HODKINSON

Whole Life Cycle Carbon Emissions Assessment

Bellway Homes Limited

Southern Gas Network Belvedere Holders Stations, Yarnton Way, DA17 6JP

Final

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ABOUT HODKINSON CONSULTANCY

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost-effective solutions that respond to increasing demands for quality and construction efficiency.

Executive Summary

This Whole Life Cycle Carbon Emissions (WLCCE) Assessment for the proposed development at Southern Gas Network Belvedere Holders Stations in the London Borough of Bexley, has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Bellway Homes Limited.

The proposed development will comprise redevelopment of the site to provide residential units including affordable housing (Use Class C3) and commercial floorspace (Class E) in new buildings ranging between 3 to 5 storeys in height, together with associated car parking and cycle storage, landscaping including new areas of public open space and a reptile retention zone, associated infrastructure including new junctions off Yarnton Way, drainage and land raising.

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

WLCCE are the carbon emissions resulting from the construction and the use of a building over its entire life, through four stages described as life-cycle modules, as shown in Figure i;

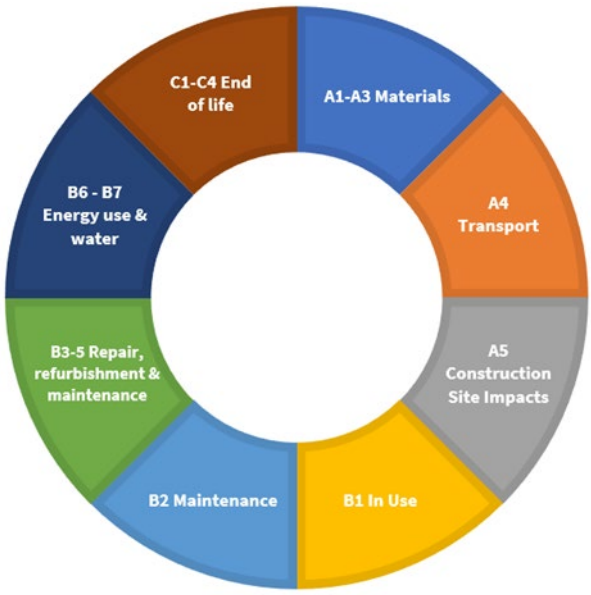

Figure i: Life cycle modules included within WLCCE assessment

They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions. Embodied emissions are those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with

maintenance, repair, and replacement as well as dismantling, demolition, and eventual material disposal. The assessment provides a picture of a building's carbon impact on the environment.

This WLCCE assessment is being undertaken in compliance with London Plan 2021 Policy (SI 2), the methodology has followed the principles of BS EN 15978 and has used both the GLA guidance and RICS as the methodology for assessment. This has been facilitated through the use of GLA approved One Click LCA software.

The following table outlines the assumptions made within this WLCCE assessment:

Table i: WLCCE assumptions

Data	Data source
Material types and volumes (A1-A3)	Material types were provided by the applicant. Where material types and volumes were not available from these sources, the One Click LCA Carbon tool was used to estimate values. 95% of the cost allocated to each building element category has been accounted for in the assessment.
Transport data (A4)	Default values provided by One Click.
Construction site impacts (A5)	Construction value provided by applicant and baseline target provided by BRE. Waste estimates were provided by the Applicant.
Refrigerants (B1)	Refrigerant quantity has been estimated based on the use of approximately 75kg of R32 within the Heat Pumps with annual leakage of 2% and 1% end of life leakage rate with a 99% end of life recovery (as per TM65).
Maintenance (B2)	For module B2 emissions, a total figure of 10 $kgCO_2e/m^2$ (GIA) has been used to cover all building element categories.
Repair and Replacement data (B3-B4)	B3 emissions have been assumed to be 25% of B2 emissions, as per GLA Guidance.
Refurbishment (B5)	At present One Click does not have ways to consider B5 emissions. However, based on the information provided for B3 and B4 it is likely that these have emissions have been accounted for.
Operational energy (B6)	Energy calculations based on SAP and SBEM calculations from the Energy Statement by Hodkinson Consultancy (August, 2023).
Operational water (B7)	Water consumption based on Building Regulations Part G 'Enhanced Consumption' of 110 l/pp/d and multiplied by the intended full occupancy of the development. Commercial water consumption has been calculated in line with BREEAM occupant density factors.

Data	Data source
End of life (C1-C4)	Default values provided by One Click based on the information within the EPD database.
Building areas	Building areas were provided by the architect in the drawings: Total GIA: 30,469 m^2
Number of occupants	1,269 as per the Accommodation Schedule (Stockwool- August, 2023)
Assessment period	60 years

The total emissions, based on the GLA guidance is **963 $kgCO_2/m^2$ GIA over 60 years excluding sequestered carbon or 905 $kgCO_2/m^2$ when sequestered carbon is included.**

> 596 $kgCO_2/m^2$ for modules A1-A5 (excluding sequestered carbon).

