



# INSIGHTS INTO HEALTHIER INDOOR ENVIRONMENTS: HIGHER EDUCATION

The COVID-19 pandemic has presented significant challenges for colleges and universities. While the health and safety of students and staff remain the top priority, these concerns must be weighed against financial and societal pressures to provide in-person experiences. With the right strategies in place, institutions of higher education (IHEs) can address these challenges moving forward and create healthier and more resilient college and university campuses that support human health, well-being and performance.

## THE NEED

Globally, enrollment in IHEs more than doubled between 2000 and 2014<sup>1</sup> with about 19.7 million students expected for fall 2020 in the U.S. alone.<sup>2</sup> Higher education provides tremendous value to society, and the campus environment plays a direct role in the overall success of these institutions. The need to provide a safe, on-campus experience has never been more pressing, and to do that, IHEs must consider health when updating aging campus buildings and infrastructure.



**The average age of IHE buildings in North America is 37.5 years.** But the vast majority of IHEs continue to invest the most in new facilities, while underestimating the renovation needs of deteriorating spaces.<sup>3</sup>



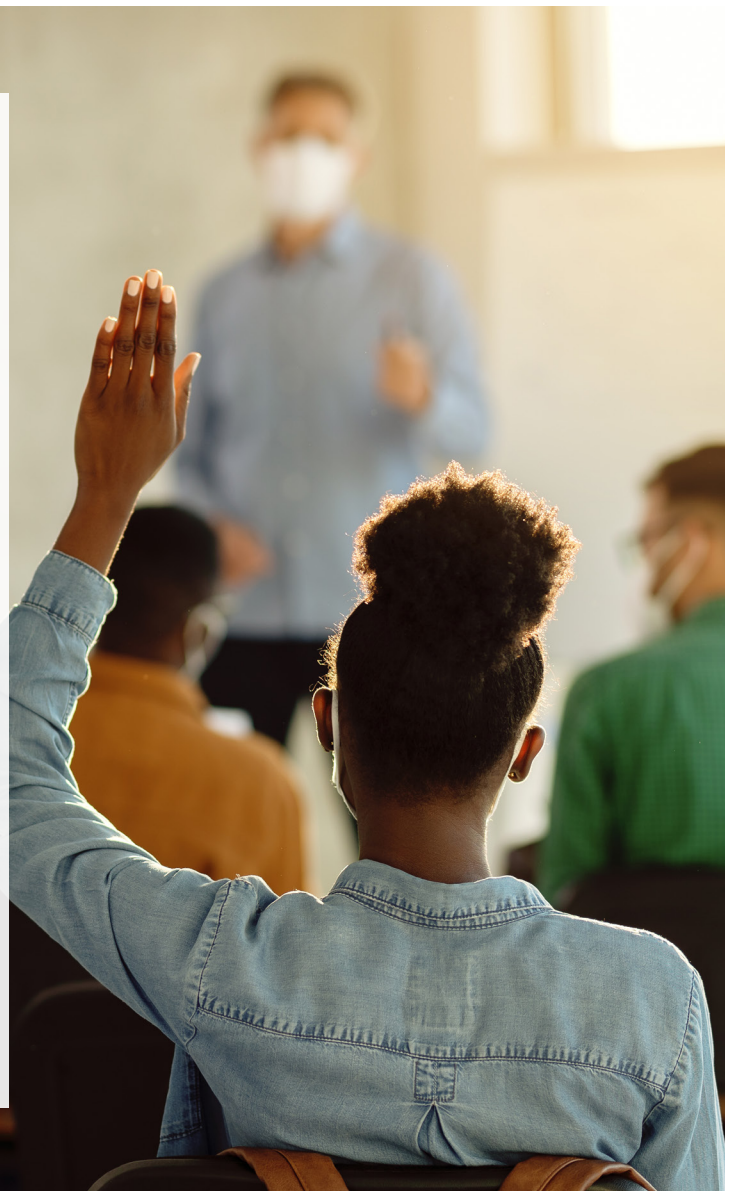
In response to the COVID-19 pandemic, **over 1,100 colleges and universities shifted to online instruction only** in March 2020 in the U.S. alone, canceling major in-person events and graduation ceremonies.<sup>4</sup>



The public health and societal costs of closures impact local economies and the lives of millions of students, faculty and staff. **Closures have resulted in decreased academic achievement, sedentary lifestyles, an inability to connect with others** and even legal action for refunds on tuition and other costs.



