Concrete Sustainability Hub@MIT: Life Cycle Assessment Research Brief – December 2012

The State of LCA for Residential Buildings

Problem

The construction and occupation of buildings contributes one-third of global greenhouse gas (GHG) emissions and more than 40% of global energy use. As global populations swell, particularly in urban areas, sustainable housing has become a major focus for reducing GHG emissions. Building codes and other standards encourage (or require) energy efficiency, but the impact of the materials used to improve energy efficiency is often ignored. To truly meet GHG mitigation goals, the entire life cycle of a building should be considered. The goal of this research is to understand the current state of tools that quantify the GHG and energy impact of residential buildings, looking for ways to refine and improve methodologies.

Approach

Life cycle assessment (LCA) is a technique often used to estimate environmental impacts. While LCA can quantify many impacts, including water use and human health, this research focuses on GHG emissions, both embodied and operational, over the life cycle. Thirty articles from the last five years were assessed, identifying trends in results, as well as gaps or inconsistencies that could be refined to provide accurate results. Data was collected on the structures and materials under assessment, including methodologies, data sources, and results.

Findings

Differences in the methodologies for building LCAs make it challenging to compare results in a meaningful way. Studies differed in terms of the size of the building under consideration, the materials employed, and the length of time the home will be occupied and maintained. Further, each study generally focused on one geographic region, adapting the home's structure and heating/cooling regime to the unique climatic conditions.

In spite of the differences, there are some overarching trends within the studies' results. First, the choice of materials used to increase the energy efficiency of a home may have an embodied GHG impact that outweighs the gains related to reduced energy consumption in the use phase.

As shown in Figure 1, when compared to the manufacturing and construction phases, studies that considered shorter building lifetimes demonstrated greater variability in the dominance of energy impacts in the use phase. Though this figure does not capture all of the data contained in the focal studies, it's clear that further investigation of the impact of materials is needed. As one study noted, floors, walls, and roofs make up largest materials impact, but infrequently considered building features, like paint and floor finishes, can have a significant GHG impact as well.

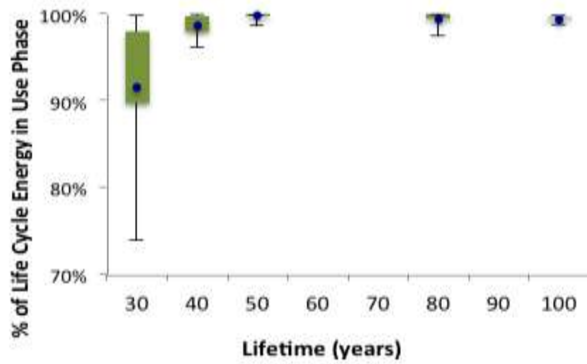

Figure 1. The percent of total energy use attributed to the use phase of the building. Bars represent the range of data points.

Several gaps were noted in existing building LCA studies. Namely, there was no consistent methodology that could be scaled to address various housing types, materials, and climates. Further, there is a lack of primary data; most studies rely largely on commercial databases. The lack of data illuminates the potential for uncertainty within the results, an aspect not accounted for in most studies. Finally, there is limited research on the impact of renovating existing housing.

Impact

In order for LCA to be scaled to fit the building sector, a method is needed to calculate life cycle impacts under diverse conditions, while fully accounting for uncertainty. Policymakers, engineers, and architects need an LCA method that can be used to ensure that sustainable buildings are being designed to meet long-term energy savings standards while also reaching today's GHG reduction goals. Ongoing research in the CSHub seeks to address these needs.

More

Research presented by Suzanne Greene and supervised by Elsa Olivetti, Randa Ghattas, and Jeremy Gregory.

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