Hotter Days, Higher Costs

The Cooling Crisis in America's Classrooms

The Center for Climate Integrity

Resilient Analytics

SEPTEMBER 2021

AUTHORS

Sverre LeRoy, PhD

Megan Matthews

Richard Wiles

CONTRIBUTORS

Paul Chinowsky, PhD

Jacob Helman

Matthew Huddleston

Loni Unser

COMMUNITY PROFILES

Emily Sanders

CENTER FOR CLIMATE INTEGRITY

ABOUT CCI

The Center for Climate Integrity (CCI) helps cities and states across the country hold corporate polluters accountable for the massive impacts of climate change. CCI launched in 2017 amid the growing call for climate accountability across the U.S. and around the globe. Our team has decades of experience in climate science and law, communications, campaigns, social science, government, and investigations. CCI's mission is to empower communities and elected officials with the knowledge and tools they need to hold polluters accountable for their contributions to the climate crisis. Through campaigns, communications, and strategic legal support, we ensure that the fossil fuel industry pays its fair share for the massive existing (and projected) costs of climate change.

ABOUT THIS STUDY

This study and the data it produced are available at www.coolingcrisis.org.

Contents

Executive Summary

From rising seas and more intense storms to record floods, heat waves, and droughts, climate change spares no one, and neither do the costs of dealing with it. Nearly every upgrade to public infrastructure, from raising roads to hardening ports, to expanding drainage and sewage systems, and cooling public buildings costs more due to added capacity and defenses made necessary by increasing global temperatures. Yet few of these costs have been calculated, attributed to climate change, or more importantly, linked to the corporations that knew decades ago that their products would cause an unprecedented and catastrophic global crisis.

Hotter Days, Higher Costs: The Cooling Crisis in America's Schools estimates just one cost of climate change, but an urgent and particularly relevant one: the cost of cooling the nation's public schools to provide a safe and productive learning environment for our children. As climate change produces more hot days across the country, school districts that did not need air conditioning systems in 1970 have had to install them, and many that had existing systems in place in 1970 are being forced to increase their capacity. As temperatures have risen, so have operations and maintenance costs, a process that will continue far into the future as the climate continues to heat up.

Numerous studies have shown that learning suffers when classrooms are overheated. As scores of districts now experience three to four more school weeks over 80°F than they did in 1970, many have spent millions to install cooling systems. Others, particularly large school districts with older buildings and limited capital funds, increasingly struggle with overheated classrooms and forced closures.

In the wake of COVID-19, upgrading school ventilation systems is widely acknowledged as an important component of a healthy school environment. American public schools have suddenly been given access to unprecedented federal funds that can be put toward ventilation upgrades and installations. But most districts have many competing demands for those funds, from addressing a chronic backlog of basic maintenance costs to hiring new staff, implementing security measures, upgrading remote learning systems, and remediating other health issues such as lead in drinking water.

The climate-driven cost to keep classrooms cool: more than $40 billion by 2025

The Center for Climate Integrity and Resilient Analytics estimated the cost of cooling system installations, upgrades, and increased operations and maintenance in school districts in the continental U.S. that were driven by rising temperatures between 1970 and 2025. The analysis, the first-ever national estimate of the climate-driven cost to keep schools cool, is based on publicly available climate models, the federal government's national school database, a survey of more than 150 school districts, and standard engineering protocols for HVAC costs. The cost estimates in this study are based on installation or upgrades of HVAC systems. Window units or other short-term equipment choices are not recommended by engineers or public health experts and are not considered a viable long-term cooling option for public buildings.

Our analysis found:

- More than 13,700 public schools (K–12) in the contiguous U.S. that did not need cooling systems in 1970 have installed or will need to install HVAC systems by 2025, at a cost of over $40 billion.
- More than 13,000 additional schools will need to upgrade their existing HVAC systems due to a need for increased cooling capacity, at a cost of more than $414 million.
- Ten states—California, Colorado, Illinois, Iowa, Massachusetts, Michigan, New Jersey, New York, Ohio, and Pennsylvania—will face more than $1 billion each in new cooling equipment costs by 2025.
- Four more states—Idaho, Indiana, Maryland, and Utah—face $500 million each in added school air conditioning equipment costs by 2025.
- Two school districts—Chicago and New York City—will face more than $1 billion each in new HVAC system costs by 2025, and 30 additional districts are estimated to spend at least $100 million. Due to budgetary constraints and the complexity of retrofitting older buildings, many urban school districts, including New York and Chicago, have taken a lower-cost approach and installed window unit air conditioners. While cheaper and easier up front, this strategy provides far inferior ventilation and cooling and is costlier in the long run.

