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Life Cycle Assessment of Residential Buildings: A Case Study in Canada

Authors : Venkatesh Kumar, Kasun Hewage, Rehan Sadiq

Abstract : Residential buildings consume significant amounts of energy and produce a large amount of emissions and waste. However, there is a substantial potential for energy savings in this sector which needs to be evaluated over the life cycle of residential buildings. Life Cycle Assessment (LCA) methodology has been employed to study the primary energy uses and associated environmental impacts of different phases (i.e., product, construction, use, end of life, and beyond building life) for residential buildings. Four different alternatives of residential buildings in Vancouver (BC, Canada) with a 50-year lifespan have been evaluated, including High Rise Apartment (HRA), Low Rise Apartment (LRA), Single family Attached House (SAH), and Single family Detached House (SDH). Life cycle performance of the buildings is evaluated for embodied energy, embodied environmental impacts, operational energy, operational environmental impacts, total life-cycle energy, and total life cycle environmental impacts. Estimation of operational energy and LCA are performed using DesignBuilder software and Athena Impact estimator software respectively. The study results revealed that over the life span of the buildings, the relationship between the energy use and the environmental impacts are identical. LRA is found to be the best alternative in terms of embodied energy use and embodied environmental impacts; while, HRA showed the best life-cycle performance in terms of minimum energy use and environmental impacts. Sensitivity analysis has also been carried out to study the influence of building service lifespan over 50, 75, and 100 years on the relative significance of embodied energy and total life cycle energy. The life-cycle energy requirements for SDH is found to be a significant component among the four types of residential buildings. The overall disclose that the primary operations of these buildings accounts for 90% of the total life cycle energy which far outweighs minor differences in embodied effects between the buildings.

Keywords : building simulation, environmental impacts, life cycle assessment, life cycle energy analysis, residential buildings
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