bluesky UNLIMITED

# Whole Lifecycle Carbon Assessment

## Vine House, Home Farm, Kemnal Lane, Chislehurst

Prepared by Ivan Ball

Bluesky Unlimited
39 Marsh Baldon
Oxfordshire
OX44 9LP

ivan@blueskyunlimited.co.uk

**23rd January 2023**

**Table of Contents**

**Executive Summary** **3**

**1.0 Introduction** **4**

**2.0 Methodology and Assumptions** **5**
2.1 Methodology
2.2 Assumptions

**3.0 Construction Specification** **7**

**4.0 WLC Reduction Strategies** **8**

**5.0 Results** **9**
5.1 60-Year WLC Carbon Impact – GWP Overview
5.2 60-Year WLC Carbon Impact – Material GWP Overview
5.3 60-Year WLC Carbon Impact – Material GWP (Assessment 1 v Assessment 2)
5.4 Module A1-A5 Carbon Impact – Material GWP Overview
5.5 Module A1-A5 Carbon Impact – Material GWP (Assessment 1 v Assessment 2)

**6.0 Benchmark Assessment** **12**

**7.0 Opportunities to Reduce WLC Emissions** **13**

**Executive Summary**

This Whole Lifecycle Carbon Assessment (WLC) has been prepared in support of the construction of a new dwelling on land at Home Farm, Kemnal Lane, Chislehurst. Throughout this document the dwelling will be referred to as Vine House.

Further studies will be conducted at the post-planning stage when the design will be detailed but the following assessment has been prepared based on the information currently available.

The 60-year WLC analysis estimates Total Global Warming Potential (GWP) of the house, including operational energy and water to be **1,006,693** kg CO2e for Assessment 1 (current carbon factor for electricity) and **553,528** kg CO2e for Assessment 2 (future carbon factors for electricity following de-carbonisation of the Grid over lifetime of development).

The 60-year material embodied carbon for the scheme is estimated to be **274,578** kg CO2e (for Modules - A1-A5, B1-B5, C1-C4, D), which equates to rate of **820** kg CO2e/$m^2$.

The Module A1-A5 material upfront embodied carbon for the scheme is estimated to be **169,395** kg CO2e, which equates to a rate of **506** kg CO2e/$m^2$.

**The development is therefore within the GLA (Current) Benchmark of 750 to 850 kg CO2e/$m^2$.**

The Module B-C (excluding B6 & B7) GWP for the development is estimated to be **117,873 kg CO2e**, which equates to a rate of **352 kg CO2e/$m^2$**.

**The development is therefore below the GLA (upper) benchmark is 400 CO2e/$m^2$.**

The following specification items have assisted in helping to reduce the Module A1-A5 upfront embodied carbon:

- Use of Blended Cement in Concrete Items, instead of Portland Cement;
- Use of rammed earth for external walls instead of traditional cavity wall construction;
- Use of Mineral Wool insulation instead of PIR Insulation
- Use of a 'Green Roof' for Roof Covering

## 1.0 Introduction

This Assessment has been commissioned by Mr & Mrs Selby and provides a WLC Assessment in support of a planning application for the construction of a single dwelling for their own occupation on land at Home Farm, Kemnal Lane, Chislehurst.

The site is located in Chislehurst, which is to the east of Bromley and approximately 25km from Central London. To the north of the site is Kemnal Park Cemetery and Memorial Gardens, to the southwest is Foxbury Manor and to the south and southeast are University College London Sports Ground and Chislehurst School for Girls respectively.

The site extends to 8.3 hectares and is accessed off Kemnal Road, which is privately owned.

The planning application also proposes demolition, extension and refurbishment of other buildings within the site but it is the construction of a new dwelling, which are prompted the need for a WLC and therefore this assessment just considers the new dwelling.

