UNILIN INSULATION

XCO2

RIBA Climate Challenge 2030
An Overview of The Calculation of Embodied Carbon

Commissioned by Unilin Insulation
March 2022

In 2021 Unilin Insulation launched our Sustainability Pledge to become a Zero Carbon operation by 2030.

As part of Unilin Group's One Home Sustainability Policy, we pledged to make environmental improvements in all aspect of our operation including the insulation products we manufacture.

The ECO360 insulation strategy has been a key innovation in our endeavours. ECO360 is evidence of our commitment to continually review and improve the sustainable credentials of our product offering and services, as far as technical advances in manufacturing and circularity allow.

Unilin Insulation commissioned this report as a tool to assist in the understanding of, and to encourage engagement with the accounting of embodied carbon in construction projects. The aim is to gauge the impact of our improving Environmental Product Declarations (EPDs) on a building's Life Cycle Analysis. We worked with industry bodies and software providers to educate our own team in the conventions and methods related to embodied carbon measurement.

This is only the start of a journey. Strong alliances and co-operation between manufacturers, the supply chain, designers, and contractors will be required to address the Climate Challenge crisis. All of the manufacturers we engaged with in the preparation of this report are fully committed to improving their own EPDs along with the continued decarbonising of the grid, and so results for embodied carbon shown will continue to reduce.

We hope this report and accompanying CPD learning will encourage information sharing and engagement with the subject.

UNILIN INSULATION

Table of Contents

Foreword

We have taken four relatively common house types as uncomplicated examples of Life Cycle Assessment.

We explain the measurement of materials to be accounted for, the conventions for calculation and where to obtain current and correct environmental product declarations (EPDs) for the materials chosen. Full results are also provided to allow those engaging on the subject to follow the process in determining the embodied carbon. We aim to achieve the targets set within the RIBA Climate Challenge 2030.

Life cycle assessments are still a relatively new discipline, the parameters to which the assessments are calculated are quite fluid & these background changes have a measurable influence on the results.

However, as time goes on and manufacturers, designers and contractors engage with the subject it is expected that these will normalise & the quality and breadth of material data available through software such as the OneClickLCA that was used in the report. This will only increase both in respect of a broader offering along with the quality and clarity of data.

The introduction of embodied carbon to governmental regulations and similar requirements that have already been accepted by some local authorities and industry groupings will only hasten the adoption of LCAs within the industry. This, combined with the recent revision of the EN15804 standard to EN15804 + A2, which means EPDs will be required to declare modules C1-C4 and module D.

UNILIN INSULATION

Executive Summary

XCO2 were commissioned to carry out Life Cycle Assessments (LCA)for four different dwelling types using the typical material specifications to meet the targets set within the RIBA Climate Challenge 2030.

An LCA was undertaken to account for the embodied carbon content of each dwelling to assess where improvements were required to meet the embodied carbon targets.

The four dwelling types were:

1. Detached house
2. Semi detached house
3. Mid-terraced house
4. Apartment block

The embodied carbon was calculated initially for an indicative Baseline specification consisting of materials that are commonly specified, but tend to be carbon-intensive due to their use of generic or average manufacturer LCA data.

The most contributing materials were identified and an Improved specification was proposed with materials with improved, verified EPDs including Unilin insulation, that help reduce the embodied carbon of the dwelling types.

Additionally, a building services options appraisal was undertaken to further reduce the carbon emissions associated with the MEP building elements of the dwellings. The options include the use of air source heat pumps (ASHP), passive heating with the use of Mechanical Ventilation with Heat Recovery (MVHR) and an option with electric heaters.

The RIBA 2030 Climate Challenge v2 has set a target of 625kgCO_2/m^2 for residential buildings.

Figure 1 shows the summary of results of all the dwelling types with the Baseline illustrated in blue. The Improved specification using verified EPDs and various building services options are also illustrated. The results show that for most of the dwelling types the 2030 target can be met with the use of the Improved specification.

Figure 2 shows a breakdown of the building element categories for the Improved - ASHP option with the four dwelling types. The graph shows a closer look at the contribution of each category into the overall embodied carbon of each dwelling. The Services category has the highest contribution, mainly because it accounts for the equipment and refrigerant leakage of the ASHP, followed by the external walls and roofs for the houses, whereas the upper floors take the third place in the apartment block.

Overall, with the improved specification and inclusion of sequestration it is expected that typical dwellings will meet the RIBA 2030 embodied carbon target with the use of Unilin insulation boards.

Figure 1 Summary of results of the total embodied carbon for all options of the different dwelling types
Visualisations are indicative only

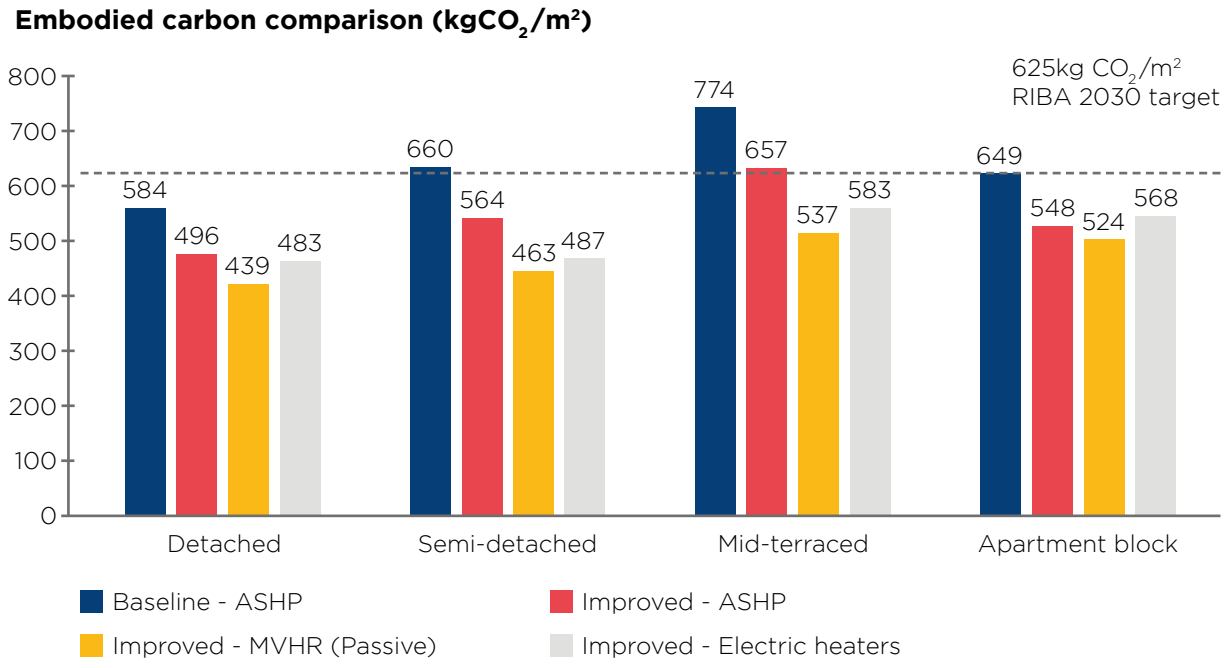
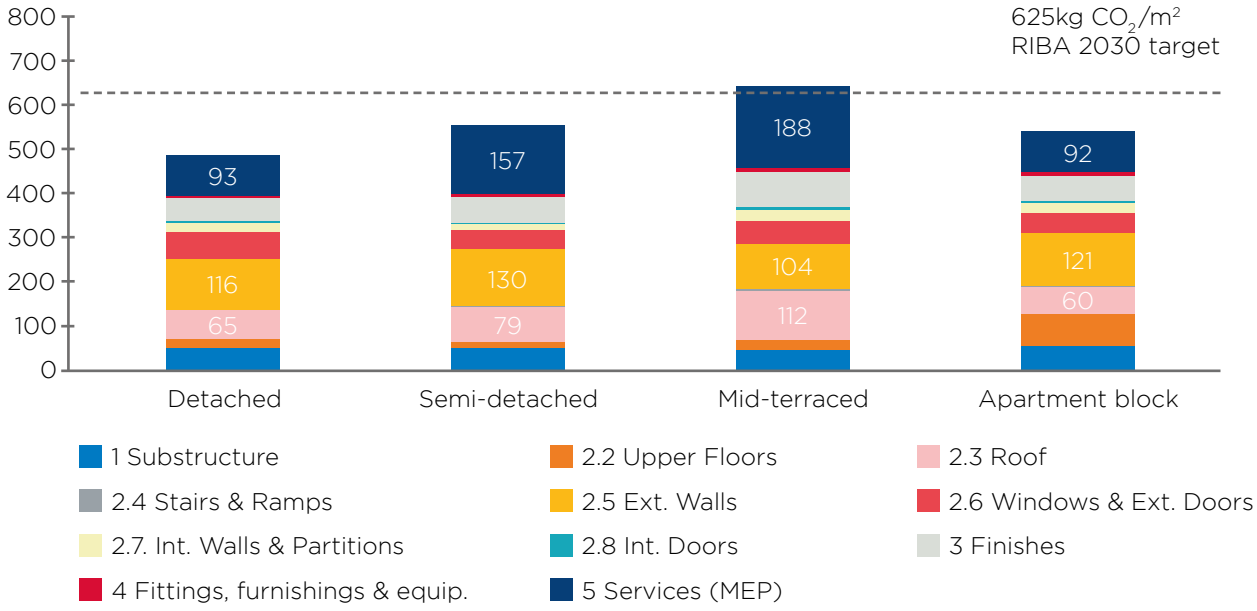


Figure 2 Summary of results of the total embodied carbon for the chosen option of the different dwelling types
Visualisations are indicative only



Introduction

Methodology

The calculation methodology follows the RICS Professional Statement (PS) for undertaking detailed carbon assessments. The RICS Whole Life Carbon Assessment for the Built Environment (2017) follows the European standard EN 15978.

Software

The tool used for this assessment is the Bionova OneClick LCA tool, which is BRE certified & ensures each EPD included in their database is independently verified. The embodied carbon was calculated based on estimations and material specifications provided by the design team.

Metrics

The metric used for quantifying the embodied carbon is kilogrammes of CO_2 equivalent ($kgCO_2eq$). This has been normalised in $kgCO_2eq$ per m^2 floor area.

For example, the floor area used for the analysis of the semi-detached house type is 98.9 m^2. This area was measured based on the drawings provided by the design team (November 2020).

The calculation period for the assessment has been considered to be 60 years for the buildings, which has an impact on the B4 Replacement stage emissions.

Modelling Parameters

OneClickLCA allows the use of a number of different calculation parameters as part of the assessment. These parameters are a set of calculation rules which apply different default values to the project. Altering these parameters can result in a different outcome for the assessment.

For the purposes of this project the following parameters were utilised:

- Service Life values ––'Technical service life', which represents how long the project materials last in good conditions and is recommended by default (B4-B5 category).
- Transportation distance ––'UK GLA', provides transport distances for project materials appropriate to the UK.
- Material localisation ––'v.1.0 (recommended)', this is the recommended setting for localizing the projects building materials to take account of the energy profile for the UK by adjusting manufacturing electricity to the UK energy mix.
- End of life calculation ––'Material locked (recommended)'. This calculation method influences the C1-C4 and D phase emissions.

Building Elements

The RICS PS outlines the building elements that should be included in a whole life carbon assessment. The building elements considered for the assessment are included in Table 1.

Most of the building elements have been included in the assessment. A Quantity Surveyor was appointed to provide all relevant information for each of the dwelling types. Only the external areas have been excluded from the assessment.

Table 1
Building elements scope

	Building part/Element group	Building element	Included
1	Substructure	1.1 Substructure	Y
2	Superstructure	2.1 Frame	Y
		2.2 Upper floors incl. balconies	Y
		2.3 Roof	Y
		2.4 Stairs and ramps	Y
		2.5 External walls	Y
		2.6 Windows and external doors	Y
		2.7 Internal Walls and partitions	Y
		2.8 Internal doors	Y
3	Finishes	3.1 Wall finishes	Y
		3.2 Floor finishes	Y
		3.3 Ceiling finishes	Y
4	Fittings, furnishings and equipment	4.1 Fittings, Furnishings & Equipment incl. Building-related* and Non-building related**	Y
5	Building services	5.1 - 5.14 Services	Y
6	Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building unit	N/A
7	Work to existing building	7.1 Minor demolition and alteration works	N/A
8	External works	8.1 - 8.8 External works	N

* Building related items: Building-integrated technical systems and furniture, fittings and fixtures built into the fabric. Building-related MEP and FF&E typically include the items classified under Shell and core and Category A fit-out.
** Non-building related items: Loose furniture, fittings and other technical equipment like desks, chairs, computers, refrigerators, etc. Such items are usually part of Category B fit out.

Introduction

Life Cycle Stages

The life cycle stages covered by the RICS methodology refer to EN 15978, which includes a modular approach to a built asset's life cycle, breaking it down into different stages. The five main modules are:

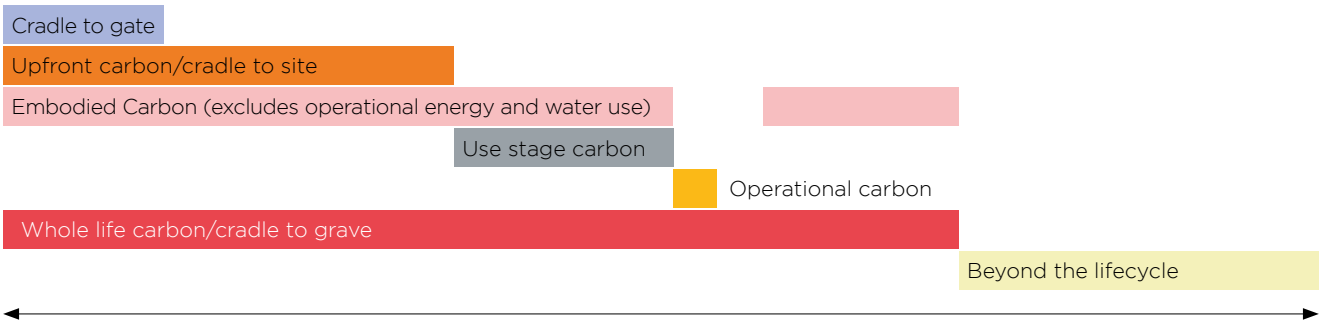
- Product stage [A1 – A3] covers the cradle to gate processes, including raw material supply, transport and manufacturing of constituent building materials.
- Construction Process stage [A4 – A5] these modules cover the transportation of the building material components and products from the factory gate to the project site and their assembly into a building.
- Use stage [B1 – B7] the emissions associated with the operation of the built asset from practical completion to end of service life. This includes the emissions associated with the refrigerant leakage of any heat pump or cooling equipment.
- End of Life stage [C1 – C4] decommissioning, strip out, disassembly, deconstruction and demolition operations at the building's end of life; including the transport and processing of these materials.
- Module D consists of the potential environmental benefits or burdens of materials beyond the life of the project. This is usually reported separately to the cradle to grave modules [A – C].

This analysis includes all life cycle stages corresponding to the Embodied Carbon of the building (A 1 D) referenced in Figure 3.

However, emissions produced from the operational energy and water use (B6 & B7) are excluded.

