

Embodied Carbon Assessment

Extension to existing Spring Park data centre campus.
ARK Data Centres, Spring Park, P6 building.

Land South of Westwells Road,
Neston, Corsham, UK.

Dario Arevalo
Sustainability Consultant
Focus ED
Director

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1. INTRODUCTION

ARK data centres have appointed Focus ED as the Sustainability Consultant of the Spring Park campus in Corsham, England. As part of the campus on Westwells Road, ARK is looking to secure an extension of the existing Spring Park development, which is proposed as the 'Spring Park Expansion - P6 data centre building'.



Figure 1. Spring Park extension proposal

The design for the proposed P6 building is currently at RIBA Stage 2. The project opportunities are being considered, and the construction methodology and material selection are being reviewed to guarantee maximum performance and durability. Simultaneously, the project's sustainability aspirations are being revised, including the overall embodied carbon impact from the proposed building.

Previous ARK data centre buildings in Spring Park (P1-P4) have been constructed using modular elements with a robust steel structure, significantly minimising the reliance on concrete, which is known to contribute the highest levels of embodied carbon in traditional construction. This approach reduces the overall carbon footprint of the data centre buildings and enhances efficiency in the building process, allowing for quicker assembly and less waste.

This report quantifies the total embodied carbon of materials from the proposed P6 building (Building Life Cycle Stages A1-A5), considering the level of definition at the Concept Stage. Once the embodied carbon of the current design has been quantified and considering the early stage of the project, this analysis aims to explore and find alternatives to replace the construction elements that count the significant carbon content in the building.

This embodied carbon assessment is part of a continuous iterative exercise to inform the design team and help to find the most sustainable material solutions for the proposed building.

2. METHODOLOGY

This Embodied Carbon Assessment report responds to the Wiltshire Local Plan Review, particularly Policy 4- Addressing Climate Change and Policy 87 Embodied Carbon:

Policy 4- Addressing Climate Change

Development proposals must support a move to carbon neutrality and adaptation to climate change.

E. Proposals for new development will be required to demonstrate through a Sustainable Energy Statement:

i). how it will take account of embodied carbon, contribute to mitigating and adapting to climate change and to meeting targets to reduce carbon dioxide emissions having regard to the above criteria (in accordance with Policy 87 - Embodied carbon).

Policy 87- Embodied carbon

*Proposals for major residential and/or non-residential development will need to be supported by an Embodied Carbon Assessment that demonstrates a score of **less than 900kg/sqm of carbon** can be achieved within the development of the substructure, superstructure, and finishes.*

In addition to the Sustainable Energy Statement for the proposal, this report quantifies the embodied carbon of the proposed building. The analysis demonstrates that the CO₂ emissions of the proposal are below the target levels, identifying the construction elements that bring the highest carbon content to be reviewed through upcoming stages and looking for a better alternative to reduce the embodied carbon even further.

Following Policy 87, Section 5.114, this assessment quantifies the embodied carbon emissions resulting from materials, production and disposal (A1-3 'Cradle to Gate' + A4-5 'Cradle to Practical Completion of Works'), assessing the construction materials used in substructure, superstructure and finishes.

The analysis follows the recommended RICS guidelines to calculate Embodied Carbon and BS EN 15978:2011 standard that set out the principles for the life cycle assessments in the construction industry:

