HOARE LEA

Manor Road / Richmond

Whole Life Carbon Assessment

Hoare Lea

July 2020

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
01	17/07.2020	Draft issue for team comment	L. WIlle	-	-
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Contents.

1. Executive Summary

This report sets out the Whole Life Carbon (WLC) assessment for Manor Road development in Richmond, London. The assessment has been undertaken in line with the guidance given in the draft guidance provided by the GLA in the *Whole Life-Cycle Carbon Assessments guidance Pre-consultation draft,* April 2020.

This report should be read in conjunction with the GLA Whole Life Carbon Assessment Template issued in Microsoft Excel Format.

Context of the project

The site is located to the south of the A316 arterial Lower Mortlake Road and is shaped by the railway lines and by Manor Road on each of its 3 sides. It is 1.5 ha. in size. Only one side of the site has street frontage, along Manor Road. It is currently occupied by a large Homebase store and associated surface level carparking. There is a functioning bus depot on the northern section of the site which will remain as part of the design proposal.

The site surroundings are dominated by large amounts of surface level carparking servicing the Sainsbury's store to the east of the site and on the site itself. There is a small pocket park adjacent to the Sainsbury's car park and some allotments to the south of the railway.

Estimated Whole Life Carbon Emissions

Table i: Summary of Whole Life Carbon emissions, using carbon factors from SAP10 and a decarbonised grid scenario.

Building Element	Assessment 1 (SAP10) kgCO2e)	Assessment 2 (Decarbonisation) (kgCO2e)
1 Substructure	3,535,841	3,535,841
2.1-2.4 Superstructure	5,843,302	5,843,302
2.5-2.6 Superstructure	2,294,325	2,294,325
2.7-2.8 Superstructure	3,215,456	3,215,456
3 Finishes	1,867,198	1,867,198
4 Fittings, furnishings & equipment	173,090	173,090
5 Services (MEP)	19,408,543	19,408,543
6 Prefabricated buildings and building units	-	-
7 Work to existing building	-	-
8 External works	3,226,210	3,226,210
Other materials - TOTAL	9,656,576	9,656,576
Site, energy and water	31,629,645	10,211,209
TOTAL kg CO2e	80,850,184	59,431,749

Actions taken to reduce whole life-cycle carbon emissions.

Energy Strategy

The energy strategy for the project is a key mechanism for reducing Whole Life Carbon of the development. In addition to a passive design approach, an 'all electric' energy strategy has been proposed, which features highly efficient heat pumps to deliver heating and hot water throughout the development. In addition to heat pumps working at greater efficiency than gas boilers, the heat pumps can take advantage of the projected decarbonisation of the national grid.

Re-use and recovery

The project pre-demolition audit has identified materials which can be re-used or recovered to be used within the proposed development. The Circular Economy statement details the strategy for recovery of materials in line with the circular economy model.

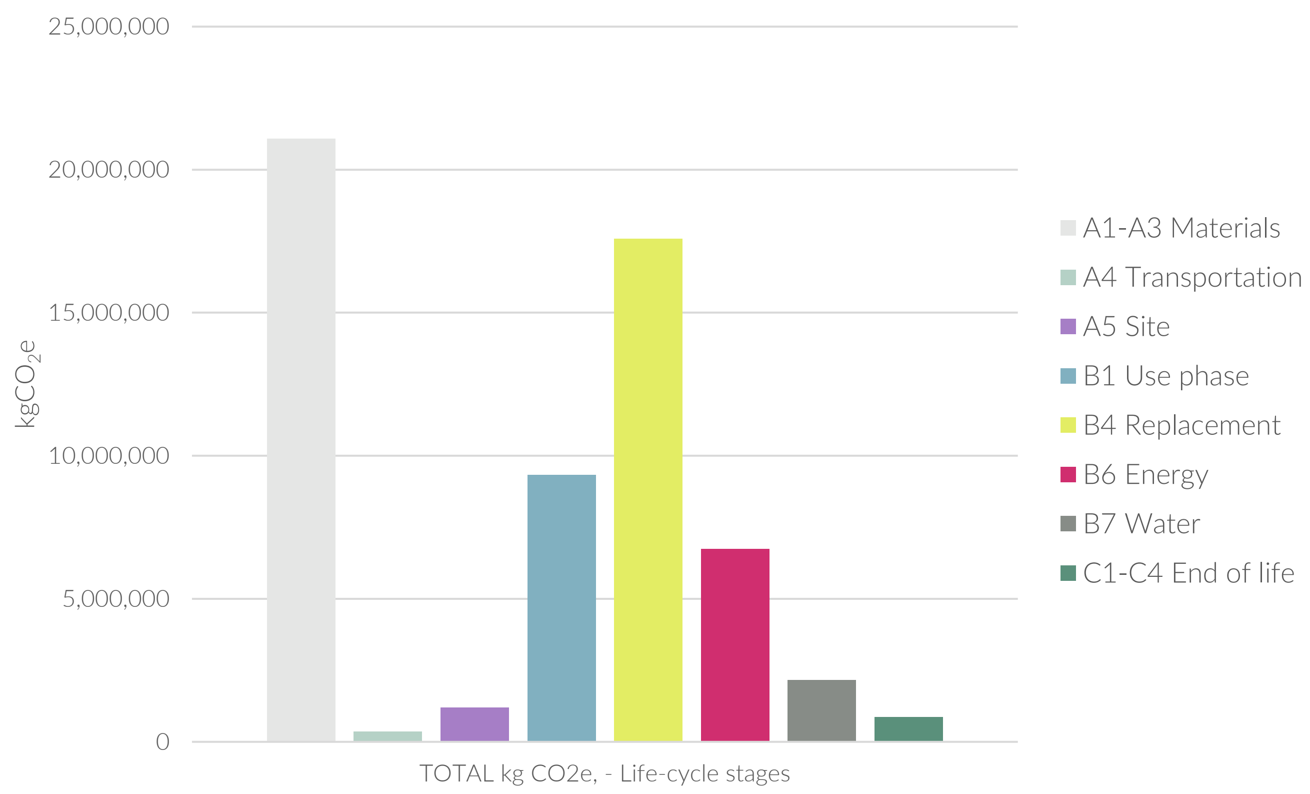


Figure i: Whole Life Carbon assessment results for Assessment 2, showing life cycle emissions at each Life Cycle Module.

Conclusion

This report has set out the Whole Life Carbon emissions estimated for the Manor Road Development in Richmond, London. This follows the GLA Whole Life-Cycle Carbon Assessments, Pre-consultation draft guidance, 2020. Assessment 2 (grid decarbonisation) forms the basis of this Whole Life Carbon Assessment as it accounts for future decarbonisation of the UK's electrical grid.

Table ii: Summary table of the Whole Life Carbon Emissions of the Proposed Development.

Whole Life Carbon Scope	Whole Life Carbon Emissions (kgCO2e)
Assessment 1: SAP10	80,850,184
Assessment 2: Decarbonisation projection	59,431,749

By accounting for decarbonisation of the UK grid electricity (Assessment 2), the emissions from module B6: Operational energy is reduced from 35% to 11% (as a proportion of Whole Life Carbon). This is significant and confirms the importance of considering grid decarbonisation. It is also worthy to note that the life cycle emissions from the Use & Replacement (B1-B7) and End of Life stages (C1-C4) will also benefit from future decarbonisation of the UK, European and Global supply chains, however the method for more accurately accounting for these life cycle stages requires further development.

2. Introduction

Hoare Lea have been appointed to undertake a Whole Life Carbon (WLC) Assessment for the Manor Road development in Richmond, London, hereafter referred to as the Proposed Development. This assessment is aligned to the planning application 'Stage 1 submission' and has been carried out in line with draft guidance provided by the GLA in the *Whole Life-Cycle Carbon Assessments guidance Pre-consultation draft,* April 2020.

The aim of this assessment is to assess the WLC for the Proposed Developments, defined as 'those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal.' This assessment captures the operational carbon emissions for the Proposed Development 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. The study 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.

This report should be read in conjunction with the 'GLA Whole Life Carbon Assessment Template' issued in Microsoft Excel Format.

2.1 Project Description

The site is located to the south of the A316 arterial Lower Mortlake Road and is shaped by the railway lines and by Manor Road on each of its 3 sides. It is 1.5 ha. in size. Only one side of the site has street frontage, along Manor Road. It is currently occupied by a large Homebase store and associated surface level carparking. There is a functioning bus depot on the northern section of the site which will remain as part of the design proposal.

The site surroundings are dominated by large amounts of surface level carparking servicing the Sainsbury's store to the east of the site and on the site itself. There is a small pocket park adjacent to the Sainsbury's car park and some allotments to the south of the railway.

Figure 1: Architect's impression of the Proposed Development. Source: Assael Architecture.

2.2 Background to Whole Life Carbon assessments

Global climate change is widely considered to be one of the most pressing challenges at a regional, national and international level. Industrialisation has resulted in the use of refined and unrefined fossil fuels as an energy source and since the start of the industrial revolution, use of fossil fuels and their resultant release of carbon dioxide into the atmosphere has caused an exponential increase in the concentration of carbon dioxide and other pollutants that are generally agreed to result in increasing global average surface temperature.

It is outside the scope of this report to describe the wide-ranging impacts of climate change; however urgent action is required to limit carbon dioxide and limit the impacts of climate change.

Carbon emissions from operational use of buildings has been the subject of regulation for some time and has historically been the primary focus of reducing the impact of built environment projects. More recently, this focus has been expanded to also include carbon emission associated with the building materials themselves.

Some studies have historically suggested that 10 – 20% of the total carbon emissions for buildings over their lifetime are due to embodied carbon. With increasing energy efficiency within buildings and an increasingly decarbonised electricity supply, building operational carbon emission are being acknowledged to be rapidly reducing. As this occurs, the significance of embodied carbon emissions increases and the potential for reduction of overall carbon emissions through structural design choice and material selection becomes greater.

2.3 RICS Whole Life Carbon

The RICS professional statement: Whole Life Carbon Assessment (WLC) for the Build Environment, released in 2017, seeks to standardise WLC assessment and enhance consistency in outputs by providing guidance on implementing the broad appraisal methodology set out in EN 15978: Sustainability of Construction Works. The Greater London Authority have adopted the RICS WLC methodology in their guidance methodology for Whole Life Carbon assessment of referable planning applications.

Figure 2: RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment.

2.4 UK Green Building Council (GBC) Net Zero carbon

As a response to mainstream scientific consensus on the urgent need to reduce carbon emissions, the UK Government has legislated to achieve Net Zero carbon by 2050. As part of the definition of Net Zero, the UK Green Building Council has developed a Framework Definition that includes embodied carbon emissions and this definition is widely being used to develop a roadmap to the 2050 Net Zero target. It's worth noting that the UKGBC approach has not set out a methodology for the appraisal of Whole Life Carbon, which is still being developed.

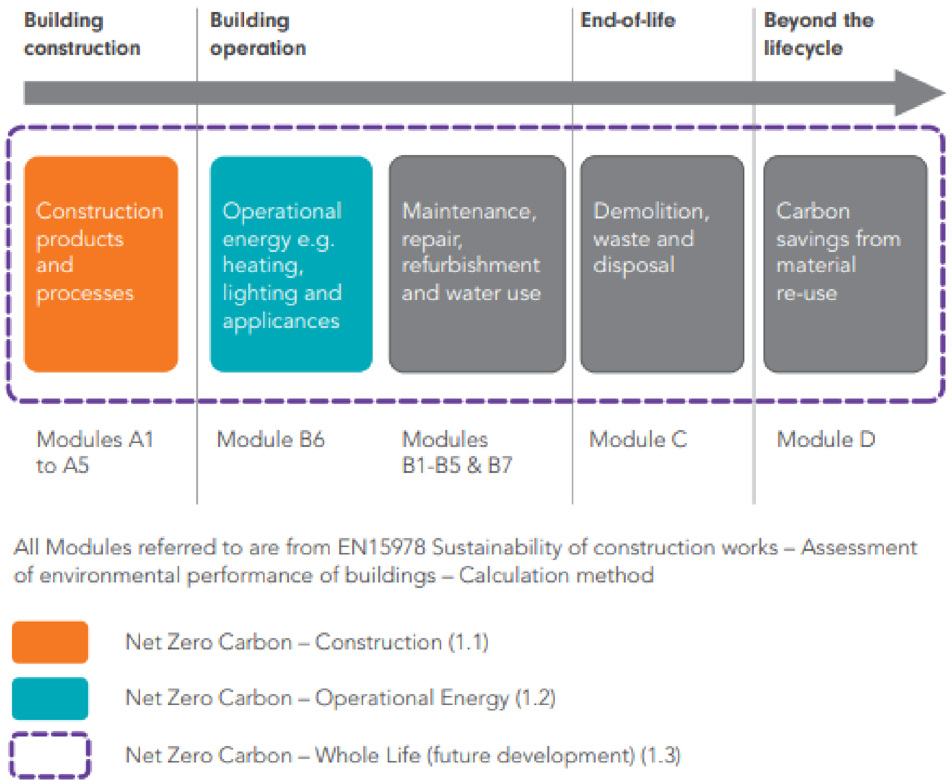


Figure 3: UKGBC Advancing Net Zero Carbon framework approach.

