August 2014

9 Cambridge Avenue (Relocation of 816 Leigh Road)

Whole Life Carbon: Post Completion Report

9 Cambridge Avenue Post-Completion

for

SEGRO plc

by

Sturgis Carbon Profiling LLP

sturgis carbon profiling™

Issue and revision record

Revision	Written by	Checked by	Description
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Contents

1. Definitions

- **LCA**: Life Cycle Assessment, the life cycle of the building is taken as 60 years.

- **Global-warming potential (GWP)**: is a relative measure of how much heat a greenhouse gas traps in the atmosphere. A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1).

- **Carbon emission:** the term 'carbon emission' in this assessment refers to carbon dioxide and the bundle of green house gases (i.e. carbon dioxide equivalents such as methane), the unit of measurement of which is $KgCO_2e$.

- **Embodied carbon:** are the emissions that are created through construction, transportation, assembly, maintenance and eventual deconstruction of a building, i.e. how much damage is caused by creating the physical aspects of a building or space.

- **Operational carbon:** relates to the emissions associated with heating, cooling and lighting of a building, i.e. the emissions associated with the using of a building or space.

- **Whole Life Carbon:** This is the Combination of Embodied and Operational emission over the life of the building, usually taken as 60 years.

2. Executive Summary

Sturgis Carbon Profiling was commissioned by SEGRO plc to assess the Whole Life Carbon impact of an office and warehouse space to be dismantled from an older site and re-erected at 9 Cambridge Avenue, reusing existing building's components wherever feasible. This was done in order to provide SEGRO with an understanding of any potential carbon savings compared to a new build; and also identify options that could reduce its embodied carbon impacts further. The study covered:

- Whole Life Carbon Assessment (at Practical Completion and Over 60 Years)
- Whole Life Carbon Comparisons with Benchmark Building (Part L compliant new-build)
- Identification of Embodied Carbon Reduction Options for future projects

Key Achievements

- 3180m^2 of office space and warehouse on 816 Leigh Road successfully dismantled and re-erected at 9 Cambridge Avenue, about 1 mile away
- **56 % lower embodied carbon** at practical completion compared to a comparative New Build*
- **25% saving in costs** compared to a comparative New Build*
- **6% lower Whole Life Carbon Footprint** compared to a comparative New Build
- **No Organic Waste**

The 56% reduction in embodied carbon at completion is equivalent to a saving of about **700 tonnes CO_2e***. The graph below shows the embodied carbon reduction achieved by building components.

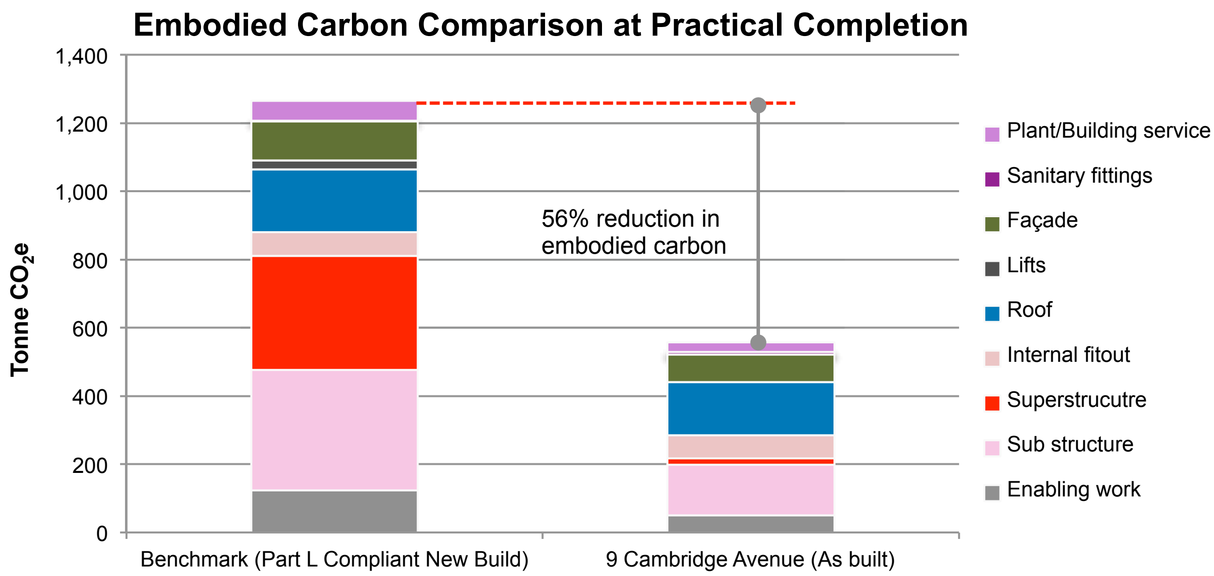


Figure 1: Embodied carbon Savings at Practical Completion

This saving is also equivalent to:

X 40
Car journeys around the world (≈1.6m km)

X 5800
Trees preserved**

X 150
Return flights from London to Hong Kong*** (≈ 1.44m km)

** Excluding external works*
*** Carbon sequestration value of trees referenced from: Climate change information pack, section 6 Mitigation: planting more trees (http://www.forestry.gov.uk/forestry/INFD-7S7FC7, last accessed 10th July 2014). Assumed lifespan for each tree as 60 years*
*** Mike Berners – Lee (2010), How Bad are bananas? The Carbon Footprint of Everything*

3. Embodied Carbon Saving at Practical Completion

The Carbon footprint at practical completion includes the carbon emissions at the following stages:

- Product manufacture (carbon arising through production process)
- Construction (carbon arising from the transportation of material to site and through site works etc.)

Based on the as-built information received at project completion, SCP's assessment found **embodied carbon footprint** of 9 Cambridge Avenue to be about **760 tonnes at practical completion** (excluding external works), which is about **56% lower than a comparative new build** previously assessed by SCP. This is equivalent to a saving of about **700 tonne CO_2e**; mainly achieved by reusing majority of the building's structure and facade, and conforming to Sturgis's recommendations on material specification including cement replacement, high recycled content in reinforcement and insulation materials, etc.

The re-use and recycling of building components also allowed **a saving of 25% in costs of materials for the building** compared to a comparative new build. A large proportion of the saving comes from reusing the superstructure components. The savings could have been further extended had the other components also been re-usable, and the superstructure been designed for dismantling and reuse from the outset.

Listed below are the key areas of embodied carbon saving, alongside site photographs to demonstrate how the material was re-used at 9 Cambridge Avenue.

