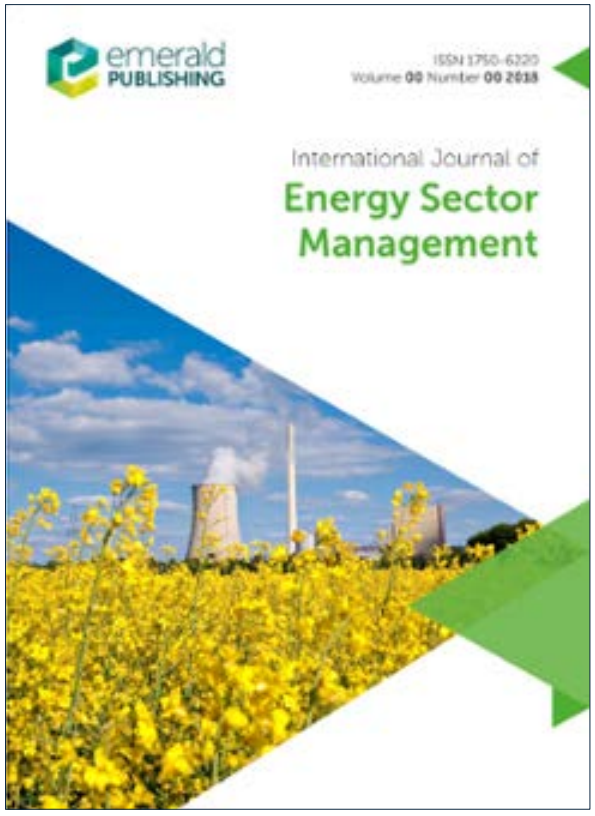
Analysis of the Amount of Latent Carbon in the Reconstruction of Residential Buildings with a Multi-Objective Optimization Approach



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ABSTRACT

Due to the increase in energy demand and the effects of global warming, energy-efficient buildings have gained significant importance in the modern construction industry. To create a suitable framework with the aim of reducing energy consumption in the building sector, the external walls of a residential building were considered with two criteria of global warming potential and energy consumption. In the first stage, to achieve a nearly zero-energy building, energy analysis was performed for 37 different states of thermal insulation. Then, the insulation materials' life cycle assessment was performed. These results were used to find a set of optimal modes in the Pareto front by using non-dominated sorting genetic algorithm II multi-objective genetic algorithm. Thus, based on the data obtained from this method, it was possible to compare and choose different thermal insulation materials based on the distance from the Pareto front, reducing the environmental effects. The results showed ...

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Analysis of the amount of latent carbon in the reconstruction of residential buildings with a multi-objective optimization approach

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Abstract

Purpose – Due to the increase in energy demand and the effects of global warming, energy-efficient buildings have gained significant importance in the modern construction industry. To create a suitable framework with the aim of reducing energy consumption in the building sector, the external walls of a residential building were considered with two criteria of global warming potential and energy consumption.

Design/methodology/approach – In the first stage, to achieve a nearly zero-energy building, energy analysis was performed for 37 different states of thermal insulation. Then, the insulation materials' life cycle assessment was performed. These results were used to find a set of optimal modes in the Pareto front by using non-dominated sorting genetic algorithm II multi-objective genetic algorithm. Thus, based on the data obtained from this method, it was possible to compare and choose different thermal insulation materials based on the distance from the Pareto front, reducing the environmental effects.

Findings – The results showed that replacing the windows was possible to save 3.24% in energy consumption. Also, selecting the proper insulation reduced energy consumption value by 63.13%. Finally, this building can save 69.31% of energy consumption compared to the base building by following the zero-energy building standard. As a result, the Pareto curve was introduced as a guide for the optimal design of the building's wall insulation.

Originality/value – The proposed method provides designers with a framework for latent carbon analysis to access quickly and select optimal scenarios. It can also be used without restrictions for other decisions with different goals and criteria.

Keywords Life cycle assessment (LCA), Multi-objective optimization, Building energy analysis (BEA), Latent carbon, Nearly zero-energy building (nZEB), NSGA-II evolutionary algorithm

Paper type Research paper

Abbreviations

ANSI = American National Standards Institute;
Ar = Argon;
ASHRAE = American Society of Heating, Refrigeration and Air-Conditioning Engineers;

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