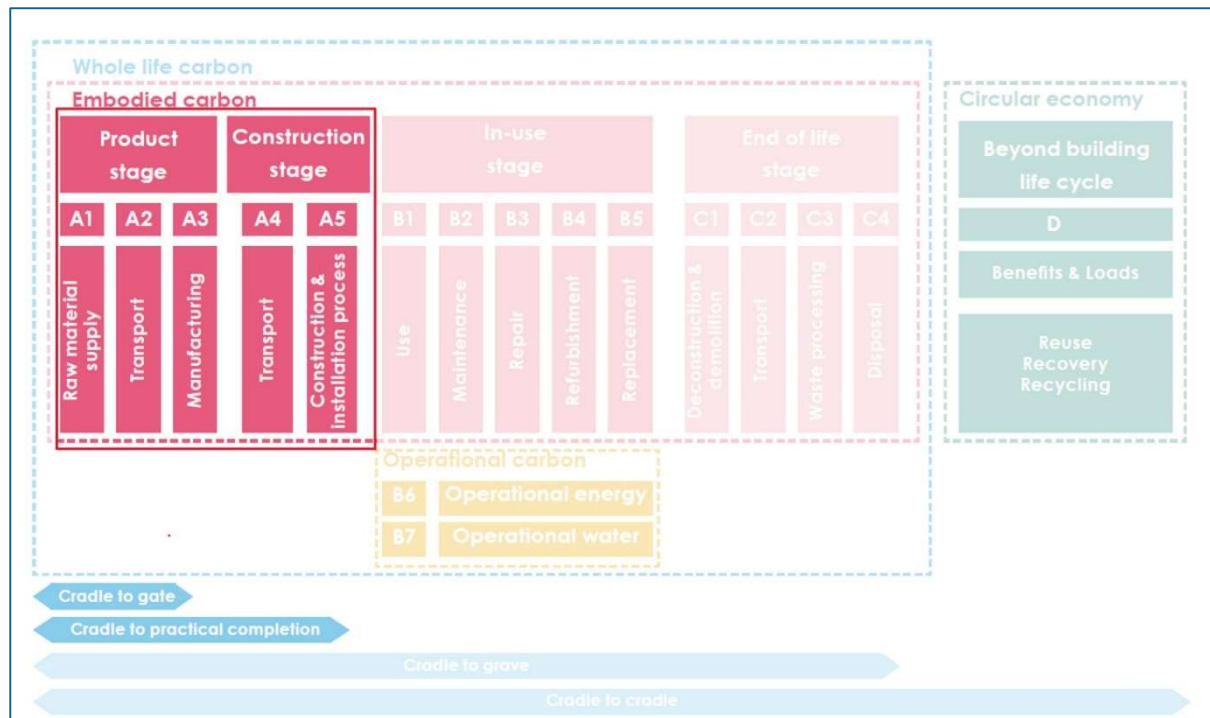


Figure 2. Embodied Carbon Assessment. A1-A5 stages. Image credits: LETI Embodied Carbon Primer, LETI.

The analysis consists in the iteration of two different options to understand the impact of the embodied carbon of the proposed building, and at the same time looking for further improvements, as follows:

Application for Spring Park extension. P6 data centre building development. RIBA Stage 2. Net floor area for Embodied Carbon calculation 23.500m ²		
Scenario 1	Proposed building (RIBA Stage 2)	Using steel structure.
Scenario 2	Optimised design	Iteration reducing carbon emissions from Scenario 1. Replacing the material elements that show the highest carbon contribution.

Material quantities and construction elements are obtained from the early-stage design (RIBA Stage 2) from the info received by Bladeroom (data centre modules) and Hale (ancillary building).

Calculations have been developed using One Click LCA tool, as a recognised software (EN 15978 and RICS compliant) to measure the environmental impact and life cycle assessment of construction elements. Based on the RICS guidelines, the following categories have been considered for the assessment:

Carbon hotspots (shown in grey) – carbon critical elements which RICS recommends to be included in embodied carbon calculations delivered by quantity surveyors.

Building components	Carbon critical elements* which RICS recommends to be included in embodied carbon calculations delivered by quantity surveyors
0 Facilitating works	
1 Substructure	Foundations
	Basement retaining walls
	Ground floor construction
2 Superstructure	Frame
	Upper floors
	Roof
	Stairs and ramps
	External walls
	Windows and external doors
	Internal walls and partitions
3 Internal finishes	Wall finishes
	Floor finishes
	Ceiling finishes
4 Fittings, furnishings and equipment	
5 Services**	
6 Prefabricated buildings and building units	
7 Work to existing buildings	
8 External works	Roads, paths and pavings
	External drainage
	External services

* The selected carbon hotspots should be measured net where applicable (e.g. external walls should be measured deducting openings for windows and external doors).

** Although detailed studies have shown that services can sometimes contribute up to 15 per cent of the overall embodied carbon footprint, they are extremely complex to assess and the mitigation potential is very limited.

Figure 3. Embodied Carbon Building Components for calculation. Image credits: RICS Methodology to Calculate Embodied Carbon of Materials, (RICS, IP 32/2012).

The level of project definition for the calculations corresponds to the expected detail at early stage (RIBA Stage 2). At the same time, the number of assumptions for the analysis is minimal, and does not deviate from the construction elements verified on previous ARK buildings in the Spring Park campus.

3. RESULTS

The analysis demonstrates that the resultant embodied carbon for the proposed building (**414.06 kgCO₂e/m²**) is lower than the industry benchmarks (RICS, LETI) and significantly lower (54% reduction) than the recommended levels by the Wiltshire Local Plan Review, Policy 87(900 kgCO₂e/m²). The following summarises the results from the embodied carbon calculations:

Application for Spring Park extension. P6 data centre building development. - RIBA Stage 2. Net floor area for Embodied Carbon calculation 23.500m ²			
Iteration	Version	Comments	Embodied Carbon results (A1-3 + A4-5)
Scenario 1	Proposed building (RIBA Stage 2)	Using steel structure.	414.06 kgCO₂e/m² 54% reduction from Local Plan target
Scenario 2	Optimised design	Iteration reducing carbon emissions from Scenario 1. Replacing the material elements that show the highest carbon contribution.	399.37kgCO ₂ e/m ² 10% reduction from the proposed building

3.1. Proposed Building. Scenario 1

The proposed development represents a total embodied carbon of **414.06 kgCO₂e/m²** with an impact of 378.74 kgCO₂e/m² for materials ('Cradle to Gate' A1-A3 Product Stages).

