# Life Cycle Assessment
## RIBA Stage 2
## Chenies Street

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**Disclaimer**


**Contents:**

# Introduction
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### Introduction

Eight Associates has undertaken a life cycle assessment (LCA) exercise. The results presented in this report are in line with ISO 14040 2006, ISO 14044 2006, and ISO 15686-5:200 standards. The methodology followed is also aligned with the GLA's whole life carbon and building circularity policy documents. This report can be used to demonstrate compliance with GLA policy at RIBA Stage 2.

### Statement of Compliance

The persons undertaking this assessment can confirm that they are a 'competent person' as defined in the BREEAM manual. They have undertaken training in IMPACT-compliant LCA software (both One Click and eTool) and have carried out a minimum of 20 life cycle assessment and life cycle costing studies over a range of varied projects. They can confirm that they are not professionally connected to a single manufacturer.

### Summary of Results

The embodied carbon of the scheme is 167 $kgCO_2e/m^2$for stages A1-A5, and 149 $kgCO_2e/m^2$ for stages B-C (excluding B6-B7) and therefore, the scheme meets the GLA benchmarks for whole life carbon set 900- 1,000 $kgCO_2e/m^2$and 400- 500 $kgCO_2e/m^2$, respectively.

# Methodology
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### Life Cycle Assessment

The LCA has been undertaken using the following tools and data:

- 'eTool LCD' software
- Building Regulations compliant energy modelling software and the REEB energy consumption benchmarks
- Construction data from Eight Associates' database and the project's Construction Method Statement.

Life Cycle Assessment (LCA) is a technique for assessing the potential environmental impacts of a product or service. LCAs involve cradle-to-grave analysis of production systems and provide comprehensive evaluations of all upstream and downstream energy inputs and a number of environmental emissions. A graphical illustration of each of the LCA stages is shown in Figure 1:

Existing buildings are responsible for a major share of energy use, greenhouse gas emissions and the environmental impacts of the construction sector. Renovating buildings improves operational energy performance, but it also increases the environmental impacts due to the materials and building services that are added to improve energy performance.

To address these trade-offs and establish which specification and design decisions will have the least environmental impact, it is essential to take a life cycle approach. Conducting an LCA will provide more insight into the development's environmental profile and avoid the common occurrence of simply transferring impacts between the operational and construction stages.


***Figure 1:*** *Stages included within an LCA (courtesy of OneclickLCA)*

# Methodology
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## Study Boundary

To undertake an LCA and an LCC for a building, different building elements need to be considered at different life stages. What is and is not included is referred to as the 'boundary'. This report has been based on a GLA Whole Life Carbon compliant boundary, this includes 95% of all building elements as well as operational energy and water. This includes elements which are excluded in a typical BREEAM LCA boundary.

The following life stages are considered in both the LCA and LCC analyses:

- A1–A3: Product stage – raw materials supply, transport and manufacturing
- A4: Transport of the products to the construction site
- A5: Construction of the building
- B1: Use
- B2–B3: Maintenance and repair
- B4–B5: Material replacement and refurbishment
- B6: Operational energy use
- B7: Operational water use
- C1–C4: Deconstruction/demolition
- D: Reuse, recovery and recycling potential

The following building elements have been included in both the LCA and LCC analyses:

- Structural frame (all columns and beams and miscellaneous connections)
- Construction envelope – all walls, roof and floor elements, as well as finishes
- Windows and fenestration
- Internal finishes and fittings
- Building services
- External works (landscape, pavements, roads)
- Transport of all the construction materials to the site
- Maintenance and replacement of building elements during the material lifespan

## Study Period

The study period for this project is 60 years, in accordance with ISO methodologies.

## Assumptions and Standards

The following data sets have been used for this analysis:

- Average transport values for the UK, according to eTool database
- Grid electricity carbon intensity profile following the 'slow progression decarbonisation scenario' from the National Grid Future Energy Scenarios 2015

Operational energy consumption using the REEB Benchmarks and supplemented by CIBSE Guide A where necessary for working hours occupancy patterns/density.

The software used to undertake the analysis is eTool LCD, which complies with:

- ISO 14040 2006: Environmental management – Life cycle assessment – Principles and framework
- ISO 14044 2006: Environmental management – Life cycle assessment – Requirements and guidelines
- EN 15978 2011: Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method

# Benchmarks
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### Overview

LCA benchmarks are provided in this report for context and to provide an indication of how well the proposed scheme performs. Note that the benchmarks vary according to the boundary used.

### Embodied vs operational energy and $CO_2$

The construction industry globally consumes around 40% of global raw stone, gravel, and sand; 20% of virgin wood; and consumes about 40% of total energy. The national share of energy consumption in buildings varies in different countries from between 25 to 50%. In Europe this share is approximately 50%.

The operational phase of a building is often considered have the largest single environmental impact of all of the LCA stages. However, the embodied stage of buildings is increasing due to the following:

1) Increased energy efficiency regulations which reduce in-use consumption
2) Increasing use of highly-engineered, more complex materials and construction systems
3) The ongoing and anticipated future decarbonisation of the national grid

### Benchmarks

The Greater London Authority have published a new set of benchmarks that focus on the embodied carbon of Construction Stage modules (A1-A5) and Use and Deconstruction Stage modules (B-C) whilst excluding operational energy. The building types that have benchmarks are Offices, Retail, Education, and Apartment/Hotel. Further benchmarks have been proposed for those with more aspirational targets. A table summarising this is provided below.

| | Benchmark ($kgCO_2e/m^2$) | | Aspirational Benchmark ($kgCO_2e/m^2$) | |
|---|---|---|---|---|
| | A1-A5 | B-C (excl. B6-B7) | A1-A5 | B-C (excl. B6-B7) |
| Offices | 900 – 1,000 | 400 – 500 | 550 – 600 | 250 – 300 |
| Retail | 900 – 1,000 | 100 – 200 | 550 – 600 | 60 – 120 |
| Education | 700 – 800 | 200 – 300 | 450 – 500 | 120 – 180 |
| Apartment/Hotel | 750 – 850 | 300 – 400 | 450 – 500 | 180 – 240 |

# The Scheme
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### Description of Site

The scheme comprises the construction of 2 buildings. The first one is Minerva House, a 5-storey office building with one further storey below ground level, and its total gross internal area equates to approximately 3,000 m2. The second building is Telephone Exchange, which is a 5-storey office building with one further storey below ground level, and its total gross internal area equates to approximately 5,300 m2. A plan of the ground floor of the proposed scheme is shown below in Figure 2.

***Figure 2:*** *Plan of the proposed ground floor layout*

# LCA Results
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### Overview

The following pages present the results from the LCA of the proposed scheme. The embodied $CO_2$ figure should include manufacturing, transport, construction and deconstruction of the materials, therefore, the total embodied carbon for the building is the sum of A1–A3, A4, A5 and C1–C4 life stages. The table below provides a summary of the GWP for each stage.

| Life stage | GWP ($kgCO_2e/m^2$) |
|---|---|
| A1– A3. Construction materials | 147 |
| A4. Transport to site | 12 |
| A5. Construction/installation process | 8 |
| B1. Use | –1 |
| B2–B3. Maintenance and repair | 3 |
| B4–B5. Material replacement and refurbishment | 107 |
| B6. Energy use | 514 |
| B7. Water use | 9 |
| C1– C4. Deconstruction | 40 |
| D. Reuse, recovery and recycling potential | –5 |

The D stage has been calculated as a potential figure, based upon the A1–A3 stage impacts, as per GLA guidance.