> 367 $kgCO_2/m^2$ for modules B-C.

When operational energy and water emissions are included in the calculation above the total emissions are expected to be **1,208 $kgCO_2/m^2$ GIA over 60 years.**

The development is performing better than the GLA benchmark for Modules A1-A5. Though the development is performing slightly higher than the benchmark for Modules B-C, this is because the design is still in development and assumptions have been made in terms of repair and maintenance. The proposed development is performing better than the GLA benchmark for Modules A-C and is therefore compliant with London Policy SI 2. The results demonstrate that the development has taken account of relevant policy and reduced emissions as far as reasonably possible based on current information available, as shown in Figure ii.

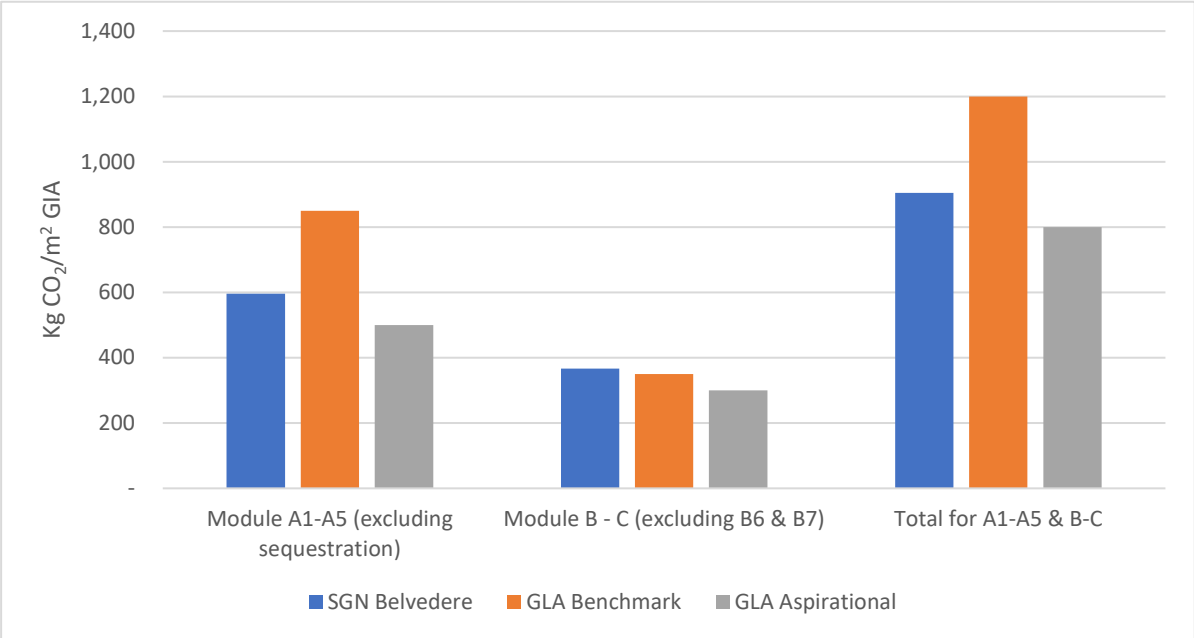

Figure ii: Total kgCO_2 /m^2 Gross Internal Floor Area (GIA) performance compared to GLA Benchmarks

A series of high-level opportunities to further reduce carbon emissions post planning have also been made. These measures will be looked at in detail in the next stage of the design development process and included, where possible.

CONTENTS

1. INTRODUCTION

1.1 This Whole Life Cycle Carbon Emissions (WLCCE) Assessment for the proposed development at Southern Gas Network Belvedere Holders Stations within the London Borough of Bexley has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Bellway Homes Limited.

1.2 The proposed development will comprise redevelopment of the site to provide residential units including affordable housing (Use Class C3) and commercial floorspace (Class E) in new buildings ranging between 3 to 5 storeys in height, together with associated car parking and cycle storage, landscaping including new areas of public open space and a reptile retention zone, associated infrastructure including new junctions off Yarnton Way, drainage and land raising.

1.3 The purpose of this WLCCE assessment is to demonstrate that the proposed development has undertaken an initial assessment to determine the whole life carbon impact of the proposed development, based on the current design.

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

1.5 The assessment of the proposed development endeavours to help the design team understand, at concept design stage, the lifetime consequences of their design decisions. This report should be read in conjunction with the '*GLA Whole Life Carbon Assessment Template*' which has been submitted alongside this application.

