MAYOR OF LONDON

WHOLE LIFE-CYCLE CARBON ASSESSMENTS GUIDANCE

CONSULTATION DRAFT

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CONTENTS

1 Introduction

1.1 What is this guidance?

1.1.1 This guidance explains how to prepare a Whole Life-Cycle Carbon (WLC) assessment in line with Policy SI 2DB of the Intend to Publish London Plan (London Plan). It is for anyone involved in, or with an interest in, developing WLC assessments including planning applicants, developers, designers, energy consultants and local government officials. Policy SI 2DB applies to planning applications which are referred to the Mayor. However, WLC assessments are also supported and encouraged on major applications which are not referable to the Mayor.

1.1.2 This guidance explains how to calculate WLC emissions and the information that needs to be submitted to comply with the policy. It also includes information on design principles and WLC benchmarks to aid planning applicants in designing buildings that have low operational carbon and low embodied carbon.

1.2 What are Whole Life-Cycle Carbon emissions?

1.2.1 WLC emissions are those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated[1] and unregulated[2] energy use, as well as its embodied carbon emissions, i.e. those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. A WLC assessment also includes an assessment of the potential carbon emissions 'benefits' from the reuse or recycling of components after the end of a building's useful life. It provides a true picture of a building's carbon impact on the environment.

1.2.2 The World Green Building Council estimates that, globally, construction accounts for 11% of carbon emissions. Key players in the construction industry, from developers to engineers and architects, must play their part in responding to the climate emergency by designing and building according to WLC principles.

2 Background and related information

2.1 The Mayor's net zero-carbon target

2.1.1 National Building Regulations and the Mayor's net zero-carbon target for new development account for a building's operational carbon emissions. As methods and approaches for reducing operational emissions have become better understood, and as targets have become more stringent, these emissions are now beginning to make up a declining proportion of a development's carbon emissions. Attention now needs to turn to WLC to incorporate embodied carbon emissions.

2.1.2 The Mayor's net zero-carbon target continues to apply to the operational emissions of a building. The WLC requirement is not subject to the Mayor's net zero-carbon target for new development but, as set out in London Plan Policy SI 2, planning applicants are required to calculate these emissions and demonstrate how they can be reduced as part of the WLC assessment. Planning applicants should continue to follow the GLA's Energy Assessment Guidance to assess and reduce operational emissions and insert the relevant information into the WLC assessment. This is explained further in the following section.

2.1.3 A set of WLC benchmarks have been developed which applicants will be asked to compare against their own results as part of their WLC assessment and which the GLA will refer to in its review of these assessments. An 'aspirational' set of WLC benchmarks have been devised for applicants that wish to go further. Both sets of benchmarks are included in Appendix 2.

2.2 Principle benefits of a WLC assessment

2.2.1 Calculating and reducing WLC emissions offers a wealth of benefits including:

- Ensuring that a significant source of emissions from the built environment are accounted for which is necessary in achieving a net zero-carbon city.
- Achieving resource efficiency and cost savings by encouraging the re-use of existing materials instead of new materials and the retrofit and retention of existing structures and fabric over new construction.
- Identifying the carbon benefits of using recycled material and the benefits of designing for future reuse and recycling to reduce waste and support the circular economy.
- Encouraging a 'fabric first' approach to building design thereby minimising mechanical plant and services in favour of natural ventilation.
- Considering operational and embodied emissions simultaneously to find the optimum solutions for the development over its lifetime.

- Identifying the impact of maintenance, repair and replacement over a building's life-cycle which improves life-time resource efficiency and reduces life-cycle costs, contributing to the future proofing of asset value.

- Encouraging local sourcing of materials and short supply chains, with resulting carbon, social and economic benefits for the local economy.

- Encouraging durable construction and flexible design, both of which contribute to greater longevity, reduced obsolescence of buildings and avoiding carbon emissions associated with demolition and new construction.

3 Process and methodology

3.1 When to submit a Whole Life-Cycle Carbon assessment

3.1.1 Planning applicants for proposals referred to the Mayor are required to submit a WLC assessment at the following stages:

- Pre-application
- Planning application submission (i.e. RIBA Stage 2/3)
- Post-construction (i.e. upon commencement of RIBA Stage 6 and prior to the building being handed over, if applicable. Generally, it would be expected that the assessment would be received three months post-construction)

3.2 WLC assessment template

3.2.1 A WLC assessment template has been developed which comprises all of the information applicants will need to submit at each stage and is available on the GLA's website[3]. This template should be completed and submitted to the GLA to ensure clarity and transparency. Section 4 explains what is included in the assessment template at each stage i.e. pre-application, planning application submission and post-construction, and further details on submitting the template to the GLA.

3.3 Integration of WLC assessments with other documents submitted at planning application stage

3.3.1 A WLC assessment will have links to the energy assessment for the development and the Circular Economy Statement which will be submitted as part of the planning application. All three documents should be aligned with appropriate cross-referencing. This section provides further detail on how work undertaken as part of the energy assessment and the Circular Economy Statement feeds into the WLC assessment.

3.3.2 Examples of other documents which may have an impact on the WLC assessment include:

- Design and Access Statements
- Environmental Impact Assessments
- Sustainability Statements and/or Sustainability Checklists
- Sustainability Assessment Method Reports
- Site Waste/Resource Management Plan

3.4 Methodology

3.4.1 WLC assessments should be carried out using a nationally recognised assessment methodology and should demonstrate the actions that have and will be taken to reduce WLC emissions. The assessment should cover the development's carbon emissions over its life-time, accounting for:

- its operational carbon emissions (both regulated and unregulated)
- its embodied carbon emissions
- any future potential carbon emissions 'benefits', post 'end of life', including benefits from reuse and recycling of building structure and materials. See also London Plan Policy SI 7 'Reducing waste and supporting the circular economy'.

3.4.2 In the UK, the framework for appraising the environmental impacts of the built environment is provided by BS EN 15978: 2011: (Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method). It sets out the principles and calculation method for whole life assessment of the environmental impacts from built projects based on life-cycle assessment.

3.4.3 Underpinning BS EN 15978 is the RICS Professional Statement: Whole Life Carbon assessment for the built environment (referred to as the RICS PS for the remainder of this guidance)[4]. The RICS PS serves as a guide to the practical implementation of the BS EN 15978 principles. It sets out technical details and calculation requirements.