Figure 3 Life cycle stages (modules) according to EN 15978 and terminology of carbon emissions scopes. Visualisations are indicative only

Product Stage			Construction Process Stage		Use Stage							End-of-Life Stage				Benefits/Loads beyond the system		
Raw material supply	Transport	Manufacturing	Transport to building site	Construction installation process	Use/application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/demolition	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D



* This study accounts for embodied carbon at all stages A1 - D inclusive on Table 1

Introduction

RIBA 2030 Climate Challenge

In response to the climate emergency, the RIBA 2030 Climate Challenge has been developed to help leaders in the construction industry to meet zero whole life carbon for new and retrofitted buildings by 2030. It sets target metrics to adopt in order to reduce operational energy, embodied carbon and potable water.

For domestic buildings, the total embodied carbon should be less than 625kgCO_2eq per m^2. The embodied carbon of all of the dwelling types has been estimated and compared against the target.

A proposed Improved specification of materials was developed to further reduce the embodied carbon. Additionally, three different building services options were also assessed to compare the embodied carbon of the dwellings with each option.

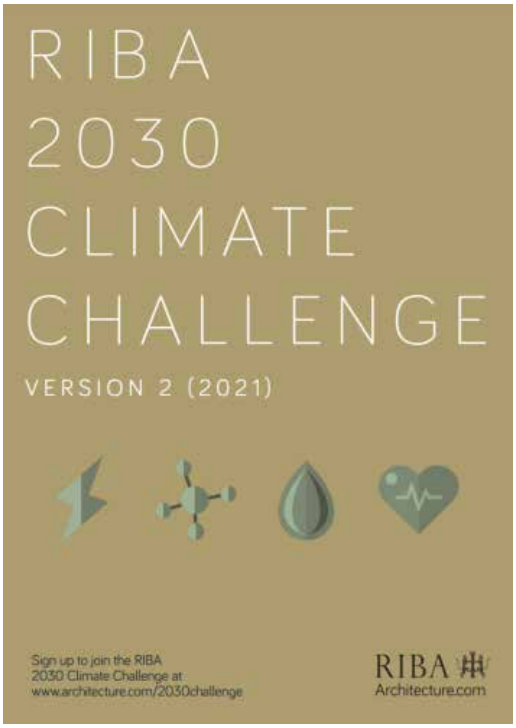
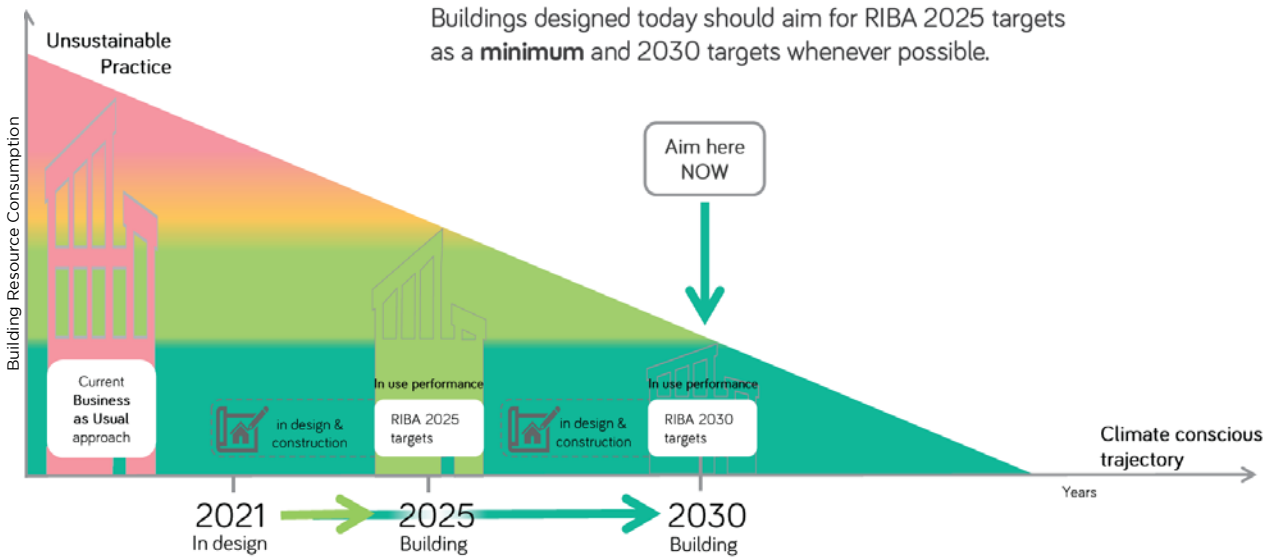


Figure 4 RIBA 2030 Climate Challenge v2 (June 2021)



RIBA Sustainable Outcome Metrics	Business as Usual	2025 Targets	2030 Targets	Notes
Operational Energy kWh/m²/y	120 kWh/m²/y	< 60 kWh/m²/y	< 35 kWh/m²/y	Targets based on GIA. Figures include regulated & unregulated energy consumption irrespective of source (grid/renewables). BAU based on median all electric across housing typologies in CIBSE benchmarking tool. 1. Use a 'Fabric First' approach 2. Minimise energy demand. Use efficient services and low carbon heat 3. Maximise onsite renewables
Embodied Carbon kgCO2e/m²	1200 kgCO₂e/m²	< 800 kgCO₂e/m²	< 625 kgCO₂e/m²	Use RICS Whole Life Carbon (modules A1-A5, B1-B5, C1-C4 incl sequestration). Analysis should include minimum of 95% of cost, include substructure, superstructure, finishes, fixed FF&E, building services and associated refrigerant leakage. 1. Whole Life Carbon Analysis 2. Use circular economy strategies 3. Minimise offsetting and use as last resort (accredited and verifiable) BAU aligned with LETI band E; 2025 target aligned with LETI band C and 2030 target aligned with LETI band B.
Potable Water Use Litres/person/day	125 l/p/day (Building Regulations England and Wales)	< 95 l/p/day	< 75 l/p/day	CIBSE Guide G.

Dwelling Types

In order to aid the understanding of embodied carbon calculations, four dwelling types were assessed.

The four dwellings that were assessed were:

1. Detached house
2. Semi-detached house
3. Mid-terraced house
4. Apartment block

Figure 5 shows the Gross Internal Area (GIA) of each of the dwellings and the drawings that were used to quantify the materials.

The house types are 2 to 3-storey high homes which share a similar internal distribution and construction system. The apartment block is a 4-storey high building with 16 dwellings, 4 per floor.

Figure 5
Dwelling types

Detached house
GIA 186.1m²

Mid-terraced house
GIA 82.4m²

Semi-detached house
GIA 98.9m²

Apartment block
GIA 1724m²

Baseline Specification

The embodied carbon was initially calculated using a Baseline specification consisting of materials that are currently commonly specified, but tend to be carbon-intensive.

House types

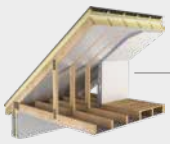
Figure 6 shows the Baseline specification for the Detached house which is consistent across the other two house types. The construction system consists of concrete strip foundations (CEM I) and precast concrete slab for the ground floor, cement screed and the generic PIR insulation. The upper floor consists of a timber floor with 200x75mm timber joists and 400mm centres.

The roof is made of prefabricated roof trusses with concrete roof tiles and generic PIR insulation above and between the rafters. The cavity walls have generic PIR cavity wall insulation and the internal walls consist of 75x50mm timber studding and blockwork in some areas.

Apartment block

The Baseline case for the Apartment block has a similar specification as the houses. CEM I Concrete strip foundations and precast concrete slab at the ground floor with generic PIR insulation. The upper slabs & roof are also 150mm concrete planks with cement screed & generic PIR in the roof. The external walls are blockwork walls with generic PIR cavity wall insulation and the internal walls are 100mm metal stud partitions and blockwork around the lift shaft.

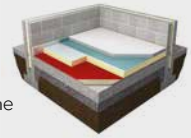
Figure 6 Baseline specification of Detached house type



Roof
16mm concrete roof tiles on timber battens
Sto render to dormer
Prefab roof trusses
100 x 50 s/w timber to roof structure
80mm Generic PIR insulation above rafters
100mm Generic PIR insulation between rafters
18mm WPB plywood sheathing

Upper Floors
Carpet flooring (bedrooms/corridors)
20mm flooring grade/chipboard
200mm quilt insulation to timber floors
250 x 75 timber floor joists at 400 centres

Ground Floor
Vinyl flooring (kitchen)
75mm cement screed
150mm Generic PIR insulation
1200 gauge damp proof membrane
150mm concrete slab



Windows & Glazed doors
uPVC framed double-glazed windows & doors

External Walls
Half brick wall in clay facing bricks
125mm Generic PIR cavity wall insulation
100mm blockwork walls in cement mortar (1:3)
Damp proof course
Mineral wool cavity closer
12.5mm plasterboard and 3mm skim coat

Internal Walls
100mm blockwork walls in cement mortar (1:3)
75 x 50 s/w timber studding
75mm mineral wool insulation
12.5mm fireline board
12.5mm plasterboard and 3mm skim coat

Foundations
100mm blockwork walls in cement mortar (1:3)
Imported hardcore in filling
C15 concrete in cavity filling
C35 concrete strip foundations - 900 x 300 for cavity wall and 600 x 300 for internal block walls

Improved Specification

The most contributing materials were identified and an Improved specification was chosen and calculated using verified EPDs. This included Unilin insulation, with the aim of reducing the embodied carbon of each dwelling type to reach the embodied carbon targets.

House types

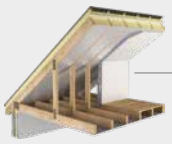
Figure 7 shows the Improved specification for the Detached house. The same specification was used across the other two house types. The concrete used in the strip foundations was replaced with a cement mix with 70% Ground Granulated Blast furnace Slag (GGBS). The generic PIR specification was replaced with the specific Unilin Insulation alternatives in the floor, wall & roof. The cement screed in the ground floor slab was replaced with calcium sulphate screed. The construction of the roof remained the same but the concrete roof tiles were replaced with slate roof tiles.

The blockwork in the cavity walls and some partition walls was replaced with a generic precast block based upon an EPD produced by the British Pre-cast Concrete Federation (BPCF).

Apartment block

The concrete in the foundations was also replaced with a mix with 70% GGBS. The cement screed in the ground, upper floor slabs and roof was replaced with calcium sulphate screed and 200mm Unilin Flat Roof Insulation in the roof. The blockwork in the cavity walls and lift shaft was replaced with a generic precast block by the BPCF and the metal studs found in the partitions were replaced with timber stud walls.

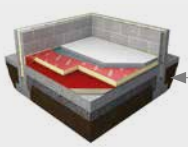
Figure 7 Improved specification of Detached house type



Roof
5mm Slate roof tiles on timber battens
Sto render to dormer
Prefab roof trusses
100 x 50 s/w timber to roof structure
80mm Thin-R PIR insulation above rafters
100mm Thin-R PIR insulation between rafters
18mm WPB plywood sheathing

Upper Floors
Carpet flooring with high recycled content
20mm flooring grade/chipboard
200mm quilt insulation to timber floors
250 x 75 timber floor joists at 400 centres

Ground Floor
Resilient lineleum flooring (kitchen)
75mm calcium sulphate screed
150mm Thin-R Hyfloor
1200 gauge damp proof membrane
150mm concrete slab



Windows & Glazed doors
uPVC framed double-glazed windows & doors

External Walls
Half brick wall in clay facing bricks
125mm CT/PIR cavity wall insulation
100mm Precast concrete blockwork by British Precast Concrete Federation
Damp proof course
Mineral wool cavity closer
12.5mm plasterboard and 3mm skim coat

Internal Walls
100mm Precast concrete block by British Precast Concrete Federation
75 x 50 s/w timber studding
75mm mineral wool insulation
12.5mm fireline board
12.5mm plasterboard and 3mm skim coat

Foundations
100mm Precast concrete blockwork by British Precast Concrete Federation
Imported hardcore in filling
C15 concrete with 70% GGBS
C35 concrete strip foundations with 70% GGBS

Building Service Options

Building services options appraisal

An options appraisal of three different space heating and domestic hot water (DHW) systems was carried out to compare the impact on the embodied carbon of the dwelling.

The building services were modelled based on high level estimates and approximate quantities as the M&E design has not been developed for the house type. The improved materials specifications remained the same to ensure consistency throughout.

The three options are listed below and the description of the items included under each option is shown on the right:

1. Air Source Heat Pump (ASHP)
2. Mechanical ventilation with heat recovery (MVHR) & passive heating
3. Electric heaters

It is worth noting that option 2 is based on Passivhaus principles. The fabric performance for all elements is at minimum 0.15W/m^{2}k which correlates with the recommended Passivhaus backstop U-Values.

Option 3 – Electric heaters represent an alternative design to what is typically specified. As with all designs, consideration would be required to ensure it is line with other RIBA targets.

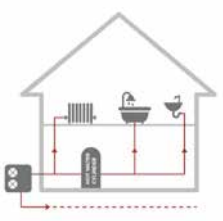


Figure 8
Option 1 - ASHP

Air Source Heat Pump (ASHP)
ASHP supplies space heating and DHW. Includes the following:

- Air-to-water ASHP 5kW
- Refrigerant leakage
- Heat distribution piping network & radiators (6 no.)
- 150-200L hot water cylinder
- Water supply piping network

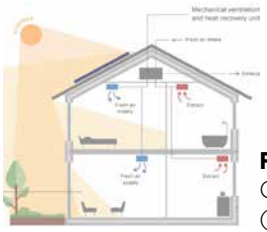


Figure 9
Option 2 - MVHR (Passive solar heating)

Mechanical ventilation with heat recovery (MVHR) & passive heating
MVHR to provide ventilation with heat recovery. Electric water heater to provide DWH. Includes the following:

- Centralised MVHR unit (690m3/h)
- PVC ductwork for ventilation (supply & return)
- 150-200L electric water cylinder
- Water supply piping network

Figure 10
Option 3 - Electric heaters

Electric heaters
Electric heaters to provide space heating. Electric water heater to provide DWH. Includes the following:

- Electric heaters*
- 150-200L electric water cylinder
- Water supply piping network

*Electric heaters were modelled as electric radiators due to limitations of the software.

Building Service Options

Building services options appraisal

The results of the building services options appraisal are shown in the graph below.

The results indicate that the lowest embodied carbon option would be the passive heating option with only an MVHR as it only requires the ventilation unit and PVC ductwork. It does not include any heat distribution piping network, heat pump or refrigerant leakage.

The embodied carbon associated with each of the MEP services follow a similar trend depending on the dwelling construction. While the MVHR is the best performing in this study, each option would appear to represent a viable solution based on the obtained results.

Refrigerant leakage

The emissions produced by the refrigerant found in ASHPs during the In Use phase are a main contributor to the total embodied carbon. Hence, it is important to specify refrigerants with low Global Warming Potential (GWP) to minimise the emissions produced at this stage (Table 2).

The refrigerant assumed for the Baseline case was taken from a 5kW Daikin ASHP with 1.3kg of R410A refrigerant charge. For the Improved scenario, the manufacturer confirmed that the refrigerant could be replaced by 3kg of R32, a refrigerant with a lower GWP. The emissions associated with the refrigerant leakage dropped significantly from 48.1 to 35.9kgCO_2/m^2.