It is well known that using steel is more sustainable than concrete, with a higher carbon footprint. Steel structures typically require less maintenance, contribute to improved energy efficiency, and reduce the overall volume of concrete needed, thereby minimising environmental impact. Also, as a fully recyclable material, steel presents a more sustainable option than concrete.

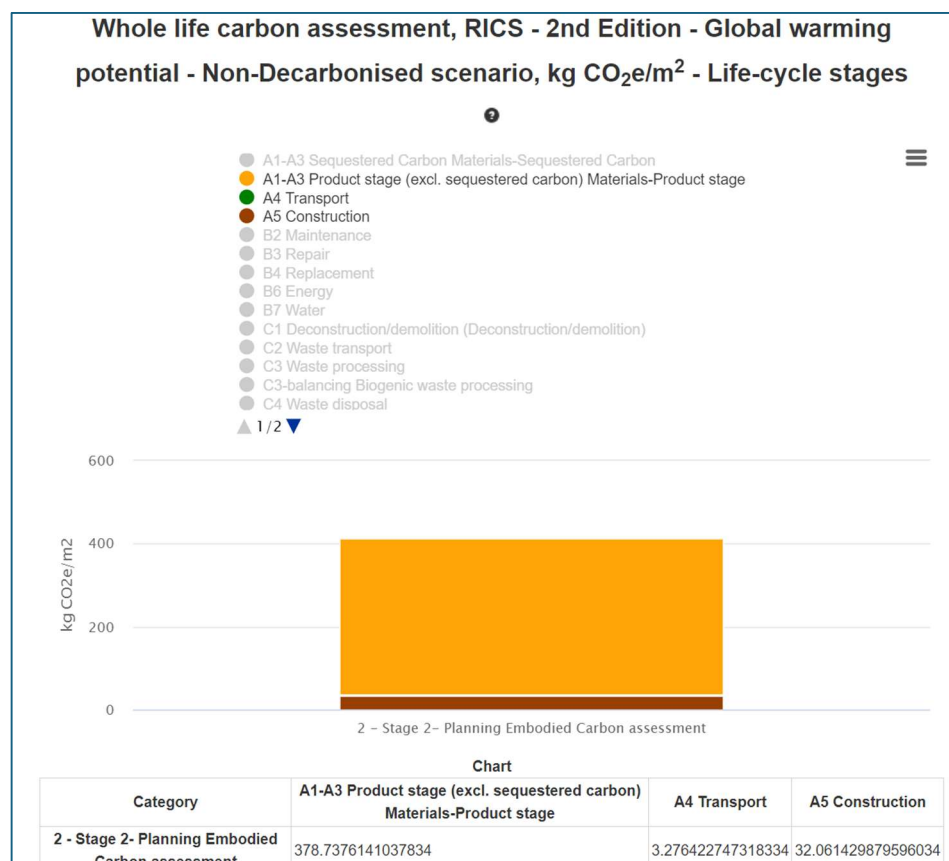


Figure 4. Proposed building. Embodied carbon assessment. Life Cycle Stages A1-A3+A4-A5

The analysis reveals that one of the construction materials with the highest carbon contributions are the floor finishes (considering its large area). This material can be reviewed to consider a substitution for a more carbon efficient alternative (as shown in Scenario 2). The embodied carbon of all materials can be reviewed in detail in Appendix A.