### Benchmark Comparison

The project is an office building and should therefore be compared against the following benchmarks:

- **A1–A5:** 900 – 1,000 $kgCO_2e/m^2$
- **B–C (excluding B6–B7):** 400 – 500 $kgCO_2e/m^2$

The scheme exceeds the benchmarks detailed by the Greater London Authority, with 167 $kgCO_2e/m^2$ for A1–A5 and 149 $kgCO_2e/m^2$ for B–C. In the Options Appraisal section of this report, various scenarios have been modelled that may help the development progress towards the aspirational benchmarks.

# LCA Results
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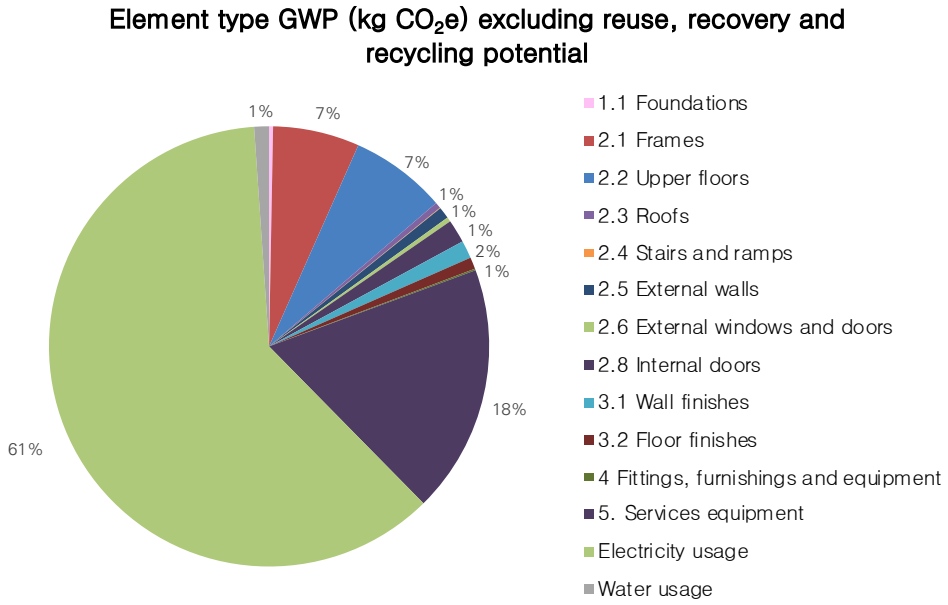


***Figure 3:*** *Elemental GWP breakdown by building element over 60 years*

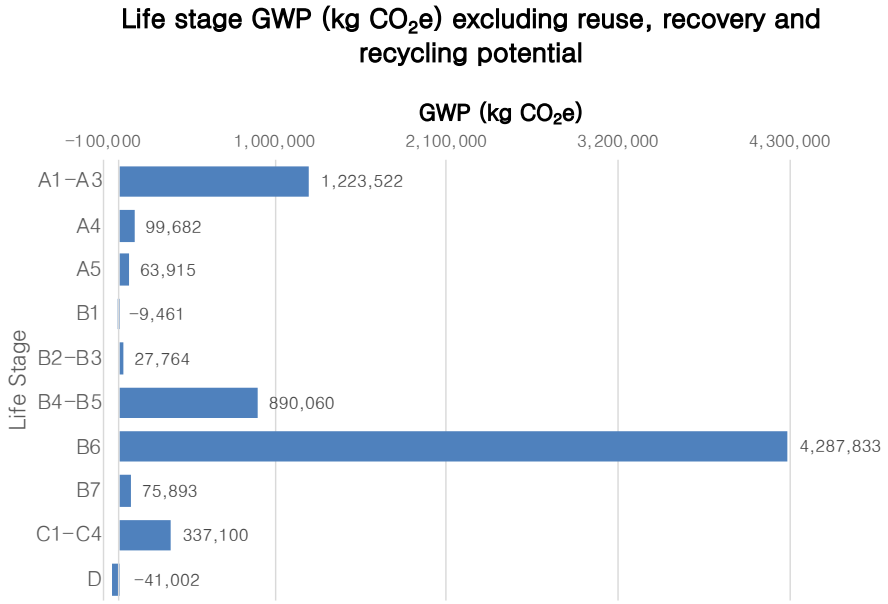


***Figure 4:*** *Life stage GWP breakdown over 60 years*

# Options Appraisal
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### Overview

Following the quantification of the environmental impacts of the proposed the scheme, the next step is to undertake an options appraisal. These options are opportunities to reduce the global warming potential and/or the cost of the scheme over a 60 year life cycle.

### Options Appraisal

Several options have been analysed, with two iterations demonstrating an increase in the GWP of the development, and three demonstrating a decrease in the GWP against the proposed scheme.

The results of this analysis are presented in Figure 5 on the following page and the impact of the option is compared against the scheme as currently proposed i.e. the 'baseline scheme' as outlined in the LCA Results section of this report.

Options to reduce the embodied carbon may not be adopted by the design team because of various other factors such as more frequent maintenance/replacement, aesthetic preference, and structural performance. All of the options proposed in this report should be evaluated by the design team to determine which are feasible. Where they are deemed feasible, they should be actioned and added to the project's specifications. Further information can be provided to assist with this process if required.

Figure 5 demonstrates that the options with the largest impact are Option 4 and Option 3, which correspond to the substitution of KoolDuct system for galvanised steel ductwork and the substitution of aluminium window frames for composite window frames. Option 2 and Option 3 show that GRC cladding has a better environmental performance that can be explained by the longer lifespan compared to the aluminium cladding.

| Option | Description | Change in GWP ($kgCO_2e$) |
|---|---|---|
| 1 | Substitution of Glass Reinforced Concrete (GRC) cladding for aluminium cladding with 25 years lifespan | 208,000 |
| 2 | Substitution of Glass Reinforced Concrete (GRC) cladding for aluminium cladding with 35 years lifespan | 113,000 |
| 3 | Substitution of aluminium window frames for composite window frames | −6,000 |
| 4 | Substitution of KoolDuct system for galvanised steel ductwork | −20,800 |
| 5 | Substitution of 22mm copper pipe for Aquatherm plastic pipework | −3,300 |

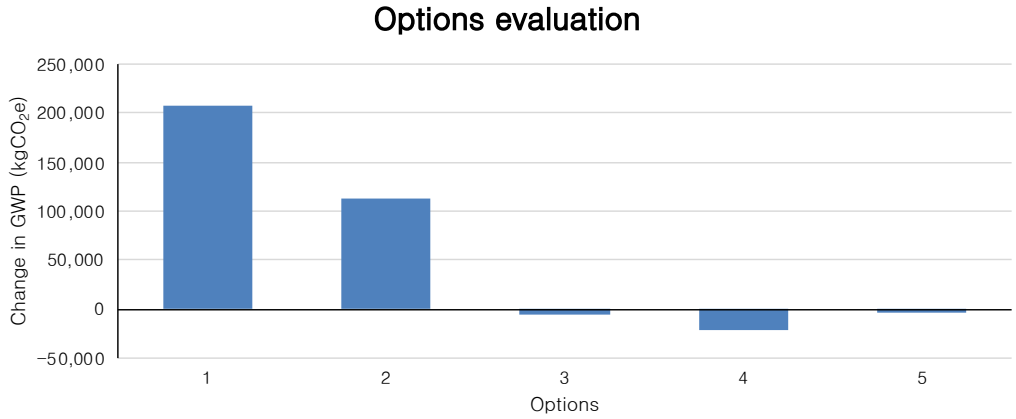


*Figure 5: GWP change for each of the options*

# Sensitivity Analysis
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### Sensitivity Analysis

Several iterations have been analysed, with a variation of replacement rates of different services. The proposed iterations investigate the GWP change when changing replacement period of the lighting and the fan coil units. The results of this analysis are presented in Figure 6 for the lights and in Figure 7 for the fan coil units. In both cases, results demonstrate that longer replacement cycles result in a decrease in the GWP.

