Curtain Wall Interventions for Energy Efficiency: A Carbon Life Cycle Assessment

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Figure 1. Libraltar Savings and Loan Building, Nighttime Elevation View ca. 1959. (Source: Arts & Architecture. “Financial Institution by Greacen and Brogniez, Architects,” August 1960).

ABSTRACT

Historic glass curtain wall systems have an energy use problem. Developed and popularized during a period of energy abundance, the curtain wall is often a major cause of poor energy performance in modern buildings. In the face of the climate crisis, pressure to address the performance of these buildings is mounting. Strategies for addressing the environmental impacts of glass curtain walls while remaining sensitive to their historical value are necessary to ensure their continued preservation. This research assesses the balance between energy improvement and impact on historic integrity for seven curtain wall retrofit strategies -Sealant Replacement, Low-E Applied Film, Glass Replacement, Secondary Interior Glazing, Exterior Shading, Full Curtain wall Replacement, and Demolition+ Replacement. The environmental performance of each strategy is evaluated using a carbon life cycle assessment (LCA)for the Gibraltar Savings and Loan Building (1959) in Houston, Texas by Greacen & Brogniez Architects. Upfront embodied carbon and long-term operational carbon were estimated using energy modeling and LCA databases to evaluate the total carbon emissions over time for each strategy. Each strategy was evaluated for its potential to yield carbon savings over the next 10-30 years, the critical period for mitigating the worst impacts of the climate crisis. The results of the study found that all retrofit strategies yielded positive carbon payback over the baseline scenario in the first three years. Under a projection of constant electrical grid carbon efficiency, demolition was less carbon efficient than all retrofits for the first 10-20 years. At the 30-year mark, Secondary Glazing was shown to be the most carbon-efficient of all strategies. Under alternative projections for renewable energy sourcing and grid decarbonization, demolition was shown to be less carbon efficient than all retrofit strategies besides sealant replacement. These results show that demolition and inaction are unacceptable approaches for treating the sustainability of historic glass curtain walls. Retrofit is the only effective approach, and a range of approaches are available to balance preservation of historic integrity and improvement of energy efficiency.

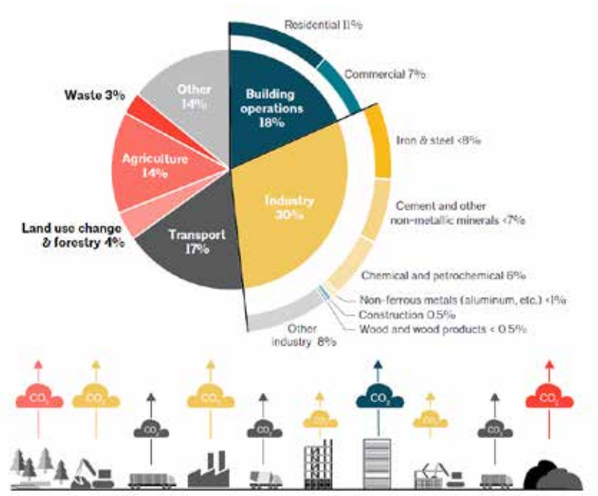

Figure 2. Global Greenhouse Gas Emissions and Building Life Cycle Carbon Emissions. (Source: Lewis, Meghan, Stephanie Huang, Stephanie Carlisle, and Kate Simonen. “Introduction to Embodied Carbon.” Carbon Leadership Forum, 2021).

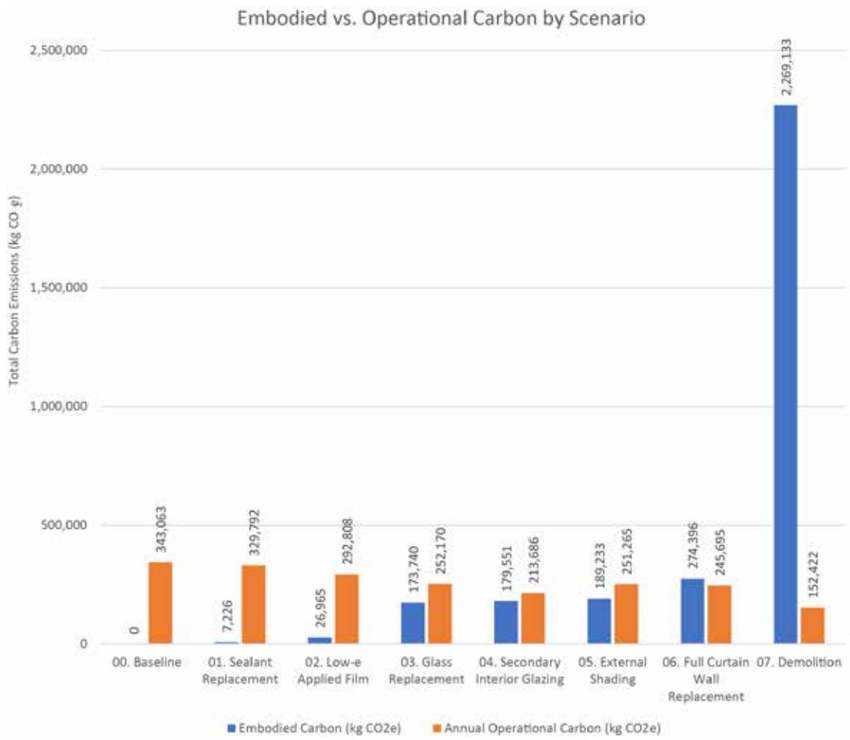

Figure 3. Embodied vs. Annual Operational Carbon by Scenario. (Source: Author).