Abbey Road Phase 3

Stage 2/3 Whole-Life Cycle Carbon Assessment

Wates Group

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Quality information

Prepared by	Checked by	Verified by	Approved by
Nial Parkash Graduate Sustainability Consultant	Jon Hall Principal Sustainability Consultant	Dave Cheshire Director	Ben Spence Associate Sustainability Consultant

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01	01/06/2022	Following CBRE comments		Ben Spence	Associate

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	01	Wates Group

Prepared for:

Wates Group

Prepared by:

Nial Parkash
Graduate Sustainability Consultant
E: Nial.Parkash@aecom.com

AECOM Limited
Marlborough Court
10 Bricket Road
St Albans
Hertfordshire AL1 3JX
United Kingdom

T: +44(0)1727 535000
aecom.com

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Executive Summary

Brief Description of the Development

AECOM has been appointed by Wates to produce a Whole Life-Cycle Carbon Assessment for the London Borough of Camden ("the Applicant") planning application for the Abbey Road Phase 3 development within the London Borough of Camden local planning authority. The application seeks consent for the demolition and redevelopment of Emminster and Hinstock blocks including Belsize Priory Health Centre, Abbey Community Centre, public house and commercial units to provide new residential accommodation (Use Class C3) and ground floor commercial space (Use Class E/Sui Generis) to be used as flexible commercial units, across three buildings ranging from 4 to 11 storeys, along with car and bicycle parking, landscaping and all necessary ancillary and enabling works.

Scope of the Assessment

AECOM are appointed by Wates ('the Applicant') to prepare a Whole Life-Cycle Carbon (WLC) assessment in support of proposals to transform the Abbey Road area.

Approach to assessment

The Whole Life-Cycle Carbon Assessment (WLCA) has been conducted in accordance with BS EN 15978: 2011: (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method) using the RICS Professional Statement: Whole Life Carbon assessment for the built environment), over a 60-year study period, covering the entirety of the life-cycle modules (see Figure 1).

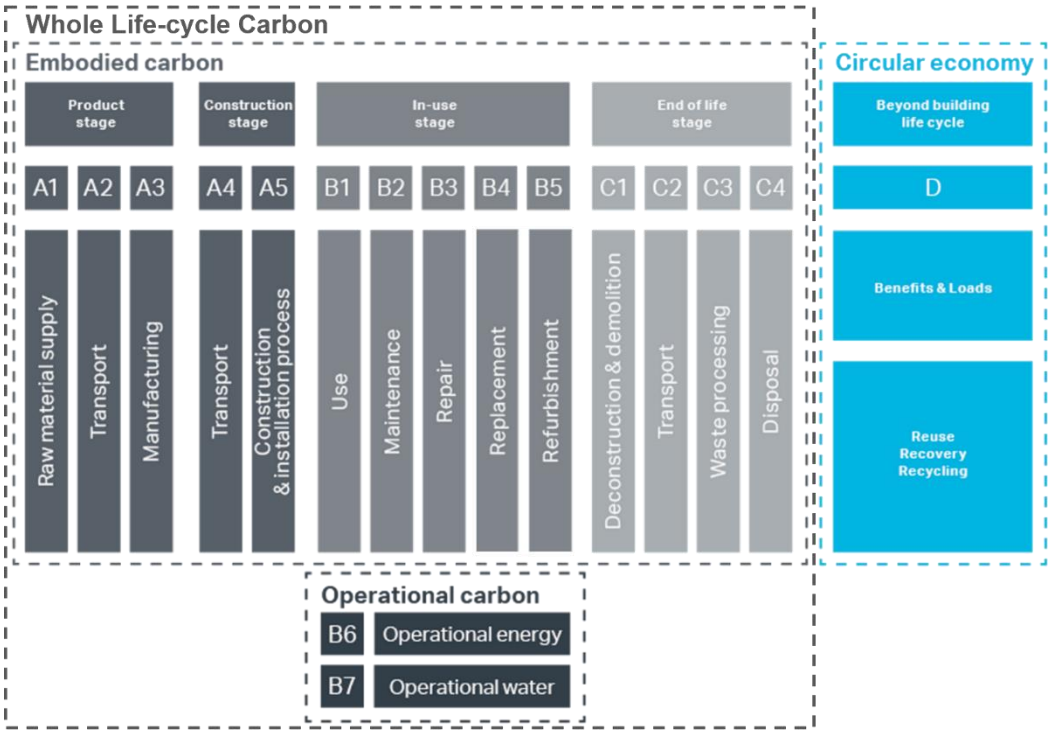


Figure 1 Whole life carbon and life-cycle modules: EN 15978:2011 Display of modular information for the different stages of the building assessment

The Greater London Authority (GLA) Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022) states that the reference study period for the WLC Assessment should be 60 years, even in instances that the design life of a building exceeds or is less than 60 years. All the building elements listed in Table 1 of the GLA Guidance have been included in the WLC Assessment, in line with the RICS Professional Statement.

The embodied carbon calculation for the WLC Assessment has been conducted using the LCA software One Click LCA. One Click LCA is an industry-recognised tool and is third-party verified for EN 15978, ISO 21931–1, ISO 21929–1 and for input data for ISO 14040/44 and EN 15804 standards.

For this assessment the “Whole life carbon assessment, Greater London Authority” tool was used to prepare the baseline and option studies, aligned with the RICS Professional Statement “Whole Life Carbon Assessment for the Built Environment” (2017) for service life of materials and transport distances.

The calculation of the operational carbon emissions has been based on the Building Regulations Part L 2013 modelling that has been carried out for the Energy Statement of the Proposed Development by AECOM. The scope of the operational carbon emissions in the WLC Assessment therefore includes regulated energy consumption (heating, cooling, auxiliary, lighting, and hot water) and unregulated energy consumption based on the BRUKL report. Renewable electricity generated on-site from solar photovoltaics (PV) is also accounted for in the calculations. The operational energy consumption of the development has been calculated for a life cycle of 60 years based on the assumption that the annual operational energy consumption will remain the same throughout the life-cycle of the project, as per the Building Regulations Part L modelling.

In accordance with the GLA’s Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022), no long-term decarbonisation of the electricity grid is accounted for in this WLC Assessment due to a lack of reliable data, which would impact the exercise’s accuracy. This is in line with EN 15978.

A list of the proposed materials, which were provided by the design team and form the basis of the embodied carbon modelling can be seen below in Table 1.

Table 1 Proposed Materials

Building Component	Description
Substructure	• Reinforced concrete ground beams, piles and pile caps, lowest floor slab Piles: concrete **32/40** with **50%** recycled content and rebar with 97% recycled content UK CARES) Pile caps, ground beams, lowest floor slab, retaining walls: concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Frame	• Reinforced concrete columns and walls: (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES) • Reinforced concrete wall upstands: (concrete **32/40** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Stairs	• Reinforced concrete precast in-place stair
Upper Floors	• Reinforced concrete flat slab and inset balconies (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Roof	• Reinforced concrete flat slab (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES) • Metal deck (D46, 1.2mm gauge) • Paved roof: 40mm paving on 15mm support pads / 50mm ballast / Waterflow control layer / 280mm XPS insulation – screed / slab structure • Green roof: 30-40mm sedum blanket / 80mm substrate / drainage later / waterflow control layer / 280mm XPS insulation / screed / slab structure
External Walls	• **E1/E2/E10:** 102.5mm clay facing brick / 62.5mm cavity / 220 mineral wool / breather membrane / 10mm fibre cement board / 100mm SFS mineral wool fill / vapour control layer / 2x 15mm plasterboard / skim • **E3:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / shear wall structure / 15mm plasterboard on dabs / skim • **E4/E5:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / medium density concrete block • **E6:** 102.5mm clay facing brick / 62.5mm cavity / 80 mineral wool / shear wall structure / 15mm plasterboard on dabs / skim • **E7/E9:** 102.5mm clay facing brick / 62.5mm cavity / 190 mineral wool / breather membrane / 10mm fibre cement board / 100mm SFS mineral wool fill / vapour control layer / 2x 15mm plasterboard / skim • **E8:** 2x 102.5mm clay facing brick • **E11**: 102.5mm clay facing brick / 140mm concrete block • **E12:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / shear wall structure / 70mm glass mineral wool insulation / 50mm mineral wool insulation / 2x 15mm plasterboard
Windows	• Aluminium-timber hybrid framed, triple glazed windows
Finishes	• Floor Type 1: Anti-slip Paint

Building Component	Description
	Type 2: Vinyl Type 3: Carpet Type 4: Ceramic Tile Type 5: Timber Type 6: Porcelain Tile • Wall Type 1: Paint Type 2: Tile • Ceiling Type 1: Plasterboard, paint Type 2: Moisture resistant plasterboard, paint
Fitting, furnishings, and equipment (FFE)	• Bathroom furniture
Building Services	• Building plumbing • Ducting • Electrical cables • ASHP, PVs
Hard Landscaping	• Clay and Concrete Pavers • Resin Bound Gravel • Brick Walls

Whole Life-cycle Carbon Assessment Results

The overall baseline WLC and embodied carbon of the Proposed Development over its 60-year life cycle is as follows:

Table 2 WLC carbon and total embodied carbon of the Proposed Development over its 60-year life-cycle

	GIA (m^2)	Overall Carbon (tCO_2e)	Carbon per m^2 GIA ($kgCO_2e/m^2$)
WLC carbon (A-C)	**13,176**	**18,141**	**1,377**
Embodied carbon only (A, B1-B5, C)		**9,626**	**731**

* The results exclude Module D as per GLA guidance

The embodied figures have also been determined for modules A1-A5 and B-C to enable them to be compared to the GLA benchmark (see Table 3).

53% of the whole life-cycle carbon is attributed to the embodied carbon (modules A, B1-B5, C) and **47%** to the operational carbon (modules B6-B7). The operational carbon (module B6) has been determined based on the proposed energy strategy in the Energy Statement. Therefore, this document assesses the embodied carbon. The largest share of embodied carbon emissions, approximately **59%** of the whole, is attributed to the product stage (life cycle stages A1-A3, also known as the cradle to gate stage). The transport and construction stages (A4 – A5) contribute approximately **8%** of total embodied carbon. The embodied carbon from recurring building elements (maintenance and replacement) (B1-B5) contributes approximately **28%** of the total embodied carbon.

These results demonstrate that in order to reduce the embodied carbon of a building, it is imperative to focus on material selection and reduction of the quantities and mass of materials specified.

The Superstructure is responsible for approximately **44%** of the embodied carbon, while the Substructure has the second highest impact accounting for **17%** of overall embodied carbon emissions. It has been demonstrated that most of the embodied carbon from the development can be attributed to the large quantities of reinforced concrete.

Comparison to Benchmarks

According to the GLA's Whole Life-Cycle Carbon Assessment Guidance, paragraph 2.1.2 (GLA, 2022) it is required that the results of the WLC Assessment of the Proposed Development are compared to the benchmarks provided in the same document (GLA, 2022). The GLA provides a WLC Benchmark based on WLC analysis gathered from multiple projects within London, and an Aspirational WLC Benchmark based on a 40% reduction on the WLC Benchmark. The embodied carbon results of the Proposed Development have been compared to the GLA benchmarks for Residential buildings.

Based on the current assumptions, the Proposed Development is meeting the aspirational benchmark for modules A1-A5 and significantly exceeding the aspirational benchmark for modules B-C (Table 3). The low A1-A5 can partly be attributed by the baseline percentage of GGBS in the scheme of 50%. The low B-C value can partly be attributed to the selection of refrigerant R-744, which has a low GWP (see Table 17).

Table 3 Comparison of the results of the WLC Assessment of the Proposed Development with the WLC Benchmarks for Residential buildings

Modules	WLC Benchmark ($kgCO_2e/m^2$)	Aspirational WLC Benchmark ($kgCO_2e/m^2$)	Proposed Development ($kgCO_2e/m^2$)
A1- A5	<850	<500	**496**
B – C*	<350	<300	**249**

* (excl. B6- B7, excl. sequestration, as per GLA guidance)

Recommendations

The specification of low carbon and robust materials can significantly reduce the embodied carbon of the development over a 60-year study period.

To further reduce the embodied carbon of the Proposed Development, which currently meets the GLA aspirational benchmark, it is suggested that **the percentage of recycled binder content within cement is increased, and a low carbon steel is selected to deliver a further embodied carbon reduction. This will reduce the embodied carbon attributed to the structural frames.**

In addition, it is suggested that internal finishes and fittings are sourced with Environmental Product Declarations (EPDs) and compared to influence their selection and ensure the lowest impact possible is attributed to these elements.

Post Construction WLC Assessment

A further WLC Assessment will be completed at post-construction stage, as per the GLA's Whole Life-Cycle Carbon Assessment Guidance. Accordingly, the post-construction results will be compared with planning submission stage results and GLA benchmarks, accompanied with an explanation for any significant difference.

1. Introduction

1.1 Background

AECOM's Sustainable Development Group has been commissioned by Wates Group on behalf of the London Borough of Camden (hereafter referred to as the 'Applicant') to prepare a Whole Life-Cycle Carbon (WLC) assessment, to accompany an application for Full Planning Permission for the redevelopment of Emminster and Hinstock blocks including Belsize Priory Health Centre, Abbey Community Centre, public house and commercial units otherwise known as Abbey Road Phase 3 (hereafter the 'Site').

The detailed description of development is as follows:

Demolition and redevelopment of Emminster and Hinstock blocks including Belsize Priory Health Centre, Abbey Community Centre, public house and commercial units to provide new residential accommodation (Use Class C3) and ground floor commercial space (Use Class E/Sui Generis) to be used as flexible commercial units, across three buildings ranging from 4 to 11 storeys, along with car and bicycle parking, landscaping and all necessary ancillary and enabling works.

Hereafter the "Proposed Development".

The Greater London Authority (GLA) Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022) states:

> "The Mayor's net zero-carbon target for new development continues to apply to the operational emissions of a building. The WLC requirement is not subject to the Mayor's net zero-carbon target; but planning applicants are required to calculate operational and embodied emissions, and demonstrate how they can be reduced as part of the WLC assessment. Planning applicants should continue to follow the GLA's Energy Assessment Guidance to assess and reduce operational emissions and insert the relevant information into the WLC assessment, as explained in this guidance."

The GLA guidance also states

> "WLC emissions are those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions, i.e. those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. A WLC Assessment also includes an assessment of the potential carbon emissions 'benefits' from the reuse or recycling of components after the end of a building's useful life. It provides a true picture of a building's carbon impact on the environment."

This document accompanies the GLA WLC Assessment Templates, which have been developed to meet the relevant planning Policy SI 2 F of the London Plan, March 2021 (GLA, 2021).

The scope of this report is to:

- Outline the scope of the Whole Life-Cycle Carbon Assessment;
- Outline the methodology that was followed to complete the GLA WLC Assessment Templates;
- Present and analyse the results of the WLC Assessment of the Proposed Development;
- Compare the results of the WLC Assessment with the corresponding Benchmarks that are provided in the GLA's Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022);
- Provide recommendations for carbon optimisation of the design of the Proposed Development.