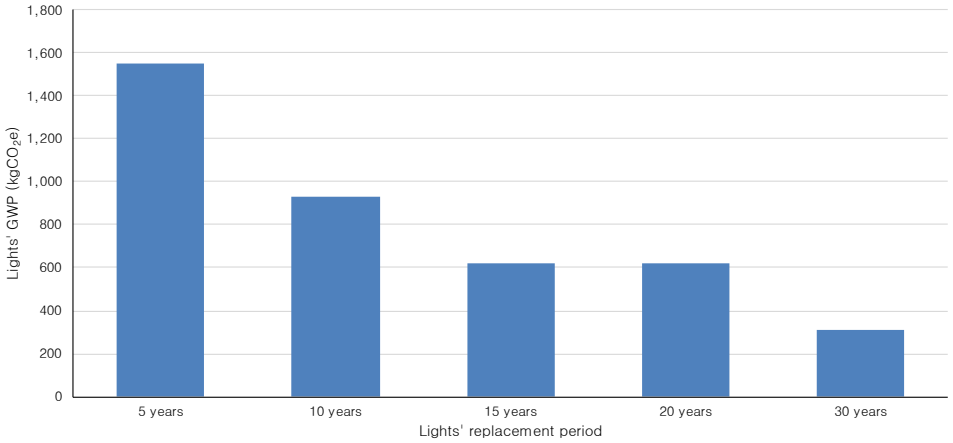


***Figure 6:*** *GWP change for different replacement period of lighting*

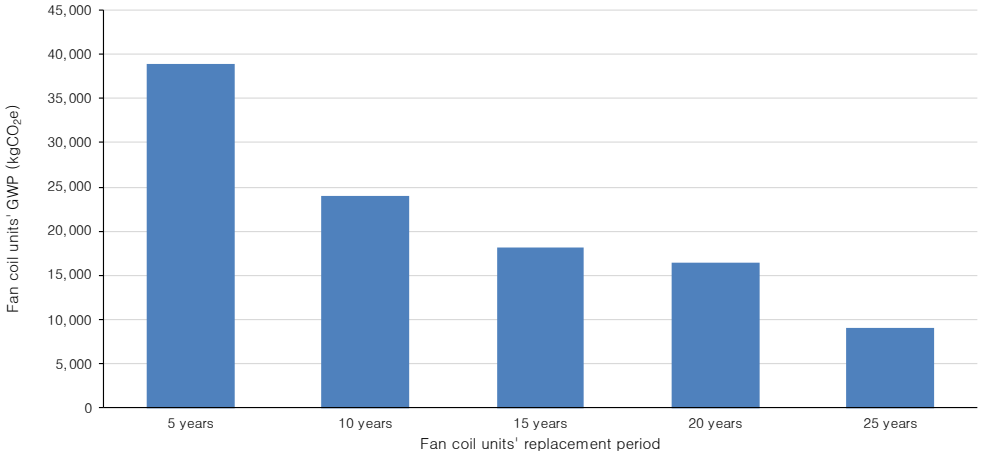


***Figure 7:*** *GWP change for different replacement period of fan copil units*

# Conclusions
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### Conclusions

The life cycle assessment (LCA) concludes that the largest global warming potential (GWP) impact over a 60 year period will come from the construction and operational life stages of the building.

It should be noted that when implementing more sustainable materials specification, careful consideration should be given to the lifespan of a given material or element. This is a highly sensitive variable in the analysis so changes in the life-span or replacement rates can significantly change the projects GWP. A schedule of replacement rates used in this study has been provided in the Appendix for reference.

The options appraisal provides enhancement that can be made to reduce the embodied carbon. All of the options proposed in this report should be evaluated by the design team to determine which are feasible. Where they are deemed feasible, they should be actioned and added to the project's specifications. Further information can be provided to assist with this process if required.

### Recommendations for further work

A subsequent analysis should be undertaken at RIBA Stage 4 when more detailed design information is available. This will enable the identification of further opportunities to reduce the life cycle environmental impacts and costs.