3.4.4 In developing a WLC assessment for compliance with Policy SI 2, applicants should follow BS EN 15978 using the RICS PS as the methodology for assessment. The rest of this section confirms various aspects of the RICS PS which are to be followed or where a different approach should be taken to comply with Policy SI 2.

3.5 Life-cycle modules

3.5.1 BS EN 15978 and the RICS PS set out four stages in the life of a typical project described as life-cycle modules:

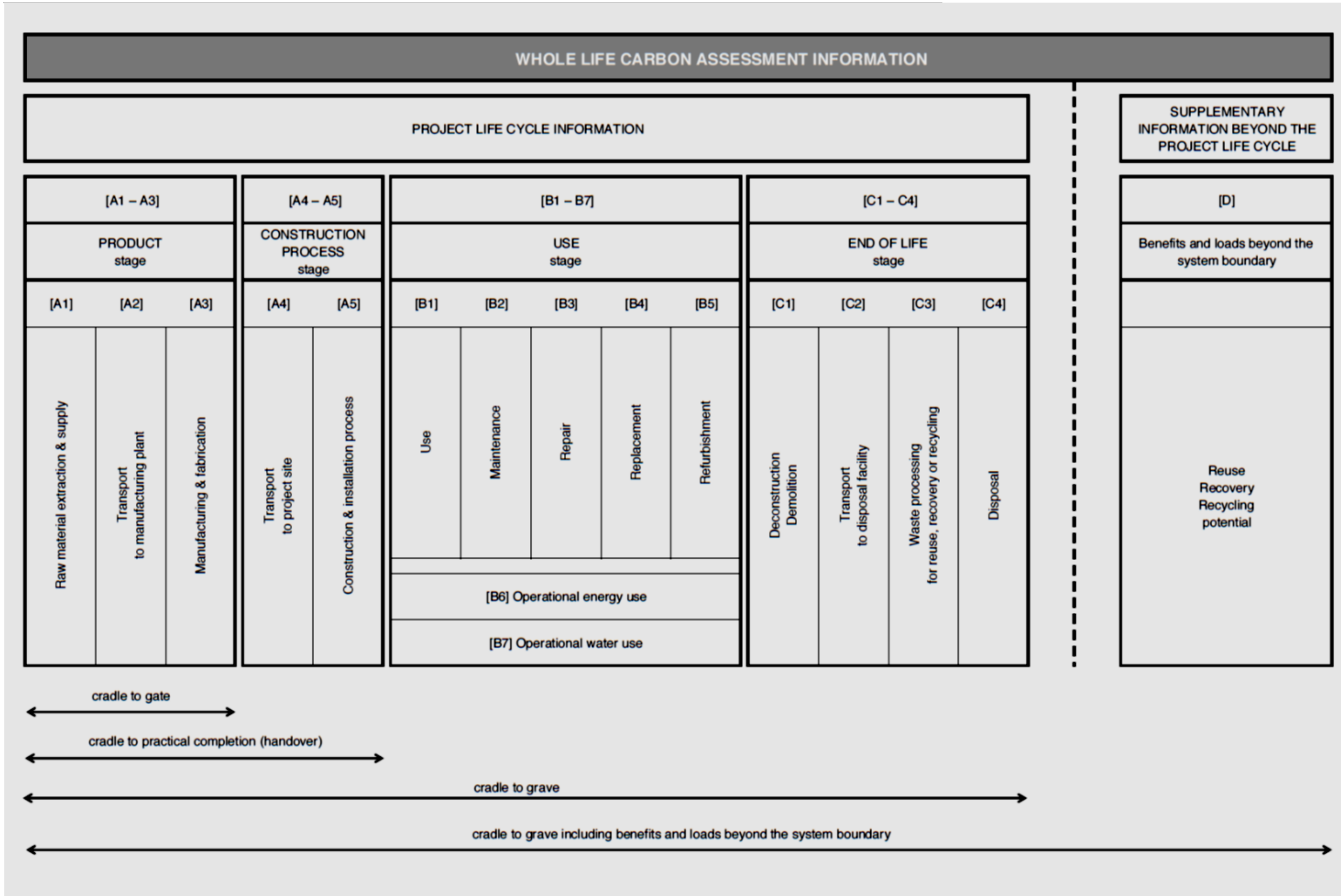
- Module A1 – A5 (Product sourcing and construction stage)
- Module B1 – B7 (Use stage)
- Module C1 – C4 (End of life stage)
- Module D (Benefits and loads beyond the system boundary)

3.5.2 A WLC assessment needs to cover the entirety of modules A, B, C and D to comply with Policy SI 2, rather than just the minimum requirements identified in the RICS

PS. Figure 1 outlines what is captured under each module with further detail provided below and in the RICS PS.

3.5.3 Each module should be presented separately, as identified in the WLC assessment template. The reference study period (i.e. the assumed building life expectancy) for the purposes of the assessment is 60 years. Where the design life of the project exceeds or is less than 60 years, the assessment should still be done to 60 years but with an accompanying explanation of the life-cycle and end of life scenarios for the actual design life.

Figure 1 Life-cycle modules (BS EN 15978)



Module A (Product sourcing and construction stages)

3.5.4 The first objective of this module is to reduce carbon emissions from the sourcing, transportation, fabrication and construction of all materials and products (A1-A5). Secondly, to ensure that the choices that are made will also help reduce future carbon emissions through subsequent life-cycle stages (B, C, D), a close understanding of the supply chain is needed. For example, whether virgin or recycled material sources are being used (A1); the energy sources and local energy grid associated with the manufacture of products (A1); the location of manufacturing plants in relation to the site, the transport methods and travel distances from material sources to fabrication plants (A2), and from fabrication to site (A4); the level of waste associated with the manufacture of the product (A1, A3); and the on-site assembly of products into the finished scheme (A5). Emissions should be estimated using manufacturers' recommendations and Environment Product Declarations (EPDs) where possible, identifying the source of the EPDs.

3.5.5 The processes used in fabricating products (A3) are also important, as well as the methods used to construct the building, including contractor related items such as temporary works, shuttering type and energy use (A5). Off-site or modern methods of construction (MMC) can have significant benefits in reducing waste (A1, A3, A5) and the extent of repair and maintenance as part of the 'snagging' process (A5). Whilst the focus of module A is on the materials and processes up to project completion, the selections made should also take account of the future life-cycle of the building (modules B, C, D).