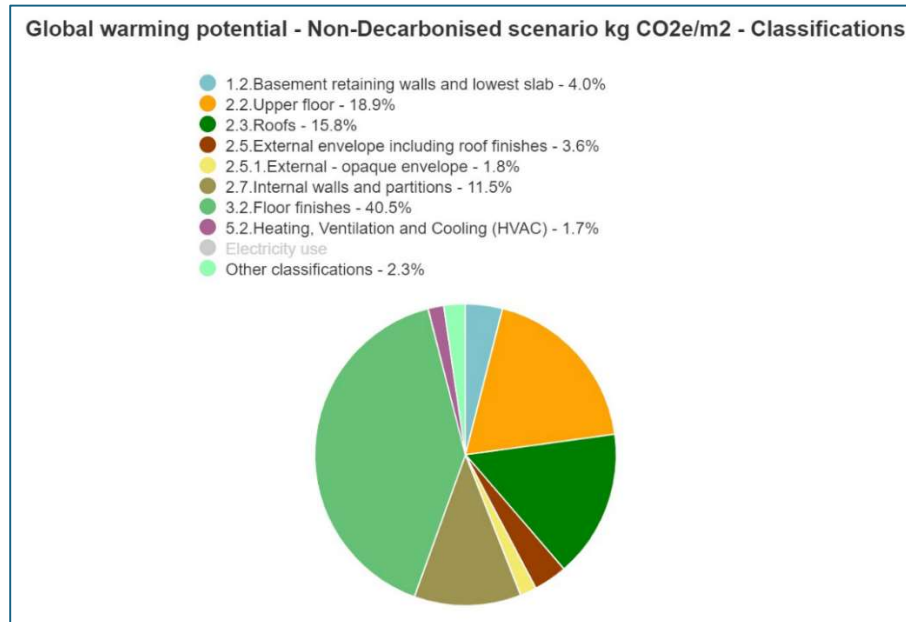


Figure 5. Proposed building. Embodied carbon by material classification

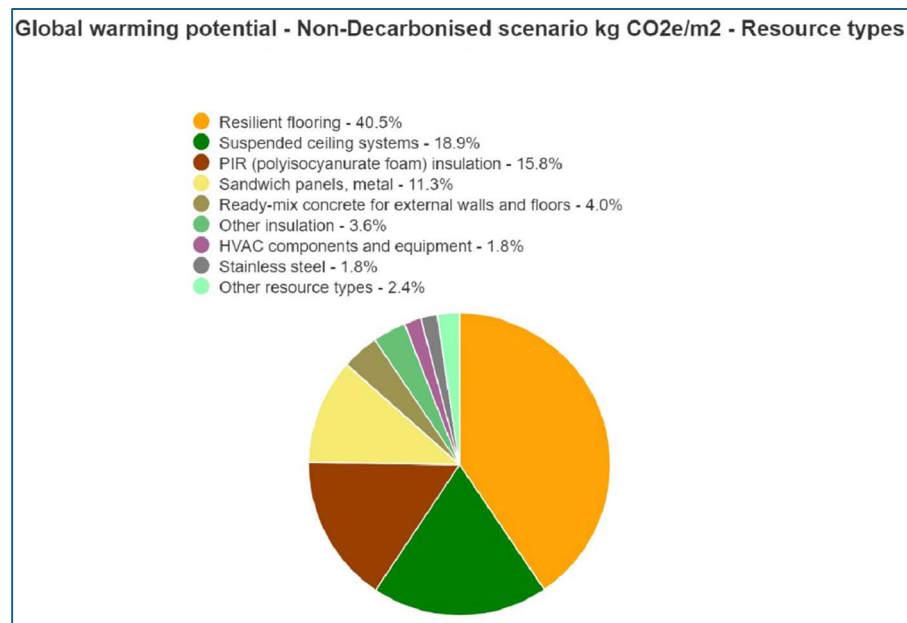


Figure 6. Proposed building. Embodied carbon by resource types

3.2. Optimised Design. Scenario 2.

Scenario 2 has been produced based on the current design (Scenario 1) with the aim of exploring options for reducing the embodied carbon for the proposed building. This scenario shows a total **399.37 kgCO₂e/m²**, equivalent to 10% carbon reduction from the proposed building, replacing the material element with the highest carbon contribution (PVC flooring for an option with same durability properties and more recycled content):

Homogeneous PVC flooring, 2 mm, 2.80 kg/m2, Palettone PUR (Polyflor)

Homogeneous PVC flooring, 2 mm, 2.8 ?
84798
m2
0.35t - 13%
Polyflor Floor finishes
3.2.Floor finishes

Foam backed vinyl (PVC) flooring ?
84798
m2
0.22t - 8%
PVC recycled flooring
3.2.Floor finishes

Foam backed vinyl (PVC) flooring, heterogeneous, 2.6 mm, 1.8 kg/m², TX Classic (Tarkett)

This calculation suggests that exploring further alternatives during upcoming project phases will help to reduce the embodied carbon of the proposed building.

