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Building to net zero

Net Zero – New Build

Suffolk Preservation Society

Joe Jack Williams

06 July 2022

Overview

1. Net Zero Definition
2. LETI Definition of “minimised”
   a) Operational Energy
   b) Embodied Carbon
3. Designing for Net Zero Carbon
   a) LETI Design Guide
   b) Materials
4. FCBS CARBON
5. Case Study – Croft Gardens, Kings College Cambridge

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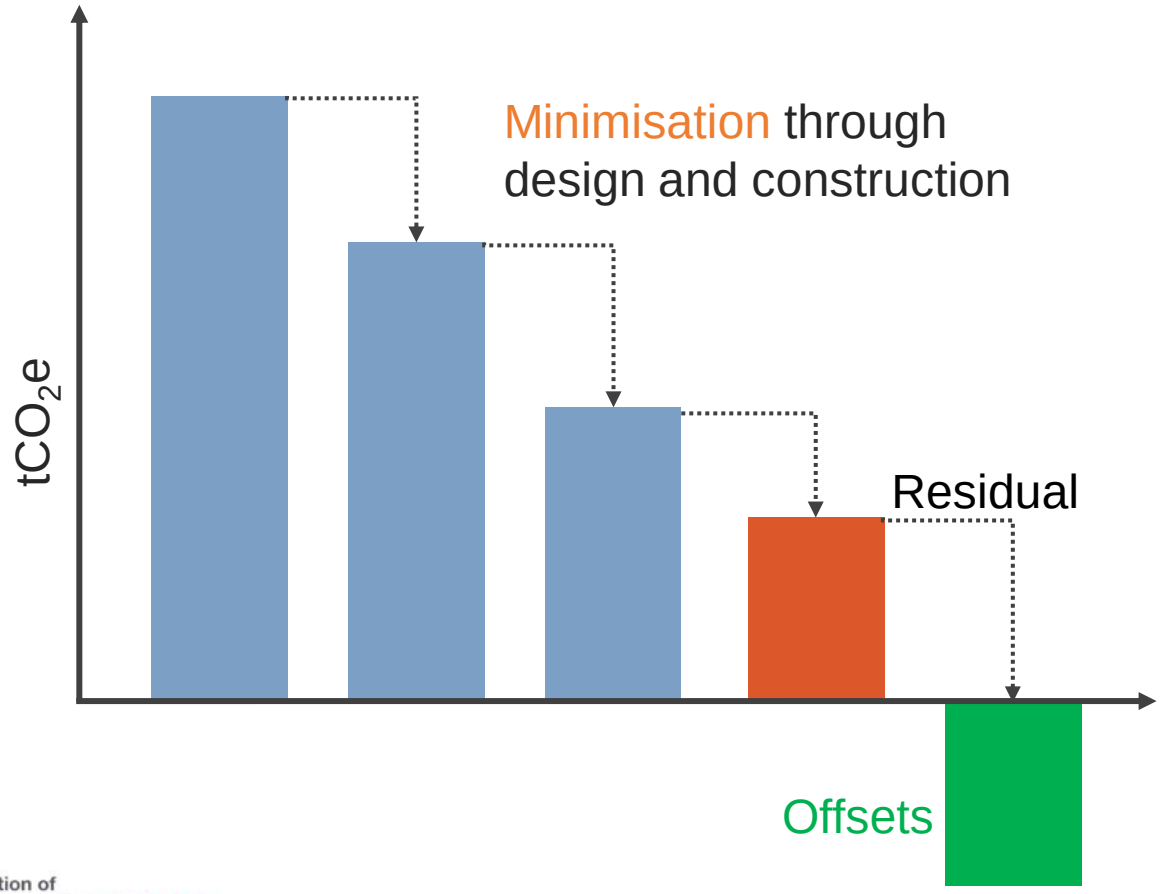
Net Zero Whole Life Carbon Definition

A 'Net Zero Whole Life Carbon' Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A1-A5, B1-B7, C1-C4) **are minimised, meet local carbon,** energy and water targets, and **with residual 'offsets', equals zero.**



LETI WLCN RIBA Architecture.com The Institution of StructuralEngineers

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LETI and Targets

Who is LETI, and what they have defined as “good” for minimisation?

Low Energy Transformation Initiative (LETI)

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LETI

Collective

Participatory

Impartial

Provocative

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LETI

Climate Emergency Design Guide

Downloaded over
40,000 times

Across **100+** countries

https://www.leti.london/cedg

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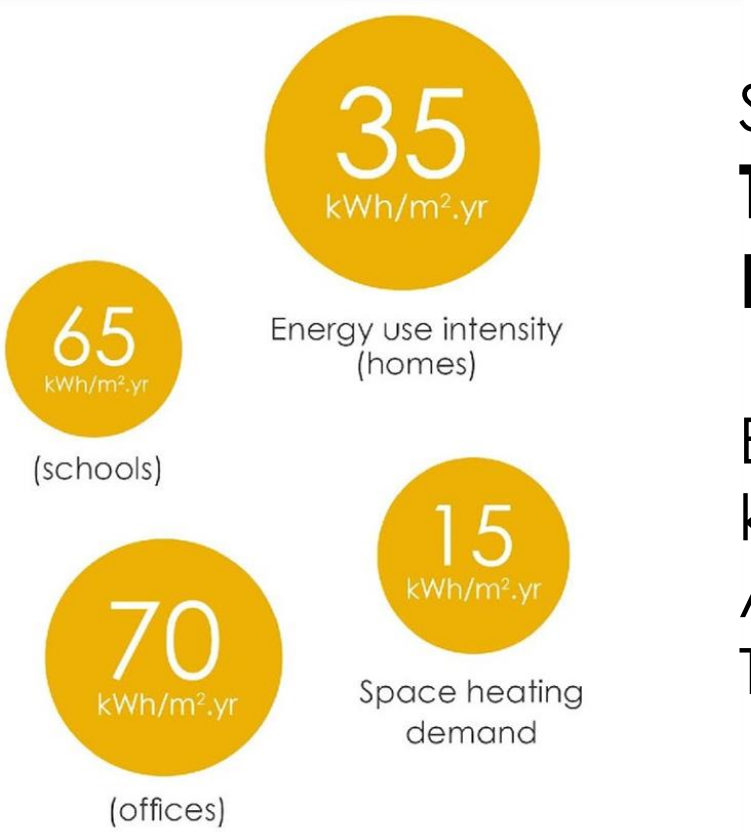
LETI

Operational Energy Targets



Separate energy targets for **TOTAL** energy, and for **HEATING** demand.

