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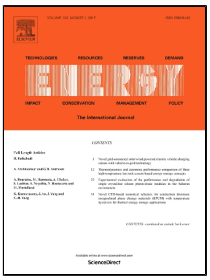

A general model for the optimization of energy supply systems of buildings

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A general model for the optimization of energy supply systems of buildings.

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Abstract

In this paper, a general model for the optimization of the energy supply systems of buildings is proposed. The model is based on a general superstructure that allows to include all the existing and future technologies, covering heating, domestic hot water, cooling and electricity. The model is linked to a Mixed Integer Linear Programming (MILP) problem that allows the selection of equipment and its operation, enabling the minimization of the annual cost for a set of constraints imposed by the designer, such as a Non-Renewable Primary Energy (NRPE) consumption limit.

The model has been applied to a case study consisting of a domestic building located in Bilbao (Northern Spain). 13 different technologies were taken under consideration together with the specific conditions of the Spanish context. Three different objectives were determined: (i) the optimal cost; (ii) the Zero Energy Building (ZEB); and (iii) the ZEB', an alternative ZEB where the whole electricity consumption is considered for the calculation of the NRPE. The 3 cases were compared and analyzed and, finally, a parametric evaluation was carried out, setting the aspects that limit the feasibility of low energy buildings: economic feasibility and physical constraints such as roof availability for renewables.

Keywords: optimization, MILP, nZEB, ZEB

1. Introduction

Climate change and resource scarcity drive the need for an energy transition based on lowering primary energy consumption, increasing energy efficiency and promoting the production by renewable energy sources. This energy transition strongly affects buildings, which are responsible for 40% of the overall primary energy consumption of the European Union [1]. Along these lines, the Directive 2010/31/EU on the energy performance of buildings [2] aims to cut this consumption enforcing that, in the next decade, all new buildings, and gradually the existing stock, should be nearly Zero Energy Buildings (nZEB).

nZEB is defined as a building of very high energy performance and the nearly zero amount of energy required should be covered to a very significant extent by energy from renewable sources. In this context, a Zero Energy Building (ZEB) would be an nZEB with no net non-renewable primary energy consumption. The specific definition of nZEB is intended for