The importance of performance-based regulations for residential ventilation. State of the art.

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1 INTRODUCTION

The context of climate change and the need of saving energy has required rethinking the ventilation and the air change rates in buildings, because of their increased impact on thermal losses. Indeed, ventilation plays a crucial role estimated around 30-50% of the energy delivered to buildings, becoming an even higher part in high-efficient buildings (Liddament and Orme, 1998, AIVC FAQ).

Indoor air quality is another major area of concern in buildings which is influenced by ventilation. Because people spend most of the time in residential buildings (Klepeis et al., 2001) and 60-90% of their life in indoor environments (homes, offices, schools, etc.) (Klepeis et al., 2001; European Commission, 2003; Brasche and Bischof, 2005; Zeghnoun et al., 2010; Jantunen et al., 2011), indoor air quality is a major factor affecting public health. Logue et al. (2011b) estimated that the current damage to public health from all sources attributable to IAQ, excluding second-hand smoke (SHS) and radon, was in the range of 4,000–11,000 μDALYs (disability-adjusted life years) per person per year. By way of comparison, this means the damage attributable to indoor air is somewhere between the health effects of road traffic accidents (4,000 μDALYs/p/yr) and heart disease from all causes (11,000 μDALYs/p/yr). According to the World Health Organization (WHO, 2014), 99,000 deaths in Europe and 81,000 in the Americas were attributable to household (indoor) air pollution in 2012.

Thus, by optimizing airflows where and when needs are higher, a smart ventilation system can truly improve IEQ while significantly minimizing energy consumption (Durier et al., 2018; Guyot et al., 2018a).

2 A MAJORITY OF VENTILATION REGULATIONS ARE PRESCRIPTIVE

IAQ performance-based approaches for ventilation at the design stage of a building are rarely used. Instead, prescribed ventilation rates have been used. As a result, standards and regulations, such as ASHRAE 62.2-2016 and others in Europe (Dimitroulopoulou, 2012), often prescribe ventilation strategies requiring three constraints on airflow rates:

1. A constant airflow based on a rough estimation of the emissions of the buildings, for instance one that considers size of the home, the number and type of occupants, or combinations thereof;
2. Minimum airflows (for instance during unoccupied periods);

3. Sometimes also provisions for short-term forced airflows to dilute and remove a source pollutant generated by activities as cooking, showering, house cleaning, etc.

3 PERFORMANCE-BASED APPROACHES FOR SMART VENTILATION

In order to conciliate energy saving and indoor air quality issues, interest for smart ventilation systems has been growing thanks to performance-based approaches. Such systems must often be compared either to constant-airflow systems ("equivalence approaches") or to fixed IAQ metrics thresholds.

A paper published in 2016 proposed a review of performance-based approaches used in 5 countries around the world for the assessment of smart ventilation strategies (Guyot et al., 2019, 2018b).

4 WHAT IS NEW IN 2024 ?

In our international context in 2024, IAQ and energy are still issues of interest. Nevertheless, other aspects should be included in the performance indicators. An efficient ventilation system should ensure the exchange of stale indoor air with fresh outdoor air, thus improving indoor environmental quality (IEQ), preventing the build-up of pollutants and excessive moisture or viruses, without needlessly wasting energy heating or cooling incoming air, taking into account environmental and climate changes (heatwaves, pollution peaks, pandemics, …).

Since 2016, new research has been published and collected, notably in the context of the IEA-EBC Annex 86 Energy Efficient Indoor Air Quality Management in Residential Buildings (2022-2025).

This new presentation gives an updated overview of how the performance-based concept has been used and developed in research projects since 2016, and how it has been transposed in standards and some regulations since.

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