ED-DES1

City of London Corporation

Carbon Options Guidance

Planning advice note - March **2023 - Rev 01**

CITY OF LONDON

Hilson Moran

Contents

Executive Summary

The City of London Corporation (CoLC) has committed working towards net zero carbon (NZC) for both embodied and operational carbon emissions. The Climate Action Strategy (CAS) specifically commits to

- **NZC for by 2027 in the CoLC's operations**
- **NZC by 2040 across the CoLC's full value chain and in the Square Mile.**

These targets include embodied carbon emissions for the CoLC's own capital projects, but they do not include embodied carbon emissions of other Square Mile buildings that occur outside the boundaries of the City of London. However, in addition to setting up a fully funded action plan to deliver and achieve annual targets against a decarbonisation pathway, the CAS is also supporting workstreams to address the reduction of embodied carbon emissions that make up a large proportion of overall emissions from the built environment.

Planning applications under consideration in 2021 and early 2022 have reported carbon optioneering and whole life-cycle carbon assessment (WLCA) in various ways. The diversity of approaches was making it difficult for planning officers to assess and evaluate proposals as well as to report consistent key results and conclusions to the CoLC's members for decision making.

Hilson Moran was appointed to develop a Planning Advice Note (PAN) for early stage Carbon Options Guidance. The purpose of this study is to advise on:

- The merits of a whole life-cycle carbon (WLC) emission options appraisal as part of the pre-application process to ensure that development proposals maximise the reduction of carbon emissions from the earliest project stages.
- The scope and methodology of comparative WLC emission options for development proposals at the earliest project stage.
- To ensure a like for like comparison, enable consistency of reporting of carbon emissions and the evaluation of pre-application schemes as a substantive basis for the planning application scheme.

The majority of planning applications, 76%, fall under the definition of major development, (which includes the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more). The remaining applications are varied full applications covering change of use, external works and extensions. This means that major development will be responsible for a large proportion of new carbon emissions in the City of London.

The review of data concludes that there is a need for emissions to be accounted for and for options to be considered in the City of London for **all major and referable applications**. Major applications are to consider development options and carbon impacts, applying the methodology presented later in this document. Optioneering should also be carried out for non-major applications, where the majority of the substructure and superstructure (by mass) is not retained. All schemes should undertake independent third-partyreview as a quality assurance mechanism for their optioneering results (see Appendix 7 Third Party Review Guidance).

Other applications should aim to follow this guidance wherever possible, setting out how carbon emissions have been reduced in the design of the proposed works.

Following the optioneering study, planning officers expect that all major developments undertake a WLCA for the chosen option in the planning application.

This is supported by Greater London Authority (GLA) WLC assessment guidance, recommending that all major applications undertake WLCA.

This PAN establishes the variety of ways by which carbon is estimated in the current planning process and proposes an outline methodology that recommends options for different degrees of major interventions in development to be considered and presented.

The methodology establishes the minimum data set required at the pre-planning and planning stages, and the level of transparency to be disclosed to planning officers. The proposed methodology aligns with the principles in the GLA's adopted guidance on Whole Life-Cycle Carbon Assessments (March 2022). The detailed WLC reporting for the chosen option should be provided as part of the planning application.

Two dashboards have been created to equip planning officers with visual and quantified information that is clear and benchmarkable, enabling informed discussions between the applicants, planning officers and other stakeholders. Both the proposed dashboards, for the options and for the planning application scheme, are designed to clearly and consistently present data and results in the planning application documents so they can be more easily scrutinized by all stakeholders and interested parties.

An excel reporting tool accompanies this report which enables a format for consent reporting to be established based on the dashboards.

The Carbon Options Guidance (COG) PAN is designed to be adaptable to the evolving carbon policies and procedures. However, future updates of the methodology may be required as the market matures, industry standards are updated and as assessment tools become more robust and reliable.

Scope of Document

This PAN is designed to provide guidance for development site WLC optioneering evaluations. The PAN is a first step of carbon evaluation and is designed to enable a consistent, early-stage approach to assessing options.

The optioneering exercise is a means of comparing a representative number of development options, in order to find the optimum balance in carbon emissions terms, prior to evaluating other considerations in the planning process.

This is considered to be one of the first steps in the CoLC's pursuit to achieve outstanding, best in class buildings that contribute to an attractive and vibrant City environment.

This approach will be recommended to aid the review and decision-making process, through the submission of more in-depth information that demonstrates how applicants have come to a development decision. This process can be relevant to various application types, that have a significant proportion of new build elements.

The assessment will contribute to the justification for the application proposal and may help with achieving a successful outcome.

An evaluation of recent planning applications and types has been undertaken, based on the City of London Corporation Development Schedule *'Development Schedules March 2021 - Updated Jan'* issued to Hilson Moran by CoLC. The details can be viewed in Appendix 6.

The document sets out a recommended approach to optioneering and provides a reporting dashboard which is expected to be completed as part of the pre-application process. An Excel reporting spreadsheet (Carbon Options Tool) has been created which contains the minimum reporting levels expected for a scheme in line with the dashboard, however, applicants can create their own report should they choose to. The Carbon Options Tool will enable applicants to provide the information for pre-applications and submissions.

Section 8 sets out how options will be considered in the planning process.

Once completed, it is advised that applicants complete the full WLCA analysis for the chosen option for the planning application, in line with the Mayor of London's (Greater London Authority, GLA) *'Whole Life-Cycle Carbon Assessment Guidance (March 2002)'* or, where updated, in line with the guidance in force at the time of application.

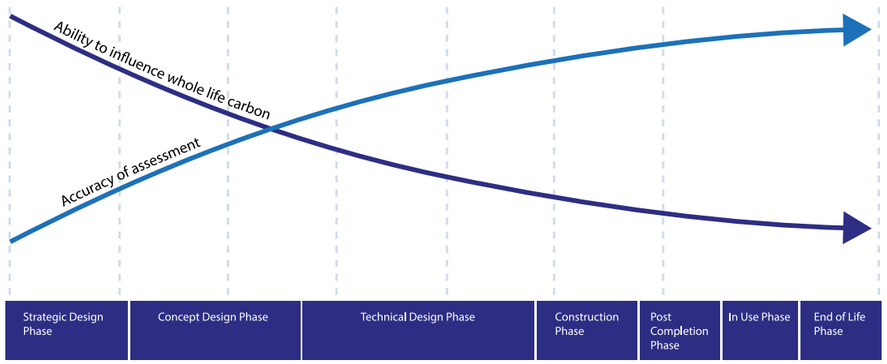


Figure 1: Carbon influence vs Assessment Accuracy from draft RICS Whole-life carbon assessments - 2nd edition

Climate Change

Human activities which result in the release of greenhouse gases, including carbon dioxide ($C0_2$), are estimated to have caused 1°C of global heating above pre-industrial levels. As a result, there have already been sea level rises, increased likelihoods of extreme weather events and melting of sea ice and permafrost. This has direct and devastating impacts on society, including land loss; increased severity and occurrence of wildfires; drought; and difficulties producing food.

Alongside this, there have been unprecedented declines in global biodiversity, with the average abundance of native species in most major land-based habitats falling by at least 20%, mostly since 1900. The quality of habitats which support this biodiversity has also declined, with a 30% reduction in global terrestrial habitat integrity caused by habitat loss, fragmentation and deterioration.' (CIEEM, 2019).

Global emissions need to decrease by 43% by the end of this decade to stay under the preferable 1.5 degrees C global warming target set as part of the Paris Agreement (2015). This is the current recommended threshold to avoid unprecedented heatwaves, terrifying storms, flooding and widespread water shortages (Intergovernmental Panel on Climate Change IPCC, 2022).

The built environment contributes 25% of UK greenhouse gas emissions (CO_2e) that it has direct control over. If emissions influenced by the built environment are included (surface transport vehicle emissions) the built environment contributes around 42% of the UK's total greenhouse gas emissions, $MtCO_2e$. (Net Nero Whole Life Carbon Roadmap, UKGBC, 2021).

The property and construction industry has a moral duty to act and reduce the environmental impacts of this sector as well as mitigate the effects of climate change.

Climate Action Strategy 2020-2027

The City of London is major global commerce centre with huge influence and opportunity to lead the net zero carbon and climate change mitigation and adaptation agenda.

The City of London Corporation (CoLC) has adopted a radical Climate Action Strategy which breaks new ground and sets out how the organisation will achieve net zero, build climate resilience and champion sustainable growth, both in the UK and globally, over the next two decades. By adopting the strategy, CoLC has committed to:

- **Achieve net zero carbon emissions from their own operations by 2027**
- **Achieve net zero carbon emissions across their investments and supply chain by 2040**
- **Support the achievement of net zero for the Square Mile by 2040**
- **Invest £68m over the next six years to support these goals of which £15m is dedicated to preparing the Square Mile for extreme weather events.**

CoLC has set out a fully funded action plan for 2020-2027 and set annual targets. Data on progress will be shared via a programme dashboard, expected to go live for the public mid-2022. At the end of each year CoLC will publish a report of progress against targets for that year. Stakeholders will be invited to participate in a survey to help us understand how well they are reaching and engaging with them.

Carbon Options Guidance
1. Carbon in Planning Policy

This section outlines the means by which carbon emission quantification and reduction are required or encouraged to be reported for planning applications in the City of London.

Part 2 R.2.i of the National Model Design Code (Ministry of Housing, communities and Government, 2021) states a preference for reuse/ refurbishment of buildings over new build development.

Development proposals are generally required to report, for GLA/ CoLC, both the:

- **Embodied carbon emissions, i.e. carbon emissions resulting from materials, construction and the maintenance of a building's life-cycle, and**
- **Operational carbon emissions, from energy consumption throughout the life-cycle of the building.**

However, the scope of reporting in applications is determined by several factors relating to the type of application, the size of the building and the scope of the intervention proposed.

There are a number of policy and guidance documents that determine reporting requirements:

Building Regulations:

At a National Level, in England, Approved Documents Part L Conservation of fuel and power, Volume 1: Dwellings and Part L Conservation of fuel and power, Volume 2: Buildings other than dwellings 2021 editions incorporating 2023 amendments, set out energy efficiency requirements. These regulate some elements of design and specification of buildings that affect energy consumption, including insulation, solar control, the efficiency of building services and renewable energy generation. Part L sets minimum requirements and targets for carbon emissions and defines the carbon intensity of fuel and power. The Part L 2021 update tightens target requirements and introduces a minimum Primary Energy metric to place more emphasis on reducing energy demand and on site renewable energy generation.

'Unregulated emissions' refer to the elements of energy use that sit outside Part L and includes carbon emissions from plug-in equipment and cooking.

Embodied carbon emissions are not regulated at a national level. A bill was proposed in Parliament in February 2022 to change this based on a proposed Part Z, developed by industry experts. Whilst Part Z has been widely supported by industry, at the bill's second reading the Government declined to support it. However, the UK Government have committed to undertake consultations on embodied carbon in 2023 and 2024 *(Environmental Audit committee - Building to net zero: costing carbon in construction: Government Response to the Committee's First Report, third special report of session 2022-2023, September 2022).*

The UK Government has recently set out a project to evaluate Measurement and Reduction of Embodied Carbon in New Buildings with the research to be concluded in Q1 2024.

Greater London Authority (GLA) policy:

The Mayor of London's London Plan 2021 requires proposals referable to the MGLA to be net zero carbon.

The London Plan Policy SI 2 sets out the strategies for GLA referable projects to minimise carbon emissions. Part F of Policy SI 2 requires development proposals referable to the GLA 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. There is a separate GLA (London Plan) policy guidance document - *Whole Life-Cycle Carbon Assessments Guidance, March 2022* - which sets out the requirements applicants must undertake. The GLA methodology uses RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment, 1st edition (November 2017) and sets out some requirements that go beyond the 2017 RICS scope in Box 1 of the GLA guidance.

Figure 2: The proposed amendment of the Building Regulations, Part Z, to regulate embodied carbon on a national scale.

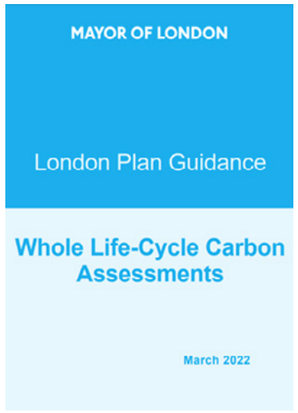


Figure 3: The new London Plan Guidance 'Whole Life-cycle Carbon Assessments' March 2022, sets out a framework of priorities and carbon information required

Figure 4: Regulated target operational carbon emissions are reduced further by local planning policy minimum requirements

Reporting requirements and the scope of the assessment are defined in the London Plan Guidance for WLCA https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/london-plan-guidance/whole-life-cycle-carbon-assessments-guidance. WLCA reporting is required at pre-application, application and post-completion stages of schemes that are referable to the GLA, but it is also encouraged for all major developments. All studies account for a 60-year life-cycle period, as standard. Provisions for a different assessment period can be established if accompanying explanations are provided.

The guidance document is recognised as industry-leading. It contains a detailed methodology and list of information to be included for materials across a number of Life-Cycle Assessment (LCA) modules (Table 1) as well as including requirements for reporting emissions for demolition of existing assets on site and from refrigerants.

The Mayor of London's London Plan 2021 sets out a clear energy hierarchy for net zero operational carbon emissions. It defines the process required for reducing these emissions, clarifying local priorities for heating and cooling strategies, setting minimum target savings and local carbon offsetting mechanisms. The carbon savings targets are based on regulated operational carbon and a 30-year life-cycle. Reporting unregulated carbon is encouraged through the design process and building infrastructure provision. Other policy requirements are in place for on-site energy generation and energy storage.

The Mayor of London's *'Energy Assessment Guidance (June 2022)'* outlines reporting requirements for planning applications to demonstrate that the proposed climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy and energy performance metrics in terms of Energy Use Intensity for regulated emissions (EUI). It introduces a new 'be seen' stage to calculate whole building EUI (including unregulated emission), to monitor and report its energy performance post-construction. This will help to ensure that the actual carbon performance of the development is aligned with the Mayor's net zero carbon target.

The *'Be Seen Energy Monitoring Guidance',* (September 2021) explains the process that needs to be followed and reporting requirements to demonstrate compliance with the London Plan policy addressing the monitoring, verifying and reporting of energy performance after a building's practical completion (*'Be Seen'* level of the Energy Hierarchy). It requires undertaking analysis for regulated and unregulated energy loads using a process such as TM54 (it is aligned with the London Plan guidance for *'Whole Life-cycle Carbon Assessments (WLCA)'* module B6 approach.

City of London Corporation policy:

City of London's Local Plan (2015) aligns with the London Plan (see point 3) at the time of its adoption. The London Plan has subsequently been updated (2021). The adopted Local Plan focusses on reducing operational *'regulated'* carbon emissions resulting from energy used in operation, low and zero carbon technologies for on-site and local energy generation (including existing and planned District Energy Networks), local and national carbon offsetting mechanisms. Carbon offsets are required for a 30-year period of operation but there is no specific mention of unregulated carbon and embodied carbon (WLCA) in this policy document. However, Policy CS 15 does state that development should *'avoid demolition through reuse of existing building or their main structures...'.*

The Local Plan is being reviewed and a replacement Plan, City Plan 2040, is in preparation. This City Plan will reference the London Plan's carbon emissions requirements towards achieving whole life-cycle net zero carbon emissions. The City Plan is in the process of being drafted and will ensure that it aligns with the London Plan, recent Mayoral guidance and best practice in the City development market.

Related Reporting Requirements:

There are other carbon-related planning reports that should be taken into consideration. They include Greenhouse Gas impact assessments, the Circular Economy Statement, operational energy and operational water assessments. Where relevant, these should be referenced in WLCA reporting, in particular to highlight discrepancies and overlaps in design considerations and decisions. The related reporting requirements are in Appendix 6.

The current CoLC planning policy for major developments in the City of London does not require a WLCA. However, it does require the achievement of a minimum BREEAM 'Excellent' certification rating, with a provision to ideally achieve 'Outstanding'. BREEAM does include criteria relating to Life-Cycle Assessment, Environmental Product Declarations and Circular Economy. These aspects of design and procurement are therefore typically addressed in proposals targeting a minimum 'Excellent' rating.

The BREEAM scope for Life-Cycle Assessments extends between life-cycle stages A and C, but the scope of building elements to be included is optional and limited compared to the GLA approach (see Table 2, page 11). BREEAM does not currently require a post-completion review of embodied carbon performance.

The total life-cycle carbon emissions of major, non-referable planning applications with reduced scopes, e.g. limited to addressing BREEAM requirements for fewer building elements, are not comparable to

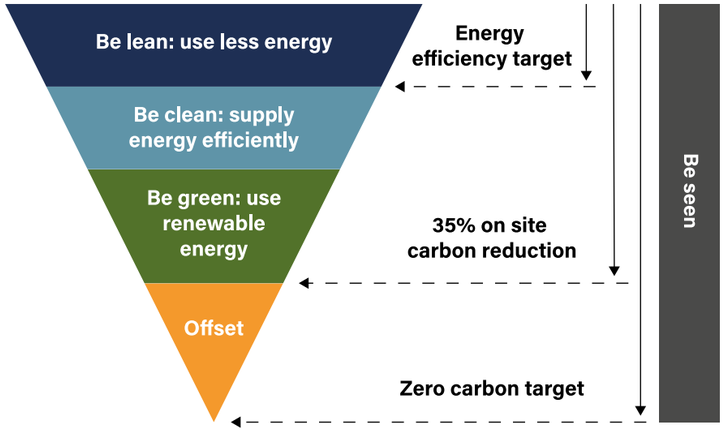


Figure 5: The Energy Hierarchy defines policy priorities and interim targets to Net Zero Carbon in operation

Figure 6: The draft City Plan 2040 is currently under development targets to Net Zero Carbon in operation

GLA benchmarks. Note that Modules B6, B7 and D (EN 15978: 2011 Sustainability of construction works. Assessment of environmental performance of building) are excluded from the GLA WLCA benchmarks.