With IHEs as major employers, livelihoods are also at stake. **In 2018, almost 4 million people in the U.S. were employed by postsecondary institutions.**<sup>5</sup>



## THE QUANTIFIABLE BENEFITS OF HEALTHIER HIGHER EDUCATION

Students, faculty and staff at IHEs spend more than 90%<sup>6</sup> of their time indoors in a wide variety of campus settings – dormitories, lecture halls, research laboratories, administrative offices and more. Creating healthier campus buildings, especially with respect to ventilation and air quality, will yield resilient environments that protect students and staff from future infectious respiratory disease outbreaks and improve overall student health, well-being and performance.



### HEALTH AND INFECTION CONTROL



The rate of acute respiratory infections **decreased from 43% in low-ventilation dormitories to 2.1% in the high-ventilation dormitories.**<sup>7</sup>



A study in Chinese dormitories found that a doubling of occupant density resulted in a **twofold increase in the students that reported episodes of illness.**<sup>8</sup>



### STUDENT PERFORMANCE



Controlled exposure to CO<sub>2</sub> during sleep in a field intervention experiment showed that objective measures of **sleep quality, as well as performance in a grammatical reasoning test, were improved** in the study arm with low average CO<sub>2</sub> levels (~660 ppm) versus the high CO<sub>2</sub> arm (~2,585 ppm).<sup>9</sup>



**Poorly ventilated classrooms showed a 5% decrease in “power of attention,”** roughly equivalent to the impact that a student might feel if skipping breakfast.<sup>10</sup>



Taking an exam on a **90°F day versus a 75°F day would result in a 12.3% likelihood of failing.**<sup>11</sup>



Among young and healthy college-age students living in air-conditioned (AC) and non-air-conditioned spaces, **the non-AC group experienced a 6.3% performance decrement and a 13.4% slower reaction time.**<sup>12</sup>

