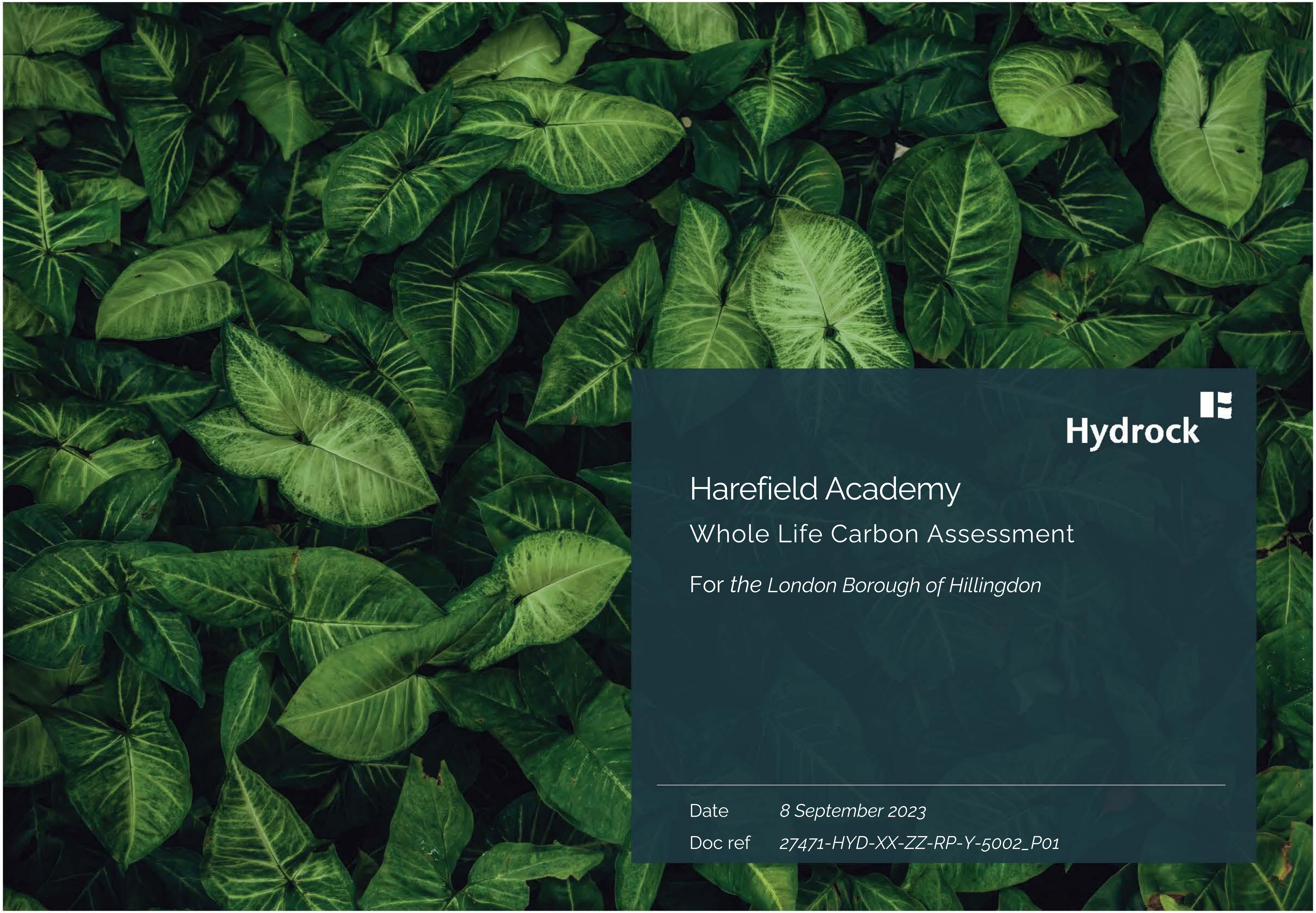

Hydrock

Harefield Academy

Whole Life Carbon Assessment

For *the London Borough of Hillingdon*

Date	*8 September 2023*
Doc ref	*27471-HYD-XX-ZZ-RP-Y-5002_P01*

Hydrock

Document control sheet

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		Project name	Harefield Academy
		Title	Whole Life Carbon Assessment
		Doc ref	27471-HYD-XX-ZZ-RP-Y-5002_P01
		Project number	27471
		Status	Draft
		Date	08/09/2023

Document production record		
Issue number	P02	Name
Prepared by		Isabel Boggust
Checked by		James Lacy-Smith
Approved by		Phil Guthrie

Document revision record			
Issue number	Status	Date	Revision details
P01	Draft	31/08/2023	Draft for comment
P02	Final	31/08/2023	Final issue

Contents

Executive Summary

The study has provided a whole life carbon assessment for both the embodied and operational carbon emissions for the Harefield Academy proposed development in the London Borough of Hillingdon.

The proposed development consists of the demolition of the former residential boarding block and erection of academic building (Use Class F1) and ancillary structures including a heat pump and substation enclosures. There will be the construction of a multi-use games area, revised vehicular access, landscaping, car and cycle parking and associated works.