2.5 The Circular Economy

The construction and operation of the built environment consumes 60% of all materials in the UK. At the end of life, materials are often diverted from landfill, but in reality, down-cycled, reducing their value.

There is growing industry consensus that the way we design, build, operate and dispose of our buildings and associated facilities needs a major overhaul to obviate waste and increase efficiency. There is an incredible breadth of opportunity that this shift in approach will create across the entire supply chain.

Designing for longevity and adaptability and maximizing the use of recycled and renewable materials could reduce greenhouse gas emissions while increasing innovation opportunities and economic growth. Replacing finite and fossil-based materials with responsibly managed renewable materials can decrease carbon emissions whilst reducing dependency on finite resources.

By considering the carbon emissions of a development from a whole life perspective, design decisions can be made to not only minimize embodied carbon in construction, but it can assist to produce a development which reduces resource consumption throughout it's use, extending life cycles of products, maximizing re-use of building components and ensuring that all components are considered as a 'product resource', rather than 'product waste'.

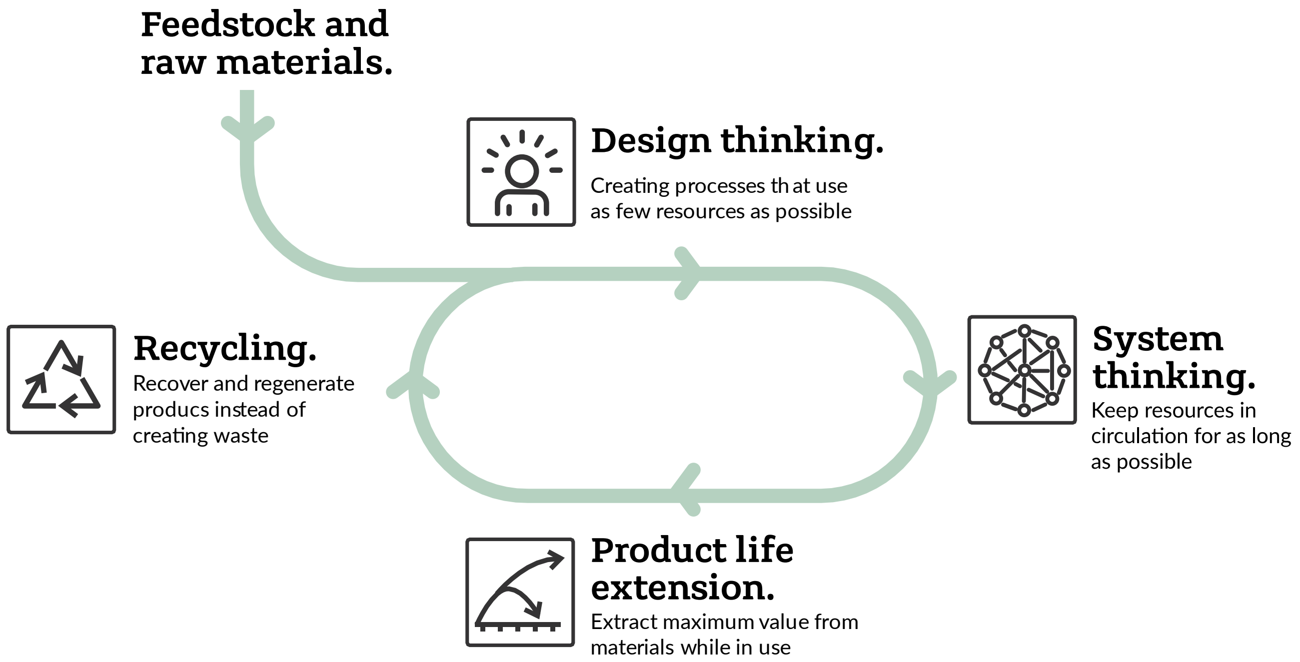


Figure 4: Simplified graphic of the Circular Economy highlighting the key components of the principle of circularity.

3. Methodology

3.1 Assessment Scope

The assessment of Whole Life Carbon (WLC) emissions consists of the following sections: total operational carbon emissions (regulated plus unregulated); embodied carbon emissions; and any future potential carbon emissions 'benefits', post end-of-life, including benefits from reuse and recycling of building structure and materials.

This assessment has been undertaken in line with the draft GLA guidance for undertaking WLC Assessments and therefore in line with the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment.

Operational carbon emissions

In line with the draft GLA guidance, the operational carbon emissions are calculated based on the Part L assessments undertaken for the Proposed Development as part of the Energy Strategy for planning. This encompasses carbon emissions related to both regulated and unregulated energy uses (in line with Part L definitions), accumulated over a 60-year study period.

Embodied carbon assessment and end-of-life emissions

To assess the embodied carbon for the project, a Life Cycle Assessment (LCA) tool – One Click LCA – has been used to make allocations for the anticipated materials quantities in an inventory analysis. The materials are represented within the model by using materials with associated Environmental Product Declarations (EPDs). EPDs are produced by manufacturers and identify the carbon emissions of a product. By scheduling the materials proposed for the development, the overall carbon emissions can be approximated.

It should be noted here that the LCA tool has a limited database of materials. In the scenario where a specified material isn't included in the database, the most similar material in terms of material composition is selected instead.

In line with standard UK practice, the LCA process and results included by this report have been assessed in line with BS 15978:2011 and the RICS Professional Statement: Whole Life Carbon assessment for the built environment. All EPDs used have been produced in line with the requirements of BS EN 15804:2012. Hence, each material has been assessed against the following lifecycle stage:

- A1-A3: Product stage
- A4: Material transportation to site
- B4-B5: Replacement and maintenance
- C1-C4: End of life

Together with these stages, the contribution of life cycle stage A5 has also been explored separately, giving an estimate of the emissions related to the construction. I.e. the electrical consumption and waste disposal.

In line with the draft GLA guidance, the assessment includes the following elements:

- Demolition
- Facilitating works
- Substructure
- Superstructure (frame, upper floors, roof, stairs and ramps, external walls, windows and external doors, internal walls and partitions, internal doors)
- Finishes
- Fittings, furnishings and equipment
- Building services
- Prefabricated buildings and building units
- Work to existing building
- External works (hard and soft landscaping, fencing, fixtures, drainage, services)

3.2 Life Cycle Assessment Impacts

A building Life Cycle Assessment considers a range of environmental indicators that assess the relevant overall impacts of the materials selections. Whilst ideally an LCA assessment would consider all environmental factors relevant to the product or material, due to lack of information in some cases, and lack of consensus in how to calculate Key Performance Indicators (KPIs) within the industry, not all environmental impacts can be considered.

Standard ratios are used to convert the various greenhouse gases into equivalent amounts of CO_2. These ratios are based on the global warming potential (GWP) of each gas. GWP is a relative measure of how much a given mass of greenhouse gas is estimated to contribute to global warming over a given time interval – usually 100 years. It is expressed relative to carbon dioxide which is set as the baseline which other emitters are compared against, and which therefore has a GWP of 1.

This assessment thus reports on the embodied carbon of the development as 'global warming potential' with the annotation 'CO_2 equivalent (CO_2e)'.

3.3 BREEAM Criteria and Scope

As a key driver for development of sustainable building developments in the UK and internationally, BREEAM is a points-based assessment scheme that aims to encourage sustainable design features.

The project is being assessed using the BREEAM New Construction (2018) scheme, and this assessment is expected to be utilised in Mat 01 assessment for the project. This assessment requires an options appraisal for the building; to consider whether alternatives that fulfil the same functional requirements could be utilised to reduce the environmental impact of the development.

3.4 Data Sources

There are a number of approaches to complete a building specific life cycle assessment. In particular, a flexible approach is needed when utilising a dataset of product specific environmental product declarations and more generic data calculated within the LCA tool.

Table 1: Types of data required for a WLC assessment.

Quantity Data	Material Data	Comments
Cost Plan	Cost Plan	Cost plans can be useful for calculation of uncertain quantities which are not product specific, however often an allowance is made at early design stages which may reduce accuracy.
Revit Model	Revit Model	Revit model & the data export function can quickly determine the quantity of main building elements, however, are reliant on accurate representation of products contained within the model families.
IES-VE Model	IES-VE Model	IES-VE model & the data export function can quickly determine the quantity of main building elements but there is limited functionality in calculating the volume of materials.
Architectural Drawings	Architectural Build-ups	A more traditional and slower approach to determining quantity of building elements, if build-ups are available to support.

The assessment has utilised multiple data sources described above and is based on the level of detail available at the current stage of design.

3.5 Current and future carbon emissions

In line with the guidance given in the draft GLA guidance to Whole Life Carbon assessments, the assessment has been undertaken based on two sets of carbon emissions:

3.5.1 SAP 10

The first set of figures is based on the current status of the electricity grid and provides a point-in-time assessment. For materials manufactured in the UK, SAP 10 emission factors are used in line with the GLA's Energy Assessment Guidance. Products sourced from outside the UK use data appropriate to the local energy grid at that location. This set of figures is used in the comparison to the WLC benchmarks.

3.5.2 Decarbonisation

It is also important to consider the potential longer-term decarbonisation of the electricity grid and how this may impact on design decisions. The second set of figures is therefore based on the expected decarbonisation of the electricity grid over the lifetime of the development (i.e. 60 years).

The RICS WLC guidance (2017) and the GLA WLC guidance (2020) documents makes reference to use of the "slow progression' scenario *from the latest Future Energy Scenarios* (FES) developed by the National Grid and makes reference to the 2015 edition of FES.

This edition has been revised each year, with the latest edition 2019 accounting for more recent developments in the future performance of the National Grid. As noted in Figure 5, the actual performance of the national grid (black line) deviated from the FES 2016 'Slow Progression' scenario and is inaccurate.

Therefore, for this Whole Life Carbon Assessment, the National Grid's 2019 edition of the 'Steady Progression' scenario was chosen as this more closely maps the departments of Business Energy and Industrial Strategy (BEIS) declared grid carbon projection.

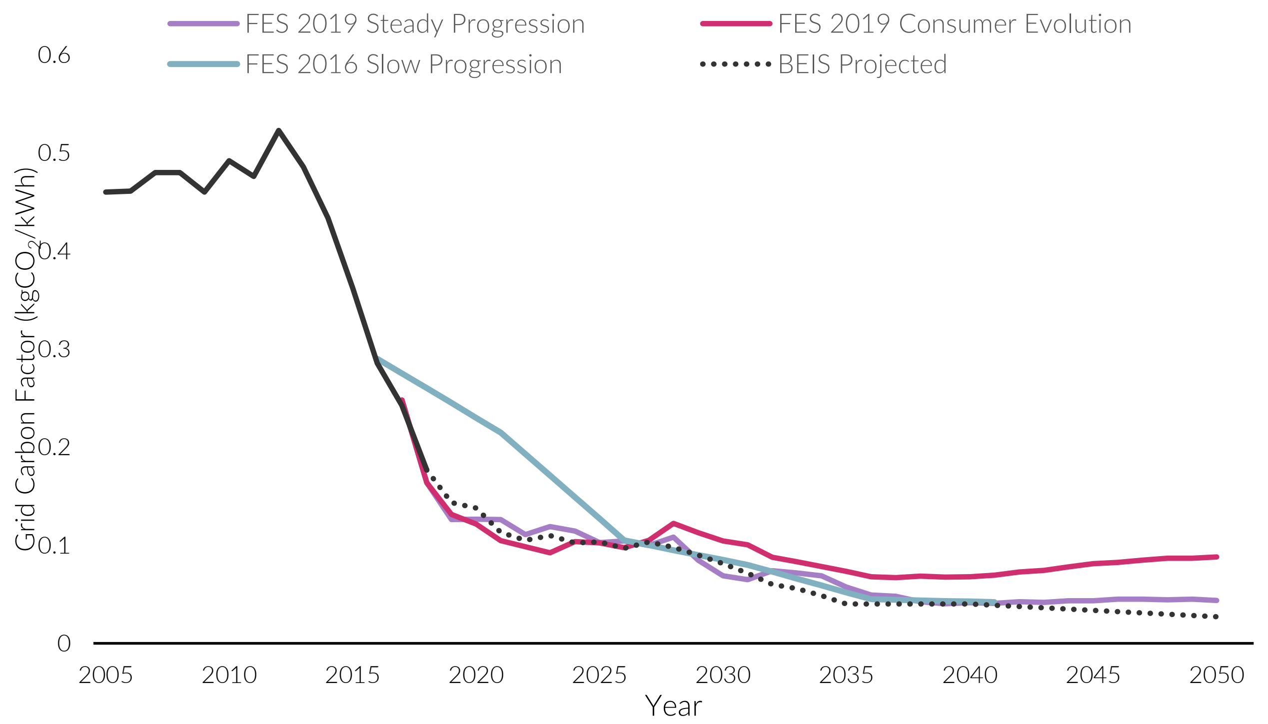


Figure 5: National Grid Future Energy Scenarios projection comparisons.