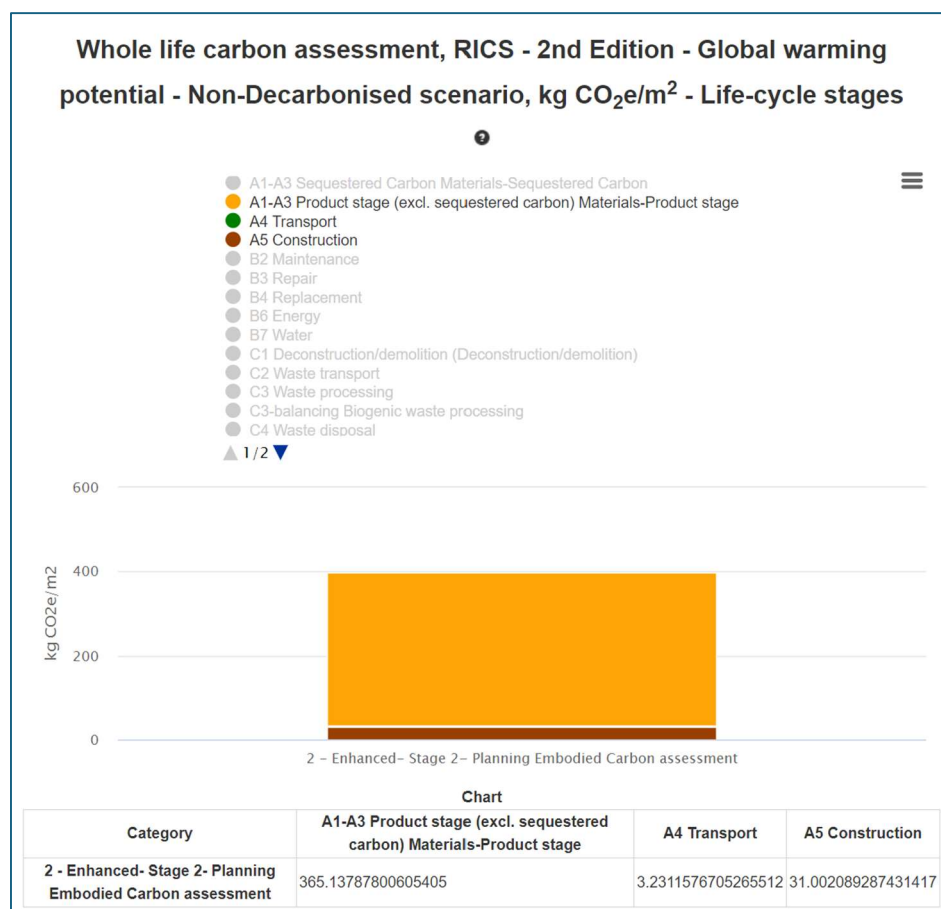


Figure 7. Optimised design. Embodied carbon assessment. Life Cycle Stages A1-A3+A4-A5

The Enhanced scenario shows a significant reduction in the embodied carbon for 3.2 Floor Finishes from 40.5% to 29.7% total embodied carbon.

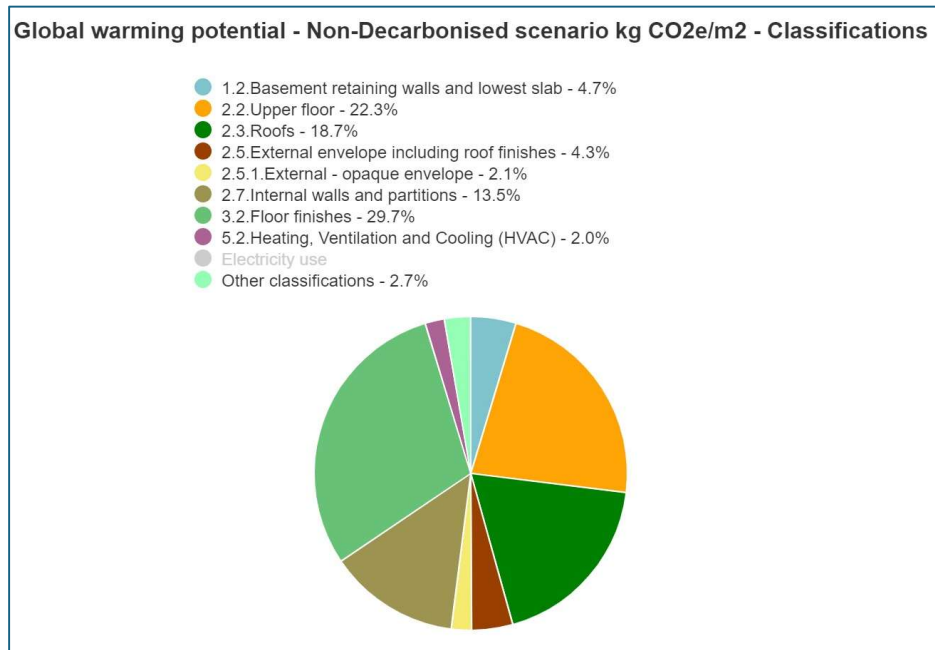


Figure 8. Optimised design. Embodied carbon by material classification

Similarly, in the classification by resource type, after the material replacement, the total embodied carbon content for Resilient Flooring is reduced by 27% :