Key materials used in this design include a concrete superstructure, a steel framed superstructure and a brick façade.

The energy hierarchy has been followed to reduce operational carbon, with an all-electric system within the proposed development. Renewable energy from solar photovoltaic panels and a green roof have been included with the design of the new school.

The overall whole life carbon assessment result from the initial proposed development is shown in Table 1, which are in line with achieving the benchmark targets for a school. A breakdown into the modules of the whole life carbon assessment can be seen in Table 2.

Key suggestions for reducing the whole life carbon of this building include:

- Reducing the operational carbon through the use of low energy systems and renewable energy generation
- Utilising high percentage of cement replacement with GGBS

Table 1 Overall whole life carbon results for Harefield Academy.

	Whole Life Carbon Emissions (Tons CO2e)	**Whole Life Carbon Emissions** (kgCO2e/m2 GIA)
Harefield Academy	2,274	992

Table 2 Summary of whole life carbon breakdown for Harefield Academy

Whole Life Carbon Scope	**Model Design** ($kgCO_2e/m^2$ GIA)	**WLC Benchmark** (kgCO2e/m2 GIA)
A1-A5 (Product Stage + Construction Stage)	664	750
B1-B5 (In-Use Stage)	248	250
C1-C4 (End of Life Stage)	80	
B6 (Operational Energy)	383	
B7 (Operational Water)	6	

Harefield Academy

1. Introduction

Hydrock have been appointed by the London Borough of Hillingdon to produce a Whole Life Carbon (WLC) Assessment to demonstrate that the proposed development at Harefield Academy in the London Borough of Hillingdon has considered reducing carbon in across all life stages in embodied and operational carbon, minimising the impact of the construction of this development on local and national carbon budgets.

2. Site Description

The proposed development on site at Harefield Academy, Northwood Road, UB9 6ET, will see the demolition of the former residential boarding block and erection of academic building (Use Class F1) and ancillary structures including heat pump and substation enclosures, construction of a multi-use games area, revised vehicular access, landscaping, car and cycle parking and associated works.

This site originally applied for planning application to repurpose and modify the existing residential building with the addition of an extension. However, after an analysis of the existing building, difficulties were identified in adapting the existing building to meet standards. Therefore, a new building is required to be constructed in place of the existing structure to satisfy the sites requirements.

Introduction to Whole Life Carbon

This section explores the importance of whole life carbon assessments as well as the planning policy requirements that must be satisfied to gain planning approval.

3. Importance of Assessing Whole Life Carbon

As efforts accelerate to reduce carbon across both the UK and the wider world to meet climate change and net-zero commitments, the building and construction industry is feeling the pressure to rapidly reduce its impact.

Whole Life Carbon (WLC) assessments provide an opportunity to calculate the total carbon emissions over a building's entire life, from the raw supply of materials and construction through to demolition and disposal at end of life.

Carbon emissions with a WLC are reported ad assessed in two different categories:

- **Embodied Carbon**: the emissions associated with materials and construction processes (A1-C4).
- **Operational Carbon**: the emissions associated with energy used (B6 in Figure 1) to operate the building or in the operation of infrastructure.

The WLC assessment also includes an assessment of the potential savings in carbon from the reuse or recycling of components after the end of a building's useful life, with close ties to the work completed within a Circular Economy report.

A WLC assessment assumes a 60-year study period, the typical lifetime assumed for buildings.

1.1 Scope of WLC

WLC has been officially launched in the New London Plan (Policy SI2: Minimising Greenhouse Gas Emissions), however, the Greater London Authority (GLA) are already including this requirement in planning conditions on major schemes. The GLA are also encouraging local boroughs to include it on smaller developments.

There are three stages to the WLC assessment:

- A pre-planning edition covers the proposed principles which will be adopted on site.
- A second phase which includes full modelling of the carbon emissions across the building, including options for improving the results.
- A third, post-construction version, provides results using project specific construction data and compares these results against a target.

This study is an initial analysis within the pre-planning stage that uses the latest interim RIBA Stage 3 information and accounts for at least 95% of the capital cost with the exception of FFE which are not included in the design. Please note this is subject to change as the design progresses. The analysis provides initial insight into the potential embodied environmental impact of the materials proposed for Harefield Academy.

Figure 1 demonstrates the different lifecycle modules included in a whole life carbon study, as well as the differences between embodied carbon, operational carbon, the circular economy and whole life carbon.

