HEALTHY SAFE AND SUSTAINABLE INDOOR ENVIRONMENTS – MANAGING TRADE-OFFS FOR INDOOR AIR QUALITY AND NET ZERO GOALS

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As media attention over recent years has highlighted, air pollution has negative effects on health throughout the course of people's lives. Research shows this often exacerbates existing inequalities, with households in more deprived areas experienced higher levels of indoor air pollution.

Indoor air quality depends on the ingress of outdoor pollutants into the indoor environment; and air pollutants that are emitted indoors. Levels of indoor air pollution depend on factors such as:

- the quality of the building and provision of fresh air;
- where the building is located - near busy or congested roads, or industrial sites;
- indoor activities such as cooking, and heating;
- cleaning and personal care products that can emit pollutants.

Concentrations of these indoor pollutants can be increased by higher occupancy levels, and lack of adequate ventilation. But we know from the work undertaken by the National Engineering Policy Centre, a partnership of 42 professional engineering organisations that cover the breadth and depth of our profession, led by the Royal Academy of Engineering, during the COVID-19 pandemic that ventilation is not well managed in the UK. As it became clear that the COVID-19 virus spreads through aerosols and droplets in the air as well as close contact, the design and operation of buildings and transport infrastructure and the potential to ventilate them well, became public health and policy priorities. But we discovered the UK's infrastructure lacks infection resilience, that is, it was not well equipped to minimise transmission of COVID-19.

While managers of many buildings mobilised quickly to provide hand sanitiser, encourage the use of face coverings, and implement social distancing measures, it was not always easy to provide clean air for people to breathe. With windows painted shut, air-filtration systems not serviced to operate at full capacity and the need to maintain a comfortable temperature, there were few adequate systems in place to respond to changing ventilation needs. A series of evidentiary hearings with building owners and managers found that ventilation systems were often not preforming at the specifications it was designed to. This was considered to be a symptom of a general lack of priority given to buildings management, resulting in a reduced capacity and capability to respond rapidly to the public health crisis and compounded by limited research and regulatory capability to respond to the new demands.

This not only posed a risk to anyone using those spaces during the height of the pandemic but will continue to be a health risk even as the pandemic has waned. Poor indoor air quality can hinder concentration and cause poor sleep, for example. Alongside poor indoor air quality, a lack of adequate ventilation exposes people to harmful contaminants, exacerbating conditions such as asthma, or enabling the transmission of common colds and seasonal influenza. A social cost benefit analysis commissioned to support this work estimated that in the event of another severe influenza-type pandemic during the next 60 years, the societal cost to the UK could equate to £23 billion a year considering costs not only for healthcare but reduction in GDP, depression etc.[1] Even without the extreme circumstances of a pandemic, the report estimates that seasonal diseases cost the country as much as £8 billion a year in disruption and sick days.

The National Engineering Policy Centre report, "Time for a major upgrade", highlights eight actions to improve the health and sustainability of our indoor environments through regulations and standards that

apply throughout the life of a new or existing buildings, setting a clear baseline for what best practice in infection resilience looks like, and encouraging a commissioning process that ensures all buildings operate as they were designed to.[2]

While we expect our buildings to have water that is safe to drink, we may not consciously have that same expectation for clean air. The quality of indoor air is not monitored or reported like energy performance or food hygiene, and many buildings have no formal management in place to monitor this. COVID-19 has been a wake-up call about the importance of good ventilation and now remains an opportune moment to take steps to improve indoor air quality more broadly. It is vital that we raise awareness of good practice, making buildings that manage clean air well stand out. This will encourage action from others, allow individuals to assess their own risk, and help to ensure we can all play a role in maintaining healthy environments, from our homes to our workplaces.

This is not the first time that a major disease outbreak has required our built environment to evolve and adapt: cholera epidemics in the early 19th century drove the development of effective sewage systems; tuberculosis led to changes in building design to allow for more sunlight and air; and major outbreaks of legionella and *E. coli* in the UK resulted in regulatory reform on water treatment and food standards.

The UK is already working to transform the built environment and transport sector to meet the Net Zero targets enshrined in UK law. Measures that seek to improve energy efficiency – such as increased insulation and double glazing and reduced infiltration – may reduce the ingress of outdoor pollutants from nearby industry and traffic. However, these measures can allow accumulation of pollutants from indoor sources if there is not also adequate ventilation for indoor pollutants to leave the building and introduce fresh air. But with intelligent engineering design, or mechanical ventilation with heat recovery systems that reduce heat loss, we can achieve both. Even simple actions such as proper installation and maintenance of ventilation systems, and managing ventilation needs throughout the day, can help reduce energy demands. There is an opportunity to be seized by aligning UK decarbonisation strategies with improving the health of our indoor environments.

This needs to be supported by regulation. To create a culture shift, the prominence of health and wellbeing should be embedded across parts of the Building Regulations. Indoor environmental quality encompasses not only air quality, but also levels of light and noise pollution and thermal control, all of which have a direct impact on health, as well as implications for energy demand. To maintain standards of safe and healthy building performance over a building's lifetime, in-use regulations need to be established with local authorities. This needs to be accompanied by the capacity, skills, and capability for enforcement, as well as clear mechanisms to measure and publicly communicate compliance.

Much research has been done during the pandemic on air flows and ventilation to control the spread of the airborne COVID-19 virus. We must take the opportunity to integrate that learning with what we know about reducing emissions and fire safety to deliver buildings that are safe, healthy and sustainable – throughout their entire lifespan as well as on the drawing board.

References

1. NERA Economic Consulting (2022). *Infection Resilient Environments: Social Cost Benefit Analysis*, the Royal Academy of Engineering.
2. National Engineering Policy Centre (2022). *Infection resilient environments: time for a major upgrade*, Royal Academy of Engineering.