Module B (Use stage)

3.5.6 The objective of this module is to understand, at the design stages, how the building will perform post-construction and how to ensure that in-use emissions (B1-B7) will be minimised. This includes the in-use emissions of some products, for example, some refrigerants and paints (B1). There are materials and products which are capable of being 'regenerative', in that they absorb carbon dioxide from the atmosphere (B1) over the life-cycle of the building, and these should be accounted for in the assessment.

3.5.7 Designing to minimise future emissions from maintenance (B2), repair (B3) and replacement (B4) across all building element categories over the future lifecycle of the building will have long-term carbon (and financial) benefits. Reasonable maintenance scenarios should be developed based on facilities management information.

3.5.8 Emissions from maintenance, repair and replacement should be estimated using manufacturers' recommendations and Environment Product Declarations (EPDs) where possible (identifying the source EPD). Alternatively, warranty periods for the replacement of major systems such as windows, cladding, services, plant should be used unless scenarios are provided, supported by evidence, for periods longer than the provided warranties. A possible source of life-span data is from Building Cost Information Service[5]. Where warranty periods are unavailable, reasonable life span periods should be assumed supported by suitable evidence. See item 3.5.3.4 of the RICS PS for details of replacement assumptions that should be made. If there is an alteration or refurbishment (B5) planned from the outset of the project, then steps can be taken during the design stages to ensure that this will be facilitated with minimum or zero waste, or damage to existing fabric. Specific future alterations or improvements that are known and planned at the point of practical completion should be included.

3.5.9 Operational energy use (B6) should be minimised by considering the overall resource efficiency of the building. In completing this module, applicants should use the estimate of operational energy use provided in the energy assessment and insert this figure directly into the WLC assessment. This should reflect the estimated figures calculated as part of the SAP and CIBSE TM54 analyses for domestic and non-domestic uses respectively. This is in line with Section 3 of the ‘Be Seen – energy monitoring guidance’. Modules A1-A5 and module B6 should be considered together. Any energy use and emissions associated with water related systems i.e. operational water use (B7) should be captured under operational energy use (B6). Module B7 covers carbon emissions related to water supply and wastewater treatment.

Module C (End of life stage)

3.5.10 This module captures the emissions from when the building has reached the end of its useful life, i.e. at the end of the 60-year reference study period. It covers deconstruction and demolition (C1), transport (C2), waste processing for reuse, recovery or recycling (C3) and disposal (C4), until the site is cleared, level and ready for further use. Suitable project-specific scenarios should be used to establish the anticipated end-of-life carbon emissions impacts of these actions (C1-C4). The carbon reduction activities undertaken for module C3 will be set out as part of the Circular Economy Statement (see Policy SI 7 and Circular Economy Statement Guidance). The potential carbon costs or benefits associated with these activities should be calculated and included in the appropriate section of the WLC assessment.

3.5.11 Designing to enable future disassembly and dismantling will reduce the likely carbon impacts of these activities and facilitate the potential carbon benefits (see module D) from a future circular outcome.

Module D (Benefits and loads beyond the system boundary)

3.5.12 Deciding what will happen to a building after it has been dismantled or demolished many years in the future is clearly speculative. However, in order to transform London to a resource-efficient, zero-carbon economy, it is essential that these issues are given careful consideration at the design stage. The Circular Economy Statement for the development will set out the carbon reduction activities undertaken for this module. The potential carbon costs or benefits associated with these activities should be calculated and included in the appropriate section of the WLC assessment.

3.5.13 The objective is to facilitate future reuse, recovery and recycling at the highest possible level. The applicant is required to develop realistic and feasible scenarios, supported by evidence, to support any carbon benefits included in the reporting of module D. Due to the speculative nature of these scenarios this module is reported separately. Module D is essentially (in combination with module C3) the ‘circular economy’ module. Its importance is that it provides a carbon emissions quantification of the potential circular benefits of a scheme.

3.5.14 Figures provided should be accompanied by the circular scenarios assumed (as per ‘material quantity and end of life scenarios’ table in the template file). The principle is that for a project that follows the ‘end of life’ of the applicant’s project, the future carbon cost of making a component (e.g. an appropriately specified steel beam) or an entire structural frame will be avoided and the saving will be the same as the process of providing a new component or system (subject to grid decarbonisation, see 3.8). As this potential future carbon benefit is the result of a design decision made today, it is recorded in this module.

3.6 Building elements

3.6.1 The WLC assessment should, in line with the RICS PS, cover all building elements listed in Table 1 that are applicable to the project and are to be included in the finished area of the completed project, including temporary works.

3.6.2 The building elements are broken down according to the RICS New Rules of Measurement (NRM) classification system level 2 sub-elements. The unit of area measurement to be used is Gross Internal Area (GIA) m^2. Floor areas should be measured in accordance with RICS Property Measurement standards.

Table 1: Building elements (RICS PS)

Building element group	Building element (NRM level 2)
Demolition	0.1 Toxic/hazardous/contaminated material treatment
	0.2 Major demolition works
0 Facilitating works	0.3 & 0.5 Temporary/enabling works
	0.4 Specialist groundworks
1 Substructure	1.1 Substructure
2 Superstructure	2.1 Frame
	2.2 Upper floors incl. balconies
	2.3 Roof
	2.4 Stairs and ramps
2 Superstructure	2.5 External walls
	2.6 Windows and external doors
2 Superstructure	2.7 Internal walls and partitions
	2.8 Internal doors
3 Finishes	3.1 Wall finishes
	3.2 Floor finishes
	3.3 Ceiling finishes
4 Fittings, furnishings and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building-related* and non-building-related**
5 Building services/MEP	5.1–5.14 Services incl. building-related* and non-building-related**
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units

7 Work to Existing Building	7.1 Minor demolition and alteration works
8 External works	8.1 Site preparation works
	8.2 Roads, paths, pavings and surfacings
	8.3 Soft landscaping, planting and irrigation systems
	8.4 Fencing, railings and walls
	8.5 External fixtures
	8.6 External drainage
	8.7 External services
	8.8 Minor building works and ancillary buildings

* Building-related items: building-integrated technical systems and furniture, fittings and fixtures built into the fabric or included in the shell and core specification. 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. Therefore, for Shell and Core construction this is not part of the assessment scope.

n.b. Scope comparison with BREEAM 2018: items 2.1 to 2.6 is mandatory for BREEAM Mat01 assessment and items 1 and 5 are optional.

