Survey of LCA Tools for Residential Buildings

Problem

The building sector is under pressure to understand and reduce the environmental impact of buildings, especially global warming potential, in order to meet voluntary environmental performance standards and increasingly stringent codes. A comprehensive life cycle assessment (LCA) technique is needed to evaluate embodied, use, and end-of-life phases, while also providing uncertainty information. Many use phase-focused tools exist that analyze whole or partial building energy consumption. Other tools examine the environmental impact of the embodied and end-of-life phases of the materials used to create and maintain a building and the construction and demolition practices. Despite an abundance of tools, there is no clear technique that enables streamlined understanding of impact tradeoffs across the phases.

Approach

This study takes a three-pronged approach, including surveys and focus groups with architects, engineers, and homebuilders and an exploration of existing tools. Surveys help to pinpoint where in the design process decision support should be targeted. Focus groups help us understand client-dependent design needs and constraints. Finally, existing tools are compared based on criteria such as scope and comprehensiveness, model accuracy, ease of use for designers, and interoperability with popular design software and XML languages.

Findings

The figure below illustrates the average frequency of responses to the survey question that asks, for each building assembly, *"At what stage in the design process is this level of specificity known?"* The Design Development stage is when many decisions about building attributes are made as can be seen from this figure. Therefore, a tool should be targeted before this stage.

Level of Specificity	Stage of the Design Process			
	Conceptual Design	Schematic Design	Design Development	Construction Documents
Geometry	22%	32%	39%	7%
Structural Components	4%	38%	50%	9%
Details	0%	6%	60%	34%
Building System Types	7%	50%	27%	17%

Focus groups are revealing the importance of short payback periods for energy efficiency mechanisms to many clients, as well as the popularity of the Architecture 2030 Challenge for energy consumption. Architecture firms seem to be charting separate paths toward environmentally preferable design due to a lack of clear, consistent guidelines.

Most use phase tools surveyed run on the EnergyPlus calculation engine from the National Renewable Energy Lab, such as the BEopt™ (Building Energy Optimization) software for analysis of the energy consumption and building cost for simple homes and OpenStudio for commercial building energy and daylight modeling.

A smaller number of tools model the embodied and end-of-life phases. For example, the Athena Impact Estimator from Athena Sustainable Materials Institute is approved for use in the LEED Pilot Credit 63: MR–Whole Building Life Cycle Assessment. Also, the National Institute of Standards and Technology developed BEES (Building for Environmental and Economic Sustainability) software for direct comparison of the LCA of a unit of a building product.

Impact

Through surveys, focus groups, and exploration of existing tools we are identifying the most effective ways to integrate environmental performance metrics into the design and decision making processes. Robust, streamlined residential building LCA tools would help decision makers, builders, and architects to make holistic decisions that integrate environmental impact of all phases of the building's life cycle.

More

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