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EMBODIED AND OPERATIONAL CARBON ASSESSMENT

CRESCENT HOUSE

15/12/2022 *by RM, reviewed by ZS, LW*

This design note has been produced to investigate the embodied carbon and energy performance of three retrofit glazing options for an existing flat located at Crescent House, Golden Lane Estate in London. Respective embodied carbon and energy savings from each option are presented and compared.

INTRODUCTION

XCO2 Energy have been appointed by City of London to undertake an embodied carbon study and energy performance assessment for Flat 347 Located in Crescent House, Golden Lane Estate. Three proposed glazing options were investigated:

- Option 1A: Vacuum glazing retrofitted to refurbished existing frames
- Option 1B: Double glazing retrofitted of refurbished existing frames
- Option 2: Triple glazing fitted to new timber frames

Embodied carbon refers to the amount of carbon dioxide emissions associated with the manufacture, installation, use and disposal within the lifecycle of a material. Within this study we have highlighted the stages A1-A3, known as the production stage, however, have predominantly focussed on a whole lifecycle assessment. Embodied carbon can be reduced in numerous ways, for example by using locally sourced materials or materials that do not require an energy intensive manufacturing process. This is measured in kilograms of carbon dioxide equivalent per square meter of material. The term ‘equivalent’ is used as this allows any other greenhouse gases produced in the process to be included in the measurement by converting these additional gases into the equivalent amount of carbon dioxide with the same global warming potential.

Operational carbon refers to the amount of carbon dioxide produced by a dwelling from its daily use – for example through heating and lighting. This can be reduced by improving the thermal performance of the building’s elements, in this case the windows, which allows the building to retain more heat. This is measured in kilograms of carbon dioxide per square meter of dwelling floor area.

RESULTS AND OPTION COMPARISON

The embodied carbon study for both Option 1A and 1B is based on the estimation that 15% of the frame area will need to be replaced, to account for any rotted timber in the existing frames, whereas Option 2 includes the embodied carbon for the glazing and total frame area.

As can be seen in Table 1, the results of the embodied carbon study indicate that the option with the lowest total embodied carbon for both production (A1 – A3) stage and whole lifecycle (WLC) is Option 1B – retrofitting double glazing to the refurbished existing frames.

Table 1: Embodied Carbon Study Results

Option	Manufacturer / Product	Material	Area (m^2)	Embodied Carbon Factor ($kgCO_2e/m^2$)		Total Embodied Carbon ($kgCO_2e$)	
				A1 – A3	WLC	A1 – A3	Total
1A – Vacuum glazing retrofitted to existing frames	Fineo / Fineo 8 vacuum Glazing	Glass	8.92	43.7	50.1	390	447
	Window Frame	Sapele	0.62	22.8	28.4	14.1	17.6
						Total	465
						Option 1A Total with 20% replacement after 10 years	**558**
1B – Double glazing retrofitted to existing frames	Saint Gobain / Climaplus Double Glazing	Glass	8.92	32.6	33.5	291	299
	Window Frame	Sapele	0.62	22.8	28.4	14.1	17.6
						Total	317
						Option 1B Total with 20% replacement after 10 years	**380**
2 – Triple glazing in new frames	Saint-Gobain / Climatop Triple Glazing	Glass	8.18	51.8	53.2	424	435
	Window Frame	Sapele	4.13	22.8	28.4	94.2	117
						Option 2 Total:	**552**

The results of the operational carbon comparison for the three options of glazing appraised are presented in Table 2 below.

Table 2: Energy Assessment Results

Option	Dwelling Emissions Rate, DER ($kgCO_2/m^2$)	Total Dwelling Emissions ($kgCO_2$)	Total Dwelling Emissions across 20 Years ($kgCO_2$)
Existing	74.87	2972	59,447
1A – Vacuum glazing retrofitted to existing frames	64.83	2574	51,475
1B – Double glazing retrofitted to existing frames	65.18	2588	51,753
2 – Triple glazing in new frames	61.26	2432	48,640

The combined embodied and operational carbon for the three options of glazing is presented in Table 3.

Table 3: Total Carbon Emissions Summary

Option	Total Embodied Carbon ($kgCO_2e$)	Total Dwelling Emissions Across 20 Years ($kgCO_2$)	Total Carbon Across 20 Years ($kgCO_2e$)
Existing	0	59,447	59,447
1A – Vacuum glazing retrofitted to existing frames	558	51,475	52,033
1B – Double glazing retrofitted to existing frames	380	51,753	52,133
2 – Triple glazing in new frames	552	48,640	49,192

Option 2 performed the best in the operational energy/carbon performance analysis. When compared to the vacuum glazing option (1A), it would be expected to save 142 $kgCO_2e$ in carbon emissions annually.

Assuming 20% of the windows in Option 1A and 1B will have to be replaced in 10 years and Option 2 windows will have a typical lifespan of 20 years, the triple glazing would be expected to save 2841 $kgCO_2e$ in total carbon (operational and embodied combined) across a 20-year period when compared to the vacuum glazed option, and a saving of 2941 $kgCO_2e$ was identified when compared to the double-glazed option. For this reason, it is recommended that the project moves forward with Option 2, utilising triple glazing in new frames in the retrofit.

CONCLUSION

An embodied carbon study and energy assessment was prepared by XCO2 Energy to assess the impact of three retrofit glazing options on the embodied and operational carbon consumption of Flat 347 in Crescent House, Golden Lane Estate in London.

It was found that the most suitable option when considering both embodied and operational carbon was Option 2 – utilising triple glazing. In the embodied carbon study carried out by XCO2 triple glazing was found to have a higher embodied carbon than the double glazing. However, when considering both the embodied and operational carbon, triple glazing with new frames, produces the lowest overall carbon emissions throughout an assumed window lifespan of 20 years, as shown in Table 3. This is followed by vacuum glazing to existing frames, and the worst option being double glazing to existing frames.