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SUSTAIN-ABILITY

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CLIMATE CHANGE AND HEALTH

Low-energy strategies for indoor air quality

Before the COVID-19 pandemic, regular surveys showed that Americans were increasingly concerned about climate change. Over the past decade, the number of people apprehensive about the state of the environment rose by over 50 percent, according to Gallup.[1] When the pandemic hit, many experts assumed these anxieties would shift toward public health, since sociologists often find that worrying about one topic will diminish concerns for others—the "finite pool of worry" theory. In late April 2020, researchers at Yale and George Mason conducted a poll to test this. What they found surprised them: The portion of people saying they were still worried about climate change was two-thirds—matching the all-time high.[2] During an unprecedented public health and economic crisis, climate change still looms large in Americans' minds.

In retrospect this should not be surprising, given the links between climate change and COVID-19. According to many scientists, climate change is dramatically undermining biodiversity through deforestation, altered habitats, and diminished resources, giving rise to novel viruses and creating conditions that allow diseases to spread more readily. Additionally, people are more susceptible to contracting COVID-19 if they live in places with poor air quality, which is exacerbated by the greenhouse gas emissions that cause climate change.[3] Rising atmospheric temperatures increase ground-level ozone and/or particulate matter air pollution, which is associated with many health problems, such as respiratory ailments.[4]

INDOOR AIR QUALITY AND CLIMATE

Americans spend 90 percent of their time indoors, where the concentration of pollutants can be two-to-five times higher than outdoors.[5] Dwelling in environments with poor indoor air quality (IAQ) can have immediate effects, such as irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue, as well as long-term health impacts, including respiratory diseases, heart disease, and cancer.[6] Poor IAQ also has been linked to hindered cognitive ability.[7]

The COVID-19 pandemic has put more focus on IAQ, with millions isolated in their homes. Recent research shows that people frequently exposed to air pollution are more susceptible to contracting the disease, which readily affects those with preexisting health conditions.[8] An earlier study of the severe acute respiratory syndrome coronavirus (SARS-CoV) found connections between air pollution levels and mortality rates.[9] And, while physical contact initially was thought to be the primary means of spreading COVID-19, scientists and public health

Passively ventilated atrium, San Diego County North Coastal Live Well Health Center, HMC Architects

> Human health and planetary health are bound together. Protecting the Earth protects us.

agencies now are warning of the risk of airborne transmission, especially in environments with poor IAQ.[10]

Frequently diluting indoor air with fresh air from the outdoors is vital, but this often requires relatively large amounts of energy. While ventilation itself consumes only about four percent of the energy used in the average building, heating and cooling the outdoor air takes more than seven times that amount, accounting for nearly a third of a building's energy use.[11]

Since the building sector contributes the lion's share of annual carbon emissions,[12] reducing its reliance on fossil fuels can address both climate and public health at the same time. However, many architectural proposals for addressing COVID-19 actually rely on higher energy consumption. For example, a commonly recommended strategy is to address physical distancing by increasing the amount of square foot per person in buildings. It has been estimated that to accommodate a six-foot person-to-person radius in buildings requires about 11 percent of additional area to house the same number of people.[13] This extra space would require more energy for heating, cooling, and lighting, as well as more materials, which take energy to produce. HMC estimates that if every commercial building in America grew by 11 percent, the result would be nearly 100 million metric tons of additional annual carbon emissions, the equivalent of an extra 21 million cars on the road or 17 million homes' worth of electricity. (See APPENDIX.)

IF EVERY COMMERCIAL BUILDING IN AMERICA added enough square footage to accommodate standard physical distancing recommendations, the result would be nearly 100 million metric tons of additional carbon emissions, the equivalent of an extra 21 million cars or 17 million homes.

Ironically, if novel viruses are caused by or at least related to climate change, energy-intensive solutions aggravate those very causes, potentially creating a vicious cycle. Similarly, a common response to the 1970s energy crisis was to seal buildings and decrease the volume of air flow, which saved energy but also impaired IAQ by accumulating mold, dust, and particulates. Health problems among occupants of new buildings became increasingly frequent. In 1984, the World Health Organization (WHO) dubbed this common malady "sick building syndrome" (SBS) and estimated that some 30 percent of new or newly renovated buildings suffered from it.[14] In short, strategies to address the energy crisis essentially created a health crisis. Today, we risk the reverse: Attempts to alleviate COVID-19 could worsen the built environment's climate impact.