- Seventy-eight school districts that did not need air conditioning in 1970 will accrue between $50 million and $100 million each in cooling equipment costs by 2025, with 32 more spending at least $100 million.

As climate-driven summer temperatures continue to push into the school year, these costs will only continue to grow.

- 2,671 additional school districts will see 32 or more days over 80°F during the school year by 2025, a 39% increase since 1970. Thirty two days over 80 is the heat threshold where cooling systems are typically installed.
- 156 school districts, serving 1,298,387 students, will see at least 30 more days over 80°F during the school year in 2025 than they did in 1970.
- 1,815 school districts, serving 10,774,046 students, will see three more weeks of days over 80°F during the school year in 2025, than they did in 1970.

And equipment costs are only the beginning. Once installed, cooling systems are expensive to operate and require sustained professional maintenance every year they are in operation.

- The climate-driven increase in the cost to operate and maintain cooling systems is estimated at nearly $1.5 billion in 2025, which would total $45 billion nationwide over the typical 30-year lifespan of a modern HVAC system.
- In five states—California, Illinois, New Jersey, New York, and Pennsylvania—school districts will face more than $100 million per year in climate-driven operations and maintenance costs for air conditioning systems needed in 2025.
- Four school districts—Chicago, Los Angeles, New York City, and Philadelphia—will face $10 million in climate-driven operations and maintenance costs for cooling systems in 2025.

To better understand how these expenses are affecting schools across the country, the Center for Climate Integrity profiled communities with some of the highest air conditioning costs and needs according to our findings. These local stories serve as a window into the stark and overwhelming toll that rising temperatures can take on students' and teachers' health, classroom learning, and a host of other critical services school districts typically provide. That harm is especially great in lower-income communities and communities of color, where

current and historic inequities exacerbate both the impact of climate-driven extreme heat in classrooms and the ability to fund and implement solutions.

Climate polluters should pay their fair share

Keeping classrooms at safe temperatures is a bare minimum requirement for a functioning educational system. Schools across the country have been, or soon will be, forced to spend billions to install and upgrade air conditioning systems in response to increasingly hot school days caused by fossil fuel-driven global warming.

These costs have been thrust on school systems by polluters who knowingly caused climate change and knew their products would lead to enormous damage and costs to society but lied about it in order to protect their profits.

COVID-19 made proper ventilation a priority, but climate change caused the cooling crisis in America's public schools. As parents, officials, teachers, and taxpayers grapple with the price tag and trade-offs necessary to keep schools at safe temperatures for students, we must hold polluters to the same standard we teach our children: When you make a mess, you have to clean it up.

Oil and gas executives turned up the heat in these classrooms; they need to pay their fair share to cool them down.

Introduction

Excessive classroom heat harms the ability of students to learn and the ability of teachers to teach. As climate change accelerates and temperatures rise, more and more students face overheated classrooms where temperatures can exceed 80° or even 90°F. The average public-school building in the United States is more than 40 years old, and many were built when temperatures during the school year did not necessitate cooling systems.[1] Since then, temperatures have risen during the school year, often exceeding healthy thresholds, and many school districts lack the funds to install cooling systems.

More than half the nation's school buildings have deferred major capital improvements such as leaking roofs or failing heating systems.[2] On top of that, security concerns stemming from gun violence, combined with the added costs of getting students back in classrooms after the COVID-19 pandemic, are pushing many school budgets to the breaking point, leaving hundreds of thousands of students in schools with seriously compromised learning environments. Climate-driven heat and resulting cooling costs only make the situation worse. Recent federal infusions of support offer a short-term lifeline for some systems but may not be enough to meet this growing need.

1 Alexander, D. & Lewis, L. (2014, March). Condition of America's Public School Facilities: 2012–13 (NCES 2014-022). *United States Department of Education National Center for Education Statistics*. https://nces.ed.gov/pubs2014/2014022.pdf

2 U.S. Government Accountability Office. (2020, June). K–12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement (Publication No. GAO-20-494). https://www.gao.gov/assets/gao-20-494.pdf

Climate change is raising temperatures and lengthening the summer season

Global air temperatures have been rising for decades as a result of increasing greenhouse gas emissions from human activity, primarily the burning of fossil fuels.[3,4] Global warming has already modified the onset and duration of the four seasons; in the Northern Hemisphere's midlatitudes, autumn, winter, and spring have been shortened, giving way to a longer summer.[5] In many parts of the continental U.S., what would have been thought of as summer temperatures not long ago are now common during the school year. Schools from Boston and Baltimore to Denver and Los Angeles have been forced to close when soaring temperatures make classrooms unsafe and unproductive.

