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Energy saving potential of occupancy-based heating control in residential buildings

Davide Bionda*, Silvia Domingo-Irigoyen

School of Engineering and Architecture, Lucerne University of Applied Sciences and Arts, CH-6048 Horw, Switzerland

Abstract

A significant amount of energy is wasted every year by heating unoccupied indoor spaces in residential buildings. How much energy can be saved by reducing the heating during the hours with no occupancy? Simulation results of a multi-family residential building typical for the Swiss housing stock show that, when the setpoint temperature is equally reduced in all apartments during the hours with no occupancy, energy savings in the order of 6-9% for the whole building and 3-13% for the individual apartments can be achieved.

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Keywords: occupancy-based heating control; heating energy use; energy saving potential; residential buildings; building simulation

1. Introduction

The vast majority of residential buildings in temperate and cold climates are heated throughout the day during the winter, regardless of whether people are in the building or not. The setpoint temperature is generally maintained constant at a thermally comfortable level and at most lowered for a few hours during the night. This way, a

* Corresponding author. Tel.: +41 41 349 34 30; fax: +41 41 349 39 60.
E-mail address: davide.bionda@hslu.ch

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significant amount of energy is wasted every year by heating unoccupied indoor spaces and, ultimately, being partly transferred to the outdoor environment by conduction through the building envelope and ventilation.

The basic technology for occupancy-based control of the heating system has long been available on the market. Occupancy sensors are nowadays considered state-of-the-art for e.g. lighting control and can be easily integrated into heating control systems. How much energy can be saved by reducing the heating (i.e. by lowering the setpoint temperature) during the hours with no occupancy using such a system? We investigated this question in the framework of a project financed by the Swiss Federal Office of Energy (SFOE) by means of building energy simulation. The full project report with a detailed description of all simulation parameters can be found in [1].

In this paper we present the results of a parametric study of a four-storey multi-family residential building, typical for the Swiss housing stock, exposed to the climate of northern Switzerland. The simulations were carried out both for the building in its original condition from the seventies and after refurbishment (i.e. upgrade of the energy efficiency of the building envelope according to the current Swiss norms).

2. Methodology

2.1. Simulation model and parameters

A multi-zone model was created using the building simulation program IDA ICE (expert edition, version 4.7.1) from EQUA Simulation AB. The model is based on an existing residential building from the seventies comprising eight apartments, a stairwell and a basement (Fig. 1). Each apartment was represented as a separate zone in the simulation model.

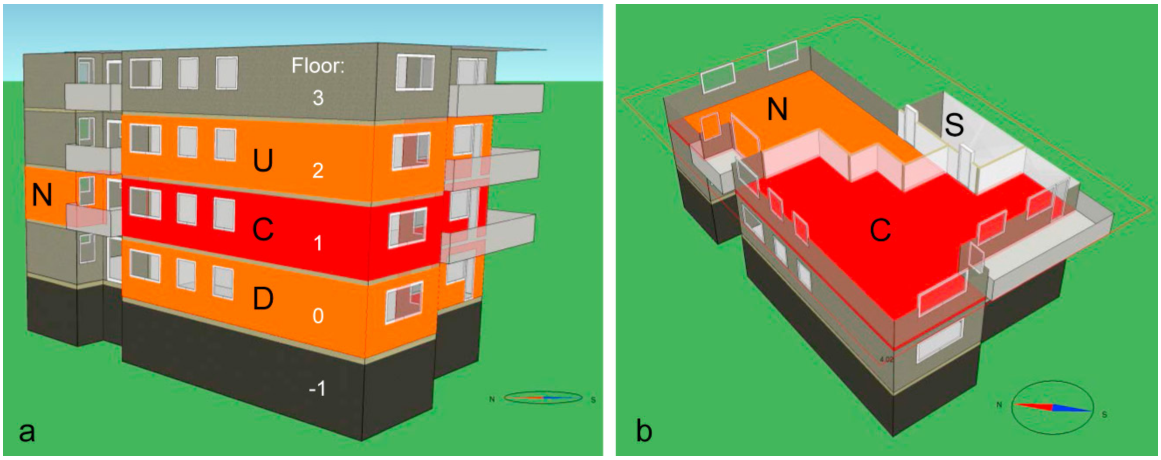

Fig. 1. (a) 3D view and (b) horizontal section (first floor) of the simulated building. C: Central apartment; U: Upstairs apartment; D: Downstairs apartment; N: Neighboring apartment; S: Stairwell.

The simulated building has the following characteristics:

- Floor area: 87 m^2 (central, upstairs and downstairs apartment); 66 m^2 (neighboring apartment)
- Exterior walls (original building): double brick masonry, U=1.08 W/(m^2K)
- Exterior walls (refurbished building): double brick masonry with external insulation, U=0.18 W/(m^2K)
- Roof (original building): reinforced concrete, U=0.97 W/(m^2K)
- Roof (refurbished building): reinforced concrete with additional insulation, U=0.19 W/(m^2K)
- Floor (original building): reinforced concrete, U=2.99 W/(m^2K)
- Floor (refurbished building): reinforced concrete with additional insulation, U=0.23 W/(m^2K)
- Interior walls: sand-lime brick masonry, U=2.87 W/(m^2K)