Table 1 in the following section outlines the typical current carbon reporting scopes driven by national, GLA and local policy requirements.

There are a number of forthcoming updates to guides and standards relating to whole life-cycle carbon and whilst the document aims to account for these, they may require further clarification in future updates to this PAN.

2. Whole Life-Cycle Carbon Assessments

There is currently a variety of different approaches and scopes relating to WLCA and the information that should be included within them. Table 1 includes a summary of scoping items for planning and table 2 includes a comparison between industry drivers such as the UK Green Building Council (UKGBC), GLA, Low Energy Transformation Initiative (LETI) and BREEAM scopes in terms of EN 15978:2011 Sustainability of construction works. The assessment of environmental performance of buildings is broken down into modules / stages and building element groups to be included.

Modules A1-A3 include the product manufacture, modules A4-A5 cover transport to site and the installation processes. Combined these are known as **upfront embodied carbon** (i.e. at Practical Completion (PC) of the building). Modules B1-B5 cover operational emissions relating to use, maintenance, repair, replacement and refurbishment, modules C1-C4 cover demolition, transport to a disposal facility, waste process and disposal. Module D covers emissions beyond the system boundary, accounting for consideration of what happens to material at the end of the building life-cycle, i.e. the benefits of reusing or recycling in the net flows of materials exiting the system boundary.

In a WLCA, operational energy use, B6 and operational water use, B7, are also included.

Table 1: Comparison of life-cycle stages. Whole life-cycle carbon Scope of whole life-cycle carbon reporting in the City of London.

Scope (Stages based on EN 15978)	Sub-groups	National –Building Regulations	GLA referable developments in CoL	Major developments in CoL*	Minor developments in CoL
Impact of Existing building					
Demolition impact of existing building structures (required to be reported separately for GLA)*			✓	✓	
Product and Construction Process (Practical Completion) Stage					
A1-A3 Construction product supply, transport and manufacturing			✓	✓	
A4-A5 Transport to site and construction impacts			✓	✓	
Use Stage					
B1-B5 Operational emissions			✓	✓	
B6 Operational energy use #	Regulated	✓ 1 year	✓ 30 years for energy strategy, 60 years for whole life carbon assessments#	✓ 30 years for energy strategy, 60 years for whole life carbon assessments#	Depends on scope of works
B6 Operational energy use #	Unregulated		✓ 60 years for whole life carbon assessments#	✓ 60 years for whole life carbon assessments#	
B7 Operational water use #			✓	✓	
End of Life-Cycle Stage					
C1-C4 End of life stage including deconstruction, demolition, transport, waste processing and disposal			✓	✓	
Beyond the Project Life-Cycle					
D Stages beyond the life-cycle, including re-use, recovery, recycling			✓		

* - Demolition of the existing assets is not currently required in the 2017 RICS PS WLC methodology, it is expected to be included in the 2023 version.

- Operational energy assessment i.e.TM54 or NABERS where possible, to enable a more accurate estimation of in use energy performance.

The policy drivers listed in Table 1 (previous page) and industry drivers by element also vary in scope as shown in Table 2. It is worth noting that the source documents may change and the landscape is evolving and continually improving at pace. The GLA methodology is currently the most comprehensive of all the industry methods. This states that the EN 15978 principles and the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment, 1st edition (November 2017) should be followed as a methodology. The GLA WLC Guidance also sets out some additional requirements in Box 1, *'Key requirements of this guidance that differ from the RICS PS methodology.'*

The Draft RICS Whole Life Carbon Assessments - 2nd edition was issued for consultation on the 7 March 2023 and the final document will be released later in 2023. BS EN 15978 will be updated and is likely to be published in Q1 of 2024, and methodologies may need to be adapted to account for these changes. The COG PAN is designed to ensure these updates would not affect the intended outcomes of the process. The current version of the guidance should be used for the optioneering assessment, and this must be stated in the reported assumptions.

For the GLA method, a minimum of 95 per cent of the capital cost allocated to each building element category should be included for at each stage of the WLCA. This should be approved by the project Quantity Surveyor. In addition, for building services the GLA guide includes a list from which the applicant is required to indicate in-scope items.

Table 2: Whole life-cycle carbon comparison of scopes vs building part element/group (full version including notes is located in Appendix 3).

Building part / Element group	UKGBC Full Assessment	UKGBC Minimum Reporting	GLA WLC Guide	RIBA 2030 CC Ver.2	LETI Embodied Carbon Primer	BREEAM NC 2018 and RFO 2014***
Demolition prior to construction			YES Reported separately. Benchmarks do not include these building elements.			
Facilitating works	✓		YES Benchmarks do not include these building elements.			
Substructure	✓	✓	✓	✓	✓	NC credit option RFO if in scope
Superstructure (Frame, upper floors, roof, stairs, ramps)	✓	✓	✓	✓	✓	NC mandatory RFO if in scope (excludes ramps)
Superstructure (External walls, windows, doors)	✓	✓	✓	✓	✓	NC mandatory RFO if in scope
Superstructure (Internal walls, partitions, doors)	✓		✓	✓	✓	NC mandatory education only RFO if in scope
Finishes	✓		✓	✓	✓	RFO if in scope
Fittings, furnishings and equipment (FF and E)	✓		✓	✓		RFO if in scope to CN7 limited furniture / shop fitting
Building services/ MEP	✓		✓	✓	✓	NC credit option RFO if in scope
Prefabricated Buildings and Building Units	✓		✓	✓	✓	
Work to Existing Building	✓		✓	✓		
External Works	✓		✓			NC credit option RFO if in scope: hard landscaping and boundary protection only

3. Introduction to Carbon Optioneering

This PAN provides the recommended methodology to compare a number of development options in order to find the best balance in carbon emission terms prior to adding other considerations into the planning process.

The PAN is a first step of carbon evaluation and is designed to enable a consistent, early-stage approach to assessing options, and is one of the first steps in the CoLC's pursuit to achieve outstanding, best in class buildings that contribute to an attractive and vibrant City environment.

This approach will be recommended to aid the review and decision-making process, through the submission of more in-depth information, that demonstrates how applicants have come to a development decision. This process can be relevant to various application types, that have a significant proportion of new build elements.

Optioneering is required for all major schemes. Non-major developments should carry out optioneering if they do not retain the majority of substructure and superstructure (by mass). All schemes that carry out optioneering should undertake independent third-party review as a quality assurance mechanism for their optioneering results.

While non-major schemes that do retain the majority of the structure are not required to undertake a full optioneering exercise, applicants are encouraged to incorporate design approaches that minimise the carbon intensity of the development.

The purpose of the optioneering exercise is to compare bespoke development options for a particular site. Comparing options for different development sites may not be possible due to the site-specific conditions and context.

The WLC PAN advises on the consistent presentation of options in planning applications (see Dashboard 1) and requires transparency to make the information easier to understand and assess, as part of the pre-application process.

The development of this methodology is driven by the growing realisation that the construction of new buildings using the most common and current construction techniques and materials result in high carbon emissions over the building's life-cycle. For this reason, the assessment and benchmarking of embodied carbon to practical completion (Modules A1-3 and A4-A5) can be used as an effective way to evaluate and then mitigate emissions from construction and

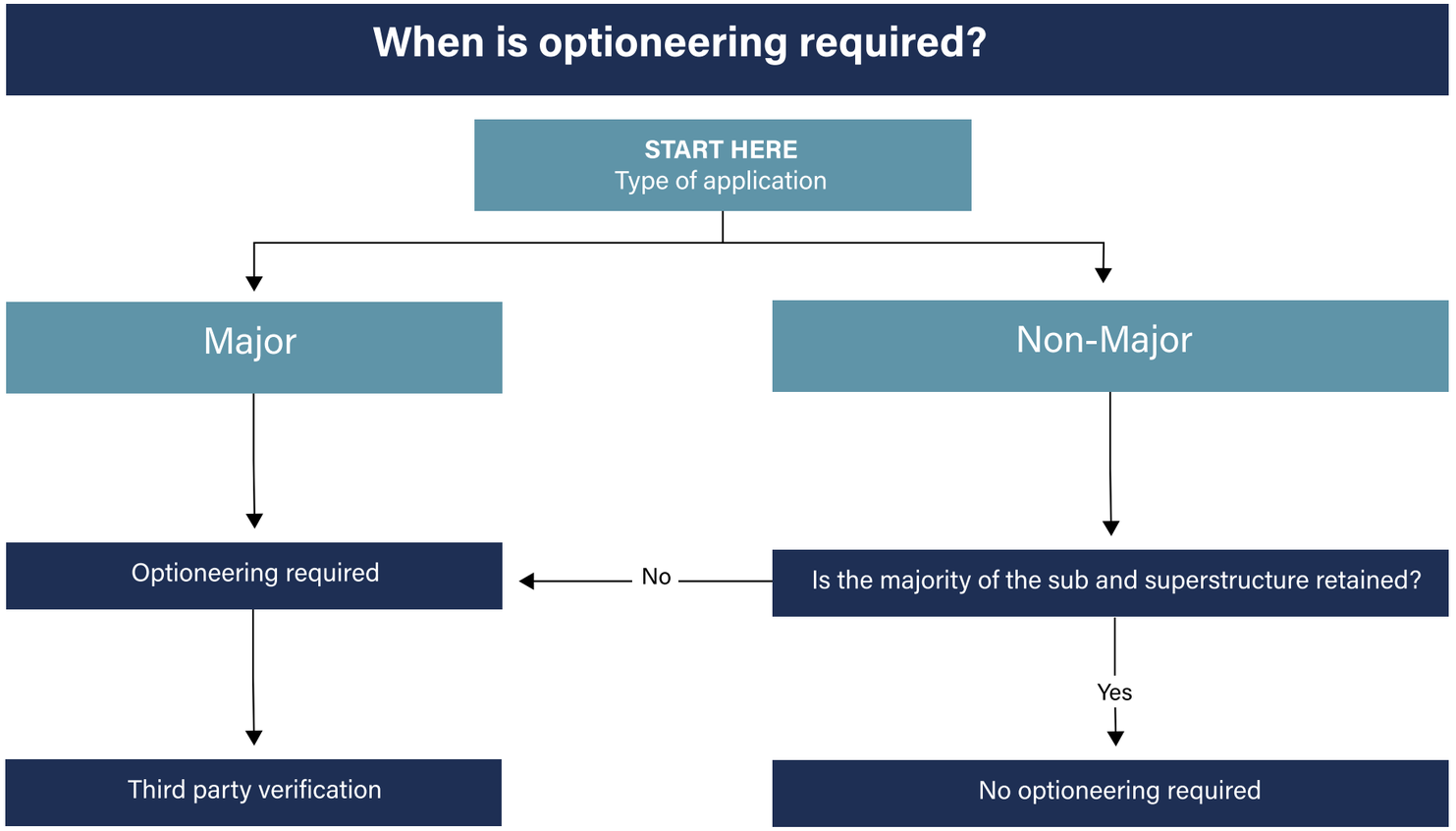


Figure 7: Decision tree for optioneering requirement

materials. It is also acknowledged that the majority of the existing building stock has relatively high operational emissions, primarily due to inferior energy efficiency standards and technologies at the time of their construction, compared to current requirements (insulation, air tightness, solar control glass, building services etc.).

Another major contributor to existing operational emissions is the common use of natural gas combustion equipment for space heating and hot water. Investments in alternative renewable power sources have resulted in the carbon emissions of electricity generation to decrease rapidly, to almost half that of gas, and this trend is set to continue. Therefore, a feasible carbon balance needs to be explored in any intervention of the built environment. This will help to provide clarity about the measures that would result in the greatest whole life-cycle carbon emissions reduction for each development proposal, both short term and long term, be it through the retention of buildings or building elements or through redevelopment.

This methodology recommends comparing a number of development options in order to find the best balance in carbon emission terms, prior to adding other considerations into the planning balance. These can be expressed as potential opportunities and constraints of each option, ensuring that all primary and secondary considerations form part of the design process, so that informed decisions can be made. These considerations frequently encountered in the decision process are set out in this section.

An Excel tool has been created for reporting purposes and enables the graphs to generate. The data generated in the tool should be presented as part of a report for the planning officers .

4. Optioneering Considerations

Quality of existing building: The condition of materials and structures in an existing building will be a critical determinant of the extent of elements that can be retained in an intervention aimed at improving an asset and bringing it up to current performance and functional market standards.

For example, a structure that was poorly constructed or maintained may require too many life-cycle interventions to maintain structural integrity for retention to be feasible. Often, existing assets require extensions to validate the Capital Expenditure (CAPEX) of a major intervention. Extension potential will be dictated by structure and substructure design from the existing building.

Adding piles and foundations to an existing building could mean a level of complexity that increases cost and programme to a degree that the proposition becomes unviable. Current industry experience shows that due to the construction techniques and curing of the concrete in building of this age, as well as the grading of the concrete/steel used at the time, particular care should be taken when considering 1950s/60s concrete structures. However, each project should check the condition of the existing building materials quality as far as practically possible, to enable informed decisions to be made. Poorly maintained windows can be restored to improve air permeability, but conductivity, light transmittance and solar control are difficult to achieve without additional material or complete replacement.

Façade interfaces: As well as quality, decisions around façade retention need to take into consideration new interfaces with the internal environment, for example for on-floor ventilation systems and mixed-mode ventilation opportunities. The two examples are increasingly being adopted by commercial buildings to improve energy efficiency, spatial adaptability (as part of a health and wellbeing design strategy) and to free up roof area for amenity uses.

Health and wellbeing: Design considerations and interventions around health and wellbeing have become more prevalent in workspace over the past few years, and increasingly so in a post-pandemic era. More consideration is being given to quantities of fresh air to dilute indoor pollutants, for example through the application of enhanced on-floor ventilation systems. Aligning a ventilation strategy to an existing façade retention can be challenging. Increased fresh air rates are also leading to increases in operational carbon emissions.

Other design considerations for healthier internal environments include internal levels of daylight and thermal comfort, which may shift a decision to replacing existing glass in a refurbishment; and the presence of toxic materials, such as asbestos, which could result in the removal of existing building elements.

Floor to ceiling heights: Existing floor to ceiling heights could constrain the functional adaptation of an existing structure and new building services solutions. For example, low floor to ceiling heights may not lend themselves to certain uses, and optimised clear heights, by transferring heating, cooling and ventilation plant to an underfloor system is often limited by existing lift lobby and stair landing levels.

Land use and building type: It is important to note that different land uses and building types have an effect on the structural requirements of a building due to loading expectations and flexibility requirements. A few examples include uses that require wider clear spans, such as retail, which could make the structural solution and carbon impact more intense; and uses that have higher loading requirements and need vibration control, for example in science labs (life sciences) and gymnasiums; and increased structural materials due to lateral loading on tall buildings.

The way a building is operated and managed also has a direct effect on operational carbon emissions from energy consumption, for example longer hours of operation by food and beverage establishments.

Power infrastructure: For the reason described in point 1 above, substituting gas-fired heating systems with energy efficient electric alternatives is a very effective way of reducing operational carbon emissions. However, in some cases, securing enough power to serve a development's decarbonisation initiatives can be challenging due to utilities infrastructure constraints. This is another reason why reducing energy demand should be prioritised. A mitigating action could be that a building's systems and controls are set to prioritise electricity and thermal storage, before gas is consumed.

Buildings that apply electric heating may still have other intermittent uses of fossil fuel, such as life safety generators and façade maintenance equipment. These systems require on-site storage of fuel, which is frequently diesel. Alternatives that can be explored for generators are secondary utility high voltage supply fed from a primary network substation that is independent from that of the primary supply, or uninterruptible power supply equipment incorporating an appropriately sized battery installation (subject to authority approval). An alternative fuel that is considered due to low environmental impact relative to diesel is Hydrotreated Vegetable Oil, a synthetic diesel, manufactured from waste products comprising a mix of vegetable oils and animal/fish fats.

Building complexity: Design complexity and the number of elemental sub-components increases carbon intensity. Therefore, simplification of structure, façades, systems, etc. has carbon benefits and is encouraged.

Procurement: The options and availability of low carbon building products on the market are currently limited. In some cases, lower carbon options are available from longer distances, increasing the emissions associated with transport (Stage A4), although these can be comparatively minor compared to the product manufacture. However, this is changing rapidly as manufacturing processes are adapting and supply chains recognise the high value of low carbon in sections of the market, for real estate in London in particular.

Invariably, a limited quantity of higher value products is less attractive during a time of economic inflation. Applicants of major developments could be asked to state what measures they have in place to increase the probability of lowering embodied and operational carbon in procurement processes.

Assumptions: In addition to fewer options of low carbon products, information about the quantity of carbon in products is also limited. A requirement for EPD certificates, or similar third party verified information, should be a requirement in procurement. For products with no certified embodied carbon data, assumptions and metrics should be clear and reliable market-average databases should be used, derived from a verifiable tool or software, such as One Click LCA and Cerclos (eTool).

Supply chains can be constrained by a very long lead time, impacting the construction programme and leading to product changes with potentially higher carbon impact.