Energy use is measured in kWh/m².a (Gross Internal Area, GIA).
This is measurable in use.

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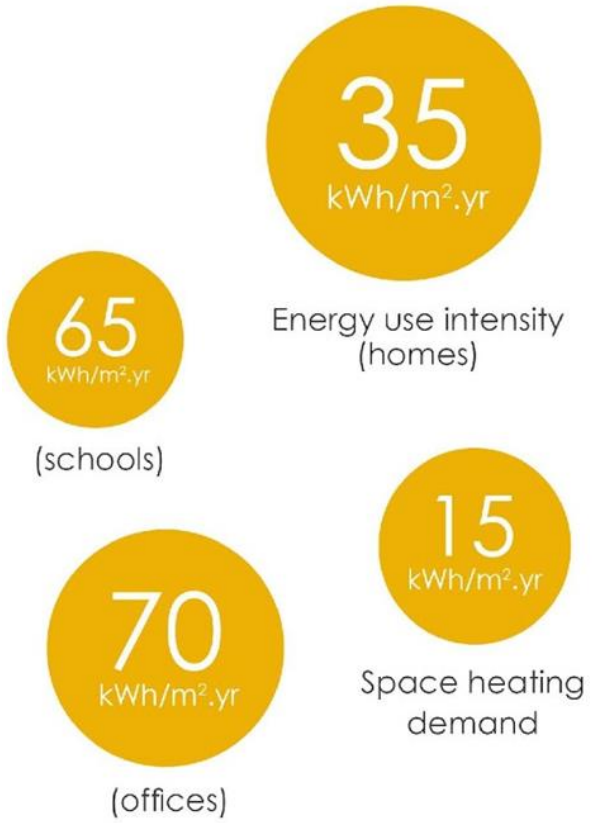
In just one year...



Operational energy targets have been met by:

+30,000 homes at masterplan level

+2,500 homes pre-construction

+1,000,000 m^2 of office space

+250,000 m^2 of education

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LETI

Upfront and Embodied Carbon Targets

Upfront Carbon, A1-5 (exc. sequestration)

	Band	Office	Residential	Education	Retail
	A++	<100	<100	<100	<100
	A+	<225	<200	<200	<200
LETI 2030 Design Target	A	<350	<300	<300	<300
	B	<475	<400	<400	<425
LETI 2020 Design Target	C	<600	<500	<500	<550
	D	<775	<675	<625	<700
	E	<950	<850	<750	<850
	F	<1100	<1000	<875	<1000
	G	<1300	<1200	<1100	<1200

Embodied Carbon, A1-5, B1-5, C1-4 (inc. sequestration)

Band	Office	Residential	Education	Retail
A++	<150	<150	<125	<125
A+	<345	<300	<260	<250
A	<530	<450	<400	<380
B	<750	<625	<540	<535
C	<970	<800	<675	<690
D	<1180	<1000	<835	<870
E	<1400	<1200	<1000	<1050
F	<1625	<1400	<1175	<1250
G	<1900	<1600	<1350	<1450

All values in $kgCO_2e/m^2$ (GIA).

Note, a "typical" new build will be on the boundary of **E** & **F**.

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Designing for Low Carbon

How to deliver a truly low carbon building

Medium and large scale housing

Operational energy

Implement the following indicative design measures:

Fabric U-values (W/m².K)

Walls	0.13 - 0.15
Floor	0.08 - 0.10
Roof	0.10 - 0.12
Exposed ceilings/floors	0.13 - 0.18
Windows	1.0 (triple glazing)
Doors	1.00

Efficiency measures

Air tightness	<1 ($m^3/h.m^2$@50Pa)
Thermal bridging	0.04 (y-value)
G-value of glass	0.6 - 0.5
MVHR	90% (efficiency) ≤2m (duct length from unit to external wall)

Window areas guide (% of wall area)

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

Balance daylight and overheating

Include external shading

Include openable windows and cross ventilation

Reduce energy consumption to:

35 kWh/m².yr

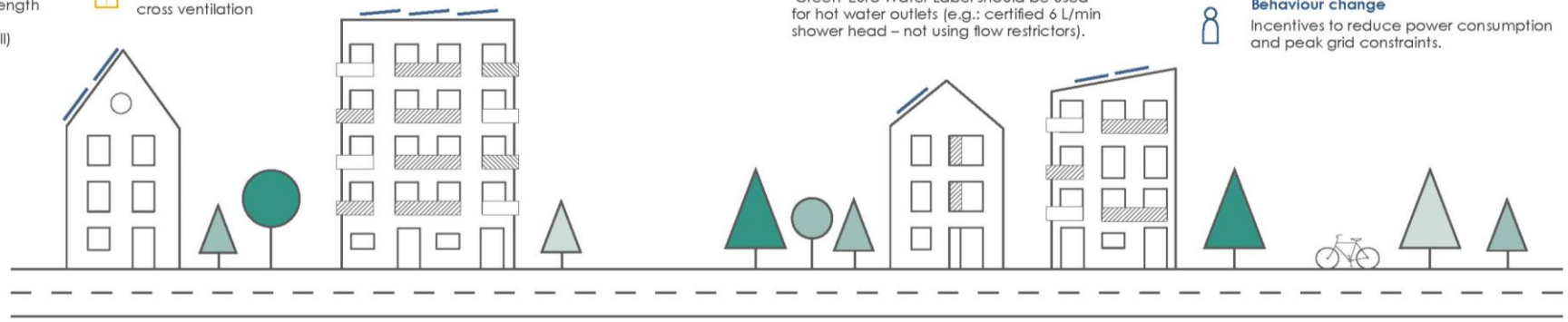
Energy Use Intensity (EUI) in GIA, excluding renewable energy contribution

Reduce space heating demand to:

15 kWh/m².yr

Maximise renewables so that 70% of the roof is covered

Form factor of <0.8 - 1.5



Heating and hot water

Implement the following measures:

Fuel
Ensure heating and hot water generation is fossil fuel free

Heat
The average carbon content of heat supplied (gCO_2/kWh.yr) should be reported in-use

Heating
Maximum 10 W/m² peak heat loss (including ventilation)

Hot water
Maximum dead leg of 1 litre for hot water pipework

'Green' Euro Water Label should be used for hot water outlets (e.g.: certified 6 L/min shower head – not using flow restrictors).