Figure 11 Comparison of total embodied carbon of the servicing options (Detached house)
Visualisations are indicative only

Detached House Building Service Options

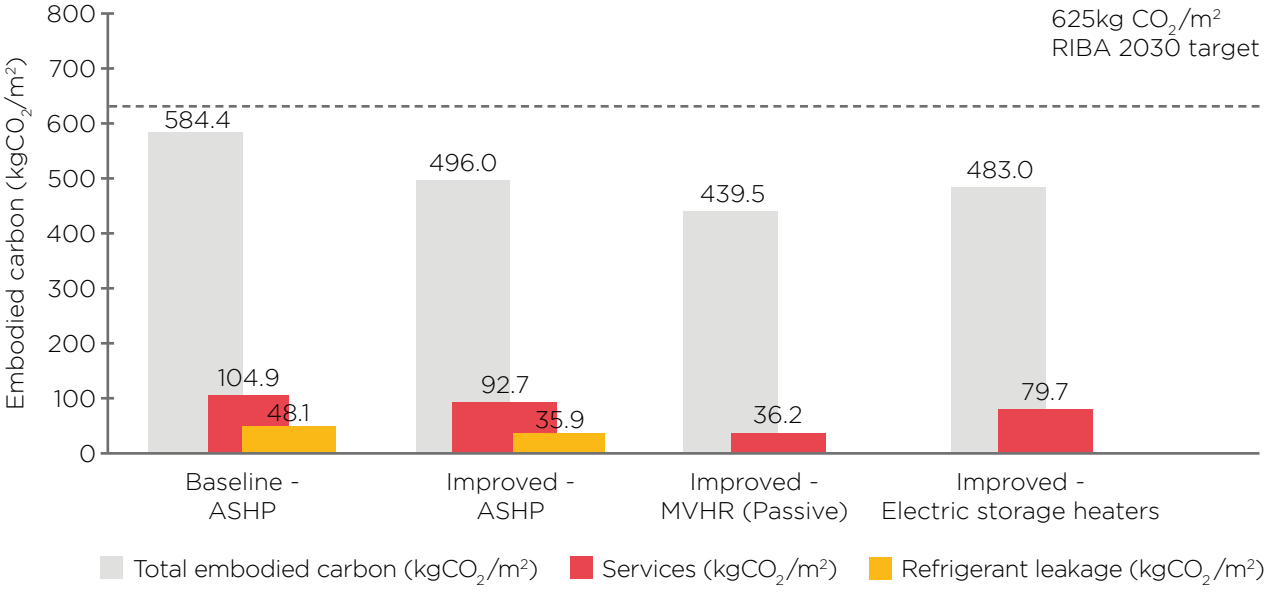


Table 2
Environmental impact of refrigerants

Type	Product R-Number	ODP[1]		GWP[2]	
Natural	717	0	Zero	0	Zero
Natural	744	0	Zero	1	Low
Natural	1270	0	Zero	2	Low
Natural	290	0	Zero	3	Low
Natural	600a	0	Zero	3	Low
Natural	1150	0	Zero	4	Low
HFO	1234yf	0	Zero	4	Low
HFO	1234ze	0	Zero	6	Low
Natural	170	0	Zero	6	Low
HFC	32	0	Zero	675	Medium
HFC	134a	0	Zero	1430	Medium
HFC	407C	0	Zero	1774	Medium
HFC	437A	0	Zero	1805	Medium
HFC	407F	0	Zero	1825	Medium
HFC	442A	0	Zero	1888	Medium
HFC	410A	0	Zero	2088	Medium
HFC	407A	0	Zero	2107	Medium
HFC	427A	0	Zero	2138	Medium
HFC	438A	0	Zero	2265	Medium
HFC	423A	0	Zero	2280	Medium
HFC	417A	0	Zero	2346	Medium
HFC	424A	0	Zero	2440	Medium
HFC	422D	0	Zero	2729	High
HFC	422A	0	Zero	3143	High
HFC	434A	0	Zero	3245	High
HFC	428A	0	Zero	3607	High
HFC	M089	0	Zero	3805	High
HFC	404A	0	Zero	3922	High
HFC	507A	0	Zero	3985	High
HFC	508B	0	Zero	13396	High
HFC	23	0	Zero	14800	High
HCFC	123	0,060	Medium	77	Low
HCFC	402B	0,030	Medium	2416	Medium
HCFC	401A	0,033	Medium	1182	Medium
HCFC	401B	0,036	Medium	1288	Medium
HCFC	409A	0,046	Medium	1909	Medium
HCFC	22	0,055	Medium	1810	Medium
HCFC	402A	0,019	Medium	2788	High
HCFC	408A	0,024	Medium	3152	High

ODP Band	Montreal Protocol Impact
Zero	No restriction
Medium	Subject to consumption phase down
High	100% global production & consumption ban

GWP band	
Less than 150	Low
150-2500	Medium
Greater than 2500	High

EU F-Gas 2 Impact[3]

No controls
Some supply restrictions and new equipment use bans
Substantial supply and use restrictions and new equipment bans

Results - Detached House Type

Baseline case

The embodied carbon of the Detached house type shows an initial result of 584.4kgCO_2/m^2 with the Baseline specification of materials.

Appendix B shows the breakdown of the embodied carbon by life cycle stage. The Product stage (A1-A3) shows the largest contribution with 50%. Also worth noting is the B1 Use phase, which shows that the refrigerant leakage of the ASHP is contributing to 8% of the overall embodied carbon.

The ten most contributing Resource types have been identified and are listed below:

1. Installations and systems
2. Precast concrete
3. Insulation
4. Doors and windows
5. Bricks and ceramics
6. Flooring
7. Ready-mix concrete
8. Wood
9. Gypsum and plaster
10. Other resource types

The above listed resource types represent a range of different materials. For instance, 'installations and systems' is composed of the consentient parts that form the basis of the residences building services (i.e ASHP, radiators, pipes, boiler etc).

Improved case

The embodied carbon of the Detached house type was calculated with the Improved specification of materials which shows a notable reduction of 15% against the Baseline case with a total of 496kgCO_2/m^2.

Figure 12 shows the reduction from the Baseline of the main building categories with the Improved specification.

Building services options

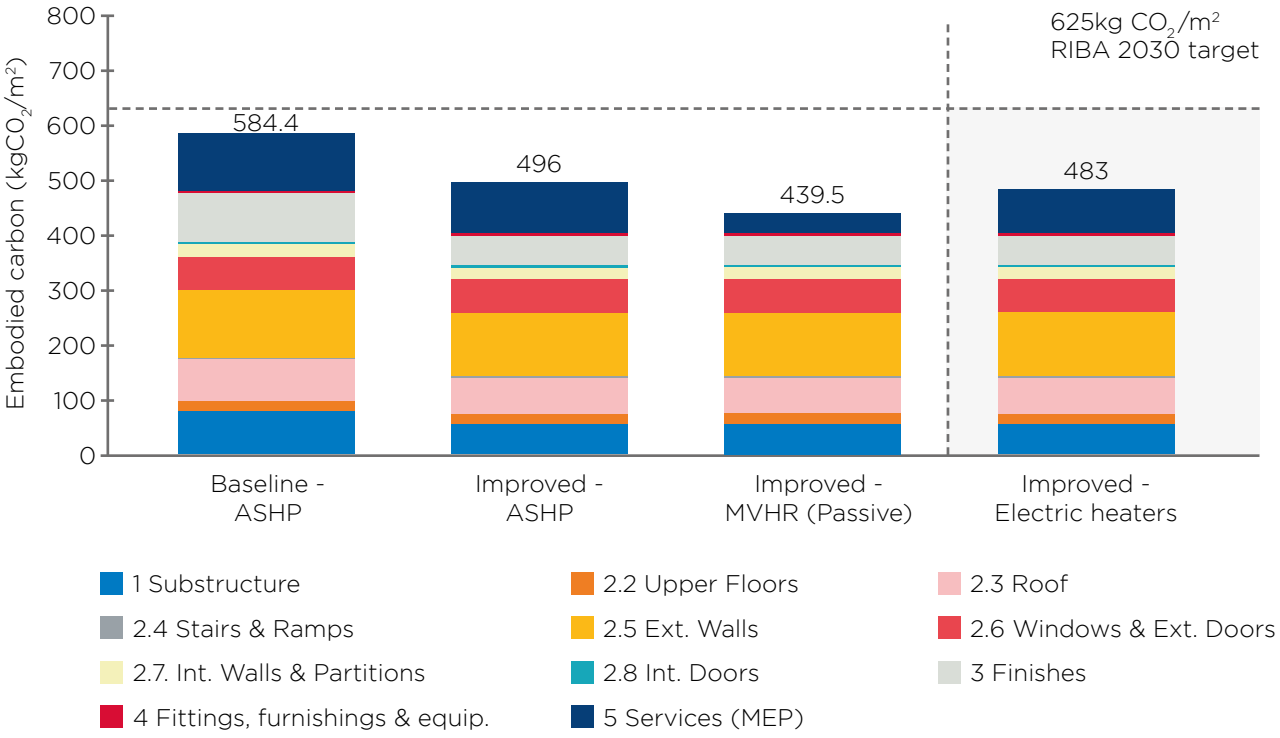
Figure 12 shows the comparison of the different building services options. The results show that the MVHR option would further reduce the embodied carbon with the Improved specification of building materials to 439.5kgCO_2/m^2 which is a 25% reduction from the Baseline. The electric heaters option would result in a total embodied carbon of 483kgCO_2/m^2 which is a reduction of 17% from the Baseline.

Biogenic Carbon

The biogenic carbon stored (sequestered) in timber elements has been deducted. The subtraction of it has resulted in -96.19kgCO_2/m^2 of the embodied carbon for the Baseline and of -96.37kgCO_2/m^2 for all the remaining options.

Figure 12 Breakdown of embodied carbon for each of the servicing options
Visualisations are indicative only

Embodied carbon of Detached house-type options



Results - Semi-Detached House Type

Baseline case

The embodied carbon of the Semi-detached house type shows an initial result of 660.3kgCO_2/m^2 with the Baseline specification of materials.

Appendix B shows the breakdown of the embodied carbon by life cycle stage. The Product stage (A1-A3) shows the largest contribution with 43%. Also worth noting is the B1 Use phase, which shows that the refrigerant leakage of the ASHP is contributing to 14% of the overall embodied carbon.

The ten most contributing resource types have been identified and are listed below:

1. Installations and systems
2. Insulation
3. Precast concrete
4. Flooring
5. Bricks & ceramics
6. Doors & windows
7. Wood
8. Gypsum & plaster
9. Ready-mix concrete
10. Other resource types

The above listed resource types represent a range of different materials. For instance, 'installations and systems' is composed of the consentient parts that form the basis of the residences building services (i.e ASHP, radiators, pipes, boiler etc).

Improved case

The embodied carbon of the semi-detached house type was calculated with the Improved specification of materials which shows a reduction of 15% against the Baseline case with a total of 564.1kgCO_2/m^2.

An option modelling the improved case ASHP with a timber frame wall would result in a reduction of the embodied carbon of 17% against the Baseline case with a total of 548.2kgCO_2/m^2. A comparison between the 2 improved ASHP models can be found in appendix B.

Figure 13 shows the reduction from the Baseline of the main building categories with the Improved specification.

Building services options

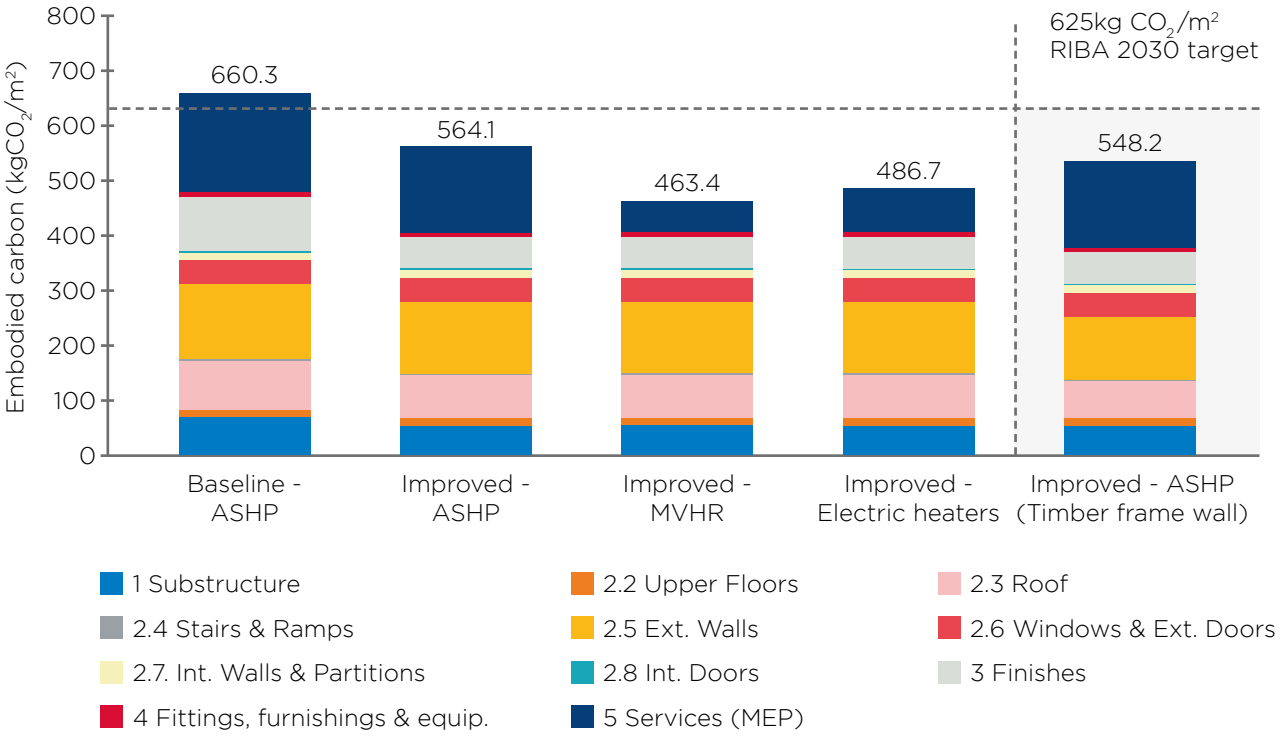
Figure 13 shows the comparison of the different building services options. The results show that the MVHR option would further reduce the embodied carbon with the Improved specification of building materials to 463.4kgCO_2/m^2 which is a 30% reduction from the Baseline. The electric heaters option would result in a total embodied carbon of 486.7kgCO_2/m^2 which is a reduction of 26% from the Baseline.

Biogenic Carbon

The biogenic carbon stored (sequestered) in timber elements has been deducted. The subtraction of it has resulted in -72.80kgCO_2/m^2 of the embodied carbon for the Baseline and of -73.02kgCO_2/m^2 for the MVHR and electric heater options. The biogenic carbon redacted from the Improved ASHP with the timber frame walls option has resulted in -108.71kgCO_2/m^2 of the embodied carbon. This is due to the increased use of timber.

Figure 13 Breakdown of embodied carbon for each of the servicing options
Visualisations are indicative only

Embodied carbon of Semi-detached house type options



Results - Mid-Terraced House Type

Baseline case

The embodied carbon of the Mid-terraced house type shows an initial result of 773.8kgCO_2/m^2 with the Baseline specification of materials.

Appendix B shows the breakdown of the embodied carbon by life cycle stage. The Product stage (A1-A3) shows the largest contribution with 39%. Also worth noting is the B1 Use phase, which shows that the refrigerant leakage of the ASHP is contributing to 14% of the overall embodied carbon.

