CUNDALL

Six 56 Warrington

Whole Life Carbon Assessment

Langtree PP + Panattoni

Job No:	**1015524**
Doc Ref:	**1015524-RPT-SY-001**
Revision:	**B**
Revision Date:	**29 July 2020**

Project title	Six 56 Warrington	**Job Number**
Report title	Whole Life Carbon Assessment	1015524

Document Revision History

Revision Ref	Issue Date	Purpose of issue / description of revision
—	14/07/2020	Draft Issue
A	22/07/2020	Minor amendments
B	29/07/2020	Minor amendments

Document Validation (latest issue)

29/07/2020

X S. O'Hara

Principal Author

Signed by: O'Hara, Scott

29/07/2020

X Qian Li

Checked by

Signed by: Li, Qian

29/07/2020

X

Verified by

Signed by: Wyatt, Simon

Executive Summary

This report is a Whole Life-Cycle Carbon Assessment (WLCA) of the proposed Six56 site located immediately South East of Warrington.

The recent update to the Climate Change Act requires that the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline is increased from 80% to 100%. National Planning Policy Framework, Section 14: '*Meeting the challenge of climate change, flooding and coastal change',* calls for projects to take a proactive approach to climate change mitigation and adaptation. Paragraph 150b states that a new development should be planned for in ways that;

- Can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the government's policy for national technical standards.

By establishing the whole-life carbon of the proposed development and implementing the carbon reduction options discussed in this report, the project can meaningfully reduce its environmental impact.

The assessment was carried out according to the British Standard BS EN15978:2011 (Sustainability of construction works* - Assessment of environmental performance of buildings - Calculation method), and the RICS Professional Statement 'Whole life carbon assessment for the built environment 2017'.

The total estimated carbon emissions of the Six56 site based on the benchmarks summarised in this report, are:

Embodied Carbon Emissions at Practical Completion (TCO_2e)	**Embodied Carbon Emissions over Life Cycle - 60 years (TCO_2e)**	**Operational Carbon Emissions over Life-Cycle – 60 years (TCO_2e)**	**Total Emissions – 60 years (TCO2e)**
175,625 (610 $kgCO_2e/m^2$)	105,087 (365 $kgCO_2e/m^2$)	582,250 (1,992 $kgCO_2e/m^2$)	**854,267,151** (2,967 $kgCO_2e/m^2$)

Figure 1: Carbon Summary

The whole life-cycle carbon emissions are equivalent of:

Figure 2: Carbon equivalent

The term 'Construction works' refers to whole life cycle stages of buildings, see section 1.3 for details.

Contents

1.0

Introduction

1.0 Introduction

This report is a Whole Life-Cycle Carbon Assessment (WLCA) of the Six56 site. The assessment was carried out in accordance with the British Standard BS EN15978:2011 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method), and the RICS Professional Statement 'Whole life carbon assessment for the built environment 2017'.

The recent update to the Climate Change Act requires that the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline is increased from 80% to 100%. National Planning Policy Framework, Section 14: '*Meeting the challenge of climate change, flooding and coastal change',* calls for projects to take a proactive approach to climate change mitigation and adaptation. Paragraph 150b states that a new development should be planned for in ways that;

- Can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the government's policy for national technical standards.

By establishing the whole-life carbon of the proposed development and implementing the carbon reduction options discussed in this report, the project can meaningfully reduce its environmental impact.

1.1 Site Description

The proposed site comprises the construction of up to **287,909m²** employment floorspace (Use Class B8 and B1(a) offices). The existing site is agricultural land and does not have existing infrastructure that could be reused, therefore the emissions associated with the current use of site is deemed to be negligible.

Figure 2: Proposed Site Plan

1.2 Study Background

Whole life-cycle carbon emissions are the total greenhouse gas emissions arising from a development over its lifetime, from the emissions associated with raw material extraction, the manufacture and transport of building materials, to installation/construction, operation, maintenance and eventual material disposal.

Operational carbon emissions from electricity consumption will make up a declining proportion of a development's whole life carbon emissions as operational carbon targets become more stringent, and the national grid is further decarbonised. Operational carbon emissions from natural gas consumption have been assumed to remain constant over the life-cycle. To fully capture a development's carbon impact, a whole life-cycle approach is needed to capture its unregulated emissions (i.e. those associated with cooking and small appliances), its embodied emissions (i.e. those associated with raw material extraction, manufacture and transport of building materials, and construction) and emissions associated with maintenance and eventual material disposal).

Calculating and reducing WLC emissions offers a wealth of benefits including:

- Ensuring that a significant source of emissions from the built environment are accounted for which is necessary in achieving a net zero-carbon city;
- Achieving resource efficiency and cost savings by encouraging the re-use of existing materials instead of new materials and the retrofit and retention of existing structures and fabric over new construction;

- Identifying the carbon benefits of using recycled material and the benefits of designing for future reuse and recycling to reduce waste and support the circular economy;
- Identifying the impact of maintenance, repair and replacement over a building's life-cycle which improves life-time resource efficiency and reduces life-cycle costs, contributing to the future proofing of asset value;
- Encouraging local sourcing of materials and short supply chains, with resulting carbon, social and economic benefits for the local economy;
- Encouraging durable construction and flexible design, both of which contribute to greater longevity, reduced obsolescence of buildings and avoiding carbon emissions associated with demolition and new construction.