# Appendix
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# LCA Analysis

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| Life stage | Resource | Quantity | Unit | Global warming (kg $CO_2e$) | Acidification (kg $SO_2e$) | Eutrophication (kg $PO_4e$) | Ozone depletion potential (kg $CFC_{11}e$) | Photochemical Ozone Creation Potential, POCP | RICS category number | Category Name | Service Life | Resource type/description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | **6,955,307** | **90,908** | **27,649** | **1** | **5,586** | | | | |
| A1A3 | Concrete Foundation slab | 3,867.6 | m2 | 570.19 | 1.13 | 0.28 | 0.00 | 0.11 | 1.1 | Substructure | 80 | Structure, concrete (in-situ, RC40, excl. reinforcement) |
| A1A3 | Steel reinforcement | 3,369.5 | kg | 7,313.93 | 33.02 | 16.26 | 0.00 | 9.13 | 1.1 | Substructure | 80 | Reinforcement for RC, steel |
| A1A3 | concrete | 58,800.0 | m2 | 11,640.83 | 28.74 | 6.92 | 0.00 | 2.35 | 1.1 | Substructure | 80 | Structure, concrete (precast, RC40) |
| A1A3 | Steel reinforcement | 698.5 | kg | 1,516.27 | 6.85 | 3.37 | 0.00 | 1.89 | 2.1 | Frame | 80 | Reinforcement for RC, steel |
| A1A3 | Metal Studwork | 0.2 | m3 | 4,528.85 | 74.03 | 23.11 | 0.00 | 4.36 | 2.1 | Frame | 80 | Framework (drywall partitions), steel (galvanized) |
| A1A3 | Concrete core wall | 68,040.0 | m2 | 13,470.10 | 33.25 | 8.01 | 0.00 | 2.72 | 2.1 | Frame | 80 | Structure, concrete (precast, RC40) |
| A1A3 | Steel frame | 205,000.0 | kg | 368,857.48 | 1,819.31 | 1,246.95 | 0.02 | 386.60 | 2.1 | Frame | 80 | Structure, steel (hot rolled) |
| A1A3 | PC concrete slab | 525.3 | m3 | 212,030.23 | 578.04 | 122.39 | 0.01 | 60.14 | 2.2 | Upper floors | 80 | Structure (floor), concrete (precast) |
| A1A3 | Metal Deck | 99,076.2 | m2 | 260,016.77 | 4,250.54 | 1,326.78 | 0.02 | 250.13 | 2.2 | Upper floors | 80 | Floor decking (deep profiled), steel |
| A1A3 | 120mm PUR Insulation | 81.8 | m2 | 424.07 | 1.82 | 0.48 | 0.00 | 0.27 | 2.3 | Roof | 80 | Insulation (rigid sheet), polyurethane |
| A1A3 | 0.3mm Vapour control membrane | 389.7 | m2 | 957.00 | 3.42 | 0.73 | 0.00 | 0.98 | 2.3 | Roof | 70 | Vapour control layer, polypropylene |
| A1A3 | PC concrete slab | 5,612.4 | m2 | 1,111.10 | 2.74 | 0.66 | 0.00 | 0.22 | 2.3 | Roof | 80 | Structure, concrete (precast, RC40) |
| A1A3 | 70mm Screed | 196,434.0 | m2 | 34,513.79 | 81.43 | 21.55 | 0.00 | 7.36 | 2.3 | Roof | 80 | Floor (screed, bonded), concrete (1:4 cement:sand) |
| A1A3 | Handrail | 0.0 | m3 | 202.70 | 1.00 | 0.69 | 0.00 | 0.21 | 2.4 | Stairs and ramps | 80 | Structure, steel (hot rolled) |
| A1A3 | concrete stairs | 7.7 | m3 | 2,512.09 | 5.03 | 1.24 | 0.00 | 0.48 | 2.4 | Stairs and ramps | 80 | Structure, concrete (in-situ, RC35, excl. reinforcement) |
| A1A3 | cladding | 71,970.0 | m2 | 48,873.85 | 288.44 | 67.73 | 0.00 | 25.67 | 2.5 | External walls | 70 | Cladding panel, sandstone |
| A1A3 | Double glazing | 2,760.1 | m2 | 3,383.83 | 29.99 | 4.12 | 0.00 | 2.15 | 2.6 | Windows and external doors | 20 | Glazing (double glazed, sealed unit), glass |
| A1A3 | aluminium frame glazing | 205.1 | m | 4,914.14 | 33.49 | 7.70 | 0.00 | 2.50 | 2.6 | Windows and external doors | 40 | Window frame, aluminium (coated/protected) |
| A1A3 | Double Glazed Window | 1,138.4 | m2 | 1,395.63 | 12.37 | 1.70 | 0.00 | 0.89 | 2.8 | Internal doors | 20 | Glazing (double glazed, sealed unit), glass |
| A1A3 | Aluminium Frame | 1,512.0 | m2 | 28,696.76 | 196.18 | 44.95 | 0.00 | 14.57 | 2.8 | Internal doors | 15 | Window furniture/hardware, aluminium |
| A1A3 | Paint | 240.8 | m2 | 954.39 | 10.75 | 4.23 | 0.00 | 1.16 | 3.1 | Wall finishes | 5 | Paint, emulsion |
| A1A3 | Gypsum plasterboard | 13.4 | m3 | 3,799.27 | 26.79 | 5.65 | 0.00 | 1.88 | 3.1 | Wall finishes | 80 | General sheet (on framework), plasterboard |
| A1A3 | Paint | 1,568.9 | m2 | 6,217.02 | 70.05 | 27.55 | 0.00 | 7.55 | 3.1 | Wall finishes | 5 | Paint, emulsion |
| A1A3 | Floating screed | 175.1 | m3 | 55,377.67 | 130.65 | 34.58 | 0.00 | 11.81 | 3.2 | Floor finishes | 80 | Floor (screed, floating), concrete (1:4 cement:sand) |
| A1A3 | Toilet | 55.0 | # | 3,111.02 | 12.85 | 1.81 | 0.00 | 0.68 | 4 | Fittings, furnishings and equipment | 50 | Toilet |
| A1A3 | Light Fittings | 218.0 | kg | 312.43 | 1.34 | 1.16 | 0.00 | 0.19 | 4 | Fittings, furnishings and equipment | 30 | Unspecified |
| A1A3 | Light Fittings | 109.0 | kg | 318.01 | 1.05 | 0.14 | 0.00 | 0.11 | 4 | Fittings, furnishings and equipment | 15 | Unspecified |
| A1A3 | Pump control unit | 0.1 | kg | 0.75 | 0.01 | 0.02 | 0.00 | 0.00 | 5 | Services equipment | 7.5 | Electronics For Control Unit |
| A1A3 | Fittings | 1.0 | kg | 2.37 | 0.42 | 0.35 | 0.00 | 0.02 | 5 | Services equipment | 30 | Copper Unspecified |
| A1A3 | Pump wet end | 2.0 | kg | 5.26 | 0.03 | 0.01 | 0.00 | 0.00 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Pressure equalisation vessel | 5.0 | kg | 7.17 | 0.03 | 0.03 | 0.00 | 0.00 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | Control unit for pump | 0.6 | kg | 9.12 | 0.08 | 0.19 | 0.00 | 0.01 | 5 | Services equipment | 7.5 | Electronics For Control Unit |
| A1A3 | Control Panel | 6.3 | # | 16.61 | 0.09 | 0.03 | 0.00 | 0.01 | 5 | Services equipment | 25 | Unspecified |
| A1A3 | Fittings | 12.2 | kg | 28.84 | 5.15 | 4.28 | 0.00 | 0.20 | 5 | Services equipment | 10 | Copper Unspecified |
| A1A3 | Pump motor | 10.0 | kg | 31.54 | 0.52 | 0.30 | 0.00 | 0.03 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Pump rotor | 24.4 | kg | 64.07 | 0.34 | 0.10 | 0.00 | 0.03 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | External Door Guides and Wheels | 40.0 | kg | 100.76 | 0.43 | 0.07 | 0.00 | 0.03 | 5 | Services equipment | 10 | Synthetic |