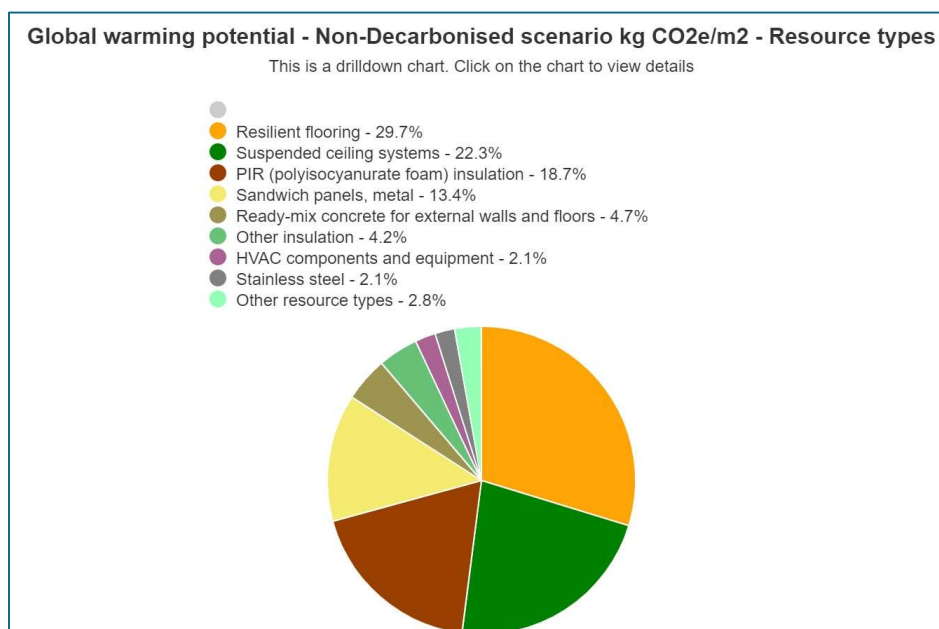


Figure 9. Optimised design. Embodied carbon by resource types.

4. CONCLUSION AND RECOMMENDATIONS

This embodied carbon assessment is expected to be implemented as a live document that evolves through the project design stages until construction. Furthermore, to understand the whole life carbon of the building (in addition to this embodied carbon assessment A1-A5), is essential to predict accurately the impact throughout the continuous life cycle stages: In-use stage (B1-B5), Operational carbon (B6-B7), End of life stage (C1-C4), Circular Economy (Stage D-Reuse-Recovery-Recycling). Effective carbon measurement and early corrective actions will help to anticipate and meet the targets for a zero-carbon environment.

It is recommended that the design team continue exploring alternatives to reduce the embodied carbon of the construction materials. Exploring material options with high durability (to avoid replacement) and, at the same time, specifying materials with robust Environmental Product Declarations (EPD) that show the lowest carbon content from manufacturing process and components with a high amount of recycled content.

Finally, it is also recommended to review the design and incorporate construction solutions that facilitate the easy disassembly of spaces and materials for reuse in the future.

REFERENCES

- **Wiltshire Council.** *Wiltshire Local Plan Pre-Submission Draft 2020-2038 (Regulation 19).* Wiltshire Council, September 2023.
- **LETI.** *Embodied Carbon Primer,* LETI, January 2020.
- **RICS.** *Methodology to calculate embodied carbon of materials (IP32/2012),* RICS, 2012.
- **RIBA Royal Institute of British Architects.** *RIBA Plan of Work 2013 Sustainability Guide,* RIBA, 2013.
- **One Click.** *Life Cycle Assessment for Buildings. One Click,* 2021.

APPENDIX A

Top-up factor, most contributing materials

No.	Resource name	Weighting, %	Total
1	Homogeneous PVC flooring, 2 mm, 2.80 kg/m2 ?	41.1	8,286 tonnes CO ₂ e
2	Suspended metal ceiling system with acoustic insert/pad, 6.500 kg/m2 ?	19.1	3,860 tonnes CO ₂ e
3	PIR insulation boards, aluminum composite foil faced, 66 mm, L = 0.022 W/mK, R = 3 m2K/W, 2.11 kg/m2, 32 kg/m3 ?	16.1	3,241 tonnes CO ₂ e
4	Sandwich panel with insulation foam core and double steel siding, L = 0.18 W/m2k, 100 mm, 11.3 kg/m2 ?	11.5	2,314 tonnes CO ₂ e
5	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3) ?	4.0	808 tonnes CO ₂ e
6	Insulated wall/roofing cladding panel, 100 mm, 14.4 kg/m2, U 0.18 W/m2K ?	3.6	730 tonnes CO ₂ e
7	Stainless steel façade cladding panel, 9.5 kg/m2 ?	1.8	358 tonnes CO ₂ e
8	VRV Condensing unit, external body, 33.5 kW heating, 213 kg/unit, refrigerant charge 9 kg (R32) ?	1.7	345 tonnes CO ₂ e
9	Copper sheet, 1 mm, 8.96 kg/m2, 8960 kg/m3, 50% recycled ?	0.6	116 tonnes CO ₂ e
10	Cold formed aluminium sheet, 2700 kg/m3 ?	0.6	112 tonnes CO ₂ e