This assessment will also include both operational energy use intensity, and upfront embodied carbon targets, which together, will help shape the whole life carbon impact of the development. This analysis then assesses the carbon emitted at each of the life cycle stage:

- A1 to A3 Product: extraction and processing of materials, energy and water consumption used by the factory or in constructing the product or building, and transport of materials and products A4 to A5 Construction: building the development
- B1 to B7 Use: maintenance, replacement and emissions associated with refrigerant leakage
- C1 to C4 End of life: demolition, disassembly waste processing and disposal of any parts of product or building and any transportation relating to the above.
- Module D benefits and loads beyond the system boundary

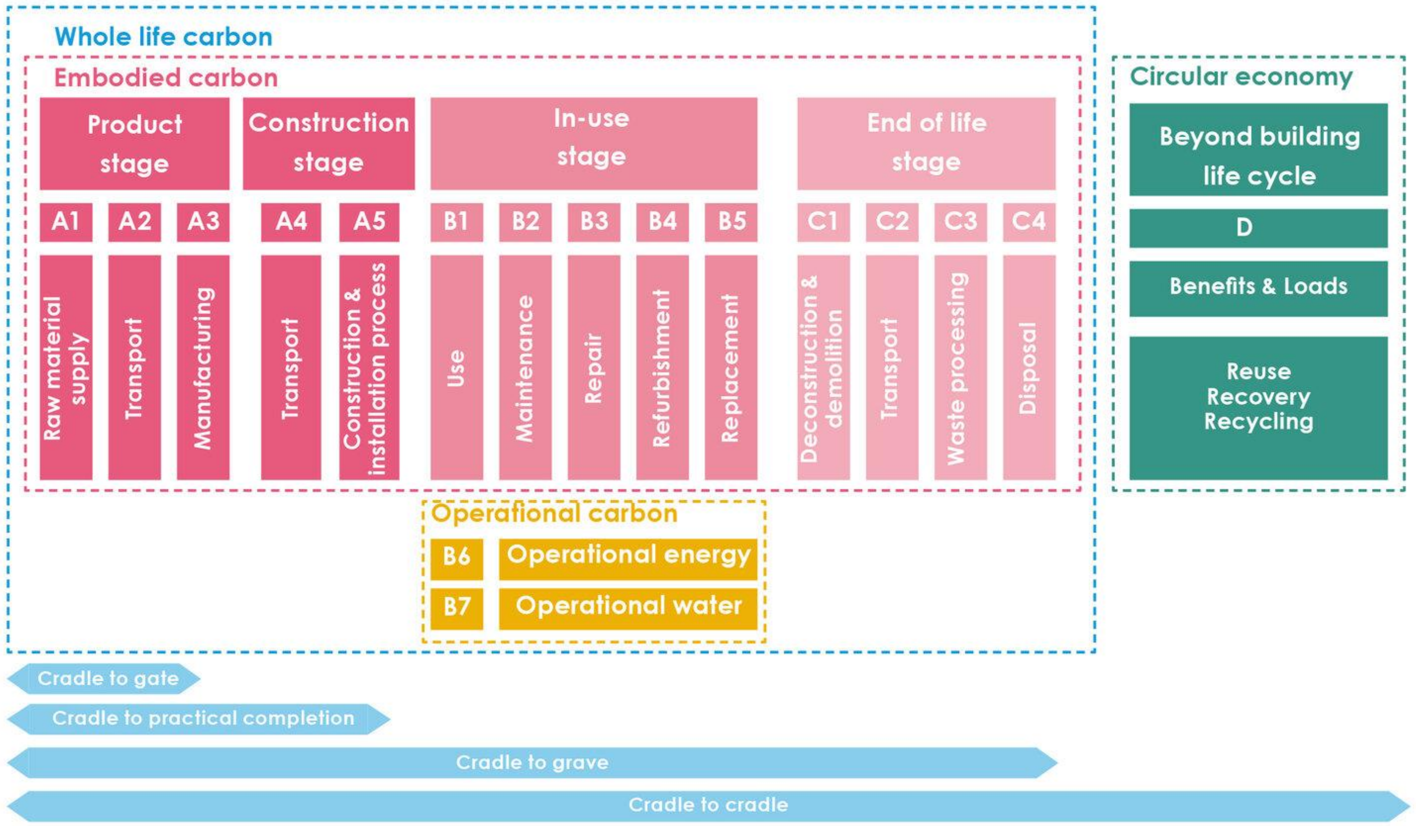

Figure 1, Display of modular information for the different stages of the building assessment (Source: LETI Embodied Carbon Primer).

4. National Carbon Targets, Policies and Guidance

Undertaking a WLC assessment is influenced by a variety of both national and local policies and guidance, which is summarised below.

4.1 UK Climate Change Act 2008

Although there are no national policies directly laying out CE guidance, the UK government amended the Climate Change Act 2008 in June 2019 to target net zero carbon emissions by 2050. The target requires the UK to bring all greenhouse gas emissions to net zero by 2050, compared with the previous target of at least 80% reduction from 1990 levels.

Any emissions must be balanced by schemes to offset an equivalent amount of greenhouse gases.

4.2 UK Net Zero Strategy

In May 2019, UK Government introduced a commitment to reach net zero carbon emissions by 2050. This includes all emissions (Scopes 1-3) across all industries and sectors.

Prior to the net zero carbon target, the Climate Change Act (2008) committed the UK government to reduce emissions by 80% by 2050, compared to 1990 levels. A report by the Climate Change Committee (CCC) has confirmed that the net zero by 2050 commitment will go beyond what is necessary to limit temperature rise to well-below 2°C.