Due to market fluctuations and limitations, it is recommended that, at application stage, the WLCA is based on market averages of a committed specification, based on a Quantity Surveyor's bill of quantities. Product-specific Environmental Product Declaration (EPD) certificates should not be used in early design stages (unless the manufacturer is known, sector level data e.g. EPDs that use data covering several manufacturers could be used) because they may be giving a false impression of future procurement opportunities. This is an area the industry needs to improve upon over the next few years.

Commerciality: A critical factor in decision making around the level of intervention in a building is the commerciality of the asset. In commercial buildings, the net lettable area and lease value are imperative metrics. The market in City of London is shifting demand for net zero carbon, fossil fuel free, health and wellbeing conscious and smarter workspace. As market demands change, a number of asset holders are racing to update their lettable spaces at the end of the next lease term. This is to ensure that buildings don't become stranded assets, and equity and operating value are maintained.

The standard for what is required in a building update needs to be competitive in the market that it is trying to attract, and the cost of the intervention needs to be justified by a likely return on investment.

Densification: As London tries to move towards a polycentric city to release infrastructural pressures and improve quality of life, its existing 'mega-centres' remain very relevant. Urban densification (the increasing density of people in urban areas) is accepted as a necessary part of limiting land take while serving population growth. Densification tends to occur in fast growing population centres with a combination of demographic change, economic pressure and large transport infrastructure projects. The City of London is very well served by sustainable transport infrastructure and planning policies are in place to limit pressures on utility infrastructure and the existing community (the people who live, work and use the City of London).

Densification, e.g. extensions and taller buildings, tend to increase the carbon intensity of structural elements relative to benchmarks derived from mid-height buildings.

Striking the right balance between the environmental (and social) costs and benefits of increasing NIA on brownfield sites is a critical factor that policy makers have to deal with, in particular in addressing climate change. Resilience and sustainability should be central priorities for increasing existing building heights.

5. Other Policy Opportunities

This section addresses circumstances where other planning policy requirements may result in lower or higher carbon emissions. All factors need careful consideration on a project-by-project basis, and policy requirements need to be fine-tuned depending on priorities discussed at pre-application stage.

Circular Economy:

The Mayor of London has introduced a requirement for referable proposed developments to develop a circular economy strategy and produce a statement as part of an application. The approach is defined in the 'Circular Economy Statement Guidance' (adopted 25th March 2022). The principles encourage building reuse, recovery of material for reuse and recycling, material efficiency, waste management and infrastructure to support material reuse (such as storage and collection systems).

The circular approach often aligns with the principles of low carbon interventions. For example, it encourages refurbishment and efficient use of materials and requires consideration of the end-of-life stage by a proposed new building (building as a material banks/materials passport approach). This area is still evolving and can significantly reduce carbon.

There are, however, some circumstances where actions that align with circular principles can increase carbon emissions. For example, on occasion, it has been found that recovering/repurposing a material for re-use on site frequently requires the material to be reformulated into a new high value use (or upcycled), a process that requires transport to and from the site and energy to repurpose the materials. Recovering material can also lengthen construction programmes prolonging stage A5 of the life-cycle and local environmental impact.

Therefore, it is important to compare the carbon emissions of the product stages of recycled elements to their newly made equivalents with the lowest carbon opportunity established.

Low and zero carbon technologies:

Planning policy, building regulations and the BREEAM assessments have for years required the inclusion of low carbon and zero carbon technology in the energy hierarchy of proposed developments. One example, and the most viable option in the City of London, is frequently to install a maximum area of roof-mounted photovoltaics (PV) and air source heat pumps (ASHPs). Policy prioritises operational energy and carbon reduction in advance of renewable energy generation, but no consideration is given to reducing the embodied carbon of PV and other renewable energy sources. An array in London can achieve carbon break-even within a decade, but as the electrical grid decarbonises, there is an argument that the array will displace less carbon and could never recover the embodied carbon emitted. For this reason, it is recommended that circularity principles are applied to their specification (e.g. reusable mounting and take-back schemes) and energy storage is incorporated to increase the proportion of renewable energy uptake at time of use.

It is important to note that PV can bring other benefits like localised power, and we tend not to factor in the impact or wider power networks' embodied carbon (i.e. the impact of the power plant construction upgrades, cabling etc.). PV will be a crucial piece of the UK energy and decarbonisation strategy.

District Energy Networks:

Another local policy requirement is connecting to existing District Energy Networks (DEN) or preparing for a future connection to a planned DEN. This is emphasised by both the London Plan's and draft City Plan's heat infrastructure priorities. The City of London includes the extensive Citigen network, which is planned to extend south in the near future and eastwards at a later date. However, due to the drive to remove fossil fuel combustion from buildings, for reasons relating to both carbon reduction and air quality targets, electrically heated buildings tend to have much lower carbon emissions then existing heat networks. This is because the Energy Centres that serve the DENs still run on gas systems, and while they are intended to decarbonise over time, there is very little information about their programme. In addition, the carbon intensity of planned networks is unknown at this stage. Therefore, the policy can be interpreted to contradict the Climate Action Plan and can impact life-cycle aspirations, such as high NABERS UK energy ratings.

Public realm and urban greening:

The City of London includes a network of gardens, small open spaces and squares that are maintained by the Corporation. Nevertheless, the area of green and open space per capita is relatively small, and the discrepancy will increase as the population and densification rises.

Planning policy encourages urban greening and biodiversity net gain, for which the City of London has adapted the London Plan's Urban Greening Factor (UGF) calculation which is required for proposed developments to demonstrate higher value green infrastructure. However, urban greening does not often translate into open space, because private roof gardens and green walls are often used to satisfy the UGF target.

In order to increase the amount of open and green space in the City, brownfield and lower quality space may need to be upgraded. This may result in decisions to demolish lower quality infrastructure. In addition, the UGF can be difficult to achieve on existing structures mostly due to loading limits and plant requirements, however, all solutions to overcome this should be explored and communicated.

In addition, major developments are required to carry out ecological surveys of the site, and propose ecological protection, enhancement and maintenance measures.

Climate resilience:

Adapting to climate change is crucial in the City as a densely built environment which is especially prone to local flooding and urban heat island effects. Integrating measures to minimise the risk of local flooding and overheating of buildings as well as the public realm are key to making the City a resilient area as the effects of climate change become more pronounced. Space constraints and loading limits of existing buildings can make it challenging to incorporate measures such as green roofs and walls, sustainable urban drainage measures such as blue roofs, rainwater harvesting and attenuation tanks, adapted façade systems and sustainable heating, ventilation and air conditioning (HVAC) systems. Opportunities and constraints must be clearly communicated to identify the balance between climate change mitigation and adaptation.

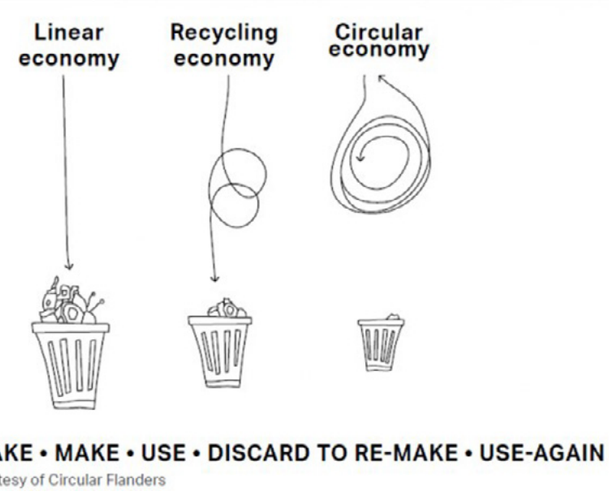


Figure 8: Circular Economy compared to Linear Economy (Source: Circular Flanders)

6. Outline Methodology

The GLA's Whole Life-Cycle Carbon Assessments Guidance and Circular Economy Statement Guidance require the full exploration of options before considering substantial demolition. This PAN recommends a methodology to do so, and it recommends how this should be demonstrated in the planning application.

Due to the significant impact on carbon emissions and climate change by major interventions and new construction, proposed developments need to demonstrate reduction and mitigation of carbon emissions using a consistent optioneering approach.

Options will be developed in early discussions with applicants in the pre-application process, and their details will vary on a case-by-case basis. The number of options will be limited and agreed based on presenting clearly discernible, feasible design approaches to the proposal in order to inform the optimum design for the application scheme, both in WLC carbon terms and in considering other environmental opportunities such as urban greening and climate resilience measures.

Options should provide an indication of the potential for a given site. They should be based on the same assumptions including which energy strategy is thought to be the most advantageous in carbon reduction terms, in order to be able to compare the options - unless there are reasons for not doing so, which should be stated. Option review reporting and their considerations should be transparent with identified opportunities and constraints.

The CoLC requires all major developments to consider and assess both operational and embodied carbon emissions over a whole life-cycle. There may be development proposals where an optioneering exercise would not provide useful information in which case the consideration of options should be discussed and agreed with officers.

Optioneering should also be carried out for non-major applications, where the majority of the sub- and superstructure (by mass) is not retained.

Pre-Application stage

Optioneering as part of pre-application discussions with the City of London should include the following:

1. Well-considered options that are realistic and feasible development proposal for a specific site.
2. Demonstrating different levels of interventions to the existing buildings on site in the design process.
3. Providing options information in Table A of the WLCA Dashboard 1 (section 7 and the Excel tool), including:

- Gross internal area (GIA)
- Net internal area (NIA) increase/change in net internal area
- Embodied carbon to practical completion (Modules A1-A5)
- Life-cycle embodied carbon (A1-A5, B1-B5, C1-C4)
- Percentage of material retained by mass for substructure, superstructure (frame, upper floors, roof, stairs and ramps) and by area for superstructure (external walls, windows external doors)
- Pre-Construction Demolition Impact needs to be accounted for. For full demolition, applicants should use 50 $kgCO_2e/m^2$ of demolished area as per GLA WLC guidance.
- Operational carbon from energy consumption (Module B6) (see carbon factors below). Estimated operation energy consumption should be reported in KWh/m^2 GIA per year. The assumptions behind the figures provided, i.e. UKGBC target or similar, should be stated
- EPC rating
- Fuel source for operational energy (gas, electricity, other to be defined)
- Carbon factor(s) used for operational energy
- Whole life-cycle carbon (A1-A5, B1-B6, C1-C4) in $kgCO_2e/m^2GIA$ and tCO_2e
- Opportunities and constraints, specifically in relation to carbon emissions and other policy areas.
- Any assumptions and justifications for the above in the estimations

4. The embodied carbon of the structure should be calculated for each option using structural engineer estimations. Other elements or layers can either be based on a detailed calculation, should the information be available, or on an estimation based on percentage rates from the GLA WLC (A-C, excluding B6 & B7) benchmarks. Where a different methodology/estimation is chosen, this should be identified and explained.
5. Using consistent carbon factors across options for the type of fuel used. Figure 9 shows the Part L carbon factors for Part L 2013 and Part L 2021, however these figures do not account for electricity grid decarbonisation.

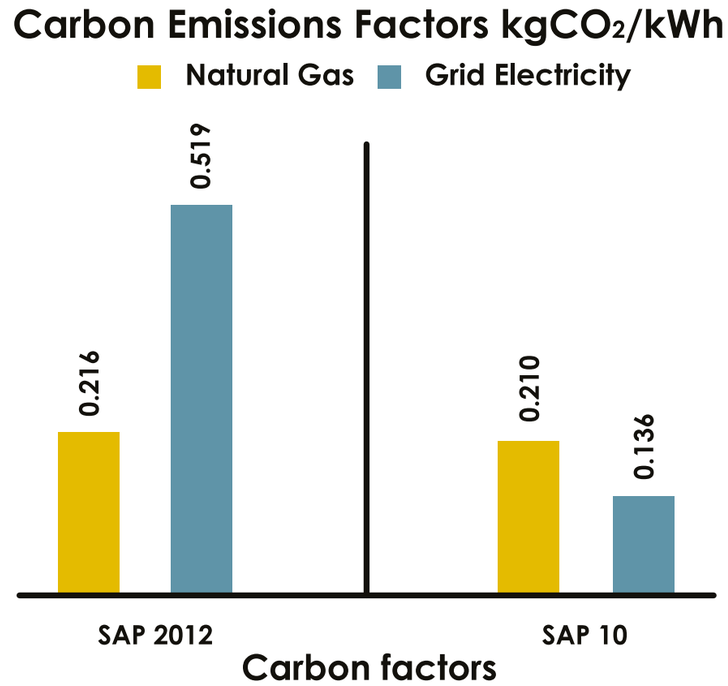


Figure 9: Investments in renewable energy and infrastructure are resulting in rapid decarbonisation of grid electricity compared to natural gas. SAP 10.1 was published in October 2019 with subsequent updates.

- **Carbon factors**

  Estimated annual energy consumption in kWh or kWhe (equivalent) must be converted to carbon using the appropriate carbon factor. The Part L carbon emission factor figures for electricity should not be used as it does not account for grid decarbonisation. Part L conversion factors can be seen in figure 9 for reference.

- **Electricity:**

  The Future Energy Scenarios (FES) developed by National Grid (https://www.nationalgrideso.com/future-energy/future-energy-scenarios#fullsuite) should be used for calculating the WLC impact for life-cycle module B6. The falling short scenario (excluding negative emissions and generation output from Bioenergy with carbon capture and storage, BECCS) should be used. This aligns with the Draft RICS Whole-life carbon assessments, 2nd edition methodology.

  For the purpose of optioneering, the electricity figure is based on the average decarbonisation figures over the projects design life or Reference Study Period (typically 60 years). The FES carbon

factors are provided until 2050. Following this point, it should be assumed the carbon emissions flatline, i.e. they stay in line with the 2050 figure for the remaining years of the project.

For example, a project that completes in 2025 over a 60 year reference study period would calculate emissions to 2085. Using the National Grid FES 2022 ES.E.10 falling short figures this would result in an average factor of **0.0376 kgCO_2/kWh**.

- **District Energy**

  Where a district energy network is used, the carbon factor should be stated based on information from the network provider and must be referenced in the reporting.

- **Gas:**

  Where gas is supplied, the 0.210 kgCO_2/kWh Part L figure should be used. Where gas is used, it will need to be converted to an electric equivalent in kWh. To convert gas consumption (kWh/m2) to electrical equivalent (kWhe/m^2), multiply kWh gas by 0.75. Refer to latest guidance from NABERS/BRE/BBP/UKGBC as appropriate.

In Summary:

- Electricity: In line with National Grid FES falling short approach in KgCO_2/kWh
- Gas: 0.210 kgCO_2e/kWh
- District Network: Based on supplier information (follow GLA Energy Assessment Guidance) and report assumptions in Dashboard 1.
- Should a different factor be used across options, this must be declared for each option with clear justification provided. Carbon factors must be declared in the report.
- Where a mix of carbon factors are used, estimations depending on consumption by fuel type should be calculated.

6. Ensuring like-for-like reporting, without bias to favour one option against the others. For example, the opportunity for energy and carbon improvements should be equivalent across all options, except where constraints can be demonstrated, and the equivalent level of aspiration to reduce elemental embodied carbon should be applied equally across all options.
7. Presenting the development options on the basis of consistent, assumed and proposed data including:

- An equivalent approach to the level of assumptions and certainty applied to embodied carbon estimates
- Reporting in line with the equivalent scope for the WLCA (life-cycle stage and building element scopes)
- Embodied carbon impact of further interventions with justifications provided i.e. what has been assumed. For example, estimated impact of plant replacement every 15 years of operation over the life-cycle, using life-cycle modules B1-B5, C1-C4.

8. Exclude Module B7 'Water Consumption' at this stage, because it does not vary significantly between options. Any variances, in particular where an opportunity or constraint occurs for one option and not another, should be shown.

It should also be noted that the WLCA emissions fluctuate and are likely to be different in later design and construction stages. Generally, this is due to the availability of more detailed design and cost plans. Emissions at practical completion may also change due to procurement variations and the market. As more data becomes available it will inform future projects to refine early estimations.

Application stage

The preferred option to be developed after the pre-application optioneering should include the following:

1. Justification to support the decision of the application proposal
2. Calculations of the WLCA in alignment with GLA guidance at the time of the assessment, and completion of the GLA reporting template spreadsheet, i.e. including all modules and building elements.
3. Clarification of the scope of the WLCA (life-cycle stage and building element scopes), by completion of Table B (section 7).
4. Clarification of all assumptions, exclusions and level of certainty of the data used in the assessments.
5. Plotting of the life-cycle stages A1-A5, B-C (excluding B6 and B7) against the GLA WLCA benchmarks (see Dashboard 1 Figure B):

- By stage for the proposed land use
- By building element for Stage A1-A5 (embodied carbon to practical completion)

6. Reporting of the total kgCO_2e/m^2 GIA and the total whole life-cycle carbon in tonnes.

The WLCA should be based on the cost plan in line with GLA guidance. The GLA WLCA reporting template should be completed and submitted to the CoLC and GLA where applicable. The post-completion report should follow the GLA WLC guidance and include CIBSE TM 65 data for building services as required in the GLA guidance.

7. Dashboard

Dashboard 1: Pre-application Options Appraisal

Completion of Dashboard 1 is required to improve reporting consistency, transparency and standardisation across applications. An Excel reporting tool has been created for design teams to use. This should be completed and presented at pre-application stage. The template should be completed with project information, which will populate some of the required graphs.

The graph in **Dashboard Figure A** will need to be created separately.

Dashboard Input Methodology- General Recommendations:

The optioneering information is not based on a prescriptive method. Assumptions and building information should be as transparent as possible with assumptions clearly identified.

Third party review will be required.

