An IAQ and thermal comfort coach prototype to improve comfort and energy consumption thanks to adequate management of natural ventilation: development and first feedback results

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ABSTRACT

Over time with thermal and energy regulations, buildings are increasingly insulated and airtight to control better the heat exchanges between the indoor and outdoor environments. The primary function of the mechanical ventilation system is to ensure healthy air by diluting odours and humidity with fresh air. However, in many situations, windows opening can be much more effective in terms of thermal comfort, air quality, or release heat loads due to a higher air change rate than the mechanical ventilation system itself. On the contrary, opening the windows can be counterproductive and, in particular, leads to overconsumption of energy because it is not necessarily obvious whether it is appropriate to open or close a window. In addition, opening a window can improve air quality and generate additional energy consumption, leading to a complex decision process.

This presentation presents a coaching tool developed to help occupants to know whether it is a good option to open or close their windows. The objective of this coach is to consider the three components: thermal comfort, indoor air quality (IAQ) and energy consumption. The coaching tool is based on environmental data monitored thanks to 3 sensors in its first version: indoor and outdoor air temperature and indoor CO_2 concentration. The outside air temperature is first used to calculate the outdoor running temperature based on the last three days of measuring data. This running outdoor temperature is used to define the adaptive comfort temperature range. The indoor air temperature is then compared to both instantaneous outdoor air temperature and adaptive comfort temperature range to check if the thermal potential (heating or cooling) is in accordance with the thermal need of the indoor environment. In parallel, the IAQ is monitored thanks to the CO_2 concentration sensors and compared to different ranges to define whether opening the window might be necessary to bring cleaner air into the room. All these data are integrated into a rule-based algorithm to determine the coaching advice, which might take three states: Open, Close or Free. The last one means open or close will neither improve nor deteriorate the indoor environment quality (IEQ). One of the challenges of this tool is to be autonomous in energy for at least one season. Energy consumption of the tool, frequency of computation of the algorithm and advice displayed to the user are other bottlenecks developed in parallel with the algorithm's performance.

A testing campaign with five prototypes was run at the end of summer 2022 in an office building at Le Bourget-du-Lac (73) in France. Some first feedbacks are presented in Figure 1 within the upper graph, the measured data: indoor air temperature in orange, outdoor air temperature in green, the bandwidth of adaptative thermal comfort in red, and CO_2 concentration in blue. In the lower graph, the status of the windows is presented in yellow, and the advice from the coach is in blue. Unfortunately, in this first period, the outdoor conditions were inappropriate for testing the coach at full capacity.
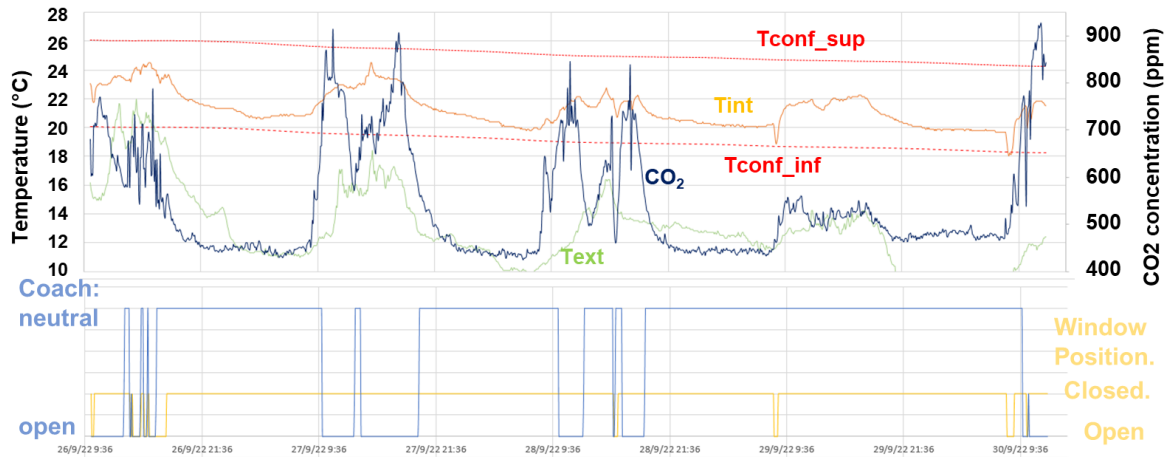
Figure 1 - 1st test of the coaching in a summer week