This document has been produced in accordance with the GLA's Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022).

1.2 Policy

1.2.1 The London Plan

The London Plan is the statutory Spatial Development Strategy for Greater London prepared by the Mayor of London ("the Mayor"). The new London Plan was adopted on 2 March 2021 and includes the following policy in relation to the Whole Life Carbon (WLC) Assessment:

Policy SI 2 Minimising Greenhouse Gas Emissions

Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

1.2.2 London Borough of Camden Local Plan

The London Borough of Camden adopted their local plan core strategy in 2017 to set out strategies that would aid the development of the borough. The document sets out the Council's planning policies and replaces the Core Strategy and Development Policies planning documents (adopted in 2010). It ensures that Camden continues to have robust, effective, and up-to-date planning policies that respond to changing circumstances and the borough's unique characteristics and contribute to delivering the Camden Plan and other local priorities. The Local Plan will cover the period from 2016-2031.

1.2.2.1 CC1 Climate Change Mitigation

The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. [Steps shown within document].

1.2.2.2 CC2 Adapting to Climate Change

The Council will require development to be resilient to climate change. All development should adopt appropriate climate change adaptation measures such as: (a.) the protection of existing green spaces and promoting new appropriate green infrastructure; (b.) not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems; (c.) incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and (d.) measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy. Any development involving 5 or more residential units or 500 sqm or more of any additional floorspace is required to demonstrate the above in a Sustainability Statement.

1.2.2.3 CC3 Water and Flooding

The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. [Steps shown within document].

1.2.2.4 CC4 Air Quality

The Council will ensure that the impact of development on air quality is mitigated and ensure that exposure to poor air quality is reduced in the borough. The Council will consider the impact of air quality when assessing development proposals, through the consideration of both the exposure of occupants to air pollution and the effect of the development on air quality. Consideration must be taken to the actions identified in the Council's Air Quality Action Plan.

1.2.2.5 CC5 Waste

The Council will seek to make Camden a low waste borough. We will: (a.) aim to reduce the amount of waste produced in the borough and increase recycling and the reuse of materials to meet the London Plan targets of 50% of household waste recycled/composted by 2020 and aspiring to achieve 60% by 2031; (b.) deal with North London's waste by working with our partner boroughs in North London to produce a Waste Plan, which will ensure that sufficient land is allocated to manage the amount of waste apportioned to the area in the London Plan; (c.) safeguard Camden's existing waste site at Regis Road unless a suitable compensatory waste site is provided that replaces the maximum throughput achievable at the existing site; and (d.) make sure that developments include facilities for the storage and collection of waste and recycling.

1.3 Description of Development

1.3.1 Proposed Development

The Applicant is seeking full planning permission for Demolition and redevelopment of Emminster and Hinstock blocks including Belsize Priory Health Centre, Abbey Community Centre, public house and commercial units to provide new residential accommodation (Use Class C3) and ground floor commercial space (Use Class E/Sui Generis) to be used as flexible commercial units, across three buildings ranging from 4 to 11 storeys, along with car and bicycle parking, landscaping and all necessary ancillary and enabling works.

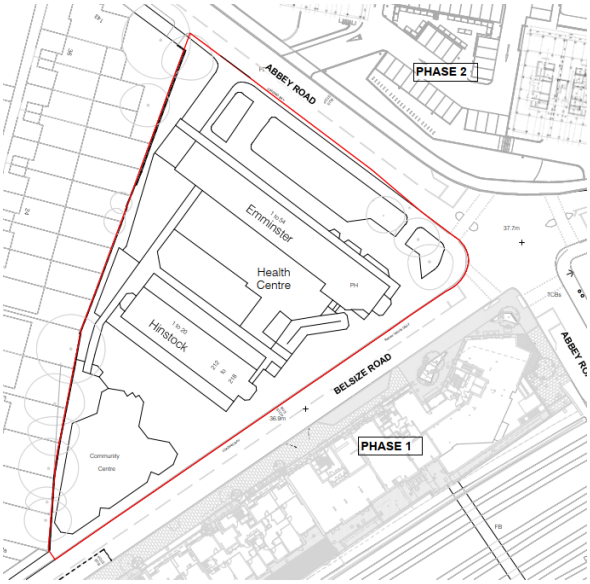
Table 4 Proposed Development's gross internal area (GIA)

	GIA (m^2)
Residential (incl. landlord areas)	12,871
Commercial	305
Total	**13,176**

1.3.2 Existing Site

The Site currently comprises the Belsize Priory Health Centre, the Abbey Community Centre and affordable housing units, which span across a five-storey block (Hinstock) and an eight-storey block (Emminster). The existing residential buildings comprise of 74 units (55 1-beds and 19 studios, totalling 3793.5m^2 GIA) all of which were social rented units but are now predominantly vacant aside from occupation by property guardians, and 835m^2 GIA of commercial floorspace. Several tenants have already been re-housed within the neighbouring Phase 1 residential development or within other developments in the Borough. In addition to these uses at ground floor there are retail units and a hot food takeaway, as well as a public house, the Lillie Langtry. The common areas on site consists of hardstanding and a limited number of trees, mainly along Abbey Road.

The site is bound by the Priory Road Conservation Area to the north and west, by Abbey Road to the east and by Belsize Road to the south. Snowman House, Casterbridge and the new Abbey Road Phase 2 Health and Community Centre (currently under construction) lie to the east on the opposite side of Abbey Road. The completed Abbey Road Phase 1 development lies to the south, on the opposite side of Belsize Road.



Existing site plan (Source: PTE Architects)

Proposed site plan showing the locations of the Phase 1, 2 and 3 developments (Source: PTE Architects)

Figure 2 Site plans of the existing and proposed sites

1.3.3 Background

The site forms part of the wider Abbey Road Estate Regeneration Scheme. Outline consent was originally granted in 2012 (2012/0096/P) for the comprehensive redevelopment of the three sites within the Estate to deliver up to 296 residential units, a health and community centre as well as a range of ancillary uses including plant, landscaping, and parking.

Following this a later Hybrid permission (2013/4678/P) granted full planning consent for Phase 1 of the regeneration securing consent for 141 residential units, commercial floorspace, a retail unit and ancillary space including a basement car park. This detailed element of the consent was implemented in December 2014 following the grant of permission in May 2014. This Hybrid permission also secured outline consent for the second and third phases of the Abbey Road regeneration. Phase 2 would deliver a health and community centre with Phase 3 delivering further residential units along with car parking and commercial floorspace. Matters such as dwelling mix, affordable housing provision and the decanting strategy around the existing phase 3 building and residents into the first to be delivered phase 1 part of the hybrid consent were considered holistically. The Outline elements of this planning consent relating to phase 2 and 3 have not been implemented. A Reserved Matters application was submitted for Phase 3 but was subsequently withdrawn.

A fresh full planning permission for Phase 2 was granted in November 2020, this provides a high-quality health and community centre set within enhanced landscaping for the wider community. The Applicant is now seeking to bring forward the third phase of development to complete the regeneration at this important junction site. Whilst the applications have moved away from a single overall permission for the three phases the reality is that the actual delivery, linkages, and holistic development approach has not.

1.3.4 Refurbishment vs Redevelopment

The Applicant recognises that developments that relate to land where an existing building is present, an emphasis should be put on the feasibility of retrofitting the structure or the reuse of some structural elements before committing to a site-wide redevelopment. This is to limit the damage that the development in questions has on the environment. This has been further brought to the forefront by the release of the new London Plan Guidance for Whole Life-cycle Carbon (2022), which stipulates the need to show evidence of retrofit vs redevelopment consideration. The relevant terms are defined in this context below:

Retrofit: The up-cycling of the existing structures on the site to produce new, refurbished dwellings within the limits of the existing structure.

Redevelopment: The demolition of all existing structures on site, being replaced with new construction.

This section analyses the suitability of redevelopment over retrofit from a number of perspectives such as dwelling density and floor to ceiling heights. A carbon study has also been undertaken by PTE Architects highlighting the whole life carbon of a light, partial and deep retrofit, the results of which have been compared to the whole life carbon of a redevelopment by AECOM.

Refer to Section 2.7 of the Design and Access Statement for further information.

Carbon Intensity:

PTE explored a number of retrofit options, with the aim of identifying the extent of the whole life carbon of different retrofit options. A description of the 3 retrofit options involved in the study, the redevelopment option, and their results, are detailed below:

Level of Retrofit	Description	WLC Results ($kgCO_2e/m^2$ GIA)
New Build	Redevelopment	1,159
Light	Baseline with improvements	3,113
Partial	Part L compliant	2,262
Deep	EnerPhit & Net Zero	1,403

Figure 3 compares the above results against the whole life carbon of the proposed redevelopment in this report, per m^2 of development. The Light Retrofit option exhibits the least embodied carbon, as the least amount of material is required for this option, but this results in large operational carbon emissions due to the poorly performing thermal fabric. The Deep Retrofit has a significantly higher amount of embodied carbon associated with it, but a significantly

lower operational value than the Light Retrofit as a result. The New Build (redevelopment) option has the least associated whole life carbon emissions due to the efficiency of spatial capacity.

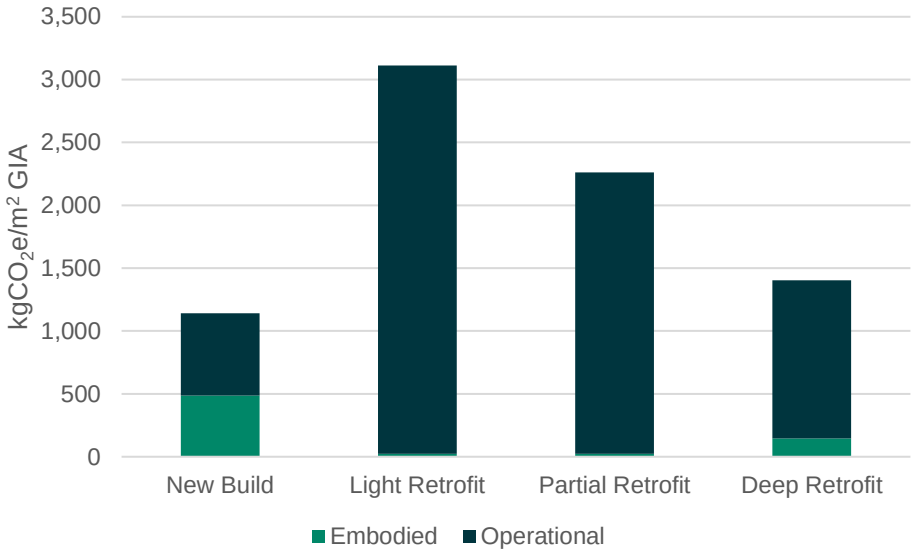


Figure 3 The New Build option has the lowest associated carbon emissions when considering the developments on a square meter basis

Spatial Capacity:

A partial demolition of the community centre was considered, however the centre's proximity to the site boundary with Priory Terrace is likely to accommodate a limited number of new units.

The existing residential mix does not satisfy Camden's demand for larger family homes. The current units consist of 1-bedroom flats and studios, with the load bearing elements of the frame forming the party walls. These party walls could be manipulated (see Figure 4) to form larger 2B3P and 2B4P dwellings, however this could only provide approximately 38 homes. In contrast, the design-led approach to redevelop the site demonstrates the site has the capacity to accommodate 139 homes, including larger homes, to address the housing needs in the borough.

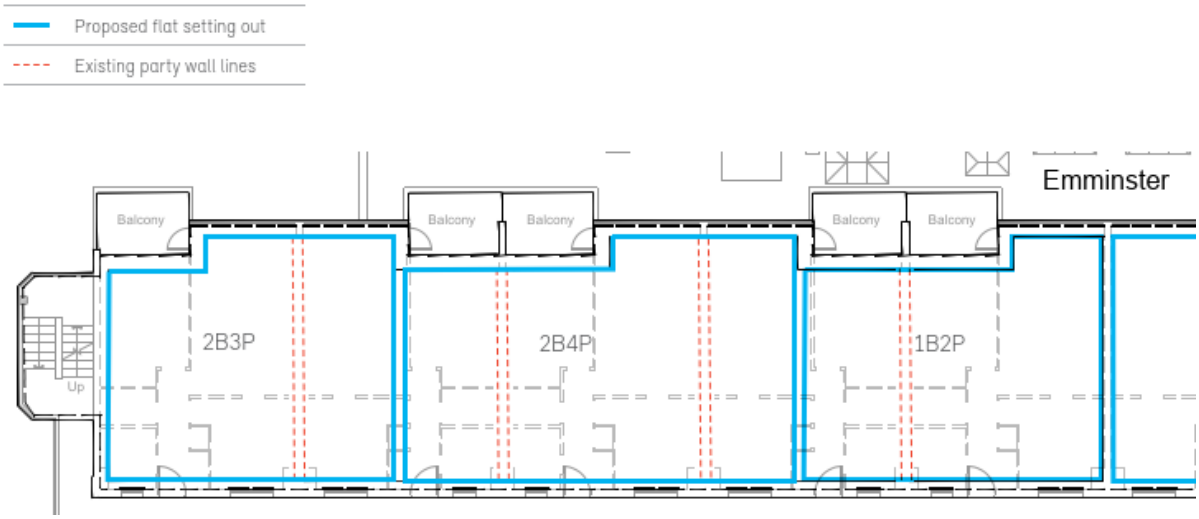


Figure 4 Emminster (existing block on site) floor plan showing flats combined into a mix of homes

Floor to Ceiling Heights:

A typical new build floor-to-floor requires 3150mm to allow for a service zone whilst achieving a floor to ceiling height of 2500mm.

The existing residential accommodation has a floor-to-floor height of 2650mm (providing a floor to ceiling of 2450mm). For the existing building to have new services installed, a service zone would need to be allowed for

below the existing structure. As a minimum NDSS (current residential standards) would expect 2300mm, whilst 2500mm is more commonly expected (i.e. LBC's own design brief). The existing section could potentially achieve 2200mm with a compromised service zone.

Regulatory Requirements:

The primary acoustic concern in a refurbishment is the difficulty in achieving acceptable standards of sound insulation between residential units. This is primarily an issue of the existing building limiting the degree to which new internal (party) walls can accommodate effective detailing, for example the junction of party walls with the existing frame. This issue is recognised in the current Building regulations Approved Document E, where a lower standard is allowed for refurbished buildings than for new-build projects.

Material Reuse

Although the scheme does not include the reuse of existing structural elements, assumptions have been made within the Pre-Development Plan to reuse the following:

- Approximately 1200m^2 of concrete blocks (assumed 100mm thick)
- Approximately 1000m^2 of concrete paving (assumed 60mm deep)

When taking these quantities of potentially reused material into account within One Click LCA modelling software, a total of 45 tCO_2e, or 3.5 $kgCO_2e/m^2$ could potentially be saved from the development's total. These potential reductions have not been included in the WLC modelling in this report.