The following recommendations have been made to guide design teams:

Whole life-cycle operational energy:

- Scope of works should be summarised/defined for each option.
- The information should aim to be consistent across options where the fuel source is the same.
- The recommended carbon factors for electricity and gas should be used (as appropriate, see section 6).
- The applied carbon factor needs to be declared where district heating and/or cooling is proposed, i.e. from Citigen London Network. This should be listed in the assumptions. Reasonable estimations of energy use intensity should be used for the whole building. This should be reported based on GIA per m^2. If a lighter touch refurbishment is proposed, it is recommended to apply general assumptions in anticipation of future policy. After a 15–20-year period for example, building services upgrades may be required (due to forthcoming legislation and system life expectancy) as it is unlikely that the building could be left operating in situ over a period of 60 years or more. For operational energy reporting of estimated whole building operational energy in kWhe if gas is used, it will need to be converted to an electric equivalent in kWh. To convert gas consumption (kWh/m2) to electrical equivalent (kWhe/m^2), multiply kWh gas by 0.75. Refer to latest guidance from NABERS/BRE/BBP/UKGBC as appropriate.

Embodied carbon estimates:

New Build

- The embodied carbon of the substructure and structure should be calculated for each option using structural engineer estimations.
- Other elements or layers can either be based on a detailed calculation, should the information be available, or on an estimation based on percentage rates from the GLA WLC (A-C, excluding B6 & B7) benchmarks. Where a different methodology/ estimation is chosen, this should be identified and explained.

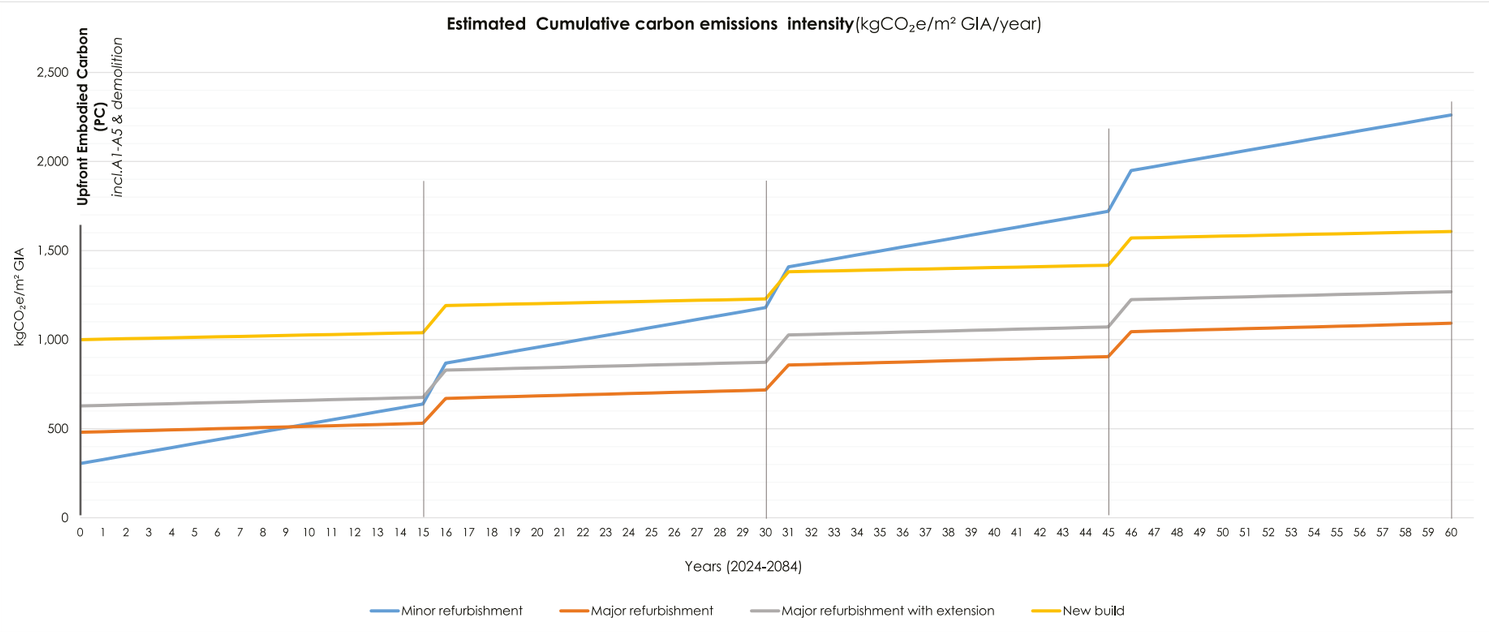
Major Refurbishment/Retrofit

- The structure and substructure interventions should be calculated for each option using structural engineer estimations. The type of works should be declared in the assumptions section.
- Other elements can either be based on a detailed calculation, should the information be available, or on an estimation based on percentage rates from the GLA WLC benchmarks or similar building types. Where a different methodology is chosen, this should be identified and explained with data sets referenced.

Each option should clearly state the assumptions made in the determining factors for the outputs provided.

The graph below demonstrates, in general terms, the relationship between carbon emitted at practical completion of a building intervention and the estimated operational carbon over the building's life-cycle (year on year). The decarbonisation of the electrical grid and minor maintenance and replacement interventions during the life-cycle are also included. The existing building approach could not claim to be net zero carbon in operation where fossil fuels are used, and it would be likely to undergo upgrades at some point during the 60-year period. It is difficult to predict decarbonisation of materials and embodied carbon - this could be lower in future as sectors/global supply chains decarbonise, however currently it should not be accounted for.

The cumulative carbon emissions graph (Figure A) is an example showing options comparisons. This could vary depending on the levels of intervention and scope of works, especially in relation to the minor refurb/major refurb options.



Dashboard Figure A: Cumulative carbon emissions ($kgCO_2e/m^2$ GIA) over a 60-year period, including whole life-cycle carbon (embodied and operational) emissions
Note: The impacts of interventions are depend on the project scope. In this graph, each option has different increase in each year (based on the option's operational carbon per year). In regard to the replacements, it is assumed that each option has 3 replacements with 15-year intervals. It is also assumed that each intervention of the option results same amount of increase, and the total increase of interventions equals to the In-use & End-of-life Embodied Carbon (B-C, excl. B6&B7) results of the options. See scenario for cumulative chart tab.

The graph (figure A, previous page) should be created on the basis of:

- The scope of works for each option should be identified (see dashboard 1) and assumptions stated.
- The estimated / predicted energy consumption of each option should be provided.
- An equal rate of electrical grid decarbonisation over time applied to operational energy. See section 6 Outline Methodology.
- An equivalent approach to the level of assumptions and certainty applied to embodied carbon estimates.
- The declared fuel source and carbon factor used.
- An equivalent scope for the WLCA (life-cycle stage and building element scopes).
- The embodied carbon impact of further interventions to be included, for instance every 15 years of operation over the life-cycle, using life-cycle modules B1-B5, C1-C4. Where different, the method should be stated and clarified in the dashboard. This could be the total B1-B5, C1-C4 emissions, split by estimated intervention points.
- In the Excel tool a comparison graph with early estimated, year on year emissions change has been provided for the 60 year reference period and can be used. The assumptions must be stated. The Excel tool will set up estimations based on the Dashboard 1 project assumptions. The graph automatically updates, however the figures and intervention points can be edited as required with the approach and assumptions stated in the reporting.

  Note: *Buildings will likely be de-gassed to meet future market demand and policy drivers for fossil-free heating / hot water. The above diagram does not currently take account of future de-gassing due to unpredictability. This would necessitate the refurbishment of existing heating infrastructure."*

- In addition to the cumulative carbon emissions graph showing data per square metre (Figure A), the absolute carbon emissions values should be demonstrated for each option in the table (right) showing the split between embodied carbon and operational energy in Table A (refer to the separate Excel Tool).

Dashboard Table A: Optioneering outcomes to be presented to planning officers at the pre-application stage (refer to seperate City of London Carbon Options Tool).

Applicable	Option 1	Option 2	Option 3	Option 4	3rd Party Review Check
	Minor refurbishment	Major refurbishment	Major refurbishment with extension	New build	Comments / Questions or indciate in box if acceptable
Typical Plan **Existing building** **New build**	*image*	*image*	*image*	*image*	
Scope of works summary					
Project reference period					
Gross Internal area (GIA) m²					
Net Internal area (NIA) m²					
Change in NIA (compared to existing) m²					
Substructure % retained by mass					
Superstructure (Frame, Upper floors, Roof, Stairs and ramps) **% retained by mass**					
Superstructure (External walls, Windows and External doors) **% retained by area**					
Estimated existing building demolition ($kgCO_2e/m^2$ GIA)					
Upfront Embodied Carbon (A1-A5) excl. sequestration ($kgCO_2e/m^2$ GIA)					
In-use & End of Life Embodied Carbon (B-C) excl. B6 & B7($kgCO_2e/m^2$ GIA)					
Life-cycle Embodied Carbon (A1-A5, B1-B5, C1-C4) ($kgCO_2e/m^2$ GIA)	**0**	**0**	**0**	**0**	
Estimated Whole Building Operational Energy (kWh/m² GIA per year)					
Fuel source	☐ Gas ☐ Electricity ☐ Other (please state) Other fuel source:	☐ Gas ☐ Electricity ☐ Other (please state) Other fuel source:	☐ Gas ☐ Electricity ☐ Other (please state) Other fuel source:	☐ Gas ☐ Electricity ☐ Other (please state) Other fuel source:	
Estimated Whole Building Operational Carbon for building life time (B6) ($kgCO_2e/m^2$ GIA)	**0.0**	**0.0**	**0.0**	**0.0**	
Average Electricity carbon factor for building life used for B6 ($kgCO_2e/kWh$)					
Percentage of electricity on overall operational energy (%)	100%	100%	100%	100%	
District heating carbon factor ($kgCO_2e/kWh$)					
Percentage of district heating on overall operational energy (%)	0.0%	0.0%	0.0%	0.0%	
District cooling carbon factor ($kgCO_2e/kWh$)					
Percentage of district cooling on overall operational energy (%)	0.0%	0.0%	0.0%	0.0%	
Carbon factor if Gas used ($kgCO_2e/kWh$) convert to electrical equivlant using appropriate conversion metric					
Percentage of gas on overall operational energy (%)	0.0%	0.0%	0.0%	0.0%	
EPC rating					
Total WLCA (incl. B6 & pre-demolition) ($kgCO_2e/m^2$ GIA) *Module B7 is not considered*	**0.0**	**0.0**	**0.0**	**0.0**	
Total WLCA (incl. B6 and pre-demolition) (tCO_2e) *Module B7 is not considered*	**0**	**0**	**0**	**0**	
Total existing building demolition (tCO_2e)	0	0	0	0	
Upfront Embodied carbon (A1-A5) (tCO_2e)	0	0	0	0	
In-use embodied carbon (B-C) (tCO_2e)	0	0	0	0	
Operational Carbon for building life time (B6) (tCO_2e)	0	0	0	0	
A1-A5 Results by element category breakdown (Optional) ($kgCO_2e/m^2$ GIA) **Substructure**					
Superstructure (Frame, Upper floors, Roof, Stairs and ramps)					
Superstructure (External walls, windows and external doors)					
Superstructure (Internal walls and partitions)					
Finishes					
FF&E					
MEP					
External works					
Opportunities	•	•	•	•	
Constraints	•	•	•	•	
Notes and assumptions used for calculations	•	•	•	•	

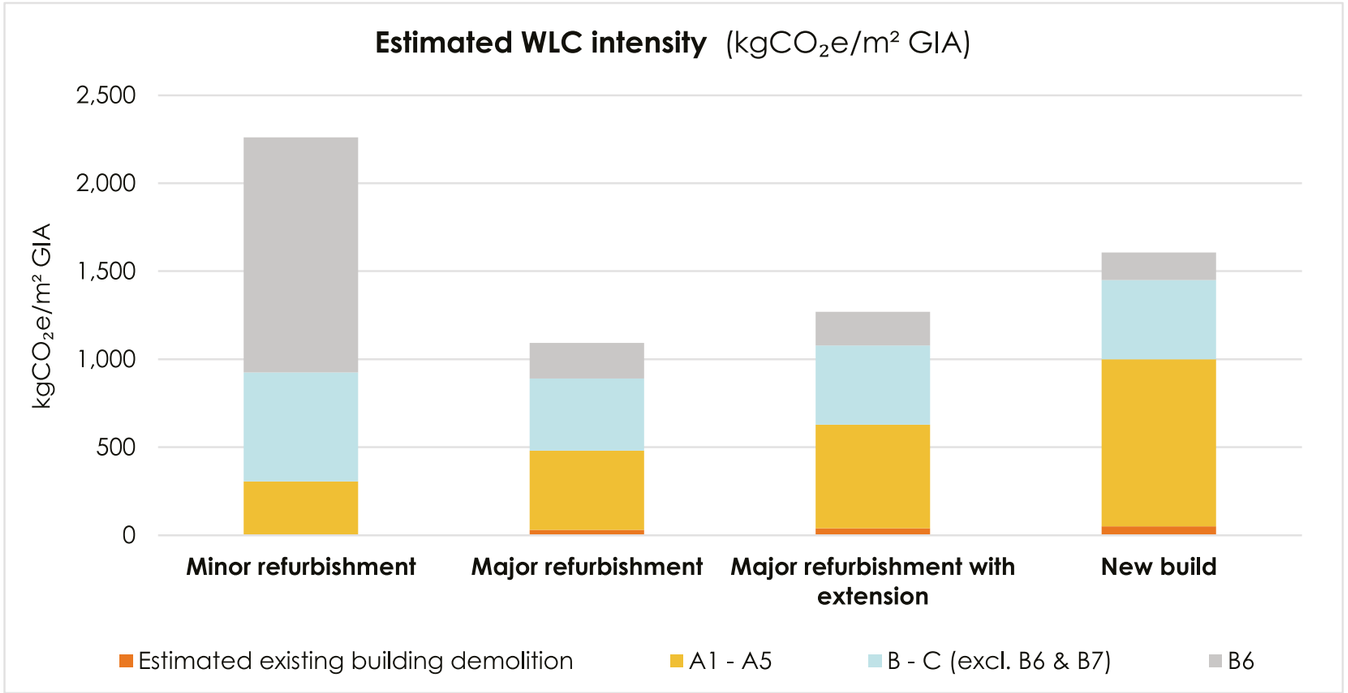
3rd Party Review	**YES/ NO/ COMMENTS TO BE RESOLVED**
3rd Party Reviewer(s) Name(s)	
3rd Party Reviewer Company	
3rd Party Reviewer Experience	
3rd Party Reviewer Signature	**ADD SIGNATURE**

Colour code of the table for data

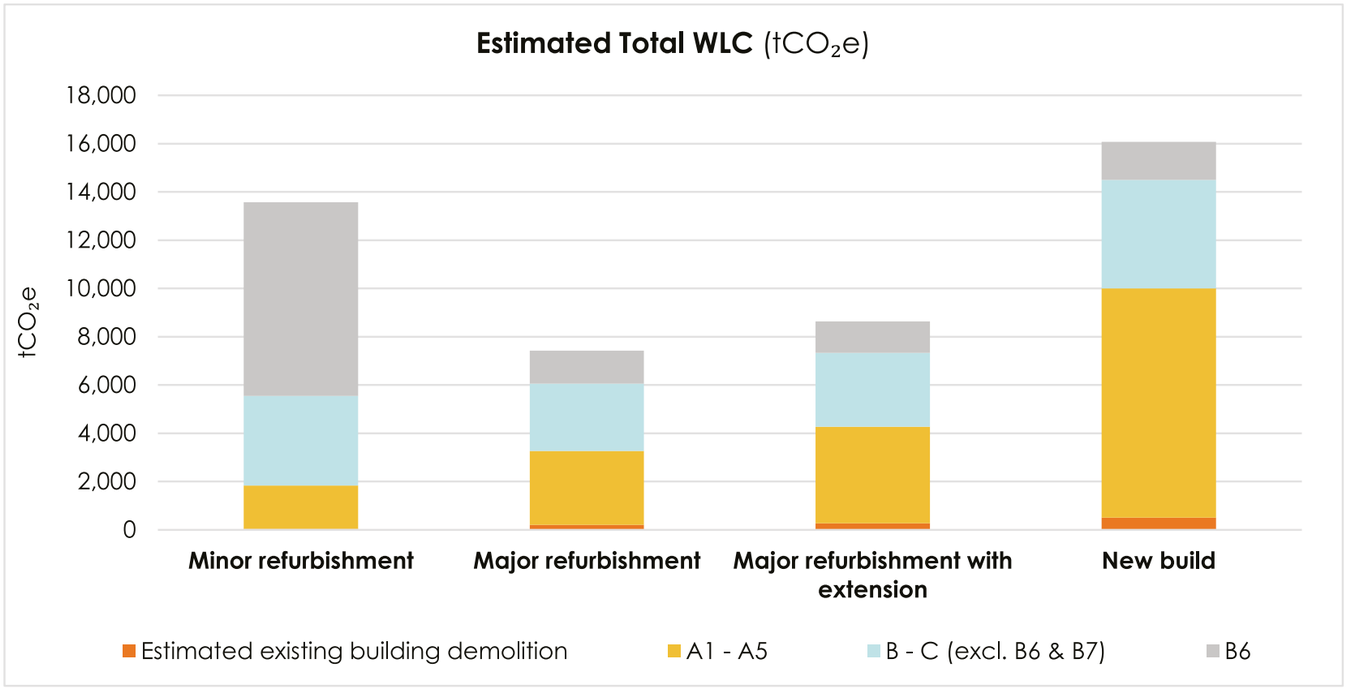
Includes automated calculations.

