In partnership with

Railway Tavern

Carbon Assessment Report

Design Stage Report

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EXECUTIVE SUMMARY

The report shows the whole life-cycle carbon assessment for the proposed refurbishment of the Railway Tavern in Norton using the FCBS beta V0.8.3 spreadsheet.

Assumptions have been outlined for reference, along with building information gleaned from the package provided.

It predicts a whole life-cycle cost of 2,008 kgCO_2e/m² for the development over 60 years, with 466 kgCO_2e/m² at practical competition and 718 kgCO_2e/m² for the embodied carbon over the life cycle. The operational energy whole life carbon cost is predicted to be 1,290 kgCO_2e/m².

The operational energy could be reduced through an ASHP, this would reduce the operational carbon significantly and move the building towards best practice. The additional of PV could further offset the operational energy, although it is to be noted the neither of these options have been modelled within the study.

There are shown to be significant advantage to refurbishment in terms of embodied carbon compared to if a typical new build is constructed. If the building lasts 30 years there are significant advantages to the refurbishment when looking at the whole life-cycle carbon analysis with a break-even point at 60 years, the assumed life of the building. The refurbished development also offers potential for reduce carbon costs if the grid decarbonises in line with government promises.

INTRODUCTION

The building is an old 19th century public house that has been closed for a number of years and sits in the centre of Norton town, which lies in a conservation area. The proposal is to develop the building into eight single bedroom flats, whilst retaining the traditional look.

This report uses the beta version FCBS Carbon tool to analyse the whole life cycle carbon of the project. This is a high-level tool with the associated limitations and as such will not provide a full whole life carbon study which would require full building models for operational energy and exact quantities/ materials and sourcing data for all materials and their embodied carbon.

SAP procedure will be used to identify operational energy.

Life cycle modules are based on (BS EN 15978)

Where possible reference and assumptions will be taken from the “Whole Life-Cycle Carbon Assessments guidance Pre-consultation draft” produced for the major of London and “LETI Embodied Carbon Primer”.

APPROACH

The methodology for Whole Life-cycle Carbon Assessment as defined BS EN 15978 is described in the following diagram:

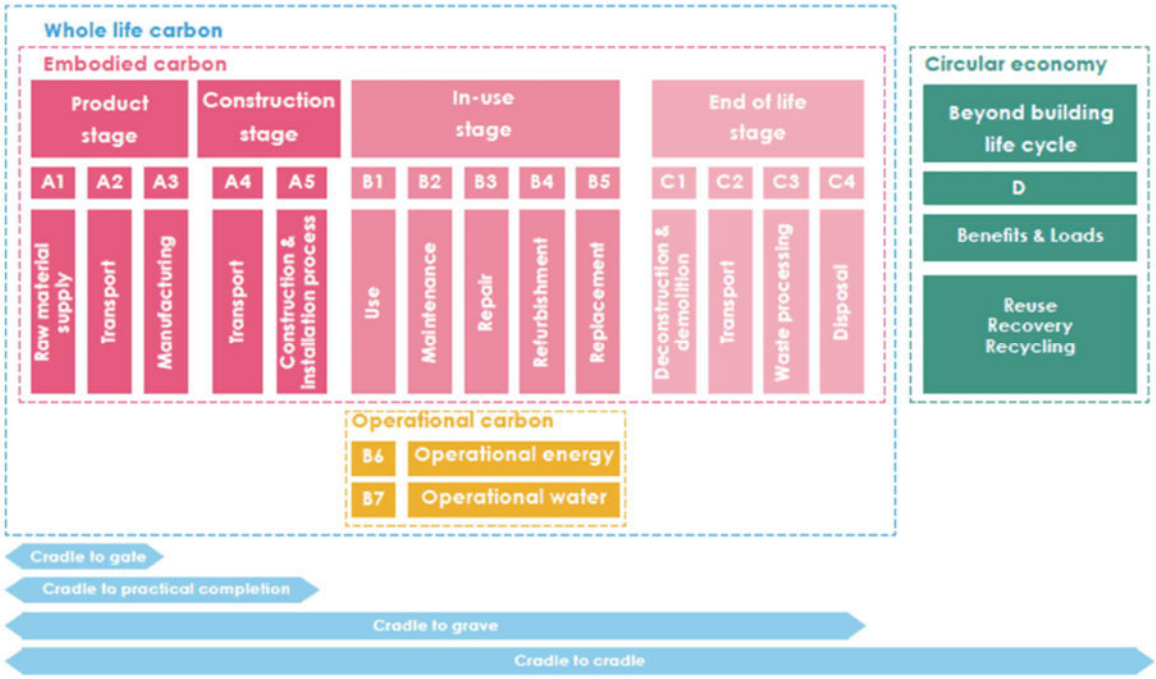


Figure 1 - EN15978 system boundaries

To assess the whole life cycle of this refurbishment requires a number of assumptions to be made:

