Retrofitting and Ventilation: Challenges, Benefits and Lessons Learnt

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ABSTRACT

A significant challenge lies in decarbonising existing residential stock to meet higher energy performance standards, necessitating increased energy retrofit activity. Despite the importance of energy retrofits, challenges arise in maintaining indoor environmental quality. While positive air quality and health benefits have been reported through targeted energy-retrofit activities, there are also numerous cases where indoor pollutant concentrations increase post-retrofit. Ventilation is often directly or indirectly impacted by changes in airtightness and/or ventilation systems, and the introduction of new building materials/products. Addressing these challenges ensures energy retrofits contribute to reduced environmental impact while maintaining a healthy indoor environment. Highlighting several examples of case studies is anticipated to promote discussion on informing priorities regarding retrofit strategies.

KEYWORDS

Energy retrofit, radon, ventilation, IEQ

1 INTRODUCTION

The 2021 Glasgow Agreement highlighted the urgent need for global carbon emission reductions to avert a climate catastrophe. In response, various countries have established climate-neutral greenhouse gas emission targets for 2030 and 2050, including the European Climate Directive (Regulation 2021/1119/EU).

In Europe, buildings are reported as the single largest energy consumer sector, accounting for 40% of energy consumption and 36% of CO_2 emissions. A major challenge is decarbonising the existing residential stock by meeting higher energy performance standards and increasing renovation activity. The issue is further complicated due to the consequences of the renovation process on the health and well-being of residents, such as thermal comfort and indoor environmental quality (IEQ). The EU Energy Performance of Buildings Directive (EPBD) (Directive (EU) 2018/844) also states that "Measures to further improve the energy performance of buildings should take into account climatic and local conditions as well as indoor climate environment and cost-effectiveness".

Changes in a building's airtightness due to energy retrofit strategies can adversely impact IEQ. Ventilation is a critical aspect that affects IEQ and thermal comfort in buildings. However, while improving thermal efficiency reduces energy consumption, indoor environmental quality may become compromised if adequate ventilation is not maintained. Several studies have reported the challenges associated with increased pollutant concentrations following energy retrofits (Underhill et al., 2020, Földváry et al., 2017). For example, Du et al. (2019) investigated 37 Finish buildings in Finland and 15 Lithuanian buildings that underwent energy retrofits and observed a significant increase in BTEX concentrations post-energy retrofit. A study of 15 Irish dwellings reported that CO_2, VOCs, and $PM_{2.5}$ concentrations significantly increased post-retrofit and were correlated with lower building air exchange rates (Broderick et al., 2017), underperforming ventilation, and new building materials played a role in the increased pollution concentrations.

In addition to indoor-generated air pollutants, radon poses unique challenges in certain countries due to its geogenic radon potential. One French study reported that thermally retrofitted homes had a median radon concentration of 180 Bq/m^3 compared to 114 Bq/m^3 in non-retrofitted dwellings (Collignan et al., 2016). Computer simulations reported that radon concentrations could increase up to 107% in Irish dwellings post-renovation based on modest changes to the building's airtightness. While it was acknowledged that ventilation strategies could address increases in radon concentrations (McGrath et al., 2021).

Similarly, Tieskens et al. (2021) simulated the impact on indoor air quality resulting from energy renovations in multi-family housing complexes in Boston. They reported that incorporating increased ventilation into the renovation strategy offers opportunities to provide cost-effective interventions to address health disparities.

2 CONCLUSION

Despite the importance of energy retrofits, maintaining indoor environmental quality presents challenges. While targeted energy-retrofit activities have reported positive IEQ and health benefits, numerous cases show increased indoor pollutant concentrations post-retrofit. The scale of retrofit projects varies due to national considerations, building types, occupants' needs, and local conditions. Addressing these challenges is crucial to ensure that energy retrofits reduce environmental impact while maintaining a healthy indoor environment. The presentation will summarise case studies from the literature on the challenges, benefits, and lessons learnt from retrofitting and ventilation. Highlighting several case studies will promote discussion and inform priorities regarding effective retrofit strategies.

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