As spring and fall heat up, summer temperatures are also getting hotter, along with the frequency of extremely hot days. By mid-century, the number of days over 100°F in the United States is predicted to double, and days over 105°F is predicted to triple.[6] As summer temperatures extend deeper into the spring and fall and reach higher extremes in traditional summer months, communities will experience more dangerous heat waves, drier droughts, and larger and more frequent wildfires, among other impacts.

Overheated classrooms have adverse impacts on students but can be mitigated by air conditioning

A growing body of scientific literature connects the increase in hot school days with a decrease in the rate of learning, and increased cumulative exposure to heat with a reduction in cognitive performance and academic achievement.

3 Bindoff, N.L., et al. (2013). Detection and Attribution of Climate Change: from Global to Regional. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

4 Hayhoe, K., et al. (2018) Our Changing Climate, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, edited by Reidmiller, D.R., et al. U.S. Global Change Research Program, Washington, DC, USA, 72–144. doi:10.7930/NCA4.2018.CH2

5 Wang, J. et al. (2021). Changing lengths of the four seasons by global warming. *Geophysical Research Letters, 46*, 6. doi:10.1029/2020GL091753

6 Dahl, K. et al. (2019). Increased frequency of and population exposure to extreme heat index days in the United States during the 21st century *Environ. Res. Commun., 1*, 075002. doi:10.1088/2515-7620/ab27cf

The authors of the 2018 National Bureau of Economic Research working paper *Heat and Learning*, as well as the similarly titled 2020 journal article in *American Economic Association: Economic Policy*, found that hot days inhibit learning and that on average, a one-degree increase in school-year temperature leads to a one percent learning loss, with impacts up to three times as damaging for students who are Black, Hispanic, or living in the lowest-income ZIP codes.[7,8] The authors expanded their work to include countries outside the U.S. in a study published in *Nature Human Behavior* and found that more hot days led to lower test scores for students across 58 countries, and that U.S. students tested during hotter years scored lower than their peers from the same school district during cooler years.[9]

Not surprisingly, *Heat and Learning* also found that school air conditioning "almost entirely offset" the learning impacts caused by cumulative heat exposure. Without mitigation, the authors note, these findings suggest that the long-term effects of prolonged heat exposure may even threaten a nation's rate of economic growth.[10]

U.S. schools struggle with competing priorities for limited funds

America's public-school buildings are in terrible financial shape. Proper funding is a constant challenge and high-stakes political issue for communities across the country. A June 2020 report from the Government Accountability Office (GAO) found that more than half the nation's schools need to replace at least two major building systems (including electrical, fire, security, heating and cooling, roofing), and in 40 percent of the nation's school districts more than half of the buildings need to update or replace heating, ventilation, and air conditioning (HVAC) systems.[11]

7 Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. (2018). Heat and Learning (NBER Working Paper No. 24639). National Bureau of Economic Research, Cambridge, MA. https://scholar.harvard.edu/files/joshuagoodman/files/w24639.pdf

8 Park, R. J., Goodman, J., Hurwitz, M. & Smith, J. (2020). Heat and Learning. American Economic Journal: Economic Policy, 12(2), 306-39. doi:10.1257/pol.20180612

9 Park, R. J., Behrer, A. P. & Goodman, J. (2020). Learning is inhibited by heat exposure, both internationally and withing the United States. Nature Human Behavior, 5(1), 19-27. doi:10.1038/s41562-020-00959-9

10 Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. (2018). Heat and Learning (NBER Working Paper No. 24639). National Bureau of Economic Research, Cambridge, MA. https://scholar.harvard.edu/files/joshuagoodman/files/w24639.pdf

11 U.S. Government Accountability Office. (2020, June). K–12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement (Publication No. GAO-20-494). https://www.gao.gov/assets/gao-20-494.pdf

As a society, we place huge demands on public schools, even as many are starved for resources. Beyond teaching, schools are expected to feed our children—schools provide 30 million free or heavily discounted lunches a day[12]—counsel them, and keep them safe. Largely in response to a series of mass shootings at schools across the country, security was the top facility upgrade priority for 92 percent of the school districts surveyed by the GAO (pre-COVID-19).[13] A 2020 study from the Century Foundation estimated that K–12 schools in the United States are underfunded by nearly $150 billion every year.[14]