The ten most contributing resource types have been identified and are listed below:

1. Installations & systems
2. Insulation
3. Precast concrete
4. Flooring
5. Wood
6. Doors & windows
7. Gypsum & plaster
8. Plastics, membranes & roofing
9. Ready mix concrete
10. Other resource types

The above listed resource types represent a range of different materials. For instance, 'installations and systems' is composed of the consentient parts that form the basis of the residences building services (i.e ASHP, radiators, pipes, boiler etc).

Improved case

The embodied carbon of the Mid-terraced house type was calculated with the Improved specification of materials which shows a reduction of 15% against the Baseline case with a total of 657.4kgCO_2/m^2.

Figure 14 shows the reduction from the Baseline of the main building categories with the Improved specification.

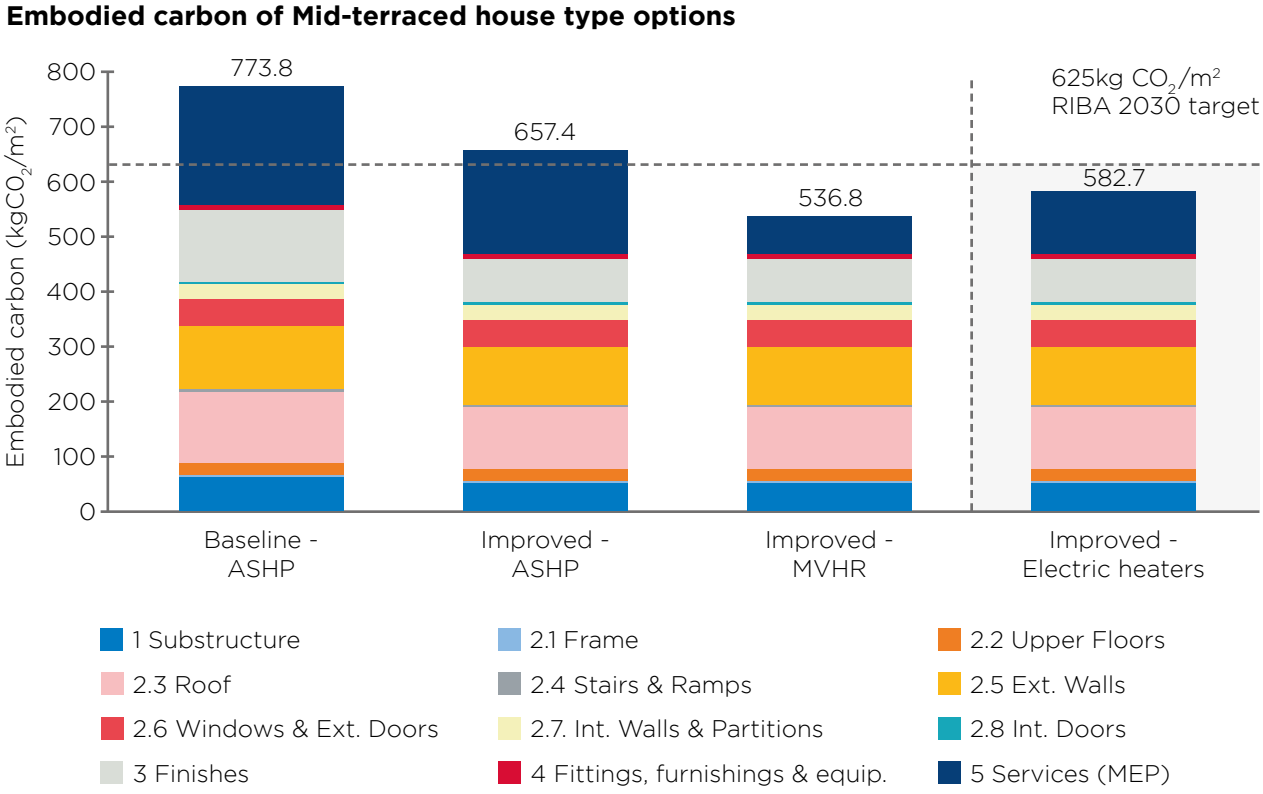
Building services options

Figure 14 shows the comparison of the different building services options. The results show that the MVHR option would further reduce the embodied carbon with the Improved specification of building materials to 536.8kgCO_2/m^2 which is a 31% reduction from the Baseline. The electric heaters option would result in a total embodied carbon of 582.7kgCO_2/m^2 which is a reduction of 25% from the Baseline.

Biogenic Carbon

The biogenic carbon stored (sequestered) in timber elements has been deducted. The subtraction of it has resulted in -133.67kgCO_2/m^2 of the embodied carbon for the Baseline and of -134.0kgCO_2/m^2 for all the remaining options.

Figure 14 Breakdown of embodied carbon for each of the servicing options
Visualisations are indicative only



Embodied carbon of Mid-terraced house type options

Results - Apartment block

Baseline case

The embodied carbon of the Apartment block shows an initial result of 649kgCO_2/m^2 with the Baseline specification of materials.

Appendix B shows the breakdown of the embodied carbon by life cycle stage. The Product stage (A1-A3) shows the largest contribution with 55%. Also worth noting is the B1 Use phase, which shows that the refrigerant leakage of the ASHP is contributing to 3% of the overall embodied carbon. This is because it was specified that 4no. 5kW ASHP would serve the whole building (1no. ASHP per 4 dwellings).

The ten most contributing resource types have been identified and are listed below:

1. Precast concrete
2. Installations and systems
3. Insulation
4. Flooring
5. Ready-mix concrete
6. Gypsum & plaster
7. Doors & windows
8. Metals
9. Plastics, membranes & roofing
10. Other resource types

The above listed resource types represent a range of different materials. For instance 'precast concrete' is composed of the various precast products in the building (concrete blocks, ground floor slab etc).

Improved case

The embodied carbon of the Apartment block house type was calculated with the Improved specification of materials which shows a reduction of 16% against the Baseline case with a total of 548.5kgCO_2/m^2.

Figure 15 shows the reduction from the Baseline of the main building categories with the Improved specification.

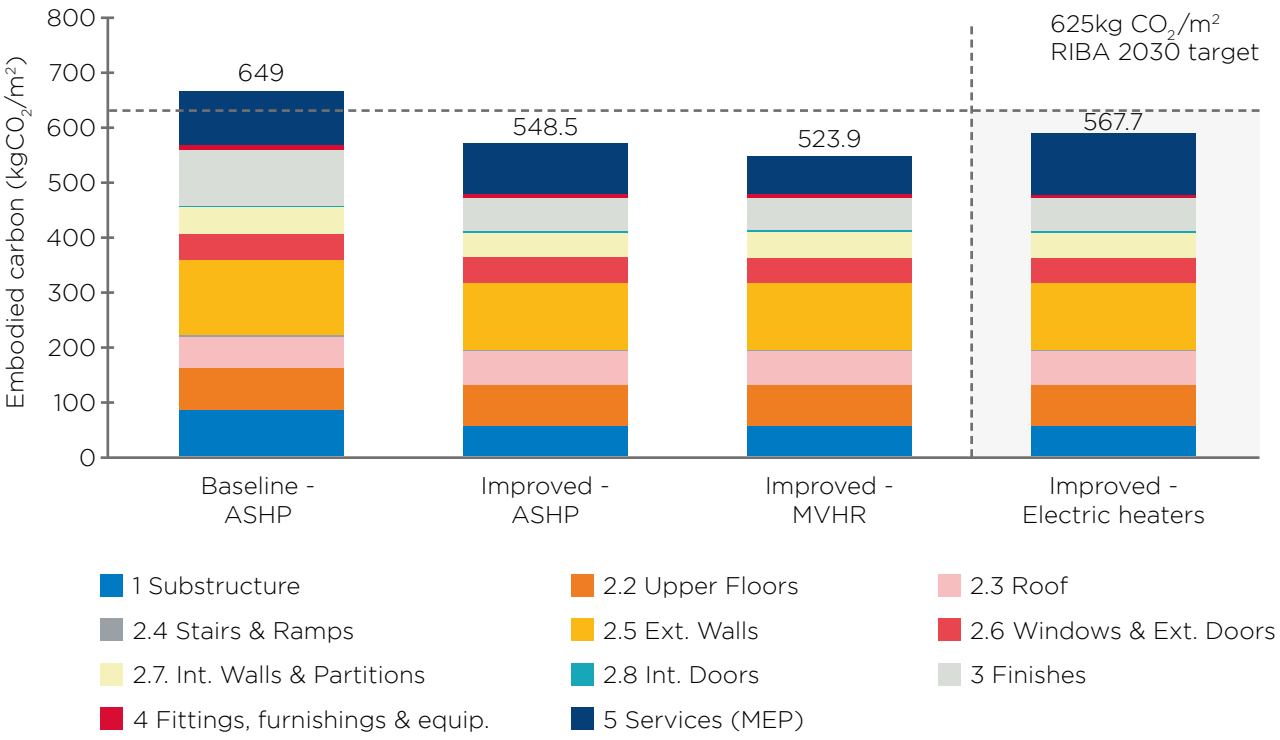
Building services options

Figure 15 shows the comparison of the different building services options. The results show that the MVHR option would further reduce the embodied carbon with the Improved specification of building materials to 523.9kgCO_2/m^2 which is a 19% reduction from the Baseline. The electric heaters option would result in a total embodied carbon of 567.7kgCO_2/m^2 which is a reduction of 13% from the Baseline.

Biogenic Carbon

The biogenic carbon stored (sequestered) in timber elements has been deducted. The subtraction of it has resulted in -0.89kgCO_2/m^2 of the embodied carbon for the Baseline and of -24.10kgCO_2/m^2 for all the remaining options. This is due to the replacement of the metal studs by timber studs in the partition walls for the Improved specification case.

Figure 15 Breakdown of embodied carbon for each of the servicing options
Visualisations are indicative only



Embodied carbon of Apartment block options

Conclusions

The life cycle assessment (LCA) of the four dwelling types was carried out using typical construction systems with the incorporation of the following Unilin insulation products:

- Unilin Insulation Thin-R for ground floors and roofs and;
- CavityTherm insulation for cavity walls

The Environmental Product Declarations (EPD) for these products were used in the assessment.

Baseline and Improved specification

The results of the LCA of the dwelling types with the Baseline specification helped identify the most contributing materials. These were then replaced by materials which are less carbon-intensive to help reduce the overall embodied carbon of the dwellings.

The use of the Improved specification ensures that the RIBA 2030 target can be met for all dwellings aside from that of the Mid-terraced House – ASHP.

Biogenic carbon sequestration

Biogenic carbon is the carbon that is stored in biological materials, such as timber. This process is commonly referred to as sequestration.

Carbon accumulates in plants through the process of photosynthesis. Therefore, wood products can contribute to reducing the levels of carbon dioxide in the atmosphere and help mitigate climate change.

When a bio-based material is used for a building product, the carbon will be stored as long as the material service life or until the end of life of the building.

For the purposes of this assessment it has been assumed that any bio-based materials present in the building design, will not be incinerated at end-of-life and therefore the biogenic carbon has been subtracted from the total embodied carbon figure.

Building services

The results of the building services options appraisal show that for all of the dwellings the passive heating option with an MVHR would be the option with the lowest embodied carbon. This is mainly because of the reduced equipment and pipework required.

It is worth noting that for this option the fabric performance of the dwellings would need to be at a premium level as demonstrated in the insulation specification of each house type. This re-emphasises the importance of a fabric first approach when combating the climate challenge.

A notable trend across all specifications and building typologies indicates that the use of an ASHP system comes with a higher embodied carbon cost than the MVHR.

The electric heaters option while offering an improvement on the ASHP in the majority of cases would possibly not match its operational carbon performance.

Overall, the inclusion of the Unilin insulation can be seen to have a marked improvement on all dwelling types & contributes positively to each dwelling achieving the desired RIBA 2030 targets.

It should not be forgotten that it is important to balance the need to reduce the embodied carbon of a built asset against those to reduce operational carbon. Adopting a holistic approach to this and considering both in context is an important component to deciding on the correct building services option for a development.

Future developments

Life cycle assessments are still a relatively new discipline. The parameters to which the assessments are calculated are quite fluid and these background changes have a measurable influence on the results.

However, as time goes on it is expected that these will normalise & the quality and breadth of material data available through OneClickLCA will only increase.

The introduction of embodied carbon to governmental regulations, such as that proposed in the form of Part Z will only hasten the adoption of LCAs within the industry.

With this then, combined with the recent revision of the EN15804 standard to EN15804 + A2, which means EPD's will be required to declare modules C1-C4 and module D. As well as the ongoing and future decarbonisation of the UK's electrical grid, it is expected that the overall embodied carbon of the modelled dwellings will decrease with time.

Appendix. A - Detailed Results

Detached
Baseline ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	-265	12,583	715	589
2.2 Upper Floors	-8,947	2,440	28	429
2.3 Roof	-6,219	5,162	32	472
2.4 Stairs & Ramps	-598	347	4	69
2.5 Ext. Walls	0	19,711	222	967
2.6 Windows & Ext. Doors	-670	3,473	12	0
2.7 Int. Walls & Partitions	-1,106	2,835	51	233
2.8 Int. Doors	104	332	5	0
3 Finishes	-171	3,695	35	463
4 Fittings, furnishings & equipments	-30	159	1	7
5 Services (MEP)	0	3,443	162	31
TOTAL kg CO_2e	-17,901	54,181	1,269	3,259
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	1,087	14,709
0	0	0	0	9,606	3,556
0	3,817	954	1,456	8,455	14,130
0	0	0	0	632	455
0	0	0	195	1,879	22,974
0	3,392	848	3,473	719	11,247
0	0	0	1,153	1,282	4,448
0	0	0	332	28	801
0	1,415	354	9,953	341	16,085
0	0	0	635	46	819
8,955	0	0	6,887	47	19,526
8,955	8,624	2,156	24,085	24,122	108,749
					584

Appendix. A - Detailed Results

Detached
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	-265	8,448	704	441
2.2 Upper Floors	-8,947	2,440	28	429
2.3 Roof	-6,219	4,782	25	472
2.4 Stairs & Ramps	-598	347	4	69
2.5 Ext. Walls	0	18,416	190	963
2.6 Windows & Ext. Doors	-670	3,473	12	0
2.7 Int. Walls & Partitions	-1,106	2,475	42	231
2.8 Int. Doors	104	332	5	0
3 Finishes	-204	2,221	36	460
4 Fittings, furnishings & equipments	-30	159	1	7
5 Services (MEP)	0	3,443	162	31
TOTAL kg CO_2e	-17,934	46,536	1,209	3,103
TOTAL kg CO_2e/m^2				

Detached
Improved MVHR

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	2,172	161	11
TOTAL kg CO_2e	-17,934	45,264	1,208	3,084
TOTAL kg CO_2e/m^2				

Detached
Improved electric heaters

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	4,811	166	182
TOTAL kg CO_2e	-17,934	47,903	1,213	3,254
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	1,087	10,400
0	0	0	0	9,606	3,556
0	2,865	716	1,076	8,446	12,163
0	0	0	0	632	455
0	0	0	195	1,841	21,605
0	3,392	848	3,473	719	11,247
0	0	0	1,153	1,271	4,068
0	0	0	332	28	801
0	1,415	354	3,768	1,889	9,939
0	0	0	635	46	819
6,683	0	0	6,887	47	17,253
6,683	7,672	1,918	17,520	25,598	92,305
					496

