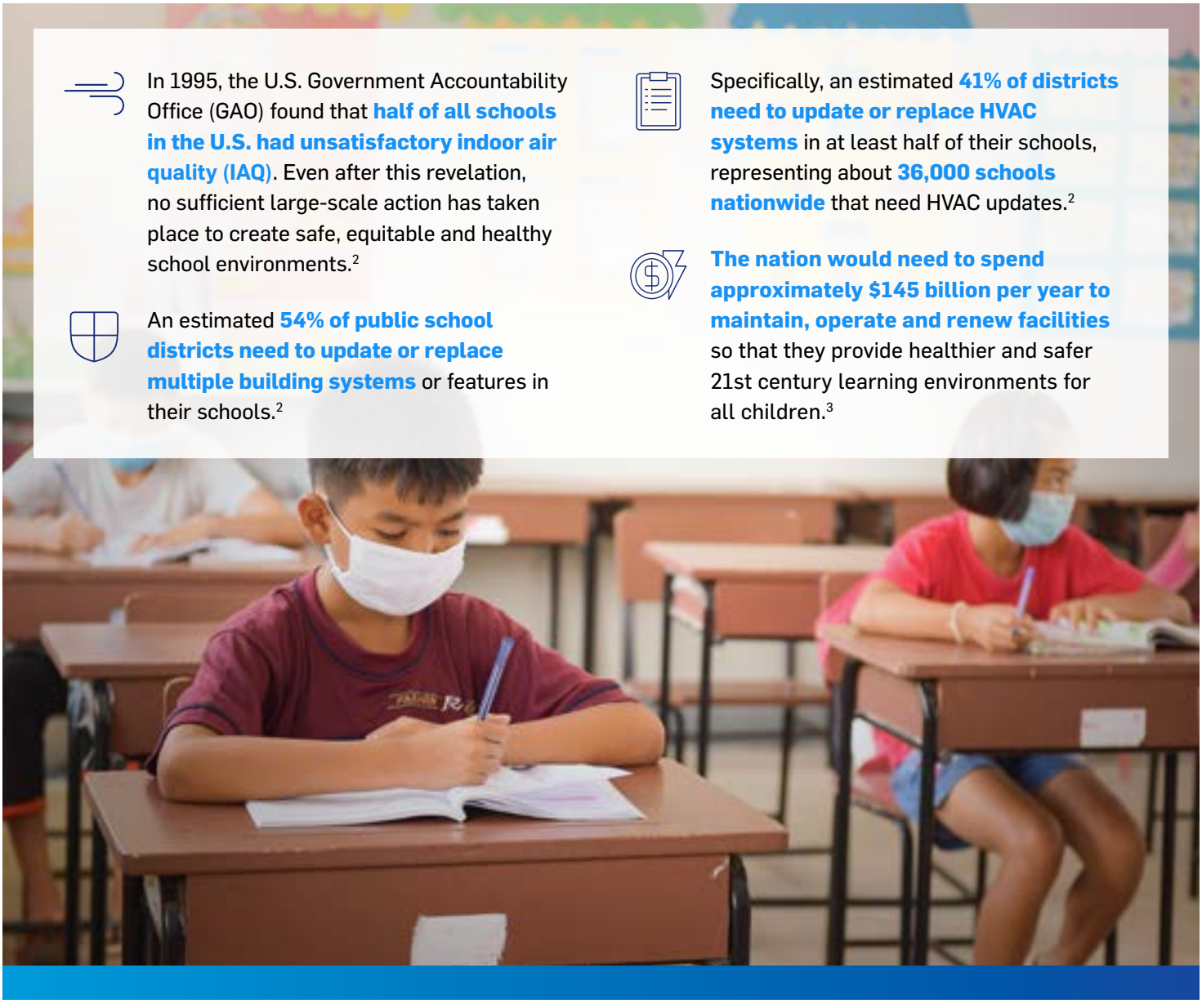
INSIGHTS INTO HEALTHIER INDOOR ENVIRONMENTS: K-12

The COVID-19 pandemic increased the focus on the health and safety of students, teachers and staff in schools around the world. Many school districts are now challenged with improving the indoor environment in buildings that were not designed with health in mind. With the right strategies in place, a healthier indoor environment can have a significant impact on the well-being and performance in K-12 schools, which provide what is commonly known as basic education.

THE NEED

Before COVID-19, every school day, nearly 50 million students and 6 million adults were working and learning in approximately 100,000 buildings across the United States.[1] And while there's a renewed focus on the health and safety of schools, the global pandemic has also brought to light long-standing deficiencies and needs for upgrades.