Capital upgrades like air conditioning are typically incurred at the school district level and generally are funded through bonds paid for with property tax increases. According to the GAO, roughly 40 percent of the nation's school districts do not have the financial capacity to issue bonds or raise property taxes, and they rely instead on state money for improvements at this scale. Often this money is delayed or not forthcoming. More than half the nation's students attend school in these "high-poverty" districts.[15]

COVID-19 has increased the need for school ventilation, but relief funding will not solve the cooling crisis

On top of these existing financial constraints came the COVID-19 pandemic, which upended the precarious funding of public schools to a greater extent than perhaps anything else in modern American history. Suddenly the issue of inadequate school ventilation took on a new urgency, as many officials—as well as parents and teachers—came to demand state-of-the-art ventilation as a vitally important tool to combat airborne transmission of the virus in classrooms.[16]

12 Economic Research Service. (2020, October 1). National School Lunch Program. *United States Department of Agriculture*. https://www.ers.usda.gov/topics/food-nutrition-assistance/child-nutrition-programs/national-school-lunch-program

13 U.S. Government Accountability Office. (2020, June). K–12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement (Publication No. GAO-20-494). https://www.gao.gov/assets/gao-20-494.pdf

14 TCF Education. (2020, July 22). TCF Study Finds U.S. Schools Underfunded by nearly $150 Billion Annually. *The Century Foundation*. https://tcf.org/content/about-tcf/tcf-study-finds-u-s-schools-underfunded-nearly-150-billion-annually/?agreed=1

15 U.S. Government Accountability Office. (2020, June). K–12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement (Publication No. GAO-20-494). https://www.gao.gov/assets/gao-20-494.pdf

16 NEA News. (2020, August 8). School Ventilation Must Be Addressed in Reopening Plans. *National Education Association*. https://www.nea.org/advocating-for-change/new-from-nea/school-ventilation-must-be-addressed-reopening-plans

In response to the crisis, American public schools have suddenly been given access to unprecedented federal funds that can be put toward long overdue ventilation upgrades and installation, among other pressing needs. The CARES Act of 2020 and the American Rescue Plan of 2021 allocated close to $54 billion and $130 billion, respectively, for K–12 schools, to make improvements to safely reopen and operate.[17] President Biden's proposed American Jobs Plan of 2021, released in March, recommends an additional $100 billion for school upgrades, with a stated priority of "improving indoor air quality and ventilation."[18]

Many school systems will undoubtedly be able to commit a portion of these funds toward ventilation upgrades. It must be recognized, however, that each system will have competing demands for how those funds are spent, from addressing basic maintenance that has too long been deferred to hiring new staff, implementing security measures, upgrading technology and remote learning systems, and remediating other health hazards such as lead in drinking water, asbestos, and toxic PCBs. Twenty percent of the $130 billion K–12 school funds allocated in the 2021 American Rescue Plan, for example, must be put toward combating learning loss during the pandemic.

In the absence of tough action to address climate change, as temperatures continue to rise and cooling costs continue to mount, even this much-needed infusion of cash may not be enough to solve the cooling crisis in America's public schools.

17 U.S. Department of Education. (2021, January 5). Secretary DeVos Quickly Makes Available an Additional $54 Billion in COVID Relief Aid for K–12 Students, Teachers, and Schools [Press release]. https://www.ed.gov/news/press-releases/secretary-devos-quickly-makes-available-additional-54-billion-covid-relief-aid-k-12-students-teachers-and-schools

18 The White House, Office of the Press Secretary. (2021, March 31). FACT SHEET: The American Jobs Plan. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

Methodology

School and School District Data

The school data are from the U.S. Department of Education's National Center for Education Statistics (NCES) Common Core of Data (CCD), which provides publicly available, comprehensive annual data on all public elementary and secondary schools in the U.S.[19] The school dataset used in this report is composed of all public primary and secondary education facilities in the 48 contiguous states for the school year 2018–2019. We removed facilities that the NCES designated as either virtual, home, or charter schools. The school district and county boundaries are from the most recent NCES and Census datasets available.[20,21] The school year length for each state is based on the 2018–2019 school year calendar for the most populous district in each state (sources vary by state).