Demand response

Implement the following measures to smooth energy demand and consumption:

Peak reduction
Reduce heating and hot water peak energy demand

Active demand response measures
Install heating set point control and thermal storage

Electricity generation and storage
Consider battery storage

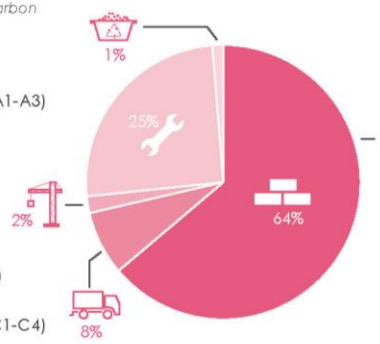
Electric vehicle (EV) charging
Electric vehicle turn down

Behaviour change
Incentives to reduce power consumption and peak grid constraints.

Embodied carbon

Focus on reducing embodied carbon for the largest uses:

- Products/materials (A1-A3)
- Transport (A4)
- Construction (A5)
- Maintenance and replacements (B1-B5)
- End of life disposal (C1-C4)



Average split of embodied carbon per building element:

46% - Superstructure

21% - Substructure

16% - Internal finishes

13% - Façade

4% - MEP

Reduce embodied carbon by 40% or to:

<500 kgCO₂/m²

Area in GIA

Data disclosure

Meter and disclose energy consumption as follows:

Metering

1. Submeter renewables for energy generation
2. Submeter electric vehicle charging
3. Submeter heating fuel (e.g. heat pump consumption)
4. Continuously monitor with a smart meter
5. Consider monitoring internal temperatures
6. For multiple properties include a data logger alongside the smart meter to make data sharing possible.

Disclosure

1. Collect annual building energy consumption and generation
2. Aggregate average operational reporting e.g. by post code for anonymity or upstream meters from part or whole of apartment block
3. Collect water consumption meter readings
4. Upload five years of data to GLA and/or CarbonBuzz online platform
5. Consider uploading to Low Energy Building Database.

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LONDON ENERGY TRANSFORMATION INITIATIVE

https://www.leti.london/cedg

Medium and large scale housing

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Balance daylight and overheating

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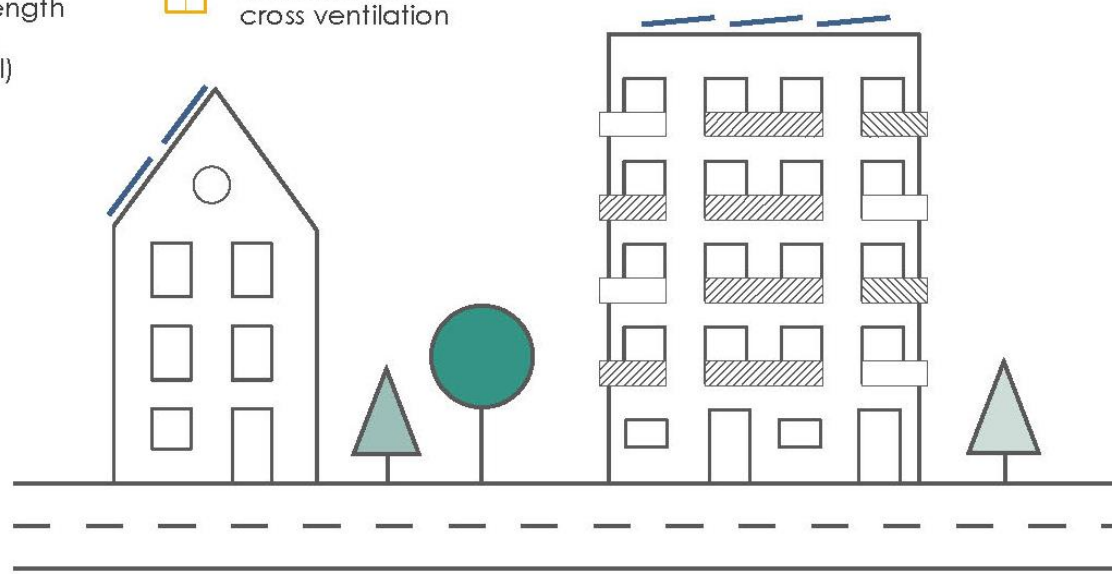
Reduce energy consumption to:

35 kWh/m².yr

Energy Use Intensity (EUI) in GIA, excluding renewable energy contribution

Reduce space heating demand to: 15 kWh/m².yr



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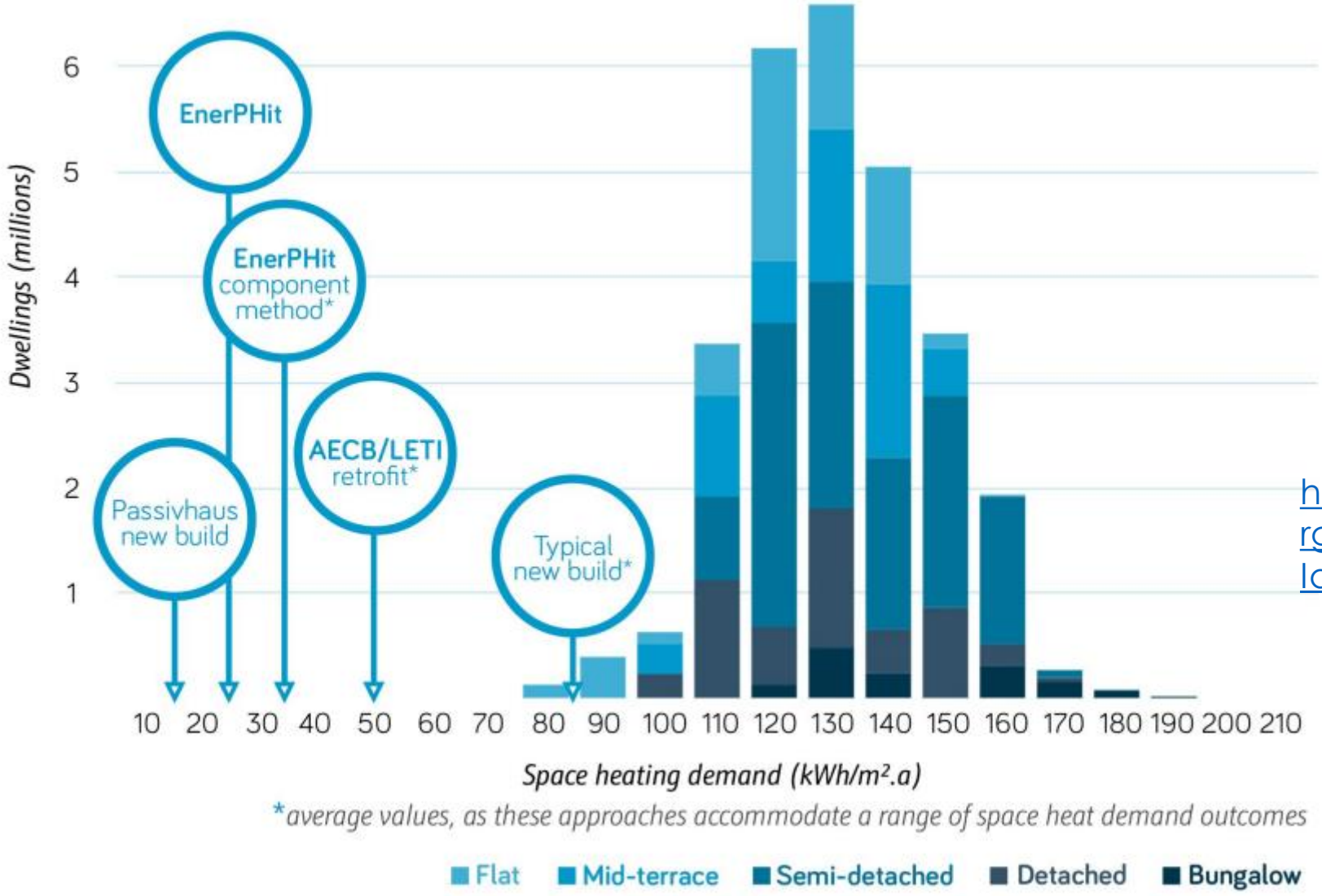
Passivhaus Standard