Breakdown of Embodied Carbon Savings at Practical Completion

Reusing Steel Structure

- *Reuse of Structural frame and roof purlins*

Saving:

- 260 T CO_2e
- 80 Kg CO_2e/m^2

Building frame re-erected at 9 Cambridge Avenue

Concrete Specification

- *70% GGBS cement replacement*
- *98% Recycled content for reinforcement*
- *Concrete sourced from within 10 km*

Saving:

- 200 T CO_2e
- 63 Kg CO_2e/m^2

Breakdown of Embodied Carbon Savings at Practical Completion

Reusing Plant/ MEP

- *Reuse of pipework, flues, pumps, etc.*

Saving

- 30 T CO2e
- 10 Kg CO2e/m2

Duct, pipework, flues, ceiling and floor panels, etc. prepared to be transported from 816 Leigh Road to 9 Cambridge Avenue

Reuse Building Components in Concrete

- *Reuse of concrete Ground Beams*
- *Reuse of Precast floor slabs*

Saving:

- 130 T CO_2e
- 40 Kg CO_2e/m^2

Reusing precast slabs at 9 Cambridge Avenue

- *External paving blocks retained*

External Paving blocks prepared to be transported to new site

Breakdown of Embodied Carbon Savings at Practical Completion

Reuse Building Facade

- *Retaining curtain walling system, spandrel panels and doors to loading bays*

Saving:

- 30 T CO_2e
- 9 Kg CO_2e/m^2

Dismantled façade to be transported to 9 Cambridge Avenue

Building Façade post-completion at 9 Cambridge Avenue

Breakdown of Embodied Carbon Savings at Practical Completion

Reuse Roofing Components

- *Reuse of roof water gutters etc.*

Saving:
- 25 T CO_2e
- 8 Kg CO_2e/m^2

Roofing components prepared to be transported to new site

Reuse Internal fit-out

- *Reuse of raised access floor panels*
- *Internal doors*

Saving:
- 10 T CO_2e
- 3 Kg CO_2e/m^2

Ceiling and Flooring panels to be re-used

Reuse Lift

- *Reuse of Lift*

Saving:
- 25 T CO_2e
- 8 Kg CO_2e/m^2

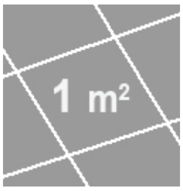
Lift carefully transported from old site at 9 Cambridge Avenue

Table 1: Embodied Carbon Savings

4. Whole Life Carbon

'Whole Life Carbon' is the combined assessment of both embodied and operational emissions over the life of the building (assumed as 60 years), including the original construction and final disposal.

The Whole Life Carbon footprint of 9 Cambridge Avenue based on 'As-built' information is about **4,820 tonnes.** The Carbon footprint is split between embodied emissions, which are **1,770 tonnes** and operational emissions, which are **3,050 tonnes***. These are equivalent to:



1,500-1,550
Kg CO_2e/m$^{2\ NIA}$

20-25
Kg CO_2e/m$^{2\ NIA}$ /year

The figure puts the volume of emissions into the context of landmark buildings in London. Whole life carbon emissions from 9 Cambridge Avenue cover approximately **2.4 million m^3,** equivalent to a sphere with a diameter about **167 metres,** comparable to the height of The Gherkin.

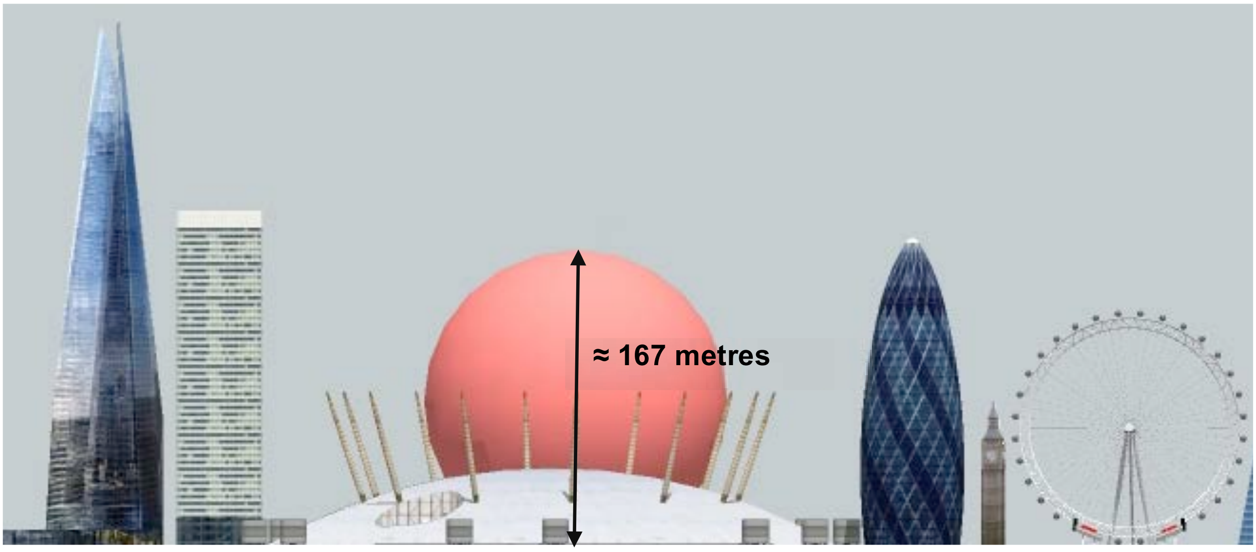


Figure 2: Carbon Emissions for 9 Carbon Avenue

4.1 Scope of Components Examined

Analysing a building according to its main elements is crucial in developing an accurate picture of the interdependencies in the design so it is possible to identify the weakest links. This assessment considered carbon emissions throughout the building's life cycle, including the main building elements required to support a building as well as doors, windows, internal finishes, mechanical and electrical components, etc. It also takes into consideration the impact of transporting any re-usable components from the old site to 9 Cambridge Avenue at the onset of the project and replacement impacts of all components over the life cycle.

The Figure below identifies the main building components that are analysed as part of this process; the darker the element the longer is life and so the less its influence on the buildings lifecycle impacts.