2. DEVELOPMENT OVERVIEW

Site Location

2.1 The proposed development site at Southern Gas Network Belvedere Holders Stations is located in the London Borough of Bexley, as shown in Figure 1 below. Please note, the eastern gas holder is now removed.

Figure 1: Site Location – Map data © 2023 Google

2.2 The existing site is largely vacant, with the exception of one remaining gasholder. The site is bounded to the north by Yarnton Way and a dual carriageway and to the south by the existing railway.

Proposed Development

2.3 The proposed development is described as follows:

"Redevelopment of the site to provide residential units including affordable housing (Use Class C3) and commercial floorspace (Class E) in new buildings ranging between 3 to 5 storeys in height, together with associated car parking and cycle storage, landscaping including new areas of public open space and a reptile retention zone, associated infrastructure including new junctions off Yarnton Way, drainage and land raising."

2.4 Figure 2 below illustrates the proposed site layout.

Figure 2: Proposed Site Layout- Stockwool (August, 2023)

2.5 The total Gross Internal Floor Area (GIA) for the proposed development is 30,469 m^2. The principles noted within this report apply to this GIA.

3. POLICY AND REGULATIONS

Regional Policy: The London Plan

London Plan (2021)

3.1 The London Plan sets out an integrated economic, environmental, transport and social framework for the development of London. The following policies are considered relevant to the proposed development and this Statement:

3.2 **Policy SI 2 Minimising Greenhouse Gas Emissions, states:**

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

Operational carbon emissions will make up a declining proportion of a development's whole life-cycle carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole life-cycle approach is needed to capture its unregulated emissions (i.e., those associated with cooking and small appliances), its embodied emissions (i.e., those associated with raw material extraction, manufacture and transport of building materials and construction) and emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal). Whole life-cycle carbon emission assessments are therefore required for development proposals referable to the Mayor. Major non-referable development should calculate unregulated emissions and are encouraged to undertake whole life-cycle carbon assessments. The approach to whole life-cycle carbon emissions assessments, including when they should take place, what they should contain and how information should be reported, will be set out in guidance'.

London Borough of Bexley Local Plan

3.3 The London Borough of Bexley's Local Plan was adopted in April 2023 and sets out how the Council will seek to achieve the principles of sustainable development. The following policy is considered relevant to this Statement:

3.4 **Policy DP30 Mitigating Climate Change states:**

'Major development proposals must meet London Plan requirements and 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.'

Guidance Documents

3.5 Guidance has been released by the Greater London Authority *"Whole Life-Cycle Carbon Assessments guidance – March 2022".* It outlines how to prepare a WLCCE assessment which should accompany all referable planning applications in line with London Plan Policy SI 2 *'Minimising Greenhouse Gas Emissions'*.

3.6 The guidance is accompanied by an assessment template, which provides separate tabs outlining the information that should be submitted at each stage. This template has been provided as a standalone document which should be read in addition to this report.

3.7 In addition, the following guidance is available to conduct assessments:

> **BS EN 15978:2011 -** *Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.*

> **ISO 14040:2006 -** *Environmental management — Life cycle assessment — Principles and framework.*

> **RICS Professional Statement Whole life carbon assessment: 2017 -** *Whole life carbon assessment for the built environment.*

3.8 The above documents are used to complete the WLCCE assessment, further planning reports submitted alongside this report will also be used and/or referenced within this assessment, including:

> Energy Statement- Hodkinson Consultancy (August, 2023).

> Design and Access Statement-Stockwool (August, 2023).

4. WHOLE LIFE CYCLE CARBON EMISSIONS ASSESSMENT

4.1 Undertaking WLCCE assessments is a way to fully understand and minimise the carbon emissions associated with building designs over the entire life cycle of the building. This will be done at the proposed development to quantify the WLCCE that will be released, considering not only operational and embodied emissions but also demolition, construction, and refurbishment and replacement cycles.

4.2 The London Plan has introduced a requirement (Policy SI 2 *'Minimising Greenhouse Gas Emissions'*) for all new referable developments to calculate and reduce WLCCE, this is both embodied and operational carbon:

> **Operational carbon** is the energy required to heat and power a building.

> **Embodied carbon** is the carbon that is released in the manufacturing, production, and transportation of the building materials used.

4.3 In addition to the two metrics above there are additional life cycle stages that are considered during WLCCE assessments, these include demolition, end of life and refurbishment/replacement cycles.

4.4 The two metrics (operational and embodied) and the additional life cycle stages, as noted above, have been included in this WLCCE assessment as per GLA guidance.

4.5 Undertaking a WLCCE assessment provides a full overview of the material and construction of a building using science-based metrics whilst also identifying the overall best combined opportunities for reducing lifetime emissions, and also helps to avoid any unintended consequences of focusing on operational emissions alone.