https://www.passivhaustrust.org.uk/guidance_detail.php?gId=51

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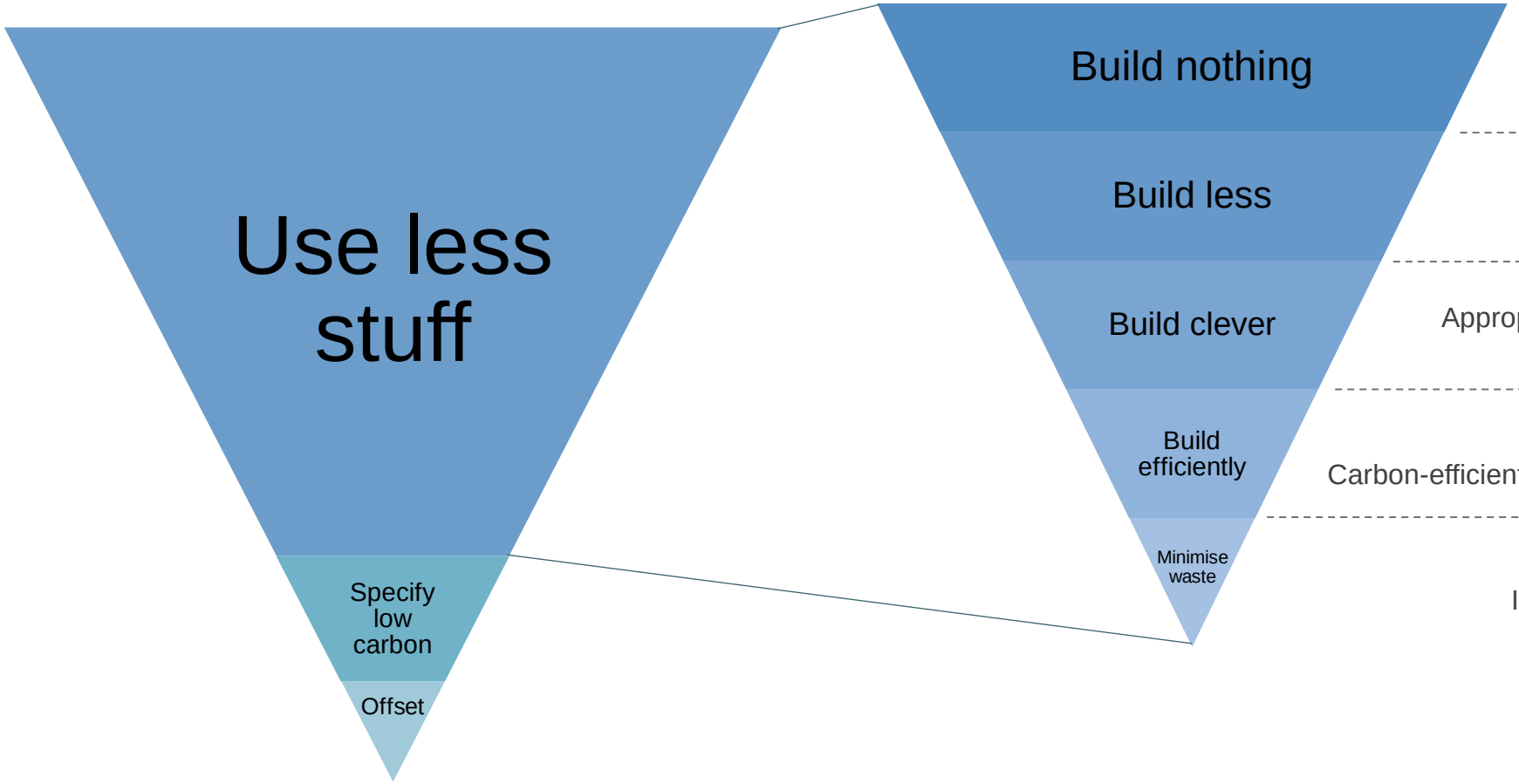
Low Embodied Carbon



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The Institution of Structural Engineers

Material Pyramid

https://www.materialepyramiden.dk/

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FCBS CARBON

Making carbon part of the decision making process

FCBS CARBON Approach

Building an accurate Whole Life Carbon model requires a detailed **bill of materials.**

But as designers we need to know the **impact of our decisions quickly** and BoMs are time consuming.

Instead, in FCBS CARBON we have a library of standard construction build-ups that can be applied to an algorithmically described building.

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The role of FCBS CARBON

We developed a tool:

- To record the details of our projects
- To estimate the whole life of our projects
- To understand how our buildings emit carbon

We need to understand direction & magnitude at the early stages, keeping carbon in the discussion.