Open for manual data entries.

Graphs for options should also be provided (the opposite are for illustrative purposes only), number of options and assumptions may vary for the project.



Dashboard Figure B: Whole-life carbon comparison for each option in $KgCO_2e/m^2$ GIA



Dashboard Figure C: Whole-life carbon comparison in total tonnes of CO_2e for each option.
Note: the difference in floor area of options will affect the total tonnage of CO_2e for each option

Dashboard 2:
Application WLCA Preferred Option

Life-cycle stage scope

Dashboard Table B: Life-cycle scope table for whole life-cycle carbon

Scope (Modules based on EN 15978)	Proposed development
Product and construction process stage	
A1-A3	
A4-A5	
Use Stage	
B1-B5	
B6	SAP ☐ TM54 ☐ NABERS UK ☐
B7	
End of life stage	
C1-C4	
Beyond project Life-cycle	
D	

Building elements scope

Dashboard Table C: Building element scope for the whole life-cycle carbon assessment

Building part/Element group	Proposed development
Demolition prior to construction	
Facilitating works	
Substructure	
Superstructure (Frame, upper floors, roof, stairs, ramps)	
Superstructure (External walls, windows, doors)	
Superstructure (Internal walls, partitions, doors)	
Finishes	
Fittings, furnishings, and equipment (FF and E)	
Building services / MEP	
Prefabricated Buildings and Building Units	
Work to Existing Building	
External Works	

Dashboard Table D: Information in relation to the preferred option providing justification for preference, and clarity on assumptions, exclusions and level of certainty of the data used in the assessment

Comments	
Justification	
Exclusions	
Assumptions	
Certainty	

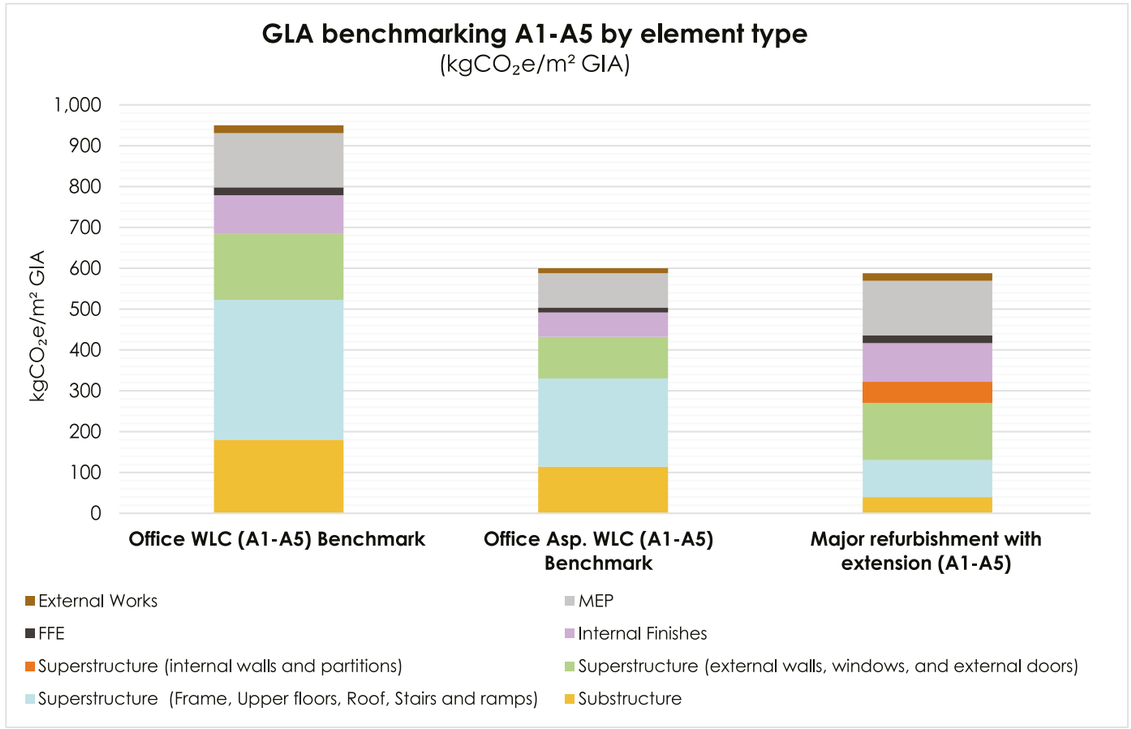
Completion of Dashboard 2 is required to provide reporting consistency, improved transparency and standardisation across applications. Applicants are to complete and include it in the executive summary of the WLCA report that forms part of the planning application. The GLA WLCA reporting template should also be used for submitting the final results.

Applicant to identify reasons where benchmarks are exceeded for life-cycle stages and building elements, using evidence of explored improvements where possible.

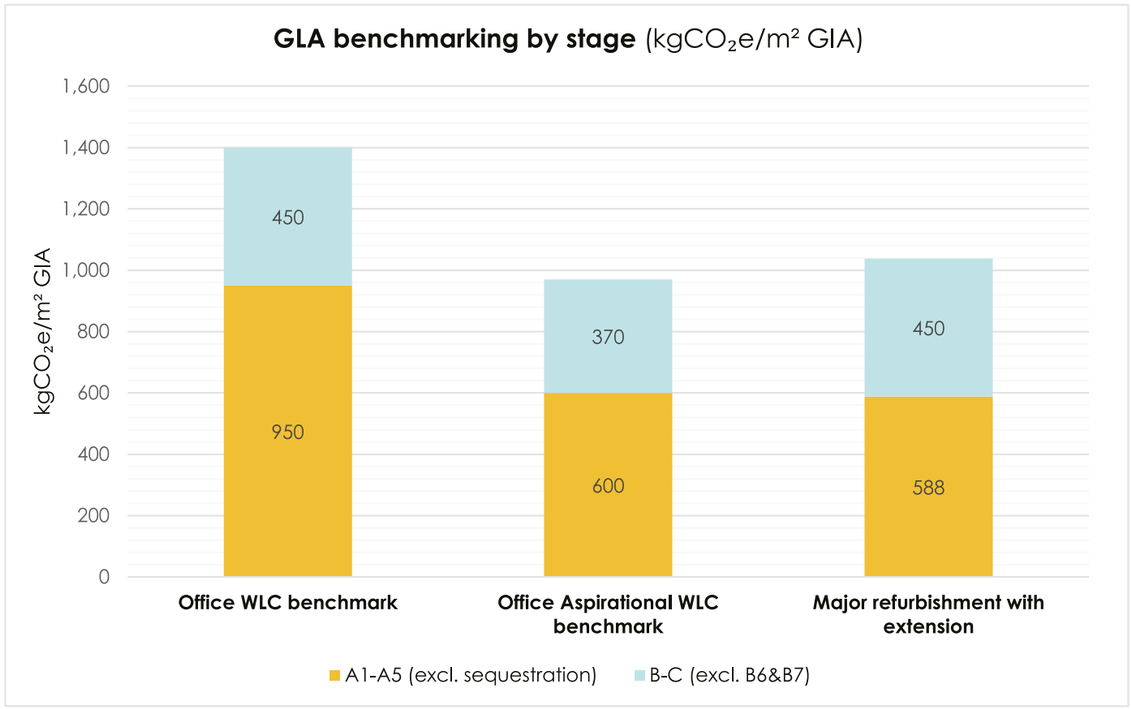
Additional opportunities for improvements should also be identified in the application report.

Please note:

In addition to Dashboard 2 figures D & E report Whole life-cycle carbon kgCO$_2$e/m^2 GIA and total tCO$_2$e for modules A1-A5, B1-B5, B6, B7, C1-C4 and D.



Dashboard Figure D: Comparing the Upfront embodied carbon (A1-A5, excl. sequestered carbon and demolition) results of building elements to the published GLA standard and aspirational benchmarks and associated percentage breakdown estimates



Dashboard Figure E: Comparing the Upfront embodied carbon (A1-A5, excl. sequestration & demolition) and In-use and End-of-life embodied carbon (B-C, excl. B6&B7) results to the published GLA standard and aspirational benchmarks

8. The Consideration of Options in the Planning Application Process

Planning applications received by the CoLC are expected to provide a narrative of how optioneering considerations about reducing carbon emissions have informed the design of an application scheme. The optioneering results include high level data about whole life-cycle carbon emissions and an analysis of the opportunities and constraints of each option against the vision and deliverables of a site. The optioneering exercise is designed as a tool in the discussion and negotiation of a proposal in the early pre-application stage between applicants and planning officers to help optimise the design of the application scheme.

This methodology is not designed to link the optioneering designs and results to the details of the planning application scheme as the latter is based on more, and perhaps different, design detail compared with the options. The chosen option should follow the GLA WLC assessment guidance for the application and achieve the current benchmark guidance.

Once a planning application scheme has been given planning permission, the Energy, Whole Life-Cycle Carbon and Circular Economy strategies of the approved scheme will be further detailed and approved during the planning conditions stages. The CoLC will monitor post-completion results that are required to be submitted by condition.

The methodology set out in the previous chapters will be updated as frequently as necessary to reflect the latest scientific advances, technologies, policies and regulations.

Appendix 1 Climate Action Strategy 2020-2027

Headlines

Through this strategy the City Corporation commits to achieving:

- Net zero by 2027 in the City Corporation's operations
- Net zero by 2040 across the City Corporation's full value chain
- Net zero by 2040 in the Square Mile
- Climate resilience in our buildings, public spaces and infrastructure

Across the Square Mile we will:

- Work with all stakeholder groups to accelerate the transition to net zero
- Support SMEs to reach net zero
- Invest in making the Square Mile more resilient to extreme weather and flooding

At the City Corporation we will do this through major investments in:

- Improving energy efficiency at our investment and corporate properties
- Aligning our investment portfolio with the Paris Agreement
- Enhancing carbon removal in our open spaces
- Protecting our shared natural resources
- Driving net zero through our supply chain
- Integrating climate considerations into all our decisions

Our climate vision, aims and goals

Our vision

- The City of London is Responsible, Sustainable and Competitive

Our aims

- To support the achievement of net zero
  To build climate resilience
- To champion sustainable growth

Our goals

For the City of London Corporation:

- City of London Corporation **scope 1 and 2 emissions are net zero by 2027** and **scope 3 emissions are net zero by 2040**.
- The City of London Corporation and its assets **are resilient to climate change**.
- The City of London Corporation supports UK and overseas organisations to **become climate responsible**.

For the Square Mile's fabric and function

- The Square Mile's scope 1, 2 and 3 emissions (BASIC+ definition) are net zero by 2040.
- The Square Mile's buildings, public spaces and infrastructure are **resilient to climate change**.

For society

- People in the Square Mile and beyond **benefit from a clean, green and safe environment and job creation**.

The first six years

Actions to support the achievement of net zero

The City of London Corporation

- Transform the energy efficiency of our operational buildings through the adoption of best available technologies
- Maximise the use of renewable energy sources across our operational buildings
- Introduce new land management practices across our open spaces aiming to maximise their ability to remove carbon, and optimise their biodiversity and resilience value
- Align our financial investment portfolio with the goals of the Paris Agreement on climate change
- Embed circular economy principles into our capital projects and reduce carbon intensity by using life cycle carbon and cost assessment techniques and design specifications
- Accelerate the move to net zero carbon and energy efficient tenanted buildings, working closely with tenants to achieve shared goals
- Strengthen our requirements and supplier engagement to drive performance and innovation in delivering sustainable products and solutions
- Upskill our workforce on net zero

The Square Mile

- Work with other organisations to develop a Climate Action Fund to invest in effective zero carbon technologies and accelerate decarbonisation
- Develop a Square Mile renewable energy strategy Use our planning role to influence others to embed carbon analysis and circular economy principles in capital projects
- Advocate the importance of green spaces and urban greening as natural carbon sinks, and their contribution to biodiversity and overall wellbeing
- Support organisations in the Square Mile to build circular, low carbon and resilient supply chains
- Provide tailored support to SMEs on their decarbonisation journeys
- Increase engagement and communications about sustainability with residents, businesses, visitors and other stakeholders

Actions to build climate resilience

The City of London Corporation

- Build on our existing work to develop an early warning system, and clear resilience strategies for pests and diseases across our ports and markets, driving down the climate related food security risks
- Embed resilience measures into our upgrade plans for our owned and operated buildings
- Upskill our workforce on climate resilience
- Embed a climate resilience lens into all our decision-making

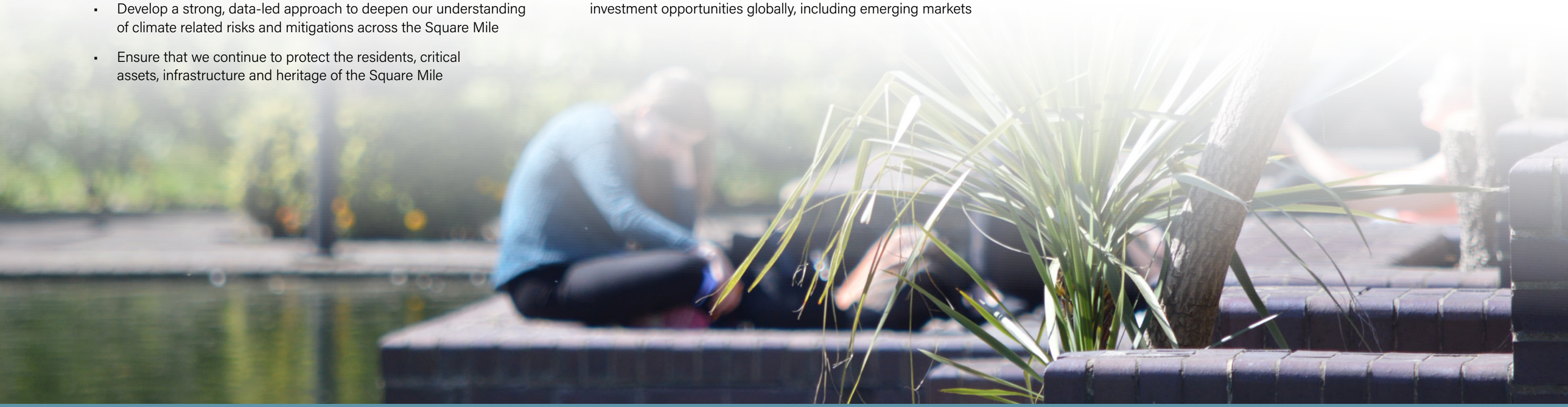
The Square Mile

- Make the Square Mile public realm more climate change ready through adding in more green spaces, urban greening, flood resistant road surfaces, adaptable planting regimes and heat resistant materials
- Reduce the risk of flooding through developing sustainable rain and surface water management policies, resulting in a connected system of water recycling, sustainable urban draining and rainwater management measures
- Strengthen our planning guidance on climate resilience measures for new developments
- Work with our partners to create a more climate resilient and diversified energy network across the Square Mile
- Develop a strong, data-led approach to deepen our understanding of climate related risks and mitigations across the Square Mile
- Ensure that we continue to protect the residents, critical assets, infrastructure and heritage of the Square Mile

Actions to champion sustainable growth

The City of London Corporation

- Mobilise capital into sustainable finance
- Secure the UK's place as a leader for investment in sustainable finance products
- Help faster development and adoption of sustainable finance products and services
- Share best practice on standards, tools, platforms and expertise to facilitate green and sustainable investment and growth
- Encourage global movement towards disclosure and production of credible transition plans as the norm
- Foster an ambition to achieve net zero emissions by 2050 or sooner for UK-based financial and professional services firms
- Join other investors working through development and implementation of net zero transition action plans
- Support financial institutions committing to net zero in the 2040s at the latest, covering all emissions, including scope 3 and where data allows reliable measurement
- Support charities and SMEs to consider, prepare for and lead the response to climate change
- Promote responsible procurement and investment practices
- Enhance the UK/London's capacity to finance sustainable investment opportunities globally, including emerging markets
- Work with the financial services sector and UK Government to promote and scale sustainable finance products and services that countries and corporates need to help them transition to net zero
- Influence and support the delivery of technical solutions to increase comparability of data and ease of reporting
- Share learning and best practice about the challenges and opportunities of our net zero journey
- Address existing inequalities and ensure no one is left behind
- Prepare people for skills needed in a net zero economy
- Facilitate collaborative action on air pollution in London
- Reduce pollution and increase the resilience of the Square Mile
- Reduce air pollution through implementing our ambitious air quality and transport strategies
- Embrace circular economy principles across our strategies and work
- Work with our creative and educational sector partners to deliver sustainable initiatives
- Enhance greening and biodiversity across our public realm and open spaces



Appendix 2 Related Reporting Requirements

Non-policy related reporting for net zero carbon

Over the past three years, the UK property industry has done more to advance the environmental agenda than ever before. Developers, consultants and professional bodies have come together to declare a climate and biodiversity emergency and have taken concrete action. Together we have developed much needed clarity and guidance on how to truly achieve zero carbon by 2030.

Property lenders, investors, asset managers and occupiers are all driving this shift by demanding a very high standard of environmental, social and governance policy as a prerequisite to any transaction. This trend is increasing rapidly across all workplace environments, both for new and existing assets.

A number of businesses have declared that they have become net zero carbon in operation across portfolio assets and activity within their control. These declarations in the London market tend to align with the World Green Building Council or UK Green Building Council Definition Framework and consists of accounting for and reducing carbon emissions, investing in renewable energy, offsetting residual carbon through accepted credit frameworks and publicly disclosing their pathway.