| A1A3 | Drain pipes | 71.3 | # | 186.15 | 0.54 | 0.09 | 0.00 | 0.03 | 5 | Services equipment | 200 | PVC Pipe |
| A1A3 | Element | 125.0 | kg | 295.82 | 52.87 | 43.87 | 0.00 | 2.04 | 5 | Services equipment | 10 | Copper Unspecified |
| A1A3 | Tank | 200.0 | kg | 380.40 | 1.63 | 1.29 | 0.00 | 0.22 | 5 | Services equipment | 100 | Unspecified |
| A1A3 | Allowance for Electric Motor | 121.9 | kg | 384.37 | 6.31 | 3.62 | 0.00 | 0.36 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | Associated Plumbing for HWS | 250.0 | kg | 591.64 | 105.73 | 87.73 | 0.00 | 4.08 | 5 | Services equipment | 50 | Copper Unspecified |
| A1A3 | Copper pipes | 340.6 | # | 805.96 | 144.03 | 119.51 | 0.00 | 5.56 | 5 | Services equipment | 150 | Copper Unspecified |
| A1A3 | Insulation | 197.4 | # | 992.96 | 4.02 | 0.76 | 0.00 | 0.47 | 5 | Services equipment | 10 | Polyurethane |
| A1A3 | Sacrificial Anode | 187.5 | kg | 1,042.69 | 7.04 | 1.79 | 0.00 | 0.61 | 5 | Services equipment | 5 | Aluminium Unspecified |
| A1A3 | Tank | 1,000.0 | kg | 1,433.02 | 6.16 | 5.31 | 0.00 | 0.87 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | Plastic Moulding etc | 500.0 | kg | 1,458.61 | 4.83 | 0.65 | 0.00 | 0.52 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | Hoist Rope | 1,191.3 | m | 1,707.14 | 7.34 | 6.32 | 0.00 | 1.04 | 5 | Services equipment | 20 | Unspecified |
| A1A3 | Door rails and guides | 1,200.0 | kg | 1,719.62 | 7.39 | 6.37 | 0.00 | 1.05 | 5 | Services equipment | 20 | Unspecified |
| A1A3 | External Doors | 667.4 | # | 1,754.42 | 9.32 | 2.78 | 0.00 | 0.84 | 5 | Services equipment | 25 | Unspecified |
| A1A3 | Brakes, door opening motors etc | 1,000.0 | kg | 3,154.36 | 51.77 | 29.73 | 0.00 | 2.96 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Pipework Insulation 100mm thick 25mm pipe di | 770.5 | # | 3,875.85 | 15.69 | 2.96 | 0.00 | 1.85 | 5 | Services equipment | 20 | Polyurethane |
| A1A3 | 1m 22mm copper pipe | 2,015.0 | # | 4,768.67 | 852.20 | 707.12 | 0.00 | 32.88 | 5 | Services equipment | 47 | Copper Unspecified |
| A1A3 | Inverter for hoist motor | 75.0 | kg | 564.52 | 12.26 | 9.38 | 0.00 | 0.91 | 5 | Services equipment | 15 | Solar Inverter Generic |
| A1A3 | Hoist Motor | 3,750.0 | kg | 11,265.59 | 184.90 | 106.19 | 0.00 | 10.58 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Glass bulb | 0.1 | kg | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 5 | Services equipment | 10 | Flat Glass |
| A1A3 | Deflector, cap etc | 0.3 | kg | 1.33 | 0.05 | 0.02 | 0.00 | 0.00 | 5 | Services equipment | 10 | Brass |
| A1A3 | Smoke detector casing | 3.6 | kg | 10.50 | 0.03 | 0.00 | 0.00 | 0.00 | 5 | Services equipment | 10 | Unspecified |
| A1A3 | cicrcuit board | 3.6 | kg | 53.88 | 0.49 | 1.14 | 0.00 | 0.04 | 5 | Services equipment | 10 | Electronics For Control Unit |
| A1A3 | per floor electronic controls | 10.0 | kg | 149.68 | 1.37 | 3.16 | 0.00 | 0.10 | 5 | Services equipment | 15 | Electronics For Control Unit |
| A1A3 | filter | 12.0 | kg | 31.55 | 0.17 | 0.05 | 0.00 | 0.02 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | 5000L empty tank weight (150kg) | 360.0 | kg | 1,076.24 | 14.63 | 5.90 | 0.00 | 0.64 | 5 | Services equipment | 50 | Zinc Coated & Coloured Sheet 0.56mm |
| A1A3 | Controls | 900.0 | # | 130.38 | 0.88 | 1.55 | 0.00 | 0.05 | 5 | Services equipment | 15 | General Electrical Equipment |
| A1A3 | Refrigerant (Leakage Component) | 5.0 | kg | 177.40 | 0.27 | 0.04 | 0.01 | 0.01 | 5 | Services equipment | 1 | R-410A (Puron, AZ-20) |
| A1A3 | Insulation | 150.0 | kg | 232.52 | 1.87 | 0.24 | 0.00 | 0.07 | 5 | Services equipment | 15 | R 1.5 |
| A1A3 | Controls | 1,827.8 | # | 264.80 | 1.79 | 3.14 | 0.00 | 0.10 | 5 | Services equipment | 15 | General Electrical Equipment |
| A1A3 | Insulation | 304.6 | kg | 472.22 | 3.79 | 0.49 | 0.00 | 0.14 | 5 | Services equipment | 15 | R 1.5 |
| A1A3 | Solvent | 350.2 | # | 985.70 | 7.78 | 1.10 | 0.00 | 0.56 | 5 | Services equipment | 50 | Urea Formaldehyde |
| A1A3 | Airconditioning Internal Unit | 575.0 | kg | 1,360.78 | 243.18 | 201.78 | 0.00 | 9.38 | 5 | Services equipment | 20 | Copper Unspecified |
| A1A3 | Pipes | 575.0 | kg | 1,360.78 | 243.18 | 201.78 | 0.00 | 9.38 | 5 | Services equipment | 40 | Copper Unspecified |
| A1A3 | Heat exchanger copper pipe and fins | 600.0 | kg | 1,419.94 | 253.76 | 210.56 | 0.00 | 9.79 | 5 | Services equipment | 15 | Copper Unspecified |
| A1A3 | Refrigerant (Captured Component) | 244.3 | kg | 1,421.36 | 17.31 | 1.77 | 0.03 | 0.68 | 5 | Services equipment | 20 | R-134a (HFC-134a) No manufacturing fugitive emissions |
| A1A3 | Airconditioning Internal Unit | 690.0 | kg | 2,012.88 | 6.67 | 0.90 | 0.00 | 0.72 | 5 | Services equipment | 20 | Unspecified |
| A1A3 | Pump / Chiller Components | 447.8 | kg | 2,490.29 | 16.81 | 4.28 | 0.00 | 1.45 | 5 | Services equipment | 15 | Aluminium Unspecified |
| A1A3 | Heat exchanger copper pipe and fins | 1,218.5 | kg | 2,883.77 | 515.35 | 427.62 | 0.00 | 19.88 | 5 | Services equipment | 15 | Copper Unspecified |
| A1A3 | Airconditioning Internal Unit and Hoses | 1,150.0 | kg | 2,896.83 | 12.34 | 2.13 | 0.00 | 0.73 | 5 | Services equipment | 20 | Synthetic |
| A1A3 | Cast Iron Pump / Chiller Components | 4,925.3 | kg | 5,406.00 | 20.86 | 6.42 | 0.00 | 3.78 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Pump / Chiller Components | 10,074.3 | kg | 14,436.60 | 62.06 | 53.45 | 0.00 | 8.81 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Pump / Chiller Components | 6,492.4 | kg | 15,364.71 | 2,745.80 | 2,278.36 | 0.00 | 105.94 | 5 | Services equipment | 15 | Copper Unspecified |
| A1A3 | Ducting | 9,398.1 | # | 28,096.07 | 382.00 | 153.95 | 0.00 | 16.76 | 5 | Services equipment | 50 | Zinc Coated & Coloured Sheet 0.43mm |

