



# HVAC Choices for Student Health and Learning

## Key Impacts & Big Ideas

### 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. Schools can meet these challenges by investing in modern technology. Here are the big ideas that every education system leader and stakeholder engaging on the topic of improving school HVAC systems should understand.

#### Modern HVAC Systems Move Heat Rather Than Making It

While legacy HVAC systems burn fossil fuels to make heat, modern HVAC systems operate much more efficiently by moving heat. This is accomplished most commonly with a heat pump. When in heating mode, the pump moves heat from an external source – the air, water, or ground – and transports it indoors. In cooling mode, the system operates in reverse, expelling heat from indoors to outdoors. Heat pumps are not a new technology, but advances in their design and engineering now make it possible for pumps to operate efficiently and effectively in all climates, and in facilities of all types and sizes. Importantly, heat pumps do not rely on fossil fuel combustion to generate heat.

#### Modern HVAC Systems Enable Cost-Effective Ventilation in Any Climate

Modern HVAC systems can be configured to provide healthy ventilation in all climates. In a hot and humid climate, for example, an HVAC system can be geared to regularly flush stale indoor air and replace it with filtered, preconditioned outdoor air. In a variable temperate climate, however, HVAC can cycle-in outdoor air only when temperature and humidity conditions are favorable. In any case, a modern HVAC system can be set up and adjusted to minimize the energy required for ventilation, often using demand controls or sensors to match the rate of ventilation to the actual occupancy of rooms or zones.

#### Modern HVAC Systems Incorporate High-Performance Air Filters

Without extensive retrofitting, legacy HVAC systems have limited capacity to accommodate high-performance filters that reliably

Photo by Joseph Romeo/Watkins Elementary School







capture the smallest and most dangerous airborne hazards such as viruses, and particles carried by wildfire smoke. Consequently, many schools operating legacy HVAC systems rely on makeshift fixes such as portable air cleaners – or simply opening windows in the hope of providing “fresh” air. By contrast, effective modern HVAC solutions incorporate high-performance filters at multiple points throughout the system.

### **Modern HVAC Systems Reduce Energy Use, Costs, and Emissions**

Today, over 70% of all indoor space in U.S. schools is heated by burning fossil gas on-site, and more than half of all the energy schools consume goes to their HVAC systems. When schools invest in legacy HVAC systems, they lock in reliance on fossil fuels – an unsustainable strategy. Transitioning to modern HVAC systems is both more effective, in health terms, and more efficient in terms of future energy use and emissions. Moreover, the federal Inflation Reduction Act offers incentives that slash the initial cost to install modern HVAC equipment.

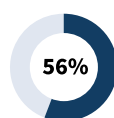
### **All HVAC Systems Require Ongoing Maintenance and Adjustment**

Effective HVAC systems can contend with a range of atmospheric conditions – hot/cold, dry/moist – and maintain healthy indoor air quality, temperature, and humidity. Effective systems also keep their own noise to a muffled minimum. To perform optimally, however, these complex systems require regular monitoring, settings adjustments, and replacement of parts. Decision-making around school HVAC systems should always include attention to system controls and anticipated maintenance. Controls should give decision-makers the data they need to make timely adjustments, often at little or no cost, that sustain healthy environmental conditions for teaching and learning.

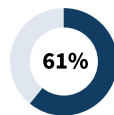
### **All HVAC Systems Must Be Designed to Fit a Context**

Factors to consider when configuring a school HVAC system include the building size, building orientation, and the quality of the building envelope. Robust building insulation, for example, enables a downsized HVAC system to operate effectively, using less energy. While these material specifications are critical to consider, effective operation of an HVAC system also depends on human and financial resources. For example, a more complex system is likely to require greater investment in staffing and maintenance, though it may also save costs over its lifetime through superior performance and energy efficiency. Decision-making around school HVAC systems should always be grounded in a full evaluation of the context, including material, financial and organizational factors over the short and long-term.

### **National Profile of K-12 School HVAC Systems**



**ANNUAL ENERGY USE**  
HVAC functions account for 56% of energy used in K-12 schools.



**POWERED BY FOSSIL FUELS**  
Around 61% of energy used by HVAC functions is tied to fossil fuel combustion on-site.

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.



Photo by Joseph Romeo/Watkins Elementary School