1.3 Life-cycle modules

The WLC assessment covers the all modules A, B and C set out in BS EN 15978 and the RICS PS in the life of a typical project described as life-cycle modules. The reference study period (i.e. the assumed building life expectancy) for the purposes of the assessment is 60 years.

To provide a holistic view of the Global Warming Potential (GWP), the whole life carbon assessment accounts for all components relating to the project during all life stages. Embodied carbon emissions are attributed to four main categories taken from BS EN 15978. The categories are:

- Product Stages (module A1 to A3): The carbon emissions generated at this stage arise from extracting the raw materials from the ground, their transport to a point of manufacture and then the primary energy used (and the associated carbon impacts that arise) from transforming the raw materials into construction products.
- Construction (module A4 to A5): These carbon impacts arise from transporting the construction products to site, and their subsequent processing and assembly into the building.
- In-Use Stages (module B1 to B5): This covers a wide range of sources from the embodied carbon emissions associated with the operation of the building, including the materials used during maintenance, replacement and refurbishment. Module B6 and B7 refer to operational emissions and are not included in the assessment scope of this study.
- End of Life Stages (module C1 to C4): The eventual deconstruction and disposal of the existing building at the end of its life takes account of the on-site activities of the demolition contractors. No 'credit' is taken for any future carbon benefit associated with the reuse or recycling of a material into new products.
- Benefits and loads beyond the system boundary Module (D): Any potential benefit from the reuse, recovery and recycling potential of a building or a building product. This module is not included in the assessment scope of this study.

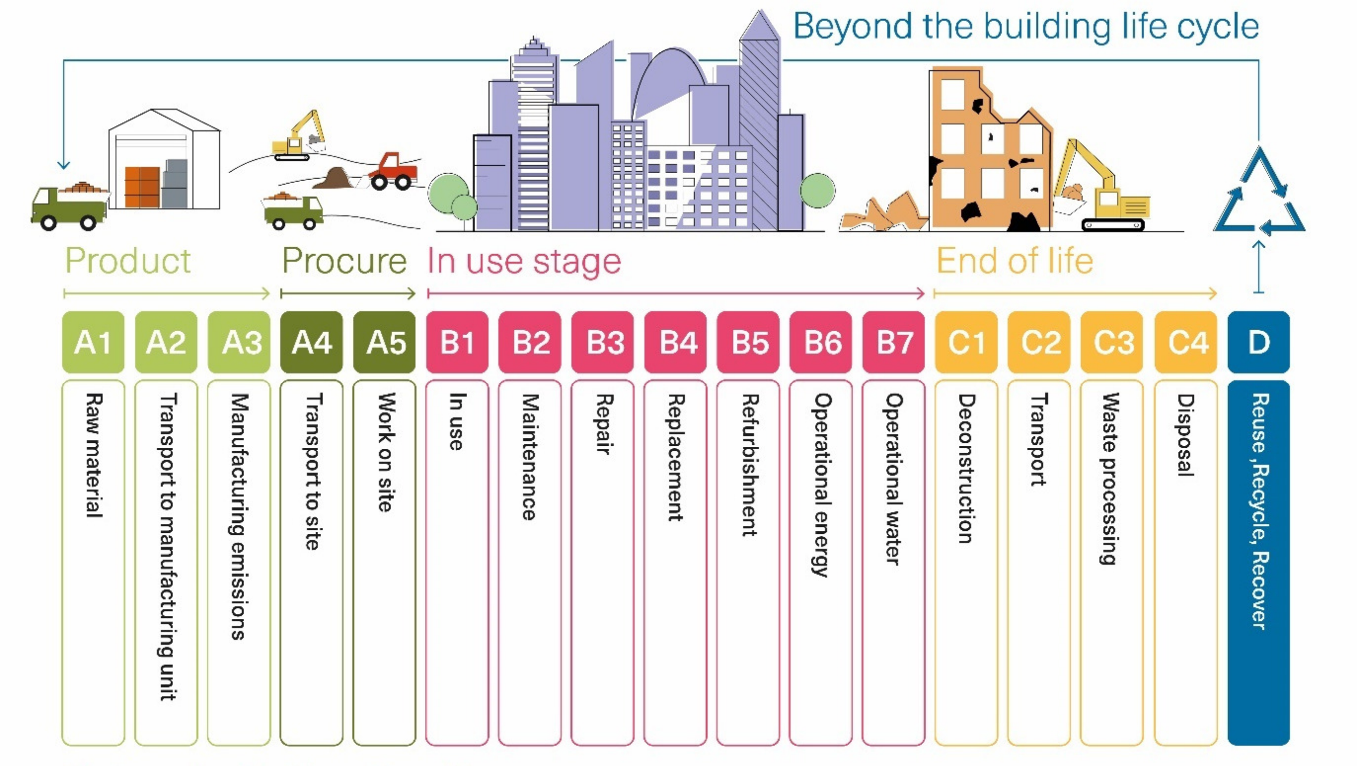

Figure 3: Life Cycle Modules as per BS EN 15978

1.4 Methodology

The assessment follows a nationally recognised assessment methodology, namely, BS EN 15978: 2011: (Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method).