eight associates

# LCA Analysis

## Chenies street

| Life stage | Resource | Quantity | Unit | Global warming (kg $CO_2e$) | Acidification (kg $SO_2e$) | Eutrophication (kg $PO_4e$) | Ozone depletion potential (kg $CFC_{11}e$) | Photochemical Ozone Creation Potential, POCP | RICS category number | Category Name | Service Life | Resource type/description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1A3 | Wire casing 3mm diam | 47.1 | # | 118.63 | 0.51 | 0.09 | 0.00 | 0.03 | 5 | Services equipment | 30 | Synthetic |
| A1A3 | Switches | 41.9 | kg | 315.08 | 6.84 | 5.24 | 0.00 | 0.51 | 5 | Services equipment | 27 | Solar Inverter Generic |
| A1A3 | fans | 300.0 | kg | 429.90 | 1.85 | 1.59 | 0.00 | 0.26 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | fans | 609.3 | kg | 873.09 | 3.75 | 3.23 | 0.00 | 0.53 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Conduit 20mm diameter | 346.6 | # | 904.34 | 2.63 | 0.46 | 0.00 | 0.16 | 5 | Services equipment | 30 | PVC Pipe |
| A1A3 | Meter Box | 661.4 | # | 947.78 | 4.07 | 3.51 | 0.00 | 0.58 | 5 | Services equipment | 29 | Unspecified |
| A1A3 | Motors | 447.8 | kg | 1,412.57 | 23.18 | 13.31 | 0.00 | 1.33 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Copper wire 6mm | 648.0 | # | 1,533.52 | 274.05 | 227.40 | 0.00 | 10.57 | 5 | Services equipment | 30 | Copper Unspecified |
| A1A3 | Casing | 1,200.0 | kg | 1,719.62 | 7.39 | 6.37 | 0.00 | 1.05 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Casing | 2,437.1 | kg | 3,492.37 | 15.01 | 12.93 | 0.00 | 2.13 | 5 | Services equipment | 15 | Unspecified |
| A1A3 | Plastic associated with electrical wire and fittings | 2,616.3 | kg | 7,632.16 | 25.28 | 3.41 | 0.00 | 2.71 | 5 | Services equipment | 30 | Unspecified |
| A1A3 | Copper electrical wire | 3,270.3 | kg | 7,739.44 | 1,383.10 | 1,147.65 | 0.00 | 53.36 | 5 | Services equipment | 150 | Copper Unspecified |

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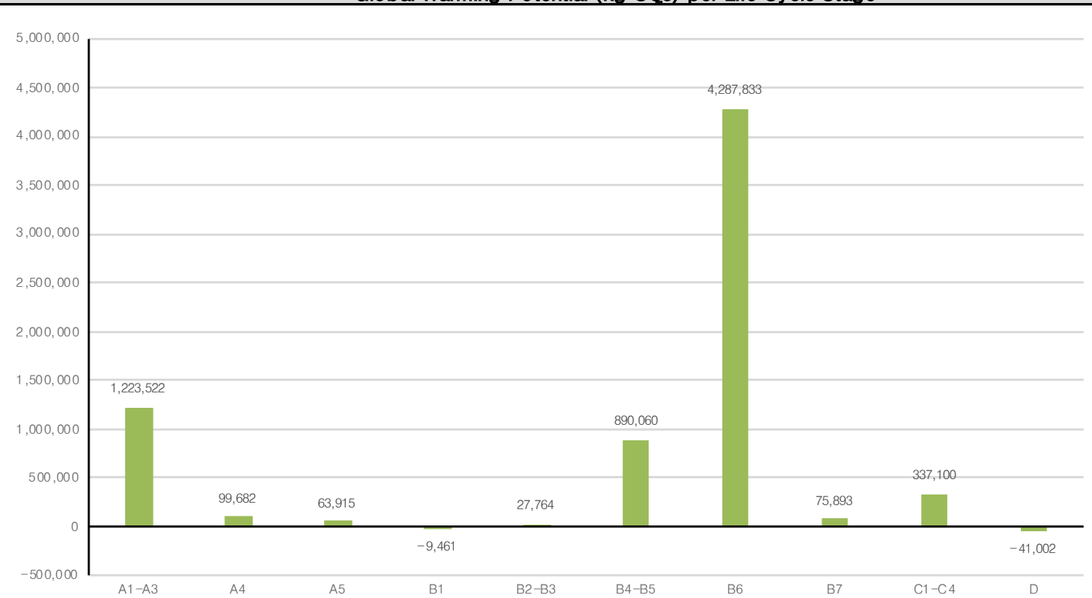
# LCA Analysis

## Chenies street

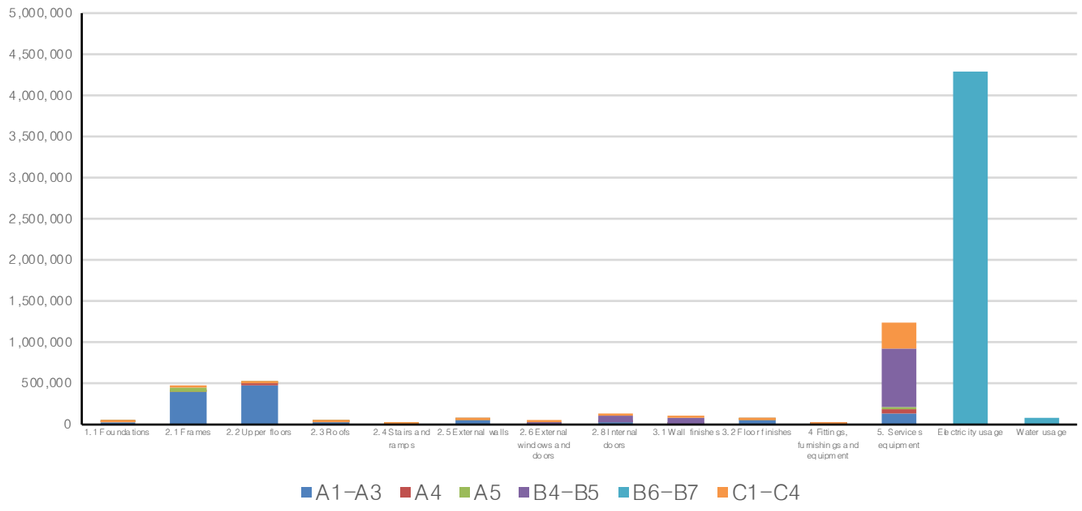
| Calculation Parameters | | | |
|---|---|---|---|
| Service life values for materials | | | Technical service |
| Transportation distance values for materials | | | United Kingdom |
| Local compensation target region | | | London |
| **Global Warming Potential per life stage** | **Life Stage** | **Sector** | **Global Warming Potential (kg $CO_2e$)** |
| Construction Impact | A1–A3 | Construction materials | 1,223,522 |
| | A4 | Transportation to site | 99,682 |
| | A5 | Construction/installation process | 63,915 |
| Operation Impact | B1 | Use | −9,461 |
| | B2–B3 | Maintenance and repair | 27,764 |
| | B4–B5 | Material replacement and refurbishment | 890,060 |
| | B6 | Electricity usage | 4,287,833 |
| | B7 | Water usage | 75,893 |
| Deconstruction impact | C1–C4 | Deconstruction | 337,100 |
| Reuse, recovery, and recycling potential | D | Reuse, recovery, and recycling potential | −41,002 |
| **TOTAL (Excluding reuse, recovery and recycling potential)** | | | **6,996,309** |
| **TOTAL** | | | **6,955,307** |

