Experimental and numerical methods for thermal characterization of adaptive building envelope elements

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Abstract.

The European building construction sector, encompassing residential and industrial domains, accounts for 40% of energy consumption, according to the European Commission. Moreover, in the residential sector, energy demand is dominated by space heating. This emphasizes the importance of energy savings in buildings, specifically in terms of heating load. The building façade is a crucial element in building envelope as it serves as the interface between the outdoor and the indoor environments, thus having a significant impact on the energy consumption of heating, ventilating, and air conditioning systems.

Adaptive façades (AF) are one of the promising solutions to improve energy efficiency and occupant comfort. This concept distinguishes between passive façades, which maintain a static behaviour during climate variations, and climate-responsive façades, that adapt to the environment by anticipating responses, potentially influencing heat transfer and other variables in the indoor building environment.

Various technologies in the façade market fall under the subcategory of adaptive façades, aiming to reduce HVAC energy consumption and improve occupant comfort. These include green façades, bio-inspired façades, and façades with integrated shading devices that can be manipulated automatically or manually. Evaluating the thermal performance of these innovative façade technologies is essential, especially in sizing and scheduling HVAC systems. Although existing simulation software can predict façade performance, these tools need further development to handle the complexities of unconventional façade systems. This is particularly important as current parameters for thermal characterization often consider façade behaviour as univariable, which is not the case for AF.

The key objective of this research study is to investigate the potential of a climate responsive façade using outdoor experimental measurements. To achieve this, a methodology for evaluating performance will be developed in order to yield a range of key performance indicators suitable for charactering such dynamic behaviour.

Key words: Outdoor experiment; heat transfer; adaptive element.