Refer to Section 2.7 of the Design and Access Statement for further information.

1.4 Proposed Elements and Materials

Table 5 Proposed Elements and Materials

Building Component	Description
Substructure	• Reinforced concrete ground beams, piles and pile caps, lowest floor slabs: concrete **32/40** with **50%** recycled content and rebar with 97% recycled content UK CARES) Pile caps, ground beams, lowest floor slab, retaining walls: concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Frame	• Reinforced concrete columns and walls: (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES) • Reinforced concrete wall upstands: (concrete **32/40** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Stairs	• Reinforced concrete precast in-place stair
Upper Floors	• Reinforced concrete flat slab and inset balconies (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES)
Roof	• Reinforced concrete flat slab (concrete **40/50** with **50%** recycled content and rebar with 97% recycled content UK CARES) • Metal deck (D46, 1.2mm gauge) • Paved roof: 40mm paving on 15mm support pads / 50mm ballast / Waterflow control layer / 280mm XPS insulation – screed / slab structure • Green roof: 30-40mm sedum blanket / 80mm substrate / drainage later / waterflow control layer / 280mm XPS insulation / screed / slab structure
External Walls	• **E1/E2/E10:** 102.5mm clay facing brick / 62.5mm cavity / 220 mineral wool / breather membrane / 10mm fibre cement board / 100mm SFS mineral wool fill / vapour control layer / 2x 15mm plasterboard / skim • **E3:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / shear wall structure / 15mm plasterboard on dabs / skim • **E4/E5:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / medium density concrete block • **E6:** 102.5mm clay facing brick / 62.5mm cavity / 80 mineral wool / shear wall structure / 15mm plasterboard on dabs / skim • **E7/E9:** 102.5mm clay facing brick / 62.5mm cavity / 190 mineral wool / breather membrane / 10mm fibre cement board / 100mm SFS mineral wool fill / vapour control layer / 2x 15mm plasterboard / skim • **E8:** 2x 102.5mm clay facing brick • **E11**: 102.5mm clay facing brick / 140mm concrete block • **E12:** 102.5mm clay facing brick / 62.5mm cavity / 110 mineral wool / shear wall structure / 70mm glass mineral wool insulation / 50mm mineral wool insulation / 2x 15mm plasterboard
Windows	• Aluminium-timber hybrid framed, triple glazed windows
Finishes	• Floor: Type 1: Anti-slip Paint Type 2: Vinyl Type 3: Carpet Type 4: Ceramic Tile Type 5: Timber Type 6: Porcelain Tile • Wall: Type 1: Paint Type 2: Tile • Ceiling: Type 1: Plasterboard, paint Type 2: Moisture resistant plasterboard, paint
Fitting, furnishings, and equipment (FFE)	• Bathroom furniture
Building Services	• Building plumbing • Ducting • Electrical cables • ASHP, PVs
Hard Landscaping	• Clay and Concrete Pavers • Resin Bound Gravel • Brick Walls

1.5 Scope

The WLC Assessment has been conducted in accordance with BS EN 15978: 2011: (Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method) using the RICS Professional Statement: Whole Life Carbon assessment for the built environment (hereafter referred to as the 'RICS PS').

The WLC Assessment covers the carbon emissions of the Proposed Development over its lifetime, accounting for:

- Embodied carbon emissions
- The operational carbon emissions (regulated and unregulated)
- Future potential carbon emission 'benefits', post 'end of life', including benefits from reuse and recycling of building structures and materials (lifecycle module D).

The future benefits from reuse and recycling of building structure and materials are not included in the reported results of the WLC Assessment as they are also not yet stated within GLA WLC benchmarks.

1.6 Life-cycle modules

This WLC Assessment has followed the BS EN 15978 standard over a 60-year study period, covering the entirety of modules A, B, C and D:

- Module A1 – A5 (Product sourcing and construction stage)
- Module B1 – B7 (Use stage)
- Module C1 – C4 (End of life stage)
- Module D (Benefits and loads beyond the system boundary)

Figure 5 demonstrates the different life-cycle modules included in the WLC Assessment as well as the difference between embodied carbon and whole life-cycle carbon.

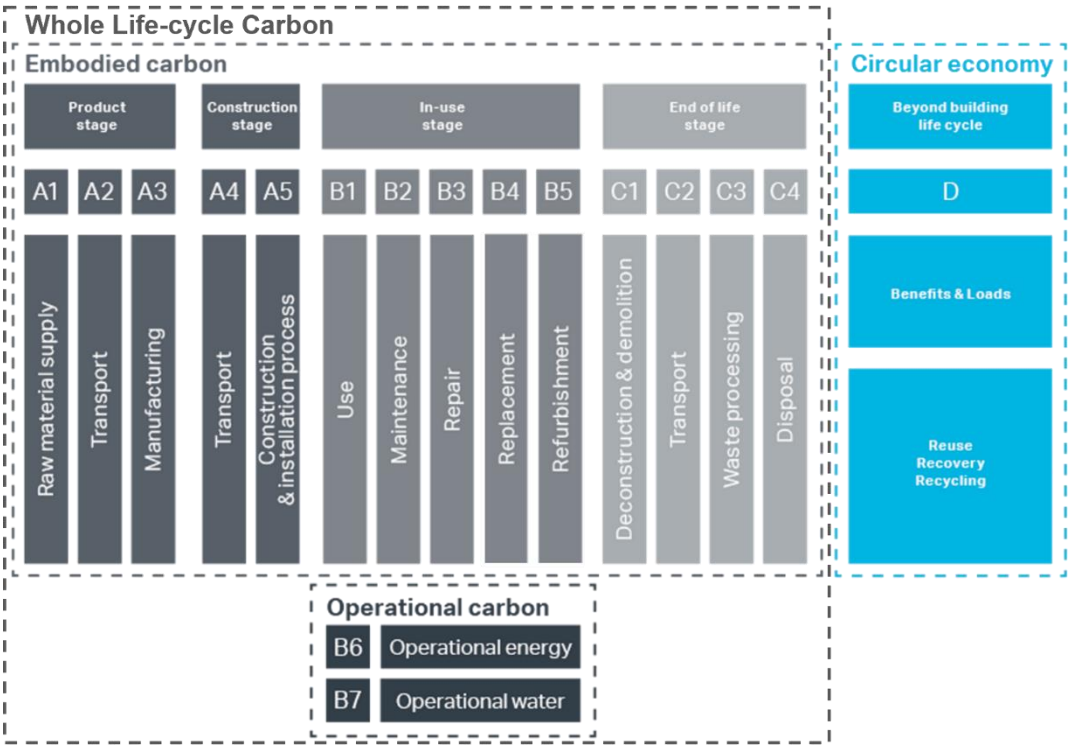


Figure 5 Whole life carbon and life-cycle modules: EN 15978:2011 Display of modular information for the different stages of the building assessment

The GLA Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022) states that the reference study period for the WLC Assessment should be 60 years, even in instances that the design life of a building exceeds or is less than 60 years.

The embodied carbon estimates from construction and materials for applicable life-cycle stages A1 – C4, otherwise known as a cradle-to-grave study, are estimated for a life cycle of 60 years. This includes embodied emissions related to the raw extraction of materials, their processing in a factory or equivalent, transport and construction on site, any replacements assumed over the study period and finally end of life disposal. Benefits and loads beyond the building life cycle, Module D, are shown in the GLA WLCA template.

The operational carbon estimate includes the carbon emissions associated with the operational energy consumption of the development. This has been calculated for a life cycle of 60 years based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project, as per the Building Regulations Part L 2013 modelling.

The operational carbon estimate also includes the carbon emissions associated with water use during the operation of the building, related to water supply and wastewater treatment. This has been calculated for a life cycle of 60 years based on the Energy Saving Trust's Water Energy Calculator values[1] regarding the litres/person/day assumptions.

1.7 Building elements

All the applicable building elements listed in Table 6 have been included in the WLC Assessment, in line with the RICS PS. The building elements are broken down according to the RICS New Rules of Measurement (NRM) classification system level 2 sub-elements.

Table 6 Building elements (RICS PS) that have been included in the WLC Assessment

Building Element Group	Building Element (NRM level 2)
Demolition	01 Toxic/hazardous/contaminated material treatment 0.2 Major demolition works
0 Facilitating works	0.3 & 0.5 Temporary/enabling works 0.4 Specialist groundworks
1.1 Substructure	1.1 Substructure
2 Superstructure	2.1 Frame 2.2 Upper floors incl. balconies 2.3 Roof 2.4 Stairs and ramps 2.5 External walls 2.6 Windows and external doors 2.7 Internal walls and partitions 2.8 Internal doors
3 Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes
4 Fittings, furnishings and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building related and non-building-related
5 Building services/MEP	5.1–5.14 Services incl. building-related and non-building-related
8 External works	8.1 Site preparation works 8.2 Roads, paths, paving and surfacing 8.3 Soft landscaping, planting and irrigation systems 8.4 Fencing, railings and walls 8.5-8.7 External fixtures, drainage, services 8.8 Minor building works and ancillary buildings

Building element 6, Prefabricated Buildings and Building Units, and 7, Work to Existing Building, are not applicable to this WLC assessment and are excluded.

[1] https://www.energysavingtrust.org.uk/sites/default/files/reports/AtHomewithWater%287%29.pdf

1.8 LCA Software and Databases

The embodied carbon calculation for the WLC Assessment has been conducted using the LCA software 'One Click LCA'. It is an industry-recognised tool and is third-party verified for EN 15978, ISO 21931–1, ISO 21929–1 and for input data for ISO 14040/44 and EN 15804 standards.

For this assessment the "Whole life carbon assessment, Greater London Authority" tool was used to prepare the baseline and option studies, aligned with the RICS Professional Statement "Whole Life Carbon Assessment for the Built Environment" (2017) for service life of materials and transport distances. The detailed catalogue of the materials-building products used can be found in Appendix D-Data Sources.

1.9 Operational Energy Analysis

The operational energy data has been produced for the domestic elements following the Building Regulations Part L1A 2013, using SAP 2012 methodology and for the non-domestic elements following the Building Regulations Part L2A, using the National Calculation Methodology (NCM) and the Simplified Energy Model (SBEM). The operational energy consumption of the development has been calculated for a life cycle of 60 years (the 'reference study period') based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project, as per the Building Regulations Part L 2013 modelling.

The Energy Strategy for the planning application includes Building Regulations Part L energy and carbon estimates and does not include estimates from detailed operational energy modelling, for instance from modelling following the CIBSE TM54 (Evaluating Operational Energy Performance of Buildings at the Design Stage) methodology. At the planning stage, the Building Regulations Part L 2013 modelling provides a reasonable early estimate of energy consumption for all buildings of the Proposed Development, including energy consumption for regulated and unregulated uses, as well as renewable energy generation on-site.

The outputs of the Building Regulations Part L modelling include:

- Regulated energy consumption required for Building Regulations Part L (heating, cooling, auxiliary, lighting and hot water);
- Unregulated energy consumption, not regulated under Building Regulations Part L but estimated using the same modelling process;
- Renewable electricity generated on-site (from solar photovoltaic (PV).

An overview of the regulated, unregulated, and renewable of the Proposed Development is provided in Table 7.

Table 7 Overview of the Regulated and Unregulated Energy Consumption and Production of the Proposed Development (PV not subtracted from totals)

	MWh/year
Annual unregulated energy	**344 (electricity)**
Annual regulated energy	**314 (electricity)**
Annual energy generation from PV	**51 (electricity)**

1.10 Grid Decarbonisation

The GLA's WLC Carbon Assessment Guidance (GLA, 2022) states "the UK's electricity grid is decarbonising, and this will have an impact on the WLC emissions of a development. It will be important for consistent decarbonisation assumptions to be built into the available software tools and industry's progress with this will be monitored. However, at present, the data is not reliable to do so accurately for embodied carbon emissions. Applicants are therefore not required to account for the long-term decarbonisation of the electricity grid in their WLC assessments, in line with EN 15978."

1.11 Collection and Use of Data

Prior to the LCA modelling, a Request for Information (RFI) spreadsheet was distributed to the construction stakeholders that was formatted in a similar way to the RICS list of building elements seen in Table 6.

The GLA's WLC Carbon Assessment Guidance (GLA, 2022) requires that 95% of the cost allocated to each building element category has been accounted for in the assessment. However, as a detailed cost plan describing materials

and materials quantities was not available at this stage, the model was based on information provided and confirmed by the relevant parties (e.g. architect, structural engineers etc.). This assessment is based on similar developments of similar size, type, scale and location to improve accuracy and completeness.

1.12 Methodology

The calculation of the embodied carbon of the Proposed Development was based on input from the design team. RFI forms were issued to the design team addressing both the outline and detailed aspects. These were returned with information about the quantities and types of materials per building component including specification details such as masses and volumes.

The embodied carbon of the materials was calculated in One Click LCA, in accordance with the RICS PS. The operational carbon over a 60-year study period was added to the total embodied carbon, in order to calculate the whole life carbon of the Proposed Development.

1.13 Assumptions

1.13.1 Product Stage (A1 - A3)

Recycled content for the steel and aluminium elements are as per RICS methodology default recommendations (Table 8).

Table 8 Overview of the proposed recycled content and recycle rates at end of life for the metals elements of the Proposed Development

Material	Recycled Content	
	Details	Specification
Steel	Reinforcement bars	97% Recycled Content
	Structural steel sections	20% Recycled Content
	Studwork/Support frames	Galvanised steel, 15% Recycled Content
Aluminium	Cladding panels	Aluminium sheet, 35% Recycled Content
	Glazing frames	Aluminium extrusions, 35% Recycled Content

1.13.2 Construction Process Stages (A4 – A5)

Waste factors for the materials to the traditional build types have been taken from the default values provided within the software tool.

Transport distances are as per RICS methodology default figures where applicable (Table 9).

Table 9 Overview of the proposed transport distances as per RICS methodology default figures where applicable

Transport scenario	Distance	
	km by Road	km by Sea
Locally manufactured	50	-
Nationally manufactured	300	-
European manufactured	1,500	-
Globally manufactured	200	10,000

Construction emissions have been based on the carbon emissions within the LCA tool with default processes for each material/building element.

1.13.3 Use Stage (B1 – B5)

The in-use life stages mainly comprise of replacements to materials/building components over the 60-year study period. This is defined by the expected lifespan of each building element. Material lifespans are as per RICS methodology default figures (Table 10).