3.6.3 The total quantities for the project should be used (including temporary works), as provided or approved by the project Quantity Surveyor, to inform the project cost appraisal at planning submission stage of the WLC assessment. At the post-construction stage of the WLC assessment, the ‘as built’ information should be used, with quantities approved by the project Quantity Surveyor. A minimum of 95% (EN 15804; 6.3.5) of the cost allocated to each building element category should be accounted for in the assessment.

3.7 Materials and products

Acceptable sources of carbon data for materials and products

3.7.1 The following are acceptable sources of carbon data for materials and products, in line with the RICS PS and in order of preference:

- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with BS EN 15804

- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 21930

- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 14067

- EPDs and datasets in accordance with ISO 14025, ISO 14040 and 14044

- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with PAS 2050

- If no EPDs can be sourced for a product or system, then an EPD can be used of the closest similar product adjusted to reflect any variations. If that is not possible then a bespoke EPD can be produced using carbon factors from the Bath ICE Database[6], material quantities, and with allowances for fabrication processes, transport etc.

3.7.2 Sequestered (or biogenic) carbon from the use of timber should be assessed in accordance with Clause 3.4.1 of the RICS PS. Sequestered carbon should be included within the reported totals for A1-A3 but must also be identified separately in the relevant part of the WLC assessment template.

3.7.3 The carbon footprint of mechanical, electrical and plumbing engineering (MEP) systems may be difficult to calculate in detail due to a lack of EPDs or other data sources. Where information is lacking or incomplete, applicants should use the carbon footprint of the key materials used to manufacture the equipment, by weight. Such data should be available from manufacturers' datasheets. The total weight calculated should be no less than 95% of the total equipment weight. The transportation emissions (A4) of MEP systems must use the 'European manufactured' transportation scenarios (see Table 7, page 19 of the RICS PS) for calculation at all reporting stages. This is to ensure the complexity and transportation of components used for MEP systems is taken into account.

3.8 Grid decarbonisation

3.8.1 Applicants should provide two sets of WLC emission figures at both planning application submission and at the post-construction stage. The WLC assessment template allows for both sets of figures to be provided at both stages.

3.8.2 The first set of figures will be based on the current status of the electricity grid and will provide a point in time assessment. For materials manufactured in the UK, SAP 10 emission factors should be used in line with the GLA's Energy Assessment Guidance. Products sourced from outside the UK should use data appropriate to the local energy grid at that location. It is this first set of figures which will be compared to the WLC benchmarks.

3.8.3 It is also important to consider the potential longer-term decarbonisation of the electricity grid and how this may impact on design decisions. The second set of figures should therefore be based on the expected decarbonisation of the electricity grid over the lifetime of the development (i.e. 60 years). This should be done in accordance with the latest ‘National Grid’s Future Energy Scenario: Steady progression’[7], including in relation to the EPDs of all materials (UK and non-UK, for simplicity).

3.8.4 Applicants should state which set of figures will form the basis for their design decisions and this should be maintained throughout the assessment.

4 Content of a WLC assessment by stage

4.1 Pre-application stage

4.1.1 Achieving the maximum WLC reductions for a proposed building begins early on in a development's design. At pre-application stage, applicants are required to complete the pre-application tab of the WLC assessment template, to confirm various site details and to confirm which of the WLC principles are informing the development of the site. This should be submitted to the GLA at pre-application along with all other pre-application documentation.

4.1.2 The WLC principles are listed in Table 2. Applicants should consider and apply all of the below principles subject to each development's unique characteristics and report, in the template, on how each one is influencing the development's design. Reasons for not considering certain principles should also be provided in the template.

Table 2: *Principles for reducing WLC emissions*

No.	Principle	Description	Relevant life-cycle modules
1	**Reuse and retrofit of existing built structures**	Before embarking on the design of a new structure or building, the retrofit or reuse of any existing built structures, in part or as a whole, should be a priority consideration as this is typically the lowest carbon option. Significant retention and reuse of structures also reduces construction costs and can contribute to a smoother planning process.	A1-A5, B1-B6, C1-C4, D
2	**Use recycled or repurposed materials**	Using recycled or repurposed materials, as opposed to newly sourced raw materials, typically reduces the carbon emissions from constructing a new building and reduces waste. This process would start by reviewing the materials already on site for their potential for inclusion into the proposed scheme. Many of the currently available standard products already include a degree of recycled content. Applicants should obtain this information from the supply chain, preferably in the form of an EPD.	A1-A5, B1-B5, C1-C4, D

3	**Material selection**	This is the most important issue affecting the WLC ‘cost’ of a new building. Appropriate low carbon material choices are key to carbon reduction. Ensuring that there is synchronicity between materials selected and planned life expectancy of the building reduces waste and the need for replacement, thus reducing in-use costs. EPDs should be referenced. It is important to note that the overall life-time carbon footprint of a product can be as much down to its durability as to what it is made of. For example, bricks may have a high carbon cost in terms of their manufacture, however they have an exceptionally long and durable life expectancy. The selection of reused or recycled materials and products, plus products made from renewable sources, such as timber, will also help reduce the carbon footprint of a project.	A1-A5, B1-B5, C1-C4, D
4	**Minimise operational energy use**	A ‘fabric first’ approach should be prioritised to minimise the heating and cooling requirement of a building. Naturally ventilated buildings avoid the initial carbon and financial costs of a ventilation system installation, and the repeat carbon and financial costs of its regular replacement.	A1-A5, B1-B4, B6
5	**Minimise operational water use**	Carbon emissions from water use are largely due to the materials and systems used for its storage and distribution, the energy required to transfer it around the building, and the energy required to treat any wastewater. The choice of materials used and the durability of the systems, which help avoid leakage and resulting damage to building fabric, are therefore key aspects of reducing the carbon cost of water use. On-site water collection, recycling and treatment, and storage can have additional positive environmental impacts as well as reducing in-use costs.	A1-A5, B1-B5, B7, C1-C4, D
6	**Disassembly and reuse**	Designing for future disassembly ensures that products do not become future waste and that they maintain their environmental and economic value.	A1-A5, B1-B5, C1-C4, D