The WLC is defined as assessing;

*'those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal.'*

WLC assessments are required for all referrable developments and in accordance with the Greater London Authority (GLA) guidance this assessment considers both the embodied carbon emissions (i.e. the emissions from material extraction, manufacture and transport, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and consequentially disposal of materials) as well as the operational carbon emissions from both regulated and unregulated energy use. As buildings become more energy efficient, with continuing improvements to building fabric and the use of low-carbon and renewable technologies so the embodied carbon of the materials within the buildings and the construction processes forms an increasing percentage of the total emissions associated with the development.

The WLC Assessment is based on the completed 'GLA Whole Life Carbon Assessment Template'.

The report has been prepared by Ivan Ball of Bluesky Unlimited who are sustainability consultants.

## 2.0 Methodology and Assumptions

### 2.1 Methodology

The Life Cycle Assessment considers the following building elements:

- **Substructure;**
- **Superstructure - f**loors, external walls, external doors and windows and roof;
- **Finishes;**
- **Fittings** - furnishings & equipment;
- **Services (MEP)** and
- **External Works.**

The study has been carried out for the following LCA Modules:

- **A1-A3:** Product Stage;
- **A4-A5:** Construction Stage;
- **B1-B5:** Use, replacement and maintenance;
- **C1-C4:** End of life;
- **D2-D4:** Benefits beyond the system boundary.

**Models**

Life Cycle Assessment (LCA) is the leading standard in clearly identifying optimum strategies for reducing environmental impacts. This report presents the results of the LCA completed for the proposed development that has been used to calculate the buildings' Global Warming Potential (GWP).

Two models were built and were assessed separately.

**Assessment 1** is based on the current carbon emissions factors for the electricity Grid and,

**Assessment 2** is based on the expected de-carbonisation of the electricity Grid over the lifetime of the development (60 years).

## 2.2 Assumptions

The assumptions made in relation to maintenance, repair and replacement cycles are extracted from the default database for each material and component used in the model. A detailed indication of the time frame that was assumed for the maintenance, repair and replacement of all primary building elements is given in the GLA WLC Template spreadsheet.

No Environmental Product Declarations (EPDs) were used at this stage because the exact specification of the elements has not been agreed but the default database in eTool has been used to inform the assessment. More detailed analysis can be carried out at the technical design stage.

The data for the $CO_2$ associated with the regulated and unregulated operational energy has been extracted from the SAP 10 Carbon Emissions Reporting Spreadsheet.

The operational carbon estimate includes the carbon emissions associated with the operational energy consumption of the development. This has been calculated for a lifecycle of 60 years based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project.

## 3.0 Construction Specification

### Substructure and superstructure (floor slab and retaining walls)

All concrete elements in the business-as-usual model have been specified as 40MPa, no recycled content was added to this model. In the improved scenario all concrete elements e.g., foundations, ground floor slab and retaining walls were optimised.

### External walls and windows

All external walls are to be made of rammed earth (except retaining structures). All windows and glazed doors will consist of aluminium frames with double-glazed units.

### Roof

The roof of the house will consist of an engineering timber structure with a green roof over a single ply membrane.

### Internal walls and doors

All internal partitions are assumed to be metal studwork with plasterboard finish. All internal doors are assumed to be pre-finished timber with steel ironmongery.

### Internal Finishes

All internal finishes are assumed to be plasterboard drylining, scrimmed and painted. The architraves and skirting boards are formed in medium density fibreboard (MDF) and painted.

### Fittings and furnishing

It is assumed that the kitchens units are constructed from (MDF).

### Building services

The house will benefit from a ground source heat pump, which will provide all space heating and hot water to the dwelling. Electricity to the house is to be provided via a ground-mounted photovoltaic array. Energy will be stored as hydrogen via fuel cell. When electricity is required for the heat pump or other uses within the house the fuel cell with generated electricity from stored hydrogen. The regulated emissions from the house are designed to be zero carbon.

### External works

The external landscaping includes porous surface to the driveway to the house will it is assumed will include concrete paved footpaths and a timber deck on the southern side of the house. A number of new trees are proposed as part of the planting plan.

The planning drawings for the house have been used in order to allow a Design Stage Bill of Quantities to be prepared.