Underpinning BS EN 15978 is the RICS Professional Statement: Whole Life Carbon assessment for the built environment (referred to as the RICS PS for the remainder of this document). The RICS PS serves as a guide to the practical implementation of the BS EN 15978 principles. It sets out technical details and calculation details and was used as the methodology for the assessment.

This study covers the following,

- Embodied carbon at Practical Completion (EC-PC);
- Embodied carbon over the life-cycle (EC-LC);
- Operational carbon over the life-cycle;
- Carbon reduction options.

The following building components are included in the assessment:

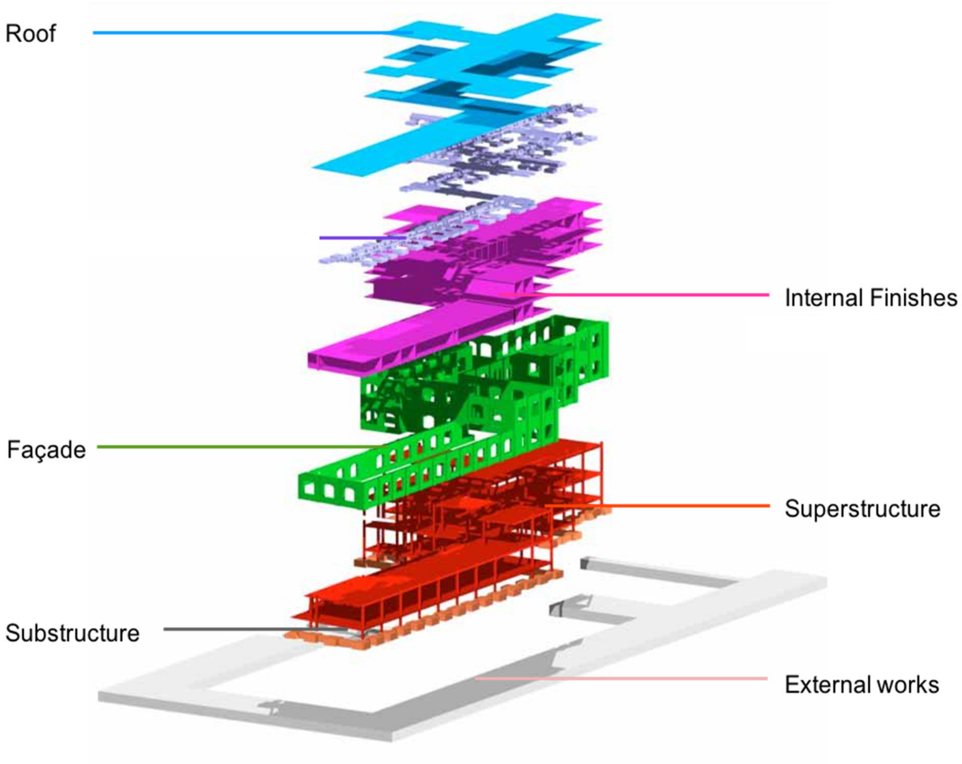

Figure 4: Indicative 3D Model of scope of elements analysed for embodied carbon Impact

Items excluded from the assessment:

- Furniture
- Sanitary ware
- Soft landscape and Water feature

1.5 Data sources

The project information (including Gross Internal Area) is based on the following drawing provided by Stephen George architects;

- 16-184-F013-001-Y-Illustrative Masterplan

Due to the early stage of the project, there is very little data available relating to quantities. Cundall has recently collaborated with the Greater London Authority to develop embodied carbon benchmarks of various building types in the UK, the benchmark figures of warehouse buildings have been used to calculate a preliminary estimate of embodied carbon at practical completion, and over the entire life-cycle.

To estimate operational carbon emissions, gas and electricity benchmarks from CIBSE Guide F, Table 20.20 for an industrial warehouse were used.

2.0

Embodied Carbon Assessment

2.0 Embodied Carbon Assessment

2.1 Assessment Result

The proposed plot consists of undeveloped land and as such it was deemed unnecessary to establish the baseline emissions for the existing site. Table 1 to 7 below itemise the embodied carbon emissions of the each plot of the proposed Six56 site at Practical Completion (EC-PC). Table 8 provides the same for the entire site, and Table 9 provides a breakdown of whole-life carbon for the entire site over a Life Cycle period of 60 years (EC-LC).

Based on the benchmark values, most of the development's embodied carbon emissions over its life cycle occur at practical completion stage (>60%), with the high values being associated with structural elements, façade and building services. The embodied carbon of permanently fixed structural items will remain roughly constant between practical completion and over the life cycle. On the other hand, the embodied carbon of fittings, internal finishes and services increases over the building life cycle due to replacement events.