		A simple example is using lime rather than cement mortar; the former being removable at the end of a building's life, the latter not. This enables the building's components (e.g. bricks) to have a future economic value as they can be reused for their original purpose rather than becoming waste or recycled at a lower level (e.g. hardcore in foundations). Designing building systems (e.g. cladding or structure) for disassembly and dismantling has similar and even broader benefits. Ease of disassembly facilitates easy access for maintenance and replacement leading to reduced maintenance carbon emissions and reduced material waste during the 'in-use' and 'end of life' phases. This leads to the potential for material and product reuse which also reduces waste and contributes to the circular economy principle.	
7	**Building shape and form**	Compact efficient shapes help minimise both operational and embodied carbon emissions from repair and replacement for a given floor area. This leads to a more efficient building overall, resulting in lower construction and in-use costs. A complex building shape with a large external surface area in relation to the floor area requires a larger envelope than a more compact building. This measure of efficiency can be referred to as the 'wall to floor ratio', or the 'heat loss form factor'. This requires a greater use of materials to create the envelope, and a potentially greater heating and/or cooling load to manage the internal environment.	A1-A5, B1-B6
8	**Regenerative design**	Removing CO_2 from the atmosphere through materials and systems absorbing it makes a direct contribution to carbon reduction. Examples include unfinished concrete, some carpet products and maximising the amount of vegetation.	A1, B1, D
9	**Designing for durability and flexibility**	Durability means that repair and replacement is reduced which in turn helps reduce life-time building costs. A building designed for flexibility can respond with minimum environmental impact to future	A1-A5, B1-B5,

		changing requirements and a changing climate, thus avoiding obsolescence which also underwrites future building value. Buildings designed with this principle in mind will be less likely to be demolished at the 'end of life' as they lend themselves to future refurbishment. Examples include buildings being designed with 'soft spots' in floors to allow for future modification and design as well as non-structural internal partitions to allow layout change.	C1-C4, D
10	**Optimisation of the relationship between operational and embodied carbon**	Optimising the relationship between operational and embodied emissions contributes directly to resource efficiency and overall cost reduction. For example, the use of insulation has a clear carbon benefit whereas its fabrication has a carbon cost. This means that it is important to look not only at the U-value of insulation, but also the carbon cost of the manufacture and installation of different product options. Avoiding fully glazed façades will reduce cooling demand and limits the need for high-carbon materials (glass units, metal frame, shading device etc) both at the construction stage, and the 'in use' stage through wholesale replacements.	A1-A5, B1-B6
11	**Building life expectancy**	Defining building life expectancy gives guidance to project teams as to the most efficient life expectancy choices for materials and products. This aids overall resource efficiency, including cost efficiency and helps future proof asset value.	A1-A5, B1-B5, C1-C4, D
12	**Local sourcing**	Sourcing local materials reduces transport distances and therefore supply chain lengths and has associated local social and economic benefits e.g. employment opportunities. It also has benefits for occupiers as replacement materials are easier to source. Transport type is also highly relevant. A product transported by ship will have a significantly lower carbon cost per mile than one sent by HGV. A close understanding of the supply chain and its transport processes is therefore essential when selecting materials and products.	A1-A5, B3-B4
13	**Minimising waste**	Waste represents an unnecessary and avoidable carbon cost. Buildings should be designed to minimise fabrication and construction waste, and to	A1-A5, B1-B7,

		ease repair and replacement with minimum waste, which helps reduce initial and in-use costs. This can be achieved through the use of standard sizes of components and specification and by using modern methods of construction. Where waste is unavoidable, the designers should establish the suppliers' processes for disposal or preferably reuse of waste.	C1-C4, D
14	**Efficient fabrication**	Efficient construction methods (e.g. modular systems, precision manufacturing and modern methods of construction) can contribute to better build quality, reduce construction phase waste and reduce the need for repairs in the post completion and defects period (snagging). Such methods can also enable future disassembly and reuse with attendant future carbon benefits.	A1-A5, B1-B7, C1-C4, D
15	**Lightweight construction**	Lightweight construction uses less material which reduces the carbon footprint of the building as there is less material to source, fabricate and deliver to site. Foundations can then also be reduced with parallel savings. Lightweight construction can also be easier to design for future disassembly and reuse. The benefits of lighter construction should be seen in the context of other principles such as durability.	A1-A5, C1-C4, D
16	**Circular economy**	The circular economy principle focusses on a more efficient use of materials which in turn leads to financial efficiency. Optimising recycled content, reuse and retrofit of existing buildings, and designing new buildings for easy disassembly, reuse and retrofit, and recycling as equivalent components for future reuse is essential. The use of composite materials and products can make future recycling difficult. Where such products are proposed, the supplier should be asked for a method statement for future disposal and recycling.	A1-A5, B1-B5, C1-C4, D

4.2 Planning application submission stage (outline and detailed)

4.2.1 At the planning submission stage (RIBA Stage 2/3), applicants are required to complete the applicable tab of the WLC assessment template (depending on whether it is an outline or detailed application) and submit it to the GLA along with their planning application. This stage of the process requires a WLC assessment against each life-cycle module to be undertaken.

4.2.2 The WLC assessment template will require the following headline information at this stage:

- Context of the project
- Estimated WLC Emissions (kg CO_2e and kg CO_2e/m^2 GIA) for each life-cycle module, which will form the baseline for the development. (At outline planning stage this can be based on default figures from the RICS PS. At detailed planning stage this should be based on bespoke building assumptions).
- Actions taken to reduce whole life-cycle carbon emissions and emission reductions achieved
- Opportunities specified to further reduce the development's WLC emissions
- Assumptions made with respect to maintenance, repair and replacement cycles for all primary building systems (structure, substructure, envelope, MEP services, internal finishes).
- A list of EPDs used to assess product carbon factors
- Key site constraints and opportunities in terms of reducing WLC emissions

4.2.3 The WLC baseline for the development should be compared against the WLC benchmark using the table in the template for this purpose with an explanation comparing the two and outlining any additional reductions that may be possible during the next stages of design.

4.2.4 Applicants will also need to provide the material quantity information in the 'building element category' table which should be informed by the Circular Economy Statement, and then complete the Global Warming Potential (GWP) reporting table at each life-cycle module. Modules C3 and D of the GWP reporting table should also be informed by the Circular Economy Statement. Module B6 should be informed by the methodology outlined in the 'Be Seen' energy monitoring guidance.

4.2.5 For outline planning applications, the applicant should use the default material baseline recommended by the RICS PS (Table 6: Default specifications for main building materials) and the component life spans recommended by RICS PS (Table 9: Indicative component life spans). At the detailed planning application stage, the applicant will be required to review the information provided in the outline tab of the WLC assessment template and replace the default material baseline with a baseline using project specific material specifications and with project specific life span data.