Climate Baseline and Projections

The climate projections are derived from the LOCA[22] statistically downscaled CMIP5[23] climate projections for North America.[24,25] We selected daily maximum and minimum temperatures (T_{max} and T_{min}) at 1/16th of a degree (3.7 mile) resolution from 32 global climate models under a moderate greenhouse gas and aerosol emission scenario (Representative Concentration

19 National Center for Education Statistics, Common Core of Data & Education Demographic and Geographic Estimate programs (10 Aug 2020). Public School Characteristics 2018–19, *United States Department of Education*. https://data-nces.opendata.arcgis.com/datasets/nces::public-school-characteristics-2018-19/about

20 National Center for Education Statistics, Common Core of Data. (n.d.). Public Elementary/Secondary School Universe Survey Geographic Data 2018–2019 (EDGE), v.1a. *United States Department of Education*. https://nces.ed.gov/ccd/pubschuniv.asp

21 U.S. Census Bureau. (2018). Cartographic Boundary Files - Shapefile. United States Census Bureau. https://www.census.gov/geographies/mapping-files/time-series/geo/carto-boundary-file.html

22 LOCA: Localized Constructed Analogs

23 CMIP5: Coupled Model Intercomparison Project Phase

24 Pierce, D. W., Cayan, D. R. & Thrasher, B. L. (2014). Statistical downscaling using Localized Constructed Analogs (LOCA). *Journal of Hydrometeorology*, 15, 2558-2585. doi:10.1175/jhm-d-14-0082.1

25 Pierce, D. W. et al. (2015). Improved bias correction techniques for hydrological simulations of climate change. *Journal of Hydrometeorology*, 16, 6, 2421-2442. doi:10.1175/JHM-D-14-0236.1

Pathway [RCP] 4.5).[26] The projection time periods used are 30-year averages centered on 2025 (2010–2039) and 2055 (2040–2069). This report focuses only on 2025 projections; however, 2055 projections and estimated costs can be downloaded from www.coolingcrisis.org. The climate baseline in this study is derived from Livneh et al. (2015), which provides a historical gridded dataset from 1950 to 2013. We define the climate baseline in this study as a 30-year average centered on 1970 (1955 to 1984).

Climate Metrics

We calculated the number of days over 80°F (also referred to in this report as *hot days*) and cooling degree days (CDD)[27] for the baseline and projection time periods for each individual school. We selected 80°F as the daily temperature threshold based on previous studies on heat and cognitive performance that found adverse impacts beginning around 80°F.[28] The days over 80°F metric represents a 30-year average number of days over 80°F during the school year for our baseline as well as our two future projection scenarios. The CDD metric represents the 30-year average CDD for both base 50°F (CDD50) and base 65°F (CDD65). For all metrics, we used the median RCP 4.5 T_{max} value of the 32 global climate models for 2025 (2010–2039) and 2055 (2040–2069).

Estimating Costs

ESTABLISH A TEMPORAL THRESHOLD: 32 DAYS OVER 80°F

We used a multipronged approach to establish the temporal threshold (*number of days* over 80°F) that determined whether a school should have had HVAC during the baseline time period. Using a phone call campaign and news article research, we gathered air conditioning data for 104 individual schools and 56 school districts across the country. We plotted these individual schools and districts in a GIS map that distributed the schools into regions that, based on the empirical data we collected, currently have HVAC. We then overlaid those school/district

26 Van Vuuren, D. P., et al. (2011). The representative concentration pathways: an overview. *Climatic Change*, 109, 5. doi:10.1007/s10584-011-0148-z

27 *Cooling degree days* (CDD) is a measure of how much (in degrees), and for how long (in days), the outside air temperature is above a specified temperature threshold.

28 Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. (2018). Heat and Learning (NBER Working Paper No. 24639). National Bureau of Economic Research, Cambridge, MA. https://scholar.harvard.edu/files/joshuagoodman/files/w24639.pdf

locations with the historical number of days over 80°F to determine how many *hot days* were needed to justify the installation of HVAC.

From the call campaign, we learned that individual schools with an average of at least 32 days over 80°F reported having full HVAC coverage 100 percent of the time. From news article research, we found that school districts with an average of at least 32 days over 80°F reported having HVAC in all the schools 70 percent of the time (12 out of 17). Of the five that did not report HVAC in all schools, two districts are in coastal California (Long Beach Unified and Santa Paula Unified), where schools close to the ocean or mountains may not have HVAC due to local microclimates. The remaining three districts—Jefferson County School District R-1 (Denver, CO), Baltimore City Public Schools (Baltimore, MD), and Columbus City Schools (Columbus, OH)—are working toward installing HVAC in all schools. Finally, we performed a sensitivity analysis to determine how varying the number of days over 80°F from 25 to 40 by increments of one day affects the total costs, which yielded total cost results within 15 percent or less compared to the total cost for 32 days for RCP 4.5–2025.