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	4,344	47	6,736
0	7,672	1,918	14,977	25,598	81,787
					439

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	9,621	48	14,828
0	7,672	1,918	20,254	25,599	89,880
					483

Appendix. A - Detailed Results

Semi-detached
Baseline ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	11,779	594	494
2.2 Upper Floors	-6,008	1,864	19	306
2.3 Roof	-6,061	6,183	32	562
2.4 Stairs & Ramps	-523	318	4	64
2.5 Ext. Walls	0	21,889	216	1,111
2.6 Windows & Ext. Doors	-344	1,848	6	0
2.7 Int. Walls & Partitions	-1,294	1,088	12	149
2.8 Int. Doors	73	235	4	0
3 Finishes	-184	4,735	44	590
4 Fittings, furnishings & equipments	59	318	2	14
5 Services (MEP)	0	5,716	322	45
TOTAL kg CO_2e	-14,401	55,973	1,254	3,335
TOTAL kg CO_2e/m^2				

Semi-detached
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	9,022	584	398
2.2 Upper Floors	-6,008	1,864	19	306
2.3 Roof	-6,061	5,775	24	562
2.4 Stairs & Ramps	-523	318	4	64
2.5 Ext. Walls	0	20,588	183	1,107
2.6 Windows & Ext. Doors	-344	1,848	6	0
2.7 Int. Walls & Partitions	-1,294	1,088	12	149
2.8 Int. Doors	73	235	4	0
3 Finishes	-226	2,745	45	580
4 Fittings, furnishings & equipments	-59	318	2	14
5 Services (MEP)	0	5,716	322	45
TOTAL kg CO_2e	-14,443	49,517	1,206	3,224
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	1,065	13,931
0	0	0	0	6,451	2,632
0	5,180	1,295	1,577	8,894	17,661
0	0	0	0	557	420
0	0	0	716	3,237	27,169
0	4,184	1,046	1,848	371	8,959
0	0	0	1,088	1,439	2,483
0	0	0	235	20	566
0	1,299	325	12,421	404	19,634
0	0	0	1,270	92	1,638
17,911	0	0	11,432	94	35,521
17,911	10,663	2,666	30,588	22,623	130,613
					660

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	1,053	11,057
0	0	0	0	6,451	2,632
0	4,161	1,040	1,170	8,884	15,554
0	0	0	0	557	420
0	0	0	716	3,199	25,793
0	4,184	1,046	1,848	371	8,959
0	0	0	1,088	1,439	2,483
0	0	0	235	20	566
0	1,299	325	4,291	2,439	11,497
0	0	0	1,270	92	1,638
13,365	0	0	11,432	94	30,975
13,365	9,643	2,411	22,051	24,599	111,573
					564

Appendix. A - Detailed Results

Semi-detached
Improved MVHR

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	3,543	321	19
TOTAL kg CO_2e	-14,443	47,346	1,204	3,198
TOTAL kg CO_2e/m^2				

Semi-detached
Improved Electric Heaters

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	5,039	324	124
TOTAL kg CO_2e	-14,443	48,844	1,208	3,303
TOTAL kg CO_2e/m^2				

Semi-detached
Improved ASHP with Timber

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	9,022	584	398
2.2 Upper Floors	-6,008	1,864	19	306
2.3 Roof	-6,061	5,777	24	562
2.4 Stairs & Ramps	-523	318	4	64
2.5 Ext. Walls	-7,060	18,052	156	1,175
2.6 Windows & Ext. Doors	-344	1,848	6	0
2.7 Int. Walls & Partitions	-1,294	1,088	12	149
2.8 Int. Doors	73	235	4	0
3 Finishes	-226	2,745	45	580
4 Fittings, furnishings & equipments	-59	318	2	14
5 Services (MEP)	0	5,716	322	45
TOTAL kg CO_2e	-21,504	46,983	1,178	3,292
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	7,086	94	11,062
0	9,643	2,411	17,704	24,599	91,662
					463

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
	0	0	10,079	95	15,662
0	9,643	2,411	20,697	24,600	96,263
					487

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	1,053	11,057
0	0	0	0	6,451	2,632
0	4,161	1,040	1,170	8,884	15,556
0	0	0	0	557	420
0	0	0	716	9,620	22,658
0	4,184	1,046	1,848	371	8,959
0	0	0	1,088	1,439	2,483
0	0	0	235	20	566
0	1,299	325	4,291	2,439	11,497
0	0	0	1,270	92	1,638
13,365	0	0	11,432	94	30,975
13,365	9,643	2,411	22,051	31,020	108,440
					548

Appendix. A - Detailed Results

Mid-terraced
Baseline ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	4,383	213	182
2.1 Frame	0	307	1	10
2.2 Upper Floors	-5,454	1,143	16	234
2.3 Roof	-3,571	3,487	21	332
2.4 Stairs & Ramps	-542	326	4	65
2.5 Ext. Walls	0	7,729	99	393
2.6 Windows & Ext. Doors	-172	856	3	0
2.7 Int. Walls & Partitions	-1,163	944	10	130
2.8 Int. Doors	61	196	3	0
3 Finishes	-143	2,415	22	305
4 Fittings, furnishings & equipments	-30	159	1	7
5 Services (MEP)	0	2,858	161	24
TOTAL kg CO_2e	-11,014	24,802	553	1,682
TOTAL kg CO_2e/m^2				

Mid-terraced
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	3,478	209	152
2.1 Frame	0	307	1	10
2.2 Upper Floors	-5,454	1,143	16	234
2.3 Roof	-3,571	3,226	15	332
2.4 Stairs & Ramps	-542	326	4	65
2.5 Ext. Walls	0	6,938	79	390
2.6 Windows & Ext. Doors	-172	856	3	0
2.7 Int. Walls & Partitions	-1,163	944	10	130
2.8 Int. Doors	61	196	3	0
3 Finishes	-171	1,423	23	299
4 Fittings, furnishings & equipments	-30	159	1	7
5 Services (MEP)	0	2,858	161	24
TOTAL kg CO_2e	-11,042	21,854	525	1,643
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	442	5,220
0	0	0	0	0	318
0	0	0	0	5,852	1,791
0	3,314	829	1,077	5,116	10,603
0	0	0	0	576	428
0	0	0	0	1,189	9,410
0	1,927	482	856	185	4,137
0	0	0	944	1,291	2,156
0	0	0	196	16	471
0	746	186	6,842	275	10,647
0	0	0	635	46	819
8,955	0	0	5,716	47	17,762
8,955	5,987	1,497	16,265	15,037	63,764
					774

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	438	4,277
0	0	0	0	0	318
0	0	0	0	5,852	1,791
0	2,662	665	817	5,110	9,256
0	0	0	0	576	428
0	0	0	0	1,166	8,573
0	1,927	482	856	185	4,137
0	0	0	944	1,291	2,156
0	0	0	196	16	471
0	746	186	2,665	1,279	6,450
0	0	0	635	46	819
6,683	0	0	5,716	47	15,489
6,683	5,335	1,334	11,828	16,006	54,166
					657

Appendix. A - Detailed Results

Mid-terraced
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	1,780	160	10
TOTAL kg CO_2e	-11,042	20,777	524	1,629
TOTAL kg CO_2e/m^2				

Mid-terraced
Improved Electric Heaters

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	0	3,012	163	92
TOTAL kg CO_2e	-11,042	22,008	527	1,711
TOTAL kg CO_2e/m^2				

Apartment block
Baseline ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	134,918	7,164	5,902
2.2 Upper Floors	0	112,396	2,739	1,471
2.3 Roof	0	55,644	1,597	1,932
2.4 Stairs & Ramps	-233	2,170	28	22
2.5 Ext. Walls	0	172,535	2,010	8,173
2.6 Windows & Ext. Doors	0	18,439	52	0
2.7 Int. Walls & Partitions	0	26,290	255	1,900
2.8 Int. Doors	654	2,092	33	0
3 Finishes	-1,462	54,263	599	7,119
4 Fittings, furnishings & equipments	-472	2,541	20	113
5 Services (MEP)	-23	34,188	2,590	182
TOTAL kg CO_2e	-1,537	615,477	17,087	26,814
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	3,561	47	5,558
0	5,335	1,334	9,673	16,006	44,236
					537

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	6,024	47	9,338
0	5,335	1,334	12,136	16,007	48,015
					583

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	5,988	153,972
0	0	0	9,486	4,685	130,776
0	18,839	4,710	6,319	9,788	98,829
0	0	0		240	2,226
0	13,381	3,345	9,622	27,914	236,981
0	35,040	8,760	18,439	35	80,765
0	0	0	22,148	834	51,428
0	0	0	2,092	174	5,044
0	8,537	2,134	101,627	5,693	178,511
0	0	0	10,164	739	13,104
35,822	20,510	5,128	68,377	776	167,550
35,822	96,306	24,077	248,273	56,867	1,119,185
					649

Appendix. A - Detailed Results

Apartment block
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
1 Substructure	0	86,016	7,164	3,946
2.2 Upper Floors	0	110,856	2,739	1,271
2.3 Roof	0	60,364	1,597	2,121
2.4 Stairs & Ramps	-233	2,170	28	22
2.5 Ext. Walls	0	146,227	1,480	6,800
2.6 Windows & Ext. Doors	0	18,439	52	0
2.7 Int. Walls & Partitions	-39,067	20,652	283	2,966
2.8 Int. Doors	654	2,092	33	0
3 Finishes	-2,410	34,072	610	6,078
4 Fittings, furnishings & equipments	-472	2,541	20	113
5 Services (MEP)	-23	34,188	2,590	182
TOTAL kg CO_2e	-41,552	517,618	16,596	23,499
TOTAL kg CO_2e/m^2				

Apartment block
Improved ASHP

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	-23	29,024	2,584	76
TOTAL kg CO_2e	-41,552	512,453	16,589	23,393
TOTAL kg CO_2e/m^2				

Apartment block
Improved Electric Heaters

	Sequestered carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations
5 Services (MEP)	-23	56,872	2,680	1,482
TOTAL kg CO_2e	-41,552	540,301	16,686	24,798
TOTAL kg CO_2e/m^2				

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	0	0	0	5,988	103,114
0	0	0	9,486	4,685	129,037
0	18,839	4,710	6,319	9,788	103,737
0	0	0	0	240	2,226
0	13,381	3,345	9,622	27,285	208,140
0	35,040	8,760	18,439	35	80,765
0	0	0	13,040	42,921	40,796
0	0	0	2,092	174	5,044
0	8,537	2,134	34,158	17,957	101,136
0	0	0	10,164	739	13,104
26,730	20,510	5,128	68,377	776	158,459
26,730	96,306	24,077	171,696	110,587	945,557
					548

B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	20,510	5,128	58,047	777	116,122
0	96,306	24,077	161,366	110,588	903,220
					524

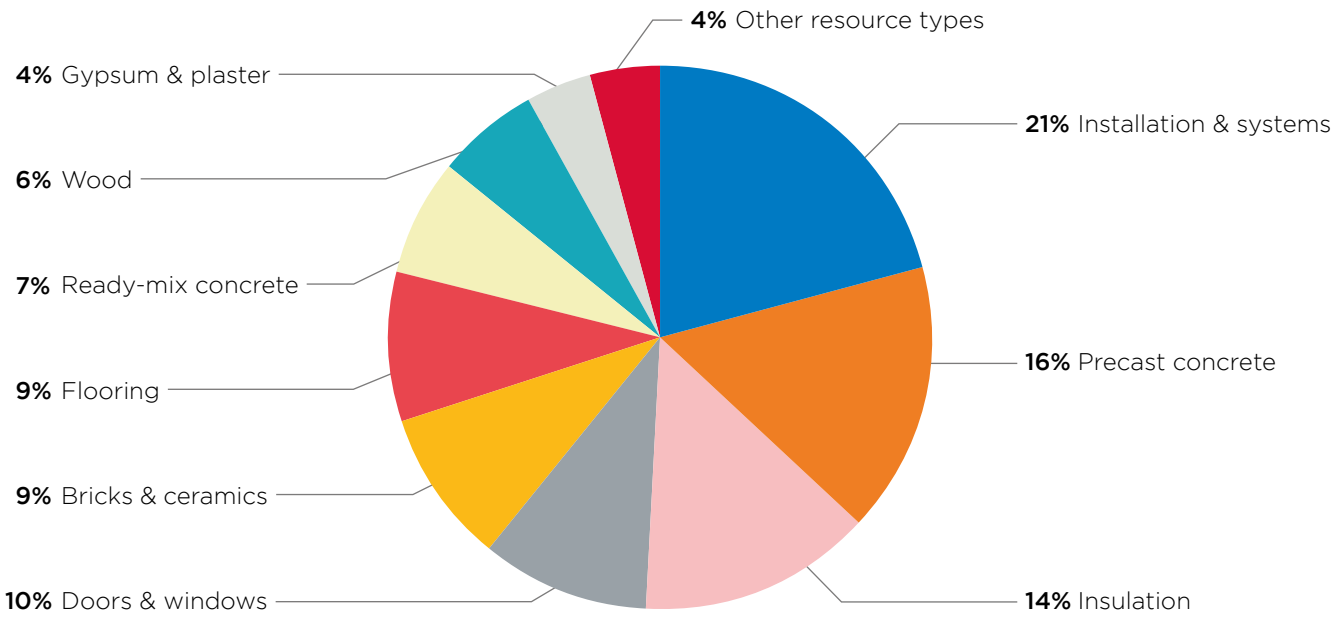
B1 Use Phase	B2 Maintenance	B3 Repair	B4-B5 Replacement	C1-C4 End of Life stage	TOTAL kg CO_2e
0	20,510	5,128	104,256	787	191,692
0	96,306	24,077	207,575	110,599	978,790
					568

Appendix. B - Detailed Results

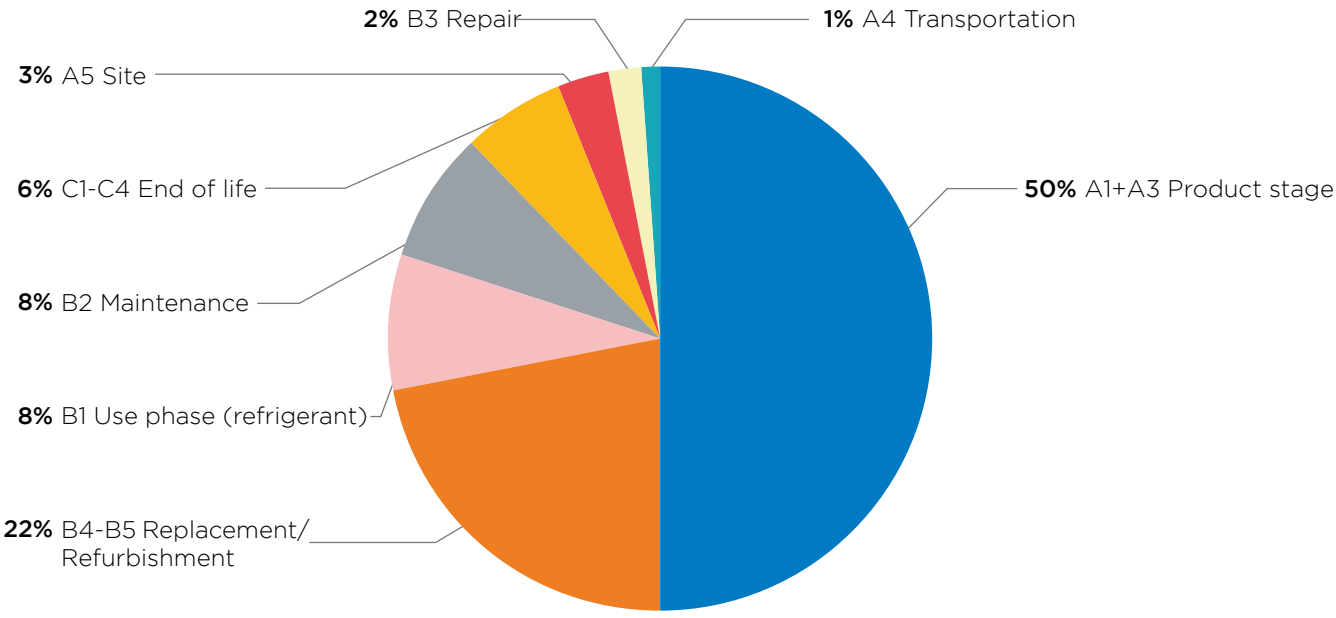
Detached House Type

Most contributing materials (Baseline)