Methodology

4.6 WLCCE assessments are sensitive to changes in design and specification and therefore detailed design will impact the results as the scheme progress. As noted in the GLA guidance, WLCCE assessments should be conducted at the following stages in order to maximise design efficiencies:

> Pre application;

> Stage 1 submission (RIBA 2/3);

> Post construction (RIBA 6).

4.7 This assessment is considered to be the Stage 1 submission and has been completed for the proposed development using the drawings provided by Stockwool (August, 2023) and energy calculations from the Energy Statement submitted for planning (Hodkinson Consultancy- August, 2023).

4.8 A set of WLCCE benchmarks have been developed by the GLA in which applicants are required to compare against their own results as part of the assessment and which the GLA will refer to in its review of these assessments. An 'aspirational' set of benchmarks have also been devised for applicants that wish to go further. Both sets of benchmarks are included in this assessment and are being reported on.

Study Period

4.9 The reference study period (RSP) is 60 years, this is based on the principles outlined in BS EN 15978: 2011, section 7.3 and the RICS guidance. RSPs are fixed to enable comparability between whole life carbon results for different projects. It ensures that the assessment is representative of typical service life of different building elements.

Operational Carbon

4.10 Operational energy is the inputted energy required for all heating and power needs. It can be split into two variants:

> **Regulated emissions** are assessed using the Government's approved methodology for Building Regulations Part L compliance, the Standard Assessment Procedure (SAP) for residential units; and

> **Unregulated emissions** are energy use as a direct result of user behaviour. This includes cooking, white goods (fridges, washing machines, etc), and plug-in electrical loads (televisions, laptops, lamps, etc).

4.11 Both of the above elements have been accounted for in this WLCCE assessment, these were provided by the calculations completed for the Energy Statement submitted for planning (Hodkinson Consultancy- August, 2023). For clarity, as unregulated energy demands are largely reliant on the behaviour of occupants, they have been considered a fixed entity in the calculations in accordance with the guidance.

Non-Residential

4.12 The estimated energy demand for the commercial unit has been calculated using Simplified Building Energy Model (SBEM) software, using the National Calculation Method (NCM 2021 Edition). SBEM calculates the Regulated energy demands associated with hot water, space heating, and fixed electrical items, as well as unregulated energy demands.

4.13 A sample shell only SBEM calculation has been carried out on the commercial unit. The sample calculation has been extrapolated to gain energy demand estimates representative of the total area to be provided.

4.14 As the commercial unit is shell only and less than 500m^2, SBEM is considered an appropriate tool and therefore TM54 has not been considered.

Residential

4.15 The estimated annual energy demand for the residential portion of the development has been calculated using Standard Assessment Procedure (SAP) methodology. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items.

4.16 SAP calculations have been carried out for representative home types. These encompass houses and exposed floor, mid floor, top floor and corner flats, at different orientations, and therefore represent a fair aggregation of the unit mix of the site.

4.17 To provide energy demands across the entirety of the scheme, the accommodation schedule has been used to extrapolate the energy performance across the whole application area.

4.18 The unregulated energy demands, discussed further in Be Seen, for the residential units have been calculated using the methodology outlined in the SAP 10.2 document. This calculates the CO_2 emissions associated with appliances and cooking and are calculated using the BRE methodology.

Embodied Carbon

One Click LCA

4.19 OneClick LCA is the software that has been used to conduct the WLCCE assessment. This is a web-based piece of design software for buildings and infrastructure approved for use by the GLA.

4.20 OneClick LCA consists of a large database of generic and average Life Cycle Indicator (LCI) data, and global Environmental Product Declaration (EPDs). The most suitable option for each material (where available) was chosen from the database in OneClick. The material LCI data has been chosen to be representative of the typical UK supply chain.