CATEGORIZE SCHOOLS BASED ON HISTORIC NEED FOR HVAC

We applied our defined threshold of at least 32 days over 80°F during the school year to determine if a school should have had HVAC in the baseline time period and if a school needs HVAC in the projected time period. If a school is located in an area that had at least 32 days over 80°F in the 1970 baseline, the school should have had HVAC and therefore incurs no installation cost. If a school is located in an area that had fewer than 32 days over 80°F in 1970 and has over 32 days above 80°F in the projected time period, the school needs to install HVAC.

MODELING INSTALLATION COSTS

We utilized several metrics from the CCD database to estimate the size/cost of the necessary HVAC installation for those schools that did not need cooling systems prior to 1970 but have since risen above the designed *hot-day threshold*. We assume that the area of a school is a function of the school enrollment, and we adopted the area-per-student assumptions presented in the Annual Official Education Construction Reports from 2003 to 2009: 123, 145, and 150 square feet per student for elementary, middle, and high schools, respectively.[29]

29 Argon, J. (2003–2009). Annual Official Education Construction Reports. *American School and University.* https://www.asumag.com/research

The installation cost is based on R.S. Means regional building construction cost data.[30] Project data from multiple cities was used to validate the R.S. Means number. The cost per square foot is assumed to be $32, $32, and $35 for elementary, middle, and high schools, respectively. An installation cost was calculated for each school for the baseline and projection periods.

MODELING UPGRADE COSTS

Some schools that should have had HVAC prior to 1970 require increased cooling capacity to contend with more *hot days*. To determine which of those schools would need upgraded systems, we needed to establish a numerical relationship between CDD and cooling system capacity.

The U.S. Department of Energy's commercial reference building models[31] define the characteristics of a representative primary and secondary school for every climate zone defined by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)[32] based on nationwide survey data. DOE reference models were available for buildings constructed pre-1980, post-1980, and new (2010). We used only the post-1980 models for the purposes of this study. Cooling system type, cooling system capacity, and building square footage as defined by the DOE reference models were used to calculate cooling capacity intensity (square foot per ton) for a representative primary and secondary school in each ASHRAE climate zone.

To identify the relationship between CDD50/CDD65 (reported in ASHRAE Standard 90.1-2004[33]) and the cooling capacity intensity for each representative school, we fit a linear regression model to the data. CDD50 showed a closer correlation to cooling capacity intensity than did CDD65. The resulting relationship between CDD50 and cooling capacity intensity allowed us to calculate cooling system capacity for any school using inputs of local CDD50,

30 R.S. Means. (2019). Building Construction Cost Data. *RS Means*, Kingston, MA.

31 Office of Energy Efficiency & Renewable Energy. (2010). Commercial Reference Buildings. *United States Department of Energy*. https://www.energy.gov/eere/buildings/existing-commercial-reference-buildings-constructed-or-after-1980

32 ASHRAE. (2013). Climatic Data for Building Design Standards. ANSI/ASHRAE Standard 169-2013. *American Society of Heating, Refrigeration, and Air-Conditioning Engineers*, Atlanta, GA.

33 ASHRAE. (2004). Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings. ANSI/ASHRAE/IESNA Standard 90.1-2004. *American Society of Heating, Refrigeration, and Air-Conditioning Engineers*, Atlanta, GA.

school area, and school type (primary or secondary).

We applied the cooling system capacity relationship to each school in the national database. Using climate data from the historical[34] and projection datasets,[35] we calculated annual CDD50 for each school in the database for the baseline and projection time periods. We then calculated cooling system capacities for the baseline and projection time periods for each individual school, using its respective CDD50 values, area, and school type.

We assumed that an upgrade would be necessary in a projection scenario if the change in the cooling system capacity in the projection was at least 10 percent greater than the cooling system capacity for the baseline. We calculated cooling system upgrade costs on a dollar per ton basis using the system types in the DOE Commercial Reference Building documentation and R.S. Means construction cost estimating data.[36] To limit the upgrade costs to those related to anthropogenic climate change, we costed only the cooling system components that require upgrading to meet the increased system capacity. The costed system components include: the central cooling equipment (packaged rooftop units for all school types in addition to air-cooled chillers for secondary schools) and air handling units (secondary schools only). Costs also include material and labor with a 20 percent factor applied for overhead and profit. Additional costs that are outside the scope of this study will be incurred on a case-by-case basis. See Assumptions section for more costing information.