3.5.3 Context of grid carbon projections

The Future Energy Scenarios (FES) document, produced by the National Grid, discusses how the UK's energy landscape is changing. FES 2019 makes projections of how the mix of generation in the grid is likely to change between now and 2050 – the year by which the Climate Change Act 2008 set the target of reducing the UK's CO_2 emissions by 80% from 1990 levels. This target has now been revised to be Net Zero in light of the Committee on Climate Change's recent report and the declaration of a Climate Emergency.

FES discusses these projections in one of four scenarios and Figure 6 combines these future trajectories with the actual carbon intensity of the National Grid over the past 13 years. The reported emissions associated with electricity generation have fallen steeply since 2012 and in all cases, the FES 2018 scenarios see the carbon factor of electricity fall below 100 gCO_2/kWh by 2035.

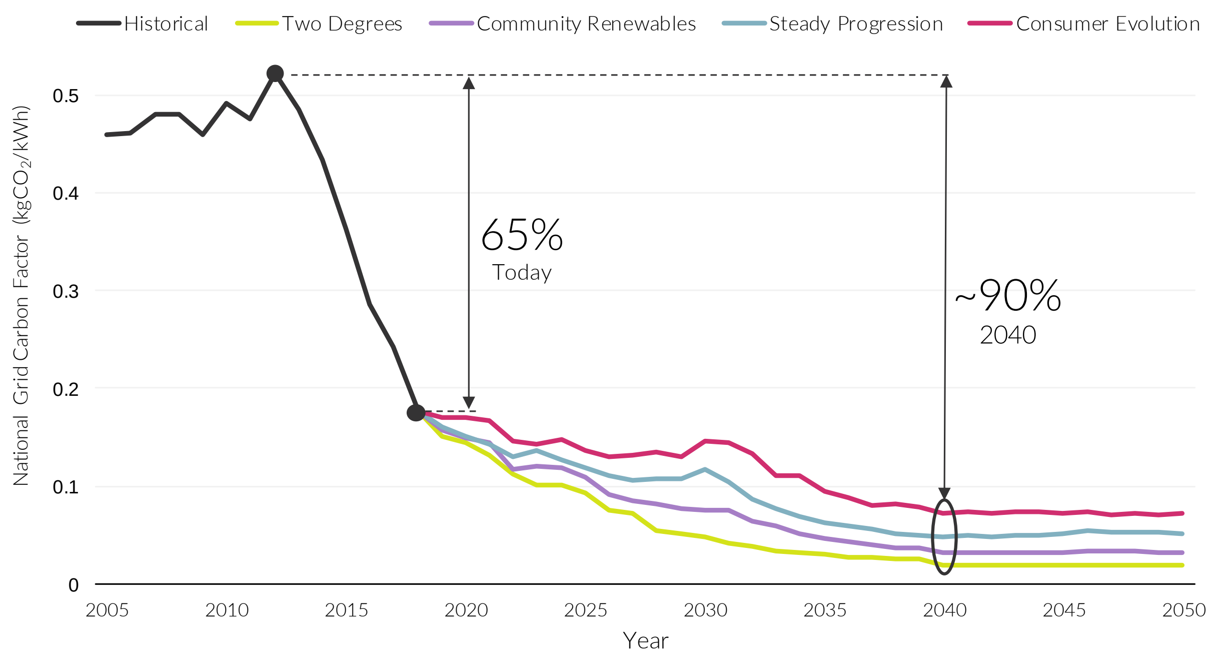


Figure 6: Historic and future projected carbon factor for the National Grid. Transmission and distribution losses are included. Sources: *BEIS Green Book* (historic carbon factors); *National Grid Future Energy Scenarios (FES) 2018* (future projected carbon factors).

3.5.4 Shifting focus

As the carbon emissions associated with the generation of electricity continue to reduce, the proportion of the UK's overall greenhouse gas emissions for which the electricity sector is responsible will fall. In fact, transport has now replaced energy supply as the greatest single contributor, responsible for 26% of national greenhouse gas emissions (BEIS).

The carbon factor of natural gas is likely to remain relatively static. With 85% of homes in the UK relying on gas to supply their heating and hot water, as well as a significant proportion of commercial buildings, heating buildings and industry represents an ever-greater proportion of UK emissions – 32% in 2015 (BEIS). In order for the UK to maintain a trajectory sufficient to meet the 2050 decarbonisation target, focus must necessarily shift to other contributors.

The BEIS Clean Growth Strategy provides an indication of the direction the UK's energy policy is likely to take and "...sets out [the government's] proposals for decarbonising all sectors of the UK economy through the 2020s." This includes investing in infrastructure and mechanisms to facilitate a transition to low emission vehicles and strengthening the energy performance requirements of new and existing buildings.

4. Inputs

This section sets out the inputs used in the Whole Life Carbon assessment.

4.1 Operational carbon assessment

Operational carbon emissions are estimated as part of the Energy Strategy, submitted in support of the planning application. The assessment of operational carbon emissions has been based on the methodology set out in Part L of the building regulations, and a total of regulated and unregulated carbon emissions is reported.

- Residential areas: Operational carbon emissions are based on SAP calculations in line with Part L1A methodology.
- Commercial areas: Operational carbon emissions are based on BRUKL calculations of regulated and unregulated energy.

4.2 Embodied Carbon and end-of-life assessment

Table 2 lists the building elements covered by the assessment, in line with the Royal Institute of Chartered Surveyors (RICS) Professional Statement: *Whole Life Carbon assessment for the built environment.*

4.2.1 Building elements

Table 2: Data used in the embodied carbon assessment.

Building element group	Building element (NRM level 2)	Basis for information
Demolition	0.1 Toxic/hazardous/contaminated material treatment	The feasibility cost estimate provided by the project quantity surveyors did not include an allowance for contaminated land removal and treatment.
	0.2 Major demolition works	An allowance for site excavation and demolition works was included in the assessment and used the average intensity of 1.39 kg CO_2e / m3 cleared debris, as developed by OneClick LCA software.
0 Facilitating works	0.3 & 0.5 Temporary/enabling works	An allowance for site preparatory works was included in the assessment in line with the feasibility cost estimate and used the average intensity of 1.39 kg CO_2e / m3 extracted soils.
	0.4 Specialist groundworks	No specialist ground works were included separately, with individual ground works accounted for in the relevant sub structure / external landscaping sections
1 substructure	1.1 Substructure	The specific foundations quantity was determined by OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type. This was informed by the structural engineer for composition & pile depths.
2. Superstructure	2.1 Frame	Material quantity and composition of the frame were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type. Each frame is calculated using the development dimensions for each building core and compiled in the assessment. The composition was informed by the structural engineers Stage 2 report.
	2.2 Upper floors incl. balconies	Material quantity and composition of the upper floor and balconies were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type. The composition was informed by the structural engineers Stage 2 report.
	2.3 Roof	Material quantity and composition of the roof were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type. This data incorporates the development dimensions for each building core and then compiled in the assessment.
	2.4 Stairs and ramps	Material quantity and composition of the stairs were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type. This data incorporates the development dimensions for each building core and then compiled in the assessment.
	2.5 External walls	The external wall areas were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type and re-adjusted to match the proposed wall build up provided by the project architect.
	2.6 Windows and external doors	The window and door areas were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type and re-adjusted to match the proposed wall build up provided by the project architect,
	2.7 Internal walls and partitions	The internal partition areas were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type.
	2.8 Internal doors	The internal doors areas were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type.
3 Finishes	3.1 Wall finishes	The wall, floor and ceiling finishes were calculated using OneClick LCA's carbon designer tool commensurate with the 'Apartment' building type and align with the cost plan allowance.
	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**	The quantum of FFE use the cost plan allowance for wardrobe and sanitaryware fittings. The quantum of sanitaryware were calculated based on the area schedule and occupancy, with EPD's matched to the fittings proposed to be installed.
5 Building services/MEP	5.1–5.14 Services incl. building-related* and nonbuilding-related**	Building services data uses data provided from the Building Services engineers which align with the proposed services strategy for the project. The lengths of duct's, electrical distribution and water distribution were calculated on a m^2 GIA basis using in-built EPD within OneClick LCA.
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units	No prefabricated elements are applicable.

Building element group	Building element (NRM level 2)	Basis for information
7 Work to Existing Building	7.1 Minor demolition and alteration works	No minor works were applicable.
8 External works	8.1 Site preparation works	Site preparation works incorporate data from the cost plan for the project.
	8.2 Roads, paths, paving and surfacing	Site preparation works incorporate data from the cost plan for the project.
	8.3 Soft landscaping, planting and irrigation systems	Site preparation works incorporate data from the cost plan for the project.
	8.4 Fencing, railings and walls	Fencing, railing and walls were excluded from the assessment due to lack of available data.
	8.5 External fixtures	External fixtures were excluded from the assessment due to lack of available data.
	8.6 External drainage	External drainage was incorporated within the build ups of the external paving and soft landscaping.
	8.7 External services	External fixtures were excluded from the assessment due to lack of available data.
	8.8 Minor building works and ancillary buildings	No allowance was considered for minor building works and ancillary buildings.

A full list of product declarations used is given in the Appendix.

4.2.2 Life-cycle modules

Table 3: The Life Cycle Modules included in the assessment and commentary on the data source.

Module	Description	Commentary of Data Source
A1-A3 Construction Materials	Raw material supply (A1) includes emissions generated when raw materials are taken from nature, transported to industrial units for processing and processed. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from the transport of all raw materials from suppliers to the manufacturer's production plant as well as impacts of production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as handling of waste formed in the production processes at the manufacturer's production plants until end-of-waste state.	Calculated using EPD's which align with the exact product (where known) or the most applicable similar product.
A4 Transportation to site	A4 includes exhaust emissions resulting from the transport of building products from manufacturer's production plant to building site as well as the environmental impacts of production of the used fuel.	The case specific transport distances were used when available. Other transport distances were estimated based on typical average transport distances based on material type & project location, provided by OneClick LCA.
A5 Construction/ installation process	A5 covers the exhaust emissions resulting from using energy during the site operations, the environmental impacts of production processes of fuel and energy and water as well as handling of waste until the end-of-waste state.	Due to lack of site-specific construction data, the climate zone average construction impact was used and sized based upon the scale of the development.
B1-B5 Maintenance and material replacement	The environmental impacts of maintenance and material replacements (B1-B5) include environmental impacts from replacing building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation and production of the replaced new material as well as the impacts from manufacturing the replaced material and handling of waste until the end-of-waste state.	Use (B1) include the impact of refrigerant leakage at leakage rate of 3% a year and 98% end of life recovery. Maintenance (B2) and Repair (B3) have not been considered due to accurate data being unavailable at this early stage. Replacement (B4) and Refurbishment (B5) account for the technical service life of the building components "BCIS Life expectancy of building components"
B6 Energy use	The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also taken into account.	Energy consumption take from the SAP and Energy assessment calculations for the project in line with GLA requirements.
B7 Water use	The considered use phase water consumption (B7) impacts include the environmental impacts of production processes of fresh water and the impacts from wastewater treatment.	Water consumption based on Building Regulations Part G 'Enhanced Consumption' of 105 l/pp/d and multiplied by the intended full occupancy of the development, using a combined EPD for freshwater and wastewater.
C1-C4 Deconstruction	The impacts of deconstruction include impacts for processing recyclable construction waste flows for recycling (C3) until the end-of-waste stage or the impacts of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on type of material. Additionally, deconstruction impacts include emissions caused by waste energy recovery.	C1 Deconstruction/demolition) and C2 (Transport) are based on default values. C3 (Waste Processing) and C4 (Disposal) use OneClick LCA's default end of life scenarios, please refer to the appendix for further detail.
D External impacts/end-of-life benefits	External benefits for re-used or recycled material types include the positive impact of replacing virgin-based material with recycled material and the benefits of the energy which can be recovered from the materials.	D (End of Life) use OneClick LCA's default end of life scenarios, please refer to the appendix for further detail.

