What Can Congress Do to Build Better Buildings?

Environmental and Energy Study Institute
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Room 485 Russell Senate Office Building

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While, as indicated, I am a scientist at Lawrence Berkeley National Laboratory, I am speaking to you today at the request of ASHRAE -- the society of 57000 professionals, most whom design, build, install, and maintain systems for heating, ventilating, air conditioning, and refrigeration in buildings. ASHRAE plays a key role in educating its members. It is a forum where competitors in business sit together, often with scientists like me at the table, to develop consensus standards and guidelines and to craft conference programs that improve professional practices. Among ASHRAE's many widely used standards are Standard 62 that specifies minimum outdoor air ventilation rates and other procedures for maintaining acceptable indoor air quality in buildings and Standard 90 for maintaining building energy efficiency.

ASHRAE has asked me to speak about the influence of indoor environmental quality on health and productivity. Via the term "indoor environmental quality", we refer to the environmental conditions inside buildings. The indoor temperature and humidity, the levels of pollutants in indoor air and on indoor surfaces, and the indoor lighting and acoustic conditions all influence indoor environmental quality. Indoor environmental quality is strongly influenced by outdoor environmental conditions, such as levels of outdoor air pollutants and the outdoor temperature and humidity. Because we spend, on average, 90% of our time indoors[1], for many outdoor air pollutants, most of our exposure occurs, not outdoors, but while we are indoors. The features of our buildings determine the extent to which our buildings shelter us from outdoor air pollutants. However, there are many sources of pollutants inside our buildings that contribute to indoor air pollution. These indoor sources include building materials and furnishings, many consumer products, cooking, tobacco smoking, pets, pests, and mold. Because of the presence of indoor sources, for many air pollutants, indoor levels far exceed outdoor levels.

Research from groups around the world, including my group, have found that indoor environmental quality affects people's health and productivity. As of 2014, about 25% of the US population and 14 million children were still exposed to secondhand tobacco smoke which is linked to sudden infant deaths, respiratory and ear infections, asthma exacerbation, heart disease, and lung cancer [2]. The concentrations of radioactive radon gas are usually many times higher indoors than outdoors. Radon causes an estimated 15 thousand to 22 thousand cases of lung cancer per year in the US [3]. Indoor allergens and chemicals that cause inflammation contribute to allergy and asthma symptoms[4, 5]. An estimated 8.3% of the US population, about 27 million people, have current asthma and a larger number are allergic.

Dampness and mold are common in our buildings and are associated with increases in several adverse respiratory health effects including cough, wheeze, and increased asthma[4]. It has been estimated that 21% of current asthma in the US is attributable to dampness and mold in US homes with an annual cost of $3.4 billion in 2004 [6]. Dozens of organic chemicals are released from the products we use in buildings, with new chemicals being introduced as new products come into use. Some of these chemicals are irritants, some increase the risks of cancer, some are suspected of increasing asthma, some may be harmless, but for many of these chemicals the health risks are unknown.

Research has shown that our performance of office work and school work are improved when we maintain a high level of indoor environmental quality. For example, we work better and make better decisions, when we maintain comfortable temperatures and provide higher rates of ventilation with outdoor air [7-10]. Schools need particular attention. Available data suggest that, on average, our elementary schools provide only about half of the minimum amount of outdoor air ventilation specified in codes[11]. Lower ventilation rates in schools are associated with increased student absence and diminished student performance, including diminished performance on standard academic achievement tests [11, 12]. Students in poorly ventilated schools are at a disadvantage.

Building energy efficiency and indoor environmental quality are linked. The available evidence indicates that building energy efficiency measures usually improve thermal comfort. However, in research, the effects of building energy efficiency on indoor air pollutant levels and on health outcomes has varied e.g., [13-16]. One of the most common and cost effective energy efficiency measures, sealing of the cracks and holes in building envelopes, can increase indoor levels of air pollutants emitted from indoor sources while also increasing our sheltering from some outdoor air pollutants. However, with proper attention to the limiting of indoor pollutant sources and to assuring adequate outdoor air ventilation, energy efficiency programs can simultaneously save energy and improve indoor environmental quality and health.

I like to think of our current indoor environmental quality situation as an opportunity for improved health and performance, and an opportunity for associated large financial benefits. For example, one of our analyses [17] projects net annual economic benefits of approximately $20 billion from increasing ventilation rates, avoiding high temperatures, and reducing dampness and mold in US offices. Another analysis points to an opportunity to reduce premature mortality by using better particle filtration systems in homes, with associated annual economic benefits ranging from a few hundred to more than a $1000 per person per year and with annual health-related economic benefits often exceeding annual costs by a factor of ten [18]. Improving particle filtration is US offices is projected to be even more cost effective [18] with health-related economic benefits exceeding costs by a factor of 70 to 120. By reducing the far too common low ventilation rates in our schools, we can improve student health and academic performance. While the specific estimates of economic benefits have a high level of uncertainty, there is little doubt about the opportunity for large net health and economic

benefits from improvements in indoor environmental quality in our buildings. We need to better quantify and demonstrate the opportunities but we also need to take better advantage of what we know today as we invest in buildings.

So what is the federal connection? All federal agencies have workers in buildings; consequently all should have an interest in maintaining good environmental quality in those buildings to assure worker comfort, health, and productivity. Many federal agencies have additional mission-related reasons to be concerned about indoor environmental quality. The Department of Energy, the EPA, NIOSH, and NIH have related research programs, albeit often very modest size programs. DOE promotes building energy efficiency which, as indicated, is linked with indoor environmental quality. EPA has an environmental protection mission and has related programs to educate stakeholders about indoor environmental quality. It also develops protocols that stakeholders, such as school districts, can use to help maintain indoor environmental quality. HUD has responsibilities for housing, included subsidized housing. The Department of Education seeks to maximize effectiveness of schools which requires that schools maintain good indoor environmental quality. The General Services Administration is responsible for many federally-owned or leased buildings. With sufficient resources and attention devoted to indoor environmental quality, each of these agencies can help us maintain comfortable, healthy, and productivity-enhancing conditions in US buildings.

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