4.21 The life cycle stages (or modules) included within the WLCCE assessment as standard are shown in Figure 3 below.

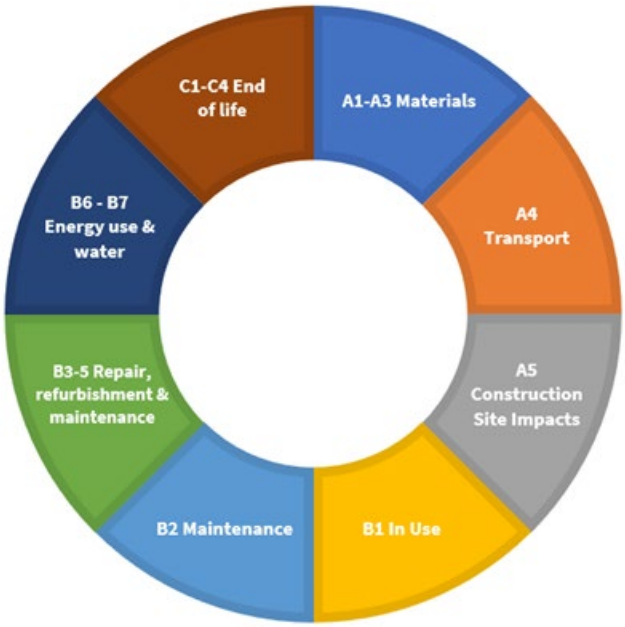

Figure 3: Life cycle modules

4.22 At this stage it is not expected that all the information will be available. Where this is the case, One Click has been used to calculate the required values for the assessment. As the design develops, we will update and refine the tool to reflect the quantity and types of materials being used.

Construction Impacts

4.23 In addition to embodied carbon in the materials used for construction, greenhouse gas (GHG) emissions will be created by transportation of materials to site and operation of onsite plant and machinery. Guidance from RICs indicates 1.4 tonnes of CO_2e per £100,000 of project value, this is further referenced and approved by the BRE. The project value has been provided by the Applicant, which has allowed the construction transport GHG emissions to be included.

Potable Water Use

4.24 The carbon impact associated with water use during the operation of the proposed development is also required to be reported, in accordance with the RICS guidance. Water consumption is based on Building Regulations Part G 'enhanced consumption' of 110 litres/per person/per day (including external water use) and multiplied by the intended full occupancy of the development annually.

4.25 1,269 occupants have been assumed based upon the expected number of residents on site as per the Accommodation Schedule (Stockwool- August, 2023). An additional allowance has been calculated for commercial aspect of the development in line with the BRREAM occupant density

factors. This gives an estimated **annual water consumption of 51,632 m³** for the development for 60 years.

Carbon Sequestration

4.26 Sequestered carbon in timber has been included in the WLCCE assessment as all timber is assumed to be sustainably sourced.

Data Sources

4.27 The assessment has utilised multiple data sources described above and is based on the level of detail available at the current stage of design. The following data sources have been used:

Table 1: Data Sources

Data	Data source
Material types and volumes (A1-A3)	Material types were provided by the applicant. Where material types and volumes were not available from these sources, the One Click LCA Carbon tool was used to estimate values. 95% of the cost allocated to each building element category has been accounted for in the assessment.
Transport data (A4)	Default values provided by One Click.
Construction site impacts (A5)	Construction value provided by applicant and baseline target provided by BRE. Waste estimates were provided by the Applicant.
Refrigerants (B1)	Refrigerant quantity has been estimated based on the use of approximately 75kg of R32 within the Heat Pumps with annual leakage of 2% and 1% end of life leakage rate with a 99% end of life recovery (as per TM65).
Maintenance (B2)	For module B2 emissions, a total figure of 10 $kgCO_2e/m^2$ (GIA) has been used to cover all building element categories.
Repair and Replacement data (B3-B4)	B3 emissions have been assumed to be 25% of B2 emissions, as per GLA Guidance.
Refurbishment (B5)	At present One Click does not have ways to consider B5 emissions. However, based on the information provided for B3 and B4 it is likely that these have emissions have been accounted for.
Operational energy (B6)	Energy calculations based on SAP and SBEM calculations from the Energy Statement by Hodkinson Consultancy (August, 2023).

Data	Data source
Operational water (B7)	Water consumption based on Building Regulations Part G 'Enhanced Consumption' of 110 l/pp/d and multiplied by the intended full occupancy of the development. Commercial water consumption has been calculated in line with BREEAM occupant density factors.
End of life (C1-C4)	Default values provided by One Click based on the information within the EPD database.
Building areas	Building areas were provided by the architect in the drawings: Total GIA: 30,469 m^2
Number of occupants	1,269 as per the Accommodation Schedule (Stockwool- August, 2023)
Assessment period	60 years

4.28 For clarity, all assumptions made within the WLCCE assessment have been noted within this report. The assessment and comments made throughout should be taken within the context of carbon and energy use only.

5. WHOLE LIFE CYCLE CARBON RESULTS

5.1 As noted above, this is an initial assessment based on the best available information which will need to be updated as the project progresses in line with GLA requirements.

Benchmark Comparison

5.2 The results when compared to the GLA benchmark values, as noted in the GLA guidance note *"Whole Life-Cycle Carbon Assessments guidance –March 2022"* are shown in Table 2 below.