In order to meet these targets, the government has set five-yearly carbon budgets which currently run until 2050. The budgets restrict the amount of greenhouse gas that the UK can legally emit in a five-year period. The UK is currently in the 4th carbon budget period (2023-2027).

1.2 Grid Carbon Intensity & Energy Reform

When the Climate Change Act was enacted in 2008, nearly 80% of the UK's electricity came from fossil fuels. Since then, there has been a considerable shift toward electrification, resulting in over 50% of the UK's electricity now being sourced from low and zero-carbon technologies.

As the National Grid moves further away from fossil fuels, and with future carbon budgets requiring an even greater contribution from the renewables sector, the changes to UK grid carbon intensity will be drastic.

At present, the Department for Business, Energy & Industrial Strategy (BEIS) estimated emission intensity for the national grid in 2030 to be roughly 100g CO_2e/kWh. This is a further 61% lower than the BEIS 2019 carbon factor used by many Local Authorities for carbon impact assessments today. Between 2040-2050, the National Grid aims to operate entirely using zero-carbon technologies.

In the coming decades, it is expected that there will be further transformations across other sectors, including the electrification of transport and industry, the digitalisation of legacy infrastructure, as well as the decarbonisation of the gas grid through the increased use of hydrogen and bio-gases.

There are still many unknowns as to how exactly the UK will meet their 2050 net zero target, however, it is imperative that industry actors take action now to help to drive the much-needed change.

4.3 The London Plan

The London Plan was adopted in March 2021 and is the Mayor of London's statement on London planning policy and provides 'regional' level material considerations when determining planning applications in London Boroughs. The policies are overseen by the Greater London Authority (GLA).

The GLA London Plan has specific requirements in carbon emission reduction and whole-life carbon practises required for major developments or those referable to the Mayor.

4.3.1 Policy SI 2 Minimising Greenhouse Gas Emissions

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

Embodied Carbon

The emissions associated with a building's materials, including its transport to site, installation and disposal at the end of the building's life. Embodied carbon approaches are integrated into the proposed design.

5. Assessing Embodied Carbon

Embodied carbon refers to the emissions associated with a building's materials. This includes the carbon emitted in producing a building's materials, their transport, installation on site, and disposal at the end of life.

Historically, there has been little guidance and no regulation with regards to embodied carbon. In the past, operational emissions have far outweighed the embodied emissions. However, as the efficiency of our buildings improve and carbon from energy sources decrease, considerations of embodied carbon impacts related to the product and construction stages of a building becomes increasingly important and can account for more than half of a building's WLC, as seen in Figure 2.

5.1 Considering Embodied Carbon in a New Development

The development will aim to provide a better understanding of the sourcing and processing of materials and products. This includes an understanding of long-term, post-completion considerations such as maintenance, durability, adaptability, and also capitalise on the carbon savings value of retaining existing built fabric.

This will be achieved through entrenching embodied carbon at the core of the projects design philosophy. Focusing on lean design, materials sourcing, longevity, and reusability will have the most significant impact on the whole life carbon emissions of the development.

For this analysis the team have conducted the analysis in line with BS EN 15978 utilising the RICS Professional Statement: Whole Life Carbon assessment for the built environment (the RICS PS), to be a guide to the implementation of practical implementation of the BS EN 15978 principles.

For this analysis Oneclick LCA has been used, using the Carbon assessment, GLA / RICS / Green Mark tool.