Plot 1	Benchmark kg.CO_2e/m2 GIA	kg.CO_2e
Substructure	118	33,973,226.60
Superstructure	287	82,629,796.90
Finishes	82	23,608,513.40
Services (MEP)	24	6,909,808.80
External Works	99	28,502,961.30
Embodied Carbon at Completion	**610**	**175,624,551**

Table 1: Embodied Carbon at Completion Breakdown by Building Element (Plot 1)

Plot 2	Benchmark kg.CO_2e/m2 GIA	kg.CO_2e
Substructure	118	9,493,560.20
Superstructure	287	23,090,269.30
Finishes	82	6,597,219.80
Services (MEP)	24	1,930,893.60
External Works	99	7,964,936.10
Embodied Carbon at Completion	**610**	**49,076,879.00**

Table 2: Embodied Carbon at Completion Breakdown by Building Element (Plot 2)

Plot 3	Benchmark kg.CO$_2$e/m2 GIA	kg.CO$_2$e
Substructure	118	3,370,976.80
Superstructure	287	8,198,901.20
Finishes	82	2,342,543.20
Services (MEP)	24	685,622.40
External Works	99	2,828,192.40
Embodied Carbon at Completion	**610**	**17,426,236.00**

Table 3: Embodied Carbon at Completion Breakdown by Building Element (Plot 3)

Plot 4	Benchmark kg.CO$_2$e/m2 GIA	kg.CO$_2$e
Substructure	118	10,977,068.00
Superstructure	287	26,698,462.00
Finishes	82	7,628,132.00
Services (MEP)	24	2,232,624.00
External Works	99	9,209,574.00
Embodied Carbon at Completion	**610**	**56,745,860.00**

Table 4: Embodied Carbon at Completion Breakdown by Building Element (Plot 4)

Plot 5	Benchmark kg.CO$_2$e/m2 GIA	kg.CO$_2$e
Substructure	118	3,908,195.40
Superstructure	287	9,505,526.10
Finishes	82	2,715,864.60
Services (MEP)	24	794,887.20
External Works	99	3,278,909.70
Embodied Carbon at Completion	**610**	**20,203,383.00**

Table 5: Embodied Carbon at Completion Breakdown by Building Element (Plot 5)

Plot 6	**Benchmark kg.CO$_2$e/m2 GIA**	**kg.CO$_2$e**
Substructure	118	2,419,472.00
Superstructure	287	5,884,648.00
Finishes	82	1,681,328.00
Services (MEP)	24	492,096.00
External Works	99	2,029,896.00
Embodied Carbon at Completion	**610**	**12,507,440.00**

Table 6: Embodied Carbon at Completion Breakdown by Building Element (Plot 6)

Plot 7	**Benchmark kg.CO$_2$e/m2 GIA**	**kg.CO$_2$e**
Substructure	118	1,052,406.60
Superstructure	287	2,559,666.90
Finishes	82	731,333.40
Services (MEP)	24	214,048.80
External Works	99	882,951.30
Embodied Carbon at Completion	**610**	**5,440,407.00**

Table 7: Embodied Carbon at Completion Breakdown by Building Element (Plot 7)

Entire Site	**Benchmark kg.CO$_2$e/m2 GIA**	**kg.CO$_2$e**
Substructure	118	33,973,273.8
Superstructure	287	82,629,911.7
Finishes	82	23,608,546.2
Services (MEP)	24	6,909,818.4
External Works	99	28,503,000.9
Embodied Carbon at Completion	**610**	**175,624,551**

Table 8: Embodied Carbon at Completion Breakdown by Building Element (Entire Site)