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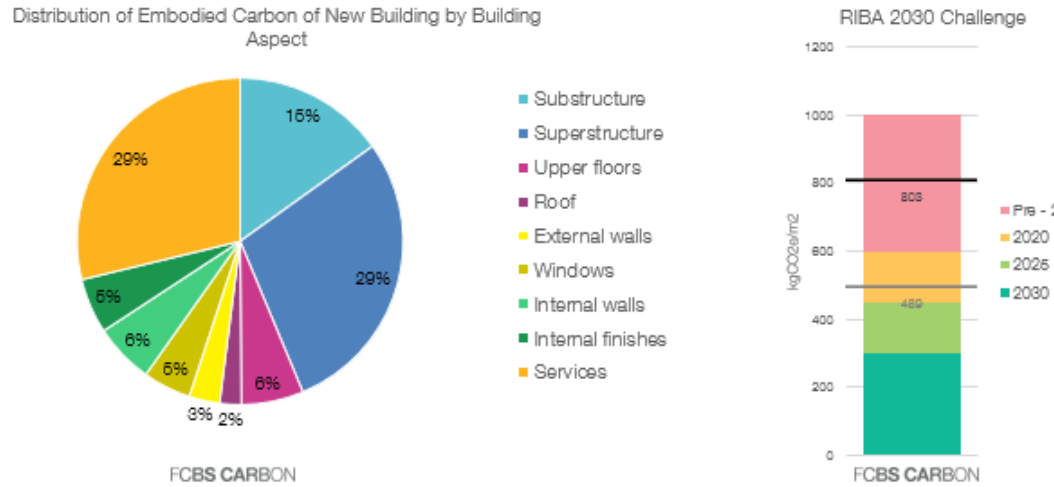
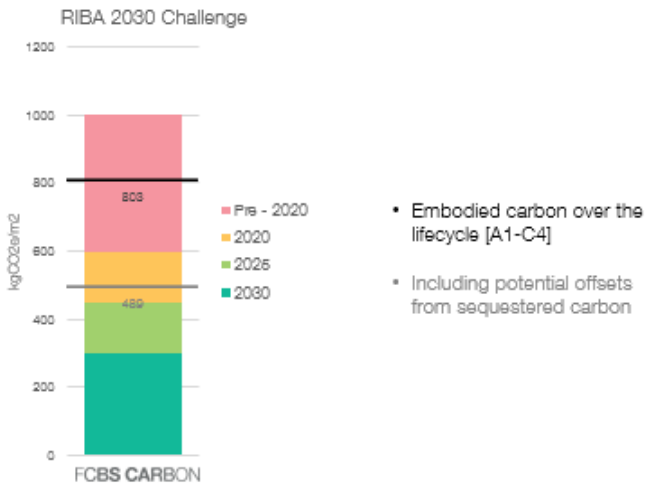
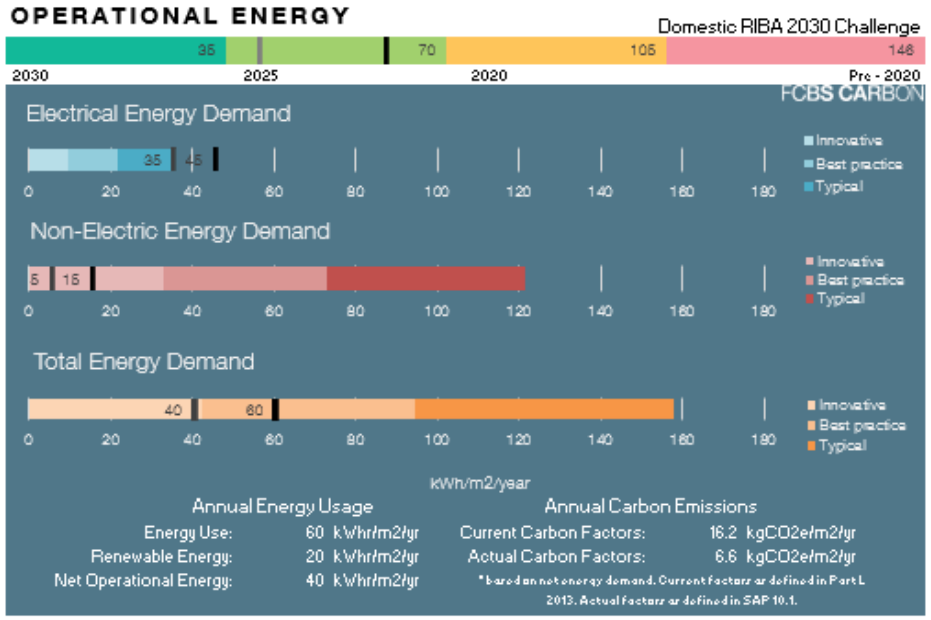
Building Details		
Supplied on 0. INPUT Project Details		
Building Name	Example Building	
Sector	Housing	
Sub-sector	Multi-family (6 - 15 storeys)	
GIA	3500	m2
Associated with selected sub-sector		
Grid size	6	m
Partitions factor	1	
RIBA 2030 Challenge Category	Domestic	
Imposed floor load	1.5	kN/m2
User inputs required		
Building perimeter	90	m
Building footprint	500	m2
Building width	20	m
Floor-to-floor height	3.5	m
No. storeys ground & above	6	
No. storeys below ground	1	
Glazing ratio	30	%