Software tools

4.2.6 It is important to ensure that the software package used to undertake the WLC assessment covers the whole BS EN 15978 and RICS PS scope as outlined in Section 3. In addition, the building element categories included in the assessment should be in line with Table 1; see Section 3.

4.2.7 A list of suitable software tools has been provided in Appendix 1. Applicants wishing to use an alternative tool should ensure that it meets the following criteria:

- It follows BS EN 15978.
- The scope covers modules A-C. Module D must still be assessed but as the majority of available tools do not include module D by default at the moment, this can be done outside the software; see following paragraph.
- The database from which the life-cycle assessment information is sourced is based on EPDs that reflect the country of origin of the material selected.

4.2.8 If the selected software does not automatically calculate figures for module D, the figures should be reported as potential savings under module D, reported in $KgCO_2e/m^2$ and calculated as follows (see also RICS PS Section 3.5.5):

- For a particular component, (e.g. a steel beam), the figures for modules A1-A3 should be used plus an allowance for transport to the future site.
- For an entire structural frame that will remain on site for future reuse, the figures from both the product and construction stages should be used (modules A1-A5), plus an allowance against any avoided deconstruction, using the figures for modules C1, C2 and C4.

4.3 Post-construction stage

4.3.1 A post construction assessment should be appropriately secured at planning stage by the local authority. At this final stage of the WLC assessment process, applicants should complete the post construction tab of the WLC assessment template and submit it to the GLA at: ZeroCarbonPlanning@london.gov.uk upon commencement of RIBA Stage 6 and prior to the building being handed over, if applicable. Generally, it would be expected that the assessment would be received three months post-construction. This should be submitted along with any associated evidence. The subject line of the email should read: WLC assessment for [insert name of development].

4.3.2 Where the planning applicant is not the developer for the site then the responsibility for providing the WLC assessment at this stage falls to the developer. It is the planning applicant's responsibility to ensure that the developer is aware of this requirement. Planning applicants are also advised to pass on the previous assessments to the developer to allow for a smooth transition of responsibility.

4.3.3 The post-construction WLC assessment will require an update of the information provided at planning submission stage (RIBA Stage 2/3) and for the actual WLC carbon emission figures to be reported. Applicants will need to update the WLC calculation results for all modules based on the actual materials, products and systems. For example, for modules A1-A5 the actual transportation emissions from the delivery of materials, removal of waste and site work emissions.

4.3.4 The evidence listed below should be provided to support the updated results. These are minimum evidence requirements and should be submitted along with the WLC assessment template:

- Site energy (including fuel) use record
- Contractor confirmation of as-built material quantities and specifications
- Record of material delivery including distance travelled and transportation mode (including materials for temporary works)
- Waste transportation record including waste quantity, distance travelled and transportation mode (including materials for temporary works)

4.3.5 Applicants will need to compare the post-construction results with the planning submission stage results and provide an explanation for the difference. The post-construction results should also be compared with the WLC benchmarks with an explanation for the difference.

4.3.6 As with the planning submission stage, the 'building element category' table and the modules C and D of the GWP reporting table should be informed by the post-construction Circular Economy Statement.

4.4 Scrutiny of assessments

4.4.1 The GLA will scrutinise assessments for:

- Completeness – has the WLC assessment template been completed in full?

- Technical quality – does the assessment use the appropriate baseline, assessment tools and methodology?
- Reduction in WLC emissions – has the applicant demonstrated that actions have been taken to reduce WLC emissions?
- Level of ambition – do the estimated and actual WLC emissions fall within the benchmarks?

Appendix 1 – Software tools

Tool	Country of origin	Applicable to UK?	Project Type	Online/offline	Scope	Data source
One Click LCA	Finland	Yes	Buildings and civils	Offline software	Modules A-C	Built-in with access to some of the most widely spread local EPD databases, including Ecoinvent.
eToolLCD	Australia	Yes	Buildings	Online software	Modules A-C (+D)	Uses Ecoinvent database (EPDs) which includes data by BRE in the UK.
IES VE	UK	Yes	Buildings	Offline software	Modules A-C	Built-in with access to some of the most widely spread local EPD databases, including Ecoinvent.
Tally	USA	Yes	Buildings	Offline software	Modules A-C	Uses Gabi database which contains EPDs.
Sturgis Carbon Calculator	UK	Yes	Buildings	Offline software	Modules A-C	EPD database built over more than 10 years of practice in the UK. It allows the possibility to input additional EPDs manually.

Appendix 2 - Benchmarks

The WLC benchmarks are based on previous project assessments carried out by Cundall and Targeting Zero and have been cross referenced with data provided by Etool, Oneclick and Hilson Moran. These assessments followed the RICS PS in terms of the scope of assessment, and material baseline assumptions and specifications. All life-cycle modules apart from B6, B7 (operational energy and operational water) and module D are included. The analysis underpinning the WLC benchmarks are based is set out in the table below.

Details of the assessments underpinning the WLC benchmarks

Method of Assessment	BS EN 15978
Life Cycle Stages	Module A1-A5, module B1-5, module C1-C4
Assessment scope* *(> 95% of the cost allocated to each building element category has been accounted for in the assessment.)	Substructure Superstructure: Frame Superstructure: Upper Floors Superstructure: Roof Superstructure: Stairs and Ramps Superstructure: External Walls Superstructure: Windows and External Doors Superstructure: Internal Walls and Partitions Superstructure: Internal Doors Internal Finishes Fittings, furnishings & equipment Services (MEP) External works
Material Carbon Data Quality	EPD in accordance with EN 15804
Material Specification assumption	RICS Professional statement
Material Life span assumption	RICS Professional statement
Material End of Life scenarios	RICS Professional statement
Grid decarbonisation	Not accounted for.