In 1995, the U.S. Government Accountability Office (GAO) found that **half of all schools in the U.S. had unsatisfactory indoor air quality (IAQ)**. Even after this revelation, no sufficient large-scale action has taken place to create safe, equitable and healthy school environments.[2]

An estimated **54% of public school districts need to update or replace multiple building systems** or features in their schools.[2]

Specifically, an estimated **41% of districts need to update or replace HVAC systems** in at least half of their schools, representing about **36,000 schools nationwide** that need HVAC updates.[2]

The nation would need to spend approximately $145 billion per year to maintain, operate and renew facilities so that they provide healthier and safer 21st century learning environments for all children.[3]

THE QUANTIFIABLE BENEFITS OF HEALTHIER SCHOOLS

By high school graduation, children and adolescents will have spent approximately 15,600 hours in school.[4] The well-being of students is directly tied to the health of their learning environments. In fact, research shows that making school buildings healthier, especially with respect to ventilation and air quality, will yield resilient schools that are more prepared to support students in future outbreaks and improve overall student well-being and performance.

HEALTH AND INFECTION CONTROL

For every room air change per hour (ACH) increase in schools, there was a **12% decrease in sick days.**[5]

Modeling showed that infection control strategies could **cut the average number of measles infections in students in a school building in half** when in combination with advanced air filtration, ventilation and purification.[6]

STUDENT PERFORMANCE

Poorly ventilated classrooms showed a 5% decrease in "power of attention," roughly equivalent to the impact that a student might feel if skipping breakfast.[7]

Taking an exam on a **90˚F day versus a 75˚F day would result in a 12.3% likelihood of failing.**[8]

STAFF RETENTION

Educational employees report **the highest proportions of work-related asthma cases in the United States.**[4]

Facility quality is an important predictor of the decision of teachers to leave their current position.[9]

ACTIONABLE STRATEGIES AND SOLUTIONS

There is no single strategy for schools to minimize the risk of airborne transmission of infections and create safer and healthier environments. Instead, a layered defense strategy should be implemented, where multiple interventions such as physical distancing, barriers, enhanced cleaning and disinfection procedures, and schedule and behavioral changes are combined simultaneously. Here, we'll focus on specific areas in which Carrier technologies can support K-12 customers.

VENTILATION

Strategies

- **Six air changes per hour in classrooms is an ideal goal,** while five is still a meaningful improvement above current ventilation rates in most classrooms.
- Buildings should **eliminate or reduce air recirculation – improving the intake of fresh outdoor air – to the greatest extent possible.**

Solutions

- Our **WeatherMaker® rooftop unit (RTU)** can improve the intake of fresh outdoor air, providing a reliable, flexible and energy-efficient solution for healthier indoor environments.
- **Carrier's Agion-coated 39M air-handling unit** provides a cost-effective improvement by inhibiting bacterial and microbial growth on the interior of the unit.

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 particles.

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 pathogens, and UV photocatalytic oxidation to help remove volatile organic compounds and improve IAQ.

- **Carrier's OptiClean™ air scrubber** uses HEPA filtration to provide cleaner indoor air.* 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 school.
- **Needlepoint bipolar ionization** (NPBI) improves air quality by introducing ions into the airflow that attach to particles, making them easier to filter.
- **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

- Buildings should not shut off or reduce their mechanical ventilation during or before school, or after school hours while there still may be people in the building.
- Schools can focus on **enhancing 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 the school year.
- Schools should **improve the ventilation rates using advanced controls** to increase outdoor air flows without compromising comfort while minimizing energy consumption at the same time.

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 CORTIX™ building IoT platform.
- **Carrier's best-in-class BluEdge service platform** offers indoor air quality assessments, wellness services, retro-commissioning and more. As a result, schools can operate at their peak performance, providing lower energy and maintenance costs and a more productive, healthier building environment.
- Schools should implement **multi-parameter IAQ monitoring** to baseline performance, identify deficiencies and enable demand control ventilation for specific contaminants of concern.
- **IAQ monitoring** provides continuous monitoring to identify IAQ issues and help 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 help provide cleaner environments to support school 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 child'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 K-12 schools, connect with a Carrier expert today.

[1] Filardo, Gutter and Rowland (2016)
[2] U.S. Government Accountability Office (2020)
[3] USGBI's Center for Green Schools
[4] Harvard Healthy Buildings Program (2017)
[5] Kolarik et al. (2016)
[6] Azimi, Keshavarz, Cedeno Laurent and Allen (2020)
[7] Coley et al. (2007)
[8] Park et al. (2016)
[9] Buckley et al. (2004)

The 9 Foundations of a Healthy Building, Allen, J.D., https://9foundations.forhealth.org