**Global Warming Potential (kg $CO_2e$) per Life Cycle Stage**




| | 0 | A1A3 | A4 | A5 | B1 | B2B3 | B4B5 | B6 | C |
|---|---|---|---|---|---|---|---|---|---|
| **Global Warming Potential (kg $CO_2e$) Breakdown** | **Total (Excluding D)** | **A1–A3** | **A4** | **A5** | **B1** | **B2–B3** | **B4–B5** | **B6–B7** | **C1–C4** |
| 1.1 Foundations | 20,482 | 19,525 | 1,191 | 107 | −359 | – | – | – | 18 |
| 2.1 Frames | 444,631 | 388,373 | 15,472 | 40,655 | – | 5 | – | – | 125 |
| 2.2 Upper floors | 494,129 | 472,047 | 21,699 | 4 | – | – | – | – | 379 |
| 2.3 Roofs | 30,977 | 37,006 | 2,997 | 5 | −9,101 | – | – | – | 70 |
| 2.4 Stairs and ramps | 2,990 | 2,715 | 270 | 0 | – | – | – | – | 5 |
| 2.5 External walls | 59,421 | 48,874 | 2,215 | 8,240 | – | – | – | – | 93 |
| 2.6 External windows and doors | 23,508 | 8,298 | 186 | 1,535 | – | – | 13,485 | – | 4 |
| 2.8 Internal doors | 119,367 | 30,092 | 103 | 0 | – | – | 89,169 | – | 3 |
| 3.1 Wall finishes | 91,611 | 10,971 | 316 | 20 | – | – | 80,210 | – | 95 |
| 3.2 Floor finishes | 60,134 | 55,378 | 4,669 | 6 | – | – | – | – | 82 |
| 4 Fittings, furnishings and equipment | 8,327 | 3,741 | 1,932 | 1,104 | – | – | 1,442 | – | 108 |
| 5. Services equipment | 1,277,007 | 146,503 | 48,632 | 12,239 | – | 27,759 | 705,754 | – | 336,119 |
| Electricity usage | 4,287,833 | – | – | – | – | – | – | 4,287,833 | – |
| Water usage | 75,893 | – | – | – | – | – | – | 75,893 | – |
| **TOTAL** | **6,996,309** | **1,223,522** | **99,682** | **63,915** | **−9,461** | **27,764** | **890,060** | **4,363,726** | **337,100** |

**Global Warming Potential (kg $CO_2e$) per RICS Category and Life Cycle Stage**



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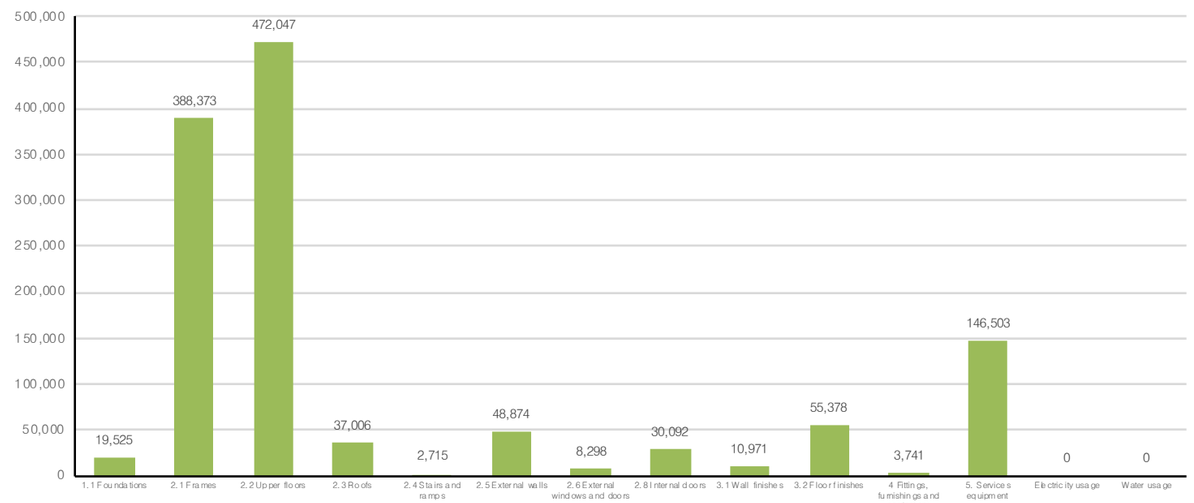
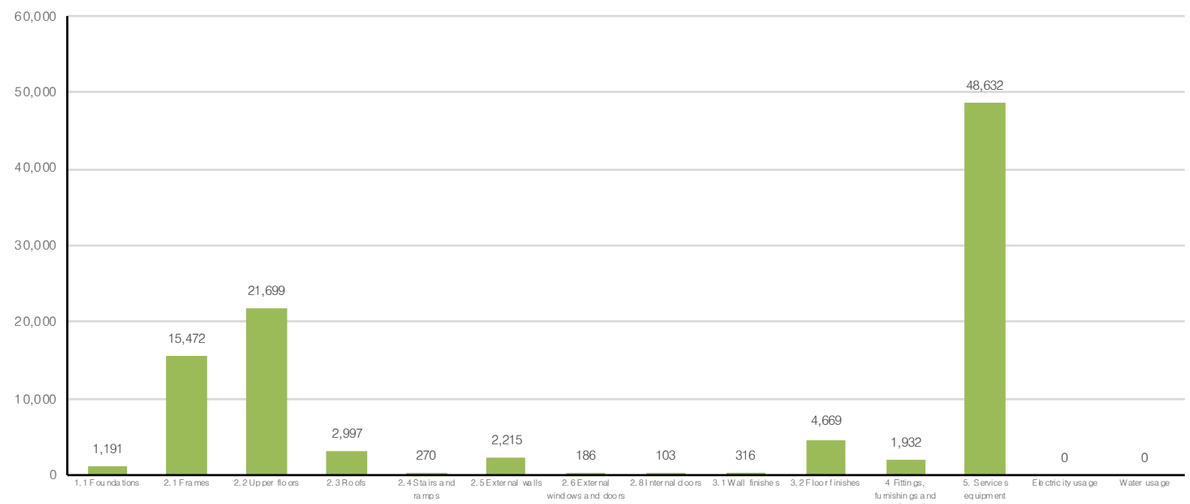
# LCA Analysis

## Chenies street

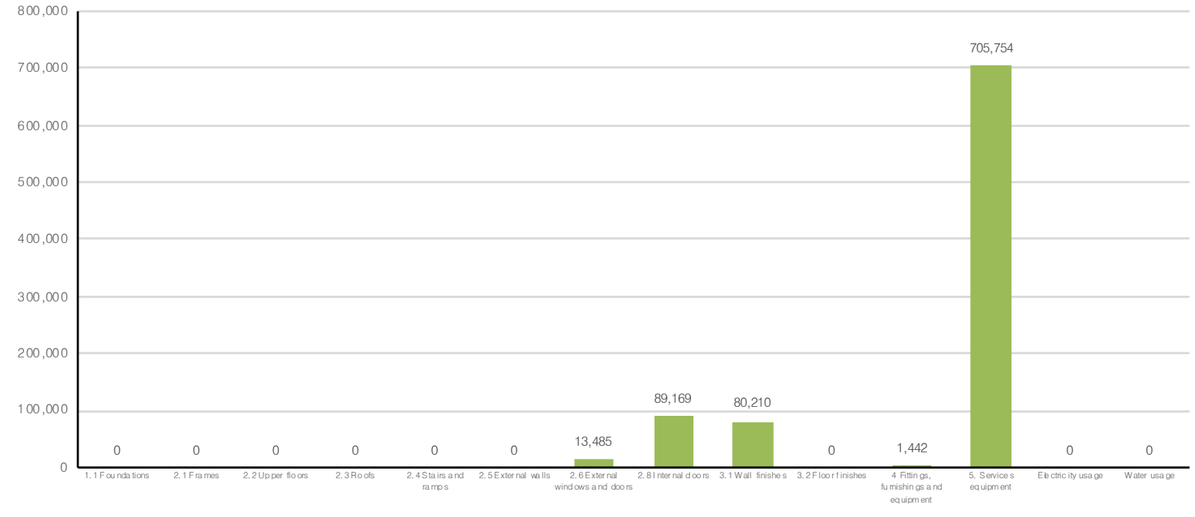
### Global Warming Potential (kg $CO_2e$) for Life Cycle Stage A1–A3



