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# EVALUATING THE FEASIBILITY OF HYBRID VENTILATION IN EDUCATIONAL SPACES: A SIMULATION STUDY IN THE NORTHERN BASQUE COUNTRY CLIMATE

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**Abstract** – This paper delves into the examination of indoor comfort in classroom environments and its interplay with ventilation on human wellbeing in scenarios of varying indoor carbon dioxide concentrations. The assessment of these parameters was done according to the provisions outlined in the Spanish national Regulation of Thermal Installations in Buildings (RITE). This study also compares various ventilation strategies, namely natural, mechanical and hybrid ventilation, commenting the pros and cons of each method in the climate of the Basque Country, Spain. To do so, a classroom in the School of Architecture of San Sebastián was modelled in thermal simulation software. Simulations were carried out for full days in 5-minute intervals using Design Builder, and considered in three different exterior scenarios (a cold day, temperate day, and a warm one) and three different ventilation systems (natural, mechanical with heat recovery, and hybrid). Two additional scenarios were added for control, one with no ventilation at all and another with a partial, constant, natural ventilation, like it was done during the COVID-19 pandemic. Thus, the natural ventilation option was evaluated under three conditions (windows always closed, windows open 15 %, and windows operated by thermal sensation of the user). The mechanical system evaluated consisted of a constant flow ventilation for IDA 2 IAQ with an airflow of 12.5 l/s-person. The modelled hybrid system consisted in a combination of simple flux mechanical ventilation and open windows and doors under some particular conditions. An occupancy rate of 50 % of the theoretical maximum occupancy of the classroom and a heating setpoint of 15 °C were considered. This article presents the CO<sub>2</sub> concentration, final energy consumption and thermal comfort results obtained in the simulation and compares between different scenarios. The results showed that the hybrid ventilation system was able to effectively control indoor air quality, providing a healthy and comfortable environment for occupants. The hybrid system demonstrated improved energy efficiency compared to the natural ventilation system, while maintaining a high level of indoor air quality. Overall, the results of this study highlight the importance of considering hybrid ventilation in educational spaces in the northern Basque Country climate. The study provides valuable insights for building design and operation, especially for renovation of existing schools and educational facilities that lack any means of mechanical ventilation, showing some of the potential for hybrid ventilation to improve indoor air quality and energy efficiency.

**Keywords** – *Indoor air quality (IAQ); human-building interaction; hybrid ventilation; natural ventilation; schools; thermal comfort*

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