Table 10 Indicative component lifespans as per RICS professional statement and guidance document

Building Part	Building Element/ components	Expected Lifespan
Roof	Roof coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall finishes: Render/Paint	30/10 years respectively
	Floor finishes, Raised Access Floor (RAF)/Finish layers	30/10 years respectively
	Ceiling finishes Substrate/Paint	20/10 years respectively
	Ductwork	20 years
	Electrical installations	30 years
	Lighting fittings	15 years
	Communications installations and controls	15 years
	Water and disposal installations	25 years
	Sanitaryware	20 years
	Lift and conveyor installations	20 years
	Glazed cladding/Curtain walling	35 years
	Windows and external doors	30 years

According to RICS PS, in the absence of project specific data (e.g. maintenance strategy reports, O&M manuals etc.), repair emissions (B3) should be assumed as equivalent to 25% of maintenance emissions (B2). The repair rate assumptions used at this stage are summarised below:

- Paint - 1% repair
- External Windows/ Doors - 0.5% repair
- Internal Doors - 1% repair
- Lifts - 1% repair

1.13.4 End of Life (C1 – C4) – Benefits and loads beyond the system boundary

Table 11 provides an overview of the assumption for the end-of-life scenario for different types of materials based on default values from the One Click LCA dataset used (see Appendix A).

Table 11 End of life scenario for different types of materials of the Proposed Development.

Material	End of Life Scenario	Recycling Rate
Structural concrete	Crushed and recycled	100%
Steel (structural, rebar, galvanised, zinc coated)	Recycled	100%
Insulation (Rockwool/ EPS)	Landfill/ Plastic-based incineration	0%
Polyurethane membranes	Plastic-based incineration	0%
Timber	Wood incineration	0%
Bricks and Mortar	Brick crushed to aggregate, Mortar used in a backfill	100%

Plasterboard	Recycled	100%
Paints	Landfill	0%
Glass	Recycled	100%
Ceramic Tiles	Crushed to aggregate	100%
Asphalt	Asphalt reuse via reprocessing	100% (reused rate)

1.13.5 Building Services

In order to accurately calculate the embodied carbon of the MEP Services, a detailed list with all the materials included in the proposed building services and their quantities is required. This was not possible at this stage due to accurately quantify the quantum of systems; therefore, assumptions have been made for the type of materials and their quantities of the proposed building services. For this reason, TM65 modelling has also not been undertaken at this stage.

There are constructions, assemblies and systems within One Click LCA that can be used to make reasonable estimations of embodied carbon. The Proposed Development has been allocated the following systems based on the building floor area to estimate the embodied carbon:

- Drinking water distribution;
- Hot water distribution;
- Heating distribution;
- Sewerage connection;
- Electrical cabling;
- Ventilation system;

Embodied carbon related to Air Source Heat Pumps (ASHPs), PVs, washing machines and sanitary appliances (ie. toilet, washbasin, shower) has also been considered in the assessment. An overview of the relevant materials and templates that are included in the assessment can be seen in Appendix C.

2. Whole Life-Cycle Carbon Assessment Results

The overall WLC carbon of the Proposed Development is **18,141 tCO_2e or 1,377 $kgCO_2e/m^2$ GIA**, as indicated in Table 12. The total GIA has been assumed as 13,176 m^2 based on information provided by PTE Architects and data provided by the cost consultants.

The total embodied carbon of the Detailed Element is **9,626 tCO_2e or 731 $kgCO_2e/m^2$ GIA**. Detailed results are presented in Table 12 and Figure 6.

Table 12 WLC carbon and total embodied carbon of the Proposed Development over its 60-year life-cycle

	GIA (m^2)	Overall Carbon (tCO_2e)	Carbon per m^2 GIA ($kgCO_2e/m^2$)
WLC carbon (A-C)*	13,176	**18,141**	**1,377**
Embodied carbon only (A, B1-B5, C)		**9,626**	**731**

* The results exclude Module D as per GLA guidance

The total Whole Life-Cycle carbon of the Proposed Development, over its 60-year life-cycle, is equivalent to:

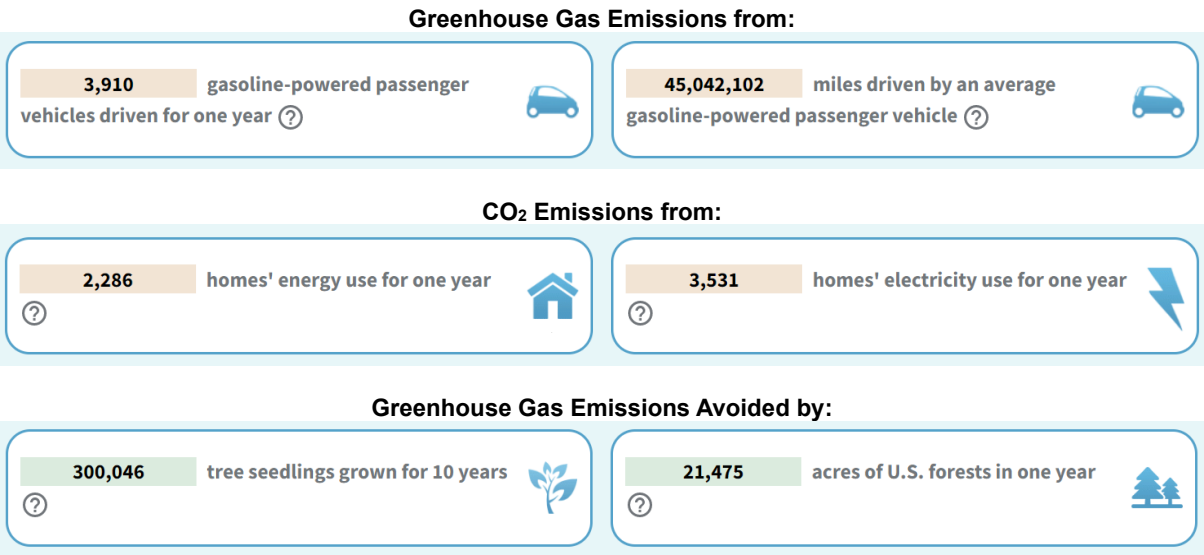


Figure 6 Greenhouse Gas Equivalencies [2]

Table 13 shows the breakdown of embodied carbon of the Proposed Development by life-cycle stages shows the breakdown of the overall WLC carbon of the Proposed Development by the main life-cycle stages, over the assumed 60-year life-cycle of the Proposed Development.

[2] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Table 13 Breakdown of embodied carbon of the Proposed Development by life-cycle stages

Life-cycle Stage		Embodied carbon (tCO_2eq)	Embodied carbon per GIA ($kgCO_2eq/ m^2$)
Biogenic Carbon		**-191**	**-15**
Products	A1-A3	**5,765**	**438**
Transport	A4	**188**	**14**
Construction	A5	**585**	**44**
Recurring	B1-B5	**2,815**	**214**
Energy & Water	B6- B7	**8,515**	**646**
End of Life	C1-C4	**464**	**35**
Product Reuse	D	**-5,056**	**-384**
Total (excluding B6-B7, Module D)	A-C	**9,626**	**731**

As indicated in Figure 7, the largest share (**53%**) of the WLC carbon of the Proposed Development is attributed to the embodied carbon (A, B1-B5, C) and the remaining **47%** to the operational carbon (B6-B7).

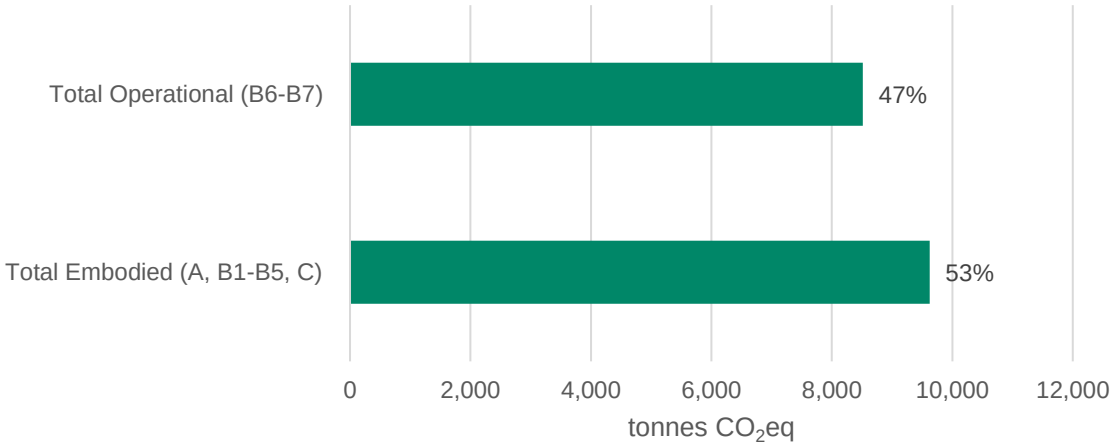


Figure 7 Breakdown of the Total Emissions to Operational and Embodied Carbon

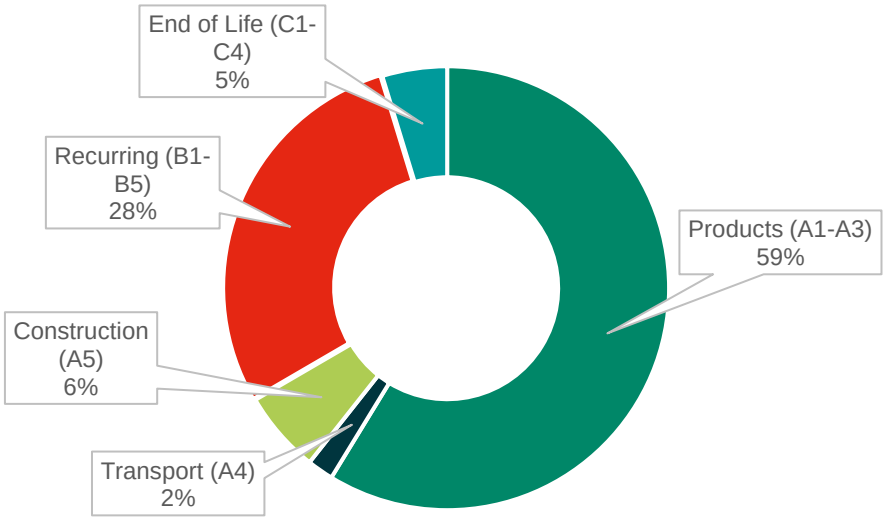


Figure 8 Breakdown of embodied carbon emissions by Life Cycle Module

Figure 8 shows the percentages of contribution of the different life-cycle stages to the total embodied carbon (A-C, excluding B6-B7). The product stage (A1 – A3) of the building life-cycle, otherwise known as the 'cradle to gate' stages, consists of raw material extraction, transport and processing within the manufacturing of the product is responsible for approximately **59%** of the total embodied carbon of the Proposed Development. Transport and construction stages (Modules A4 – A5) contribute around **8%** of the total embodied carbon. Therefore, life-cycle stages A1-A5 indicate that the embodied impact at completion of construction works accounts for **67%** of the total impact over the building's 60-year life-cycle.

The embodied carbon from recurring building elements (Modules B1-B5) contributes approximately **28%** of the total embodied carbon. This is due to elements that need replacing over the 60-year life-cycle of the building. The end of life and disposal (Module C) accounts for about **5%** of the total embodied carbon.

Figure 9 shows that **44%** of the total embodied carbon of the Proposed Development is attributed to Superstructure and **17%** to the Substructure. The rest of the building categories are responsible for around **39%** of the overall embodied carbon.

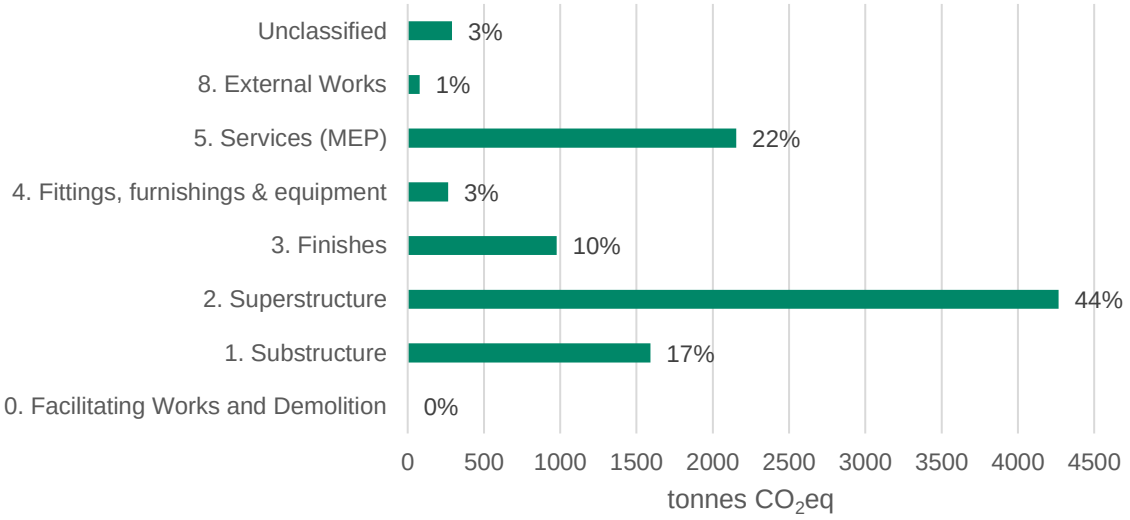


Figure 9 Breakdown of the total embodied carbon by the Building Element categories

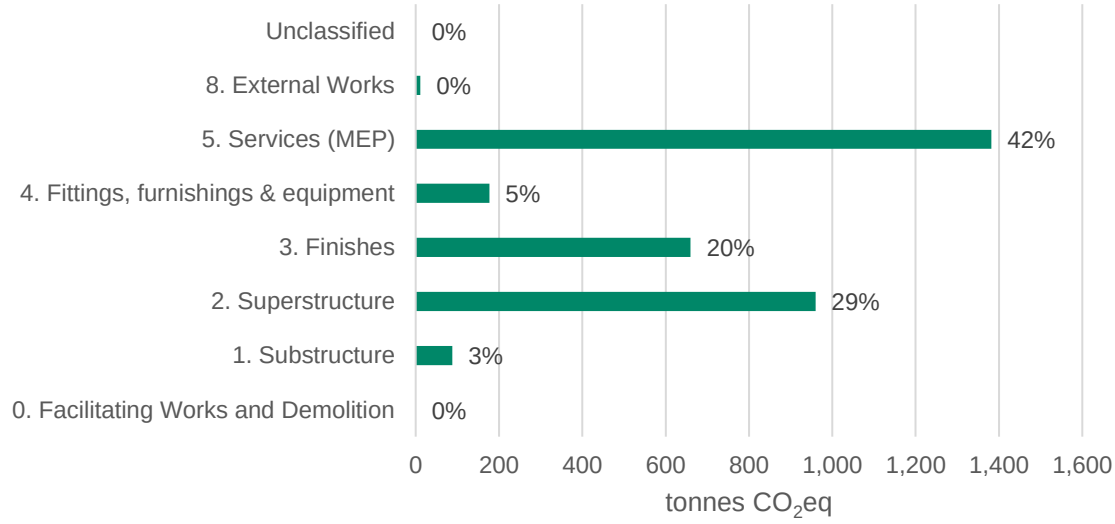


Figure 10 In Use & End of Life Embodied Carbon breakdown (B-C excl. B6-B7) by building element category