In parallel, a second version of the prototype has been developed and is shown in Figure 2. This second version will help in qualifying the algorithm during the summer of 2023.
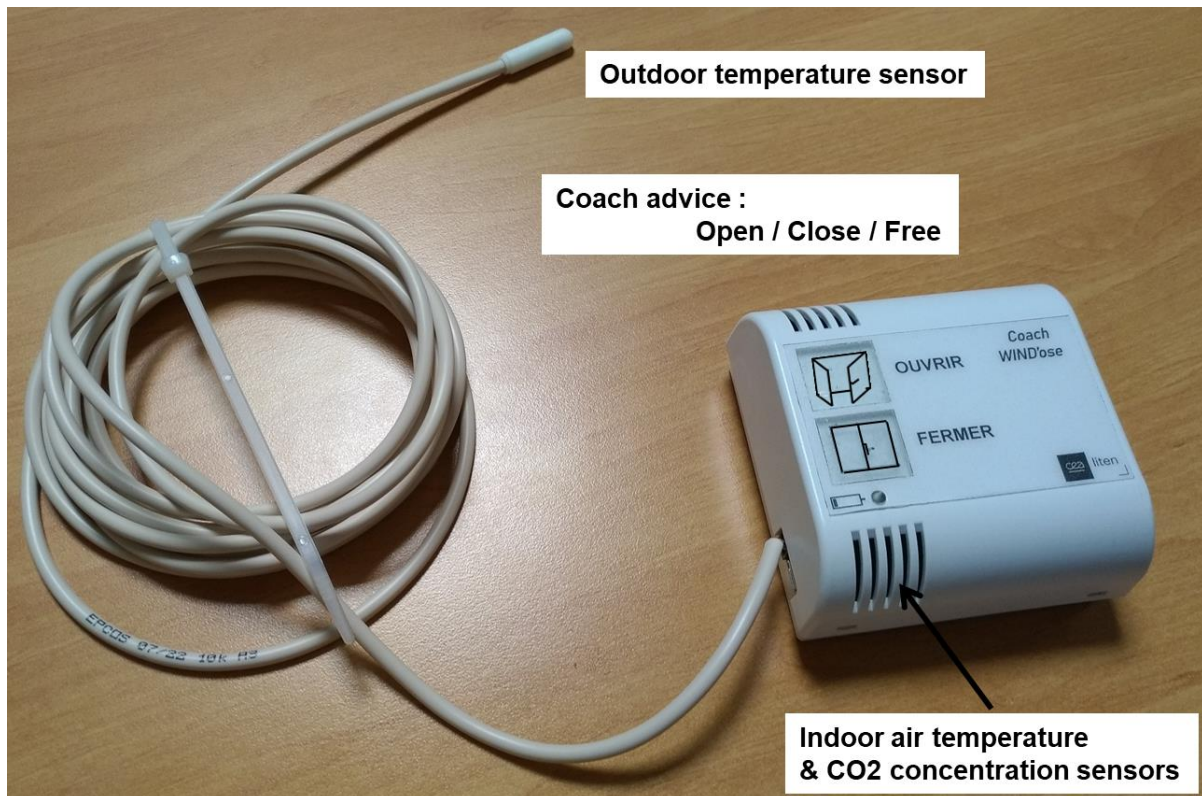

Figure 2: V2 of Wind'Ose prototype

More extended feedback on this coaching tool is necessary to quantify its impact on the three components: Thermal Comfort, IAQ and energy consumption.

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