Table 2: Whole Life Carbon Baseline (GLA Guidance)

	SGN Belvedere kg CO_2/m^2	WLC Benchmark	Aspirational Benchmark
Modules A1 – A5	**596 kg CO_2e/ m^2 GIA**	<850 kg CO_2e/ m^2 GIA	<500 kg CO_2e/ m^2 GIA
Modules B – C (excluding B6 and B7)	**367 kg CO_2e/ m^2 GIA**	<350 kg CO_2e/ m^2 GIA	<300 kg CO_2e/ m^2 GIA

Modules A-C (excluding B6 and B7 and including sequestered carbon)	**905 kg CO_2e/ m^2 GIA**	<1,200 kg CO_2e/ m^2 GIA	<800 kg CO_2e/ m^2 GIA

5.3 It must be noted that no benchmark has been set by the GLA for operational and energy use (life cycle stages B6-B7) due to insufficient data at present. The results for these have therefore been omitted from the totals in the graph above.

5.4 The total emissions, based on the GLA guidance is **963 kgCO_2/m^2 GIA over 60 years excluding sequestered carbon or 905 kgCO_2/m^2 when sequestered carbon is included.**

> 596 kgCO_2/m^2 for modules A1-A5 (excluding sequestered carbon).

> 367 kgCO_2/m^2 for modules B-C.

5.5 When operational energy and water emissions are included in the calculation above the total emissions are expected to be **1,208 kgCO_2/m^2 GIA over 60 years.**

5.6 A set of WLCCE benchmarks have been developed by the GLA in which applicants are required to compare against their own results as part of the assessment and which the GLA will refer to in its review of these assessments. An 'aspirational' set of benchmarks have also been devised for applicants that wish to go further. Both sets of benchmarks are included in this assessment are being reported on.

5.7 The development is performing better than the GLA benchmark for Modules A1-A5. Though the development is performing slightly higher than the benchmark for Modules B-C, this is because the design is still in development and assumptions have been made in terms of repair and maintenance. More detailed information will be available at a later stage.

5.8 The proposed development is performing better than the GLA benchmark for Modules A-C and is therefore compliant with London Policy SI 2. The results demonstrate that the development has taken account of relevant policy and reduced emissions as far as reasonably possible based on current information available.

5.9 The results are shown in Figure 4 below.

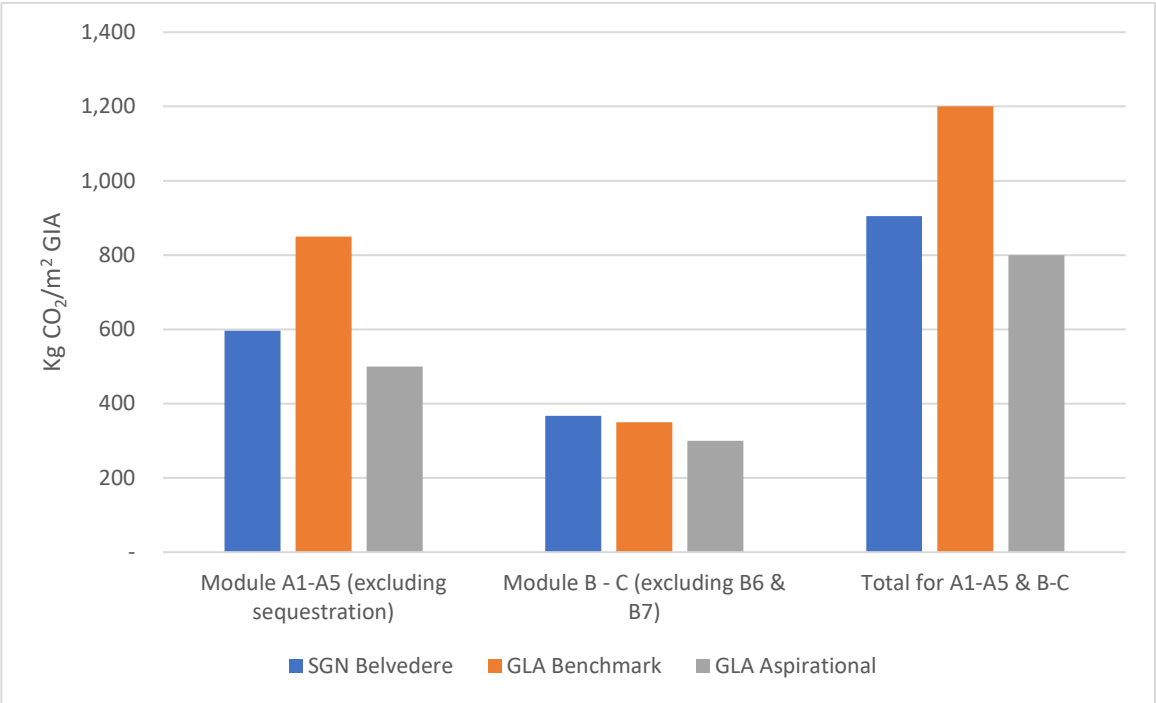

Figure 4: Total kgCO_2/m² GIA performance compared to GLA Benchmarks

5.10 These benchmarks will be subject to change as the WLCCE assessment gets updated in future. The full results are as follows:

Table 3: Full WLCCE Results

Category	Global warming potential	Total kgCO_2e over 60 years	Total kgCO_2e/m² GIA over 60 years
A1-A3	Construction Materials	15,830,712	519.57
A4	Transport	262,460	8.61
A5	Site operations	2,076,938	68.17

Category	Global warming potential	Total $kgCO_2e$ over 60 years	Total $kgCO_2e/m^2$ GIA over 60 years
B1	In Use	173,252	5.69
B2	Maintenance	304,680	10.00
B3	Repair	76,168	2.50
B4	Replacement/Refurbishment	8,220,017	269.78
B6	Operational energy use	9,234,690	303.08
B7	Operational water use	62,901	2.06
C1-C4	End of life	2,403,012	78.87
	Total	**38,644,821**	**1,268.33**
	Carbon Sequestering	-1,772,877	-58.19
	TOTAL	**36,871,944**	**1,210.15**

5.11 The above results demonstrate that **36,871 tonnes** are expected to be emitted over a 60-year period.

5.12 The operational energy (B6) makes up 24% of the overall emissions for the proposed development; 4% for regulated energy use and 20% for unregulated use.

5.13 Materials (A1 – A3) make up 41% of the overall emissions. As the design progresses, materials with a lower carbon impact can be specified in order to further reduce this share.

5.14 6% of emissions are a result from the transport of materials to site and construction stages (A4 and A5), whilst this is small in comparison to elements it is still important to reduce transport emissions through the local sourcing of materials and to reduce consumption of energy and water during consumption, where possible.

5.15 There are also impacts, with the in-use life-cycle module B1-B5 making up approximately 22% of all embodied carbon emissions. This is primarily due to materials that will need replacing over the 60 year study period.