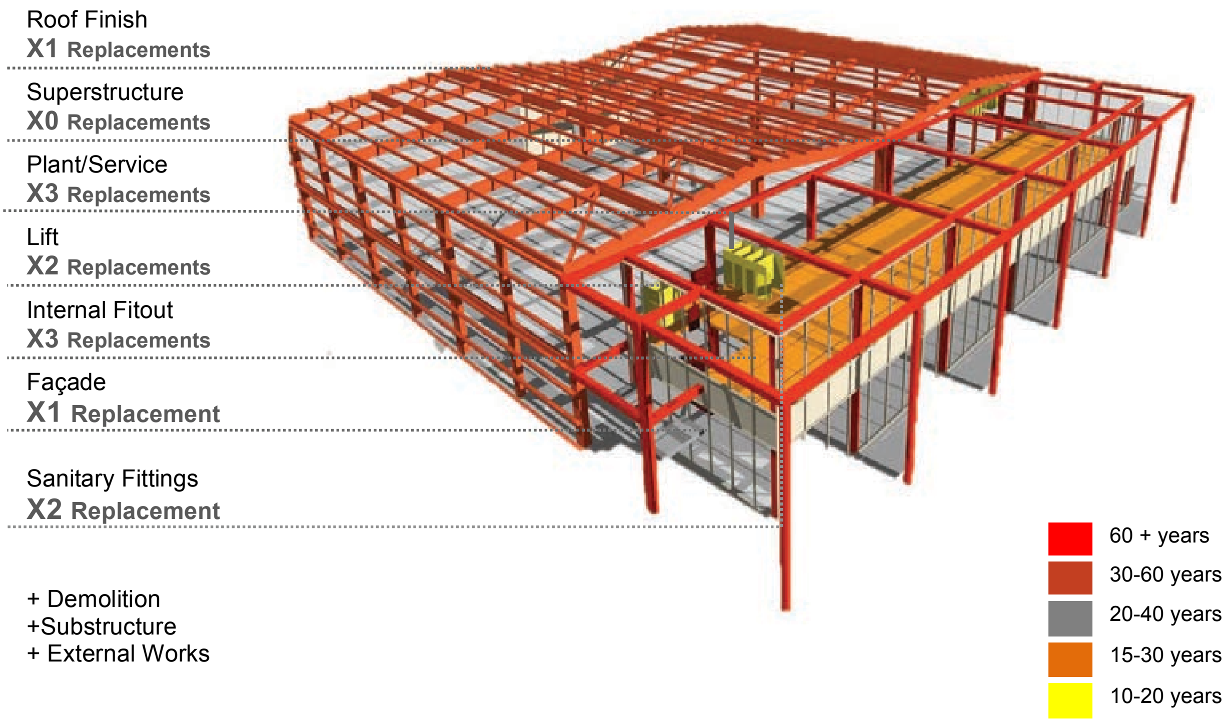


Figure 3: Model of Elements Analysed for Embodied Carbon Impact, SCP (2014)

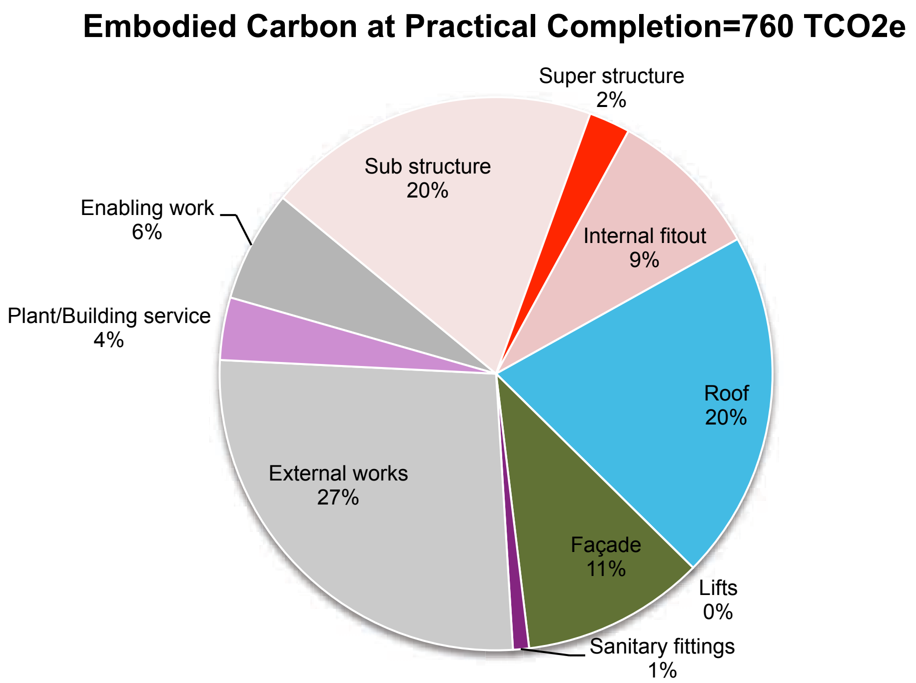
4.2 Whole Life Carbon by Building Components

Below is listed the Whole Life carbon of 9 Cambridge Avenue at practical completion and over a period of 60 years (the industry's reporting norm). The emissions are calculated based on BS EN 15978.

(TCO_2e)	Embodied Carbon	Transport Carbon	Carbon at Practical Completion	**Carbon LCA**
Enabling work	0	50	50	**50**
Sub structure	130	20	150	**150**
Super structure	20	0	20	**20**
Internal fit-out (CAT A)	60	10	70	**280**
Roof	150	10	160	**310**
Lifts	0	0	0	**20**
Façade	80	0	80	**180**
Sanitary fittings	10	0	10	**30**
External works	160	40	200	**380**
Plant/Building service	30	0	30	**100**
Emissions During Site Work	N/A		80	**80**
Regulated operational energy (Part L)*			0	**1,970**
Unregulated operational energy*			0	**1,080**
End of Life			0	**80**
Total			**760**	**4,820**

**Operational energy emissions are based on SB Partnership's calculations and considering grid decarbonisation.*

Table 2: Whole Life Carbon Emission at completion and over 60 years by building components



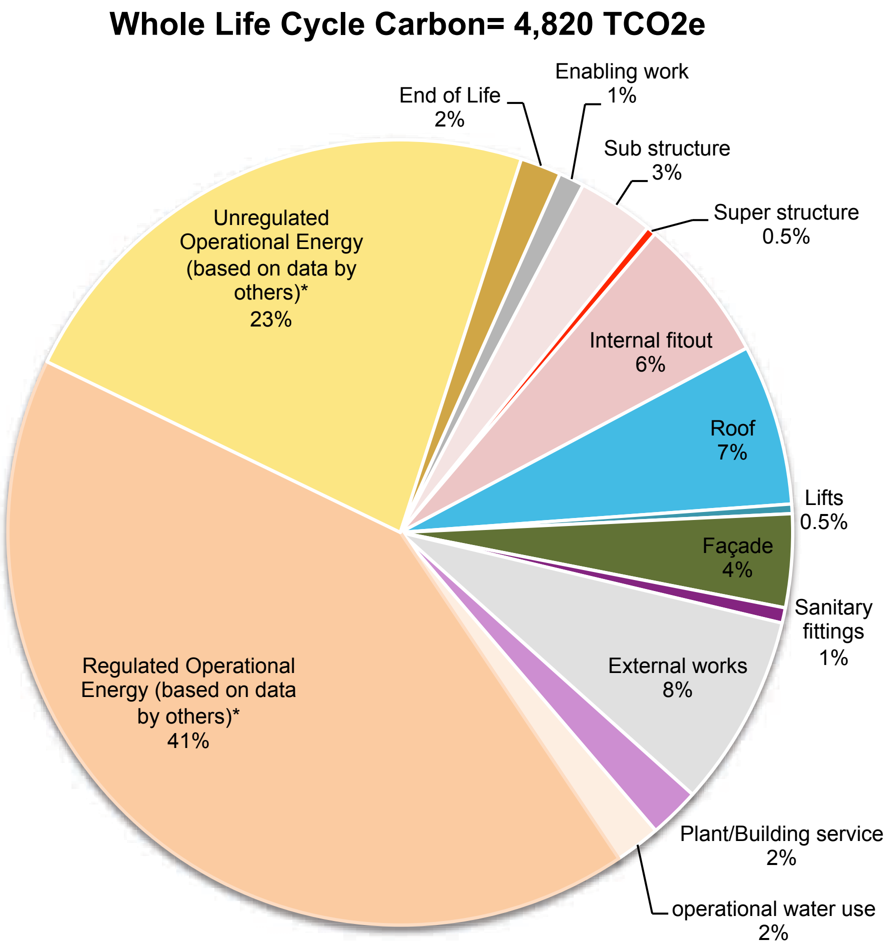


Figure 4: Carbon Emissions by Building Components at Practical Completion and over LCA