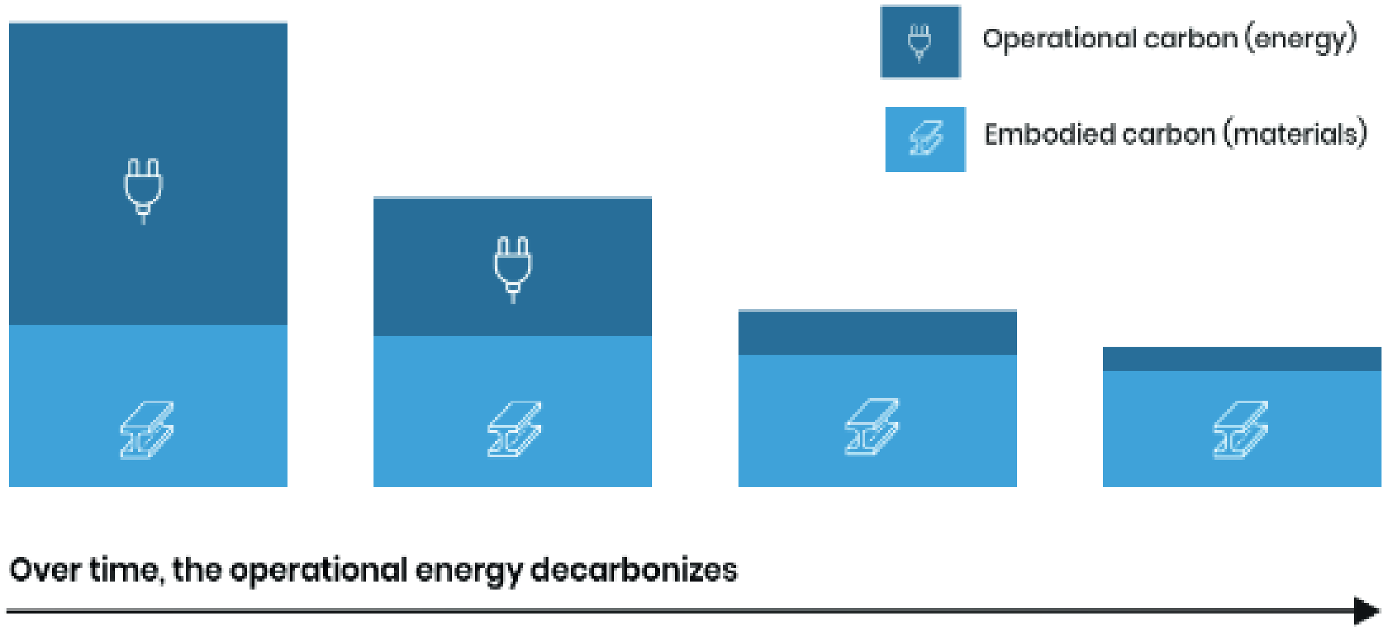

Figure 2 Operational carbon emissions will decrease over time as the grid decarbonises.

5.2 Building Elements to Assess for Embodied Carbon

Following RICS elemental methodology (British Standard), embodied carbon analysis within the built environment is broken down in to the following elements:

- **Substructure**: transfers the load of a building to the ground and isolates it horizontally from the ground. Substructures range from strip foundations through to large underground basements and are usually made from concrete, a highly emissive material. The substructure of a building is generally the element where structural performance is the largest design driver.
- **Superstructure**: the frame of the building required to support the suspended slabs, roof and internal finishes, providing stability.
- **Façade**: the external faces of a building, this can include the roof.
- **Building Services**: these comprise of the lighting, heating, cooling, ventilation and air conditioning plant. Building services have a relatively short lifespan compared to the building itself. Embodied carbon needs to be considered in parallel with operational carbon, lifespan, maintenance, comfort, health and safety, etc.
- **Internal Finishes**: the materials used on all exposed interior surfaces, such as floors, walls and ceilings. These are replaced more frequently and can require significant maintenance.
- **External Works:** This covers hard and soft landscaping on the ground floor level, terraces, roofs and below-ground items such as irrigation tanks.

6. Material Selection for the Proposed Development

The BRE 'Green Guide to Specification' will be used when selecting the construction materials for the proposed development to encourage the use of materials which have been produced with minimal impact to the environment in line with good-practice methodology. The guide promotes the use of sustainable materials with low embodied energy, low ecotoxicity and a long life-span.

Additionally, the materials selected will be responsibly sourced and where practicable meet the following guidelines:

- ISO14001;
- BES6001;
- PEFC / FSC;
- Chain of Custody.

Figure 3 illustrates that it is during the design stage that embodied carbon can be reduced the most, which is why it is integral that the materials used for the proposed development are explored as early as possible.

