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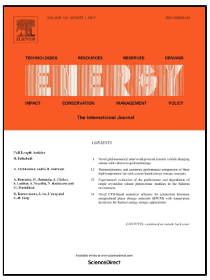

Final energy savings and cost-effectiveness of deep energy renovation of a multi-storey residential building in a cold climate

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Final energy savings and cost-effectiveness of deep energy renovation of a multi-storey residential building in a cold climate

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Abstract

In this study we present a method for analysis of cost-effectiveness of end-use energy efficiency measures and demonstrate its application for modelling a wide range of energy renovation measures for a typical 1970s multi-family building in Sweden. The method integrates energy balance and bottom-up economic calculations considering total and marginal investment costs of energy efficiency measures as well as net present value of total and marginal savings of the measures. The energy renovation measures explored include additional insulation to basement walls, exterior walls, and attic floor, improved new windows, efficient electric appliances and lighting, efficient water taps, glazed enclosed balcony systems, and exhaust air ventilation heat recovery systems. The measures are analysed first individually and then designed to form economic packages. Our results show that improved windows give the biggest single final energy savings while resource-efficient taps is the most cost-effective measure for the building. We find that the cost-effectiveness of the energy renovation measures is sensitive to real discount rates and energy price increases. Cost-optimal final heat savings varies between 34 % and 51 %, depending on the choice of real discount rate and energy price increase. The corresponding electricity savings varies between 35 % and 43 %. This study shows a method and the significance of various technical and economic-related parameters in achieving deep energy savings cost-efficiently.

Keywords: Deep energy renovation, energy efficiency measures, heat savings, electricity savings, cost-effectiveness, discount rate, energy price, residential buildings

1. Introduction

The European Commission's 2030 framework for climate and energy policy emphasized that the largest share of the energy saving potential in the EU is in the building sector [1]. Buildings account for about 40% of the total final energy use and 36% of the CO_2 emission in the European Union (EU) [2],[3]. In Sweden, the residential and service sector accounted for 147 TWh of the total final energy use in 2013, representing 40% of the total final energy use [4]. The Swedish government is aiming to reduce total energy use per heated building area by 20% by 2020 and 50% by 2050, using 1995 as baseline [5]. Strategies to achieve this goal include periodic revisions of the building energy regulation, establishment of economic incentives for building energy renovations, and requirement for energy declaration for buildings when they are built, sold or rented out.