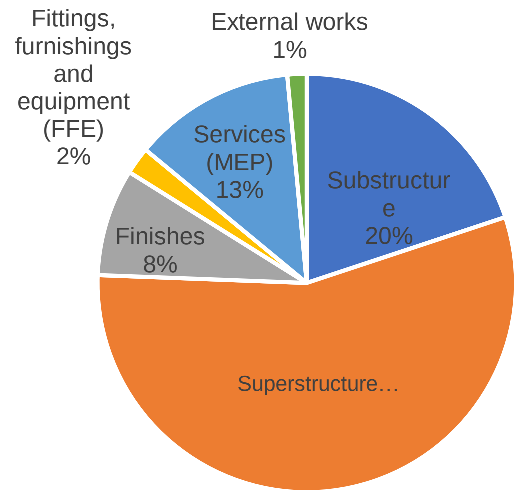
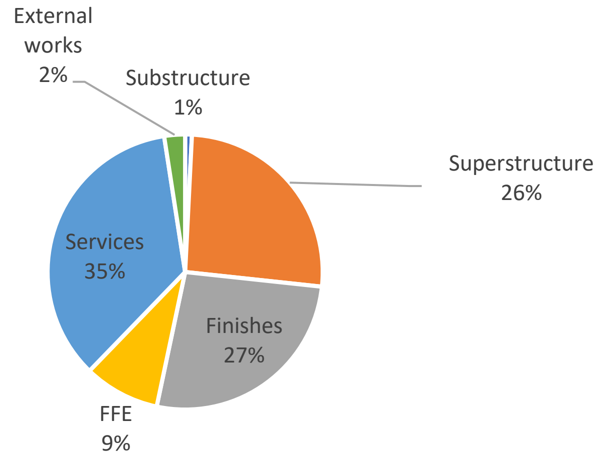
The WLC benchmarks should be used as a guide by all applicants. The benchmarks provide a range rather than a set value and are broken down into building components. Projects with higher WLC emissions than the benchmarks should carefully examine how they can reduce WLC emissions. The WLC assessment template provides space for applicants to explain how and why any variations exist.

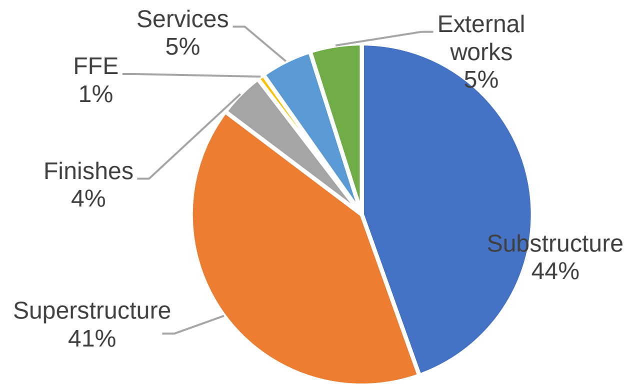
A further set of aspirational WLC benchmarks have been developed which are based on a 40% reduction in WLC emissions on the first set of WLC benchmarks. This is based on the World Green Building Council's target to achieve a 40% reduction in WLC emissions by

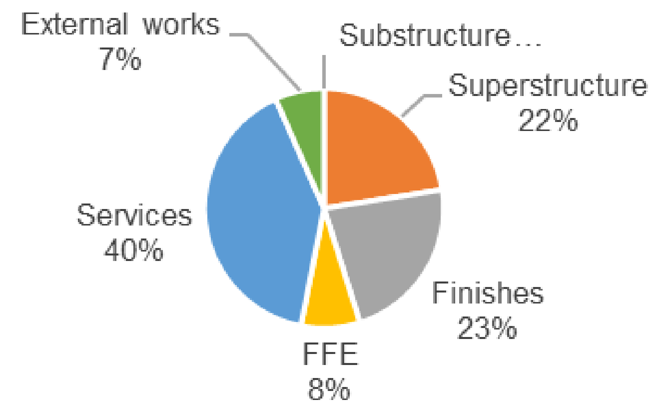
2030. Applicants who wish to go further are encouraged to consider how they can achieve reductions in line with the aspirational benchmarks.

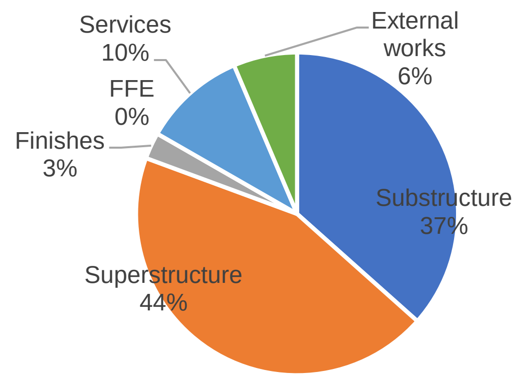
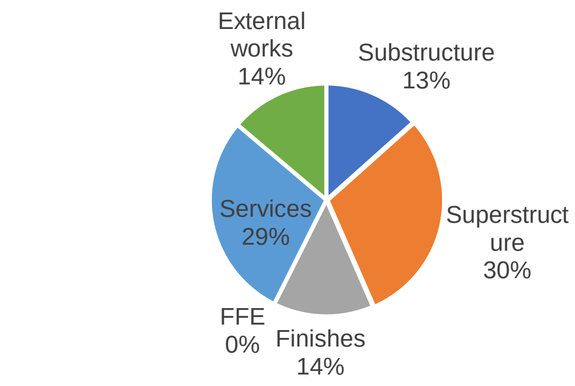
As modules B6, B7 and D have not been included in the benchmarks, due to a lack of available data, applicants will not be able to compare their module B6, B7 and D estimates. Over time, as more data is collected by the GLA and by industry more widely and as data quality improves, these benchmarks will evolve to become more accurate and comprehensive.

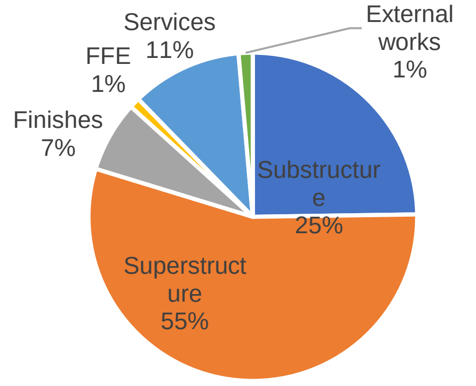
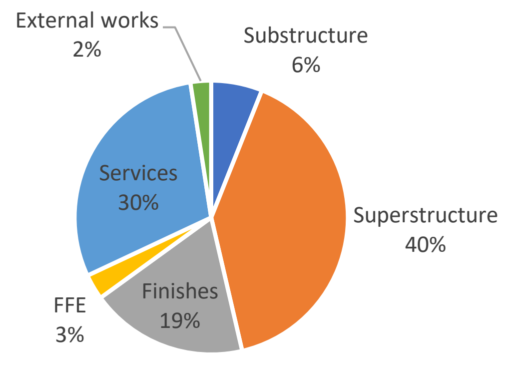
WLC benchmarks (excluding modules B6, B7 and D)