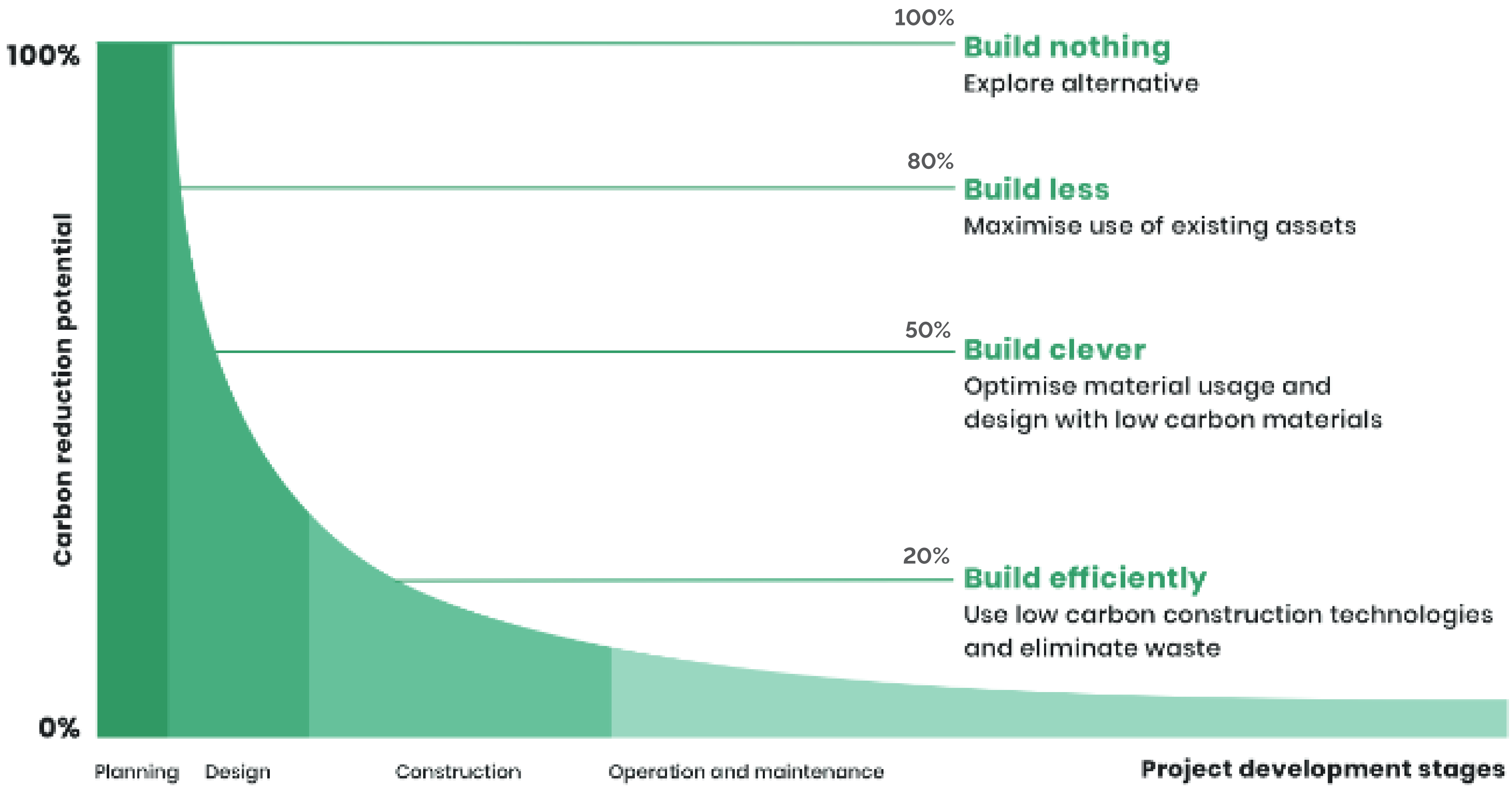

Figure 3 Embodied carbon reduction potential in different stages of a building project (adapted from LCA WLC Ebook)

Operational Carbon

Operational carbon refers to the emissions associated with the energy consumed by a building during its use, outlining operational emission reduction measures to be considered within the proposed development.

7. Assessing Operational Carbon

Operational carbon refers to the emissions associated with the energy consumed by a building during its use (B6 and B7). This includes the energy consumed by heating, hot water, cooling, ventilation, and lighting systems. Any plug-in devices such as fridges, washing machines, TVs, IT facilities, lifts, cooking and process loads are also accounted for.

In order to reduce and minimise the need for energy use, in particular space heating, the design philosophy in the first instance will focus on building form and fabric. Passive design measures will be incorporated to maximise daylight availability, minimising the need for artificial lighting. Additionally, natural ventilation and building shading devices can be employed to reduce the need for comfort cooling.

Operational energy influences a building's ability to achieve a net zero balance through a number of different interdependent factors. It is arguably the most direct and consistent environmental impact that a building has throughout its life cycle and is directly related to the ways in which we occupy and interact with buildings. The operational energy of a building is its carbon legacy. In the context of the climate emergency, there is an urgent need to limit these ongoing impacts. The proposed development should therefore aim to perform beyond Building Regulation requirements.

7.1 Regulated and Unregulated Carbon

Operational energy consumption is often categorised into two key components:

- **Regulated carbon emissions** are those associated with heating, cooling, hot water, lighting and any other fixed building services equipment. These are the emissions that are regulated under Part L of the Building Regulations.
- **Unregulated carbon emissions** are associated with small power and plug-in items and any other process or plant equipment that is not covered under Part L of the Building Regulations.

One of the well-documented shortcomings of the current Part L calculation methodology is its omission of unregulated energy loads. Therefore the design team have carried out a TM54 analysis to capture the performance gap between modelled and measured energy performance.

7.2 Energy Strategies for Proposed Harefield Academy Development

7.2.1 Implementing the Energy Hierarchy

The energy hierarchy is a classification of energy strategies, prioritised to assist progress towards a more sustainable energy system. The energy hierarchy is used in accordance with the London Local Plan (Policy SI2) to reduce greenhouse gas emissions in operation and minimise both annual and peak energy demand. The energy hierarchy recognises that there is no single solution to achieve net-zero carbon and that a portfolio of resources must be deployed in order to achieve an affordable and sustainable way forward.

The proposed development will operate on an all-electric system powered by Air Source Heat Pumps (ASHP).