5. Results

5.1 Embodied Carbon Emissions

Figure 7 shows the estimated embodied carbon of the Proposed Development, broken down by main building elements.

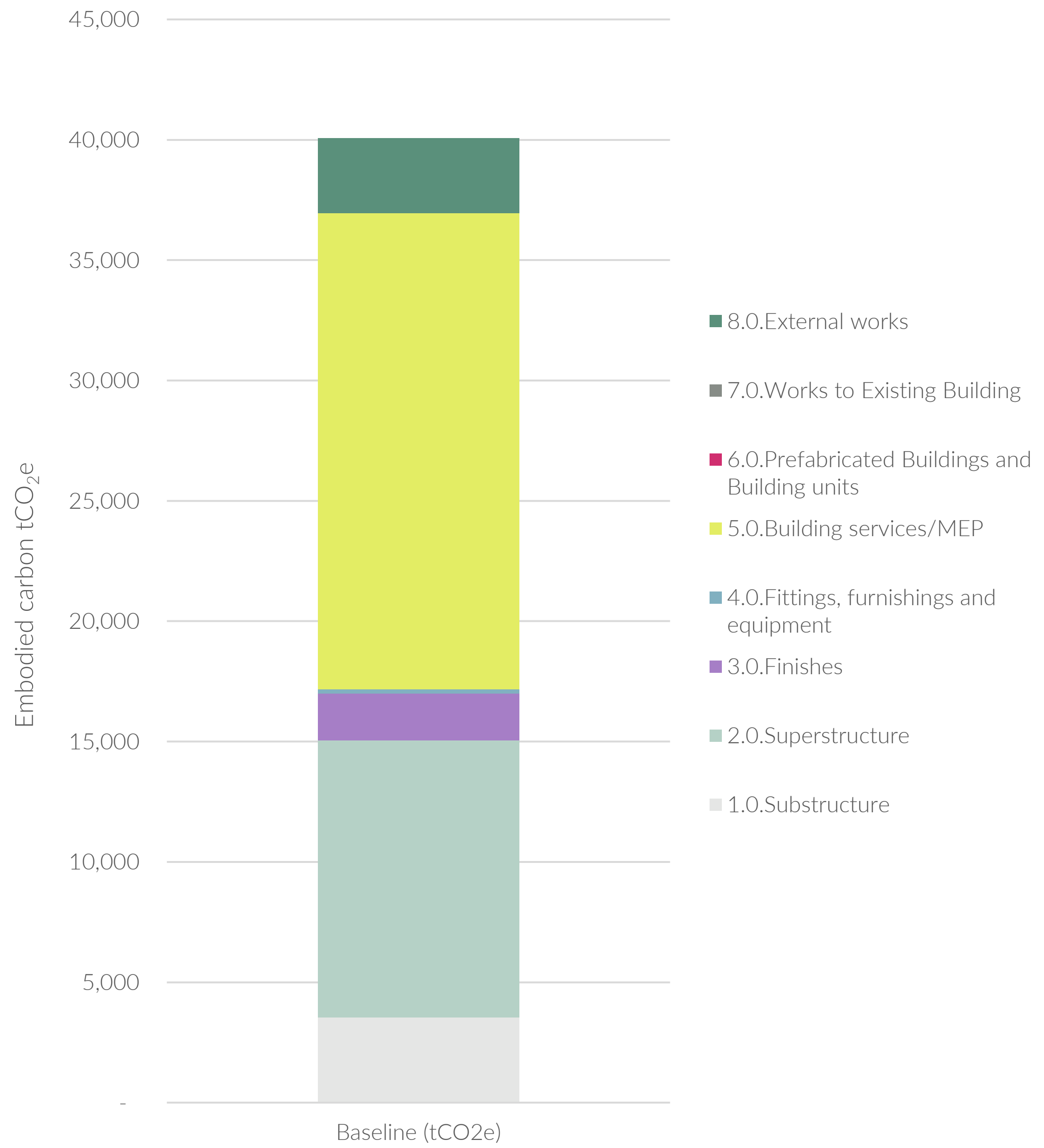


Figure 7: Overall embodied carbon breakdown showing the contributions of the main building elements incorporating emissions from scopes A1-A5 (product stage & transport), B1-B5 (use stage) and C1-C4 (demolition and end of life).

5.2 Operational carbon emissions

The total operational carbon emissions have been calculated over a 60-year study period based on two sets of carbon factors, in line with the draft GLA guidance. The total operational carbon emissions (total estimated emissions from regulated and unregulated energy uses) have been estimated to:

- 28,271 tCO_2 based on SAP10 carbon factors
- 6,852 tCO_2 based on National Grid FES 2019 ‘Steady progression’ carbon factors.

	Residential	Commercial
Area (m^2)	28,944	495

	kWh/m^2	kWh/m^2
Heating	11.7	1.98
Cooling	0.4	5.32
Auxiliary	2.7	7.13
Lighting	4.5	37.77
Hot Water	17.1	1.7
Unregulated	32.2	20.26
Sum	68.6	74.16

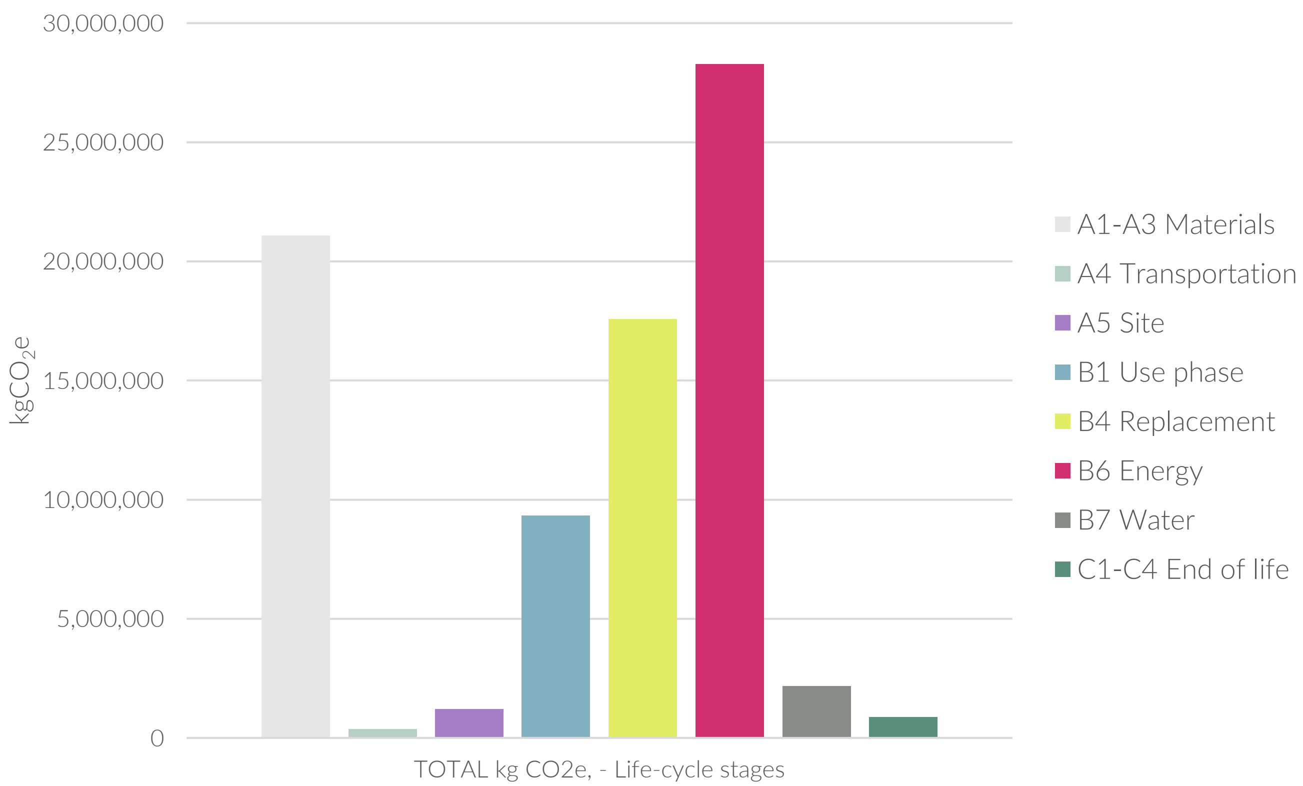
Total kWh p.a	1,985,558	36,709
Sum kWh	2,022,000	

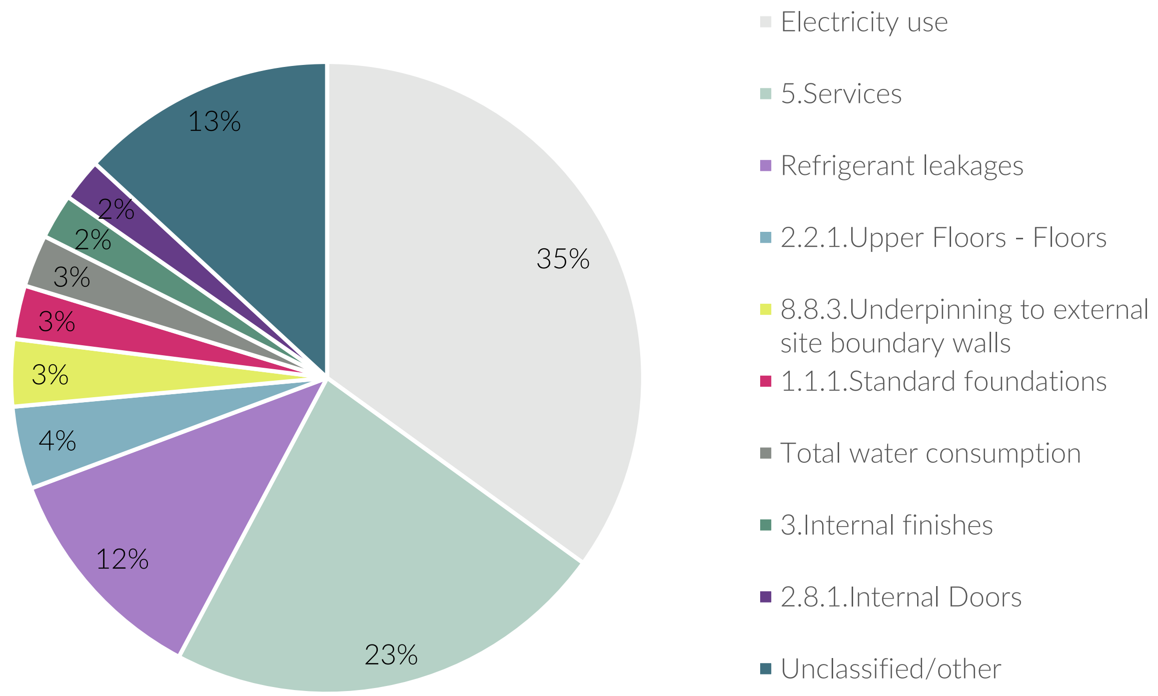
$kgCO_2$ (SAP 10)	$kgCO_2$ (FES ‘Steady Progression’)
28,271,000	6,852,900

5.3 Assessment 1 - Estimated Whole Life Carbon (WLC) Emissions

Table 4: WLC emissions for each lifecycle module, using the SAP 10 Carbon factor for module B6 Operational Energy use.