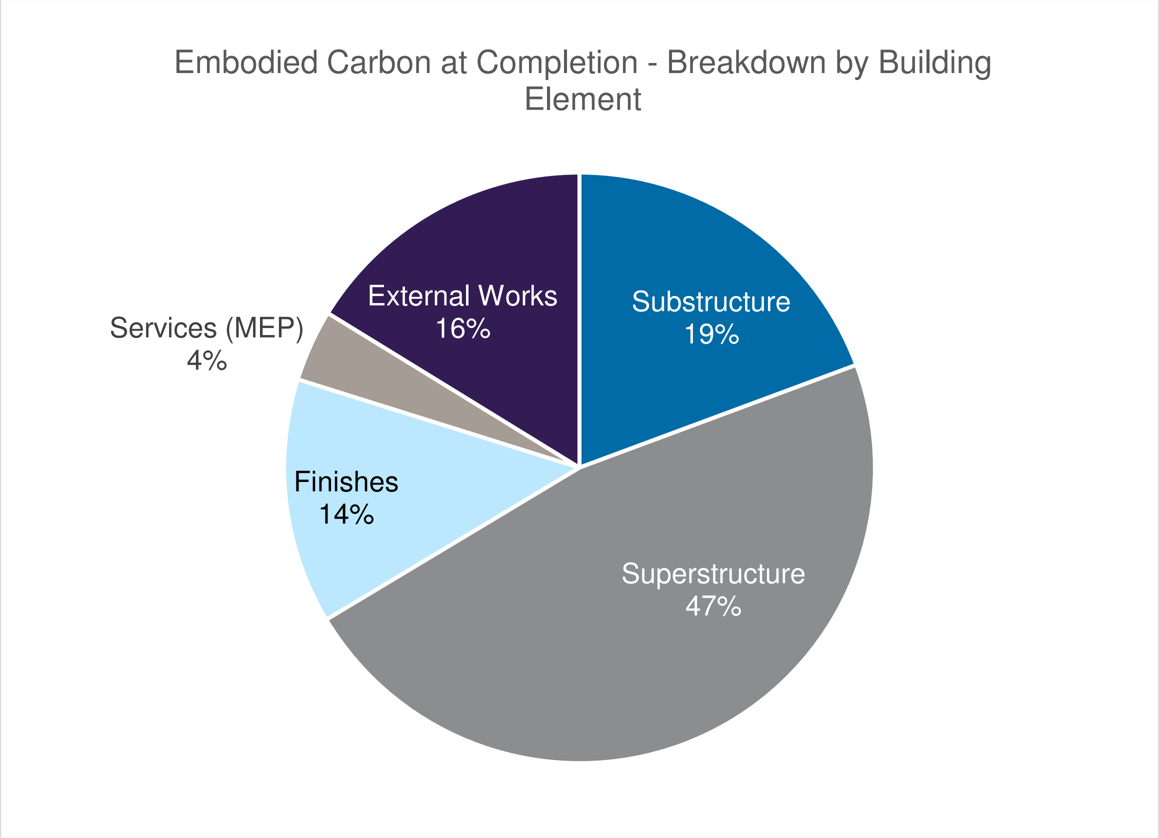

Figure 6: Embodied Carbon at Practical Completion – Breakdown by Building Element

Entire Site	**Benchmark**	**kg.CO_2e**
Embodied Carbon at Completion	610 kg.CO_2e/m^2 GIA	175,624,551
Embodied Carbon over Life-Cycle	365 kg.CO_2e/m^2 GIA	105,086,822
Operational Carbon over Life-Cycle	44/164kwh/m^2 GIA /year (Electricity/Gas)	573,556,142
Total Whole-Life Carbon	**2,967 kg.CO_2e/m2 GIA**	**854,267,151**

Table 9: Total Whole-Life Carbon

The whole life-cycle carbon emissions are equivalent of:

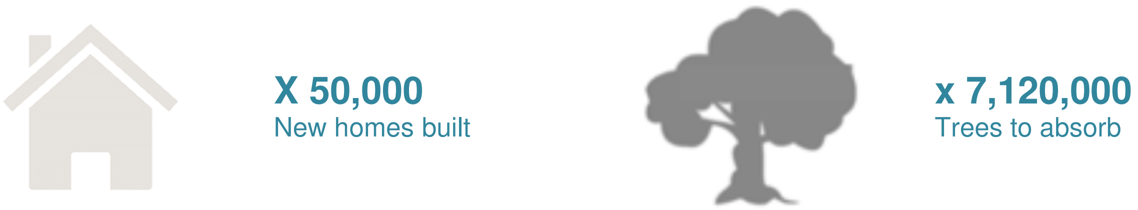

Figure 7: Carbon equivalent

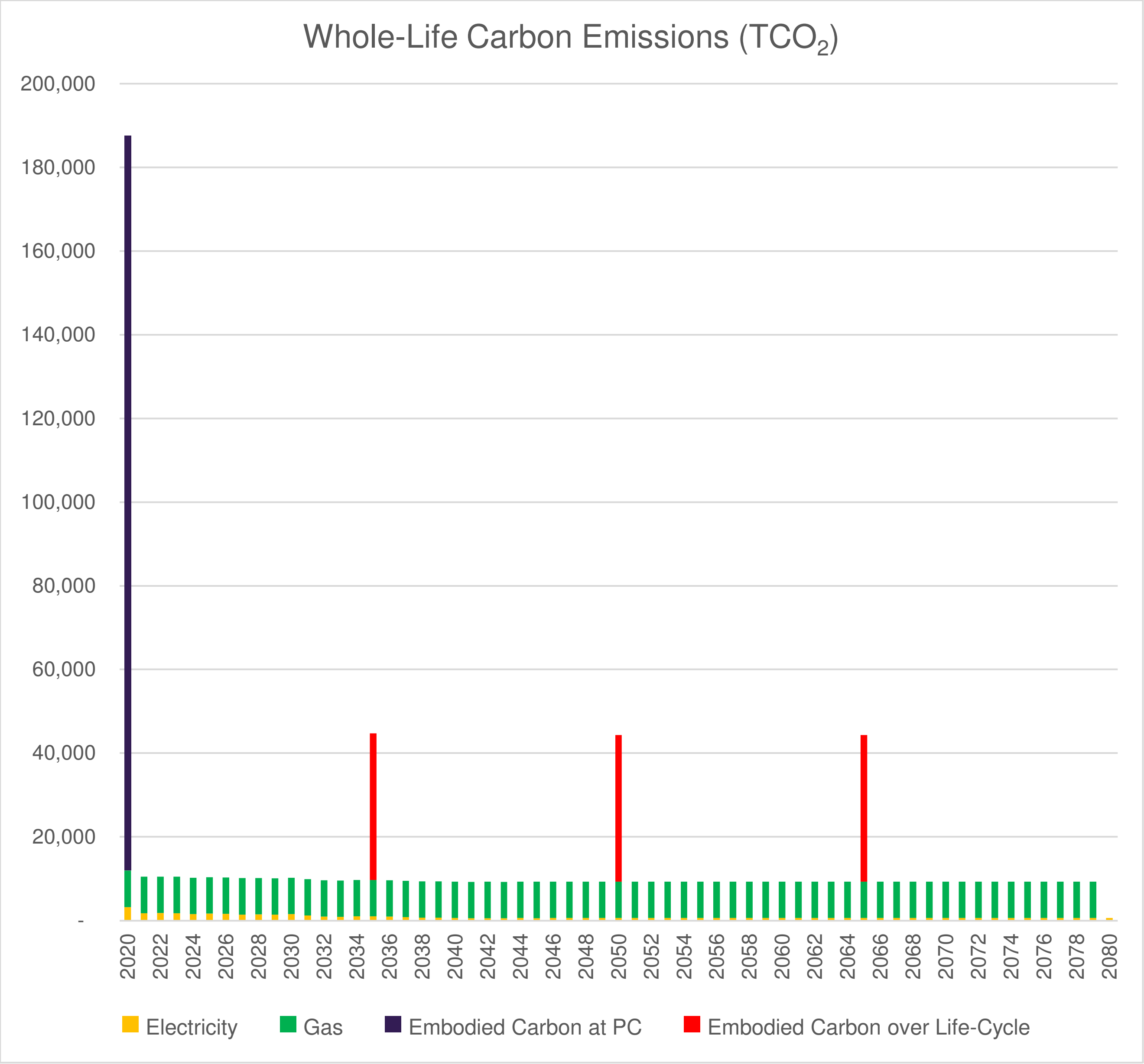

Figure 8: Whole-Life Carbon over 60 Year Life Cycle

2.2 Comparison with Benchmark Projects

In order to provide context for the embodied carbon emissions benchmark for the development, the table below compares the average carbon emissions per square metre (GIA) to a few other industrial projects which Cundall has previously assessed.

Building 1 was built with reclaimed steel structure whilst all other projects were built with steel frame with concrete foundations and metal panels for rainscreen, there are variations of office areas between them. It can be seen that the whole life embodied carbon emissions vary amongst projects. The actual emissions will obviously be subject to the real design and material choices. In order to enable the development to become ultra-low carbon, we have proposed a series of best practice materials and potential changes to the construction methods that could reduce the projects embodied carbon.

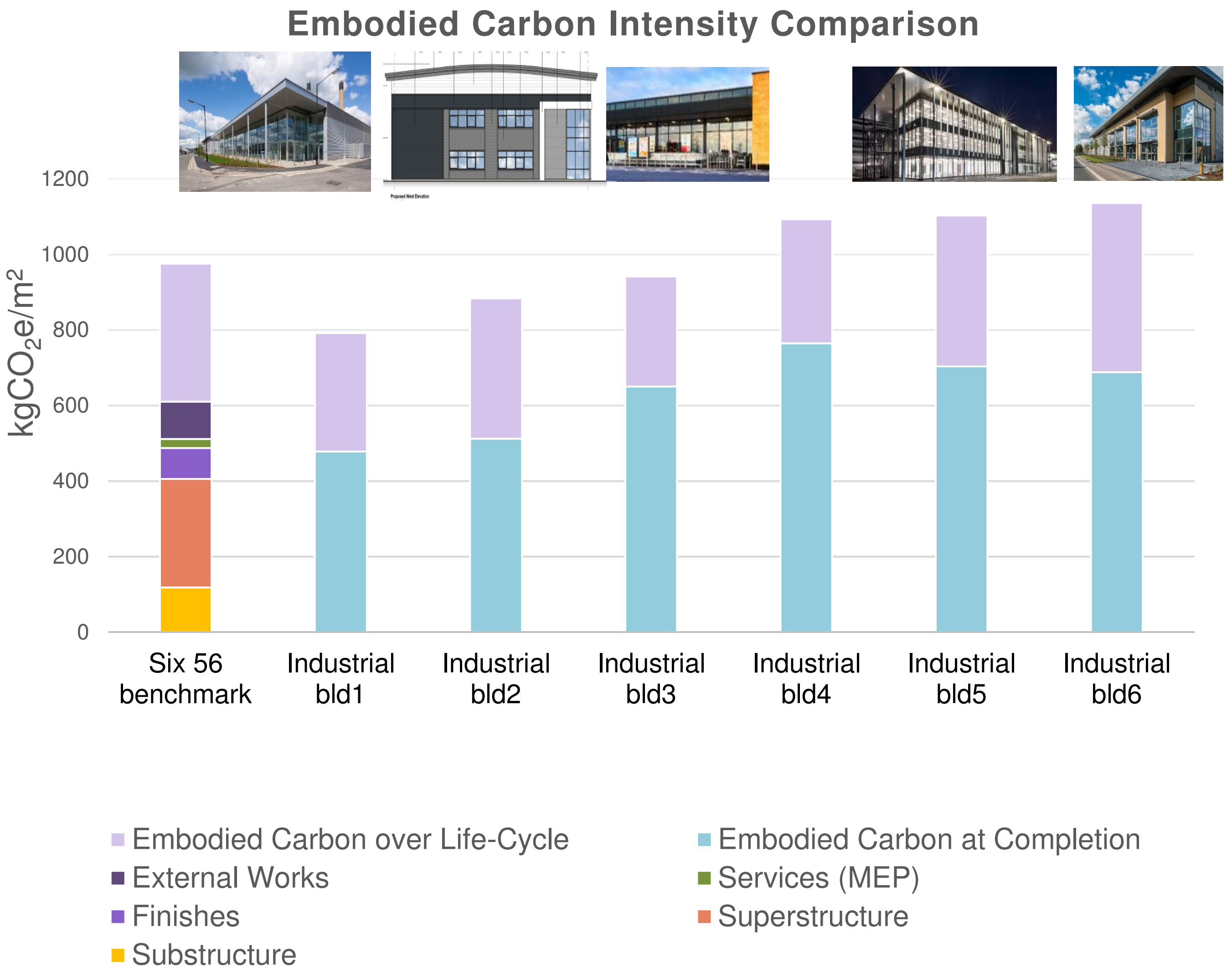

Figure 9: Indicative 3D Model of scope of elements analysed for embodied carbon Impact