HVAC OPERATING COST

To model HVAC operating costs, we first needed to establish a relationship between CDD and cooling system energy use. The DOE's commercial reference building models define the characteristics of a representative primary and secondary school for each ASHRAE climate zone based on nationwide survey data. The DOE reference models also provide annual cooling electricity usage (not including fan or pump energy) and building square footage. We used these available data to calculate cooling system annual energy use intensity (EUI) in kilowatt

34 Livneh, B., et al. (2015). A spatially comprehensive, hydrometeorological data set for Mexico, the US, and Southern Canada 1950–2013. *Scientific Data*, *2*, 150042. doi:10.1038/sdata.2015.42

35 Pierce, D. W., Cayan, D. R. & Thrasher, B. L. (2014). Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology, 15, 2558-2585. doi:10.1175/jhm-d-14-0082.1

36 R.S. Means. (2019). Building Construction Cost Data. *RS Means*, Kingston, MA.

hours per square foot for a representative primary and secondary school in each ASHRAE climate zone.

To identify the relationship between CDD50 (reported in ASHRAE Standard 90.1-2004[37]) and the EUI for each representative school, we fit a linear regression to the data. The resulting numerical relationship between CDD50 and EUI allowed us to calculate EUI for any school, using inputs of local CDD50, school area, and school type (primary or secondary).

We calculated annual cooling system energy usage for the baseline and projection time periods for each school, using its respective CDD50 values, area, and school type. Finally, we calculated the annual cooling cost for the baseline and projection time periods using the annual cooling system energy usage and the state average energy cost as reported by the U.S. Energy Information Administration.[38] For schools that should have had HVAC in 1970, the operating cost is the change between the baseline and projected costs. For schools that did not need HVAC in 1970 but will need to install HVAC by 2025, the cost reflects the full operating cost.

Assumptions

COOLING SYSTEM TYPE

For both installation and upgrade costs, we used the cooling system type assigned to post-1980 primary and secondary schools in the DOE's reference building documentation:

- **Primary Schools:** Multi-zone packaged rooftop air conditioning units for core spaces, and single-zone packaged rooftop air-conditioning units for gymnasiums, kitchens, and cafeterias.
- **Secondary Schools:** Air-cooled chiller and air handling unit for core spaces, and single-zone packaged rooftop air-conditioning units for gymnasiums, auxiliary gymnasiums, auditoriums, kitchens, and cafeterias.

37 ASHRAE. (2004). Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings. ANSI/ASHRAE/IESNA Standard 90.1-2004. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Atlanta, GA.

38 Energy Information Administration (2020, November 2). State Electricity Profiles: Data for 2019. United States Energy Information Administration. https://www.eia.gov/electricity/state/

INSTALLATION-SPECIFIC COST ASSUMPTIONS

For schools that qualified for new HVAC installations, the unit cost was generated using a combination of case studies and the R.S. Means components that were most similar to the system type reported in the DOE's reference building documentation.

UPGRADE-SPECIFIC COST ASSUMPTIONS

For schools that qualified for HVAC upgrades, we costed only those components that require upgrading for the system to meet increased capacity requirements. As we are interested in estimating the costs of anthropogenic climate change, we costed only the change from baseline capacity, rather than the full system capacity.

We used R.S. Means components that were most similar to the system type reported in the DOE's reference building documentation. We assumed the cooling capacity reported was for single units and we used only average R.S. Means cost data associated with these unit sizes.

We did not cost: hydronic pumps, variable air volume boxes, ductwork, controls, accessories, or anything else not listed in costing methodology above. Additional items that fall outside of the scope of the upgrade cost analysis are: required code improvements, structural improvements, asbestos abatement, redundant equipment, electrical upgrades, inflation, design fees, permitting, inspections, crane, constructability, demolition, and waste disposal.

The cooling capacity intensity relationship with CDD50 was calculated without the equipment sizing factor of 1.2 used by the DOE reference building models.

COOLING SYSTEM OPERATING COSTS

The annual energy usage values reflect only cooling energy and do not include fan or pump energy.