Other approaches adopted by applicants that vary in scope to planning policy requirements include:

- The Low Energy Transformation Initiative (LETI) targets and scope
- The UKGBC Net Zero Carbon Definition Framework and benchmarks
- The forthcoming Net Zero Carbon Buildings Standard. Note: this initiative is currently in the early stages of development. Once requirements become available, they should be a valuable point of reference for planners and project teams to assess proposals.

Low Energy Transformation Initiative (LETI)

LETI has recently published several design guidance documents that set out a trajectory of embodied carbon and operational energy targets required to address the climate emergency. The WLCA scope associated with their targets is limited to stages A1-A5 to practical completion.

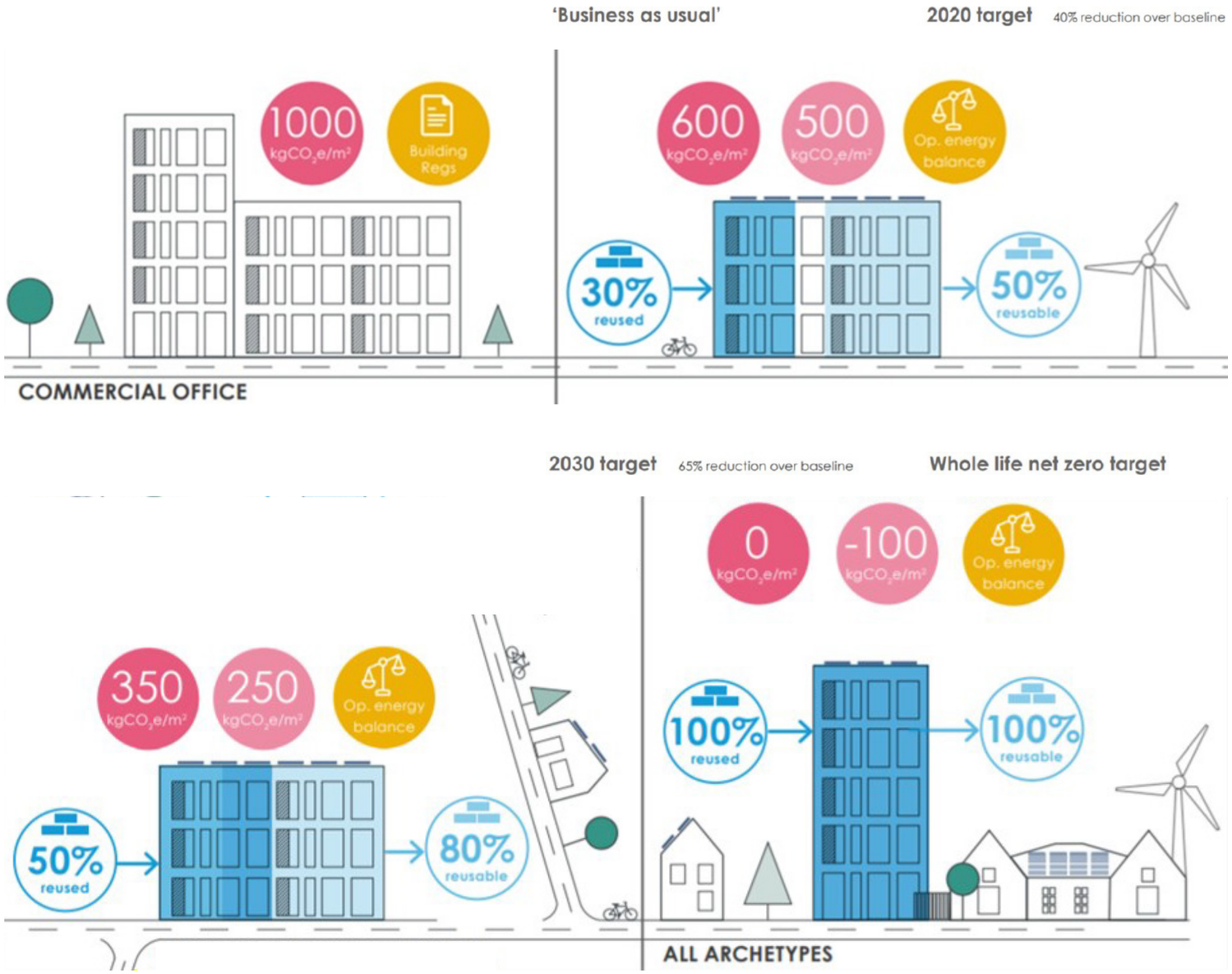


Figure 10: Example of LETI Carbon best practice targets for Commercial offices from figure 7.1 LETI Embodied Carbon Reduction Targets towards Whole Life Net Zero, Leti Embodied Carbon Primer (Jan 2020)

UKGBC Net Zero Carbon Buildings Framework Definition

The UKGBC sets out guidance in consultation with the industry to define net zero carbon. At time of writing this planning guidance, a building can claim to be net zero carbon in construction or in operation or in both. UKGBC has published benchmarks for operational energy with a trajectory to net zero carbon, but none for embodied carbon at this time.

The framework requires third party review of whole life-cycle assessments and operational energy assessments, including a minimum carbon reporting template and information that needs to be publicly disclosed. Notably, key differences between the UKGBC Net Zero Carbon definition and the London Plan definition are shown in the following table.

Since the above by the UKGBC took place. Leading industry organisations BBP, BRE, the Carbon Trust, CIBSE, IStructE, LETI, RIBA, RICS, and UKGBC have joined forces to champion a UK Net Zero Carbon Building Standard.

The UK Net Zero building standard aims to be launched at the end of 2023/early 2024. The Standard will cover more building typologies and set out metrics by which net zero carbon performance is evaluated, as well as performance targets, or limits, that need to be met. These are likely to include energy use, upfront embodied carbon, and life-cycle embodied carbon, with other metrics– such as space heating/cooling demand and peak load– also to be considered. It will also cover the approach to carbon accounting, procuring renewable energy, and the treatment of residual emissions, including carbon 'offsetting'. However, the scope and output of the Standard may evolve throughout the development process. The NZC Standard will cover all building types.

It is expected that claims will be required to be validated based on in-use measured data and interim verification of an asset at design stage or once the asset is built but not yet operating may also be considered.

Table 3: Energy performance targets for buildings targeting net zero carbon for operational energy, Net zero carbon: energy performance targets for offices UKGBC, January 2020.

Scope	Metric	Interim Targets 2020-2025	Interim Targets 2025-2030	Interim Targets 2030-2035	Paris Proof Target 2035-2050
Whole building energy	kWhe/m²(NLA)/ Year	160	115	90	70
	kWhe/m²(GIA)/Year	130	90	70	55
	DEC rating	D90	C65	B50	B40
Base building energy	kWhe/m²(NLA)/ Year	90	70	55	35
	kWhe/m²(GIA)/Year	70	55	45	30
	NABERS UK star rating	4.5	5	5.5	6
Tenant energy	kWhe/m²(NLA)/ Year	70	45	35	35

Comparison of Net Zero Carbon Definitions

Table 4: Comparison on UKGBC net zero carbon and London Plan net zero carbon definitions

	UKGBC Net Zero Carbon	London Plan Net Zero Carbon
Whole Life-Cycle carbon	Minimum reporting Stages A1-A5, B4 for superstructure ext. walls and windows/external doors, B6 operation energy. Full Assessment Modules A-C	Modules A-D (B6, B7, and D not included in benchmarks).
Regulated operational carbon emissions from energy use	Includes all energy use within declarant's control	Part L2 regulated carbon assessment used to determine net zero carbon target TM54 required for 'be seen' (non-residential)
Unregulated operational carbon emissions from energy use	Includes all energy use within declarant's control	Unregulated energy to be estimated and infrastructure in place to monitor, verify and report all annual energy consumption. NABERS UK Design for Performance (see below) encouraged for commercial office buildings 5,000m^2 TM54 requires for 'be seen' (non-residential)
Renewable energy generation	Onsite and off-site renewables	Priority for on-site renewables, but offsite renewables are acceptable alternative to carbon offset (conditional)
Carbon offsetting	Offset all residual carbon using an approved international or domestic carbon offset standard, applying standard market rates. UKGBC recommend also using higher rate from HMT Green Book at the time of offset to create Transition Fund for further decarbonisation	Offset residual carbon relative to 100% regulated carbon savings only, determined by Part L2 target. Carbon offset is recommended as £95/tonnes CO_2 paid in advance and for a 30-year life-cycle

Appendix 3
Detailed Building Element Scope

Table 5 compares the UKGBC, GLA, LETI and BREEAM reporting scopes for building elements in more detail from Table 2 in section 2.

Table 5: Detailed comparison of scopes per building part element/group

Building part/ Element group	Building Element	UKGBC Full Assessment	UKGBC Minimum Reporting	GLA WLC Guide	RIBA 2030 CC Ver.2	LETI EC Primer	BREEAM NC 2018 and RFO 2014***
Demolition prior to construction	0.1 Toxic/Hazardous/Contaminated Material Treatment			YES#			
	0.2 Major Demolition Works			YES#			
Facilitating works	0.3 and 0.5 Temporary/Enabling Works	✓		YES#			
	0.4 Specialist groundworks	✓		YES#			
Substructure	1 Substructure	✓	✓	✓	✓	✓	NC credit option, RFO if in scope***
Superstructure	2.1 Frame 2.2 Upper Floors 2.3 Roof 2.4 Stairs and Ramps	✓	✓	✓	✓	✓	NC mandatory, RFO if in scope (excludes ramps)***
Superstructure	2.5 External Walls 2.6 Windows and External Doors	✓	✓	✓	✓	✓	NC mandatory, RFO if in scope***
Superstructure	2.7 Internal Walls and Partitions 2.8 Internal Doors	✓		✓	✓	✓	NC mandatory education only, RFO if in scope***
Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes	✓		✓	✓	✓	RFO if in scope***
Fittings, furnishings and equipment (FF&E)	4.1 Fittings, Furnishings and Equipment incl. Building-related* and non-building related**	✓		✓	✓		RFO if in scope to CN7 limited furniture/shop fittings***
Building services/ MEP	5.1–5.14 Services incl. Building-related* and non-building related**	✓		✓	✓	✓	NC credit option, RFO if in scope***
Prefabricated Buildings and Building Units	6.1 Prefabricated Buildings and Building Units	✓		✓	✓	✓	
Work to Existing Building	7.1 Minor Demolition and Alteration Works	✓		✓	✓		
External Works	8.1 Site preparation works 8.2 Roads, paths, paving and surfacing 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	✓		✓			NC credit option RFO if in scope: hard landscaping and boundary protection only***

* Building-related items are 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 FFE typically include the items classified under shell and

** Non-building-related items are 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.

***BREEAM NC = BREEAM New Construction 2018; BREEAM RFO = BREEAM Refurbishment and Fit-out 2014

Reported separately. Benchmarks do not include these building elements

Appendix 4
GLA WLCA Pre-App Reduction Principles Proforma

No.	WLC reduction principles	Key benefits
1	**Reuse and retrofit of existing buildings**	Retaining existing built structures for reuse and retrofit, in part or as a whole, should be prioritised before considering substantial demolition, 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.
2	**Use re-purposed or recycled materials**	Using repurposed or recycled or materials, as opposed to newly sourced 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.
3	**Material selection**	Appropriate low-carbon material choices are key to carbon reduction. Ensuring that materials are selected with consideration of the planned life expectancy of the building reduces waste, the need for replacements, and the in-use costs. It is important to note that the overall lifetime carbon emissions of a product can be as much down to its durability as to what it is made of. For example, bricks may have high carbon emissions in terms of their manufacture, but they have an exceptionally long and durable life expectancy. The selection of reused or recycled materials and products, plus products made from renewable sources, will also help reduce the carbon emissions of a project.
4	**Minimise operational energy use**	A 'fabric first' approach should be prioritised to minimise the heating and cooling requirement of a building and the associated systems. 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.
5	**Minimise the carbon emissions associated with 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 emissions 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.
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. 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.

No.	WLC reduction principles	Key benefits
8	**Regenerative design**	Removing carbon 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.
9	**Designing for durability and flexibility**	Durability means that repair and replacement is reduced which in turn helps reduce lifetime building costs. A building designed for flexibility can respond with minimum environmental impact to future 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 their 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.
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 will generate carbon emissions. This means that it is important to look not only at the U-value of insulation, but also the carbon emissions from 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.) at both the construction and in-use stages through wholesale replacements.
11	**Building life expectancy**	Defining building life expectancy gives guidance to project teams as to the most efficient choices for materials and products. This aids overall resource efficiency, including cost efficiency and helps future-proof asset value.
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 significantly lower carbon emissions 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.
13	**Minimising waste**	Waste represents unnecessary and avoidable carbon emissions. Buildings should be designed to minimise fabrication and construction waste, and to 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 (MMC). Where waste is unavoidable, the designers should establish the suppliers' processes for disposal or preferably reuse or recycling of waste.
14	**Efficient construction**	Efficient construction methods (e.g. modular systems, precision manufacturing and MMC) can contribute to better build quality, reduce construction-phase waste and reduce the need for repairs in the post completion and defects period (snagging). These methods can also enable future disassembly and reuse with associated future carbon savings.
15	**Lightweight construction**	Lightweight construction uses less material, which reduces the emissions 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.
16	**Circular economy**	The circular economy principle focuses 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 are 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.

Appendix 5
Planning Application Trends

An evaluation of planning applications and types has been undertaken based on the City of London Development Schedule 'Development Schedules March 2021 -Updated Jan' issued to Hilson Moran by CoLC.

This review was undertaken to establish trends and to provide the evidence base to support this guidance document.

The majority of applications, 76% (of which 40% where GLA referable), fall under the City's definition of major development (> 1,000m^2) and/ or require an environment impact assessment. This demonstrates that the greatest proportion of projects are likely to have the largest carbon impact and therefore should be required to mitigate it.

The remaining applications are varied full applications covering change of use and extensions (24%). These are broken down as follows:

Table 6: Number and types of commercial development applications in the City of London.

Project type	Year(s)	Number of applications	FULMAJ	FULEIA	FULL	GLA referable
Office	2014 - March 2021	37	15	11	11	4
Office	March 2021 - 2022	9	4	5	0	8
Total		46	19	16	11	12
Percentage		100%	76%		24%	41%
Hotel/Student accommodation	2012 - 2021	9	5	0	4	2
Percentage		100%	56%		44%	22%
Other (law court, police + commercial	2021	1		1		1
Percentage			100%			100%

Table 7: Number of full planning applications, excluding major application, by development type.

Percentage	Full	Change of Use - Partial Building	Extension only	New Buildings with Change of Use	Refurbishment with Change of Use	Refurbishment without Change of Use
Office	11	1	4	2	2	2
Percentage by type	100	9	36	18	18	18

The following is a breakdown of office applications by size. The majority have an area above 10,000m² (76%). This also confirms the trend for larger scale applications with potentially bigger impacts.

Conclusion

Based on the above, it is reasonable and recommended to follow the GLA approach for a WLCA to provide a consistent approach across the City of London.

Advantages:

- Leads to consistent and more transparent results;
- Will create a uniform and well-understood approach across the industry;
- Will build consistency around the metrics used over time;
- Can be compared to GLA benchmarks for benchmarking;
- Future-proofs policy updates across London;
- Greater awareness of impacts could lead to better design decisions and to greater carbon savings.

Disadvantages:

- Will require additional time and detail from the design team for evaluation and assessment. However, the assessment will contribute to the justification for the application proposal and may help with achieving a successful outcome.

The review of data concludes that there is a need for emissions to be accounted for and for options to be considered in the City of London for all major applications. Full major applications are to consider development options and carbon impacts, applying the methodology presented in this document.

Following the optioneering CoLC expects that all major developments undertake a whole life-cycle carbon assessment (WLCA) for the final application for the chosen option.

Within this is a requirement to review building options accounting for carbon in a more consistent way, to ensure the best choices are made. There will always be some carbon emissions associated with developments. However, there is a duty to try and limit them wherever possible and for the CoLC to be able to make informed decisions in line with the CoLC's Climate Action Strategy.

Table 8: Size of office development applications in the City of London.

Project type	Total	1,000 - 5,000sqm	5,001 - 10,000sqm	10,001 - 15,000sqm	15,000sqm +
Office	46	9	2	5	30
Percentage	100	20	4	11	65

Table 9: WLC sample from recent projects submitted for planning to the City of London.

				Circular Economy	Whole Life-Cycle Carbon Assessment			Operational Energy	
Project	Size (GIA m²)	Land use class/es	Referable major	Options	Life-Cycle scope	Building elements scope	Value $kgCO_2e/m^2GIA$	Scope	Value $kgCO_2e/m^2GIA$
14-21 Holborn Viaduct	35,948	Class E	FULMAJ Referable	Demolish and rebuild, Mitigate impacts	GLA (draft guidance) A1-A5, B1-B5, C1-C4, D	GLA (draft guidance) WLC spreadsheet submitted	670 (Stage 2)	Estimated	925** (Stage 2)
115-123 Houndsditch	66,867	Class E (Sui Generis)	FULMAJ Not Referable	Demolish and rebuild, Mitigate impacts	GLA (draft guidance) A1-A5, B1-B5, C1-C4	State followed GLA (draft guidance)	768 (+25% factor used) (Excludes module D)	Estimated	844* (Stage 2)
120 Fleet Street**	61,135	Class E	FULEIA Referable	Demolish and rebuild, Mitigate impacts	GLA (draft guidance) A1-A5, B1-B5, C1-C4, D	GLA (draft guidance) WLC spreadsheet submitted	753	Estimated	1,321

*TM54 not provided, source of operational energy use unclear

** Project is using early NABERS DfP model for operational energy use rather than the CIBSE TM54 approach

*** Multiple buildings indicated but only 1 WLCA sheet submitted for main development

Appendix 6
Related Reporting Requirements

There are other carbon-related planning reports that should be taken into consideration. They include Greenhouse Gas impact assessments, the Circular Economy Statement, operational energy and operational water assessments. Where relevant, these should be referenced in WLCA reporting, in particular to highlight discrepancies and overlaps in design considerations and decisions.

