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Framework for Life Cycle Assessment (LCA) based environmental decision making during the conceptual design phase for commercial buildings

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Abstract

Introduction: In the U.S., about 50% of total CO_2 emissions stem from the built environment (e.g., building construction, operation [heating, lighting, cooling], and end-of-life) (EPA 2012). Improving the performance and efficiency of the built environment offers the largest and least cost GHG mitigation option of any sector of the global economy (IPCC 2007). Science-based Life Cycle Assessment (LCA) methods are increasingly being used to analyse the environmental impact of construction materials and products.
Objectives: This paper presents a framework for LCA-based environmental decision making for commercial buildings at the conceptual design phase, compares it to the currently available LCA tools and data bases, and identifies the "next steps" in developing a comprehensive LCA standard for assessing whole building life cycles to support environmental decision making in design and construction.
Methodology/approach: 1) CSU/AIA conducted focus groups in 8 US cities to explore actual and potential use of LCA in decision making by architects; 2) A framework created based on feedback from focus groups, 3) The framework was compared to existing LCA tools and databases, 4) Gaps were identified for next stages in developing an LCA-based environmental decision-making tool for conceptual design.
Findings and contributions: 1) Current LCA tools are balkanized and usually address only one life cycle stage, material or system in a building. 2) LCA-related databases normally only address materials and product; they do not address construction activities or building operations. 3) LCA tools and databases generally require a completely separate activity, data input and expertise; they are not integrated into routinely used architecture, engineering, and construction (AEC) tools, methods or best practices. 4) LCA based decision-making will not become an AEC

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best practice until it is fully integrated, comprehensive, standardized, affordable, and demanded by customers and municipalities.

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Keywords: LCA, life cycle assessment; green house gas emissions; buildings; carbon emissions; environmental impact; energy efficiency; environmental benchmarking; enviornmental building declarations; building information modelling; BIM; GHG.

Main Text

The built environment uses more energy and produces more Green House Gas (GHG) emissions than any other US economic sector. Unlike the transportation sector in which the combustion engine has numerous metrics to assess its efficiency and GHG emissions, buildings have no recognized standard metric by which the entire life cycle of a building can be environmentally measured and assessed. Life Cycle Assessment (LCA) offers the Architecture, Engineering and Construction (AEC) community, as well as US government agencies and municipalities, a potential method for environmentally assessing a building's impact before it is built. This paper explores a national LCA framework for the built environment that will facilitate energy efficiency and GHG emissions benchmarking to advance environmental impact remediation.

1. **Introduction:** The US Government has set a policy of increasing energy efficiency and reducing greenhouse gas emissions (GHG), principally CO2, by 2020, across all economic sectors. This policy is expressed in the National Action Plan for Energy Efficiency (NAPEE) (EPA, 2010). In addition President Obama announced in 2009 new carbon emissions goals, reducing emissions by 17% of the 2005 levels by 2020 (EPA, 2009). Moreover, it is anticipated that these emissions goals may be accelerated as a result of the UN Summit on Climate Change, COP 21, taking place in Paris in November 2015. In that the built environment contributes around 50% of the GHG emissions to the US carbon signature it must play a central role towards these targets through ever greater energy efficiency and GHG emissions reductions (EPA 2012).

Unfortunately, NAPEE is a voluntary policy and provides only broad principles and long term strategies for energy efficiency which focuses primarily on the use of macro-economic incentives for utilities to accommodate increased efficiency. It provides no methodical pathway for the architect, engineer and constructor (AEC) community nor municipalities who authorize building permits to advance energy efficiency with each building that is designed and approved for construction. Moreover, it provides no measurement standard by which the US Government and the AEC community can track our progress towards these goals. Only through benchmarking energy efficiency and GHG emissions by building type can we have a common standard with which to compare progress with each building in meeting national targets. Thus, there is a