1. The life span of the building will be considered to be 60 years, as proposed in the WLC assessment guidance.
2. The building is considered to be constructed circa 1850. While many changes must have been made through its life, the substructure will be assumed to be from this time and be capable of lasting another 60 years. Often buildings of this age have very little foundations, however some will be assumed, which can be justified due to the presence of the existing basement. This is a worst case as it will have an embodied carbon cost for the development.
3. SAP calculations have been performed for three flats, an average operational energy use will be calculated from these flats and applied throughout the building.
4. The office is assumed to have minimal use and as such the operational energy will be ignored.
5. It is assumed 50% of the walls will be retained and 50% will be new, although it is understood the actual amount will depend on the condition of repaired walls.
6. Only available constructions within the FCBS spreadsheet will be used, as these have carbon factors derived from the Inventory of Carbon and Energy (ICE) database and the Environmental Product Declarations (EPDs). A best-fit approach will be used, with the most a suitable construction selected.
7. The building will be assessed as a two-storey building; this gives more accurate calculations based on the building type, although it is known there is one apartment on what would be the second floor, the majority of the building is two-storey. If the building is modelled as three storeys, any comparisons/results will be more exaggerated.
8. For reference a new build calculation will be performed based on a similar construction and standard operational performance as defined by the notional building in the SAP calculation methodology. This will be used to provide a frame of reference to the numbers.

BUILDING INFORMATION

The following documentation has been used to base the assessment on:

- RY20003-A-020 Proposed Site Plan
- RY20003-A-126 Proposed Ground Floor Plan
- RY20003-A-127 Proposed First Floor Plan
- RY20003-A-128 Proposed Second Floor Plan
- RY20003-A-130 Proposed Roof Plan
- RY20003-A-220 Proposed Elevations Rev T2
- RY20003-A-351 Proposed Sections
- RY20003-A-360 Proposed Staircase Floor Plans
- RY20003-A-361 Proposed Staircase Sections
- RY20003-A-420 Typical Wall & Floor Construction Details
- RY20003-A-710 Rev T3 Proposed External Door & Window Schedule
- RY20003-A-800 Building Regs Compliance Notes
- RY20003-A-900 Performance Specification
- RY20003-A-900 Architectural and Structural Performance Specification
- Railway Tavern, Malton - Mechanical Performance Specification
- RT Electrical Performance Specification

Figure 2 – Image taken from google

BUILDING FABRIC

Constructions have been taken from the plans and specifications stated, basic values are presented below for the proposed development:

Element	U-Value, W/m²
Wall	0.3
Roof	0.17
Floor	0.3
Windows & Doors	1.8

Table 1 – U-Values

These U-values are better than the minimal U-values for a refurbishment.

SERVICING STRATEGY

The flats use electric panel heaters with instantaneous electrical point of use water heaters and electrical cooking facilities.

OPERATIONAL ENERGY

From the SAP calculations the operational energy for the building is:

Operational Energy	Electrical Energy, kWh/m²/yr
Space Heating	76.6
Hot Water	21.8
Cooling	0
Fans & Pumps	2.3
Lighting	5.7
Appliances	34.6
Cooking	17.1
Total	**158.1**

Table 2 – Operational energy

From the FCBS spreadsheet the following figures have been extracted (figure3):

Figure 3 – Data from FCBS for operational energy for proposed building

Figure 3 shows the building is not very energy efficient when compared to best practise, this is primarily due to the building fabric, which performs less well than a new build, as it is a renovation.

For comparison a standard new build has been input into the spreadsheet to show the difference if a new build was constructed instead (figure 4). The standard new build has been modelled with the reference set up for SAP. This new build has the same construction type, with improved u-values to match the SAP reference building and using the SAP reference systems and efficiencies.