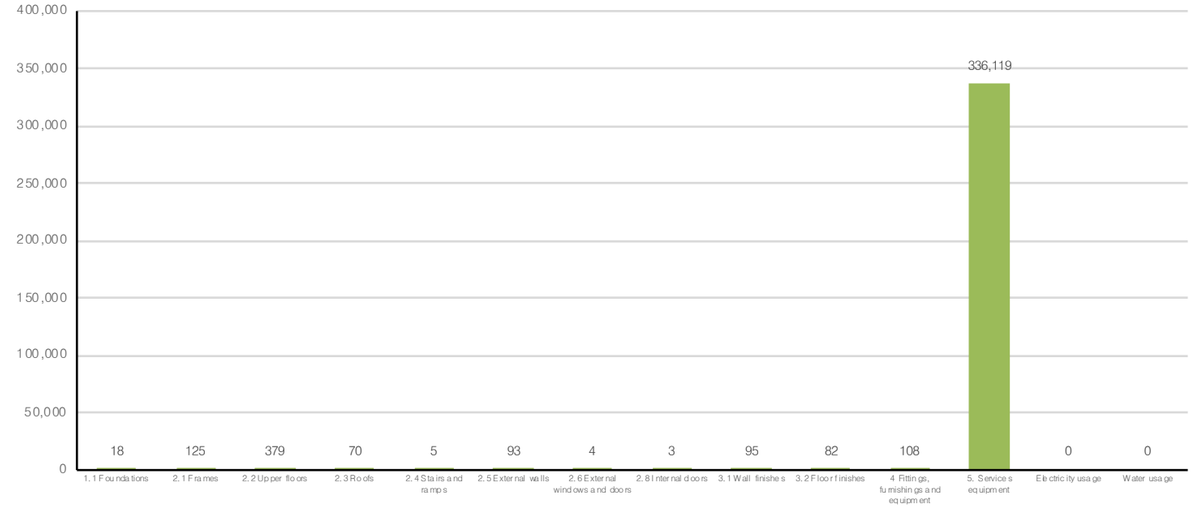

### Global Warming Potential (kg $CO_2e$) for Life Cycle Stage A4




### Global Warming Potential (kg $CO_2e$) for Life Cycle Stage B4–B5




### Global Warming Potential (kg $CO_2e$) for Life Cycle Stage C1–C4



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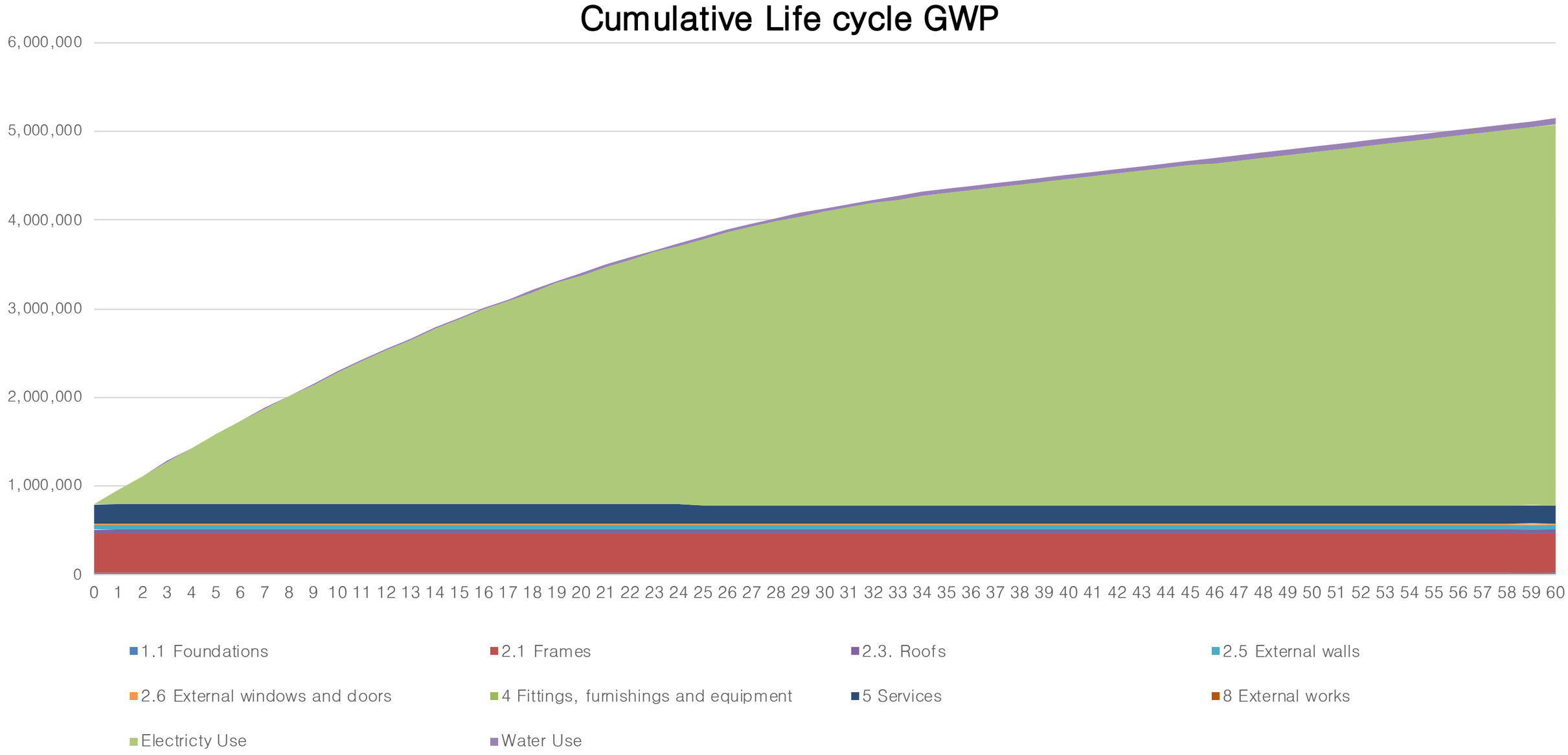
# LCA Analysis
## Chenies street

Annual GWP breakdown (kg $CO_2e$)



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# LCA Analysis

## Chenies street

Annual GWP breakdown (%)