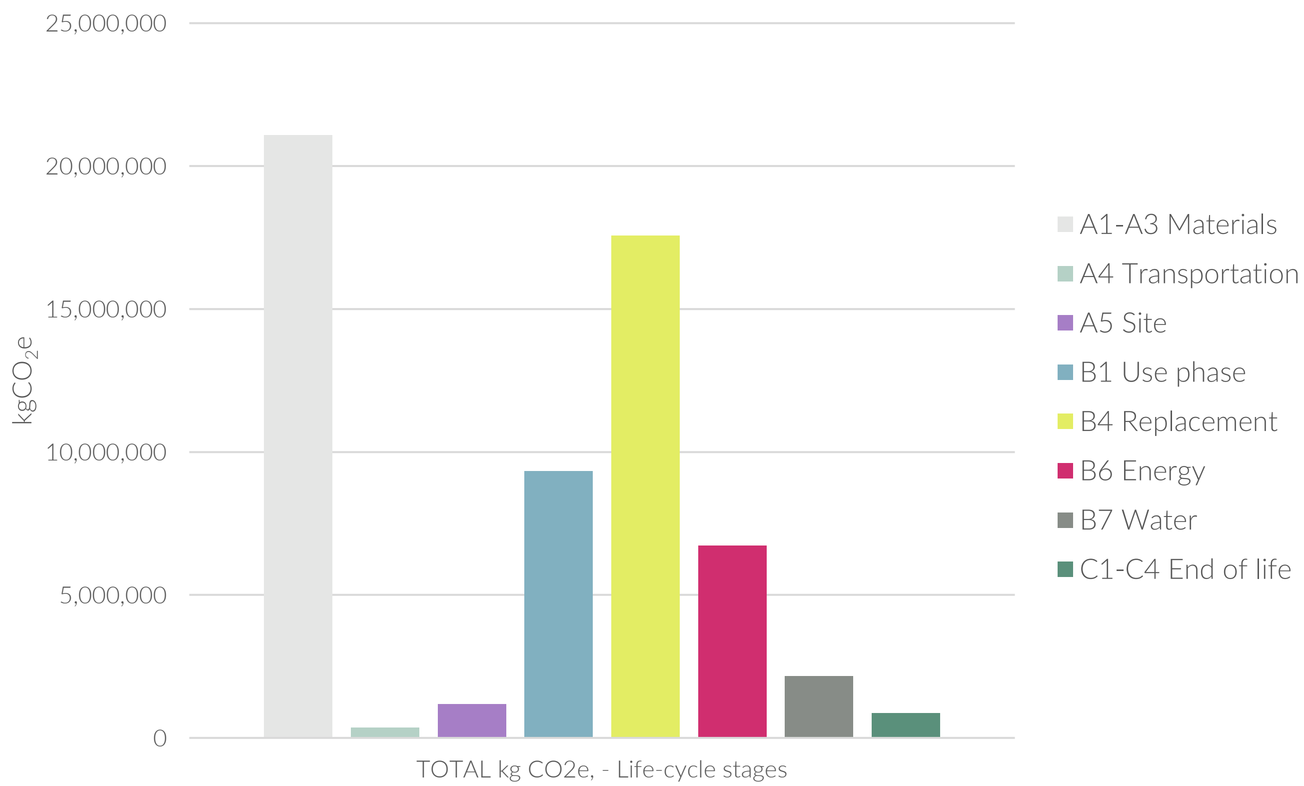
	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B3 Repair	B4 Replacement	B6 Operational Energy use	B7 Operational Water use	C1-C4 End of Life stage	Module D (not included in totals)	TOTAL kg CO_2e
1 Substructure	3,284,062	50,169			0	128,021			73,588	-739,101	3,535,841
2.1-2.4 Superstructure	5,189,848	247,519			0	48,728			357,207	-991,158	5,843,302
2.5-2.6 Superstructure	1,509,431	8,081			0	762,792			14,020	-826,177	2,294,325
2.7-2.8 Superstructure	1,544,785	6,825			0	1,563,509			100,336	-281,841	3,215,456
3 Finishes	695,034	3,222			0	1,115,487			53,454	-236,430	1,867,198
4 Fittings, furnishings & equipment	85,600	193			0	85,600			1,697	-7,922	173,090
5 Services (MEP)	5,553,067	9,713			0	13,592,019			253,742	-981,564	19,408,543
6 Prefabricated buildings and building units	-	-	-	-	-	-	-	-	-	-	-
7 Work to existing building	-	-	-	-	-	-	-	-	-	-	-
8 External works	3,111,415	37,155			0	63,899			13,741	-816,027	3,226,210
Other materials - TOTAL	108,601	631		9,327,177	0	217,201			2,966	-27,082	9,656,576
Site, energy and water			1,193,045				28,271,307	2,165,294			31,629,645
TOTAL kg CO_2e	21,081,844	363,510	1,193,045	9,327,177	0	17,577,257	28,271,307	2,165,294	870,752	-4,907,303	80,850,184

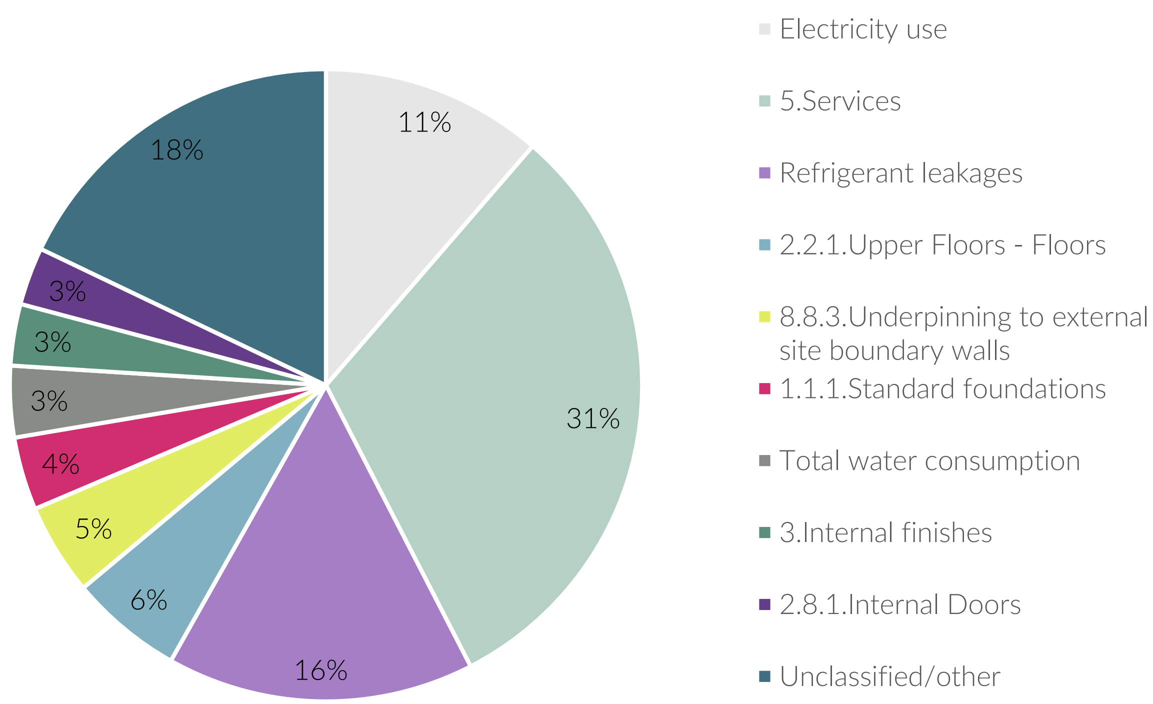




5.4 Assessment 2 - Estimated Whole Life Carbon (WLC) Emissions (Decarbonisation)

	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B3 Repair	B4 Replacement	B6 Operational Energy use	B7 Operational Water use	C1-C4 End of Life stage	Module D (not included in totals)	TOTAL kg CO_2e
1 Substructure	3,284,062	50,169			0	128,021			73,588	-739,101	3,535,841
2.1-2.4 Superstructure	5,189,848	247,519			0	48,728			357,207	-991,158	5,843,302
2.5-2.6 Superstructure	1,509,431	8,081			0	762,792			14,020	-826,177	2,294,325
2.7-2.8 Superstructure	1,544,785	6,825			0	1,563,509			100,336	-281,841	3,215,456
3 Finishes	695,034	3,222			0	1,115,487			53,454	-236,430	1,867,198
4 Fittings, furnishings & equipment	85,600	193			0	85,600			1,697	-7,922	173,090
5 Services (MEP)	5,553,067	9,713			0	13,592,019			253,742	-981,564	19,408,543
6 Prefabricated buildings and building units	-	-	-	-	-	-	-	-	-	-	-
7 Work to existing building	-	-	-	-	-	-	-	-	-	-	-
8 External works	3,111,415	37,155			0	63,899			13,741	-816,027	3,226,210
Other materials - TOTAL	108,601	631		9,327,177	0	217,201			2,966	-27,082	9,656,576
Site, energy and water			1,193,045				6,852,870	2,165,294			10,211,209
TOTAL kg CO_2e	21,081,844	363,510	1,193,045	9,327,177	0	17,577,257	6,852,870	2,165,294	870,752	-4,907,303	59,431,749





6. Opportunities for Reducing WLC

6.1 Maximise Recycled Content

By specifying products with high contents of recycled material, the product life cycle emissions can be significantly reduced, compared to products procured with virgin material. Noting the relationships confirmed in EPD data displayed in Figure 8, Figure 9 & Figure 10, embodied carbon can be reduced at the technical design stage.

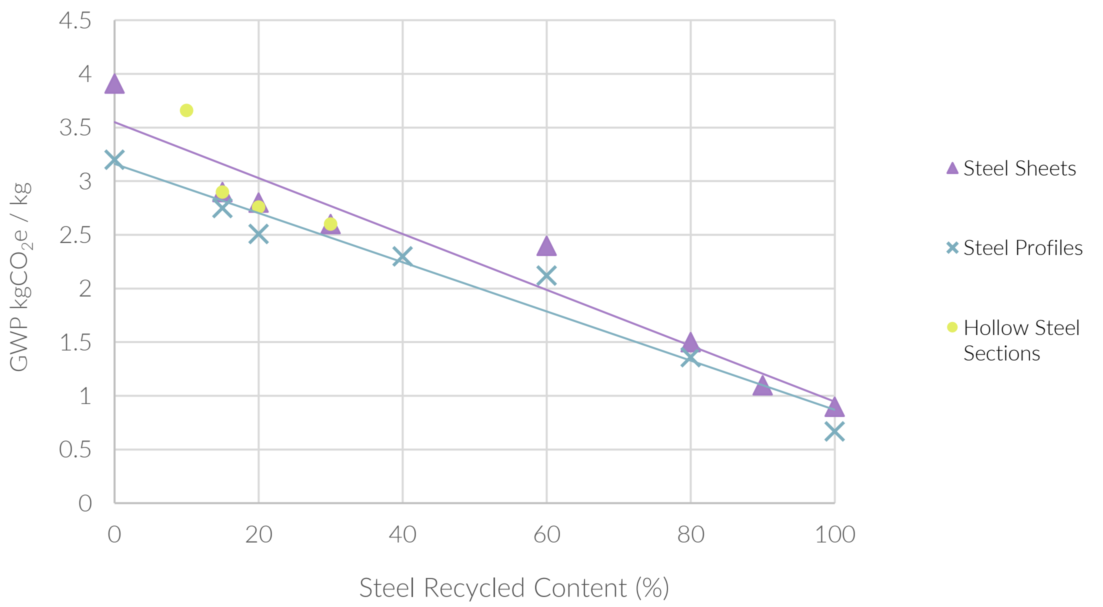


Figure 8: Product life cycle emissions (A1-A3) of construction grade steel and reporting the impact of recycled content.