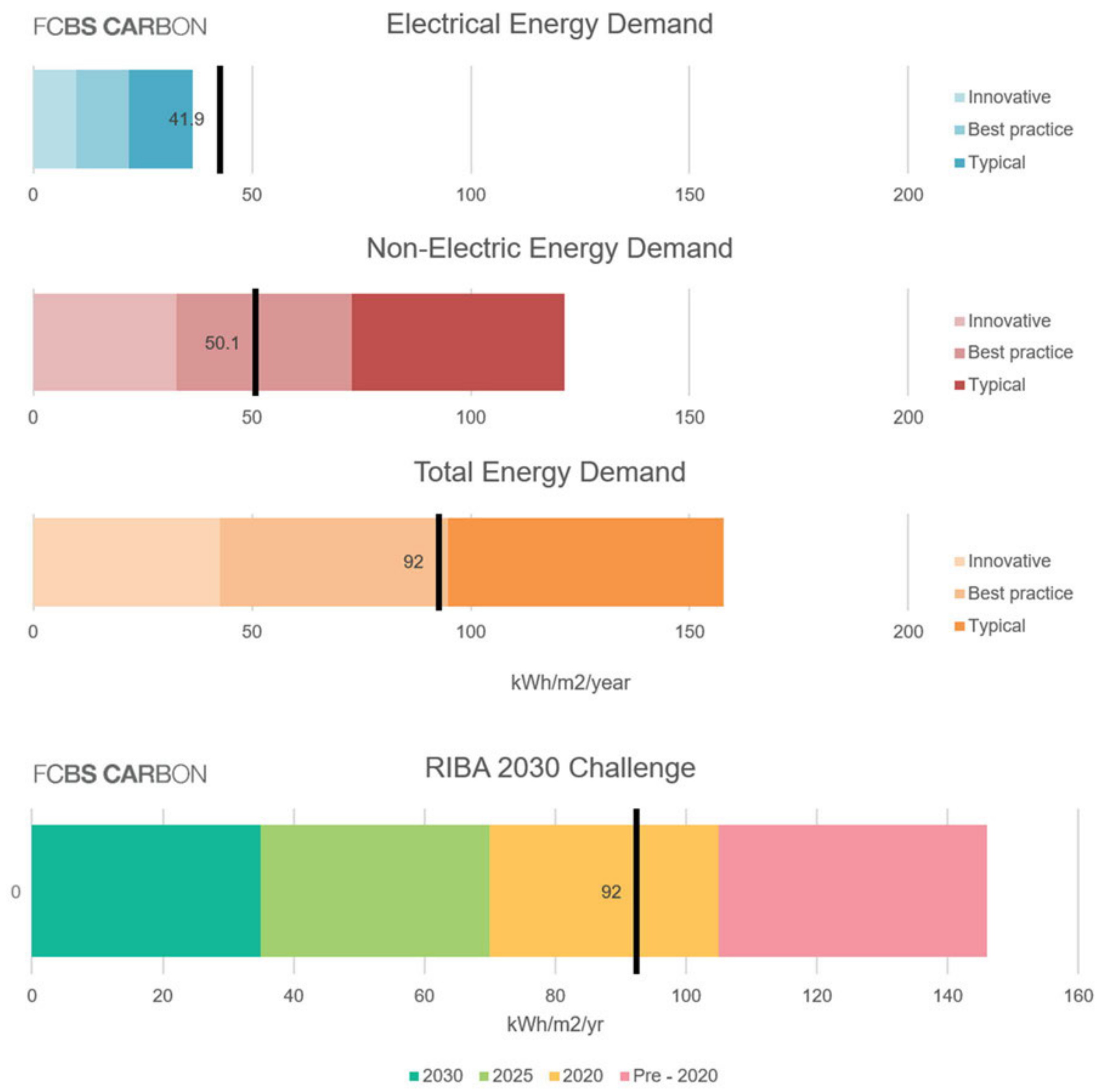


Figure 4 – Data from FCBS for operational energy for typical new build

It is worth noting figure 4 assumes a standard gas boiler, which the government are trying to phase out in favour of electrical ASHP's. The improved u-values of a typical building improve operation energy and as a result the operational carbon used. A possibility to improve the operational energy efficiency and subsequently carbon, would be to provide heating and hot water from an ASHP for the development, if this is viable.

Operational energy could be offset with installation of PV. While the generated energy may not be required when generated due to residential occupancy hours, as long as it can be supplied to the grid or stored locally by a battery, it will reduce the operational carbon.