Most contributing resource type



Total carbon lifecycle stages



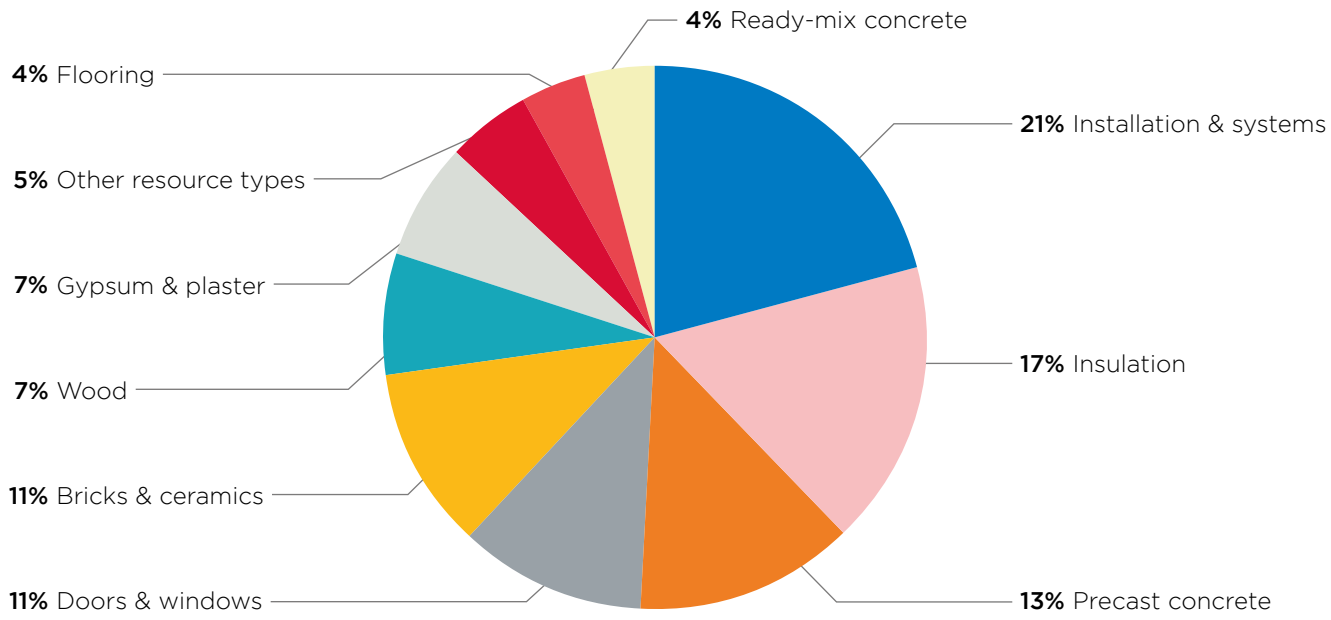
Visualisations are indicative only

Appendix. B - Detailed Results

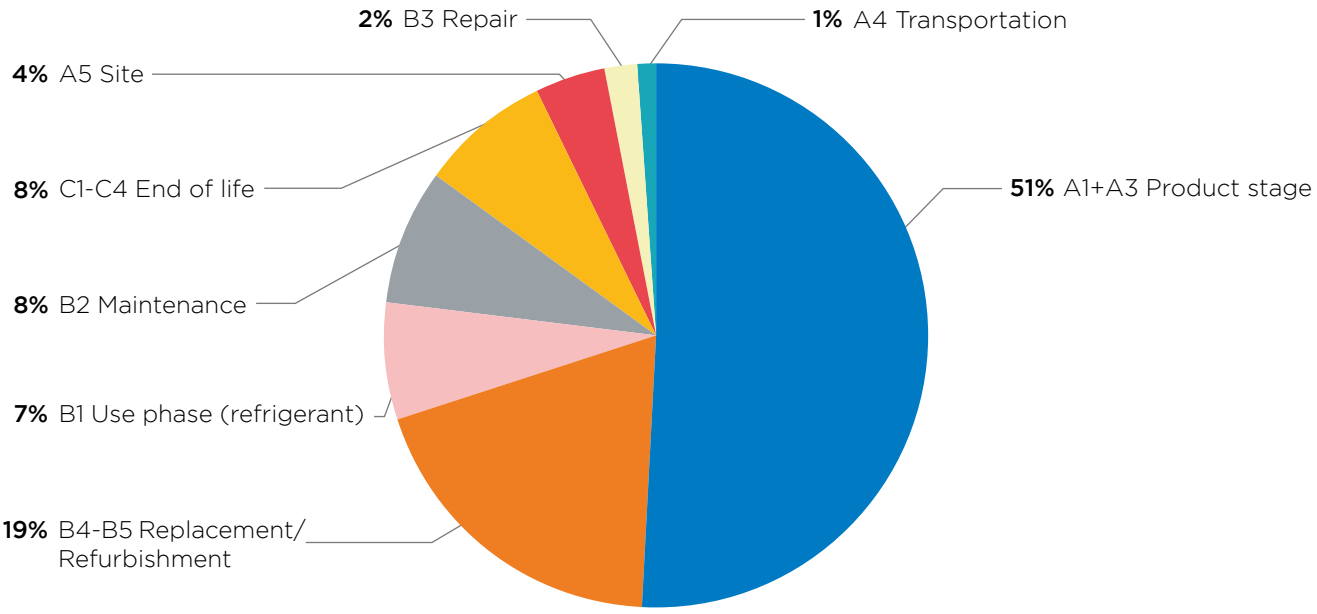
Detached House Type

Most contributing materials (Improved)

Most contributing resource type



Total carbon lifecycle stages

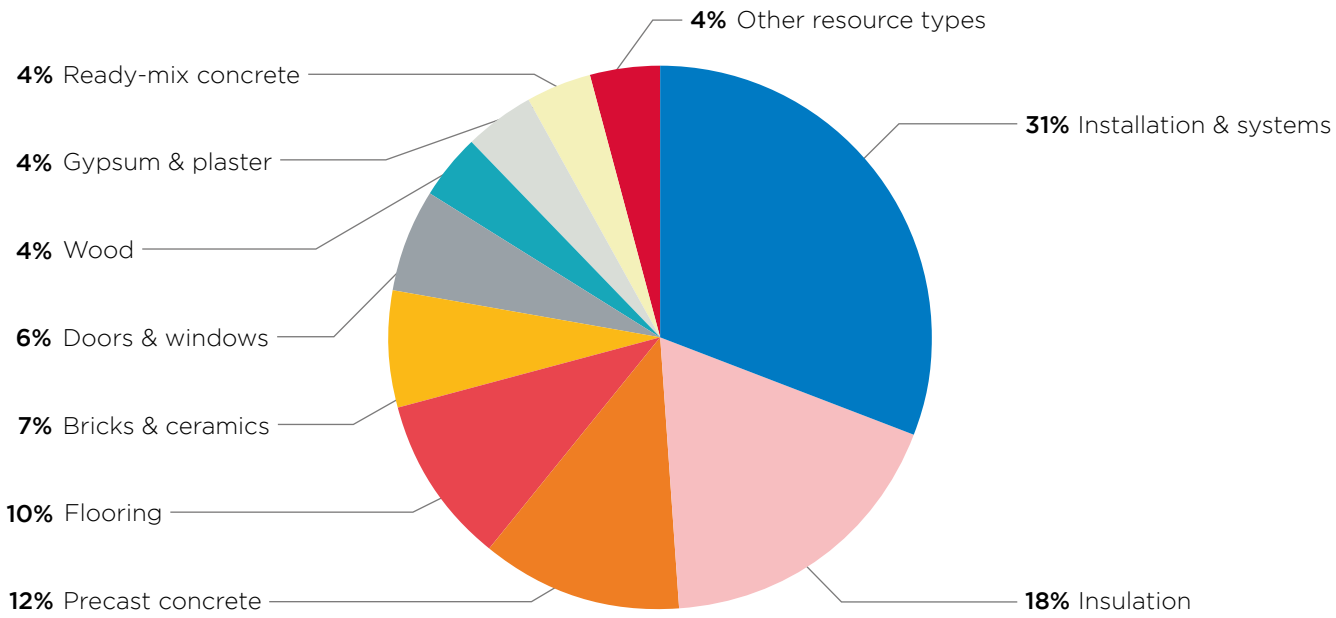


Visualisations are indicative only

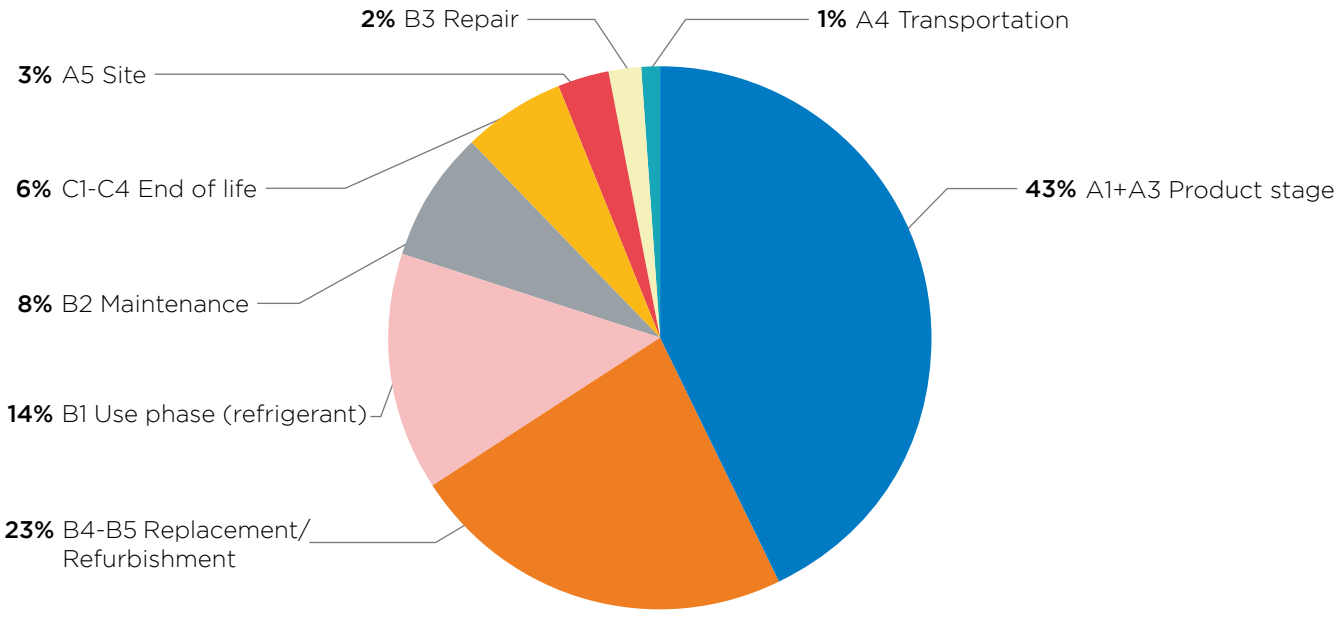
Appendix. B - Detailed Results

Semi-Detached House Type
Most contributing materials (Baseline)