Figure 11 provides an overview of the breakdown of the embodied carbon of the superstructure per building element. The study demonstrates that the largest share of the embodied carbon of the superstructure up to the practical completion of the Proposed Development is attributed to the **combination of upper floors and structural frame, with external walls contributing the second largest portion.** Therefore, the majority of the embodied

carbon is attributed to the large quantities of **concrete, steel reinforcement, and structural steel sections in the structural frame, and the material within the external walls.**

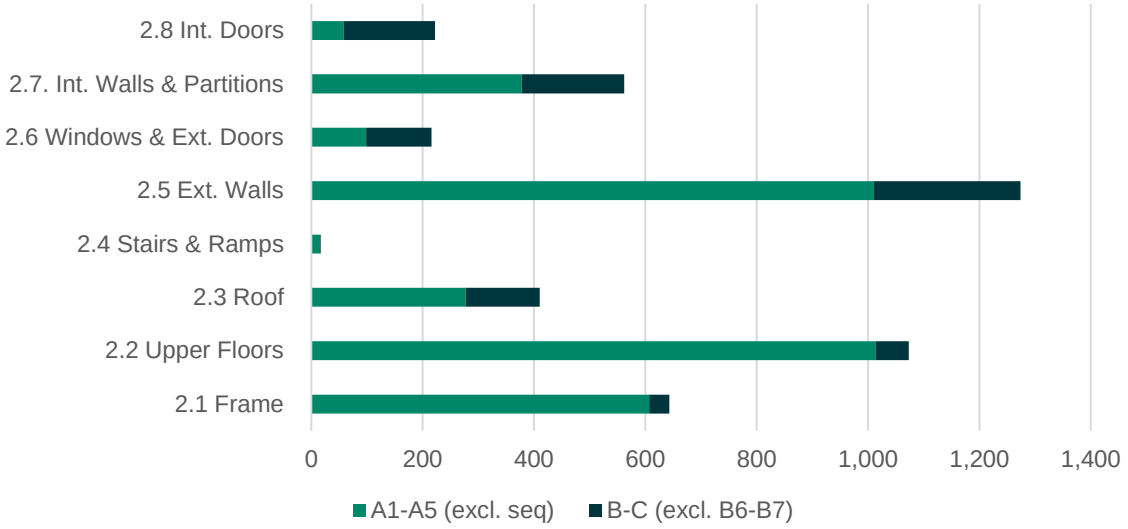


Figure 11 Breakdown of the embodied carbon of the Superstructure by the Building Element Subcategories

Smaller proportions of embodied carbon, approximately **10%** of the total, result from the combination of finishes and fittings.

2.1 Demolition

As per the GLA guidance document, carbon emissions associated with pre-construction demolition were calculated. Actual figures were unknown at the time of the assessment and a standard assumption of 50 $kgCO_2e/m^2$ to the GIA of the existing areas being demolished that fall within the boundary line was used. The estimated impact is 231,425 $kgCO_2e$.

3. Comparisons of the Results with Benchmarks

According to the GLA's Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022), it is required that the results of the WLC Assessment of the Proposed Development are compared to the benchmarks provided in the same document (GLA, 2022). The embodied carbon results of the Proposed Development have been compared to the GLA benchmarks for Residential buildings.

Based on the current assumptions, the Proposed Development is meeting the aspirational benchmark for modules A1-A5 and significantly exceeding the aspirational benchmark for modules B-C (Table 14). The low A1-A5 can partly be attributed by the baseline percentage of GGBS in the scheme of 50%. The low B-C value can partly be attributed to the selection of refrigerant R-744, which has a low GWP (see Table 17).

Table 14 provides an overview of the comparison of the results of the WLC Assessment of the Proposed Development with the WLC Benchmarks for Residential buildings. The GLA requires that the modelled embodied carbon of the buildings for the Modules A1-A5 and B-C are compared to the respective benchmarks separately. The operational carbon (B6-B7) is not included in the benchmarks for the Modules B-C.

Table 14 Comparison of the results of the WLC Assessment of the Proposed Development with the WLC Benchmarks for Residential buildings

Modules	WLC Benchmark ($kgCO_2e/m^2$)	Aspirational WLC Benchmark ($kgCO_2e/m^2$)	Proposed Development ($kgCO_2e/m^2$)
A1- A5	<850	<500	**496**
B – C*	<350	<300	**249**

* (excl. B6- B7, excl. sequestration, as per GLA guidance)

4. Whole life carbon reduction measures and further recommendations

4.1 Key actions

Despite already achieving the GLA WLC aspirational benchmark figures, additional measures should be considered. These relate to recycled content in concrete, the use of green steel, design for disassembly, locally sourced low carbon materials, and internal finishes.

4.1.1 Increasing Recycled Content in Concrete

Using a higher percentage of recycled binder content within concrete elements will further reduce the carbon impact of the scheme, due to the energy-intensive process of manufacturing cement. The baseline is modelled with a 50% recycled content; however, the below calculations have been undertaken to establish the potential embodied carbon saving of implementing a 70% level.

Table 15 Study showing the effect of increasing the recycled binder content of cement (embodied carbon figures only)

Metric	50% (Baseline)	70%
Total tCO_2e	**9,626**	**8,697**
% saving on baseline	**-**	**10%**
$kgCO_2e/m^2$ saving*	**-**	**70**

*Using a combined Detailed and Outline GIA of 13,003m^2

If, following feasibility studies, the above is implemented, the higher percentages of recycled content could reduce the Proposed Development's embodied carbon by **70 $kgCO_2e/m^2$GIA** across the entire scheme.

4.1.2 The use of Green Steel

ArcelorMittal have released XCarb, a steel product that utilises efficient technologies during the manufacturing process. These include Electric Arc Furnace (EAF) production, a process where electricity is used to heat the steel furnace instead of coal, and the use of renewable energy sources to power the EAF.

Table 16 Study showing the effect of using low carbon steel for structural sections and rebar (Outline and Detailed schemes combined)

Metric	Baseline Steel	XCarb Sections & Rebar
Total tCO_2e	**9,626**	**8,798**
% Saving on baseline	**-**	**9%**
$kgCO_2e/m^2$ saving	**-**	**63**

By sourcing XCarb (or equivalent steel with a low global warming potential) and replacing the structural steel and rebar elements of the scheme, a reduction of the Proposed Development's embodied carbon of **63 $kgCO_2e/m^2$GIA** could be possible across the entire scheme. Feasibility studies should be undertaken into the uplift of cost, and availability of material.

4.2 Further Opportunities

4.2.1 Design for Disassembly

A key consideration for embodied carbon and the circular economy is to ensure buildings can be easily dismantled and elements reused/recycled where possible. This is also important for interior finishes and building services which are likely to be replaced much more often in a building's lifespan than the structural elements. Adhesives and welding should therefore be avoided where possible.

Lime mortar is also recommended for the brickwork façade, subject to a feasibility assessment, as during demolition it can be easily removed from bricks enabling their reuse.

4.2.2 Locally Sourced Low Carbon Materials

Section 2 outlined that the majority (approximately **58%**) of the embodied carbon LCA impact is attributed to the products and materials chosen. Another significantly contributing lifecycle stage is the transport of materials to site (approximately **2%** of the total embodied carbon). Therefore, choosing low carbon and locally sourced materials is the key consideration. Choosing products with Environmental Product Declarations (EPDs) allows design teams to compare and source the lowest carbon options.

4.2.3 Internal Finishes

It is suggested that internal finishes and fittings are sourced with EPDs and compared to inform selection and ensure the lowest impact possible is attributed to these elements. In addition, if possible, leaving internal faces exposed and having bare finishes will result in a much lower life cycle carbon impact as less material is required (including less replacements). This may be suitable in secondary circulation areas such as stairs.

4.2.4 Refrigerants for Building Services

There are a wide range of refrigerants, many of which have a global warming potential (GWP, $kgCO_2e/kg$) that is many times greater than CO_2. The carbon impact of such refrigerants released into the atmosphere, which can occur from leakages, can be significant. Therefore, refrigerants with lower GWP should be preferred where feasible, but this should be considered against the energy efficiency of the heat pump system to ensure the greatest reduction in WLC in the system. A refrigerant with a GWP of less than 150 $kgCO_2e/kg$ refrigerant is recommended[3]. Refrigerants have been specified for use in the ASHPs in this development.

Table 17: Global Warming Potential of different refrigerants for Building Services

Refrigerant Name	Trade or Common Name	High GWP?	Global Warming Potential
R-744 (currently specified)	**CO_2**	**No**	**1**
R-290	Propane	No	4
R-170	Ethane	No	6
R-152a	HFC-152a	No	124
R-32	HFC-32	Yes	675
R-134a	HFC-134a	Yes	1,430
R-22	GCFC-22, Freon	Yes	1,810
R-410A	Puron, AZ-20	Yes	2,088
R-125	HFC-125	Yes	3,500
R-404A	HP-62	Yes	3,900
R-502		Yes	4,656.72
R-12	CFC-12	Yes	10,900

The refrigerant R-744 is currently specified for this project which has the lowest GWP on the market. It is heavily encouraged, from an embodied carbon perspective, that this is not altered.

[3] LETI Embodied Carbon Primer – Supplementary guidance to the Climate Emergency Design Guide 2020

4.2.5 Next Stage Assessment

A further WLC Assessment will also be completed at Post-Construction Stage, as per the GLA's Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022). The post-construction WLC assessment will require an update of the information provided at the planning submission stage (RIBA Stage 2/3) and for the actual WLC carbon emission figures to be reported. The WLC calculation results will be updated for all modules, based on the actual materials, products and systems used for the construction of the Proposed Development. The evidence listed below should be provided as a minimum to support the updated results:

- Site energy (including fuel) use record;
- Contractor confirmation of as-built material quantities and specifications per building element category;
- Record of material delivery including distance travelled and transportation mode (including materials for temporary works); and
- Waste transportation record including waste quantity, distance travelled and transportation mode (including materials for temporary works).

According to the guidance, the post-construction results will need to be compared with the planning submission stage results and the WLC benchmarks, accompanied with an explanation for the difference.

5. Conclusions and Next Steps

This document accompanies the Greater London Authority (GLA) WLC Assessment Templates, which have been developed to meet the relevant planning Policy SI 2 F of the Publication London Plan December 2020. The report outlines the Scope of the WLC Assessment, presents and analyses the results of the WLC Assessment of the Proposed Development and compares them with the corresponding benchmarks that are provided in the GLA's Whole Life-Cycle Carbon Assessment Guidance (2022).

The baseline WLC over the 60-year study period: **18,141 tCO_2e which corresponds to 1,377 $kgCO_2e/m^2$ GIA**.

The operational carbon is responsible for **47%** of the WLC of the Proposed Development, while **53%** is attributed to the embodied carbon of the building materials, facilitating works and external works.

The largest share of embodied carbon emissions, approximately **59%** of the whole, is attributed to the product stage (life cycle stages A1-A3, also known as cradle to gate stages). Transport and construction stages (A4 – A5) contribute around **8%** of total embodied carbon. The embodied carbon from recurring building elements (B1-B5) contributes approximately **28%** of the total embodied carbon.

In order to reduce the embodied carbon of the buildings, it is imperative to focus on the materials being selected and reducing the quantities and mass of materials required. The superstructure is responsible for approximately **44%** of the embodied carbon of the Proposed Development, while services are responsible for **22%** and the substructure is responsible for **17%**.

5.1 Comparison to Benchmarks

According to the GLA's Whole Life-Cycle Carbon Assessment Guidance (GLA, 2022), it is required that the results of the WLC Assessment of the Proposed Development are compared to the benchmarks provided in the same document (GLA, 2022). The embodied carbon results of the Proposed Development have been compared to the GLA benchmarks for Residential buildings.

Based on the current assumptions, the Proposed Development is meeting the aspirational benchmark for modules A1-A5 and significantly exceeding the aspirational benchmark for modules B-C (Table 18). The low A1-A5 can partly be attributed by the baseline percentage of GGBS in the scheme of 50%. The low B-C value can partly be attributed to the selection of refrigerant R-744, which has a low GWP (see Table 17).

Table 18 provides an overview of the comparison of the results of the WLC Assessment of the Proposed Development with the WLC Benchmarks for Residential buildings. The GLA requires that the modelled embodied carbon of the buildings for the Modules A1-A5 and B-C are compared to the respective benchmarks separately. The operational carbon (B6-B7) is not included in the benchmarks for the Modules B-C.

Table 18 Comparison of the results of the WLC Assessment of the Proposed Development with the WLC Benchmarks for Residential buildings

Modules	WLC Benchmark ($kgCO_2e/m^2$)	Aspirational WLC Benchmark ($kgCO_2e/m^2$)	Proposed Development ($kgCO_2e/m^2$)
A1- A5	<850	<500	**496**
B – C*	<350	<300	**249**

* (excl. B6- B7, excl. sequestration, as per GLA guidance)

5.2 Recommendations

It has been demonstrated that the majority of the embodied carbon in both models can be attributed to the large quantities of reinforced concrete and steel. Since 50% of cement replacement is proposed for all the buildings of the Proposed Development, it is suggested that a higher recycled binder content within cement is introduced based on feasibility studies. Additional opportunities have also been identified for further investigation.

5.3 Next Steps

A further WLC Assessment will be completed at post-construction stage, as per the GLA's Whole Life-Cycle Carbon Assessment Guidance. Accordingly, the post-construction results will be compared with planning submission stage results and GLA benchmarks, accompanied with an explanation for any significant differences.