EMBODIED CARBON

The embodied carbon for the proposed building is:

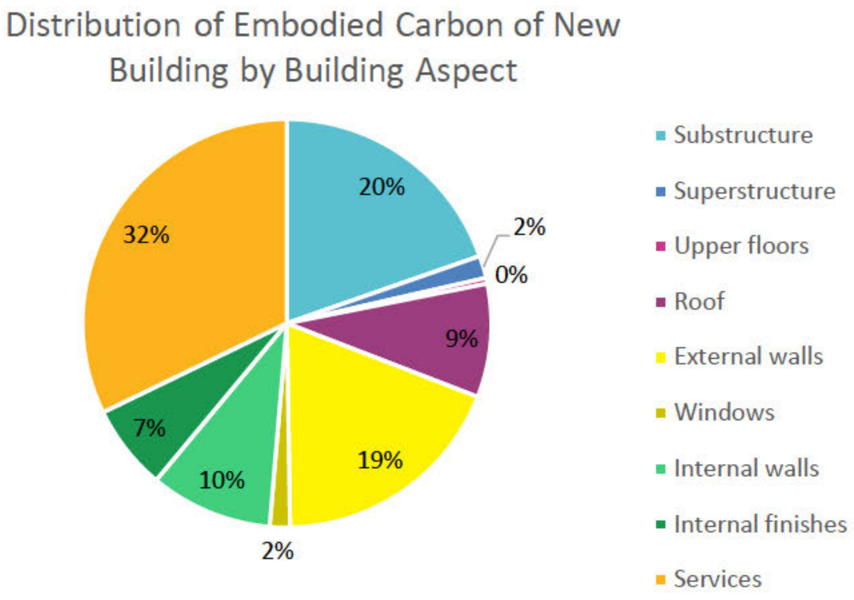


Figure 5 – Distribution of embodied carbon proposed building

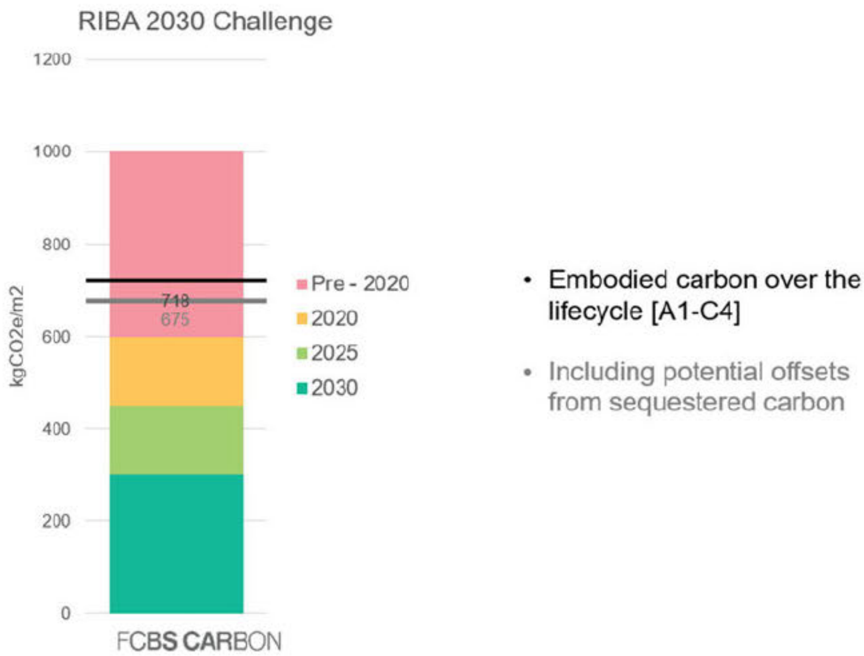


Figure 6 –Embodied carbon proposed building compared to RIBA 2030 challenge

The embodied carbon value of 718 $kgCO_2e/m^2$ is favourable and will have the building performing just below the 2020 values for the RIBA 2030 challenge. Benchmark values taken from the WLC assessment guidance are between 1050 to 1250 $kgCO_2e/m^2$ for a typical building and 630 to 740 $kgCO_2e/m^2$ for an aspirational building. The fact that the refurbishment falls just within the aspirational value shows the advantage of refurbishment over new build. These values are for Modules A1 to C4 excluding B6 and B7 operational energy and water use.