3.0

Embodied Carbon Reduction Option

3.0 Embodied Carbon Reduction Options

As the project progresses, more accurate information can allow comparison to benchmark projects to identify carbon 'hotspots' of the project and a series of carbon reduction options which could be investigated in order to reduce its life cycle carbon impact. The viability and effectiveness of the options below will depend on future, more detailed analysis.

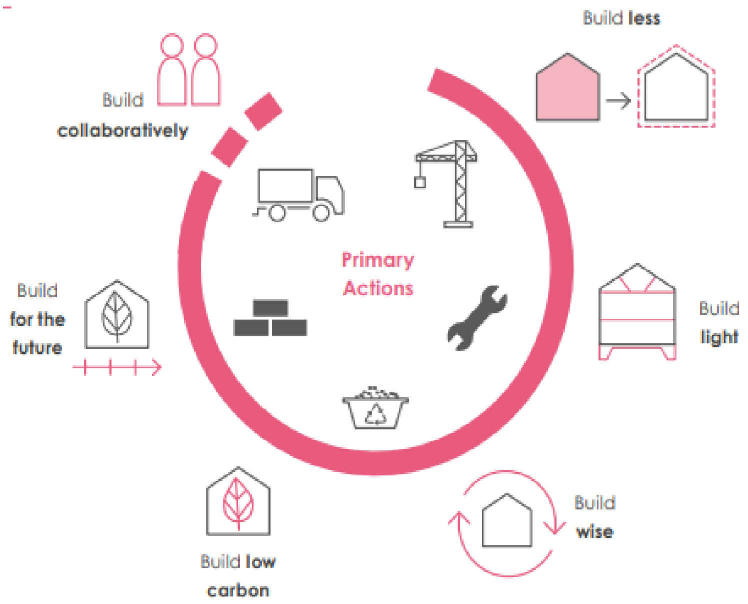

Figure 10: Embodied Carbon reduction actions from LETI embodied carbon primer.

3.1 Design for Manufacture and Assembly (DfMA)

DfMA is a design approach that focuses on ease of manufacture and efficiency of assembly. By simplifying the design of a product it is possible to manufacture and assemble it more efficiently, in the minimum time and at a lower cost. In terms of embodied carbon, by ease the manufacture of the parts, it will effectively reduce the embodied carbon from material wastage during construction and reduce emission from sitework by ease of assembly during construction.

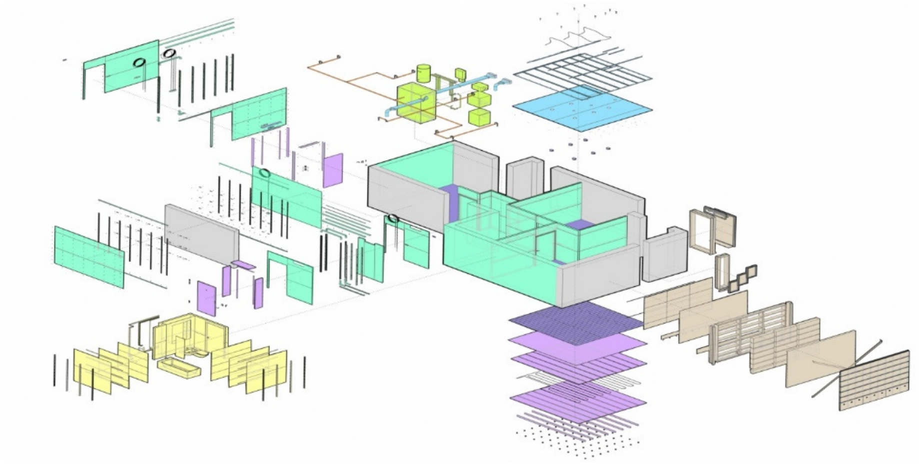

Figure 11: Design for manufacturing and assembly concept (Image from Bryden Wood Architect).

3.2 Embodied carbon reduction of structural options:

A large amount of concrete will be required specified for substructure and floor slabs, considering high cement replacement content with GGBS (Ground Granulated Blast-furnace Slag) or PFA (Pulverised Fuel Ash) could also deliver great savings. Also consider sourcing concrete from nearby concrete plant (site dependent) will also reduce the emission from transportation.

Figure 12: Concrete mix with high cement replacement.

Pre-cast slabs are good in terms of reducing concrete wastage and offer great potential for end of life recycling and reuse. But in some cases, precast manufacturers do not usually include cement replacement in their manufacturing process, it will be worth requesting this early in the design stage.

Structural steel is another 'carbon hotspot' of the development, souring steel made from recycled materials (produced from Electric Arc Furnace) could reduce its impact significantly.

Another effective way to reduce embodied carbon is to use structural timber like Glulam or CLT (cross laminated timber), as timber is an organic material and sequestrates carbon during its growth and could be considered as ‘carbon neutral’ or ‘carbon negative’.