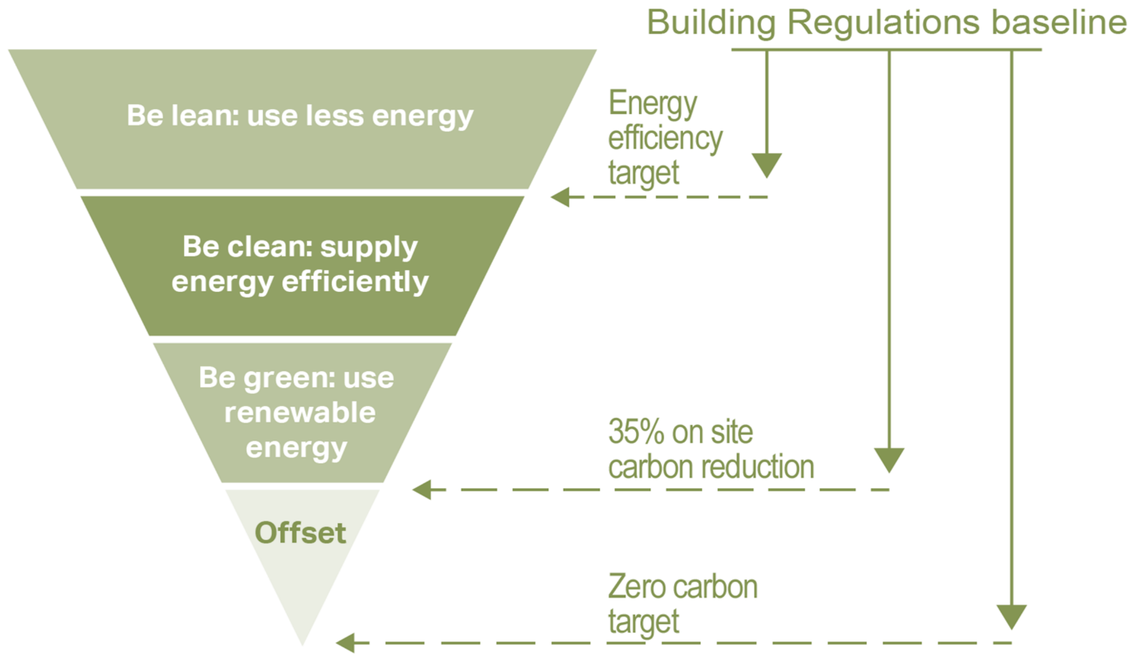

Figure 4 The London Plan energy hierarchy.

Reducing Energy Demand

Minimising a building's potential CO_2 emissions can be achieved through reducing energy demand ('Be Lean'), using passive design measures. Passive design options are those that utilise some of the following methods to help reduce the need for energy consumption by exploiting the natural surroundings:

- **Building Fabric**: the materials that make up walls, floors, roofs, windows and doors of the building. The more insulation contained within these elements, the better their thermal performance.
- **Building Form + Orientation**: the greater the building form ratio (external area: internal area), the less efficient the building and the greater the energy demand. The quantity of south-facing glazing should also be considered for overheating risks.

Use of Renewables

Solar photovoltaic panels are required to meet local council requirements and are proposed for the roof of this development. They will provide zero-carbon electricity and reduce overall operational carbon emissions.

Methodology of WLC calculation

Methods and programs used to create WLC assessment results.

8. Embodied Carbon

For this analysis the team have conducted the analysis in line with BS EN 15978 utilising the RICS Professional Statement: Whole Life Carbon assessment for the built environment (the RICS PS), to be a guide to the implementation of practical implementation of the BS EN 15978 principles.

The OneClick LCA tool has been used to calculate the embodied carbon for the lifetime of the building. This includes data such as pre-determined water use volumes, construction emissions, pre-determined energy use and volumes of building materials.

Within the OneClick LCA tools, materials and components have been selected from EPD certificates where available. Where this is not possible, similar materials have been selected from the database. As material selection has not yet been finalised, typical EPDs have been selected where possible.

The lifespan of the building has been agreed as 60 years.

9. Operational Carbon

In addition to following the London Plan Energy Hierarchy to ensure efficient energy use for the proposed development, the CIBSE TM54 methodology has also been undertaken to follow the route to Net Zero Carbon by complying with Energy Use Intensity (EUI) Targets for schools. This ensures that carbon emissions produced through unregulated energy consumption are offset as well as the regulated energy as shown within an Approved Document Part L2 2021 (ADL2 2021) simulation.

A net zero carbon analysis study has been taken in line with TM54 rather than the use of ADL2 2021, as measured operational energy is significantly higher than estimated energy use from ADL2 models as they do not factor in unregulated energy use.

The operational carbon methodology has been calculated by Clearwater, found in document TVC0024-ESS-XX-XX-RP-ME-002.

10. Material Data Sources and Quantities

Estimates of the types and quantities of materials for the assessment are from a combination of the following sources:

- **Architectural and structural 3D model** – a Revit model which contains materials and the quantities in the IFC file format.
- **Architectural drawings** – including floor layouts, elevations/facades, ceiling and floor finishes, internal wall layouts.
- **Cost plan** - a cost plan that includes line items for each of the materials of the building.

11. Carbon Emissions Factors

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

- For materials manufactured in the UK, SAP 10 emission factors are used in line with the GLA's Energy Assessment Guidance.
- Products sourced from outside the UK use data appropriate to the local energy grid at that location.

12. GLA WLC Benchmarks

The GLA has provided minimum and aspirational benchmark figures for a number of building types for the WLC assessment. It should be noted that these do not include operational carbon emissions (B6-B7).

The 'Schools' WLC benchmarks are displayed in Table 4.

