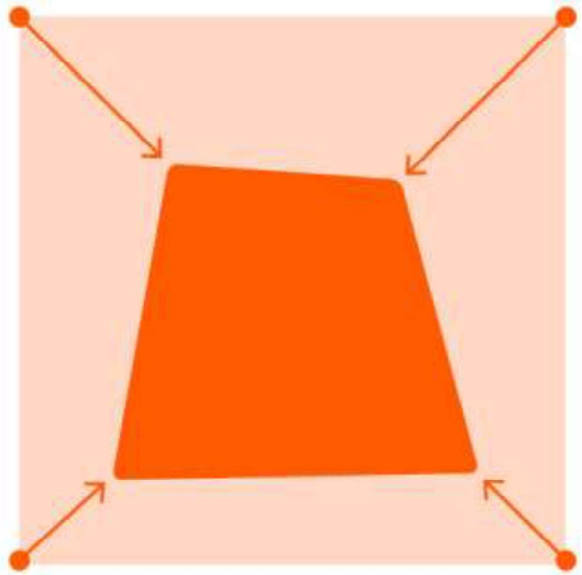
TIME

Shortening the project programme increases pressure on scope and/or quality, carbon and/or cost

Increasing carbon focus increases pressure on scope and/or schedule, quality and cost

CARBON

Decreasing carbon focus reduces pressure on scope and/or schedule, quality and cost



Increasing the project budget decreases pressure on scope and/or schedule, cost and carbon

COST

Decreasing the project budget increases pressure on scope and/or quality, schedule and cost

Increasing quality requirements increases pressure on scope and/or schedule, cost and carbon

QUALITY

Decreasing the quality decreases pressure on scope and/or schedule, cost and carbon

ECONOMY | EFFICIENCY | ELEGANCE

Efficiency

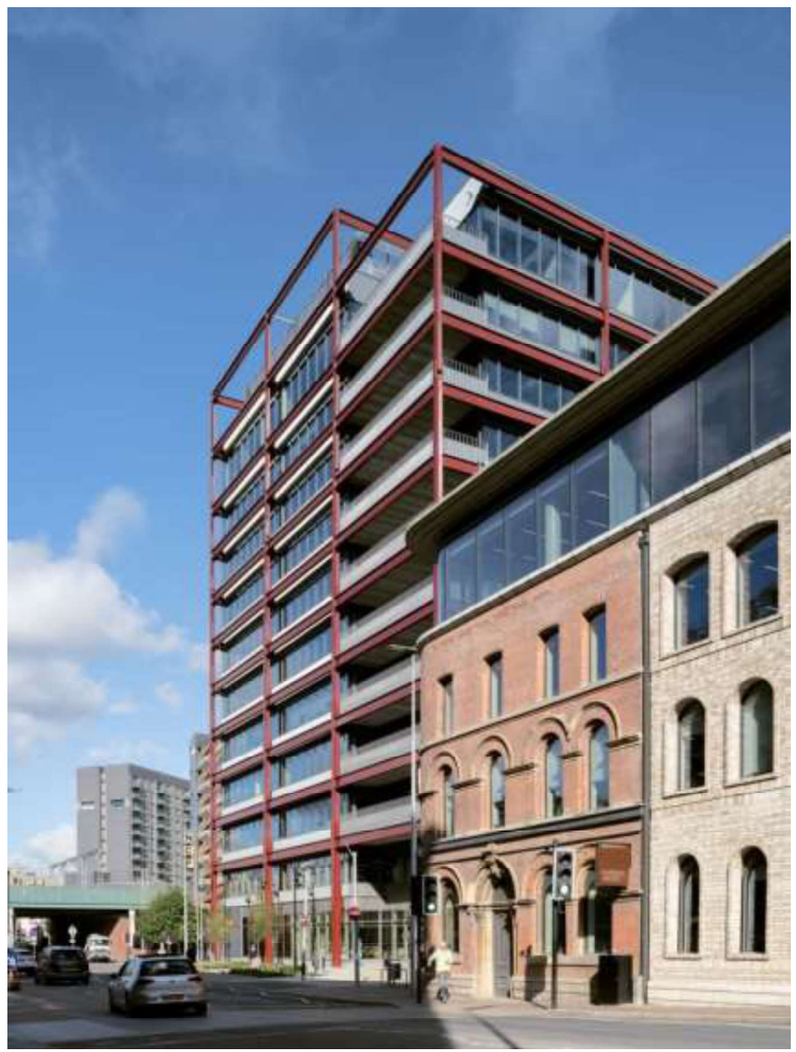
The principle of using the minimum amount of material required to meet present need and future flexibility can be applied to reducing emissions

Economy

The careful management of resources is an approach to avoiding excessive carbon emissions in the design, construction, operation and decommissioning of a building

Elegance

Recognising when the attractive appearance of materials in their finished state reduces, or even eliminates the need to add more materials solely for aesthetic reasons



KEY LESSONS

1. Performance Based Modelling
2. Set Clear & Ambitious Targets
3. Rethinking Appointments
4. Communication Is Key
5. Early Contractor Engagement
6. Team Coordination
7. Design Team Capabilities