The quantities for the main elements are estimated as follows;

| **Building Element** | Area/Length | Thickness/Area | Volume |
|---|---|---|---|
| | $m^2/m$ | $m/m^2$ | $m^3$ |
| Foundations | 111.7m | 0.6 x 0.6 | 40.20 |
| Floor Slab | 335.0 $m^2$ | 0.150 m | 50.25 |
| Screed to Slab | 335.0 $m^2$ | 0.075 m | 25.13 |
| Concrete Retaining Walls | 105.5 $m^2$ | 0.35 m | 36.60 |
| Rammed Earth Walls | 237.5 $m^2$ | 0.30 m | 71.25 |
| Roof Structure | 335.0 $m^2$ | 0.30 m | 100.50 |
| Roof Covering | 335.0 $m^2$ | 0.30 m | 100.50 |
| Internal Partitions | 93.0 m | 0.13 m | 12.09 |
| Internal Doors | 25.2 $m^2$ | 0.44 m | 11.09 |
| Windows | 111.26 $m^2$ | | |

## 4.0 WLC Reduction Strategies

This section describes the approach which has been taken with various elements of the construction.

### Approach

Lean design principles and sustainable strategies have been considered in order to minimise the use of material and waste, and with it minimising the carbon footprint of the scheme, as follows:

- Reduced excavation: avoiding the use of basement, minimising the soil volume taken off-site and also minimising increased concrete volume required.
- Utilising crushed material salvaged from the demolition works (elsewhere on the site) will be assessed to utilise it as base material below the access drive.
- Prefabrication: considering prefabricated modules where feasible will be part of the strategy for minimising quantities of materials used.
- All timber is to be procured from approved FSC or PEFC certified sources or similar.

## 5.0 Results

### 5.1 60-Year WLC Carbon Impact – GWP Overview

The breakdown of the 60-year WLCCA is as follows;

| Building Element Category | Assessment 1 | | Assessment 2 | |
|---|---|---|---|---|
| | kg CO2e | | kg CO2e | |
| 60-Year Total Embodied Emissions (A1-A5, B1-B5, C1-C4, D) | 274,578 | 27% | 224,852 | 41% |
| 60-Year Operational Energy (B6) | 620,068 | 62% | 278,374 | 50% |
| 60-Year Operational Energy (B7) | 112,047 | 11% | 50,302 | 9% |
| **Totals** | **1,006,693** | | **553,528** | |

The 60-year WLC analysis found the Total Global Warming Potential of the development including operational energy and water for Assessment 1 (current carbon factors) to be **1,006,693 kg CO2e** and for Assessment 2 (future carbon factors) to be **553,528 kg CO2e**.

### 5.2 60-Year WLC Carbon Impact – Material GWP Overview

| Building Element Category | Global Warming Potential | GWP/m$^2$ | % |
|---|---|---|---|
| | kg CO2e | | |
| Substructure | 46,783 | 139.65 | 17.04 |
| Superstructure: Roof | 9,233 | 27.56 | 3.36 |
| Superstructure: External walls | 72,675 | 216.94 | 26.47 |
| Superstructure: Windows and ext. doors | 8,489 | 25.34 | 3.09 |
| Superstructure: Internals walls and partitions | 36,612 | 109.29 | 13.33 |
| Superstructure: Internal doors | (988) | (2.95) | -0.35 |
| Finishes | 9,722 | 29.02 | 3.54 |
| Fittings, furnishings and equipment | 583 | 1.74 | 0.21 |
| Services | 5,253 | 15.68 | 1.91 |
| External Works | 86,216 | 257.36 | 31.40 |
| **Total** | **274,578** | | |

The 60-year WLC material embodied carbon is **274,578 kg CO2e**, which equates to 820 kg CO2e /m$^2$.