Table 3 GLA Schools WLC benchmarks

Modules	WLC Benchmark (kgCO_2e/m² GIA)	Aspirational WLC Benchmark (kgCO_2e/m² GIA)
A1-A5 (excluding sequestration)	< 750	< 500
B-C (excluding B6 + B7)	< 250	< 175
A-C (excl. B6 + B7, incl. sequestration)	< 1000	< 675

Whole Life Carbon Assessment Results

Results from the GLA OneClick whole life-cycle assessment of carbon based on the proposed design at Harefield Academy.

13. Operational Energy

The total operational carbon emissions have been calculated over a 60-year study period in line with the draft GLA guidance.

The total operational carbon emissions for the site (total estimated emissions from regulated and unregulated energy uses) have been calculated to be:

882 tCO_2

This figure does not include the use of the PV renewable production on site.

14. OneClick Model Results

The approximate whole-life-cycle carbon emissions (excluding operational energy + water) for the proposed design for Harefield Academy is:

2,252 tCO_2

A breakdown and summary of the embodied carbon and operational energy carbon emissions can be seen in Table 5.

14.1 Breakdown of Embodied Carbon

The study demonstrates that for the proposed development at Harefield Academy, the largest share of embodied carbon will be contained within the product stage containing life cycle stages A1-A3, also known as cradle to gate stages.

This demonstrates that in order to consider reducing the embodied carbon of a data centre, it is imperative to focus on the materials being selected and reducing the quantities and mass of materials required.

Smaller proportions of embodied carbon, approximately are a consequence of the transport of materials to site (life cycle stage A4). Whilst this might often not need to be the focus of a future optioneering exercise to reduce embodied carbon attributed to a development, it is still important to reduce transport emissions through sourcing materials locally wherever possible.

Table 4 Breakdown of OneClick WLC emission results.

<table>
<tr><th>Whole Life Carbon Scope</th><th>Model Design (kgCO_2e/m^2 GIA)</th><th>WLC Benchmark</th><th>Aspirational WLC Benchmark</th></tr>
<tr><td>A1-A5
(Product Stage + Construction Stage)</td><td>664</td><td>Met</td><td>Exceeded</td></tr>
<tr><td>B1-B5
(In-Use Stage)</td><td>248</td><td rowspan="2">Exceeded</td><td rowspan="2">Exceeded</td></tr>
<tr><td>C1-C4
(End of Life Stage)</td><td>80</td></tr>
<tr><td>B6
(Operational Energy)</td><td>383</td><td></td><td></td></tr>
<tr><td>B7
(Operational Water)</td><td>6</td><td></td><td></td></tr>
</table>

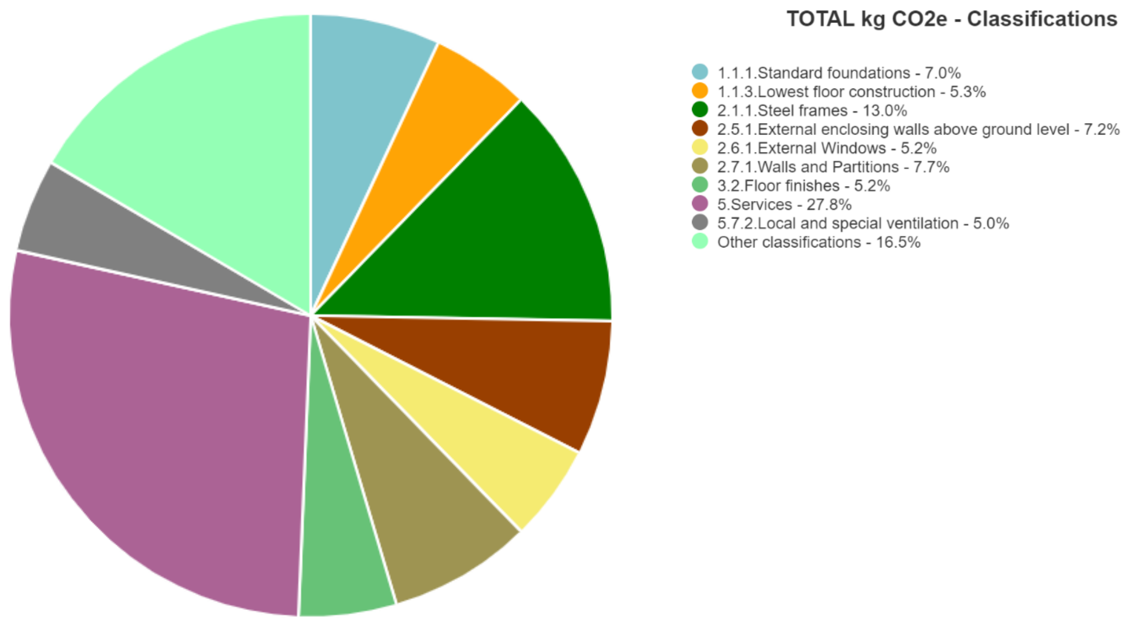

Figure 5 Breakdown of carbon emissions per RICS Element