**Operational energy emissions are based on SB Partnership's calculations and considering grid decarbonisation.*

4.3 Plotting Carbon Emissions Over Life Cycle

The graph below plots the carbon emissions over the building's assumed life cycle, including replacement and refurbishment. Peaks correspond to embodied carbon expenditure from different sources and the sloping yellow lines indicate the operation emissions reducing over time due to grid decarbonisation.

Where sensible, the replacement cycles of different systems have been co-ordinated for efficiency. This helps identify significant 'events' in the life of the building, and the potential consequent impact on leases.

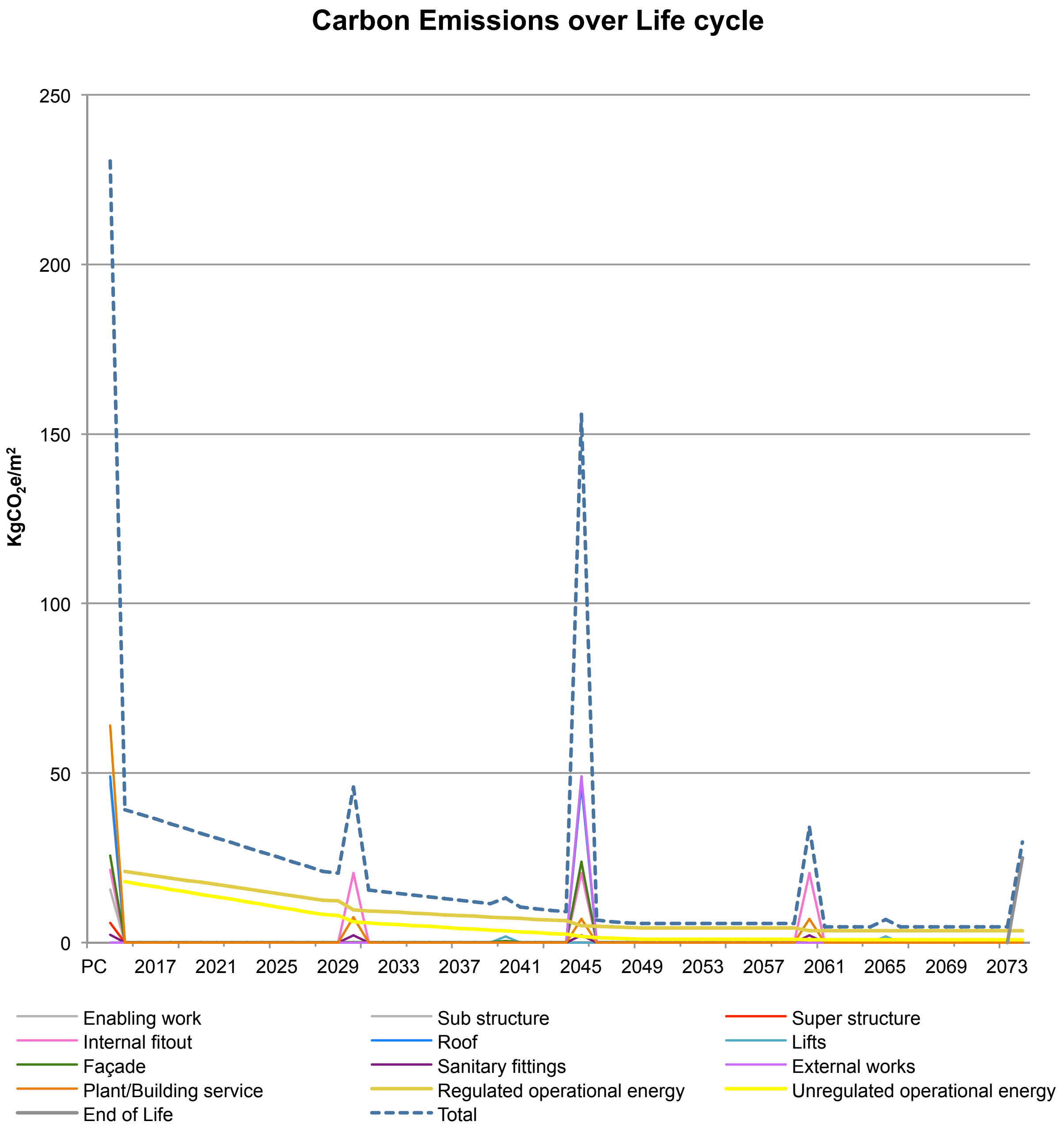


Figure 5: Carbon emissions over building's life cycle

4.4 Whole Life Carbon Footprint Comparison with Benchmark

The operational energy emissions of 9 Cambridge Avenue are 23% higher than a Part L compliant new build. This is because the building fabric fails to meet the requisite performance standards, mainly due to re-used façade components. However, over the whole life cycle of the building, this negative impact has been offset from the benefit of having a much lower embodied carbon footprint. The **overall carbon footprint is 6% less** compared to the benchmark new build, a saving equivalent to **330 TCO_2e**, achieved with no financial cost.

Table below summarises the carbon savings compared to a Part L compliant Benchmark equivalent new Build:

Embodied carbon saving compared to Benchmark New Build			
Component	**Element**	**Carbon footprint reduction at Practical Completion**	
		$KgCO_2e/m^2$ NIA	**T CO_2e**
Reusing Steel structure:	• Reuse of steel structure and roof purlins	>80	260
Concrete Specification:	• 70% GGBS cement replacement • 98% Recycled content for reinforcement • Concrete sourced from within 10 km	>60	200
Plant	• Pipework, flues, pumps etc.	>10	30
Reusing Concrete structure:	• Reuse of concrete Ground Beams • Reuse of Precast floor slabs	>40	130
Facade:	• Retaining curtain walling system, spandrel panels and doors to loading bays	>9	30
Roof	• Reuse of roof water gutters etc.	>8	25
Internal fitout	• Reuse of raised access floor panels. • Reuse of Internal doors	>3	10
Lift:	• Reuse of Lift	>8	25
Total Embodied Carbon Reduction at Practical Completion		**220**	**700**
Additional Embodied Carbon Reduction over Life Cycle		**70**	**220**
Operational Carbon Difference over Life Cycle*		-185	-590
Net Carbon Reduction over Life Cycle		**105 $KgCO_2e/m^2$ NIA**	**330 TCO_2e**

Table 3: Applied Carbon Reduction Measures

**Operational energy emissions are based on SB Partnership's calculation of Part L and unregulated energy calculations, and considering grid decarbonisation.*

The graph below summarises the net reduction in Carbon Emissions achieved by 9 Cambridge Avenue discussed above.