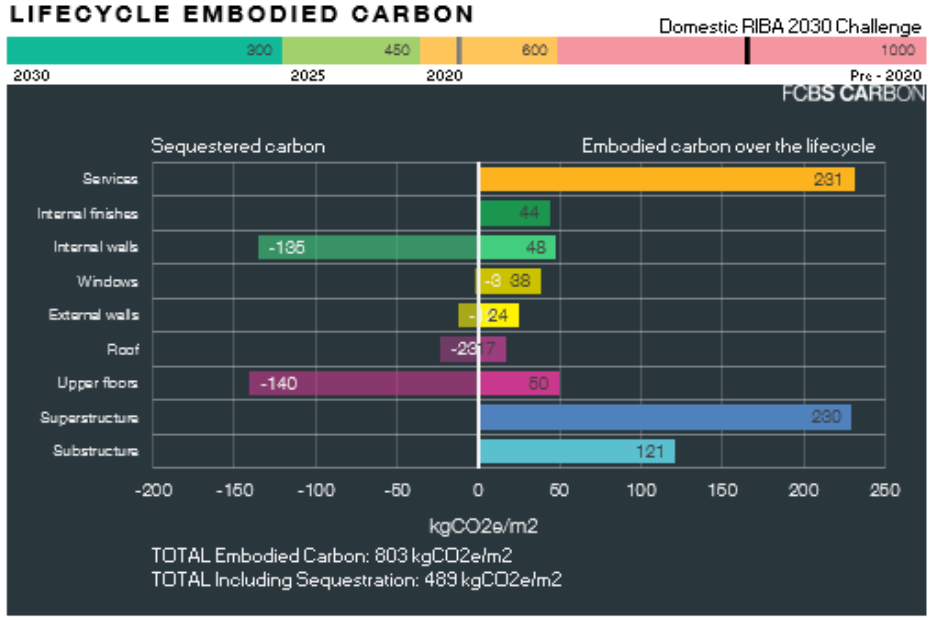


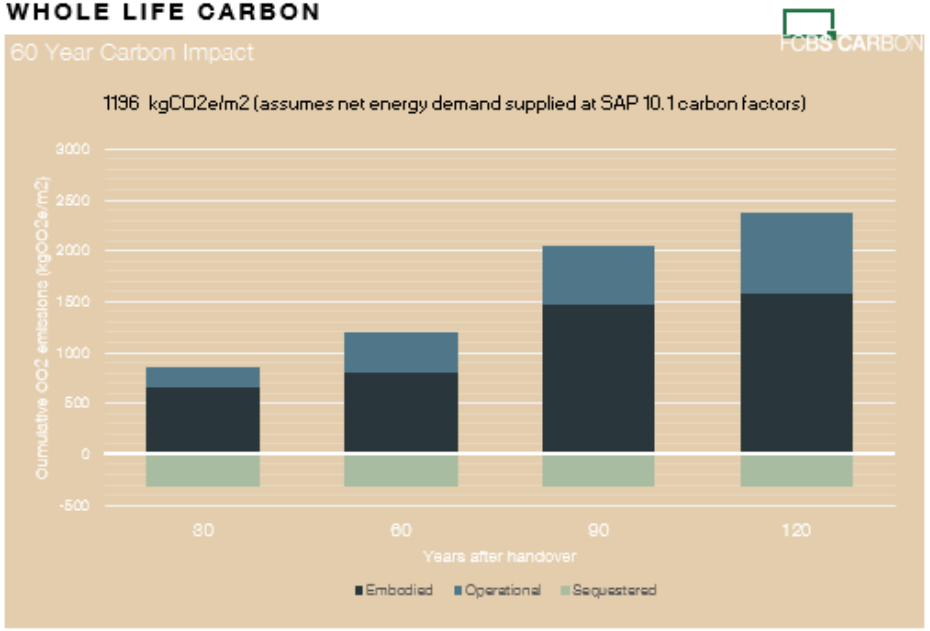


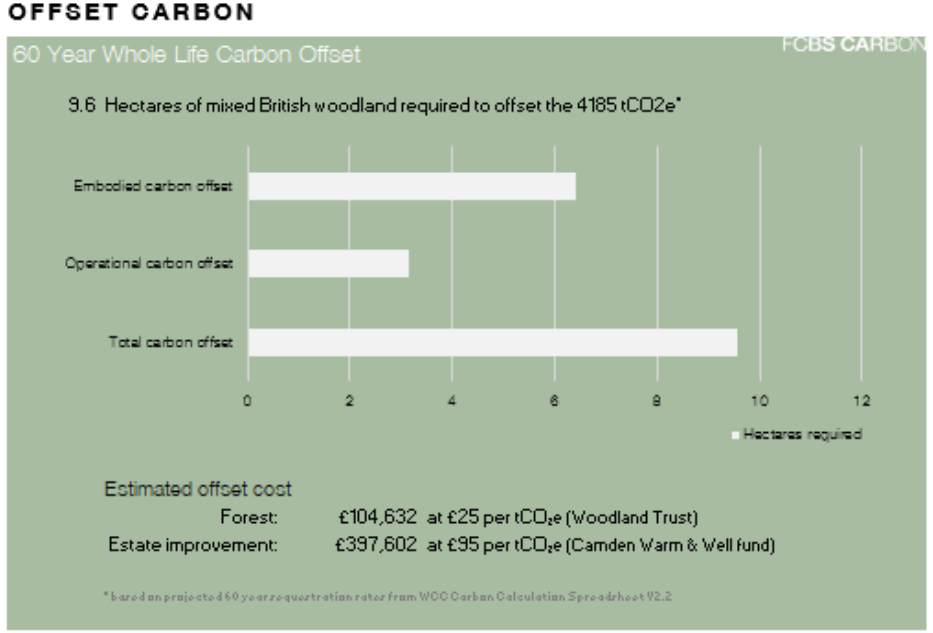
Building Aspect	Building Element	Material	Existing fabric?	Age if existing?	Adjustment Factor (%)	Component Life (years)	Designed for disassembly?	Estimated Quantity	Units	Life cycle embodied carbon estimate A - C (kgCO2e/m2)	A1 - A3 Biogenic carbon (sequestered kgCO2e/m2)	Potential benefits beyond the system boundary D (kgCO2e/m2)	Assumptions	Notes
Substructure	Piles	RC 32/40 (50kg/m3 reir	New			80	No	224.8	m3	34.7	0.0	0.0	15 m depth, 600 mm diameter, 500 kN per pile	
Substructure	Pile caps	RC 32/40 (200kg/m3 re	New			80	No	15.8	m3	3.3	0.0	0.0	0.75 x 2 x 1.5 m caps	
Substructure	Capping beams	RC 32/40 (200kg/m3 re	New			80	No	40.5	m3	8.5	0.0	0.0	750 x 600 mm beam sections	
Substructure	Basement walls	RC 32/40 (125kg/m3 rei	New			80	No	252.0	m3	46.0	0.0	0.0	800 mm wall thickness	
Substructure	Lowest floor slab	RC 32/40 (150kg/m3 rei	New			80	No	150.0	m3	28.8	0.0	0.0	300 mm slab thickness	
Superstructure	Core structure	Precast RC 32/40 (100k	New			80	No	222.2	m3	42.7	0.0	0.0	200 mm wall thickness	
Superstructure	Columns	Steel	New			80	No	6.5	m3	43.6	0.0	0.0	UC 254 x 254	
Superstructure	Beams	Steel	New			80	No	10.8	m3	72.4	0.0	0.0	UB 533 x 210	
Superstructure	Secondary beams	Steel	New			80	No	10.5	m3	70.9	0.0	0.0	75% of material in primary beam	
Upper floors	Floor slab	CLT	New			80	No	600.0	m3	49.6	-140.4	0.0	200 mm slab thickness	
Roof	Roof	CLT	New			80	No	100.0	m3	8.3	-23.4	0.0	200 mm slab thickness	
Roof	Roof insulation	Rockwool	New			30	No	125.0	m3	7.2	0.0	0.0	250 mm insulation thickness	
Roof	Roof finishes	Asphalt (Mastic)	New			30	No	500.0	m2	1.7	0.0	0.0	20 mm thickness	
External walls	Facade	Timber	New			40	No	1323.0	m2	5.4	-12.2	0.0	See "Build-ups" sheet	
External walls	Wall insulation	Rockwool	New			30	No	330.8	m3	19.1	0.0	0.0	250 mm insulation thickness	
Windows	Glazing	Double Glazing	New			40	No	6.1	m3	18.4	0.0	0.0	Two panes of 6 mm glass	
Windows	Window frames	Al/Timber Composite	New			40	No	2126.3	m	19.8	-2.7	0.0	See "Build-ups" sheet	
Internal walls	Partitions	CLT	New			80	No	578.8	m3	47.8	-135.4	0.0	120 mm wall thickness	
Internal finishes	Ceilings	Exposed Soffit	New			80	No	3500.0	m2	0.0	0.0	0.0	None	
Internal finishes	Floors	Carpet	New		70%	20	No	3500.0	m2	26.4	0.0	0.0	12 mm carpet thickness	
Internal finishes	Floors	Vinyl	New		20%	20	No	3500.0	m2	10.2	0.0	0.0	3 mm vinyl thickness	
Internal finishes	Floors	Stoneware tile	New		10%	20	No	3500.0	m2	7.2	0.0	0.0	10 mm tile thickness	
Services	Services	Medium	New			20	No	3500.0	m2	231.0	0.0	0.0	60 kgCO2e/m2 flat rate estimate	
								0		0.0	0.0	0.0		
								0		0.0	0.0	0.0		
								0		0.0	0.0	0.0		