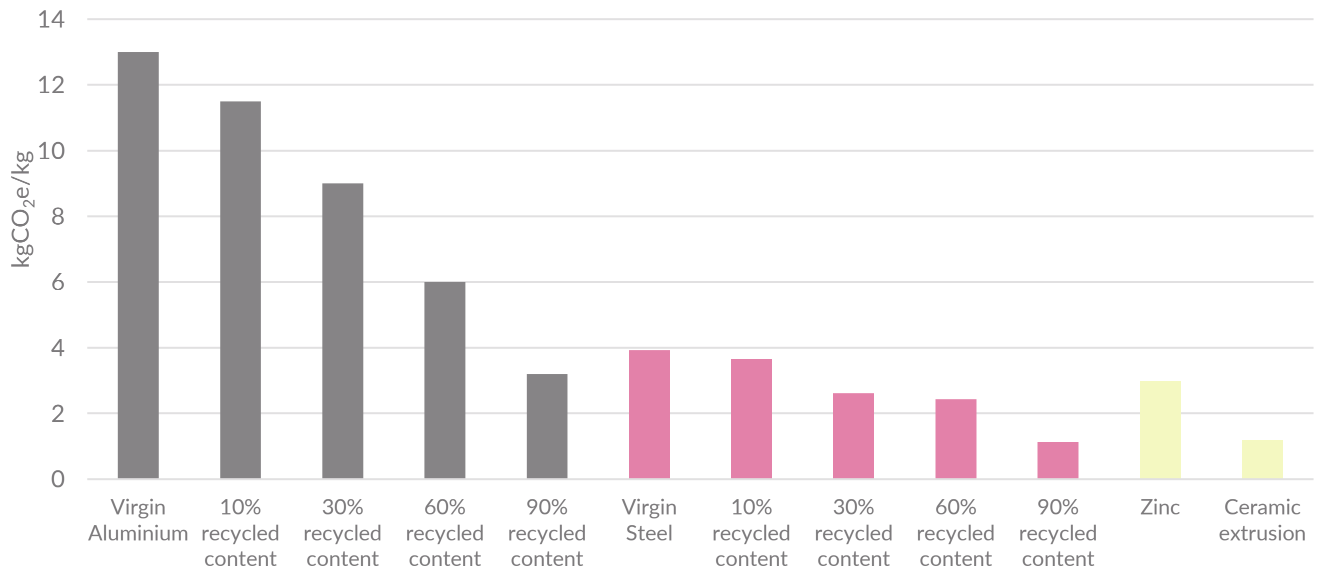


Figure 9: Product life cycle emissions (A1-A3) of aluminium, steel, zinc and ceramic and the impact of including recycled content.

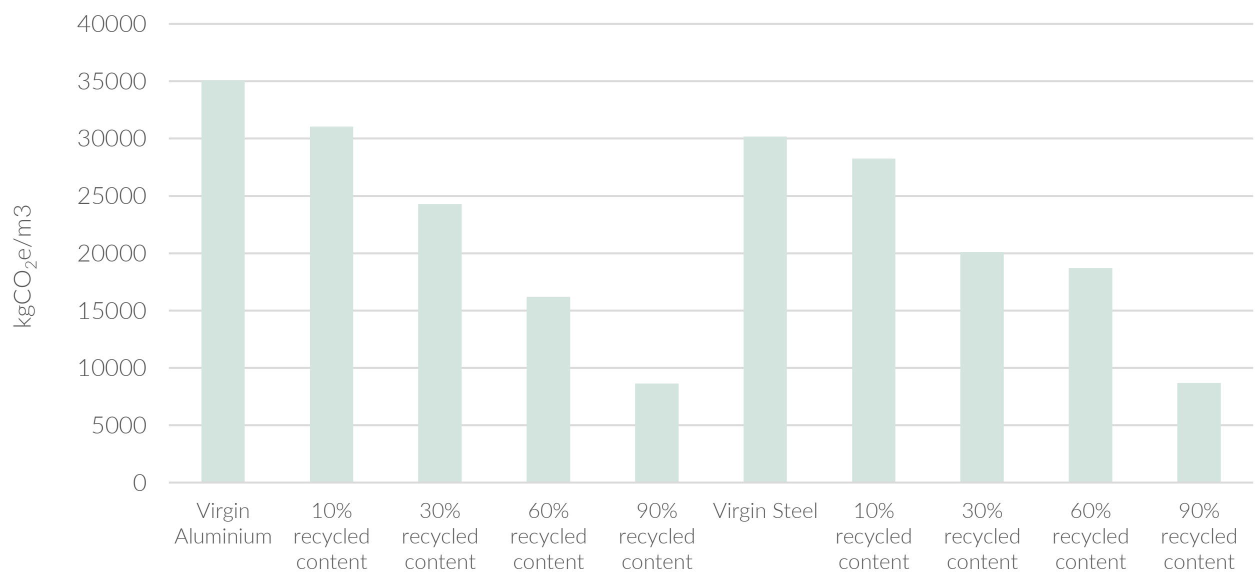


Figure 10: Product life cycle emissions (A1-A3) of aluminium and steel by volume, confirming that the quantum of material contained within a product is just as important as the material itself.

6.2 Influence of product specification

The specific requirements of a product can significantly impact the carbon emissions at the product stage, often due the components of the product requiring more carbon intensive treatment & subsequent transportation prior to fabrication.

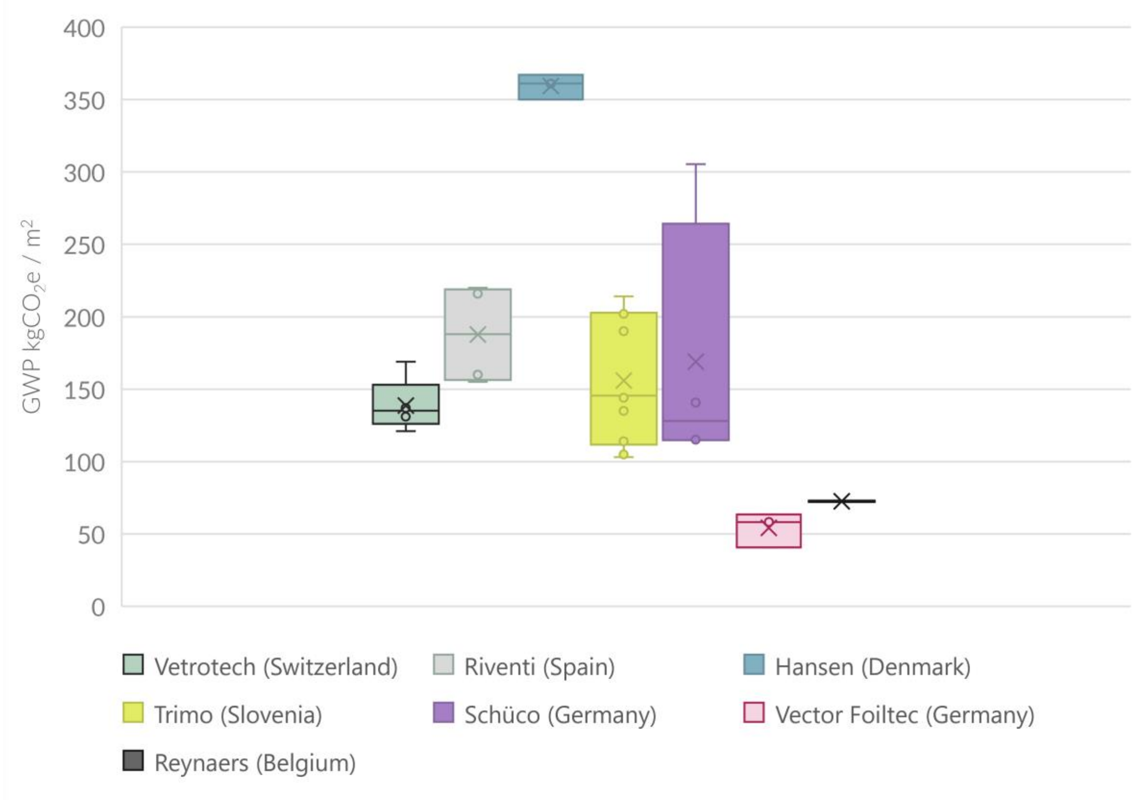


Figure 11: Comparison of Environmental Product Declarations (EPDs) of leading façade fabricators.

6.3 Actions taken to reduce whole life-cycle carbon emissions.

6.3.1 Energy Strategy
Primarily, the energy strategy for the project is a key mechanism for reducing whole life carbon of the development. In addition to a passive design approach, an 'all electric' energy strategy has been proposed, which features highly efficient heat pumps to deliver heating and hot water throughout the development. In addition to heat pumps working at greater efficiency than gas boilers, the heat pumps can take advantage of the projected decarbonisation of the national grid (previously discussed), and therefore is expected to be lower in whole life carbon terms than traditional gas boiler servicing strategy.

Comparing Assessment 1 (SAP10) and Assessment 2 (with decarbonisation) a 21,420,000 $kgCO_2e$ difference is estimated, representing 26% of the total carbon reported in Assessment 1. This reinforces the use of projected decarbonisation scenarios in Whole Life Carbon assessments as proposed by the RICS Professional Statement for Whole Life Carbon Assessment.

6.3.2 Re-use and recovery
The project pre-demolition audit has identified materials which can be re-used or recovered to be used within the proposed development. The Circular Economy statement details the strategy for recovery of materials in line with the circular economy model. The benefits of recovered materials have not been accounted for in the Whole Life Carbon Assessment at this stage due uncertainty in the quantity of replacement materials. It is understood that this would be accounted for at a more detailed stage of design when more accurate data is available.

7. Conclusion

This report has set out the Whole Life Carbon emissions estimated for the Manor Road Development in Richmond, London, completed following the GLA Whole Life-Cycle Carbon Assessment - Pre-consultation draft guidance. Assessment 2 forms the basis of this Whole Life Carbon Assessment as it accounts for future decarbonisation of the UK's electrical grid.

Table 5: Summary table of the Whole Life Carbon Emissions of the Proposed Development.

Whole Life Carbon Scope	RICS Whole Life Carbon Emissions ($kgCO_2e$)
Assessment 1: SAP10	80,850,184
Assessment 2: Decarbonisation projection	59,431,749

The life cycle module that constitutes the greatest proportion of the total Whole Life Carbon emissions of the development is Module B6: Operational Energy use at 35% of the total Whole Life Carbon emissions. The next highest category is building services at 23% which is significant primarily due to the relatively high product stage emissions of building services (A1-A3) coupled with high frequency of replacement throughout the 60-year life cycle.

By accounting for decarbonisation of the UK grid electricity (Assessment 2), the emissions from module B6: Operational energy is reduced from 35% to 11% (as a proportion of Whole Life Carbon). This is significant and confirms the importance of considering grid decarbonisation when completing carbon emissions assessments on a whole life basis.

It is worthy to note that the life cycle emissions from the Use & Replacement (B1-B7) and End of Life stages (C1-C4) will also benefit from future decarbonisation of the UK, European and Global supply chains, however the method for more accurately accounting for these life cycle stages requires further development.