Most contributing resource type



Total carbon lifecycle stages

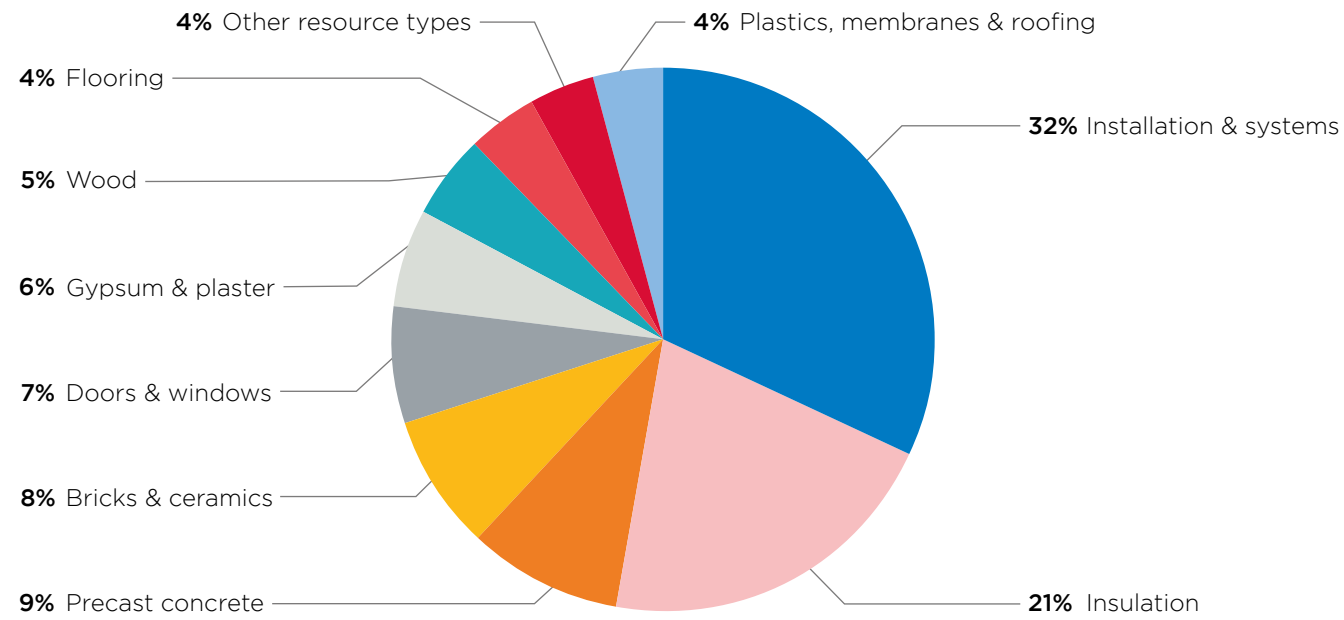


Visualisations are indicative only

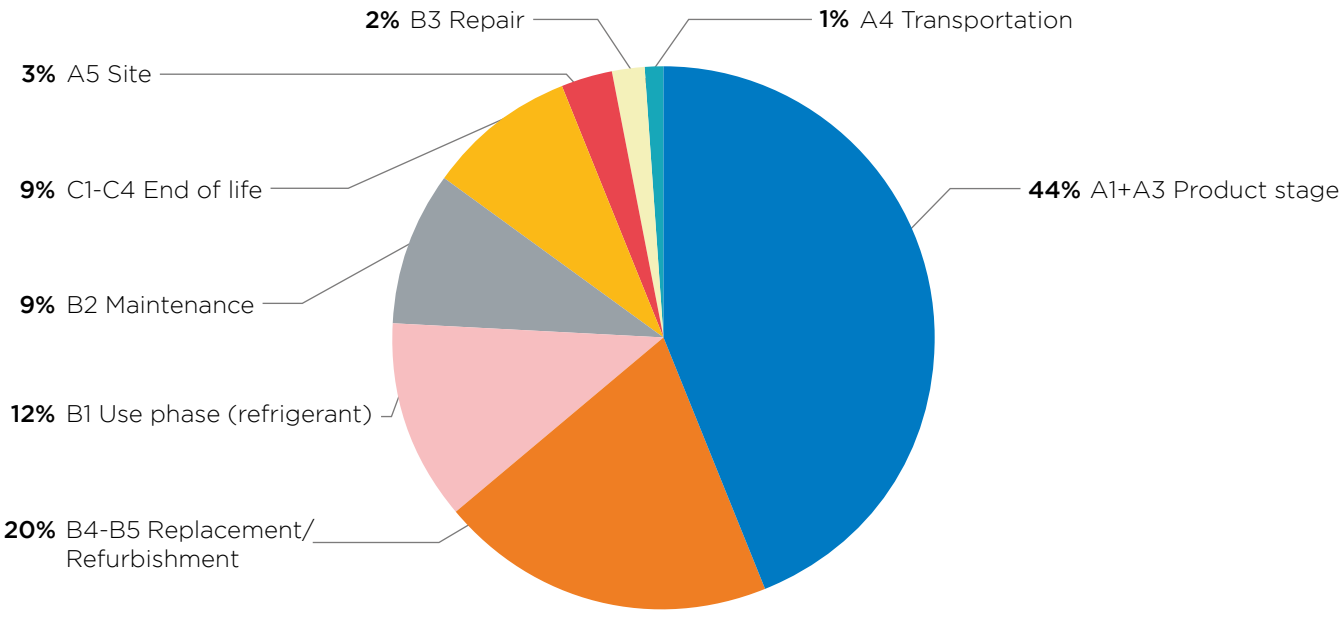
Appendix. B - Detailed Results

Semi-Detached House Type
Most contributing materials (Improved)

Most contributing resource type



Total carbon lifecycle stages

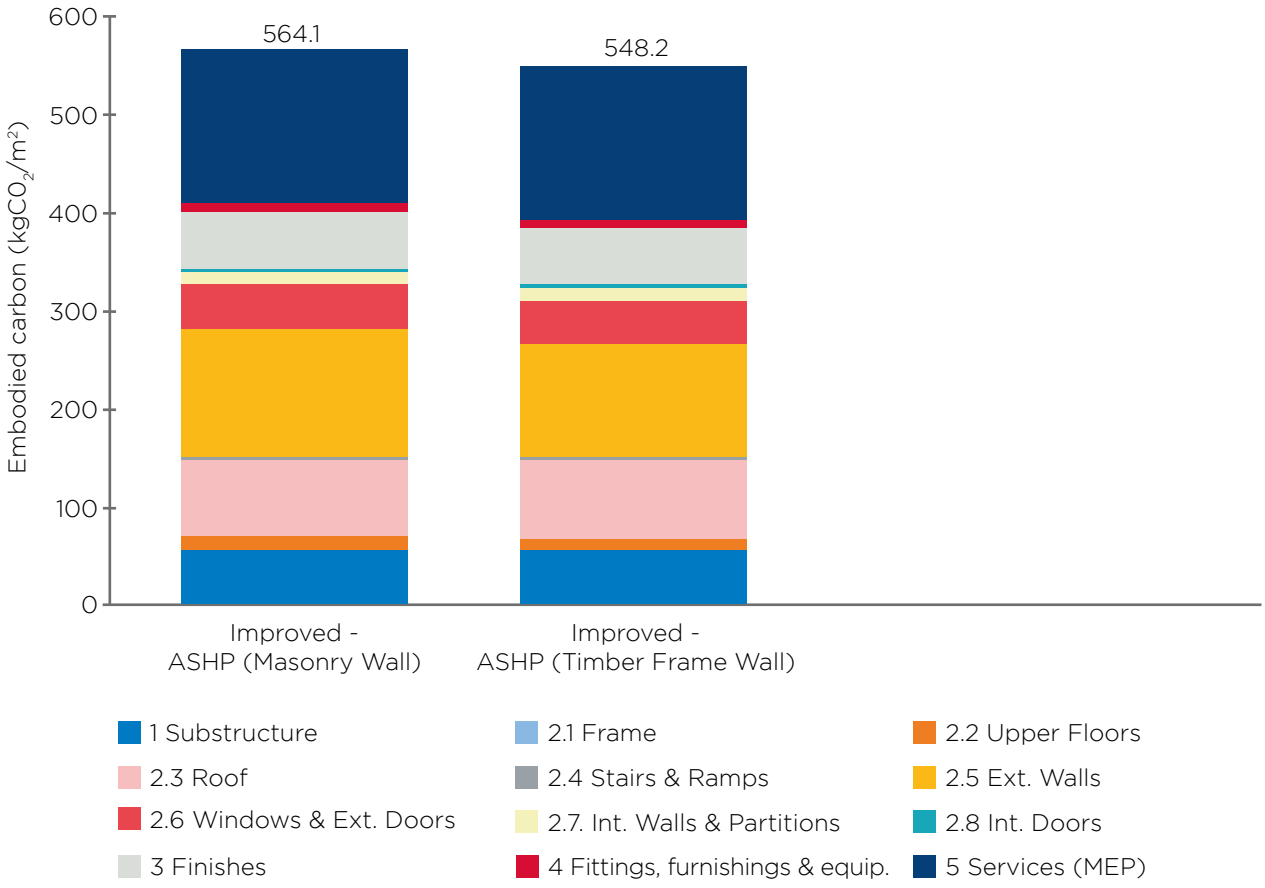


Visualisations are indicative only

Appendix. B - Detailed Results

Semi-Detached House Type
Embodied carbon comparison of Improved ASHP
(Masonry wall vs Timber frame wall)

Embodied carbon comparison of Semi-detached house type options



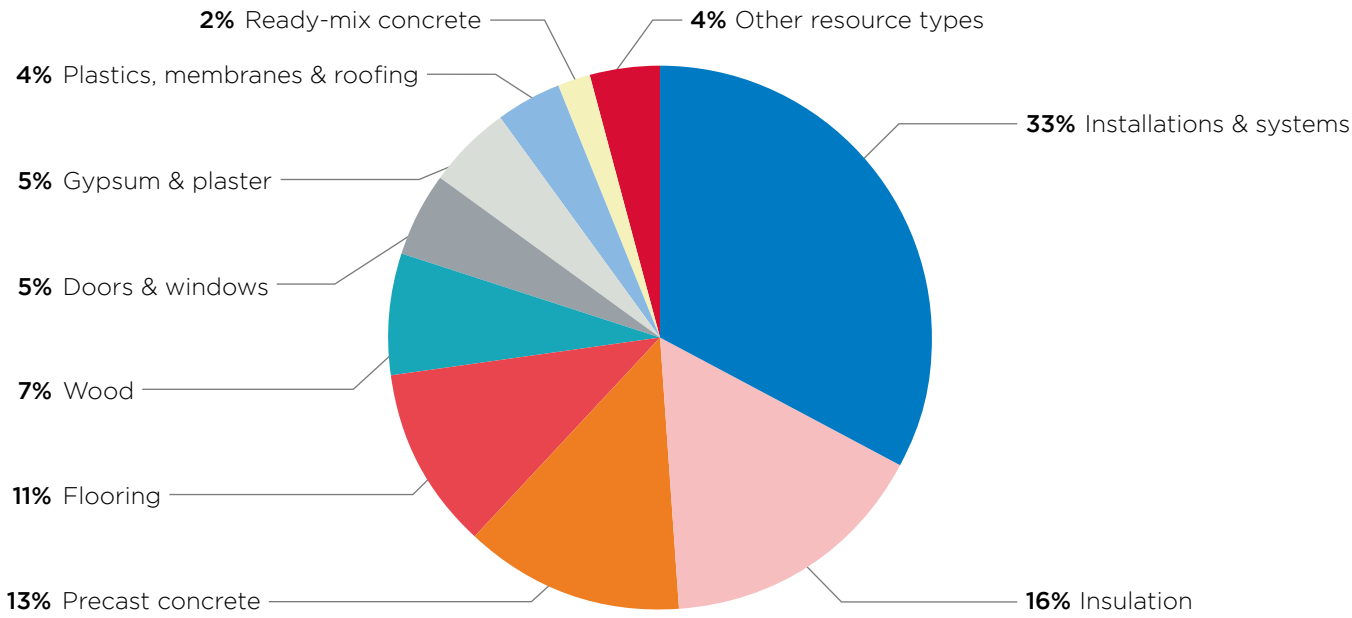
Visualisations are indicative only

Appendix. B - Detailed Results

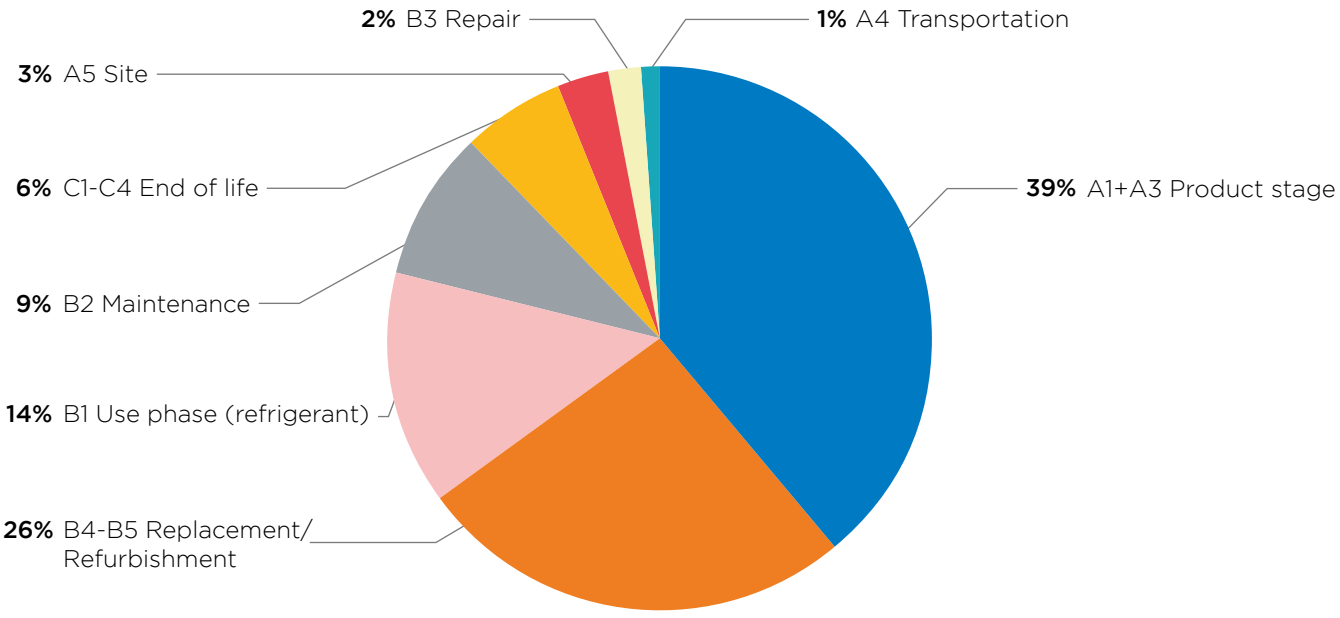
Mid-Terraced House Type

Most contributing materials (Baseline)