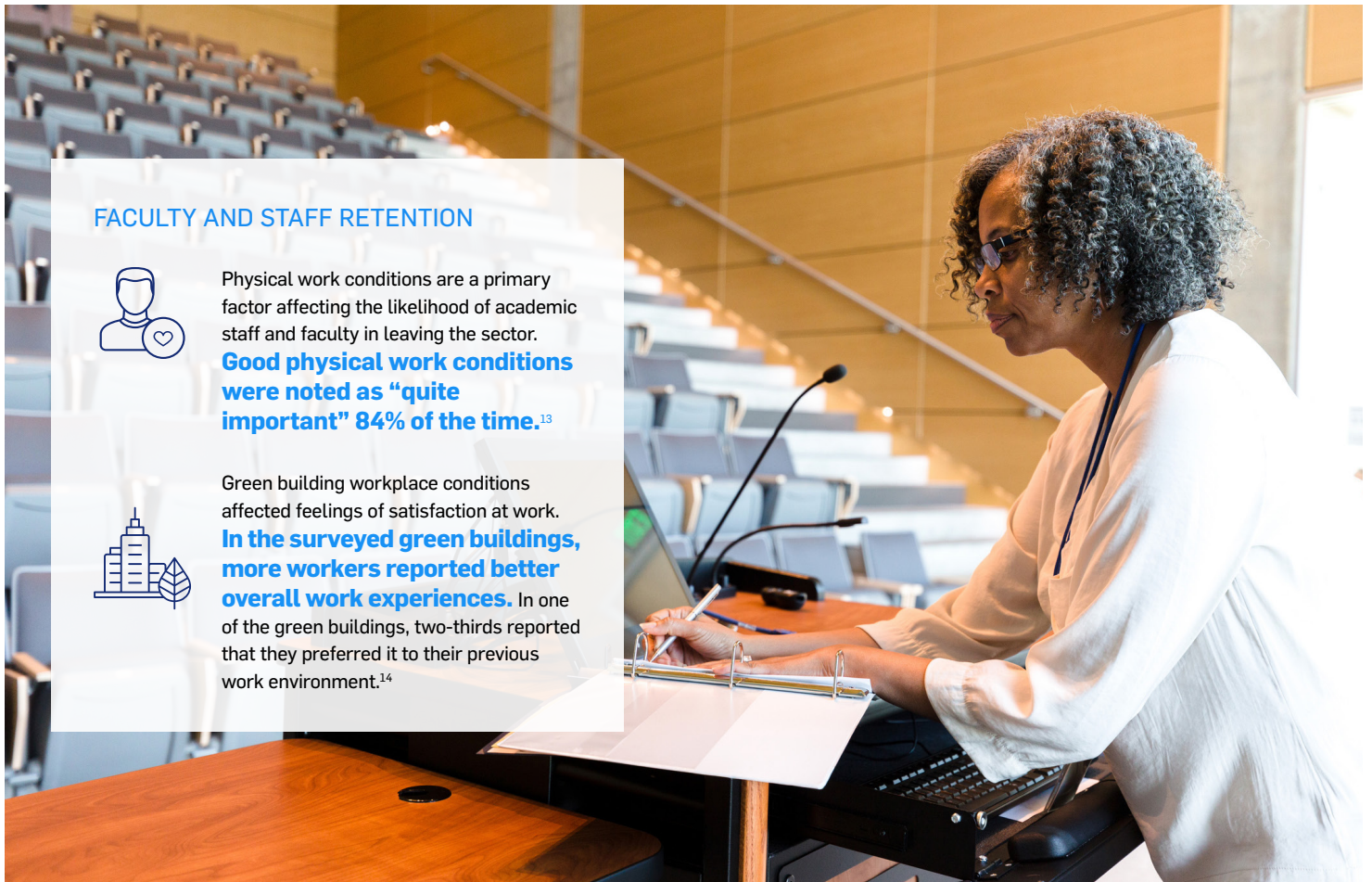
### FACULTY AND STAFF RETENTION



Physical work conditions are a primary factor affecting the likelihood of academic staff and faculty in leaving the sector. **Good physical work conditions were noted as “quite important” 84% of the time.**<sup>13</sup>



Green building workplace conditions affected feelings of satisfaction at work. **In the surveyed green buildings, more workers reported better overall work experiences.** In one of the green buildings, two-thirds reported that they preferred it to their previous work environment.<sup>14</sup>





## ASSESSMENTS

### ACTIONABLE STRATEGIES AND SOLUTIONS

Carrier Healthy Buildings capabilities can support IHEs throughout a building's life cycle, from performing health and safety assessments to upgrading building technologies and enhancing operations for optimal performance.

## OPERATIONS

## UPGRADES



## VENTILATION

### Strategies

- **Prioritize maximizing fresh air delivery rates to achieve 30 cfm/person.** Occupancy loads can also be decreased to achieve recommended air delivery rates per person.
- **Eliminate or reduce air recirculation** (thus maximizing fresh outdoor air) to the extent possible.

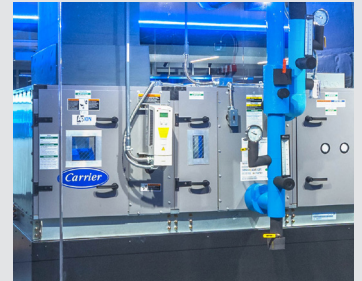
### Solutions

- **Automated Logic WebCTRL® building automation system** is the hub for intelligent integrations of technologies throughout a building. From heating,



ventilating and air-conditioning systems to security and access control to fire, lighting and more, WebCTRL enhances efficiency through greater visibility and control of all building systems.

- **Carrier AglON®-coated 39M air-handling unit** provides clean, long-lasting anti-microbial protection by resisting the growth of microbes on the equipment's interior panels.



## FILTRATION

### Strategies

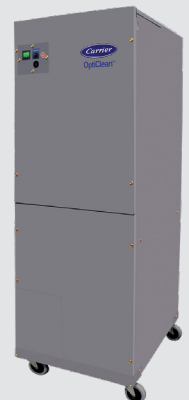
- In buildings with mechanical ventilation systems, **existing filters can be upgraded to filters with efficiency ratings of at least MERV 13 or the highest MERV rating the system can handle.**
- **Portable air cleaners with high-efficiency particulate air (HEPA) filters may be useful to reduce exposures** to airborne droplets and aerosols emitted from infectious individuals in buildings.

### Solutions

- **Carrier filtration** technologies include various MERV filters, HEPA filters for particulate matter and Infinity™ electrostatic filters for airborne pathogens. Carrier also offers devices using UVC light, which are intended to target viruses, and UV photocatalytic oxidation to help remove volatile organic compounds and improve indoor air quality (IAQ).