Appendix A – Principles for Reducing WLC Emissions

No.	Principle	Description Relevant life-cycle modules	Relevant life-cycle modules
1	Reuse and retrofit of existing built structures	Before embarking on the design of a new structure or building, the retrofit or reuse of any existing built structures, in part or as a whole, should be a priority consideration as this is typically the lowest carbon option. Significant retention and reuse of structures also reduces construction costs and can contribute to a smoother planning process.	A1-A5, B1-B6, C1-C4, D
2	Use recycled or repurposed materials	Using recycled or repurposed materials, as opposed to newly sourced raw materials, typically reduces the carbon emissions from constructing a new building and reduces waste. This process would start by reviewing the materials already on site for their potential for inclusion into the proposed scheme. Many of the currently available standard products already include a degree of recycled content. Applicants should obtain this information from the supply chain, preferably in the form of an EPD.	A1-A5, B1-B5, C1-C4, D
3	Material selection	This is the most important issue affecting the WLC 'cost' of a new building. Appropriate low carbon material choices are key to carbon reduction. Ensuring that there is synchronicity between materials selected and planned life expectancy of the building reduces waste and the need for replacement, thus reducing in-use costs. EPDs should be referenced. It is important to note that the overall life-time carbon footprint of a product can be as much down to its durability as to what it is made of. For example, bricks may have a high carbon cost in terms of their manufacture, however they have an exceptionally long and durable life expectancy. The selection of reused or recycled materials and products, plus products made from renewable sources, such as timber, will also help reduce the carbon footprint of a project.	A1-A5, B1-B5, C1-C4, D
4	Minimise operational energy use	A 'fabric first' approach should be prioritised to minimise the heating and cooling requirement of a building. Naturally ventilated buildings avoid the initial carbon and financial costs of a ventilation system installation, and the repeat carbon and financial costs of its regular replacement.	A1-A5, B1-B4, B6
5	Minimise operational water use	Carbon emissions from water use are largely due to the materials and systems used for its storage and distribution, the energy required to transfer it around the building, and the energy required to treat any wastewater. The choice of materials used and the durability of the systems, which help avoid leakage and resulting damage to building fabric, are therefore key aspects of reducing the carbon cost of water use. On-site water collection, recycling and treatment, and storage can have additional positive environmental impacts as well as reducing in-use costs.	A1-A5, B1-B5, B7, C1-C4, D
6	Disassembly and reuse	Designing for future disassembly ensures that products do not become future waste and that they maintain their environmental and economic value. A simple example is using lime rather than cement mortar; the former being removable at the end of a building's life, the latter not. This enables the building's components (e.g. bricks) to have a future economic value as they can be reused for their original purpose rather than becoming waste or recycled at a lower level (e.g. hardcore in foundations). Designing building systems (e.g. cladding or structure) for disassembly and dismantling has similar and even broader benefits. Ease of disassembly facilitates easy access for maintenance and replacement leading to reduced maintenance carbon emissions and reduced material waste during the 'in-use' and 'end of life' phases. This leads to the potential for material and product reuse which also reduces waste and contributes to the circular economy principle.	A1-A5, B1-B5, C1-C4, D
7	Building shape and form	Compact efficient shapes help minimise both operational and embodied carbon emissions from repair and replacement for a given floor area. This leads to a more efficient building overall, resulting in lower construction and in-use costs. A complex building shape with a large external surface area in relation to the floor area requires a larger envelope than a more compact building. This measure of efficiency can be referred to as the 'wall to floor ratio', or the 'heat loss form factor'. This requires a greater use of materials to create the envelope, and a potentially greater heating and/or cooling load to manage the internal environment.	A1, B1, D
8	Regenerative design	Removing CO_2 from the atmosphere through materials and systems absorbing it makes a direct contribution to carbon reduction. Examples include unfinished concrete, some carpet products and maximising the amount of vegetation.	A1, B1, D
9	Designing for durability and flexibility	Durability means that repair and replacement is reduced which in turn helps reduce life-time building costs. A building designed for flexibility can respond with minimum environmental impact to future changing requirements and a changing climate, thus avoiding obsolescence which also underwrites future building value. Buildings designed with this principle in mind will be less likely to be demolished at the 'end of life' as they lend themselves to future refurbishment. Examples include buildings being designed with 'soft spots' in floors to allow for future modification and design as well as non-structural internal partitions to allow layout change.	A1-A5, B1-B5, C1-C4, D
10	Optimisation of the relationship between operational and embodied carbon	Optimising the relationship between operational and embodied emissions contributes directly to resource efficiency and overall cost reduction. For example, the use of insulation has a clear carbon benefit whereas its fabrication has a carbon cost. This means that it is important to look not only at the Uvalue of	A1-A5, B1-B6

No.	Principle	Description Relevant life-cycle modules	Relevant life-cycle modules
		insulation, but also the carbon cost of the manufacture and installation of different product options. Avoiding fully glazed façades will reduce cooling demand and limits the need for high-carbon materials (glass units, metal frame, shading device etc) both at the construction stage, and the 'in use' stage through wholesale replacements.	
11	Building life expectancy	Defining building life expectancy gives guidance to project teams as to the most efficient life expectancy choices for materials and products. This aids overall resource efficiency, including cost efficiency and helps future proof asset value	A1-A5, B1-B5, C1-C4, D
12	Local sourcing	Sourcing local materials reduces transport distances and therefore supply chain lengths and has associated local social and economic benefits e.g. employment opportunities. It also has benefits for occupiers as replacement materials are easier to source. Transport type is also highly relevant. A product transported by ship will have a significantly lower carbon cost per mile than one sent by HGV. A close understanding of the supply chain and its transport processes is therefore essential when selecting materials and products.	A1-A5, B3- B4
13	Minimising waste	Waste represents an unnecessary and avoidable carbon cost. Buildings should be designed to minimise fabrication and construction waste, and to ease repair and replacement with minimum waste, which helps reduce initial and in-use costs. This can be achieved through the use of standard sizes of components and specification and by using modern methods of construction. Where waste is unavoidable, the designers should establish the suppliers' processes for disposal or preferably reuse of waste.	A1-A5, B1-B7, C1-C4, D
14	Efficient fabrication	Efficient construction methods (e.g. modular systems, precision manufacturing and modern methods of construction) can contribute to better build quality, reduce construction phase waste and reduce the need for repairs in the post completion and defects period (snagging). Such methods can also enable future disassembly and reuse with attendant future carbon benefits.	A1-A5, B1-B7, C1-C4, D
15	Lightweight construction	Lightweight construction uses less material which reduces the carbon footprint of the building as there is less material to source, fabricate and deliver to site. Foundations can then also be reduced with parallel savings. Lightweight construction can also be easier to design for future disassembly and reuse. The benefits of lighter construction should be seen in the context of other principles such as durability.	A1-A5, C1-C4, D
16	Circular economy	The circular economy principle focusses on a more efficient use of materials which in turn leads to financial efficiency. Optimising recycled content, reuse and retrofit of existing buildings, and designing new buildings for easy disassembly,	C1-C4, D

No.	Principle	Description Relevant life-cycle modules	Relevant life-cycle modules
		reuse and retrofit, and recycling as equivalent components for future reuse is essential. The use of composite materials and products can make future recycling difficult. Where such products are proposed, the supplier should be asked for a method statement for future disposal and recycling.	

Appendix B – End of Life Scenarios

Table 6: One Click LCA's default end of life scenarios.

Material group	End of life scenario	Materials included	C3 – C4, waste processing and landfilling	D, recycling benefits
Mineral building materials	Recycling for ground works	Concrete*, Cement*, Bricks, Porcelain, Plaster, Clay products, Stone, Ceramics, Asphalt	C3: Construction waste preparation for recycling	Recycling benefit from replacing the primary gravel
Metals	Metal preparation and recycling**	Aluminium, Steel, Stainless steel, Galvanized steel, Copper coated, Copper uncoated, Brass, Zinc, Lead	C3: Metal waste preparation	Recycling benefits for replacing virgin metal
Biobased materials with heating value	Incineration and energy recovery	Wood, Wood products	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials with heating value	Incineration and energy recovery	Plastics	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials that can be landfilled in construction waste site	Disposal / landfilling of inert material	Coatings, Synthetic materials, Panels and boards***, Insulating materials***, Glass, Window and façade components***	Disposal of inert construction waste	-

* Taking into account concrete carbonatization

** Recycling potential can only be reported for metals with shares of primary manufacturing, i.e. if a product is made of recycled material, it no longer has recycling potential. 5% of losses is assumed for recycling (the remaining 95% are recycled).

*** When not included to above groups

Appendix C – OneClick LCA information export & EPDs

Here the OneClick tool exports are shown for the baseline case.

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
Air-to-air heat pump, external unit	heating (26.9 kW) and cooling (25.1 kW)	DAIKIN : RXYQ8T - MITSUBISHI ELECTRIC : PUHYP250YKB - YACK & MITSUBISHI HEAVY INDUSTRIES : FDC224KXE6	Uniclima	INIES	UNIC-00019-V01.01-FR, 9176	PEP	EN15804	TRUE	2019	[france]	ecoinvent		PEP-PCR-ed3-FR-2015 04 02	ISO 14025
Aluminum frame sliding door	size: 1.23 x 2.18m, double glazing, 27.37 kg/m2	Concept System® 77 Door	Reynaers	European Aluminium	EPD EUROPEAN ALUMINIUM 2016 – REYNAERS 5	EPD Concept System® 77 Door	EN15804	Verified	2016	[belgium]	GaBi		EAA Product Category Rules (PCR) for Aluminium Building Products – version of 30 January 2013	Only with EN15804
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 Association (APA) a product group of British Precast	EN15804	Verified	2017	[unitedKingdom]	GaBi	600	PCR Aerated concrete, 07/2014	Only with EN15804
Bitumen sheets for waterproofing of roofs, French average	ép. 2,5 mm par couche	Donnee par default	MDEGD	INIES	INIES_DFEU20161116_164607 , 5721	MDEGD_FDES	EN15804	-	2016	[france]	ecoinvent	1800	EN15804	EN15804
Brass tap	0.4kg	Donnee par default	MDEGD	INIES	INIES_DROB20200319_151954 , 16278	MDEGD_FDES	EN15804	verified	2020	[france]	ecoinvent		EN15804	EN15804
Ceramic sink, French average		Donnee par default	MDEGD	INIES	INIES_DEVI20170317_174255, 6401	MDEGD_FDES	EN15804	-	2017	[france]	ecoinvent		EN15804	EN15804
Ceramic tiles, incl. underlayment membrane				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Ceramic toilet, French average		Donnee par default	MDEGD	INIES	INIES_DWC 20170317_174246, 6397	MDEGD_FDES	EN15804	-	2017	[france]	ecoinvent		EN15804	EN15804
Ceramic wall tiles	7.5 mm, 3000 kg/m2		Seranit Granit Seramik	International EPD System	S-P-00676	EPD for For Floor Tiles in accordance	EN15804	Verified	2015	[turkey]	ecoinvent	3000	PCR 2012:01 Construction products and	Only with EN15140 4

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
						with EN15804 and ISO14025							Construction services, ver.1.2, 15/03/2013	
Chilled beam, French average	dimensions=1,2x0,6x0,2 m	Donnee par default	MDEGD	INIES	INIES_DPOU20161116_164337, 5603	MDEGD_FDES	EN15804	-	2016	[france]	ecoinvent, ELCD		EN15804	EN15804
Clay soil, loose wet density	1760 kg/m3			One Click LCA	-	LCA inventory for clay pit operation, Ecoinvent 2014	ISO14040	-	2014	[LOCAL]	ecoinvent	1760	-	Only with EN15804
Concrete assembly for stairs and elevator shafts per one metre height				One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Concrete balcony assembly	200 mm			One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Concrete beam - for concrete buildings	L-beam/T-beam, B45			One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Concrete column - for concrete buildings	Rectangular column, B45			One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Concrete ground slab assembly incl. insulation	550 mm			One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Concrete paving	15.4 m2/m3, 96 units/m3	Andover Textured	Aggregate Industries	International EPD System	S-P-00684	EPD for precast concrete paving	EN15804	Verified	2015	[unitedKingdom]	ecoinvent	2400	PCR 2013:02 Concrete, ver. 1.02, UN CPC 375	Only with EN15804
Concrete roof assembly	U-value 0.13 W/m2K, TEK17, 520 mm			One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Concrete roof tiles	Avg. thickness per m2: 22.4 mm, 334x420 mm, 2100 kg/m3		Eternit	IBU	EPD-ETE-20130224-IAA1-DE	EPD Eternit Dachstein Heidelberg Eternit Dachstein Verona Eternit Dachstein Göteborg Eternit Dachstein Kapstadt Eternit AG	EN15804	Verified	2014	[germany]	GaBi	2100	PCR Betondachsteine, 10/2012	Only with EN15804

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
Concrete sandwich element underground wall assembly, incl. EPS insulation				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Drinking water supply piping network, per m2 GIFA (residential buildings)				One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
EPS Insulation	T: 10-2400 mm, 600 x 1200 mm, 0.031 W/m2K, 16 kg/m3		EPS-gruppen	EPD Norge	NEPD-1236-244-EN	EPD Lavlambda EPS 80 isolasjon (trykklasse 80) EPS-gruppen	EN15804	Verified	2017	[norway, sweden]	ecoinvent	16	NPCR 012 Insulation materials, rev1, 10/2/2012	Only with EN15804
Electric boiler	per 1kW / unit - beta			One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
Electric elevator elements independent of the number of floors (cabin and others)	max. transported gross weight 1000kg	Donnee par default	MDEGD	INIES	INIES_DELÉ20180427_112652, 8221	MDEGD_FDES	EN15804	-	2018	[france]	ecoinvent		EN15804	EN15804
Electricity distribution system, cabling and central, for all building types	per m2 GFA			One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
Excavation works		kg or m3 of removed masses	Required for IMPACT calculations	One Click LCA	-		EN15804	Verified	2013	[unitedKingdom]	ecoinvent	1760	EN15804	
Fibre cement facade panel	10 mm, 13 kg/m2, 1300.0 kg/m3			OKOBAUDA T	-	Oekobau.dat 2017-I	EN15804	verified	2016	[germany]	GaBi	1300	EN15804	-
Fire alarm, B.A.A.S + D.L, French average		Donnee par default	MDEGD	INIES	INIES_DB.A20161116_164323, 5576	MDEGD_FDES	EN15804	-	2016	[france]	ecoinvent , ELCD		EN15804	EN15804
Footing foundations for hard soils (sand, gravel, silt or clay) per GFA	Includes: point and strip footings			One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Galvanized steel bicycle shelters	76.7 kg/unit	Donnee par default	MDEGD	INIES	INIES_DABR20190326_161213 , 10345	MDEGD_FDES	EN15804	verified	2019	[france]	ecoinvent		EN15804	EN15804