The following shows the results for typical new build:

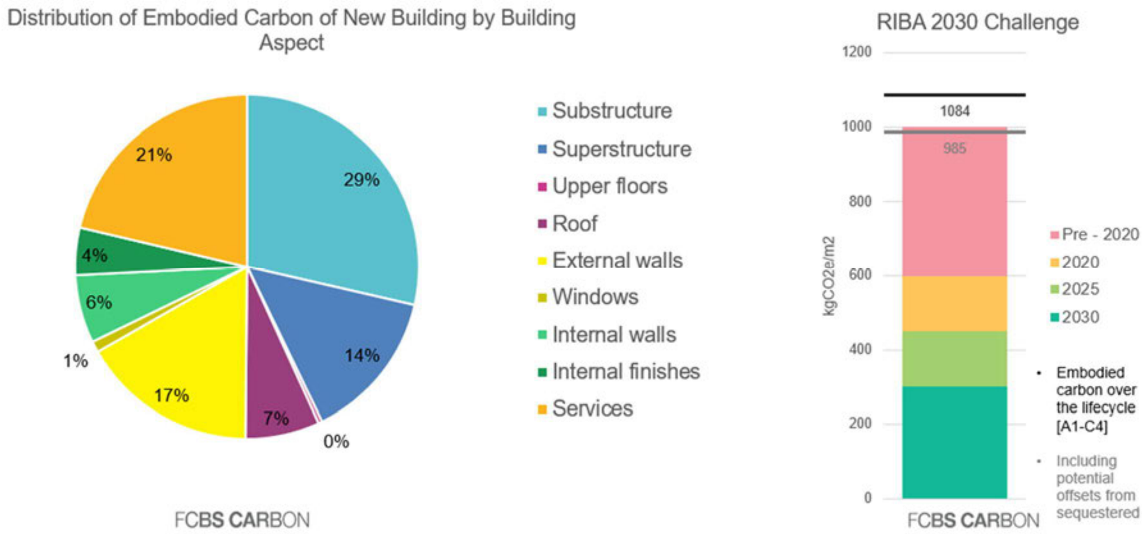


Figure 7 – Distribution of embodied carbon for a typical equivalent new build

The addition of the embodied carbon required to build the structure from scratch pushes the typical new build to 1084 $kgCO_2e/m^2$. Although the FCBS analysis is simple, it shows the benefit of refurbishment when looking at embodied carbon.

The embodied carbon to completion (modules A1 to A5) for the development is 466 $kgCO_2e/m^2$, this compares favourable to the LETI carbon primer best practise target for 2020 which are 500 $kgCO_2e/m^2$.

The typical new build case is 825 $kgCO_2e/m^2$, which is in line with the 800 $kgCO_2e/m^2$ stated as the business-as-usual case in LETI carbon primer.

WHOLE LIFE CARBON

The following chart shows the analysis for the whole life carbon for the proposed development over a 120-year period.

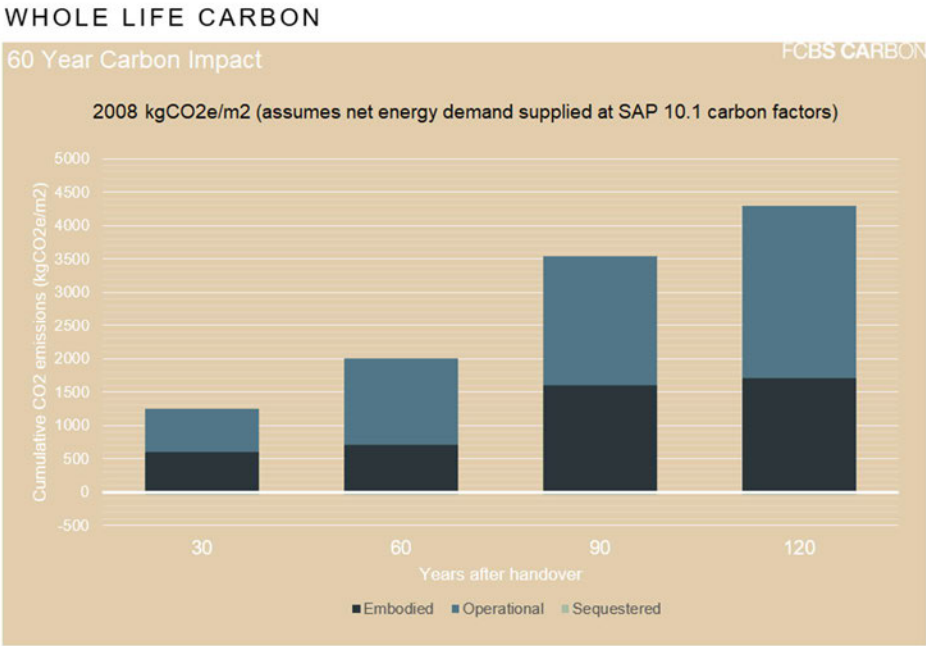


Figure 8 – Whole life carbon proposed development

The following chart shows provides a comparison for a new build over the same period