The version released is **in excel** so there are few barriers to adoption.









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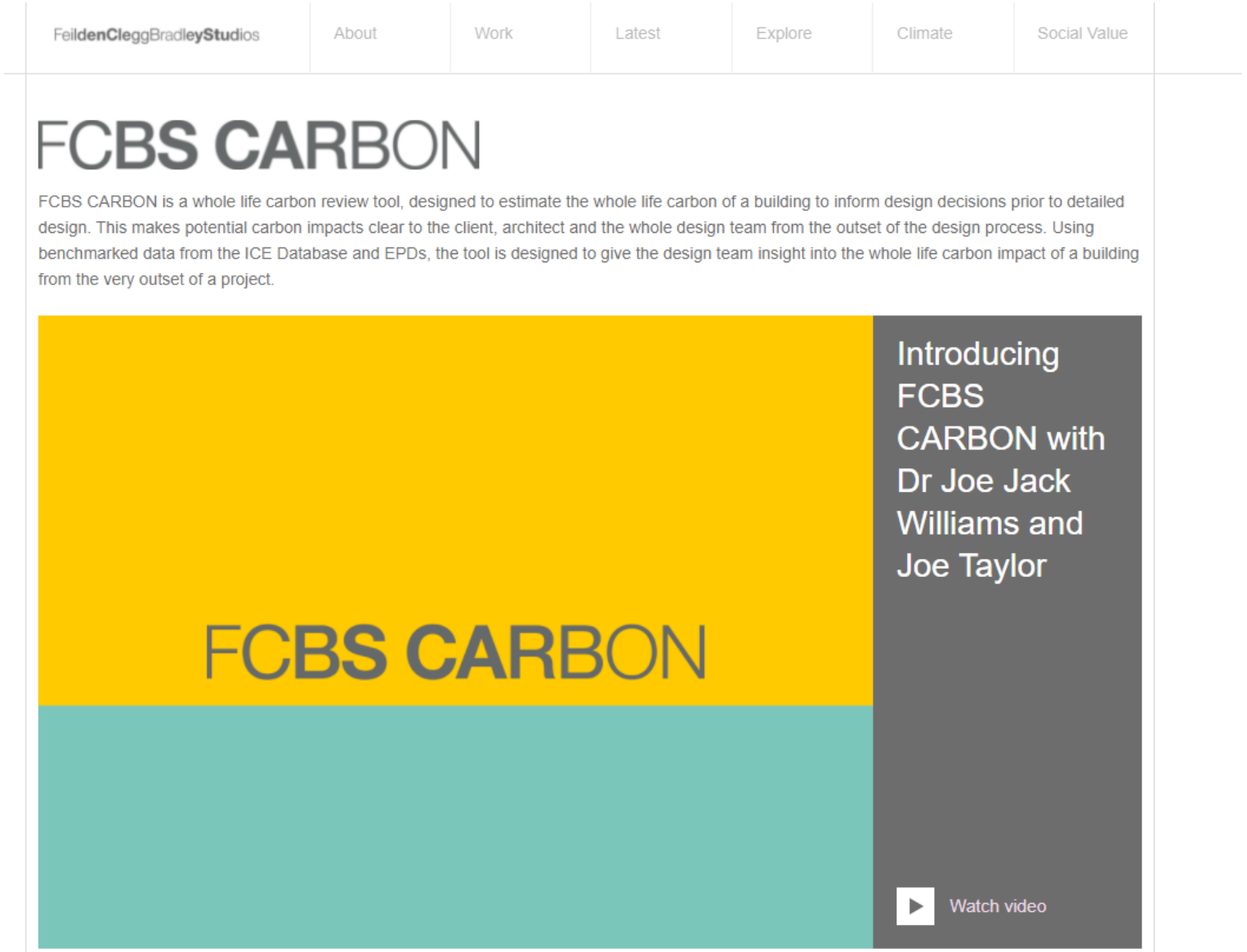
A dashboard output that covers all aspects of Whole Life Carbon



https://fcbstudios.com/fcbscarbon

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Croft Gardens, Kings College, Cambridge

A case study in whole life carbon

Case Study – Croft Gardens

Croft Gardens, Kings College, Cambridge

Student residential project

Due for completion from August 2022.

As low carbon as possible, for as long as possible:

Passivhaus
CLT structure
True 100 year design life

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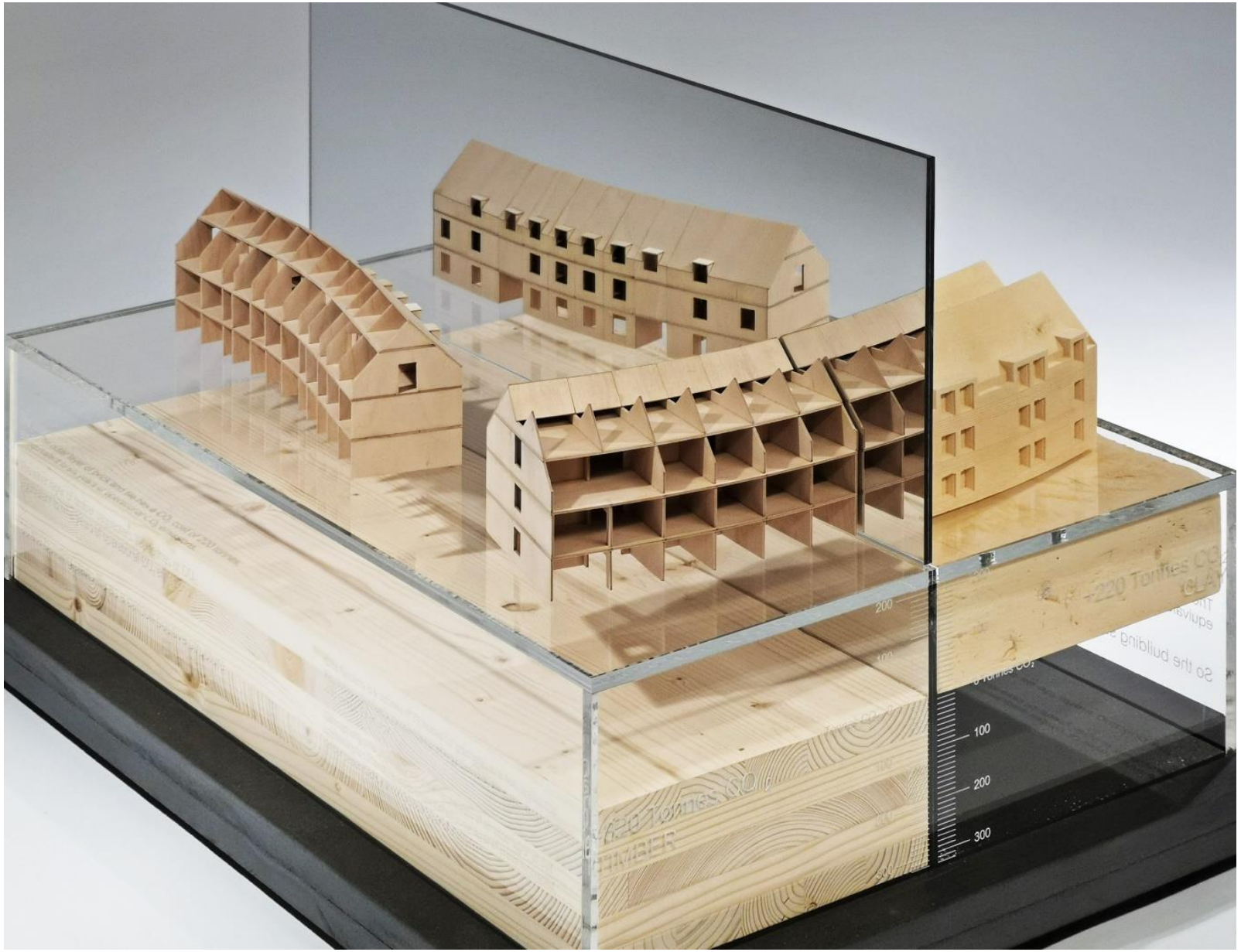
A balance of materials



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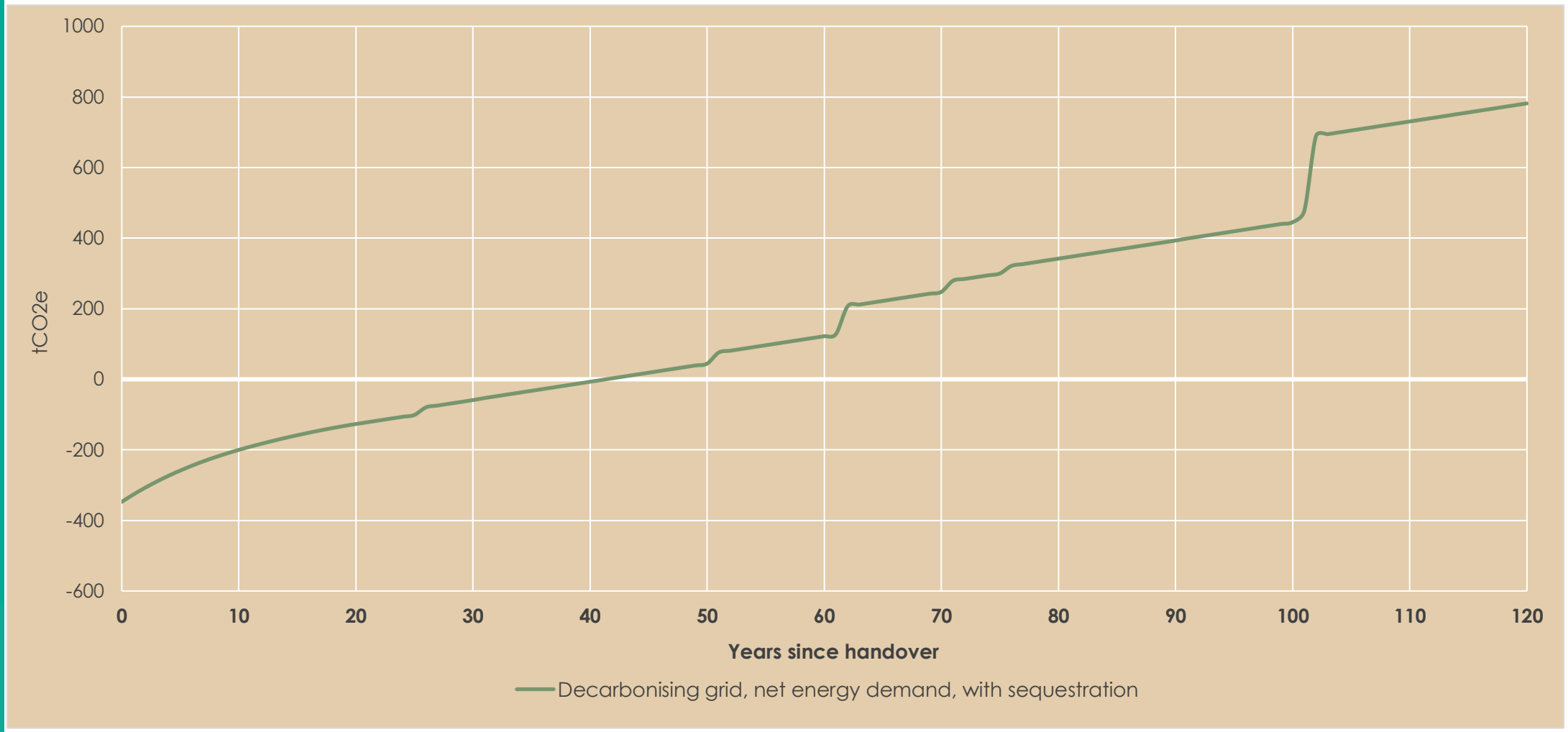
Taking a whole life approach



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Thanks for your time

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