6. References

Greater London Authority . (2020). *Whole Life-Cycle Carbon Assessment Guidance Consultation Draft.*

Greater London Authority . (March 2021). *The London Plan, The spatial development strategy for greater London.* Retrieved from https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

London Borough of Waltham Forest. (2012). *Waltham Forest Local Plan Core Strategy.*

Meinhardt. (2019). *Outline Energy Assessment: Draft Issue.*

Appendix A Bill of Materials

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
Note/example		Breakdown of material type in each category. Insert more lines if needed. e.g. Concrete	65000 kg	For all primary building systems (structure, substructure, envelope, MEP services, internal finishes) including assumed material/product lifespans and annual maintenance/repair %	Declare 'end of life' scenario as per project's Circular Economy Statement, and used in the WLC assessment to produce Module C results	0 kg	25 kg
		e.g. Reinforcement	5000 kg			2 kg	8 kg
		e.g. Formwork	250 kg			0 kg	0 kg
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment						
0.2	Major Demolition Works						
0.3	Temporary Support to Adjacent Structures						
0.4	Specialist Ground Works						
1	Substructure	Ready-mix concrete C40/50 50% GGBS	7,972,104 kg	As building	Concrete crushed to aggregate	0 kg	7,972,104 kg
		Carbon steel reinforcing bar (UK Cares)	599,447 kg	As building	Steel recycling	0 kg	599,447 kg
2.1	Superstructure: Frame	Ready-mix concrete C40/50 50% GGBS	2,944,800 kg	As building	Concrete crushed to aggregate	0 kg	2,944,800 kg
		Ready-mix concrete C32/40 50% GGBS	278,400 kg	As building	Concrete crushed to aggregate	0 kg	278,400 kg
		Carbon steel reinforcing bar (UK Cares)	270,595 kg	As building	Steel recycling	0 kg	270,595 kg
		Structural steel profiles	2,262 kg	As building	Steel recycling	0 kg	2,262 kg
2.2	Superstructure: Upper Floors	Ready-mix concrete C40/50 50% GGBS	6,084,480 kg	As building	Concrete crushed to aggregate	0 kg	6,084,480 kg
		Carbon steel reinforcing bar (UK Cares)	324,953 kg	As building	Steel recycling	0 kg	324,953 kg
		Prefabricated steel balcony with steel railings	23,562 kg	As building	Reuse as material	23,562 kg	0 kg
2.3	Superstructure: Roof	Bitumen-polymer membrane roofing	20,985 kg	Lifespan 30 years	Bitumen membrane recycling	0 kg	20,985 kg
		Drainage floor underlay	284 kg	Lifespan 30 years	Plastic-based material incineration	0 kg	0 kg
		Extruded polystyrene (XPS)	16,973 kg	Lifespan 30 years	Landfilling	0 kg	0 kg
		Planed timber	18,396 kg	Lifespan 30 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
		Soil substrates for green roofs	53,526 kg	Lifespan 30 years	Reuse as material	53,526 kg	0 kg
		Polyurethane waterproofing membrane	10,375 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	0 kg
		Waterproofing system with flexible sheets for roofing	22,866 kg	Lifespan 30 years	Plastic-based material incineration	0 kg	0 kg
		Galvanized profiled steel decking	937 kg	As building	Steel recycling	0 kg	937 kg
		Ready-mix concrete C40/50 50% GGBS	1,152,000 kg	As building	Concrete crushed to aggregate	0 kg	1,152,000 kg
		Carbon steel reinforcing bar (UK Cares)	67,200 kg	As building	Steel recycling	0 kg	67,200 kg
		Precast concrete paving tiles	176,908 kg	As building	Concrete crushed to aggregate	0 kg	176,908 kg
2.4	Superstructure: Stairs and Ramps	Ready-mix concrete C40/50 50% GGBS	110,400 kg	As building	Concrete crushed to aggregate	0 kg	110,400 kg
		Carbon steel reinforcing bar (UK Cares)	4,608 kg	As building	Steel recycling	0 kg	4,608 kg
2.5	Superstructure: External Walls	Autoclaved aerated concrete blocks	5,796 kg	As building	Concrete crushed to aggregate	0 kg	5,796 kg
		Fibre cement boards	154,253 kg	Lifespan 30 years	Concrete crushed to aggregate	0 kg	0 kg
		Glass wool insulation	10 kg	As building	Landfilling	0 kg	0 kg
		Gypsum plasterboard	352,740 kg	Lifespan 30 years	Gypsum recycling	0 kg	352,740 kg
		Gypsum plaster	47,141 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	47,141 kg
		Lightweight concrete block	10,920 kg	As building	Concrete crushed to aggregate	0 kg	10,920 kg
		Masonry mortar	138,938 kg	As building	Cement/mortar use in a backfill	0 kg	138,938 kg
		Polyurethane waterproofing membrane	39,038 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	0 kg
		Red Brick	1,373,794 kg	As building	Brick/stone crushed to aggregate	0 kg	1,373,794 kg
		Rockwool insulation	325,311 kg	As building	Landfilling (for inert materials)	0 kg	0 kg
		Steel stud	14,608 kg	As building	Steel recycling	0 kg	14,608 kg
2.6	Superstructure: Windows and External Doors	Aluminium framed glazed doors	31,290 kg	Lifespan 30 years	Glass-containing product recycling (80% glass)	0 kg	25,032 kg
		Aluminum profile for windows and doors	663 kg	Lifespan 30 years	Aluminium recycling	0 kg	663 kg
		Float glass	88,380 kg	Lifespan 30 years	Glass recycling	0 kg	88,380 kg
		Planed timber for joinery applications	8,840 kg	Lifespan 30 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
2.7	Superstructure: Internal Walls and Partitions	Autoclaved aerated concrete blocks	100,128 kg	As building	Concrete crushed to aggregate	0 kg	100,128 kg
		Glass wool insulation	83,214 kg	As building	Landfilling (for inert materials)	0 kg	0 kg
		Gypsum plaster	79,718 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	0 kg
		Gypsum plasterboard	1,116,895 kg	Lifespan 30 years	Gypsum recycling	0 kg	1,116,895 kg
		Masonry mortar	17,880 kg	As building	Cement/mortar use in a backfill	0 kg	17,880 kg
		Rockwool insulation	63,473 kg	As building	Landfilling (for inert materials)	0 kg	0 kg
		Steel stud	26,724 kg	As building	Steel recycling	0 kg	26,724 kg
2.8	Superstructure: Internal Doors	Wooden internal door	122,551 kg	Lifespan 30 years	Wood-containing product incineration (80% wood)	0 kg	0 kg

3	Finishes	Ceramic tiles	22,734 kg	Lifespan 30 years	Brick/stone crushed to aggregate	0 kg	22,734 kg
		Emulsion paint	36,982 kg	Lifespan 10 years	Landfilling (for inert materials)	0 kg	0 kg
		Engineered wood flooring	101,832 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		PVC vinyl flooring	18,463 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Steel suspended ceiling supports	98,317 kg	Lifespan 30 years	Steel recycling	0 kg	98,317 kg
		Gypsum plasterboard	226,077 kg	Lifespan 30 years	Gypsum recycling	0 kg	226,077 kg
		Porcelain stoneware	28,610 kg	Lifespan 30 years	Brick/stone crushed to aggregate	0 kg	28,610 kg
		Solvent-borne floor paint	1,107 kg	Lifespan 10 years	Landfilling (for inert materials)	0 kg	0 kg
		Wall-to-wall carpet	23,273 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
4	Fittings, furnishings & equipment (FFE)	Acrylic bathtub	2,912 kg	Lifespan 20 years	Landfilling (for inert materials)	0 kg	0 kg
		Hot water radiator	8,587 kg	Lifespan 20 years	Landfilling (for inert materials)	0 kg	0 kg
		Porcelain sink	5,624 kg	Lifespan 20 years	Landfilling (for inert materials)	0 kg	0 kg
		Porcelain WC kit (toilet and tank)	7,195 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	6,395 kg
5	Services (MEP)	Air handling unit	38,408 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	34,568 kg
		Air/air heat pump	13,680 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	12,312 kg
		Circulation pump	64 kg	Lifespan 25 years	Landfilling (for inert materials)	0 kg	0 kg
		Cogeneration heat and power plant	4,552 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	4,097 kg
		Consumer Unit 6-way	641 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)	0 kg	577 kg
		Electric boiler	960 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	864 kg
		Electric socket	1,700 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)	0 kg	1,530 kg
		Electricity cabling	58,774 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)	0 kg	52,896 kg
		Elevator for residential buildings	46,880 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	42,192 kg
		Heat distribution system (water heat distribution)	118,197 kg	Lifespan 25 years	Metal-containing product recycling (90% metal)	0 kg	106,378 kg
		Heated water storage tank	14,999 kg	Lifespan 25 years	Landfilling (for inert materials)	0 kg	0 kg
		Indoor luminescent ceiling light	2,235 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	0 kg
		Indoor pendant lights	4,704 kg	Lifespan 30 years	Landfilling (for inert materials)	0 kg	0 kg
		Inlet/Outlet valve	24 kg	Lifespan 25 years	Metal-containing product recycling (90% metal)	0 kg	22 kg
		Photovoltaic monocrystalline panel (PV)	42,565 kg	Lifespan 25 years	Metal-containing product recycling (90% metal)	0 kg	38,308 kg
		Pipesystem, hot and cold water supply	3,381 kg	Lifespan 25 years	Landfilling (for inert materials)	0 kg	0 kg
		Polypropylene rainwater storage tank	2,622 kg	Lifespan 25 years	Landfilling (for inert materials)	0 kg	0 kg
		Sewage water drainage piping network	2,398 kg	Lifespan 25 years	Metal-containing product recycling (90% metal)	0 kg	2,158 kg
		Single and three phase distribution boards	2,587 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)	0 kg	2,328 kg
		Sprinkler system	32,768 kg	Lifespan 25 years	Landfilling (for inert materials)	0 kg	0 kg
		Ventilation system for residential building	24,576 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)	0 kg	22,118 kg
6	Prefabricated Buildings and Building Units						
7	Work to Existing Building						
8	External works	Aggregate (crushed gravel)	428,400 kg	As building	Reuse as material	428,400 kg	0 kg
		Clay pavers	33,008 kg	As building	Reuse as material	33,008 kg	0 kg
		Double skin wall from bricks, including mortar	36,579 kg	As building	Brick/stone crushed to aggregate	0 kg	36,579 kg
		Geotextile	1,114 kg	Lifespan 30 years	Plastic-based material incineration	0 kg	0 kg
		Precast concrete paving tiles	126,336 kg	As building	Reuse as material	126,336 kg	0 kg
		Resin bound aggregate decorative paving system	157,940 kg	Lifespan 30 years	Asphalt reuse via reprocessing	0 kg	157,940 kg
		Sand	232,351 kg	As building	Reuse as material	232,351 kg	0 kg
Refrigerants		**Refrigerant name**	**Initial Charge(kg)**	**Annual leakage rate %**	**Refrigerant GWP ($kgCO_2e/kg$)**	**End of Life recovery rate %**	
a	Refrigerants Type 1 (if applicable) - please see CIBSE TM65 for methodology	R744	66	2	1	1	
b	Refrigerants Type 2 (if applicable) - please see CIBSE TM65 for methodology						
c	Refrigerants Type 3 (if applicable) - please see CIBSE TM65 for methodology						
		TOTAL	26,371,676 kg			897,183 kg	24,226,718 kg
		Material intensity (kg/m2 GIA)	2,001 kg/m2 GIA			68 kg/m2 GIA	1,839 kg/m2 GIA

Appendix B Results of WLC Assessment

GWP POTENTIAL FOR ALL LIFE-CYCLE MODULES ($kgCO_2e$) (See Note 1 below if you entered a reference study period in cell C12)		Sequestered (or biogenic) carbon (negative value) ($kgCO_2e$)	Product stage ($kgCO_2e$)	Construction process stage ($kgCO_2e$)		Use stage ($kgCO_2e$)							End of Life (EoL) stage ($kgCO_2e$)				TOTAL Modules A-C $kgCO_2e$	Benefits and loads beyond the system boundary ($kgCO_2e$)
			Module A			Module B							Module C					Module D
Building element category			[A1] to [A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[B6]	[B7]	[C1]	[C2]	[C3]	[C4]		
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
0.2	Major Demolition Works												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
0.3	Temporary Support to Adjacent Structures												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
0.4	Specialist Ground Works												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
0.5	Temporary Diversion Works												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
1	Substructure	0 kg CO2e	1,380,773 kg CO2e	58,705 kg CO2e	64,133 kg CO2e		30,302 kg CO2e	7,576 kg CO2e					[Where only a single C1-C4 is known, please include it here]	46,282 kg CO2e	4,062 kg CO2e		1,591,832 kg CO2e	-1,603,331 kg CO2e
2.1	Superstructure: Frame	0 kg CO2e	556,413 kg CO2e	24,085 kg CO2e	26,093 kg CO2e		12,225 kg CO2e	3,056 kg CO2e					[Where only a single C1-C4 is known, please include it here]	19,880 kg CO2e	1,708 kg CO2e		643,460 kg CO2e	-734,469 kg CO2e
2.2	Superstructure: Upper Floors	0 kg CO2e	925,446 kg CO2e	43,553 kg CO2e	44,751 kg CO2e		20,430 kg CO2e	5,108 kg CO2e					[Where only a single C1-C4 is known, please include it here]	31,150 kg CO2e	2,863 kg CO2e		1,073,300 kg CO2e	-1,009,144 kg CO2e
2.3	Superstructure: Roof	-28,908 kg CO2e	251,853 kg CO2e	12,151 kg CO2e	13,568 kg CO2e		5,590 kg CO2e	1,397 kg CO2e	52,309 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	6,687 kg CO2e	67,147 kg CO2e	47 kg CO2e	381,641 kg CO2e	-376,853 kg CO2e
2.4	Superstructure: Stairs and Ramps	0 kg CO2e	14,665 kg CO2e	771 kg CO2e	667 kg CO2e		325 kg CO2e	81 kg CO2e					[Where only a single C1-C4 is known, please include it here]	500 kg CO2e	48 kg CO2e		17,056 kg CO2e	-13,272 kg CO2e
2.5	Superstructure: External Walls	0 kg CO2e	916,528 kg CO2e	23,690 kg CO2e	70,246 kg CO2e		20,364 kg CO2e	5,091 kg CO2e	226,556 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	10,190 kg CO2e	712 kg CO2e	941 kg CO2e	1,274,318 kg CO2e	-46,265 kg CO2e
2.6	Superstructure: Windows and External Doors	-16,354 kg CO2e	96,262 kg CO2e	797 kg CO2e	1,592 kg CO2e		1,868 kg CO2e	497 kg CO2e	96,262 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	2,350 kg CO2e	16,484 kg CO2e	8 kg CO2e	199,887 kg CO2e	-41,184 kg CO2e
2.7	Superstructure: Internal Walls and Partitions	0 kg CO2e	333,514 kg CO2e	9,086 kg CO2e	35,410 kg CO2e		7,618 kg CO2e	1,905 kg CO2e	159,372 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	14,169 kg CO2e	494 kg CO2e	484 kg CO2e	562,052 kg CO2e	-66,332 kg CO2e
2.8	Superstructure: Internal Doors	-105,560 kg CO2e	56,840 kg CO2e	704 kg CO2e	0 kg CO2e		1,160 kg CO2e	290 kg CO2e	56,840 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	235 kg CO2e	106,190 kg CO2e	32 kg CO2e	116,730 kg CO2e	0 kg CO2e
3	Finishes	-39,778 kg CO2e	321,406 kg CO2e	2,765 kg CO2e	32,661 kg CO2e		7,191 kg CO2e	1,798 kg CO2e	528,972 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	4,600 kg CO2e	117,282 kg CO2e	17 kg CO2e	976,914 kg CO2e	-429,251 kg CO2e
4	Fittings, furnishings & equipment	0 kg CO2e	87,440 kg CO2e	172 kg CO2e	343 kg CO2e		1,773 kg CO2e	443 kg CO2e	174,881 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	155 kg CO2e	10 kg CO2e	41 kg CO2e	265,258 kg CO2e	-17,050 kg CO2e
5	Services (MEP)	-750 kg CO2e	764,817 kg CO2e	4,659 kg CO2e	3,705 kg CO2e	140 kg CO2e	15,582 kg CO2e	3,895 kg CO2e	1,355,367 kg CO2e	0 kg CO2e	3,675,545 kg CO2e	4,815,732 kg CO2e / 24,158 kg CO2e	[Where only a single C1-C4 is known, please include it here]	5,394 kg CO2e	1,227 kg CO2e	111 kg CO2e	10,669,583 kg CO2e	-708,406 kg CO2e
6	Prefabricated Buildings and Building Units												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
7	Work to Existing Building												[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
8	External works	0 kg CO2e	59,511 kg CO2e	6,407 kg CO2e	1,925 kg CO2e		1,367 kg CO2e	342 kg CO2e	7,291 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	807 kg CO2e	1,242 kg CO2e		78,891 kg CO2e	-10,614 kg CO2e
Other site construction impacts or overall construction stage (A5) carbon emissions not specific to an individual building element category					290,099 kg CO2e												290,099 kg CO2e	
TOTAL kg CO_2e		-191,359 kg CO2e	5,765,269 kg CO2e	187,543 kg CO2e	585,194 kg CO2e	140 kg CO2e	125,914 kg CO2e	31,478 kg CO2e	2,657,851 kg CO2e	0 kg CO2e	8,491,277 kg CO2e	24,158 kg CO2e	0 kg CO2e	142,399 kg CO2e	319,469 kg CO2e	1,680 kg CO2e	18,141,823 kg CO2e	-5,696,176 kg CO2e
TOTAL - kg CO_2e/m^2 GIA		-15 kg CO2e/m2 GIA	438 kg CO2e/m2 GIA	14 kg CO2e/m2 GIA	44 kg CO2e/m2 GIA	0 kg CO2e/m2 GIA	10 kg CO2e/m2 GIA	2 kg CO2e/m2 GIA	202 kg CO2e/m2 GIA	0 kg CO2e/m2 GIA	644 kg CO2e/m2 GIA	2 kg CO2e/m2 GIA	0 kg CO2e/m2 GIA	##########	##########	##########	1,377 kg CO2e/m2 GIA	-394 kg CO2e/m2 GIA