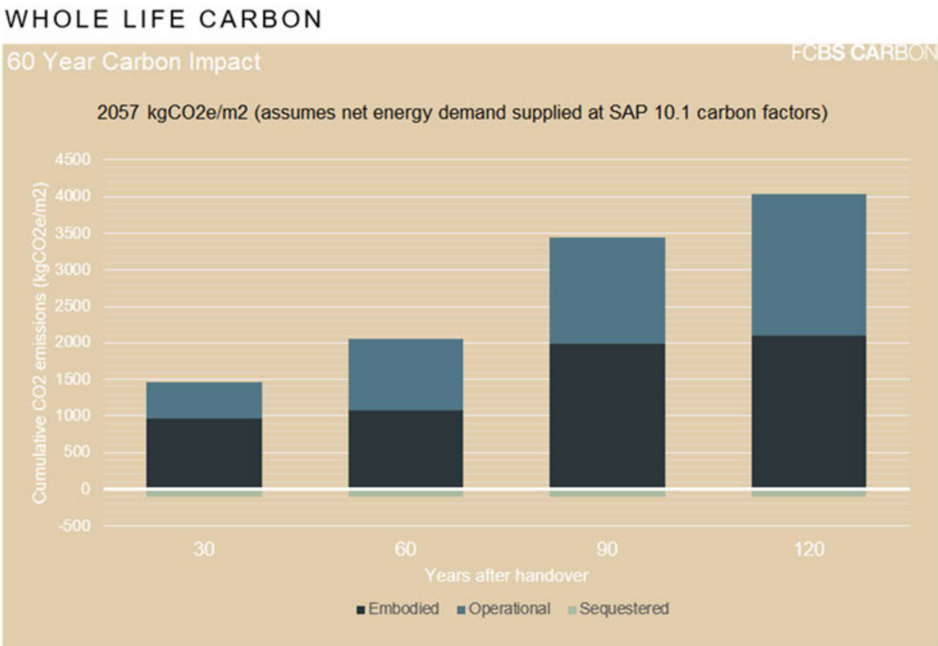


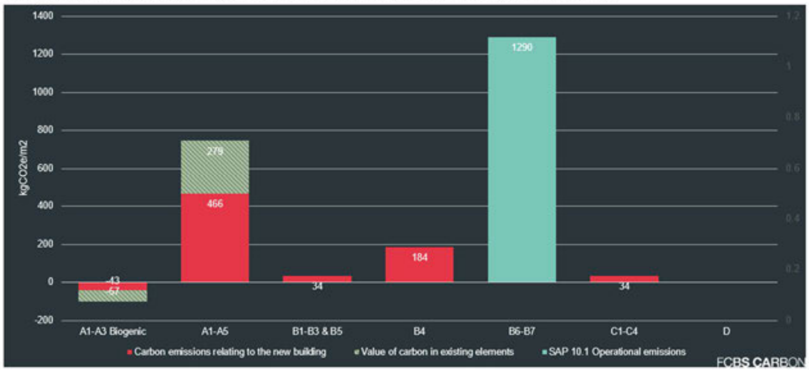
Figure 9 – Whole life carbon typical new build development

The trend shows that after 30 years refurbishment provides significant advantage compared to a new build, after 60 years both are about equal, subsequent years after this the reduction in operational energy would tip the balance in favour of new build. This is typical for any refurbishment, the improved fabric efficiency will at some time out balance the savings from not rebuilding the structure.

CARBON IMPACT OVER THE LIFE CYCLE

The following shows the Carbon impact for the proposed development:

CARBON IMPACT OVER THE LIFE CYCLE AND POTENTIAL BENEFITS



NOTES

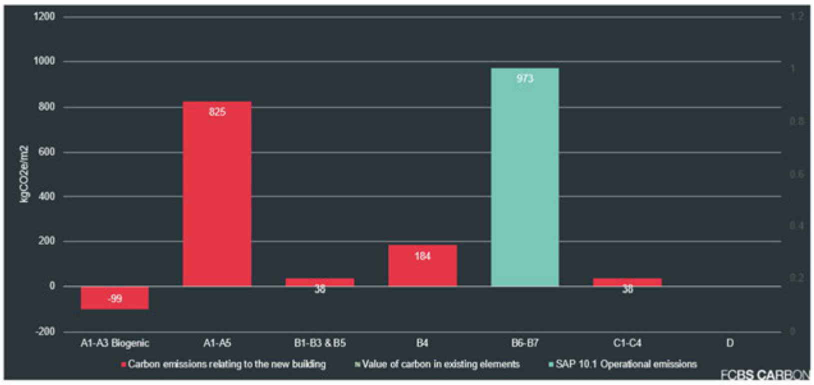
Term	Definition	Value (kgCO2e/m2)	
Embodied carbon to practical completion	Comprises stages A1-A5	466	
Embodied carbon over the life cycle	Comprises stages A1-A5, B1-B5, C1-C4	718	
Whole life carbon	Comprises stages A, B & C, with module D reported separately	A, B & C	D
		2008	0