- **The Carrier OptiClean™ air scrubber** helps clean contaminated air and removes airborne particles with HEPA filtration.\* An easy way to supplement an HVAC system without replacing or modifying existing equipment, OptiClean plugs into a standard outlet and can be easily rolled into place in classrooms and other areas of a college campus.
- **Electrostatic filters** use static electricity to catch particles as they pass through the filter and help protect buildings from harmful microscopic particles.



\*HEPA filter is 99.97% effective for particles that are 0.3 microns or larger.



## CONTROLS AND SERVICES

### Strategies

- **Campuses should not shut off or reduce their mechanical ventilation** during or before regular learning hours while there still may be people in the building.
- **IHEs can ensure that there is adequate ventilation and filtration through a process of commissioning and testing.** Commissioning and testing should be performed by trained individuals and should be performed at regular intervals throughout each semester.
- **Testing can be done through the use of low-cost IAQ monitors.** If CO<sub>2</sub> concentrations are measured at levels below 1,000 ppm while campus facilities are occupied, then the outdoor air ventilation is likely performing according to acceptable minimum standards. Higher CO<sub>2</sub> concentrations may indicate that other strategies for increasing outdoor air ventilation are necessary.
- To promote healthy indoor environments, real-time monitoring for a variety of pollutants and IAQ parameters, including (but not limited to) carbon monoxide, ozone, volatile organic compounds, formaldehyde and other aldehydes, temperature, humidity, noise and light, is recommended.

### Solutions

- **Remote Airside Management** provides continuous validation of IAQ parameters, periodic checks of equipment health and continuous airside commissioning, enabled by a 24x7 command center.
- **Remote Energy Management** connects HVAC and other building systems to provide advanced cloud-based analytics that help optimize energy efficiency, equipment uptime, occupant comfort and operational productivity. Carrier's digital services are based on actionable insights by the EcoEnergy Insights CORTIX™ building IoT platform.
- **FireWorks® Incident Management Platform** functions as a remote monitoring and control system for stand-alone buildings and expansive campuses alike, and is ready to provide coordinated, timely communications during threats in environments.
- **Carrier's best-in-class BluEdge service platform** offers IAQ assessments, wellness services, retro-commissioning and more. As a result, campuses can operate at their peak performance, providing lower energy and maintenance costs and a more productive, healthier building environment.
- IHEs should implement **multi-parameter IAQ monitoring** to baseline performance, identify deficiencies and enable demand control ventilation for specific contaminants of concern. IAQ monitoring can also confirm the effectiveness of filtration and air purification in the building.



## TOUCHLESS PRODUCTS

### Strategies

- **No-contact infrastructure** is an engineering control method used to **reduce the indirect spread of pathogens** from fomites. This includes technologies such as automatic dispensers of hand soap/hand sanitizer/paper towels, automatic toilet flushers, hands-free garbage cans and **automatic doors**.

### Solutions

- **BlueDiamond™ touchless access** enables building occupants to eliminate a significant number of access touch points through implementation of industry-leading mobile credentialing technology, supporting a healthier and safer building.



## THE BOTTOM LINE

The health and safety of students and those who educate them have always been critically important. Now, there's a sense of urgency to introduce strategies and solutions that can protect campus building occupants immediately while yielding benefits for the long term.

**“Regarding return on investment of energy, the productivity, health and absenteeism that is a result of poor IAQ should not be underestimated – a student’s ability to breathe quality air in school is foundational to their ability to learn.”**

**-U.S. Environmental Protection Agency**

To learn more about healthy buildings solutions and strategies for higher education, connect with a Carrier expert today.

<sup>1</sup> UNESCO (2017)

<sup>2</sup> National Center for Education Statistics (2020)

<sup>3</sup> Sightlines (2017)

<sup>4</sup> Smalley (2020)

<sup>5</sup> U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary

Education Data System (IPEDS)

<sup>6</sup> Klepeis et al. (2001)

<sup>7</sup> Zhu et al. (2020)

<sup>8</sup> Sun et al. (2011)

<sup>9</sup> Strøm-Tejsten, Zukowska, Wargocki and Wyon (2015)

<sup>10</sup> Coley et al. (2007)

<sup>11</sup> Park et al. (2017)

<sup>12</sup> Cedeño Laurent et al. (2018)

<sup>13</sup> Metcalf, Rolfe, Stevens and Weale (2005)

<sup>14</sup> Hedge, Miller and Dorsey (2014)