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
Generic aggregate for concrete, asphalt, fill material or landscaping application			Tarmac CRH	BRE	BREG EN EPD000105	EPD Generic Aggregate, Tarmac CRH 2016	EN15804	Verified	2016	[unitedKingdom]	ecoinvent	1600	EN15804	-
Glass wool insulation panels, unfaced, generic	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	-	2018	[LOCAL]	ecoinvent	25	EN15804	-
Glass wool, acoustic ceiling panel	20 mm, 4.0 kg/m2	Master Rigid Dp	Ecophon	International EPD System	S-P-00891	EPD for Ecophon Master Rigid	EN15804	Verified	2016	[sweden]	ecoinvent	200	PCR 2012:01 Construction products and Construction services, ver. 2.0, 03/03/2015, with the appendix SUB PCR Acoustic ceilings	Only with EN15804
Glazed steel sink	Long. 860 mm Larg. 500 mm Haut. 140 mm	Donnee par default	MDEGD	INIES	INIES_DEVI20191004_080507, 12560	MDEGD_FDES	EN15804	verified	2019	[france]	ecoinvent		EN15804	EN15804
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	-	2018	[LOCAL]	ecoinvent	858.028060 7	EN15804	-
Gypsum plasterboard	12.5 mm, 8.985 kg/m2 (average product weight)		Etex Building Performance	BRE	BREG EN EPD 000204	EPD GTEC Plasterboard	EN15804	Verified	2018	[unitedKingdom]	ecoinvent	718.8	EN15804	-
Heat distribution piping network, per m2 heated area, all building types				One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
Hollow core concrete slabs, generic	C30/37 (4400/5400 PSI), 0% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3), incl. reinforcement			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	1400	EN15804	-
Hollow-core slab floor assembly, incl. mineral wool acoustic slabs	340 mm			One Click LCA		One Click LCA generic construction definitions				[europe]	Other			

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
In-situ concrete roof assembly				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
In-situ concrete slab assembly				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
LED lighting	82W	Donnee par default	MDEGD	INIES	INIES_DRÉG20190918_145258 , 12417	MDEGD_FDES	EN15804	verified	2019	[france]	ecoinvent		EN15804	EN15804
Massive wooden flooring/parquet	22-450 x 44-7000 x 8-35 mm, 11.71 kg/m2		Verband der Deutschen Parkettindustrie	IBU	EPD-VDP-20150262-IBG1-DE	Oekobau.dat 2017-I, EPD Kreisförmige, quadratische und rechteckige Stahlbauhohlprofile Vallourec Deutschland GmbH	EN15804	Verified	2015	[germany]	GaBi	900.77	PCR Vollholzprodukte 2014	Only with EN15804
Multifunctional steel door, product group 1	1000mm x 2125 mm	H 3 D, H 3 OD, H 3 VM, H 3 KT, RS 55, D 65 OD, D 65	Hörmann	ift Rosenheim	EPD-MT-0.1.1	EPD Multifunktionstüren aus Stahl Hörmann KG Freisen	EN15804	Verified	2015	[germany]	GaBi		PCR Dokument Turen und Tore - PCR-TT-1.1 : 2013	Only with EN15804
Natural quartz surfaces	2130 - 2460 kg/m3	Silestone	Cosentino	International EPD System	S-P-01269	EPD SILESTONE	EN15804	Verified	2019	[spain]	ecoinvent	2130	PCR 2012:01 Construction products and Construction services, ver. 2.2, 03/05/2017	Only with EN15804
Painted MDF-board	11 mm	Arbor malte MDF plater til vegg og tak	Arbor-Hattfjelldal	EPD Norge	NEPD-1326-428-NO	EPD Arbor malte MDF plater til vegg og tak Arbor-Hattfjelldal AS	EN15804	Verified	2017	[norway]	ecoinvent	681.8181818	NPCR 010 Building boards, rev1, 12/2013	Only with EN15804
Parquet flooring, incl. vapourproof membrane				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Plasterboard, filled, sanded and painted				One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Plastic vapour control layer	0.2 mm		Tommen Gram	EPD Norge	NEPD-341-230-NO	Gram Dampsperre, Tommen Gram Folie AS (2015)	EN15804	Verified	2015	[norway]	ecoinvent	925	NPCR 022 Roof waterproofing, rev1, 12/2012	Only with EN15804
Plate heat exchanger	P = 150kW	Donnee par default	MDEGD	INIES	INIES_DECH20190710_161707 , 10888	MDEGD_FDES	EN15804	-	2019	[france]	ecoinvent		EN15804	EN15804

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
Power outlet, low current		Donnee par default	MDEGD	INIES	INIES_DPRI20190819_150144, 11128	MDEGD_FDES	EN15804	-	2019	[france]	ecoinvent		EN15804	EN15804
Rainwater storage tank, per cubic meter of water storage	51.3kg/m3 d´eaux stockées	REHAU RAUSIKKO BOX	REHAU	INIES	INIES_IB20200404_171153, 16353	FDES	EN15804	Verified	2020	[france]	ecoinvent	51.3	EN15804	EN15804
Ready-mix concrete, normal-strength, generic	C20/25 (2900/3600 PSI), 10% (typical) recycled binders in cement (240 kg/m3 / 14.98 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	2200	EN15804	-
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	-	2018	[LOCAL]	ecoinvent	2400	EN15804	-
Ready-mix concrete, normal-strength, generic	C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	2400	EN15804	-
Ready-mix concrete, normal-strength, generic	C40/50 (5800/7300 PSI), 10% (typical) recycled binders in cement (400 kg/m3 / 24.97 lbs/ft3)			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	2400	EN15804	-
Red brick, average production, UK			The Brick Development Association	BRE	BREG EN EPD000002	EPD BDA generic brick, The Brick Development Association 2015	EN15804	Verified	2015	[unitedKingdom]	ecoinvent	1550	EN15804	-
Reinforcement steel (rebar), generic	90% recycled content			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	7850	EN15804	-
Rock wool insulation for partitioning walls	L = 0.040 W/mK, 40-140 mm, 28-37 kg/m3	DPF-30 / TW	KNAUF	IBU	EPD-KNI-20150329-CBB1-EN	EPD DPF-30 / TW Rock Mineral Wool for partition walls Knauf Insulation	EN15804	Verified	2016	[germany, slovakRepublic]	GaBi	32	PCR Mineral insulating materials	Only with EN15804
Sand (0...8 mm), loose dry density	1555 kg/m3			One Click LCA	-	LCA inventory for sand quarry operation, Ecoinvent 2016	ISO14040	-	2016	[LOCAL]	ecoinvent	1555	-	Only with EN15804
Self levelling mortar, for floors, walls and overhead appl.	3-50 mm, 1400 kg/m3	Pericret	PCI Augsburg	IBU	EPD-PCI-20160262-IBE1-DE	Oekobau.dat 2017-I, EPD Ausgleichsmörtel PCI Pericret für Boden, Wand und Decke PCI Augsburg GmbH	EN15804	Verified	2016	[germany]	GaBi	1400	PCR Mineralische Werkmörtel, 07/2014	Only with EN15804

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
Sewage water drainage piping network, per m2 GIFA (residential buildings)				One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
Shower tray made of synthetic material, French average	Long. 90 cm Larg. 90 cm	Donnee par default	MDEGD	INIES	INIES_DREC20161116_164640 , 5751	MDEGD_FDES	EN15804	-	2016	[france]	ecoinvent		EN15804	EN15804
Sliding door system, MDF board	Thickness 66 mm, 68.7 kg, door dimensions 831x2060, steel frame dimensions 1735x2130	LIUNE-door system with glass/MDF door	Aulis Lundell	RTS	RTS_38_19	EPD LIUNE-door system with glass/MDF door	EN15804	Verified	2019	[finland]	ecoinvent		RTS PCR protocol: EPDs published by the Building Information Foundation RTS sr (2018)	Only with EN15804
Solar panel photovoltaic system, EU average				One Click LCA	-	One Click LCA	ISO14040	-	2015	[LOCAL]	ecoinvent		-	Only with EN15804
Steel core piling foundation for soft soils, 20 m (66 ft) depth, per GFA	Diameter: ø130 mm (5 1/8"), core pile length/depth to bedrock: 20 m			One Click LCA		One Click LCA generic construction definitions				[LOCAL]	Ecoinvent			
Steel stud internal wall assembly, 100 mm, incl. mineral wool insulation	Steel stud wall 100 mm, incl. mineral wool insulation 100 mm and plasterboard 13 mm on both sides			One Click LCA		One Click LCA generic construction definitions				[europe]	Other			
Street lighting pole, single light, French average	haut.=6m	Donnee par default	MDEGD	INIES	INIES_DMAT20161116_164418, 5646	MDEGD_FDES	EN15804	-	2016	[france]	ecoinvent , ELCD		EN15804	EN15804
Structural steel profiles, generic	60% recycled content, I, H, U, L, and T sections			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	7850	EN15804	-
Structural steel profiles, generic	40% recycled content, I, H, U, L, and T sections			One Click LCA	-	One Click LCA	EN15804	-	2018	[LOCAL]	ecoinvent	7850	EN15804	-
Thermostat, French average	up to 63A	Donnee par default	MDEGD	INIES	INIES_DTHE20170113_152829 , 5914	MDEGD_FDES	EN15804	-	2017	[france]	ecoinvent , ELCD		EN15804	EN15804
Thermostatic water mixer, shower		ENTRAXE 150	IDÉAL STANDARD	INIES	INIES_IMIT20140808_114744, 4936	FDES	EN15804	Verified	2014	[france]	ecoinvent		EN15804	EN15804

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
Tile adhesive, all round, for ceramics	1-5 mm, 1400 kg/m3	Verlegemörtel	PCI Augsburg	IBU	EPD-PCI-20160141-IBE1-DE	Oekobau.dat 2017-I, EPD Flexibilisierter Fliesenkleber PCI Verlegemörtel für keramische Fliesen PCI Augsburg GmbH	EN15804	Verified	2016	[germany]	GaBi	1400	PCR Mineralische Werkmörtel, 07/2014	Only with EN15804
Underfloor heating system, French average		Donnee par default	MDEGD	INIES	INIES_DPLA20170317_174030, 6304	MDEGD_FDES	EN15804	-	2017	[france]	ecoinvent , ELCD		EN15804	EN15804
Ventilation system with plastic pipes, room area m2				One Click LCA	-	One Click LCA	ISO14040	-	2013	[LOCAL]	ecoinvent		-	Only with EN15804
Ventilator for decentralized ventilation with heat recovery (wall, ceiling mounted)	60 m3/h, 3.7 kg/unit			OKOBAUDA T	-	Oekobau.dat 2017-I	EN15804	verified	2016	[germany]	GaBi		EN15804	-
Vinyl flooring		Be Natural Be Different Be easy Be Smart	DICKSON-CONSTANT	INIES	INIES_IREV20160331_155658, 4881	FDES	EN15804	Verified	2015	[france]	ecoinvent	811.688	EN15804	EN15804
Water circulation radiator	per 1kW / unit			One Click LCA	-	One Click LCA	EN15804	-	2019	[LOCAL]	ecoinvent		EN15804	-
Water-borne interior paints	1.36 kg/L, average coverage 8-10 m2/L	Biora, Ekora, Kolibri Sand, Paneelikattomaali , Ranch, Superlateksi, Tapettipohjamaali , Teknospro, Tela, Timantti, Trend	Teknos	RTS	RTS_14_18	EPD RTS EPD, Water-borne interior paints	EN15804	Verified	2018	[finland]	ecoinvent	1360	RTS PCR protocol: EPDs published by the Building Information Foundation RTS sr (2016)	Only with EN15804
Waterproof, protective, flexible coating	1.5 kg/l	Lastogum	PCI Augsburg	IBU	EPD-PCI-20150039-IBE1-DE	Oekobau.dat 2017-I, EPD Wasserdichte, flexible Schutzschicht PCI Lastogum unter Keramikbelägen in Dusche und Bad PCI Augsburg GmbH	EN15804	Verified	2015	[germany]	GaBi	1500	PCR Beschichtungen mit organischen Bindemitteln, 07/2012	Only with EN15804
Wooden entrance door, per m2	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	Verified	2018	[norway]	ecoinvent		NPCR 014 Windows and doors, rev1, 03/2013	Only with EN15804

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