

Article

Assessing the Energy Demand Reduction in a Surgical Suite by Optimizing the HVAC Operation During Off-Use Periods

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Abstract: Hospital surgical suites are high consumers of energy due to the strict indoor air quality (IAQ) conditions. However, by varying the ventilation strategies, the potential for energy savings is great, particularly during periods without activity. In addition, there is no international consensus on the ventilation and hygrothermal requirements for surgical areas. In this work, a dynamic energy model of a surgical suite of a Spanish hospital is developed. This energy model is calibrated and validated with experimental data collected during real operation. The model is used to simulate the yearly energy performance of the surgical suite under different ventilation scenarios. The common issue in the studied ventilation strategies is that the hygrothermal conditions ranges are extended during off-use hours. The maximum savings obtained are around 70% of the energy demand without compromising the safety and health of patients and medical staff, as the study complies with current heating, ventilation and air conditioning (HVAC) regulations.

Keywords: HVAC system; operating rooms; surgical suite; calibrated simulations; energy savings

1. Introduction

Hospitals operate 24/7 with high rates of occupancy and stringent air quality requirements. Accordingly, they generally present greater end-use energy consumption and greenhouse gas emissions per unit of floor area in comparison with residential and other commercial buildings. Thus, it has been recently reported that the average energy intensity of hospitals in the United States is 738.5 kW/m²/year, which is approximately 2.6 times greater than that of other buildings of the tertiary sector [1]. In turn, the energy consumption of hospitals in Greater London (UK) ranges from 194 to 1270 kWh/m²/year [2], whereas the average values for Germany and Spain are approximately 270 kWh/m²/year [3,4]. In addition, a recent study on the CO₂ emissions derived from the energy consumption in Spanish hospitals estimates that the average annual ratio is 100 kg per m² of floor area [5].

The scientific literature offers a wide range of investigations evidencing that there is a large potential for energy savings and CO₂ emissions reduction in hospitals worldwide. Such studies mostly focus on enhancing the efficiency of heating, ventilation and air conditioning (HVAC) systems, as they are typically responsible for the greatest share of the total end-use energy consumption in hospitals, with ratios ranging from 50% to 75% [6,7]. These investigations were conducted worldwide (e.g., in Europe [8] and Australia [9]), achieving similar results. For example, in China, a comprehensive