## 5.3 60-Year WLC Carbon Impact – Material GWP (Assessment 1 v Assessment 2)

| Building Element Category | Assessment 1 GWP | Assessment 2 GWP |
|---|---|---|
| | kg CO2e/m$^2$ | kg CO2e/m$^2$ |
| Substructure | 139.65 | 127.76 |
| Superstructure: Roof | 27.56 | 19.46 |
| Superstructure: External walls | 216.94 | 205.68 |
| Superstructure: Windows and ext. doors | 25.34 | 18.54 |
| Superstructure: Internals walls and partitions | 109.29 | 92.55 |
| Superstructure: Internal doors | (2.95) | (5.44) |
| Finishes | 29.02 | 20.64 |
| Fittings, furnishings and equipment | 1.74 | 1.56 |
| Services | 15.68 | 12.70 |
| External Works | 257.36 | 177.75 |

## 5.4 Module A1-A5 Carbon Impact – Material GWP Overview

| Building Element Category | Global Warming Potential | GWP/m$^2$ | % |
|---|---|---|---|
| | kg CO2e | | |
| Substructure | 38,879 | 116.06 | 22.95 |
| Superstructure: Roof | 3,446 | 10.29 | 2.03 |
| Superstructure: External walls | 65,348 | 195.07 | 38.58 |
| Superstructure: Windows and ext. doors | 4,021 | 12.00 | 2.37 |
| Superstructure: Internals walls and partitions | 25,614 | 76.46 | 15.12 |
| Superstructure: Internal doors | (2,626) | (7.84) | -1.55 |
| Finishes | 3,939 | 11.76 | 2.33 |
| Fittings, furnishings and equipment | 169 | 0.50 | 0.10 |
| Services | 1,519 | 4.53 | 0.90 |
| External Works | 29,086 | 86.82 | 17.17 |
| **Total** | **169,395** | | |

The 60-year Module A1-A5 material embodied carbon is estimated to be **169,395 kg CO2e**, which equates to 506 kg CO2e/m$^2$.

## 5.5 Module A1-A5 Carbon Impact – Material GWP (Assessment 1 v Assessment 2)

| Building Element Category | Assessment 1 GWP | Assessment 2 GWP |
|---|---|---|
| | kg CO2e/m$^2$ | kg CO2e/m$^2$ |
| Substructure | 116.06 | 116.06 |
| Superstructure: Roof | 10.29 | 10.29 |
| Superstructure: External walls | 195.07 | 195.07 |
| Superstructure: Windows and ext. doors | 12.00 | 12.00 |
| Superstructure: Internals walls and partitions | 76.46 | 76.46 |
| Superstructure: Internal doors | (7.84) | (7.84) |
| Finishes | 11.76 | 11.76 |
| Fittings, furnishings and equipment | 0.50 | 0.50 |
| Services | 4.53 | 4.53 |
| External Works | 86.82 | 86.82 |

## 6.0 Benchmark Assessment

### 6.1 Module A1-A5 Benchmark: Development v London Plan Benchmark

The 60-year Module A1-A5 material embodied carbon is estimated to be **169,395 kg CO2e**, which equates to a rate of **506 CO2e/m$^2$.**

The GLA benchmark range is 750 to 850 kg CO2e/m$^2$.

**The assessment embodied carbon is within the targeted range.**

### 6.2 Module B-C (except B6 & B7)

Module B represents use, replacement and maintenance and Module C represents end of life. Modules B6 and B7 have not been included because the London Plan benchmark excludes them.

The Module B-C (excluding B6 & B7) GWP for the development is estimated to be **117,873 kg CO2e**, which equates to a rate of **352 kg CO2e/m$^2$**.

The GLA (upper) benchmark is 400 CO2e/m$^2$.

**The assessment is within the targeted range.**

## 7.0 Opportunities to Reduce WLC Emissions

The following elements have assisted in reducing the Module A1-A5 embodied carbon;

- Use of blended cement in concrete instead of Portland Cement;
- Use of mineral wool in lieu of PIR insulation;

In addition, the following elements should be considered at the detailed working drawing and specification stage to further reduce the Module A1-A5 embodied carbon.

| Building Element Category | Specification to be Considered |
|---|---|
| | |
| Foundations | Spread foundation (50% fly ash) |
| Ground Floor | Precast concrete beams |
| Internal Partitions | Metal studs |