N.B. These totals consider emissions incurred over the life of the current building. The value of carbon in existing elements is therefore not included in the total, but is displayed for information. Biogenic carbon has been excluded from these totals to provide clarity on the unavoidable emissions arising from material use. Operational emissions consider gross demand, as opposed to net demand on 3. OUTPUT. Module D represents potential benefits from the reuse of elements designed for deconstruction, including continued lock-in of biogenic carbon, alongside projected operational savings from on-site generation.

Figure 10 – Carbon impact for the proposed development

For comparison the following shows the carbon impact for a typical new build development

CARBON IMPACT OVER THE LIFE CYCLE AND POTENTIAL BENEFITS



NOTES

Term	Definition	Value (kgCO2e/m2)	
Embodied carbon to practical completion	Comprises stages A1-A5	825	
Embodied carbon over the life cycle	Comprises stages A1-A5, B1-B5, C1-C4	1084	
Whole life carbon	Comprises stages A, B & C, with module D reported separately	A, B & C	D
		2057	0

N.B. These totals consider emissions incurred over the life of the current building. The value of carbon in existing elements is therefore not included in the total, but is displayed for information. Biogenic carbon has been excluded from these totals to provide clarity on the unavoidable emissions arising from material use. Operational emissions consider gross demand, as opposed to net demand on 3. OUTPUT. Module D represents potential benefits from the reuse of elements designed for deconstruction, including continued lock-in of biogenic carbon, alongside projected operational savings from on-site generation.

Figure 11 – Carbon impact for a typical new build development

While the totals are similar, the graphs highlight the difference in where the life-cycle carbon is used. The green hatched total shows the carbon saved by renovation to the structure. Overall, after 60 years the proposed development would have a whole life-cycle carbon cost of 2,008 $kgCO_2e/m^2$.

The following shows the potential effect on decarbonising the grid the development:

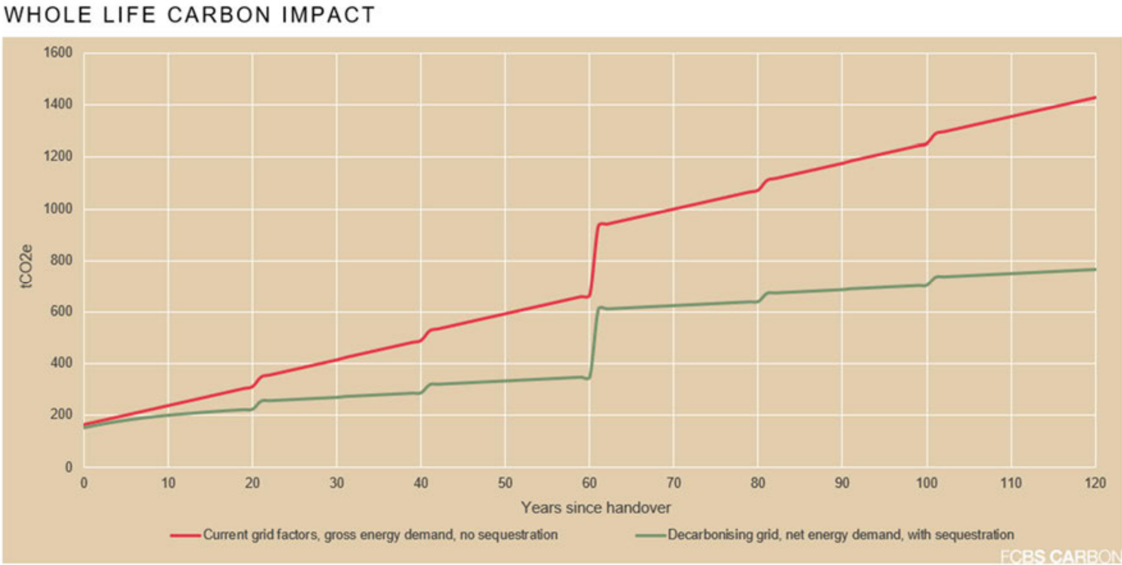


Figure 12 – Decarbonising effect on proposed development

This can be compared to the typical new build case:

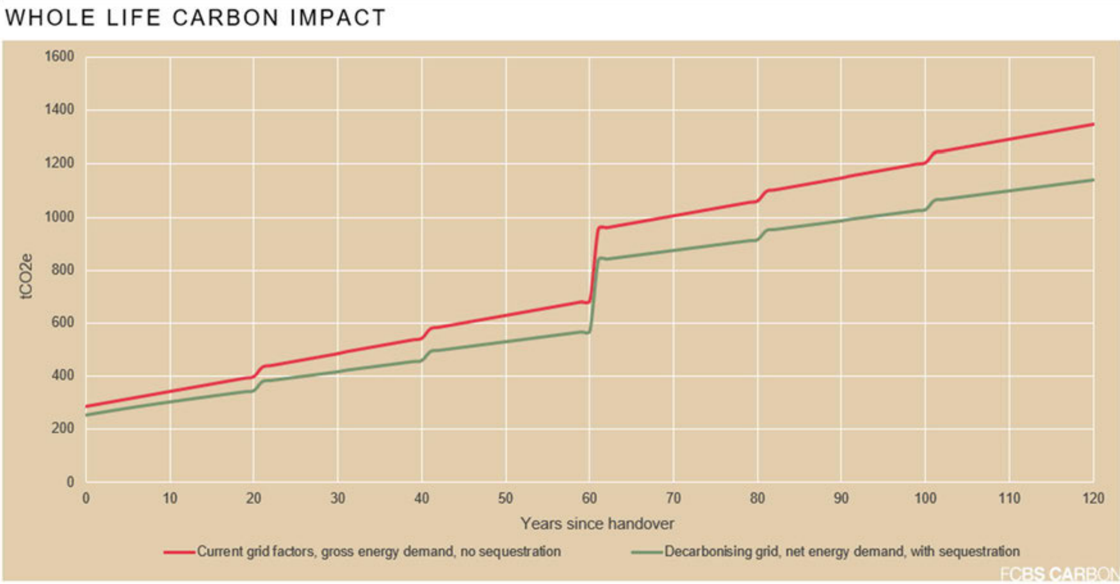


Figure 13 – Decarbonising effect on proposed development

This shows that while gross energy demand using the current grid factors (red line) for the refurbishment is just below 1,000 tCO_2e at 60 years, decarbonising of the grid and sequestration could reduce this to 600 tCO_2e (green line). For the typical new build, the value at 60 years is the same as the refurbishment. For the best case the refurbishment is at 600 $kgCO_2e/m^2$ while the new build has a best case at 60 years of 850 tCO_2e. This effect carries on and becomes more exaggerated as the years are added, there is greater potential for carbon savings for the refurbishment.

The electrical energy for the grid should decarbonise as time moves into the future, resulting in a higher comparative value for the typical building using gas. It is worth noting that these are predictions and the gas grid may decarbonise through the uptake of hydrogen technologies. Any predictions looking into the future will be relying on the electrical grid continuing to decarbonise. Many factors affect the rate at which this will happen and how far the UK power generation goes to becoming carbon neutral.

CARBON REDUCTION

The study has shown that refurbishment is the best option for reducing carbon over new build considering a 60-year life span of the building. This also offers the advantage of retaining a symbolic heritage building within Norton.

The main whole life-cycle carbon reduction available with the refurbishment is to reduce B6 and B7, the energy, and subsequently carbon involved in heating and hot water use within the building. Following a fabric first approach, any improvement that can be made to the U-values and ensuring good air tightness of the building structure will reduce heating costs, for both energy and carbon.

An ASHP can have in excess of three times the efficiency of a direct electric system, this offers savings for energy and carbon that will have effect throughout the life span of the building, with greater efficiency predicted as the technology progresses in the future. It should also be noted that a direct electric heating system has high costs and can lead to fuel poverty in winter, especially with the U-values available for refurbishment, that are below building regulation values for new build properties.

As previously mentioned, PV installation can help offset the building carbon and be fed back to the grid or stored locally, when not required within the residential apartments.

CONCLUSION

The report shows the whole life-cycle carbon assessment for the proposed refurbishment of the Railway Tavern in Norton using the FCBS beta V0.8.3 spreadsheet.

It predicts a whole life-cycle cost of 2,008 $kgCO_2e/m^2$ for the development over 60 years, with 466 $kgCO_2e/m^2$ at practical competition and 718 $kgCO_2e/m^2$ for the embodied carbon over the life cycle. The operational energy whole life carbon cost is predicted to be 1,290 $kgCO_2e/m^2$.

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