Figure 10. Proposed building. Most contributing materials

Top-up factor, most contributing materials

No.	Resource name	Weighting, %	Total
1	Foam backed vinyl (PVC) flooring, heterogeneous, 2.6 mm, 1.8 kg/m2 ?	30.2	5,150 tonnes CO ₂ e
2	Suspended metal ceiling system with acoustic insert/pad, 6.500 kg/m2 ?	22.7	3,860 tonnes CO ₂ e
3	PIR insulation boards, aluminum composite foil faced, 66 mm, L = 0.022 W/mK, R = 3 m2K/W, 2.11 kg/m2, 32 kg/m3 ?	19.0	3,241 tonnes CO ₂ e
4	Sandwich panel with insulation foam core and double steel siding, L = 0.18 W/m2k, 100 mm, 11.3 kg/m2 ?	13.6	2,314 tonnes CO ₂ e
5	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3) ?	4.7	808 tonnes CO ₂ e
6	Insulated wall/roofing cladding panel, 100 mm, 14.4 kg/m2, U 0.18 W/m2K ?	4.3	730 tonnes CO ₂ e
7	Stainless steel façade cladding panel, 9.5 kg/m2 ?	2.1	358 tonnes CO ₂ e
8	VRV Condensing unit, external body, 33.5 kW heating, 213 kg/unit, refrigerant charge 9 kg (R32) ?	2.0	345 tonnes CO ₂ e
9	Copper sheet, 1 mm, 8.96 kg/m2, 8960 kg/m3, 50% recycled ?	0.7	116 tonnes CO ₂ e
10	Cold formed aluminium sheet, 2700 kg/m3 ?	0.7	112 tonnes CO ₂ e

Figure 11. Optimised building. Most contributing materials

Spring Park Expansion - P6 building. - EPD summary for Embodied Carbon Assessment