Offices*	WLC benchmark	Aspirational WLC benchmark	Breakdown of a typical development's emissions by building element category
Modules A1-A5	900 to 1000 kg CO_2e/m^2 GIA	550 to 600 kg CO_2e/m^2 GIA	
Modules B – C (excluding B6 & B7)	400 to 500 kg CO_2e/m^2 GIA	250 to 300 kg CO_2e/m^2 GIA	

Retail*	WLC benchmark	Aspirational WLC benchmark	Breakdown of a typical development's emissions by building element category
Modules A1-A5	900 to 1000 kg CO_2e/m^2 GIA	550 to 600 kg CO_2e/m^2 GIA	

Modules B – C (excluding B6 & B7)	100 to 200 kg CO_2e/m^2 GIA	60 to 120 kg CO_2e/m^2 GIA	

Education	WLC benchmark	Aspirational WLC benchmark	Breakdown of a typical development's emissions by building element category
Modules A1-A5	700 to 800 kg CO_2e/m^2 GIA	450 to 500 kg CO_2e/m^2 GIA	
Modules B – C (excluding B6 & B7)	200 to 300 kg CO_2e/m^2 GIA	120 to 180 kg CO_2e/m^2 GIA	

Apartment/hotel	WLC benchmark	Aspirational WLC benchmark	Breakdown of a typical development's emissions by building element category
Modules A1-A5	750 to 850 kg CO_2e/m^2 GIA	450 to 500 kg CO_2e/m^2 GIA	
Modules B – C (excluding B6 & B7)	300 to 400 kg CO_2e/m^2 GIA	180 to 240 kg CO_2e/m^2 GIA	

* Separate use classes for commercial uses including retail and offices have now been replaced by use class E. The most relevant building typology or use should be selected in providing data. Consequential amendments to the reporting templates will be considered once the related changes to Building Regulations are published.

Analysis underpinning the WLC benchmarks

	Hilson Moran average (6 buildings)		eToolLCD average		One Click average (56 buildings)		Cundall average (24 buildings)					
	Office		**Office**		**Office**		**Office**		**Office WLC benchmarks**		**Office aspirational WLC benchmarks**	
	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle
Substructure	247.50	0.51					201	5				
Superstructure	654.53	165.56					562	155				
Finishes	46.00	247.82	1156	2,203*	437	102	84	159	900 to 1000 kg CO_2e/m^2 GIA	400 to 500 kg CO_2e/m^2 GIA	550 to 600 kg CO_2e/m^2 GIA	250 to 300 kg CO_2e/m^2 GIA
FFE	0.18	0.10					21	53				
Services	10.00	9.33					126	211				
External works							15	15				
Total	958.21	423.33	1,155.90	2,203.	436.64	102.00	1010	599				

*Value including refrigerant leakage.

	Hilson Moran average (2 buildings)		eToolLCD (no data)		One Click average (17 buildings)		Cundall average (4 buildings)					
	Retail		**Retail**		**Retail**		**Retail**		**Retail WLC benchmarks**		**Retail aspirational WLC benchmarks**	
	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle
Substructure	270.00	0.00					477	0				
Superstructure	790.00	10.00					437	44				
Finishes	9.00	13.00	-	-	418	89	46	44	900 to 1000 kg CO_2e/m^2 GIA	100 to 200 kg CO_2e/m^2 GIA	550 to 600 kg CO_2e/m^2 GIA	60 to 120 kg CO_2e/m^2 GIA
FFE	0.02	0.00					7	16				
Services	-	-					52	79				
External works	-	-					52	13				
Total	1,069.02	23.00	0.00	0.00	417.52	88.82	1072	195				

	Hilson Moran (1 building)		eToolLCD average		One Click average (64 buildings)		Cundall average (3 buildings)					
	Education		**Education**		**Education**		**Education**		**Education WLC benchmarks**		**Education aspirational WLC benchmarks**	
	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle
Substructure	280	0					288	74				
Superstructure	290	100					347	166				
Finishes	-	-	861	375	623	143	21	77				
FFE	-	-					0	0	700 to 800 kg CO_2e/m^2 GIA	200 to 300 Kg CO_2e/m^2 GIA	450 to 500 kg CO_2e/m^2 GIA	120 to 180 kg CO_2e/m^2 GIA
Services	-	-					81	159				
External works	36	5					50	76				
Total	606	105	861	375	623	143	788	552				

	Hilson Moran (no data)		eToolLCD average		One Click average (113 buildings)		Cundall average (6 buildings)					
	Apartment buildings & hotel		**Apartment buildings & hotel**		**Apartment buildings & hotel**		**Apartment buildings & hotel**		**Apartment/hotel WLC benchmarks**		**Apartment/hotel aspirational WLC benchmarks**	
	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle	Carbon at Completion (A1-A5)	Carbon Over Life Cycle
Substructure	-	-	541	416	440	60	218	21	750 to 850 kg CO_2e/m^2 GIA	300 to 400 kg CO_2e/m^2 GIA	450 to 500 kg CO_2e/m^2 GIA	180 to 240 kg CO_2e/m^2 GIA
Superstructure							484	139				
Finishes							61	65				
FFE							9	10				
Services							96	102				
External works							12	8				
Total	-	-	541	416	440	60	880	346				

Appendix 3 – Further guidance

- BS EN 15978
- BS EN 15804
- RICS Professional Statement: Whole Life-Cycle Carbon Assessment for the Built Environment – 2017
- RIBA Guidance: Embodied and Whole Life-Cycle Carbon assessment for architects.
- Targeting Zero: Embodied and Whole Life-Cycle Carbon explained – RIBA Publishing
- Advancing Net Zero; Net Zero Carbon Buildings: UKGBC
- Bringing embodied carbon upfront: World Green Building Council
- LETI Embodied Carbon Primer

References

[1] The carbon emissions arising from energy used by fixed building services, as defined in Approved Document Part L of the Building Regulations. These include fixed systems for lighting, heating, hot water, air conditioning and mechanical ventilation.

[2] The carbon emissions relating to cooking and all electrical appliances and other small power.

[3] https://www.london.gov.uk/sites/default/files/gla_wlc_assessment_template_may_2020_v.1.0.xlsx

[4] https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf

[5] https://www.rics.org/uk/news-insight/latest-news/news-opinion/bcis-component-life-expectancy-update-for-2018/

[6] https://ghgprotocol.org/Third-Party-Databases/Bath-ICE

[7] https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

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