Notes:
1 If you have entered a reference study period in cell C12 because the assumed building life expectancy is greater or less than 60 years, then you will need to fill in this table using a 60 year building life expectancy. If you choose to, you may create a second table below and complete it using the actual assumed life expectancy. This should be clearly labelled.

Appendix C Data Sources

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	Download EPD
Acrylic bathtub	20.8 kg/unit	DURAVIT : Starck (700345 ; 700344 ; 700342). D-Code (700097 ; 700098 ; 700104 ; 700105) // - KOHLER : Stil 2 (E6812-00 ; E6811-00). Corvette (E60900-00 ; E60901-00/60901-00 ; E60902-00/60902-00 ; E60903-00/60903-00 ; E60904-00/60904-00 ; E60905-00/60905-00). Struktura (E6D020-00/6D020-00 ;	Association Française des Industries de la Salle de Bains	INIES	INIES_CBAI20140415_133015, 14205	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2020	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD

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	Download EPD
		E6D021-00/6D021-00). Odeon Up (E6048-00/E6D231-00 ; E6049-00/E6D232-00 ; E6057-00/E6D234-00 ; E6060-00/E6D235-00 ; E6080-00/E6D233-00)													
Aggregate (crushed gravel), generic, dry bulk density	1600 kg/m3			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	1600.0	EN15804+A1	-	
Air handling unit, with heat recovery through indirect liquid circulation heat recovery	1000 m3/h (588.6 ft3/min), 92 kg/unit (203 lbs/unit)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent		EN15804+A1	-	

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	Download EPD
Air/air heat pump, ducted	152 kg/unit, P= 16 kW	DONNEE PAR DEFAUT	DED	INIES	INIES_DPAC20210726_091030, 28825	MDEGD_FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2022	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Aluminium framed glazed doors, double glazed, per unit	83% glass, 12% aluminium, 3% steel, width 990mm; height 2.60m, glass thickness 14mm	AXILE Family, EDGE Family, KINETIC Family, ELITE Aero	Optima	International EPD System	S-P-00480	EPD Aluminium Framed Glazed Doors	EN15804+A1	Third-party verified (as per ISO 14025)	2017	unitedKingdom	ecoinvent		PCR 2012:01 Construction products and Construction services, ver. 2.01, 09/03/2016	Only with EN15804	Download EPD
Aluminum profile for windows and doors	2600 kg/m3	Al Profile	Saray	International EPD System	S-P-00833	EPD for Aluminium Profiles	EN15804+A1	Third-party verified (as per ISO 14025)	2016	turkey	ecoinvent		PCR 2012:01 Construction products and Construction services, ver. 2.01, 09/03/2016	Only with EN151404	Download EPD
Autoclaved aerated concrete blocks	460-760 kg/m3	Aircrete	BPCF	IBU	EPD-BPC-20170093-CCD1-EN	EPD UK Manufactured Precast Aerated Concrete Blocks as produced by members of the Aircrete Products	EN15804+A1	Third-party verified (as per ISO 14025)	2017	unitedKingdom	GaBi	600.0	PCR Aerated concrete, 07/2014	Only with EN15804	Download EPD

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	Download EPD
						Association (APA) a product group of British Precast									
Bitumen-polymer membrane roofing, 2 layer, mechanically fastened			EWA	EPD Norge	NEPD00270E	Multi layer mechanically fastened modified bitumen roof waterproofing system, Bitumen Waterproofing Association (2014)	EN15804+A1	Third-party verified (as per ISO 14025)	2014	europe, belgium, denmark, finland, germany, italy, netherlands, sweden	-	1250.0	NPCR 022 Roof Waterproofing, rev1	Only with EN15804	Download EPD
Carbon steel reinforcing bar (secondary production route – scrap)	97.07% recycled steel, 7850 kg/m3		UK Cares	BRE	BREG EN EPD 000125	EPD Carbon steel reinforcement bar (secondary production route - scrap), Sector average, UK cares	EN15804+A1	Third-party verified (as per ISO 14025)	2016	unitedKingdom, poland, turkey, spain, france, portugal	GaBi	7850.0	EN15804+A1	-	Download EPD
Ceramic floor and wall tiles	9.53-12.7 mm, avg. weight 23.5 kg/m2		Ragno, plant Lewisport	NSF	EPD10231	EPD Lewisport, KY Quarry Tile	EN15804+A1	Third-party verified (as per ISO 14025)	2019	northAmerica	GaBi		PCR Flooring EPD Requirements. UL 10010-7, September 28, 2018	Only with EN15804	Download EPD

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	Download EPD
Ceramic tiles, unglazed, for floor application	10 mm, 26.963 kg/m2, 2200 kg/m3			INSIDE/INSIDE	NIBE259	EPD 21002-NIBE259 - Keramische tegels (dikte 10 mm) ongeglazuurd; gelijmd	EN15804+A1	Third-party verified (as per ISO 14025)	2020	netherlands	ecoinvent		EN15804+A1	-	See full dataset
Circulation pump, constant pressure	5.34 kg/unit	DONNEE PAR DEFAUT	DED	INIES	INIES_DPOM20190725_084525, 25847	MDEGD_FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2019	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Clay pavers, with chushed cigarette butts	82.52 kg/m2	PavécO	RECYCLEO	INIES	INIES_IRSX20210923_112519, 27356	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2021	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Cogeneration heat and power plant (CHP), per kW	includes only the heat and power generation machinery			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent		EN15804+A1	-	

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	Download EPD
Concrete assembly for stairs per one metre height				One Click LCA		One Click LCA generic construction definitions				LOCAL	Other				
Consumer Unit 6 way with door		PEP - Classic+ Metallic, S9HCL16	SCHNEIDER ELECTRIC INDUSTRIES SAS	INIES	SCHN-00213-V01.01-EN, 7103	PEP	-	Third-party verified (as per ISO 14025)	2017	france	ecoinvent		EN15804+A1	-	Download EPD
Double skin wall from bricks, including mortar	with Mortar 1:3 cement:sand mix (Using CEM I cement)			ICE	-	ICE database August 2019, V3.0	EN15804+A1	Self declared	2019	unitedKingdom	-		EN15804+A1	-	
Drainage floor underlay from EPS	ép.25 mm	DONNEE PAR DEFAUT	DED	INIES	INIES_DCOU20191220_144652, 13812	MDEGD_FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2019	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Electric boiler	per 1kW / unit - beta			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent		EN15804+A1	-	

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	Download EPD
Electric socket				OKOBAUDAT	-	Oekobau.dat 2020-II	EN15804+A1	Third-party verified (as per ISO 14025)	2020	germany	GaBi		EN15804+A1	-	See full dataset
Electricity cabling, room area m2				One Click LCA	-	One Click LCA	ISO14040	Internally verified	2013	LOCAL	ecoinvent		-	Only with EN15804	
Elevator for residential buildings	2930 kg/unit		FEDERATION DES ASCENSEURS	INIES	FASC-00001-V01.01-FR, 24297	PEP	EN15804+A1	Third-party verified (as per ISO 14025)	2020	france	ecoinvent		PEP-PCR-ed3-FR-2015 04 02	ISO 14025	Download EPD
Emulsion matt paint for allround interior use	Pigment: Lightfast Pigments, binder: PVA Copolymer emulsion , solvent: Water, 1.443 kg/l, 18m2/l, 0.16 kg/m2	Supermatt White, Almond White, Gardenia, Magnolia, Light Base, Medium Base	Dulux Trade	MRPI	1.1.00023.2017	EPD Dulux Trade Supermatt	EN15804+A1	Third-party verified (as per ISO 14025)	2017	unitedKingdom	ecoinvent		EN15804+A1	-	Download EPD

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	Download EPD
Engineered wood flooring, biogenic CO2 not subtracted (for CML)	7.04 kg/m2		Bois de France	INIES	INIES_CMLD20211019_085845, 29345	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2021	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Extruded polystyrene (XPS)	L = 0.035 W/mK, 34.6 kg/m2		FPX	IBU	EPD-FPX-20140157-IBE1-DE	Oekobau.dat 2017-I, EPD Extrudierter Polystyrolhartschaum (XPS) mit alternativem Flammschutzmittel FPX – Fachvereinigung Polystyrol-Extruderschaumstoff	EN15804+A1	Third-party verified (as per ISO 14025)	2014	germany	GaBi	34.6	PCR Dämmstoffe aus Schaumkunststoffen, 07/2014	Only with EN15804	Download EPD
Fibre cement boards	1300 kg/m3 (81.16 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent	1300.0	EN15804+A1	-	
Float glass, single pane, generic	3-12 mm (0.12-0.47 in), 10 kg/m2 (2.05 lbs/ft2) (for 4 mm/0.16 in),			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	2500.0	EN15804+A1	-	

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	Download EPD
	2500 kg/m3 (156 lbs/ft3)														
Foam backed vinyl (PVC) flooring, heterogeneous	2.6 mm, 1.8 kg/m2	TX Classic	Tarkett	International EPD System	S-P-01347	EPD Tapiflex and TX heterogeneous vinyl flooring	EN15804+A1	Third-party verified (as per ISO 14025)	2018	france, unitedKingdom, germany, luxembourg	ecoinvent		PCR 2012:01 Construction products and Construction services, ver. 2.2, 03/05/2017, Sub-PCR-F Resilient textile and laminate floor coverings	Only with EN15804	Download EPD
Galvanized profiled steel decking, for composite floor slabs/decks	1.2 mm sheet thickness, 17.03 kg/m2	ComFlor® 51 1.2mm	Tata Steel Europe, Tata Steel International (2021)	TATA Steel	EPD-TS-2021-008	EPD ComFlor® 51 1.2mm steel structural floor deck	EN15804+A1	Third-party verified (as per ISO 14025)	2021	unitedKingdom, unitedArabEmirates	GaBi		EN15804+A1	-	Download EPD
Galvanized steel plates for suspended ceiling systems	0.6 mm, 4.7 kg/m2, 7800 kg/m3			INSIDE/INSIDE	NIBE1983	EPD 21002-NIBE1983 - Stalen platen; 0,6 mm	EN15804+A1	Third-party verified (as per ISO 14025)	2020	netherlands	ecoinvent	7800.0	EN15804+A1	-	See full dataset

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	Download EPD
Geotextile, generic	312 g/m2 (1.02 oz/ft2), Composition: PP net, non-woven PE felt			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent		EN15804+A1	-	
Glass wool acoustic insulation with expanded recycled glass granules coating	dimensions 1000 x 600mm +/- 3mm, thickness 46.5mm +/- 0.5mm, 8.75 kg/m2		Armourcoat	International EPD System	S-P-04391	EPD Armourcoat Acoustic System	EN15804+A1, EN15804+A2	Third-party verified (as per ISO 14025)	2021	unitedKingdom, OCLEPD	ecoinvent		PCR2019:14 Construction products and services Sub PCR-C- Acoustic Systems solutions	Only with EN15804	Download EPD
Glass wool insulation panels, unfaced, generic	L = 0.031 W/mK, R = 3.23 m2K/W (18 ft2°Fh/BTU), 25 kg/m3 (1.56 lbs/ft3), (applicable for densities: 0-25 kg/m3 (0-1.56 lbs/ft3)), Lambda=0.031 W/(m.K)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	25.0	EN15804+A1	-	

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	Download EPD
Gypsum plaster	1100 kg/m3		Bundesverband der Gipsindustrie	IBU	EPD-BVG-20140073-IAG1-DE	Oekobau.dat 2017-I, EPD GIPSPUTZ Bundesverband der Gipsindustrie e.V.	EN15804+A1	Third-party verified (as per ISO 14025)	2014	germany	GaBi	1100.0	PCR Mineralische Werkmörtel, 10/2012	Only with EN15804	Download EPD
Gypsum plaster board, regular, generic	6.5-25 mm (0.25-0.98 in), 10.725 kg/m2 (2.20 lbs/ft2) (for 12.5 mm/0.49 in), 858 kg/m3 (53.6 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	858.0280607132333	EN15804+A1	-	
Gypsum plasterboard	12.5 mm, 8.985 kg/m2 (average product weight)		Etex Building Performance	BRE	BREG EN EPD 000204	EPD GTEC Plasterboard	EN15804+A1	Third-party verified (as per ISO 14025)	2018	unitedKingdom	ecoinvent	718.8	EN15804+A1	-	Download EPD
Gypsum plasterboard, moisture resistant, with square edges	12.5/15 mm, 696.8 kg/m3, 10µ water vapour resistance	Gyproc Moisture Resistant	British Gypsum	International EPD System	S-P-00507	EPD for Gyproc Moisture Resistant	EN15804+A1	Third-party verified (as per ISO 14025)	2013	unitedKingdom	ecoinvent	696.8	PCR 2012:01 Construction Products and Construction services, ver. 1.2, IBU PCR	Only with EN151404	Download EPD

