



HVAC Choices for Student Health and Learning

6 Benefits of Modern HVAC Systems

A Research Brief for Educators, Decision-Makers & Advocates

In the U.S., each year children aged five to 18 spend more than 1,000 hours inside school buildings, where their opportunities to thrive and learn are shaped by the indoor environment. In fact, a substantial body of research links air quality, temperature, and humidity to student health and learning outcomes.

To safeguard their indoor air, most schools rely on heating, ventilation, and air conditioning equipment – an HVAC system – to perform three essential functions:

- **Ventilation:** cycling air between indoor and outdoor spaces;
- **Filtration:** removing airborne pollutants and contaminants;
- **Conditioning:** heating, cooling, and regulating humidity.

Many schools today rely on legacy HVAC equipment that leaves them vulnerable to the challenges of transmissible disease, extreme weather, and volatile fossil fuel prices. A better alternative for almost any school is an all-electric, high-performance HVAC system employing a heat pump with advanced filtration and ventilation. Here is how these efficient and cost-effective modern systems promote health and safeguard students' opportunity to learn.

Modern HVAC Systems Reduce Pollution & Improve Air Quality

A signal advantage of all-electric HVAC systems is this: they do not release harmful particulates and gas by burning fossil fuels. These pollutants, when vented by legacy equipment onto school grounds and into the community, harm children's health. And they can infiltrate back indoors, degrading classroom air quality. All-electric HVAC systems break this vicious cycle. Modern systems also incorporate high-performance filters, and they can be paired with advanced ventilation technologies to further regulate indoor air quality. Combined with electric water heaters, kitchens and bus fleets, a modern HVAC system can be the centerpiece of a healthy, combustion-free campus.

Modern HVAC Systems Protect Students' Health & Safety

Because they use no fossil gas, all-electric HVAC systems also eliminate the risk of gas leaks. Methane, the main ingredient in fossil gas, is highly flammable. And when methane builds up in a confined space, it's explosive. Another danger arises from carbon monoxide, a gas produced when fuel burns incompletely. Invisible and odorless, carbon monoxide can cause illness, even death. Every year, gas leaks in schools trigger emergency evacuations – and that's a best-case scenario. Worse are fires linked to fossil fuel combustion, a main cause of property damage and injuries on U.S. school campuses. All-electric HVAC systems minimize these hazards.

Modern HVAC Systems Use Energy Efficiently & Reduce Operating Costs

The superiority of modern HVAC is especially clear when it comes to heating, where efficiency is rated by dividing a system's heat output by the amount of power it uses to produce the heat. 100% efficiency means the system produces exactly as much heat-energy as it con-

Photo by Allison Shelley/The Verbatim Agency for EDUimages





Photo by Allison Shelley/The Verbatim Agency for EDUimages

sumes in the form of gas or electricity. 200% means twice as much heat as power. A standard legacy HVAC system, employing a gas furnace, operates at around 80% efficiency, but a modern system using an electric heat pump routinely runs at 300-400% efficiency, and can run as high as 600%. Greater energy efficiency translates directly to cost savings. And, schools can further reduce costs by deploying advanced ventilation equipment that reduces the need to warm or cool the air to maintain thermal comfort.

Modern HVAC Systems Answer an Increased Need for Cooling

The seamless capability of modern HVAC systems to provide warming or cooling is a major benefit because, as the planet warms, schools in all climate zones are finding they need to provide more cooling, more often, over more of their floor space. In historically mild climate zones, schools not equipped with cooling systems now require them. In historically warm zones, extreme heat waves are beginning to overwhelm legacy central air conditioning systems, forcing schools to shut down. Just to meet these current needs, nearly 27,000 U.S. schools must install new HVAC or upgrade their systems. As historically extreme weather continues to be more common everywhere, in all seasons, schools everywhere will need to adapt. A modern heat pump system answers these challenges, as it allows schools to maintain comfortable indoor temperatures under a wide range of circumstances.

Modern HVAC Systems Support Energy Resilience

A hard lesson learned from the COVID-19 pandemic highlights another, potentially major benefit of modern HVAC systems: they can help minimize disruptions that lead to trauma and learning loss for students. They can do this by enabling schools to stay open and safe when the surrounding community experiences a disruptive environmental event such as extreme heat or concentrated pollution – from a wildfire, for example – or when local power goes out. With climate change, extreme events are becoming more common, and so are power outages; in fact, outages are twice as likely today as they were in 2000, and they tend to last longer. Schools running all-electric HVAC systems are in a position to install solar power and battery storage on site, providing either primary or backup power to sustain their operations during an outage. Schools that stay open not only shield their students from disruption; when disaster strikes, they can also be places of refuge for the community.

Modern HVAC Systems Position Schools as Part of the Climate Solution

The U.S. has joined the global campaign to reduce greenhouse gas emissions, a commitment that is driving innovation across every sector of business and society. Climate advocates have raised the call to “electrify everything” from cars and buses to buildings and the power grid itself. State and local governments are enacting building performance standards to reduce emissions from construction and operations. In this context, switching from legacy equipment such as gas-fired boilers to all-electric, high-performance HVAC systems may be the single most impactful action schools can take to reduce their emissions, comply with emerging regulations, and position themselves, appropriately, as champions for the health and prosperity of future generations. Conversely, to continue operating inefficient legacy systems means imposing social costs – disrupted student attendance, increased healthcare needs, accelerated teacher turnover, and other harms – on their own school communities.

All information in this brief is cited in the full report, [*HVAC Choices for Student Health and Learning: What Policymakers, School Leaders, and Advocates Need to Know*](#), by Emma Hines (RMI) and Sara Ross (UndauntedK12). The full report also includes charts and illustrations, a glossary of key terms, and other practical resources.

