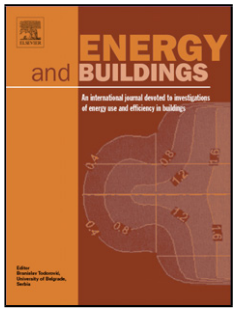

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A design tool to assess the heating energy demand and the associated financial and environmental impact in neighbourhoods

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Abstract

During the master planning of neighbourhoods, design decisions related to the urban layout and typology affect the building form and availability of solar radiation considerably. The influence of those decisions on the energy demand for heating is often neglected however because appropriate energy simulation tools are lacking.

This paper proposes a simple and accurate design tool to assess the solar gains and heating energy demand in buildings during the master planning phase of neighbourhoods. Detailed information on building geometry, constituting building elements and solar obstructions, is extracted from a 3D neighbourhood model using a plugin implemented in the modelling software SketchUp. This information is used to assess the heating energy demand of the buildings in the neighbourhood based on the dynamic Equivalent Heating Degree Day (dEHDD) method. Furthermore, the associated financial and environmental impacts are calculated based on an integrated life cycle approach, combining Life Cycle Costing (LCC) and Environmental Life Cycle Assessment (E-LCA) respectively. The design tool proposed is implemented for the Belgian context and used to analyse a number of schematic residential neighbourhood models with diverse built densities. The analysis reveals substantial differences in heating energy demand, life cycle financial and environmental costs. Neighbourhoods with a high built density and compact building types have a lower heating energy demand with potential reductions of up to 40% compared to neighbourhoods with a low built density and detached building types.

Keywords: 3D modelling; solar obstructions; building geometry; dynamic Equivalent Heating Degree Days; Environmental Life Cycle Assessment; Life Cycle Costing