Most contributing resource type



Total carbon lifecycle stages



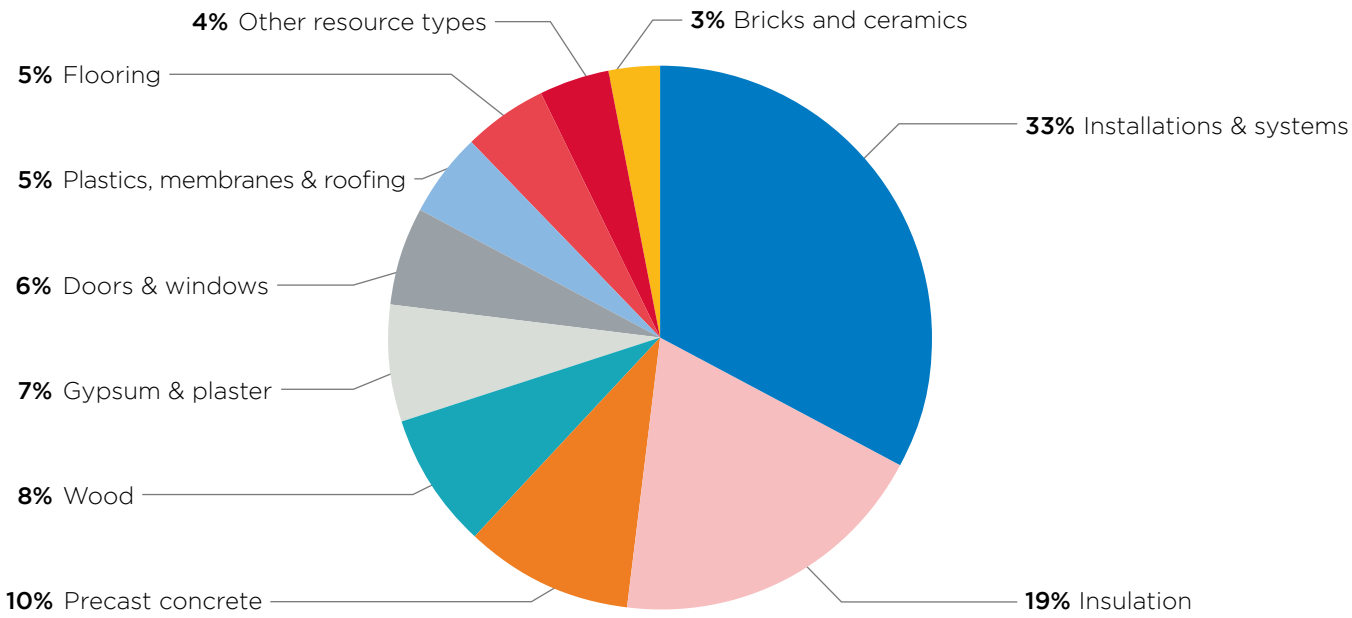
Visualisations are indicative only

Appendix. B - Detailed Results

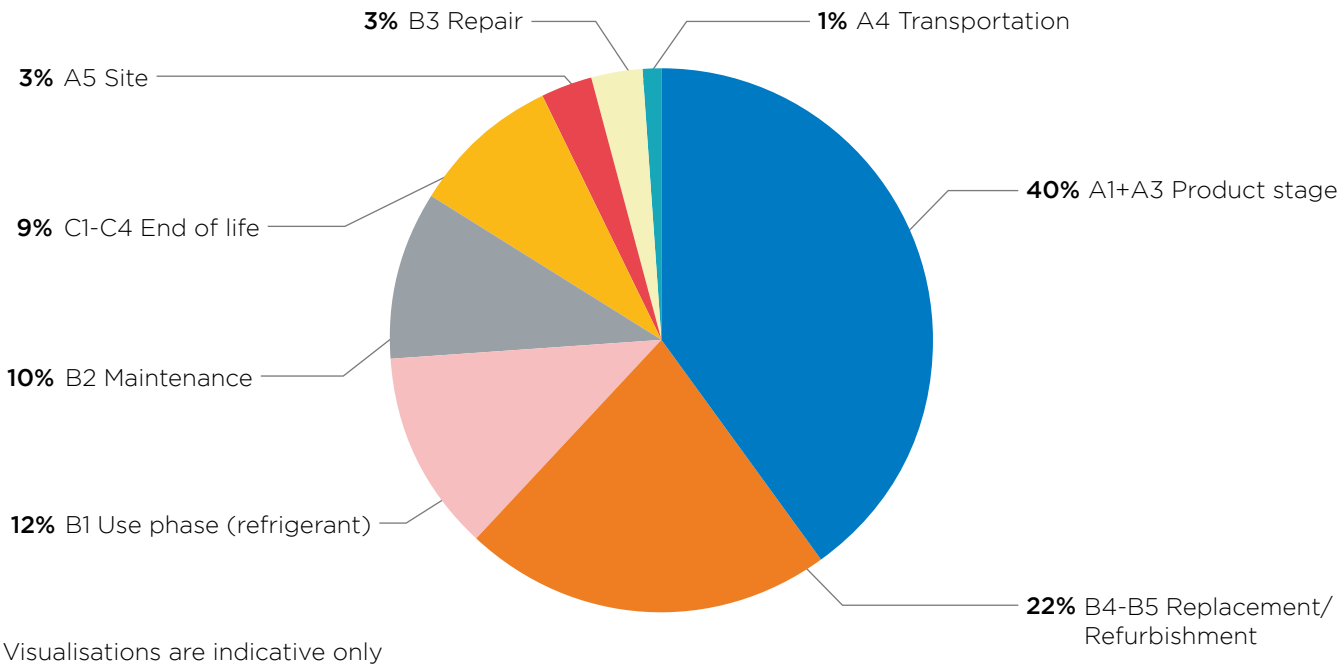
Mid-Terraced House Type

Most contributing materials (Improved)

Most contributing resource type



Total carbon lifecycle stages

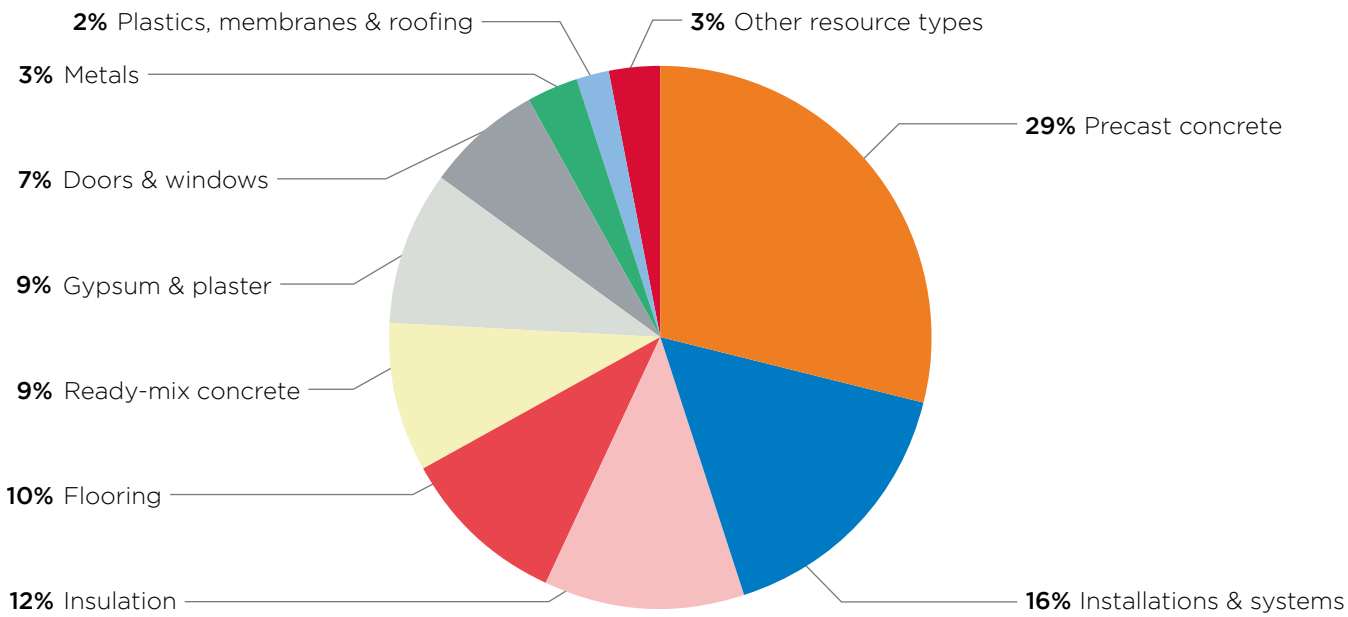


Visualisations are indicative only

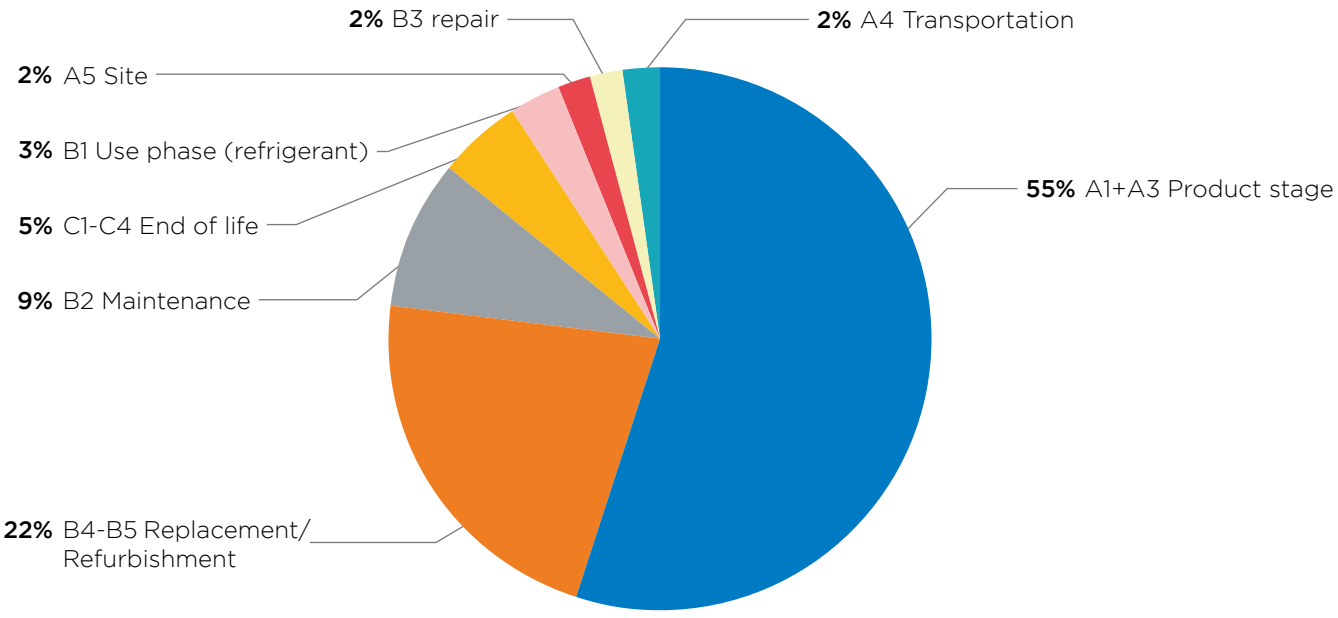
Appendix. B - Detailed Results

Apartment Block
Most contributing materials (Baseline)

Most contributing resource type



Total carbon lifecycle stages

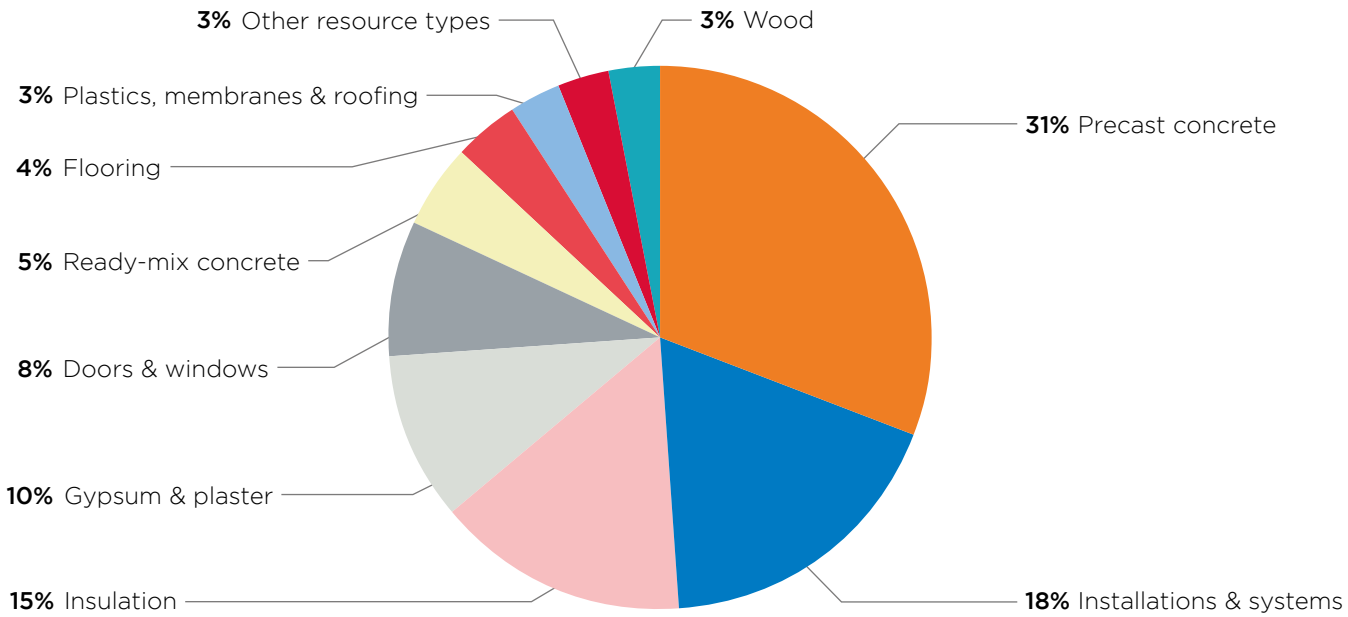


Visualisations are indicative only

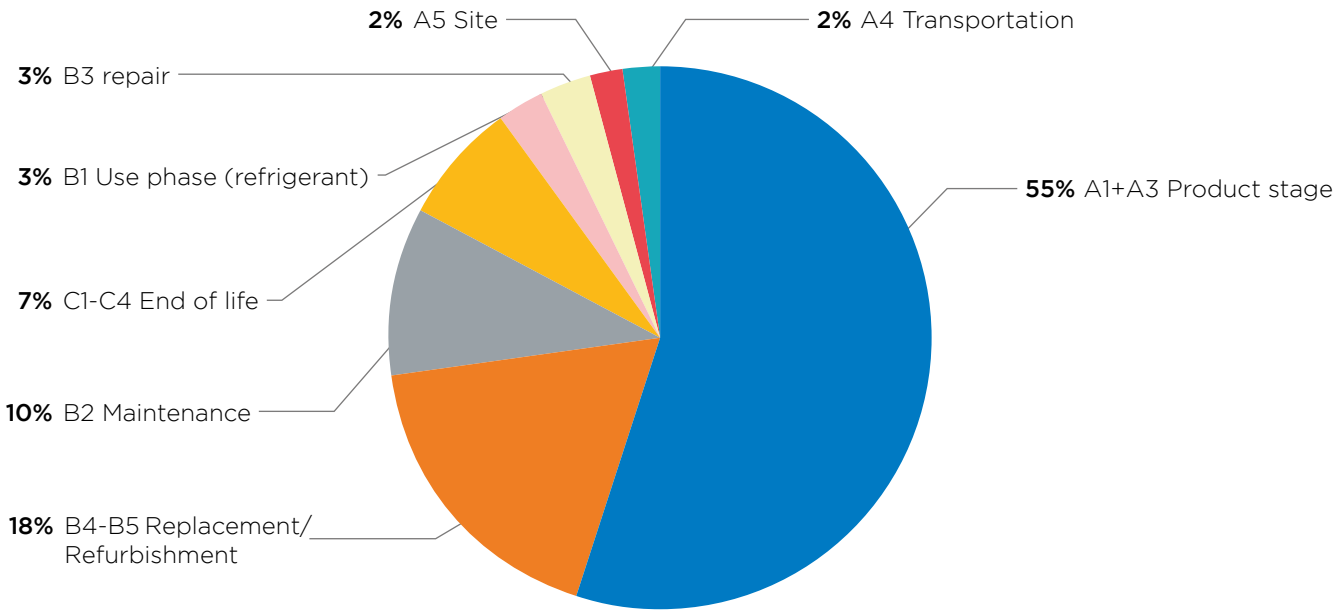
Appendix. B - Detailed Results

Apartment Block
Most contributing materials (Improved)

Most contributing resource type



Total carbon lifecycle stages



Visualisations are indicative only

Notes

ECO360

Reset to Circular

We commit through our investment in R&D to be a leader for sustainability & circularity in our industry.

The ECO360 strategy is a commitment by Unilin Insulation to continually review and improve the sustainable credentials of our product offering and services, as far as technical advances in manufacturing and circularity allow.

The advent of the ECO360 range sees the launch of a scheme for the collection of waste from aligned projects in partnership with developers as a pilot to develop a process for the reduction, reuse and recycling of materials.

- Bio-enhanced formulation
- Halogen free formula
- Biodegradable packaging
- Reduces embodied carbon
- Minimises materials on site
- Improved thermal performance of 0.020 W/mK

RIBA 2030 CLIMATE CHALLENGE · LETI · RIAI · IGBC IRISH GREEN BUILDING COUNCIL · UK GBC Member · ConstructZERO The Construction Industry's Zero carbon change programme

Available now for
Walls, Floors & Roofs

Bio Inside

0.020 W/mK

Unilin Insulation UK Ltd
Park Road, Holmewood
Chesterfield, Derbyshire
United Kingdom
S42 5UY

t. +44 (0) 371 222 1033
f. +44 (0) 371 222 1044
e. info.ui@unilin.com

unilininsulation.co.uk

Unilin Insulation Ireland Ltd
Liscarton Industrial Estate
Kells Road, Navan
Co. Meath, Ireland
C15 NP79

t. +353 (0) 46 906 6000
f. +353 (0) 46 906 6090
e. unilininsulation.ie

unilininsulation.ie

XCO2 London
56 Kingsway Place
London
EC1R 0LU

t. +44 20 7700 1000
e. mail@xco2.com

www.xco2.com