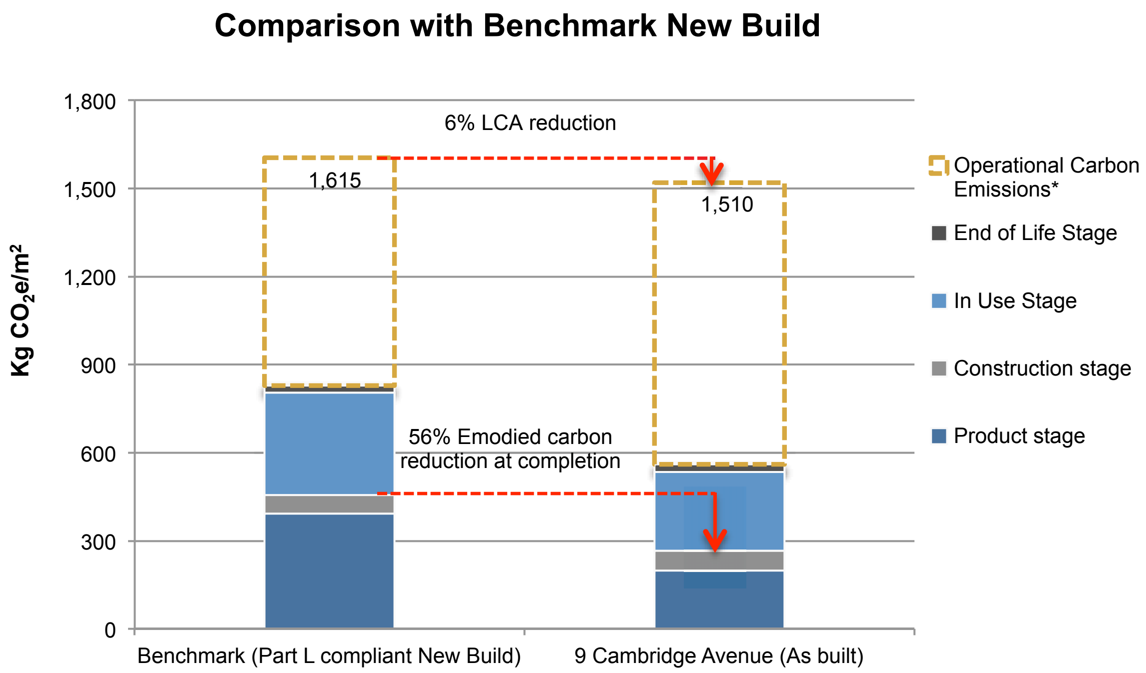


Figure 6: Whole Life Carbon Footprint Comparison

Other Observations:

- The embodied/operational split is approximately 35%: 65%. Embodied carbon forms a comparatively smaller proportion of Whole Life emissions because of recycling and reuse of building material.
- With the exception of 7 facade panels that failed and the boiler that was replaced; the entire structural frame, façade and services were successfully transported to 9 Cambridge Avenue from the old site. **
- The re-use of building components not only allows Embodied Carbon savings but also allows a saving in the overall cost of the building, a reduction of almost 25%*** for this project.
- Specifying a higher Recycled content in new components and higher GGBS in the concrete for new site works also allows a significant reduction in the embodied carbon footprint.
- Replacing the boiler effectively brought down the operational energy considerably and resulted in a lower LCA carbon footprint compared both to pre-construction analysis** and Benchmark new Build.

**Operational energy emissions are based on SB Partnership's calculation of Part L and unregulated energy calculations, and considering grid decarbonisation*
***Refer to Appendix 2 for a brief update on the carbon emissions compared to the previous issue in May 2013 (pre-construction)*
****Excluding external works and based on Client's cost data*

5. Further Carbon Reduction Potential

5.1 Background

The remainder of this report focuses on further carbon reduction opportunities that can be implemented on similar projects in the future. As per SCP's baseline calculation, the embodied carbon of the building is currently around 1,770 tonnes over its lifecycle.

5.2 Embodied Carbon Reduction Opportunities

In order to further reduce the Whole Life Carbon impacts, a few embodied carbon reduction options were investigated with an aim to choose cost neutral or reductive options that fit into the project's program.

If all the measures suggested could be successfully implemented, a further **205 tonnes** of embodied carbon could have been saved cost-neutrally, by specifying different material finishes or higher recycled content for the new elements; lowering the footprint to **4,615 tonnes**, thus allowing a whole life embodied carbon reduction of around 9%-10% compared to benchmark, as seen below.