Resource name	Technical specification	Product	Manufacturer	EPD program	EPD number	Environment Data Source	Standard	Verification	Year	Country	Upstream database	Density	Product Category Rules (PCR)	Notes about PCR
Aggregate (crushed gravel), generic, dry bulk density	1600 kg/m3	Aluminium framed unitized curtain wall system with clear float glass insulating unit, double glazed	One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	One Click LCA	1600	EN15804+A1	-
	4-16-4, 50.3 kg/m2, 0% recycled aluminium			One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2024	LOCAL	One Click LCA, LCA Commons		EN15804+A1, EN15804+A2	-
Cold formed aluminium sheet	2700 kg/m3		GAA	IBU	EPD-GDA-20130260-IBG1-EN	Cold-formed aluminium sheet for exterior applications, GDA (German Aluminium Association)	EN15804+A1	Third-party verified (as per ISO 14025)	2013	germany	GaBi	2720	PCR Products of aluminium and aluminium alloys, 10/2012	Only with EN15804
Copper sheet	1 mm, 8.96 kg/m2, 8960 kg/m3, 50% recycled		One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2024	LOCAL	One Click LCA	8960	EN15804+A1, EN15804+A2	-
Electricity, UK 2023	based on energy supplementary table of Whole life carbon assessment RICS, 2nd edition									unitedKingdom				
Homogeneous PVC flooring	2 mm, 2.80 kg/m2	Palettone PUR	Polyflor	Global Green Tag	PLF HP5 2022	EPD Homogeneous Flooring Palettone PUR	EN15804+A2	Third-party verified (as per ISO 14025)	2022	unitedKingdom	-		EN 15804 serves as the core Product Category Rules (PCR), Standard EN 15804+A2 2019 serves as core Product Category Rules (PCR) 1. Sub PCR FC:2022v1 Interior Floorcovering also applies 2.	Only with EN15804
Insulated wall/roofing cladding panel	100 mm, 14.4 kg/m2, U 0.18 W/m2K	BENCHMARK Quadcore Karrier	Kingspan	BRE	BREG EN EPD000166	BREGENEPD000166	EN15804+A1	Third-party verified (as per ISO 14025)	2017	unitedKingdom	ecoinvent	144	EN15804+A1	-
LPHW (low pressure hot water) fan heater, overhead mounted	1000 m3/h (588.6 ft3/min), 9 kW			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	One Click LCA		EN15804+A1	-
Oriented strand board (OSB)	8-30 mm		Nordboard, from Inverness mill	International EPD System	S-P-01850	EPD Nordboard	EN15804+A1	Third-party verified (as per ISO 14025)	2020	unitedKingdom	ecoinvent	600	PCR 2012:01 Construction products and Construction services, ver. 2.3	Only with EN15804
PIR insulation boards, aluminum composite foil faced	66 mm, L = 0.022 W/mK, R = 3 m2K/W, 2.11 kg/m2, 32 kg/m3	Eco-Versal, Eco-Deck baseboard, Eco-Cavity, Eco-Cavity Full Fill	EcoTherm	BRE	BREG EN EPD 000331	EPD EcoTherm Eco-Versal, Eco-Deck baseboard, Eco-Cavity, Eco-Cavity Full Fill	EN15804+A1	Third-party verified (as per ISO 14025)	2021	unitedKingdom	ecoinvent	32	EN15804+A1	-
Ready-mix concrete, normal-strength, generic	C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2018	LOCAL	One Click LCA	2400	EN15804+A1	-
Reinforcement steel (rebar), hot rolled, 98% scrap steel	diameter applicable range : 10 -50mm, length applicable range : 6 -18m		Celsa Steel UK	BRE	BREG EN EPD 000187	EPD Steel Products manufactured at the Rod and Bar Mill, Celsa Steel UK	EN15804+A1	Third-party verified (as per ISO 14025)	2018	unitedKingdom	ecoinvent	7850	EN15804+A1	-
Residential garage overhead sectional door with PUR core	2500x2125 mm, 123 kg/unit		One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2024	LOCAL	One Click LCA, LCA Commons		EN15804+A1, EN15804+A2	-
Sandwich panel with insulation foam core and double steel siding	L = 0.18 W/m2K, 100 mm, 11.3 kg/m2	QuadCore KS1000RW Wall Panel	Kingspan Insulated Panels	EPD Hub	HUB-0290	EPD Kingspan QuadCore KS1000 RW – 100 mm Kingspan Insulated Panels	EN15804+A1, EN15804+A2	Third-party verified (as per ISO 14025)	2023	unitedKingdom, OCLEPD	ecoinvent		PCR EPD Hub Core PCR version 1.0, 1 Feb 2022	Only with EN15804
Stainless steel façade cladding panel	9.5 kg/m2		One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2023	LOCAL	One Click LCA		EN15804+A1, EN15804+A2	-
Steel façade cladding panel, powder coated	9.5 kg/m2, 70% recycled content		One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2023	LOCAL	One Click LCA		EN15804+A1, EN15804+A2	-
Steel straight staircase	width: 1.2 m, for height: 2.7 m, 670 kg/unit		One Click LCA	One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2024	LOCAL	LCA Commons, Plastics Europe		EN15804+A1, EN15804+A2	-
Structural steel profiles, generic	90% recycled content (typical), I, H, U, L, and T sections, S235, S275 and S355			One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2018	LOCAL	One Click LCA	7850	EN15804+A1	-
Structural steel profiles, generic	100% recycled content, I, H, U, L, and T sections, S235, S275 and S355			One Click LCA	-	One Click LCA	EN15804+A1, EN15804+A2	Internally verified	2018	LOCAL	One Click LCA	7850	EN15804+A1	-
Suspended metal ceiling system with acoustic insert/pad	6.500 kg/m2	SAS System 150 (Steel) with Acoustic Insert/Pad	SAS International	BRE	BREG EN EPD 000288	EPD SAS System 150 (Steel) with Acoustic Insert/Pad, SAS International	EN15804+A1	Third-party verified (as per ISO 14025)	2020	unitedKingdom	ecoinvent		EN15804+A1	-
Timber board from poplar, thermally modified	409 kg/m2, 4% moisture content	Brimstone Sycamore	Vastern Timber	International EPD System	S-P-01718	EPD Brimstone cladding and decking boards	EN15804+A1	Third-party verified (as per ISO 14025)	2019	unitedKingdom	GaBi	571	PCR 2012:01 Construction Products and Construction services, ver. 2.3, SUB-PCR to PCR 2012:01: Wood and wood-based products for use in construction	Only with EN15804
VRV Condensing unit, external body	33.5 kW heating, 213 kg/unit, refrigerant charge 9 kg (R32)	REYA12A	Daikin	CIBSE TM65	-	-	CIBSE TM65 Embodied Carbon Mid-level Calculation	Self declared	2023	unitedKingdom	-		-	-