Greenhouse Gas Reporting in Environmental Impact Assessments

A greenhouse gas (GHG) is a gas that absorbs and emits radiant energy within the thermal infrared range, essentially, they trap heat causing the greenhouse effect. Very large developments, such as infrastructure projects and high-rise buildings, usually require a GHG chapter within the Environmental Impact Assessment scoping for a planning application.

In February 2022 the Institute of Environmental Management and Assessments (IEMA) published an update to their guide 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2nd ed.) to align with government and industry agendas. The methodology for writing this environmental impact assessment chapter includes a full life-cycle scope, aligning with parts of the GLA WLCA method referred to above. The approach covers similar themes but may not be as detailed as a full WLCA due to the timing of the assessment.

The differences in the approach include:

1. The range of gases is broader than carbon (carbon dioxide CO_2) and includes methane (CH_4), nitrous oxide (N_2O), and ozone (O_3);
2. The scope of emitters is broader, including for example emissions from operational transport and leaking F-gases (refrigerants). Note, the GLA requires separate calculation of refrigerant emissions in the reporting WLCA template;
3. The proposal is compared to a current baseline;
4. Exclusions, metrics, data quality, degree of uncertainty and mitigation measures need to be defined; and
5. GHG assessments can be carried out a lot earlier than a detailed application WLCA (to GLA standards), for example for an Outline Planning Application, and therefore the data tends to be based on industry averages/benchmarks.

The process and content of a GHG assessment is structured by the IEMA guidance and should not preclude the need for a WLCA. In many cases, the information in relation to carbon in a GHG assessment may differ from that of a WLCA due to timing and the accuracy of information available at the time of assessment.

IEMA Greenhouse Gas Management Hierarchy (updated 2020)
Eliminate ▪ Influence business decisions/use to prevent GHG emissions across life-cycle ▪ Potential exists when organisations change, expand, rationalise or move business ▪ Transition to new business model, alternative operation or new product/service
Reduce ▪ Real and relative (per unit) reductions in carbon and energy ▪ Efficiency in operations, processes, fleet and energy management ▪ Optimise approaches (e.g. technology) and digital enablers
Substitute ▪ Adopt renewables/low-carbon technologies (on site, transport etc.) ▪ Reduce carbon (GHG) intensity of energy use and of energy purchased ▪ Purchase inputs and services with lower embodied/embedded emissions
Compensate ▪ Compensate 'unavoidable' residual emissions (removals, offsets etc.) ▪ Investigate land management, value chain, asset sharing, carbon credits ▪ Support climate action and developing markets (beyond carbon neutral)

Table 10: GHG Management Hierarchy, 2020 (Source: EIMA, Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2nd edition.)

GLA Pre-application Optioneering

The London Plan Guidance 'Whole Life-Cycle Carbon Assessments' (March 2022) explains how to calculate WLC emissions and the information to be submitted to comply with the policy, including the scope required. It also includes information on design principles and WLC benchmarks (by life-cycle stage) to aid planning applicants in designing buildings that have low operational carbon and low embodied carbon.

A WLC assessment template needs to be completed in four parts, namely, at pre-application, planning submission (outline and details) and post construction (prior to occupation).

The GLA encourages WLC assessments on major applications that are not referable to the Mayor. The CoLC is supportive of this approach and requires that they are provided as part of the planning application in line with the GLA requirements. In addition to the above, planning officers request, by condition, a more detailed update of the WLCA following the detailed design phase (RIBA Stage 4) prior to construction when more design and procurement information is available to the project team. This is to ensure that the CoLC is aware of and understands opportunities and constraints through changes of and improvements to developments.

The GLA's pre-application section includes a hierarchy of WLC reduction principles (see Appendix 4 for full list). Principle 1 relates to options for 'significant retention and reuse of structures' as shown in Table 11, requiring examples to demonstrate that:

- Options for retaining existing buildings and structures have been fully explored before proposing substantial demolition, including incorporating the fabric of existing buildings into the new development (aligned with London Plan Guidance for Circular Economy Statements, March 2022);
- Carbon emissions associated with pre-construction demolition are currently reported separately;
- An estimate of the percentage of the new build development which will be made up of existing façades, structures and other key components is reported;
- An optional requirement to report on the effects of future grid decarbonisation on the development's embodied carbon emissions.
- The WLC principles are informing the proposed development of the site.

Confirmation that options for retaining existing buildings and structures have been fully explored before considering substantial demolition	[Outline the options that have been considered - plus an explanation of opportunities and limitations, and why demolition outweighs the benefits of retaining existing buildings/structures where applicable]
Carbon emissions associated with pre-construction demolition ($kgCO_2e$)	[If estimates are not possible, please apply standard assumption of $50kgCO_2e/m^2$ of the existing building/s]
Estimate of the percentage of the new build development which will be made up of existing elements	[e.g. X% existing facades; Y% existing foundations; Z% superstructures etc.]

Table 11: Retention of existing building and structures from the GLA WLCA assessment template, March 2022

If substantial demolition is proposed, applicants will need to demonstrate that the benefits of demolition would clearly outweigh the benefits of retaining the existing building or parts of the structure.

Further considerations and options in relation to the retention of building elements and material are required by the circular economy principles (see following page).

Note, the GLA (and optionally BREEAM) requires the reporting of refrigerant Global Warming Potential emissions in $kgCO_2e/m^2$ GIA. This is important to include in the WLCA. The GLA requires reporting of refrigerant impact in the Whole Life-Cycle Carbon Assessment template spreadsheet. Measures can be installed to prevent and manage refrigerant leakage to the atmosphere. The requirement for leak detection and containment of refrigerants as part of the commissioning process could be secured through a condition.

WLC reduction principle: 1. Reuse and retrofit of existing buildings

Key benefit: Significant retention and reuse of structures is carbon efficient and reduces construction costs

Provide examples of how the reduction principle has been used, or give reasons why it cannot be used.

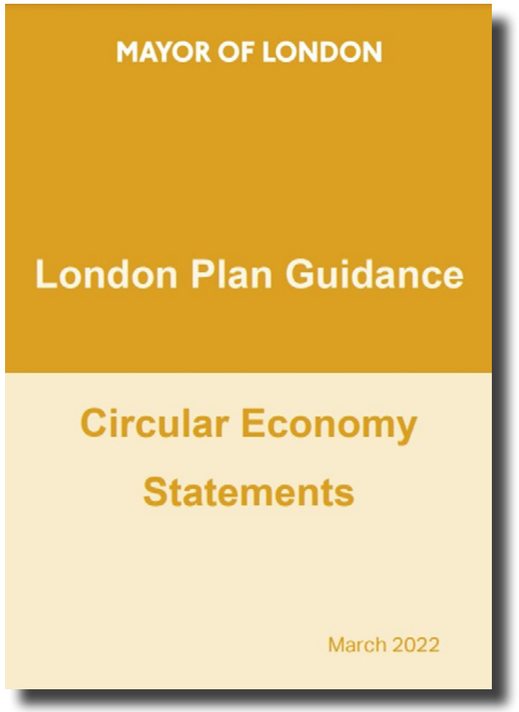


Figure 11: The new London Plan Guidance 'Circular Economy Statements' sets out the principles to be adopted to demonstrate the adoption of circularity in design and construction

Circular Economy Statement

The Mayor of London's London Plan 2021 requires proposals referable to the Mayor to calculate a development's impacts and solutions to meet circular economy principles. It sets out the aim of retaining material at their highest value for as long as possible, to increase reuse and recycling, leaving minimal residual waste.

The reporting requirements and scope of the assessment are described in a London Plan Guidance 'Circular Economy Statements' (adopted 25th March 2022), which structures a reporting framework and principles to be considered by all referable applications. This needs to be considered alongside the WLCA.

The guidance includes requirements for a decision pathway to be outlined and for pre-redevelopment and pre- demolition audits, which need to be communicated at the earliest stages possible. The aim is for projects to incorporate these into their brief at procurement stage.

The guidance sets out six principles which are seen as critical to the design process:

1. Building in layers, ensuring that different parts of the building are accessible and can be maintained and replaced where necessary
2. Designing out waste, ensuring that waste reduction is planned in from project inception to completion, including consideration of standardised components, modular build, and reuse of secondary products and materials
3. Designing for longevity
4. Designing for adaptability or flexibility
5. Designing for disassembly
6. Using systems, elements or materials that can be reused and recycled.

The principles apply to the waste hierarchy to reduce or avoid waste wherever possible and to try and ensure that materials are applied and used at their highest value. The concept for building in layers attributes design life to different aspects of the building in terms of skin, shell, structure/frame, building services, Space/space plan/interior/ interior space, stuff and contents.

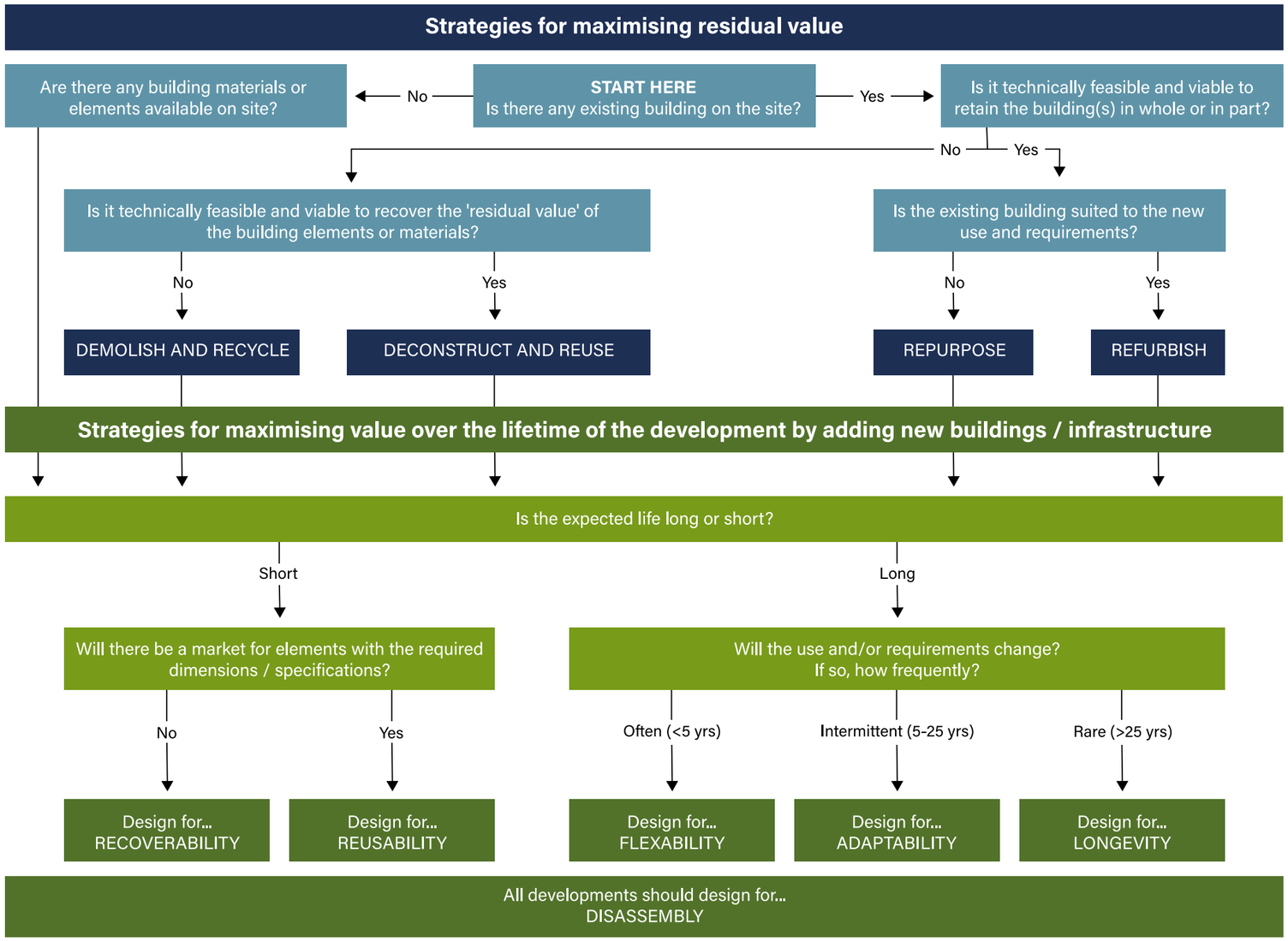


Figure 12: Decision tree for design approaches to existing structures/buildings -GLA Circular Economy Guidance March 2022

Carbon Emissions from Operational Energy and Water

The WLCA includes life-cycle stages B6 (Operational Energy) and (B7 Operational Water). GLA planning policy currently requires separate energy and water consumption reporting. This section clarifies the requirements and overlaps between reporting requirements. GLA benchmarks exclude stages B6 and B7.

Operational Energy Modelling

NABERS UK 'Design for Performance' (DfP) and CIBSE TM54 'Evaluating operational energy use at the design stage' (2022) are increasingly being used by applicants to more accurately estimate and reduce operational energy during design, and to inform metering, commissioning and management requirements to maintain low energy consumption throughout a building's life-cycle.

BREEAM New Construction's (optional) operational energy modelling requirements are similar. NABERS UK is the most onerous approach of the three because of independent design reviews required during design, post completion and post occupancy seasonal monitoring, and tuning, metering infrastructure criteria to facilitate annual rating and annual energy rating updates. Note that the UK Government is proposing to introduce a new obligatory energy rating disclosure, that aligns with NABERS UK, starting with all offices greater than 1,000m², from 2022/23, indicatively. In addition, CIBSE TM54 has recently aligned with NABERS UK Design for Performance (DfP), and BREEAM is set to do the same at the next update (estimated 2023).

The GLA requires referable schemes to evaluate operational energy as part of the 'be seen' stage of the Energy Hierarchy. The associated guidance sets out parameters for evaluating performance at the planning, post-completion and in use stages of a development.

The planning stage requires an estimation of the regulated and unregulated energy. The recommendation is for the use of analysis guided by CIBSE TM54 'Evaluating operational energy use at the design stage'. NABERS UK DfP is encouraged for office buildings greater than 5,000m².

CIBSE, TM54 and NABERS UK give a far more accurate and complete estimate of operational carbon emissions than Building Regulations Part L as they allow for detailed prediction of regulated and unregulated energy using more detail and realistic parameters to evaluate energy performance, rather than a uniform set of standardised regulated energy parameters. Part L modelling is used to ensure that buildings meet the minimum energy efficiency standards set by building regulations, while TM54 operational energy modelling is used to identify areas where energy consumption can be reduced and to inform decisions on building design and operation.

Both the TM54 and NABERS UK (currently for commercial offices only, other schemes are being developed) approaches align with the reporting requirements of Stage B6 'Operational Energy Use' under the GLA's WLCA Guidance (March 2022) and the GLA's 'Be seen' guidance.

The GLA also requires in use monitoring and Energy Use Intensity (EUI) reporting of actual energy use for the first 3 years of a building's operation.

Operational water use

Operational water consumption in planning applications is currently reported in 2 ways:

1. Part of the WLCA (module B7), in line with the RICS method, which requires all carbon emissions related to water supply and wastewater treatment to be reported, using BSRIA benchmarks initially, then estimated values once known. Carbon conversion factors for water use and treatment as published by the local water supplier should be used.

2. Part of the BREEAM Assessment, which aims to reduce and benchmark the consumption of potable water for sanitary use (credit Wat 01) in new and refurbished buildings through the use of water efficient components and water recycling systems. CoLC's current policy refers to requiring all BREEAM water credits to be achieved.

The latter consumption evaluation is therefore limited to potable water only, while the former looks at all water consumption and treatment and associated carbon emissions. BREEAM does review non potable water but in a qualitative way (credit Wat 04).

The UK Government is proposing to introduce a new obligatory water rating disclosure (in a similar way to energy, above) and to regulate all water consumption for different land uses. Currently only potable water in residential uses is regulated.

Figure 13: The new revised CIBSE Technical Manual for evaluating operational use at the design stage provides a framework for more accurate prediction of regulated and unregulated energy consumption

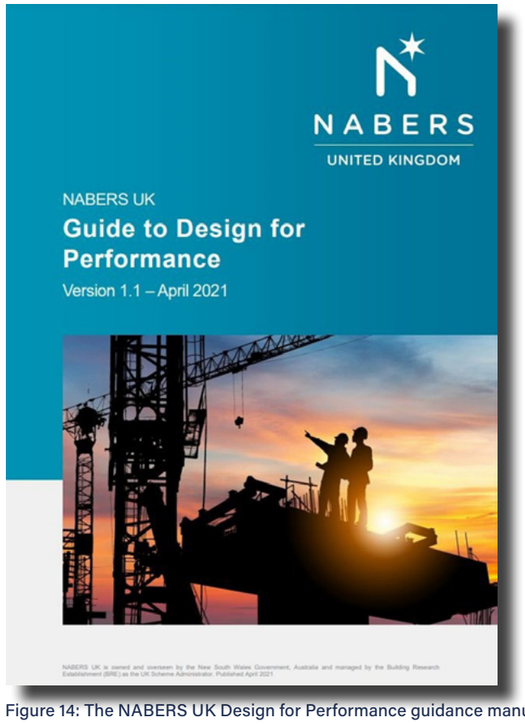


Figure 14: The NABERS UK Design for Performance guidance manual

Appendix 7
Third Party Review Guidance

Third party review is required to ensure that options have been designed, calculated and evaluated realistically and consistently.