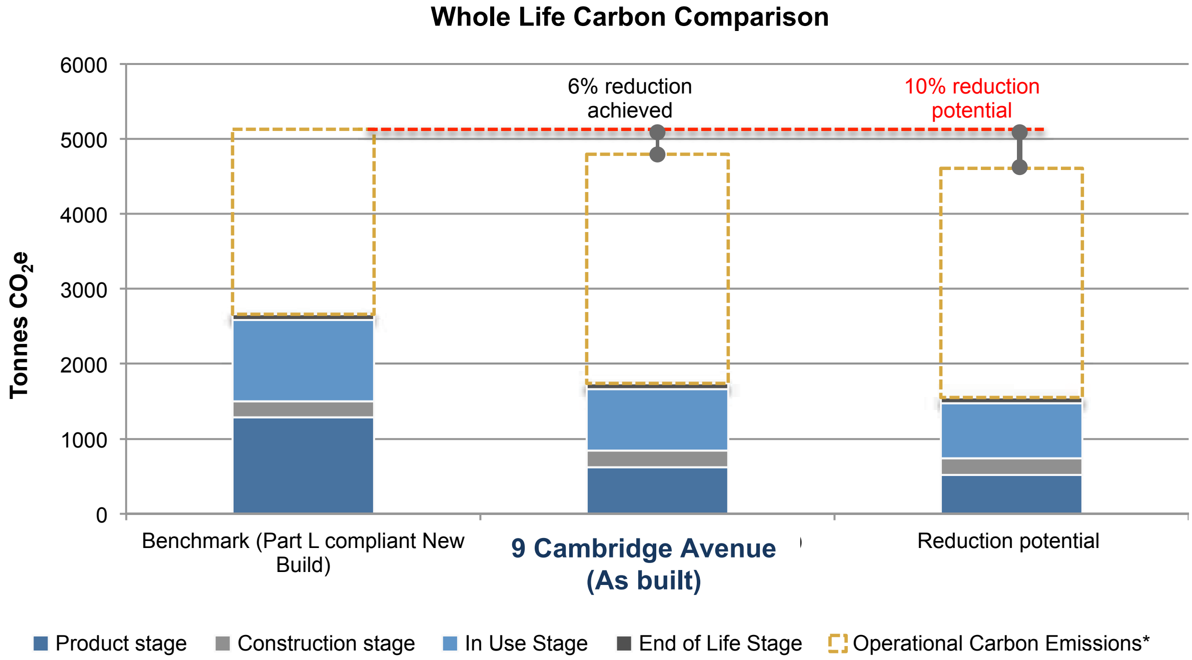


Figure 7: Further Carbon Footprint Potential

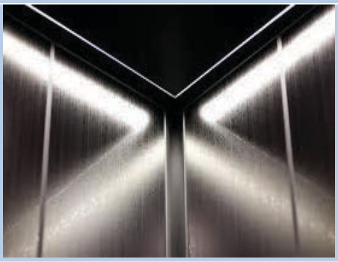
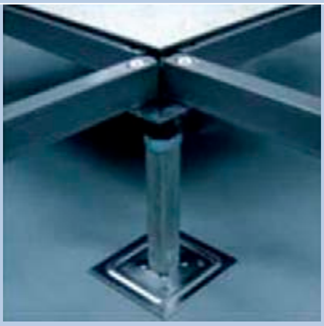
	Whole Life Carbon*		Note
Current WLC Footprint	**4,820**	T CO_2e	
	1,500-1,550	Kg CO_2e/m^2	
Potential Carbon Saving	**200-205**	T CO_2e	
	60-65	Kg CO_2e/m^2	
Reduced WLC Footprint	**4,615**	T CO_2e	Cost Neutral/ Reductive
	1,450-1,500	Kg CO_2e/m^2	

Table 4: Carbon Reduction Potential

**Operational energy emissions are based on SB Partnership's calculation of Part L and unregulated energy calculations, and considering grid decarbonisation*

5.3 Summary of Carbon Reduction Options

Table below summaries options that can potentially save most amounts of Whole Life Carbon emissions:

Option		Whole Life Carbon Reduction (T CO_2e)	Whole Life Carbon Saving (%)
	Opt 1: Using recycled Tarmac surface for road surface	**60-65**	**1.2%-1.5%**
	Opt 2: GGBS replacement (>50%) for service yard surface	**50-55**	**1%-1.2%**
	Opt 3: High recycled content for Façade steel profile	**30-35**	**0.6%-0.8%**
	Opt 4: High Recycled Content of Plasterboard and steel for partitions	**20-25**	**0.5%-0.6%**
	Opt 5: Higher Recycled Content for steel pedestals in raised access flooring	**12-15**	**0.2%-0.3%**

Option		Whole Life Carbon Reduction (T CO_2e)	Whole Life Carbon Saving (%)
	Opt 6: High recycled content of steel elements (edge trim etc.)	**10-12**	**0.2%-0.3%**
	Opt 7: Tag Back Carpet with higher recycled content	**8-10**	**0.15-0.2%**
Total		**200-205**	**4%- 6%**

Table 5: Potential Carbon Reduction Options

5.4 Embodied Carbon Reduction as an Allowable Solution

Table below summarises net carbon reduction compared to a Benchmark New Build:

	Carbon footprint reduction	
	$KgCO_2e/m^{2\ NIA}$	T CO_2e
Net reduction achieved over life cycle	**105**	**330**
Further Carbon Reduction Potential	**65**	**205**
Total Carbon Reduction Potential over Life Cycle	**170 $KgCO_2e/m^{2\ NIA}$**	**535 T CO_2e**

Table 6: Carbon Reduction Potential

Thus, the total embodied carbon reduction that can be achieved is over **535 tonnes CO_2e**; the same amount of reduction, if achieved by installing renewables (Solar PV), would cost over **£147,000**.

6. Conclusion

This Carbon assessment of 9 Cambridge Avenue demonstrates the importance of reusing and recycling building materials and components in order to reduce the financial and carbon impact of buildings.

- The overall embodied carbon saving at completion (56%) and cost saving (25%) is impressive but could be further improved if the original building had been designed for dismantling and reassembly at the outset.

  ### Re-usable New Buildings as a solution?

  SCP further proposes that there is potential to increase the percentage of material re-used closer to 80%-90%, provided the building was designed for the potential ease of disassembly and re-usability. For example, specifying re-usable concrete planks as ground slabs, etc.
  This could allow further savings both in terms of Carbon and cost; and should be considered for any new projects in the future.

- Compared to a new build, a carbon reduction of almost 6 % has been achieved over the life cycle. A number of easy options have been proposed that, if applied, could potentially increase the reduction to 10%-11% lower than an average new build; and this could be used as a reference for future projects.
- The total embodied carbon reduction potential being over **535 tonnes** compared to a benchmark new build, if achieved by installing renewables (Solar PV), would cost over **£147,000**, as shown in graph below:

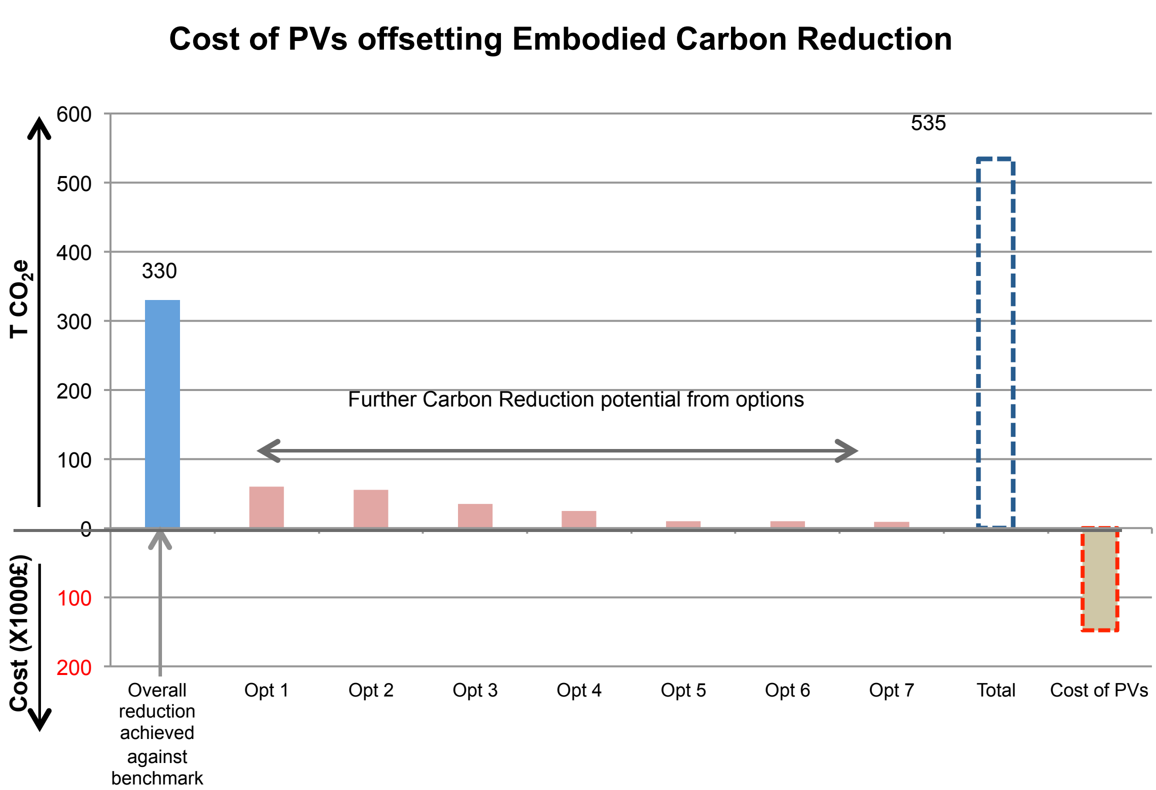


Figure 8: Embodied carbon reduction as an allowable solution

APPENDIX 1: Study Methodology

A1.1 Outline of Whole Life Carbon Assessment

Why is the Whole Life Carbon footprint important? The key contribution that Whole Life Carbon reporting makes is its ability to take account of all sources of emissions associated with the building, and not just those that arise from its use. This study is intended to illustrate to Segro the Whole Life Carbon impacts of 9 Cambridge Avenue, with a view to identifying carbon emission reduction options. Whole Life Carbon will increasingly become part of our lives as the UK responds to climate change through evolving legislation.

The study explains what a Whole Life Carbon footprint is, according to the recent British Standard BS EN 15978, which is based on the CEN/TC 350 calculation methodology for implementing European standard EN 15804. The significance of this new standard lies in the recommendations of the 2010 Low Carbon Construction IGT Report* published by HM Government, which calls for the UK Government to act and to introduce mandatory Whole Life Carbon reporting as soon as possible for all buildings.

The Whole Life Carbon figures are based on a 60-year reporting period, which takes account of grid decarbonisation. Emissions are attributed to four main categories taken from BS EN 15978. The categories are;

<u>Product Manufacture –</u>
The carbon emissions generated at this stage arise from extracting the raw materials from the ground, their transport to a point of manufacture and then the primary energy used (and the associated carbon impacts that arise) from transforming the raw materials into construction products.

<u>Construction –</u>
These carbon impacts arise from transporting the construction products to site, and their subsequent processing and assembly into the building.

<u>In Use –</u>
This covers a wide range of sources from the carbon emissions associated with the operation of the building, including the heating, lighting, cooling, small power demands, maintenance, repair and replacement over a 60 year assessment period.

<u>End of Life –</u>
The eventual deconstruction and disposal of the existing building at the end of its life takes account of the on-site activities of the deconstruction contractors. No ‘credit’ is taken for any future carbon benefit associated with the reuse or recycling of a material into new products.

** Low Carbon Construction was written by the Innovation and Growth Team, part of the Department for Business Innovation and Skills, published by HM Government, 2010*

A1.2 Methodology

The Whole Life Carbon scopes described here are based on the new British Standard BS EN 15978, which incorporates a calculation methodology that is part of the new CENTC350 family of standards, which are designed to harmonise the assessment of the sustainability of construction works across Europe. The organization responsible for this is CEN* and its Technical Committee 350 (CEN/TC350). In addition to Whole Life Carbon, the committee is also establishing calculation methodologies for the economic and social effects that buildings and construction products generate.

In many respects, the BS EN 15978, CEN/TC350 and EN 15804 build on earlier standards such as PAS 2050**. However, being developed specifically for buildings, they clear up many of the grey areas. Crucially, this includes clarifying some reporting confusions by stating at the "product stage" recycling benefits should be included, but at the "End of Life stage" any future recycling benefits should not be included and can only be reported separately to the main whole life figures produced. This paves the way for more consistent comparisons between construction materials.

Figure 1 below indicates the four main categories identified by BS EN 15978 of emission sources that accrue over the life of the building (Product Manufacture, Construction Stage, In Use, and End of Life - excluding any future recycling benefits/potential). These in turn are split down into further sub categories relating to the individual emission sources from each category, for instance, transport emissions or emissions from construction site based activities.

Figure A1.i: Building Assessment Stages as Defined by the BS EN 15978,

Source: Briefing on resource efficiency implications of CEN/TC 350, CRWP (2010)

**Committee 'Europe' en de Normalisation, based in Brussels, see:* http://www.cen.eu/cen/pages/default.aspx

***This may be downloaded from the BSI on* http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050

A1.3 Legislative Context

Whilst most of the current focus (Part L etc.) is on operational emissions, standards as described above are soon to be introduced from the EU that will require Whole Life carbon reporting of all building and product emission sources. This will mean that the emissions generated by the construction and maintenance of buildings will need to be included in the calculations, where previously they were not.

As this change is happening in the next few years it will mean that maintenance and refurbishment decisions being made today will end up having a large effect on reporting targets.

The standards outlined will have two initial purposes; firstly to provide a technical basis for comparing the carbon performance of buildings with knowledge of what is being represented. Secondly, they will provide a metric for future legislation on regulating the carbon emissions of buildings. To that end, when the current Energy Performance of Buildings Directive (EPBD) 2010 is updated, or any other new European Directive is introduced which requires carbon measurement in buildings, they will use the new CEN/TC350 standards described here as the default.

From a UK perspective legislation may move faster as the Low Carbon Construction IGT Report (2010) first recommendation to HM Government stated:

"Recommendation 2.1 That as soon as a sufficiently rigorous assessment system is in place, the Treasury should introduce into the Green Book a requirement to conduct a whole life (embodied + operational) carbon appraisal."