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	Download EPD
													GuidanceTexts for Building-Related Products and services, Part B: Requirements on the EPD for Plasterboard version 1.5		
Heat distribution system (water heat distribution) for residential building	per m2 GFA			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent		EN15804+A1	-	
Heated water storage tank, for collective use	932.5L		Uniclima	INIES	UNIC-00028-V01.01-FR, 16238	PEP	EN15804+A1	Third-party verified (as per ISO 14025)	2019	france	ecoinvent		PEP-PCR-ed3-FR-2015 04 02	ISO 14025	Download EPD
Hot water radiator with towel drying	15.03 kg/unit	ATLANTIC, FINIMETAL, RADSON, STELRAD,	Uniclima	INIES	UNIC-00006-V01.02-FR, 25891	PEP	EN15804+A1	Third-party verified (as per	2018	france	ecoinvent		PEP-PCR-ed3-FR-2015 04 02	ISO 14025	Download EPD

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	Download EPD
function, per unit		HENRAD, ZEHNDER, ACOVA						ISO 14025)							
Indoor luminescent ceiling light, waterproof	P=14W et diam.=70mm	DONNEE PAR DEFAUT	DED	INIES	INIES_DLUM20191220_143025, 13638	MDEGD_FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2019	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Indoor pendant lights, caramel finish	400 dia, 1,043 kg/unit	Coral 400 Caramel Finish	David Trubridge Limited (2020)	Australasian EPD System	S-P-00556, v. 2	EPD Kitset Pendant Light Fittings	EN15804+A1	Third-party verified (as per ISO 14025)	2020	newZealand	GaBi		PCR 2012:01 Construction products and Construction services, Version 2.33, 2020-09-18, Stockholm: International EPD® System.	Only with EN15804	Download EPD
Inlet/Outlet valve R-100, galvanized steel			RUUKKI	-	-	Kuumasinkityt rakennustuotteet, Ruukki 2014	EN15804+A1	Third-party verified (as per ISO 14025)	2014	europe	GaBi		EN15804	-	

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	Download EPD
Lightweight concrete block, with expanded clay aggregate, generic	650 kg/m3 (40.6 lbs/ft3), 18 kg/block (39.7 lbs/block), 0.5x0.3x0.185 mm (0.019x0.012x0.007 in)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	650.0	EN15804+A1	-	
Masonry mortar/facing wall mortar/mortar with special properties	1500 kg/m3, EPD coverage: >1500 kg/m3		IWM	IBU	EPD-IWM-20130239-IBG1-DE	Oekobau.dat 2017-I, EPD Mineralische Werkmörtel: Mauermörtel Vormauermörtel/Mörtel mit besonderen Eigenschaften Industrieverband WerkMörtel e.V. (IWM)	EN15804+A1	Third-party verified (as per ISO 14025)	2014	germany	GaBi	1500.0	PCR Mineralische Werkmörtel, 10/2012	Only with EN15804	Download EPD
Multi layer waterproofing system with flexible sheets for roofing, with ballast,	3.6 (top) + 3.0 (bottom) mm, 4.3 (top) + 3.8 (bottom) kg/m2		EWA	International EPD System	S-P-00414, ver. 2019	EPD Flexible Bitumen Sheets For Roof Waterproofing – sector EPD, ver. 2019	EN15804+A1	Third-party verified (as per ISO 14025)	2019	belgium, netherlands, portugal, austria, spain, france, germany, italy, sweden, denmark, finland, norway	ecoinvent		PCR Construction products – 2019:14 version 1.11 (date 2021-02-05)	Only with EN15804	Download EPD

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	Download EPD
European average															
Photovoltaic monocrystalline panel (PV), per kWc	42mm, 1.66m2, 19.23kg, 60 cells per module	TARKA VSMS 300	VOLTEC SOLAR	INIES	VSOL-00001-V01.01-FR, 14125	PEP	EN15804+A1	Third-party verified (as per ISO 14025)	2019	europe	ecoinvent		PEP-PCR-ed3-FR-2015 04 02	ISO 14025	Download EPD
Pipesystem, hot and cold water supply, PEX, per m2 GFA	0.13 kg/m2			One Click LCA	-	Ruuska et al. 2013. Rakennusmateriaalien merkitys rakentamisen ympäristövaikutusten kentässä. VTT.	EN15804+A1	Internally verified	2016	LOCAL	GaBi		EN15804	-	
Planed timber, conifer			Treindustrien	EPD Norge	NEPD-308-179-EN	Structural timber of spruce and pine, Norwegian Wood Industry Federation	EN15804+A1	Third-party verified (as per ISO 14025)	2015	norway	ecoinvent	420.0	NPCR 015 Wood and wood-based products for use in construction, rev1, 08/2013	Biogenic CO2 separated	Download EPD
Polypropylene rainwater storage tank, per cubic	51.3 kg/m3	RAUSIKKO BOX	DYKA SAS	INIES	INIES_IB20200404_171153, 26068	FDES	EN15804+A1	Third-party verified (as per	2020	france	ecoinvent	51.3	EN15804+A1	EN15804+A1	Download EPD

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	Download EPD
meter of water storage								ISO 14025)							
Polyurethane waterproofing membrane	1.4 mm, 1L/m2	Sikalastic-612	Sika	BRE	BREG EN EPD 000174	EPD Sikalastic-612	EN15804+A1	Third-party verified (as per ISO 14025)	2018	unitedKingdom	ecoinvent	1410.0	EN15804+A1	-	Download EPD
Porcelain WC kit (toilet and tank)	37.4 kg/unit	DURAVIT : Duraplus (023009+087920) KOHLER : Odeon Up (4956CK+E4708 ; 4956CK+E4740 ; 18557K+E4708 ; 18557K+E4740) . Brive (E4380+E4452 ; E4380+E4453 ; E4381+E4452 ; E4381+E4453 ; E1730+E4452).	Association Française des Industries de la Salle de Bains	INIES	INIES_CPAC20140416_145721, 14204	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2020	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD

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	Download EPD
		Eolia (E4380+E4269). Patio (UJD101+ETB111 ; UJB101+ETB111 ; UJV101+ETB111 ; UJW101+ETB111 ; UJV101+ETB211). Struktura (UJX101+ETE111 ; UJH101+ETE111) // ROCA : VICTORIA (A349392000 ; A349393000 ; A34P395000). DEBBA (A34D999000 ; A34D99L000)													
Porcelain sink	29.6 kg/unit, 50 x 70 cm		SFISB	INIES	INIES_CLAV20140416_141741, 14203	FDES	EN15804+A1	Third-party verified	2020	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD

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	Download EPD
								(as per ISO 14025)							
Porcelain stoneware floor tiles	21.83 kg/m2		Royal Mosa	INIES	INIES : 6-611:2021	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2022	netherlands	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Precast concrete paving tiles	2350kg/m3, 1.56W/(mK), width : 10 - 60 cm, length : 10 - 120 cm, thickness : 6 - 16 cm, Lambda=1.56 W/(m.K)		H. Klostermann GmbH & Co. KG Betonwerke	IBU	EPD-KLO-20170147-IAC1-DE	EPD Betonpflastersteine Klostermann GmbH & Co. KG	EN15804+A1	Third-party verified (as per ISO 14025)	2017	germany	GaBi		PCR Oberbaumaterialien für Verkehrswege im Aussenbereich	Only with EN15806	Download EPD
Prefabricated steel balcony with steel railings	W: 380 cm H: 120 cm D: 140 cm, 561 kg/unit, Steel grade: S235/S275/S355		CSK Stålindustri AS	EPD Norge	NEPD-3004-1678-EN	EPD Prefabricated steel balconies with steel railings CSK Stålindustri A/S	EN15804+A1	Third-party verified (as per ISO 14025)	2021	denmark	ecoinvent		NPCR 013:2019 Part B for Steel and aluminium construction products is used as a guiding document.	Only with EN15804	Download EPD

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	Download EPD
Ready-mix concrete	RC 40/50 (40/50 MPa), 50% Cement replacement with blast furnace slag (GGBS)			ICE	-	ICE database August 2019, V3.0	EN15804+A1	Self declared	2019	unitedKingdom	-	2400.0	EN15804+A1	-	
Ready-mix concrete	RC 32/40 (32/40 MPa), 50% Cement replacement with blast furnace slag (GGBS)			ICE	-	ICE database August 2019, V3.0	EN15804+A1	Self declared	2019	unitedKingdom	-	2400.0	EN15804+A1	-	
Ready-mix concrete, normal-strength, generic	C30/37 (4400/5400 PSI), 0% recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	2400.0	EN15804+A1	-	
Ready-mix concrete, normal-strength, generic	C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	2400.0	EN15804+A1	-	

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	Download EPD
	kg/m3 / 18.72 lbs/ft3)														
Red brick, average production, UK	215 mm x 102.5 mm x 65 mm, 2.13 kg/unit, 1485 kg/m3		Brick Development Association (BDA) Ltd (2019)	BRE	BREG EN EPD000002, issue 04	EPD BDA Generic Brick, The Brick Development Association	EN15804+A1	Third-party verified (as per ISO 14025)	2019	unitedKingdom	ecoinvent	1485.0	EN15804+A1	-	Download EPD
Reinforcement steel (rebar), generic	90% recycled content, A615			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	7850.0	EN15804+A1	-	
Resin bound aggregate decorative paving system	3-10 mm grain size, 100 - 150 mm, 1060 kg/m3	Addaset, Addabound, Terrabound and Terrabase	Addagrip Terraco	BRE	BREG EN EPD000209	EPD Addagrip Resin Bound Decorative Surfacing System	EN15804+A1	Third-party verified (as per ISO 14025)	2018	unitedKingdom	ecoinvent	1060.0	EN15804+A1	-	Download EPD
Rock wool insulation panels, unfaced, generic	L = 0.037 W/mK, R = 2.70 m2K/W (15 ft2°Fh/BTU), 150 kg/m3 (9.36 lbs/ft3) (applicable for densities: 100-			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	150.0	EN15804+A1	-	

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	Download EPD
	150 kg/m3 (6.24-9.36 lbs/ft3)), Lambda=0.037 W/(m.K)														
Rock wool insulation panels, unfaced, generic	L = 0.035 W/mK, R = 2.89 m2K/W (16 ft2°Fh/BTU), 50 kg/m3 (3.12 lbs/ft3) (applicable for densities: 25-50 kg/m3 (1.56-3.12 lbs/ft3)), Lambda=0.0346 W/(m.K)			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	50.0	EN15804+A1	-	
Sand, compacted wet density	2082 kg/m3			One Click LCA	-	LCA inventory for sand quarry operation, Ecoinvent 2016	EN15804+A1	Internally verified	2020	LOCAL	ecoinvent	2082.0	EN15804	-	
Sewage water drainage piping network, per m2 GIFA				One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL	ecoinvent		EN15804+A1	-	

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	Download EPD
(residential buildings)															
Single and three phase distribution boards	14.7 kg/unit	Acti9 Isobar P Distribution Board - SEA9BPN12	Schneider Electric	-	ENVPEP1809003_V	EPD Acti9 Isobar P Distribution Board	EN15804+A1	Internally verified	2018	unitedKingdom	-		PCR-ed3-EN-2015 04 02 Wijzingingsblad overgang naar EcoInvent v3.3 of 1th June 2017	Only with EN15804	Download EPD
Soil substrates for green roofs	10 mm, 8.25 kg/m2, 825 kg/m3	SOPRAFLOR X	SOPREMA SAS	INIES	INIES_ISUB20200921_090434, 23951	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2020	france	ecoinvent	825.0	EN15804+A1	EN15804+A1	Download EPD
Solvent-borne one-component floor paints	0.4 kg/m2		SIPEV	INIES	INIES_CPEI20200626_131156, 28926	FDES	EN15804+A1	Third-party verified (as per ISO 14025)	2020	france	ecoinvent		EN15804+A1	EN15804+A1	Download EPD
Sprinkler system, room area m2				One Click LCA	-	One Click LCA	ISO14040	Internally verified	2013	LOCAL	ecoinvent		-	Only with EN15804	

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	Download EPD
Steel stud per m2 of wall area (air gap included)	95 mm, 400 mm spacing			OKOBAUDAT	-	Oekobau.dat	EN15804+A1	Third-party verified (as per ISO 14025)	2016	europe	GaBi	23.32631578947369	EN15804+A1	-	See full dataset
Steel stud per m2 of wall area (air gap included)	42mm, 600 mm spacing			OKOBAUDAT	-	Oekobau.dat	EN15804+A1	Third-party verified (as per ISO 14025)	2016	europe	GaBi	29.73809523809524	EN15804+A1	-	See full dataset
Steel stud per m2 of wall area (air gap included)	66 mm, 600 mm spacing			OKOBAUDAT	-	Oekobau.dat	EN15804+A1	Third-party verified (as per ISO 14025)	2016	europe	GaBi	22.015151515151516	EN15804+A1	-	See full dataset
Structural steel profiles, generic	20% recycled content, I, H, U, L, and T sections, S235, S275 and S355			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2018	LOCAL	ecoinvent	7850.0	EN15804+A1	-	

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	Download EPD
Triple glazed window, incl. wood-alu frame				One Click LCA		One Click LCA generic construction definitions				europe	Other				
Ventilation system for residential building	per m2 GFA			One Click LCA	-	One Click LCA	EN15804+A1	Internally verified	2019	LOCAL, paraguay	ecoinvent		EN15804+A1	-	
Wooden decking, cladding and planed timber for joinery applications	540kg/m3, Moistr. 3-5%	Accoya Scots Pine	Accsys Technologies PLC	EPD Norge	NEPD-376-262-EN	Accoya Wood - decking, cladding and planed timber for joinery applications,Scots Pine, NEPD-376-262-EN, Accsys Technologies PLC	EN15804+A1	Third-party verified (as per ISO 14025)	2015	netherlands	ecoinvent	540.0	NPCR 015 Wood and wood-based products for use in construction, rev1, 08/2013	Biogenic CO2 separated	Download EPD
Wooden interior door, per unit	809x2053 mm, 42x92 mm frame, 52 mm door leaf		Nordic Dørfabrikk	EPD Norge	NEPD-1535-525-EN	EPD Climate door / interior door Nordic Dørfabrikk AS	EN15804+A1	Third-party verified (as per ISO 14025)	2018	norway	ecoinvent		NPCR 014 Windows and doors, rev1, 03/2013	Only with EN15804	Download EPD
Woven wall-to-wall carpet	Pile material max. 1100 g/m2		ANKER	IBU	EPD-ANK-20170123-CCA1-EN	EPD Woven wall-to-wall carpet, maximum total pile	EN15804+A1	Third-party verified	2017	germany	GaBi		PCR Floor coverings, 07/2016	Only with EN15804	Download EPD

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	Download EPD
	PA 6.6, 2.15 kg/m2					material 1100 g/m2 polyamide 6.6 ANKER		(as per ISO 14025)							
dummy				One Click LCA		One Click LCA generic construction definitions				LOCAL	Automatically assign Ecoinvent or other alternative based on inputs				Download EPD

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