STRATEGIES

To avoid these unintended consequences, it is imperative to develop low-energy strategies for promoting public health. A number of options

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are available to improve indoor air quality while reducing energy consumption and costs.

Conduct an air quality test. An easy first step is to measure the air quality. Many companies offer services using equipment to measure carbon monoxide, particular matter, volatile organic compounds, and other substances. Once you identify if there are problems, improving IAQ and energy could be as simple as replacing filters or fine-tuning the HVAC systems, or replacing certain materials, finishes, and furnishings. Consult a qualified expert to ensure that the building is operating in the most effective way.

Conduct an energy audit. Careful review of a building's energy use can reveal whether it is performing efficiently. This can include utility reviews, benchmarking with comparable buildings in the area, on-site analysis, and computer simulations. An audit generally can identify ways to lower energy use by 10 to 40 percent.[15]

Replace older systems. The average commercial building in the U.S. is about 50-years-old, and many are much older.[16] Older HVAC systems are far less energy efficient than newer systems. Current systems use 30 to 50 percent less energy to produce the same amount of cooling as air conditioners made in the mid-1970s.[17]

Convert your system. Some HVAC systems are more efficient than others. For example, switching from a Constant Volume (CV) to Variable Air Volume (VAV) can reduce annual energy use by 10 to 21 percent.[18] However, because VAV systems by definition do not supply constant airflow, some types can hinder IAQ if not coupled with other strategies.[19] Consult a qualified MEP engineer to develop an effective system.

Passive ventilation. Passive ventilation induces air movement by capturing breezes through openings in the envelope or by taking advantage of differences in temperature and air density in a space. A study of office buildings in China found that passive ventilation can cut cooling energy by as much as 78 percent.[20] Natural airflows are unpredictable, so often this strategy is coupled with fan assist or other mechanical devices.

Open spaces. The U.S. Environmental Protection Agency (USEPA) recognizes open work plans as a standard strategy for saving energy, because fewer partitions make it easier to distribute artificial light and mechanical air at lower quantities with less equipment.[21] But open space also allows natural light and outside air to spread more easily, lowering dependence on electrical systems. Many smart office buildings require no artificial lighting at all during the day, and this simply cannot be achieved with too many walls. Studies show that open workspaces can be more than twice as efficient with energy than closed offices, because fewer partitions make it easier to move air around.[22]

Use on-site renewable energy sources. Many states, including California, are setting ambitious targets for energy efficiency. The California Energy Efficiency Strategic Plan calls for all commercial buildings to be net-zero energy by 2030.[23] Solar energy is cheaper than ever. Over the past decade, installed prices for photovoltaics have fallen about 75 percent.[24]

APPENDIX: CALCULATING THE ENERGY IMPACT OF PHYSICAL DISTANCING

The U.S. Energy Information Administration (EIA) regularly conducts a national sample survey to collect information on the stock of U.S. commercial buildings, including their energy-related building characteristics and energy usage data. This database, the Commercial Buildings Energy Consumption Survey (CBECS), is released every several years. The latest, conducted in 2018, is in the process of being finalized and will be reported later this year (2020). The two most-recent previous reports were in 2012 and 2003.

According to the 2012 CBECS, in the U.S. that year there were 5.6 million commercial buildings, comprising 87 billion square feet of floorspace.

This total area represents a 21 percent increase since the previous calculation (2003), or a two percent annual increase.[25] If that trend continued, today the total commercial stock could be 100 billion square feet.

The U.S. Fire Administration calculates that accommodating physical distancing with a personal radius of six feet could add 11 percent to buildings. (See previous note.) Adding 11 percent to every commercial building in America would increase the building stock by some 11 billion square feet.

In the U.S., the carbon emissions for a typical commercial building can be 20 pounds per square foot.[26] Applying this to 11 billion square feet yields a total additional emissions of 220 billion pounds, or 100 million metric tons.

According to the USEPA's Greenhouse Gas Equivalencies Calculator, this tonnage is the equivalent of over 21 million cars or the electricity of 17 million homes.[27]

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For additional questions, contact:

Lance Hosey
Design Principal / Chief Impact Officer
lance.hosey@hmcarchitects.com

Eera Babtiwale
Associate Principal /
Vice President of Sustainability
eera.babtiwale@hmcarchitects.com