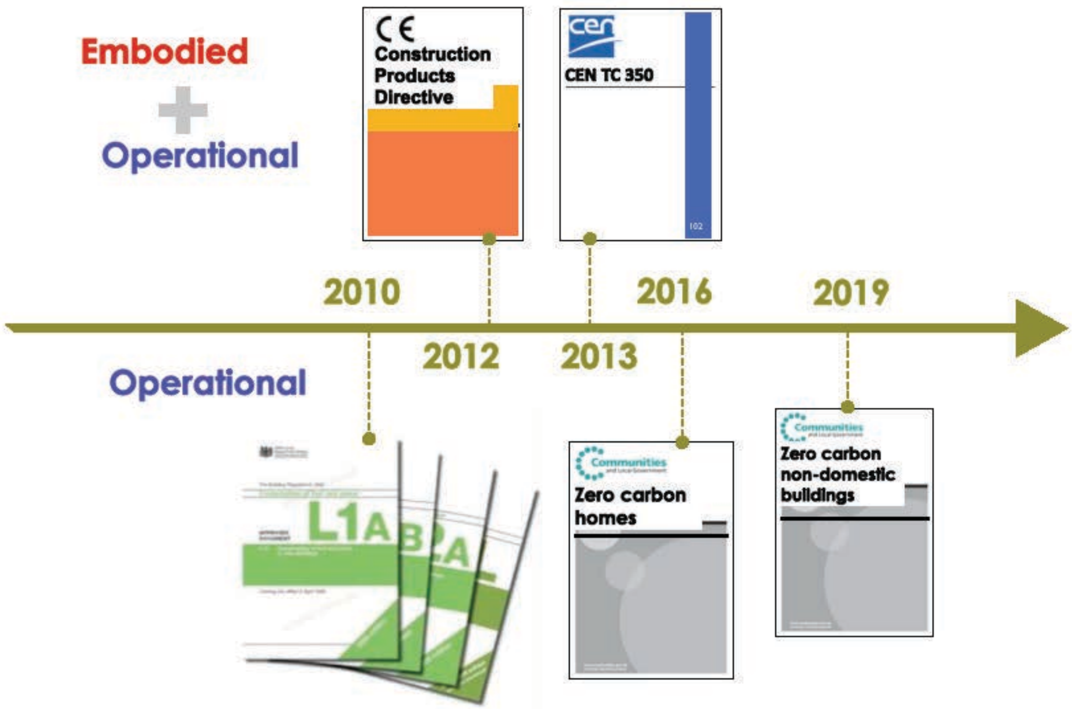


Figure A1.ii: Legislative Context, Source: Sturgis Carbon Profiling (2010)

A1.4 Data Inventory

Please note that the term ‘carbon emissions’ in this study refers to carbon dioxide and the bundle of green house gases (i.e. carbon dioxide equivalents such as methane), the unit of measurement of which is $KgCO_2e$. In completing the Whole Life Carbon assessment, we have used the following data sources:

- Operational emissions are derived from Part L calculations provided by SB Partnership.
- Conversion Factors were obtained from 2012 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting (AEA 2013)
- Grid decarbonisation projections: UK Future Energy Scenarios (National Grid, 2013)
- Building elemental cost and bill of quantities are based on a Indicative Estimate received from Chris Lawson of Mcbains Cooper in email dated 25-01-2013, 7-01-2013; and a Schedule of Materials from Francis Constructions
- Building geometry was based on architectural drawings by LHA Ltd.
- Component database of Sturgis Carbon Profiling LLP
- The Inventory of Carbon and Energy (ICE) University of Bath, BSRIA (2011)
- Life Expectancy of Building Components, RICS (2006)
- CEN M350 Carbon Calculation Methodology, CEN/TC350, Construction Resources and Waste Roadmap (CRWP) (2010)
- Whole Life Carbon Footprinting Measurement & Offices, Sturgis Carbon Profiling, JLL, BCO London (2011)
- Product manufacturers’ Environmental Product Declarations (EPDs), specifications and drawings

APPENDIX 2: Update from previous version

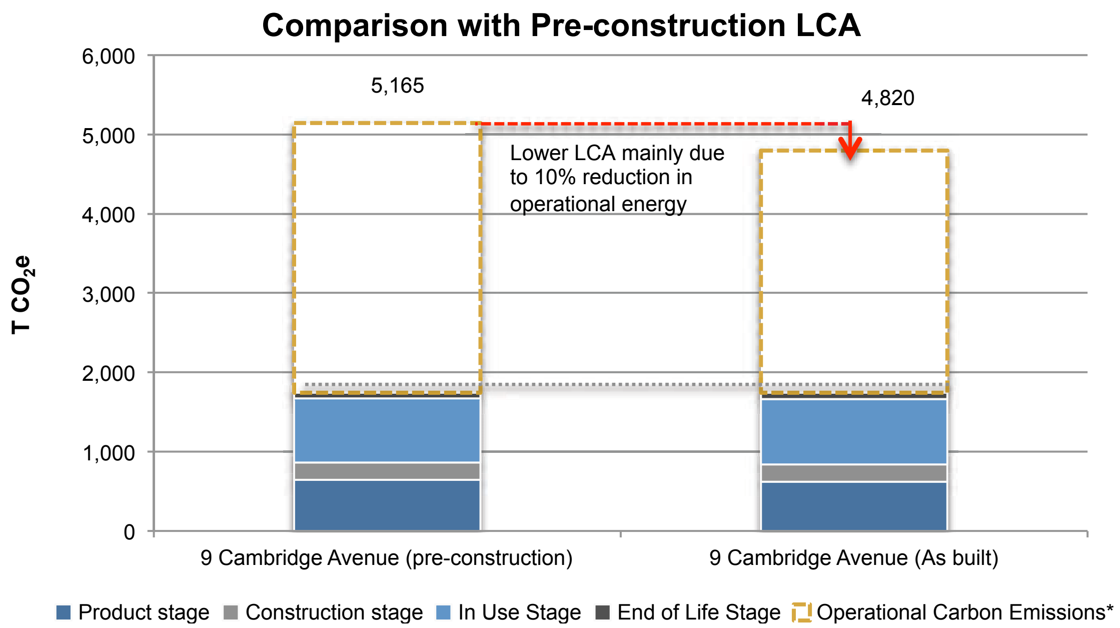
The changes during the course of project were recorded and an assessment accounting for these changes was undertaken to summarise the project.

The assessment indicated a **reduction of nearly 10% in the operational energy*** (Part L2A 2010 of Building Regulation) results in a lower LCA for the project 'as-built' in comparison to that previously reported in May 2013 at project commencement. Operational emissions are reduced mainly due to:

- ✓ Replacement of the old boiler with a new more efficient one
- ✓ Improved airtightness of building fabric

Table below lists all changes from pre-construction estimation and their associated carbon impact, resulting in a net reduction in Carbon footprint over Life cycle.

Embodied Carbon Reduction compared to Pre-construction			
Item	**Elements**	**Carbon Footprint Reduction over Life Cycle**	
		KgCO2e/m² NIA	**T CO2e**
Extra items retained	Recycling Timber components (avoiding landfill)**	1	4
	Precast Slabs	4	12
	External Glazed Doors	0.5	1.5
	Internal Doors	0.9	3
	Rainwater pipes and man safe	1.3	4
New components used opposed to reclaimed	Broken glass Replacement	-1.6	- 5
	New boiler Replacement	-4.0	- 14
Embodied Carbon Reduction over Life Cycle		**3**	**5**
Reduction in Operational Energy *		**108**	**340**
Net Carbon reduction over Life Cycle		**110 $KgCO_2e/m^2$ NIA**	**345 T CO_2e**



**Operational energy emissions are based on SB Partnership's calculations and considering grid decarbonisation.*
***Emissions from organic content being landfilled.*