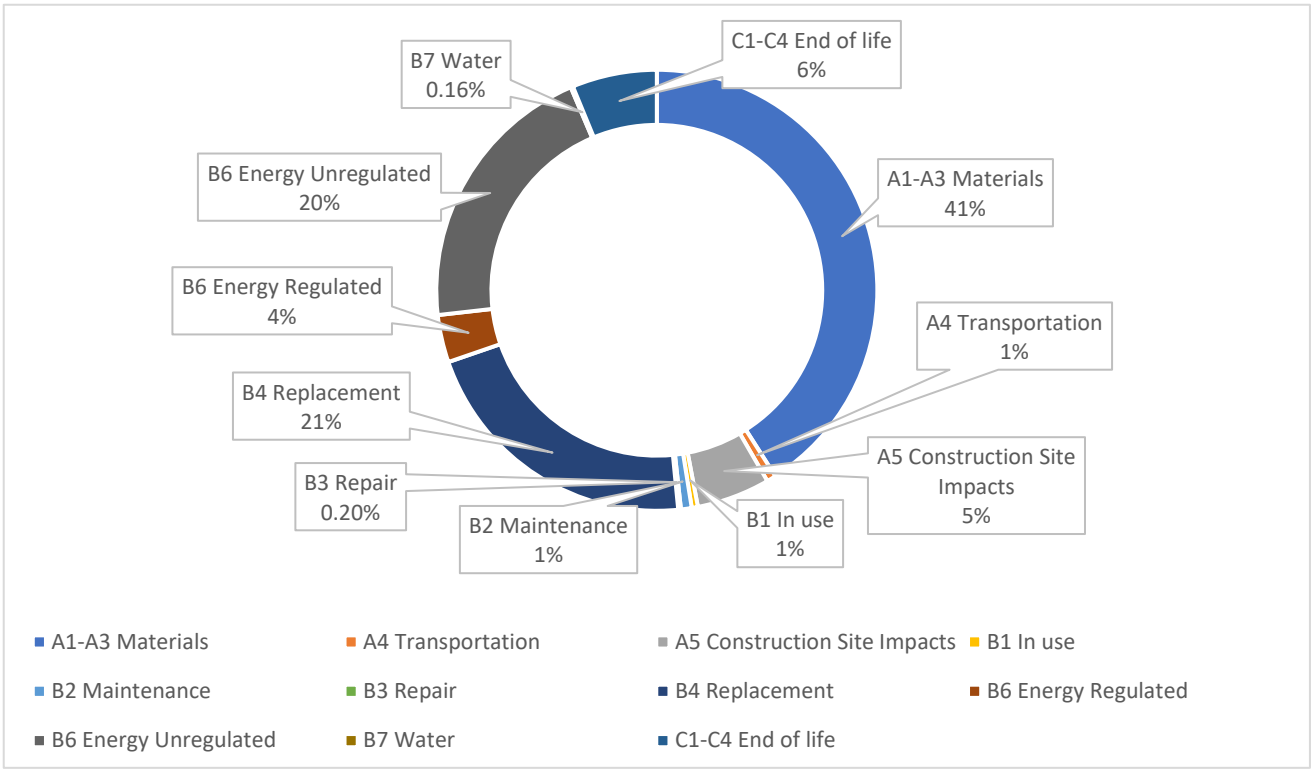

Figure 5: Total $kgCO_2e$ - Life-cycle stages

6. MEASURES IMPLEMENTED AND OPPORTUNIES

6.1 The proposed development has modelled potential measures throughout the design stage to further sustainability and reduce whole life carbon.

6.2 Specifying a high recycled content for steel is a good driver for products where the aim is to encourage and establish a market for recycled materials that are otherwise limited. Steel with 97% recycled content as opposed to virgin steel has been proposed for all floor constructions. **This has allowed for 56 $kgCO_2/m^2$ saving in A1-A3 emissions.**

6.3 The development comprises a mix of houses and flats. Timber construction performs better for whole life carbon due to the lower embodied emissions of materials, lower emissions from transport to site, less energy and time spent on site, and the benefits of carbon sequestration. As the houses are made using some timber elements, such as wooden stud internal walls and wooden stairs, this has **reduced the overall emissions by 48 $kgCO_2e/m^2$**.

Reduce material use

6.4 The **future demolition and deconstruction** of the development could be considered at the design stage. Consideration to be given to ways to facilitate dismantling, where possible.

6.5 Non-load bearing internal walls contribute material to the building that could otherwise be avoided. By **reducing the volume of non-load bearing walls** where possible, associated embodied carbon is also reduced.

6.6 The façade is under constant wear from the environment which can lead to frequent repairs and maintenance. By using **durable materials** for exposed elements, this not only reduces the cost and frequency of refurbishment but also reduces the use of material replacement and its associated carbon footprint.

6.7 Using pre-cast concrete floor slabs as opposed to hollow-core floor slabs could result in **carbon emissions savings of 58 $kgCO_2/m^2$.** The use of pre-cast concrete would also support the circular economy principles for the site.

6.8 Similarly, **an extensive maintenance and repair schedule** could also be produced during the design life of the development to ensure that specific materials and pieces of equipment are able to remain in situ during their expected lifespan. This will minimise the need to replace and refurbish and reduce emissions under life cycle stages C1-C4.

Recycled materials

6.9 **Innovative cement mixes** are now increasingly available, using a mixture that is 40% ground granulated furnace slag (GGBS) can save up to **20 $kgCO_2/m^2$** in carbon emissions. This cement mixture could be investigated further for use at the appropriate stage, and if suitable could be used for building elements such as foundations. If implemented, this could facilitate the reduction of life cycle stages A1-A3 (materials) quite significantly.

6.10 Areas of hardstanding could make use of **recycled crushed concrete/gravel** to remove the associated carbon emissions from the assessment. These materials could similarly be recycled at the end-of-life scenario.

6.11 At end-of-life, **concrete can be completely recycled**. After demolition, concrete can be processed and used as recycled aggregate in fresh concrete. If the site is intended for new construction the demolished concrete can be crushed on-site and used onsite as hard core, fill, or in landscaping.

Re use of materials

6.12 The Circular Economy statement produced by Hodkinson Consultancy (August, 2023) details the strategy for **recovery and reuse of materials**. Please refer to the report for further detail.

7. CONCLUSION

7.1 This Whole Life Cycle Carbon Emissions (WLCCE) Assessment for the proposed development at Southern Gas Network Belvedere Holders Stations within the London Borough of Bexley has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Bellway Homes Limited.

7.2 The purpose of this WLCCE assessment is to demonstrate that the proposed development has undertaken an initial assessment based on the information available to date which will need to be updated as the project progresses.

7.3 The total emissions, based on the GLA guidance is **963 $kgCO_2/m^2$ GIA over 60 years excluding sequestered carbon or 905 $kgCO_2/m^2$ when sequestered carbon is included**.

> 596 $kgCO_2/m^2$ for modules A1-A5 (excluding sequestered carbon).

> 367 $kgCO_2/m^2$ for modules B-C.

7.4 When operational energy and water emissions are included in the calculation above the total emissions are expected to be **1,208 $kgCO_2/m^2$ GIA over 60 years.**

7.5 A series of high-level opportunities to further reduce carbon emissions post planning have also been made. These measures will be looked at in detail in the next stage of the design development process and included, where possible.