The requirement for third party review introduces rigour and scrutiny into the process and to ensure that the optioneering forms a robust basis for the development of the application scheme.

The review process will be arranged by planning officers and funded by the developer (see figure 15).

Reviewers should:

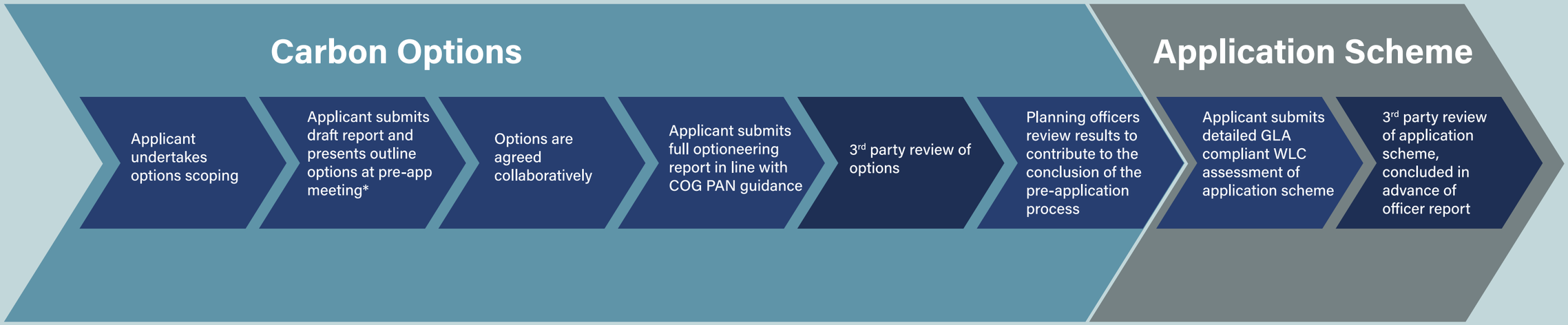
- be independent from the applicant's team
- have suitable experience of a minimum of 3 years in carrying out whole life-cycle carbon assessments and energy strategies, working in the construction industry on projects with similar scale and use, and
- provide a declaration of their independence and experience.

The output should be in the form of a statement using the City of London Carbon Options Tool (in the reviewer column) of Dashboard A.

Assessment guidance for Reviewers:

- Does the choice of options reflect realistic proposals for the maintenance, retrofit and development of the site and cover clearly discernible scenarios?
- Is the methodology followed to specify the development options, calculate the carbon impacts, and is the optioneering approach aligned with the COG's recommendations?
- Are the structural impacts calculated for each option robust, consistent and include a breakdown into relevant elements?
- Are other key design elements aligned between options, and if not, are differences declared and explained?
- Are any differences in operational emissions (life-cycle stage B6) reasonable between options and are carbon factors aligned?
- Where applicable, is the carbon impact resulting from a change of use clearly presented (e.g. changing from offices to hotel, requiring works to risers, cores, building services)?
- Where demolition / strip out is undertaken, how has demolition been considered and estimated?
- Are the constraints and the assumptions on which the options are based appropriate, consistent across the options and without bias to favour any one option? Is the scope of the works fully set out for each option?
- Are the options fully evaluated, including circular economy approaches, climate resilience measures and wider considerations, such as commerciality and risks?
- Does the evaluation of the options focus on carbon impacts, sustainability, and quality issues (in this order) separately and does it include an overall summary that is clear and comprehensible?
- Are all the relevant data as required in the methodology presented clearly and correctly in the dashboard?

The Reviewer can only be responsible for reviewing the information provided to them by the applicant's team. It is the responsibility of the applicant to ensure the information provided to the verifier is as accurate as possible. Reviewers may need to request some additional contextual information from the applicant.



*Appointed Reviewer may be present at the pre-application meeting to streamline the optioneering review process

Figure 15: Optioneering and third party review process. Informal discussions between applicant and planning officers are encouraged in all stages of the optioneering process.

Glossary

The below included a series of definition for terms used in the document. A number of these terms are aligned with industry standards including the document *Improving Consistency in Whole Life Carbon Reporting Assessment and report – Carbon definitions for the Built Environment Buildings and Infrastructure, January 2023.* (https://www.leti.uk/carbondefinitions). *'This document was put together initially by a working group within the Whole Life Carbon Network (WLCN, a group of some 90 built environment professionals) and includes detailed discussions between WLCN, LETI, CIBSE, RIBA, RICS, IStructE, ICE, and UKGBC. The 'Definitions' are structured around CEN TC 350 life-cycle modules, (e.g. BS EN 15978:2011 for buildings, BS EN 17472: 2022, PAS 2080:2016 for Infrastructure, BS EN 15643 2021.)'*

Absolute Zero Carbon: Eliminating all carbon emissions without the use of offsets.

Approved Document Part L conservation of fuel and power: Part L is a building regulation that covers both new and changes to existing dwellings and non-dwellings. Part L sets minimum requirements and targets for energy performance and carbon emissions. It also defines the carbon intensity of fuel and power.

Beyond Life-cycle (Beyond-LC): Carbon emissions arising from any benefits or burdens of materials and components beyond the life-cycle (Module D).

Biogenic Carbon: 'Biogenic Carbon' refers to the carbon removals associated with carbon sequestration into biomass as well as any emissions associated with this sequestered carbon. Biogenic carbon must be reported separately if reporting only upfront carbon but should be included in the total if reporting embodied carbon or whole life carbon.

BREEAM – Building Research Establishment Environmental Assessment Method: A leading and well-established scheme for the evaluation, rating and certification of the sustainability of buildings developed by the BRE. It is the main sustainability certification standard in the UK but also is used internationally. The main schemes apply to new buildings and both non-domestic refurbishment and fit-outs and domestic refurbishments.

Carbon Dioxide equivalent (CO_2e): A metric expressing the impact of all greenhouse gases on a carbon dioxide basis. A measure used to compare the emissions from various greenhouse gases based upon their global warming potential in a common unit over a 100 year period. E.g. 1 kg of methane is converted into the amount of CO_2 needed to cause the same effect, in this case 23 kg. Therefore 1 Kg of methane has a CO_2 equivalent of 23.

Carbon Sequestration: 'Carbon sequestration' is the process by which carbon dioxide is removed from the atmosphere and stored within a material – e.g. stored as 'biogenic carbon' in 'biomass' by plants/trees through photosynthesis and other processes.

Climate Change: Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. However, since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.

Densification: Is a term used by planners, designers, developers and theorists to describe the increasing density of people living in/using urban areas. There are a number of metrics attributing to densification, one is total building floor area divided by the area of land the buildings are built on.

Embodied Carbon or Life-Cycle Embodied Carbon: Embodied carbon emissions of an asset are the total GHG emissions and removals associated with materials and construction processes throughout the whole life-cycle of an asset (Modules A0-A5, B1-B5, C1-C4, with A0 assumed to be zero for buildings). (A0 is generally assumed to be zero for buildings, however for infrastructure projects A0 can include ground investigations and activities associated with designing the asset)

Energy use intensity (EUI): An indicator of the energy efficiency of a building's design and/or operations. It is the total amount of energy used in a building in a year divided by its floor area (kwh/m^2/yr). It can be expressed in terms of GIA or NLA, and this should be clearly stated when reporting.

Environmental Aspect: An aspect of construction works, part of works, processes or services related to their life-cycle that can cause change to the environment.

Environmental Impact: A change to the environment, whether adverse or beneficial, wholly or partially, resulting from environmental aspects.

Environmental Performance Declaration (EPD): A transparent, objective report that communicates what a product or material is made of and how it impacts the environment across its entire life-cycle. An EPD is usually valid for five years, and is generated according to a number of relevant standards.

Global Warming: Is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.

Global Warming Potential (GWP): The standard metric used to calculate CO_2 equivalent emissions of different greenhouse gases in carbon budgets and the Kyoto Protocol. GWP measures the total radiative forcing over a given period (usually 100 years) after a pulse emission, relative to that from the same mass of CO_2.

Greenhouse Effect: A process that occurs when gases in Earth's atmosphere trap the Sun's heat. This process makes the Earth much warmer than it would be without an atmosphere.

Greenhouse Gases (GHG): 'Greenhouse Gases' are constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds: For these 'carbon definitions', we are only addressing the GHGs with Global Warming Potential assigned by the Intergovernmental Panel on Climate Change (IPCC), e.g. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC's), perfluorocarbons (PFC's), and sulphur hexafluoride (SF6).

Grid Decarbonisation: The gradual reduction of the carbon intensity of electricity production.

Gross Internal Area (GIA): The area of a building measured to the internal face of the perimeter walls at each floor level. In the UK this is determined according to Royal Institute of Chartered Surveyors (RICS) property measurement standards.

IMPACT (Integrated Material Profile and Costing Tool): A specification and database for software developers to incorporate into their tools to enable consistent Life-Cycle Assessment (LCA) and Life-Cycle Costing (LCC). IMPACT compliant tools work by allowing the user to attribute environmental and cost information to drawn or scheduled items in the BIM. Put simply, IMPACT takes quantity information from the BIM and multiplies this by environmental impact and/or cost 'rates' to produce an overall impact and cost for the whole (or a selected part) of the design.

Life-cycle: consecutive and interlinked stages in the life of the object under consideration.

Life-Cycle Assessment (LCA): is a process to evaluate the environmental burdens associated with a product, process or activity:

- By identifying and quantifying energy and materials used and wastes released to the environment;
- To access the impact of those energy and materials used and releases to the environment; and
- To identify and evaluate opportunities to affect environmental improvements.

The assessment includes the entire life-cycle (from cradle to grave) of the product, process or activity encompassing extracting and processing of raw materials, manufacturing, transportation and distribution, use and re-use, maintenances, recycling and final disposal.

Minimum Energy Efficiency Standards (MEES): The Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 established the new Minimum Energy Efficiency Standards in the residential and commercial private rented sector in 2016.

NABERS UK 'Design for Performance' (DfP): A building rating scheme (currently for offices only) designed to help projects deliver against their design intent and overcome the well-evidenced performance gap between design and operation. It requires a developer or owner to commission a new office to a defined rating. It is a more detailed way of undertaking an energy model with the aim of enabling better design decisions to help reduce carbon emissions once the building is operating.

Net Zero Carbon: A 'net zero (whole life) carbon asset is one where the total sum of all assets related to GHG emissions, both operational and embodied, over an asset's life-cycle (Modules A0-A5, B1- B8, C1-C4) are minimised, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero.

NABERS Energy: NABERS Energy measures the efficiency of an office building and rates its performance (0-6 Stars). The energy rating works by comparing the energy consumption of a building against a set of benchmarks that have been developed using actual data. It is based on in-use data.

Operational Energy (modelling): A detailed energy model that attempts to reflect real world energy consumption of a building during the design and construction stages of a development. This would include more detail than a standard model used for building regulations, and would include unregulated energy.

Operational Carbon Energy building (use): 'Operational Carbon – Energy' (Module B6) are the GHG emissions arising from all energy consumed by an asset in-use, over its life-cycle.

Operational Carbon Water (use): 'Operational Carbon–Water' (Module B7) are those GHG emissions arising from water supply and wastewater treatment for an asset in-use, over its life-cycle.

Recycling: Recycling is the process of converting waste materials into new materials and objects. A recovery operation by which waste materials are reprocessed into products, materials or substances either for the original purpose or other purposes.

Refurbishment: Modification and improvements to an existing building in order to bring it up to an acceptable condition. The refurbishment of something is the act or process of cleaning it, decorating it, and providing it with new equipment or facilities.

Regulated Energy Consumption: The building energy consumption resulting from the specification of controlled, fixed building services and fittings, including space heating and cooling, hot water, ventilation, fans, pumps and lighting.

Retrofit: The act of providing something with a feature not fitted in the original construction or a replacement of a component. Often this refers to building systems upgrades, however if can refer to improving fabric and or glazing. This work generally improves amenities for the building's occupants and the overall building performance.

TM 54: A CIBSE technical memorandum that covers all types of building energy modelling with the aim of more accurately estimating a building's energy consumption in the design process and allowing more meaningful comparison with actual in-use consumption once operational.

Unregulated energy: Energy consumption that is not 'controlled', it does not fall under Part L of the Building regulations. This would include consumption from elements such as IT equipment, lifts and other plug-in equipment such as white goods, laboratory equipment, external lighting and audio visual equipment.

Upfront Carbon Embodied Carbon at Practical Completion: 'Upfront carbon' emissions are the GHG emissions associated with materials and construction processes up to practical completion (Modules A0-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion. A1-A3 covering materials product, A4 transport of materials and A5 construction and installation processes.

Whole life-cycle Carbon (WLC) or Whole Life Carbon over Life-Cycle: Whole life carbon emissions are the total sum of all asset related GHG emissions and removals, both operational and embodied over the life-cycle of an asset including its disposal (Modules: A0-A5; B1-B7; B8 optional; C1-C4, all including biogenic carbon, with A0* assumed to be zero for buildings). Overall whole life carbon asset performance includes separately reporting the potential benefits or loads from future energy or material recovery, reuse, and recycling and from exported utilities (Modules D1, D2). * A0 is generally assumed to be zero for buildings, however for infrastructure projects A0 can include ground investigations and activities associated with designing the asset.

Demolition of existing structures or buildings must be separately identified and included within Module A5.

Application types:

FULLEIA: any application requiring EIA in support

FULMAJ: – Any application over 1,000m^2 - major applications may include schemes for redevelopment, substantial refurbishments and extensions. Residential development of 10 or more dwellings or on a site of 0.5 hectares or more, and all other development of 1,000 square metres gross or more floorspace, or on a site of 1 hectare or more.

FULL: All other full applications

Organisations referenced in the report:

BBP: The Better Buildings Partnership is a collaboration of leading property owners who are working together to improve the sustainability of commercial buildings. It aims to enable market transformation through sustainability leadership and collaboration, improve professional understanding through knowledge sharing and to develop common approaches with our members, stimulating the property industry to deliver buildings that perform better.

BRE: The Building Research Establishment is a centre of building science in the United Kingdom, owned by charitable organisation the BRE Trust. It is a former UK Government national laboratory that was privatised in 1997. BRE contributes to a thriving and sustainable world by developing science-led solutions to built environment challenges, making buildings better for people and for the environment. It provides services, standards and qualifications that are used around the

world to improve the built environment. BRE is a profit-for-purpose organisation. Any profits from BRE's work go to the BRE Trust, which invests in research projects for the public benefit, or are invested in upgrading the research facilities at the BRE Science Park.

Carbon Trust: The Carbon Trust was founded by the UK Government in 2001, with the unique purpose of driving decarbonisation for businesses, governments and financial institutions. They don't have shareholders and reinvest any financial surplus to further grow their impacts. Their mission is to accelerate the move to a decarbonised future. They partner with leading businesses, governments, and financial institutions to accelerate routes to Net Zero.

CIBSE: The Chartered Institution of Building Services Engineers is the professional body that exists to advance and promote the art, science and practice of building services engineering, to invest in education and research, and to support the community of built environment professionals in their pursuit of excellence.

IStructE: The Institution of Structural Engineers is a professional body that leads and supports the development of structural engineering worldwide, in order to secure a safe and resilient built environment for all.

LETI: The Low Energy Transformation Initiative is a voluntary network of over 1,000 built environment professionals, working together to put the UK and the planet on the path to a zero carbon future. Their vision is to understand and clarify what this means in the built environment and develop the actions needed to meet the UK climate change targets. Volunteers are made up of developers, engineers, housing associations, architects, planners, academics, sustainability professionals, contractors and facilities managers, with support and input provided by local authorities and other organisations

NABERS (UK): The National Australian Built Environment Rating System UK is a simple, reliable system for rating the energy efficiency of office buildings across England, Wales, Scotland and Northern Ireland. NABERS UK measures and rates the actual energy use of offices, helping building owners to accurately track and communicate the energy performance of their buildings. It also helps identify areas for savings and improvements, and provides a rating system of 1-6 stars (1 being poor to 6 being market leading). NABERS UK is an adaptation of the highly successful rating programme NABERS that operates in Australia. Launched in Australia in 1999, NABERS is widely considered to be a world leading environmental performance rating tool for commercial buildings. NABERS UK is administered by BRE, who are responsible for the day to day operations of the scheme. The strategic operations of NABERS UK are overseen by a steering committee comprising BRE, the Better Buildings Partnership and NABERS.

RIBA: The Royal Institute of British Architects is a global professional membership body driving excellence in architecture. They serve their members and society in order to deliver better buildings and places, stronger communities and a sustainable environment. Being inclusive, ethical, environmentally aware and collaborative underpins all that they do.

RICS: The Royal Institution of Chartered Surveyors is a global professional body for those working in the built environment, construction, land, property and real estate. The RICS was founded in London in 1868. RICS promotes and enforces the highest professional qualifications and standards in the development and management of land, real estate, construction and infrastructure. The work of RICS professionals is hugely varied.

UKGBC: The UK Green Building Council is a charity organisation with over 700 members and was formed in 2007. It aims to add clarity, collaborate and improve the way that the built environment in the UK is planned, designed, constructed, maintained and operated. UKGBC is part of the World Green Building Council.

This Planning Advice Note was written by Andrew Moore and Marie-Louise Schembri (Hilson Moran) in collaboration with the City of London Corporation Planning Officers