Figure 13: Example of open space building using glulam structure

3.3 Embodied carbon reduction of building envelope:

The nature of the building function has led to fewer glazed areas which making it inherently low carbon and will require less maintenance. The windows should be PPC Aluminium, which is much better than Anodized aluminium windows. Considering timber framed or combi windows will further improve this.

For aluminium and other metal elements (cladding, mesh and gutter etc), consider products made from recycled materials.

Wall and roof panels are specified with products using PIR insulation based (embodied carbon approx. 35kgCO_2/m^2) Consider panels using mineral wool (i.e. Rockpanel, embodied carbon approx. 12 kg CO_2e/m^2) would achieve reasonable reductions.

Figure 14: Example of timber and aluminium combi window

Figure 15: Example of Rockpanel with Rockwool insulation.

3.4 Embodied carbon reduction of internal wall and finishes:

Mineral fibre ceiling does not have a high carbon footprint, however exposed ceilings would not only reduce embodied carbon but also reduce maintenance over life cycle.

Blockwork: Consider blockworks that made from recycled aggregate and using cement replacement (i.e. Forterra has 30% GGBS cement replacement and Environ block contains 70% recycled content)

Change from rockwool insulation to Hempcrete (carbon negative).

Change floor finishes to cork flooring.

Figure 16: Example of hempcrete.

Figure 17: Example of cork flooring

3.5 Other areas of improvement:

Low Carbon MEP systems: Consider alternative materials to MEP equipment like cardboard duct or fabric duct. Consider high recycled content in trunking, cable trays, pipes and other 'static' MEP equipment.

External work (asphalt paving) to consider low temperature tarmac (i.e. Eco Asphalt, mixing temperature up to 40ºc lower than standard asphalt mixes or Hanson ERA range).

Figure 18: Example of alternative ductwork

Embodied carbon reduction summary:

	Options	Specification
1	Substructure	>70% Ground Granulated Blast Furnace Slag (GGBS) for concrete
2	Concrete Floor	Insitu concrete to have >70% GGBS
3	Concrete Floor	Consider precast slab for ease of recycling
4	Steel frame	Structural steel made from recycled materials (produced from Electric Arc Furnace)
5	Steel frame	Building structure to be Glulam beams and cross laminated timber (CLT) walls
6	Change from timber formwork to plastic/steel formwork	Plastic formwork could be reused for more than 100 times compare to 3 times for timber ones, especially for projects with repetitive areas
7	Windows	Change aluminium window frame to timber frame
8	Metal elements (Aluminium cladding, gutter etc).	Consider products made from recycled materials
9	Roof panel and Wall Panels	Change from PIR insulation based panel (Kingspan KS1000) to Rockwool based products (i.e. Rockpanels)
10	Blockwork:	Consider blockworks that made from recycled aggregate and using cement replacement (i.e. Forterra has 30% GGBS cement replacement and Environ block contains 70% recycled content)
11	Flooring	Change from carpet to cork flooring
12	MEP systems	Consider Cardboard duct or fabric duct.
13	MEP systems	High recycled content in trunking, cable trays, pipes etc.
14	Externa work	Asphalt paving Low temperature tarmac (Eco Asphalt, up to 40ºc lower than standard asphalt mixes)
15	Sitework	Using renewable energy (I.e. biodiesel and ecotricity etc.) to reduce carbon emissions during construction

Table 10: Embodied Carbon reduction options

**Note: not all the option savings could be aggregated.*

4.0

Conclusions

4.0 Conclusions

The recent update to the Climate Change Act requires that the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline is increased from 80% to 100%. National Planning Policy Framework, Section 14: '*Meeting the challenge of climate change, flooding and coastal change',* calls for projects to take a proactive approach to climate change mitigation and adaptation. Paragraph 150b states that a new development should be planned for in ways that;

- Can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the government's policy for national technical standards.

This assessment reviewed the potential carbon footprint of the proposed Six56 site. The projected total whole-life carbon emissions are estimated as 862,961 tonnes which is comprised of;

- 175,625 tonnes (610 kg.CO_2e/m^2) of embodied carbon at Practical Completion;
- 105,087 tonnes (365 kg.CO_2e/m^2) of embodied carbon over the life-cycle; and
- 582,250 tonnes (2109 kg.CO_2e/m^2) of operational carbon over the life-cycle.

Further analysis of the development's 'carbon footprint' should be carried out when more detailed project information is established. Using bills of quantities and material schedules will allow a more detailed calculation of total embodied carbon, which can then be compared with benchmark data.

By establishing the whole-life carbon of the site and implementing the carbon reduction options discussed in this report, the project can meaningfully reduce its environmental impact. The assessment identified a series of material alternatives that were intended to provide a useful demonstration of possible options. Most of the low carbon options should be cost neutral or better and, for live projects, we would normally coordinate the carbon reduction measures with the QS and/or the tender process to ensure the recommendations are fully reviewed.

Cundall Johnston & Partners LLP
Exchange Place One 1 Semple Street Edinburgh
EH3 8BL Scotland United Kingdom Tel:+44
(0)131 524 3500

Asia Australia Europe MENA UK and Ireland
www.cundall.com

ONE PLANET LIVING | An initiative by Bioregional