Results

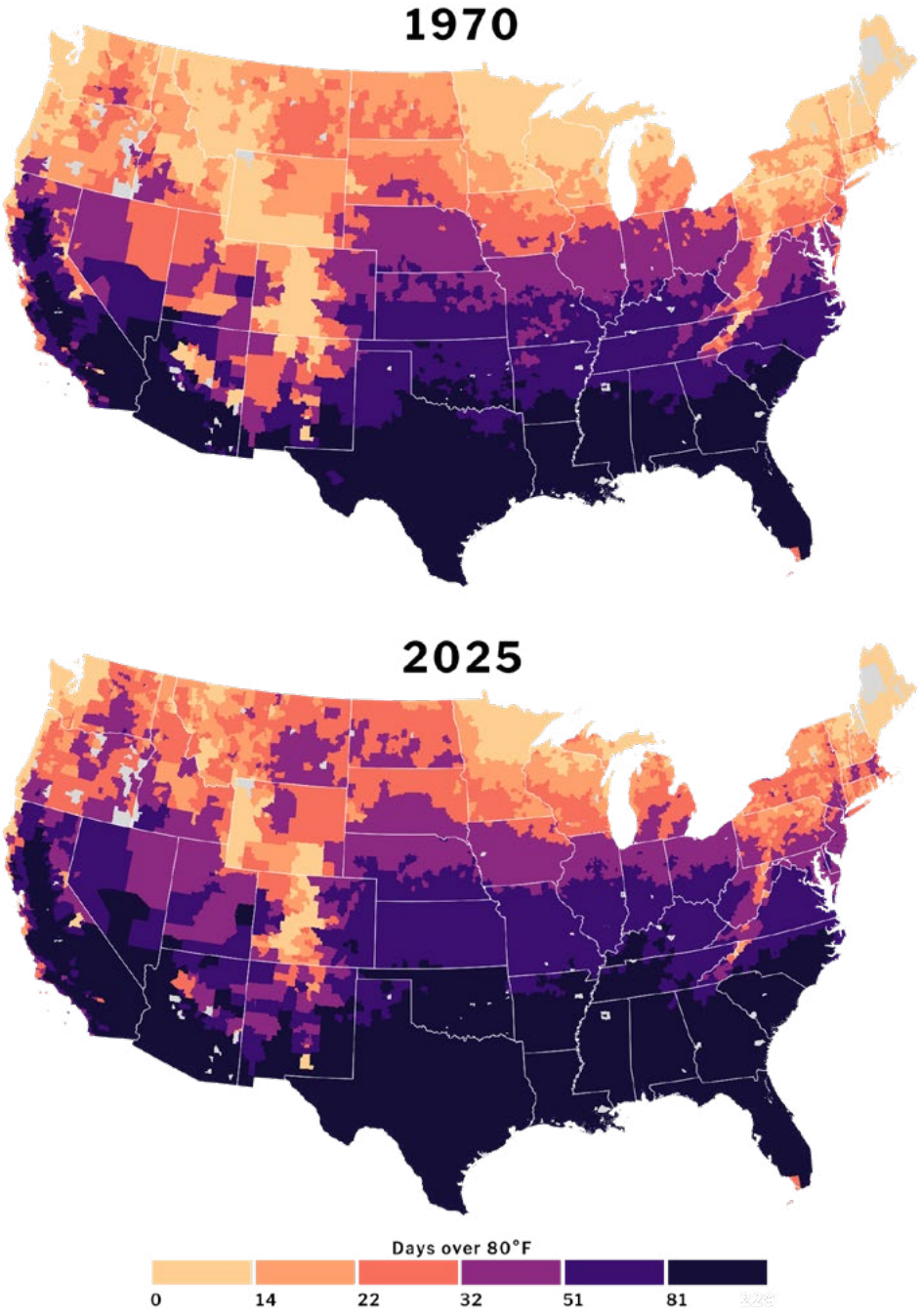
RISING TEMPERATURES

The Livneh et al. (2015) historical climate data set and LOCA downscaled climate projections from Pierce et al. (2014) that underlie this cost analysis are well established and publicly available.[39] Figure 1 illustrates the number of *hot days* (days with a maximum temperature of 80°F or warmer) during the school year in 1970 (30-year average) and 2025 (30-year average) by school district.[40] Figure 2 illustrates the locations of school districts that contain at least one school building that crosses our defined temperature threshold (had fewer than 32 *hot days* in 1970, and by 2025 is projected to have more than 32 *hot days*), layered atop Figure 1's 2025 *hot days*.

39 Pierce, D. (updated 2016, September 12). LOCA statistical downscaling. *U.C. San Diego*. http://loca.ucsd.edu

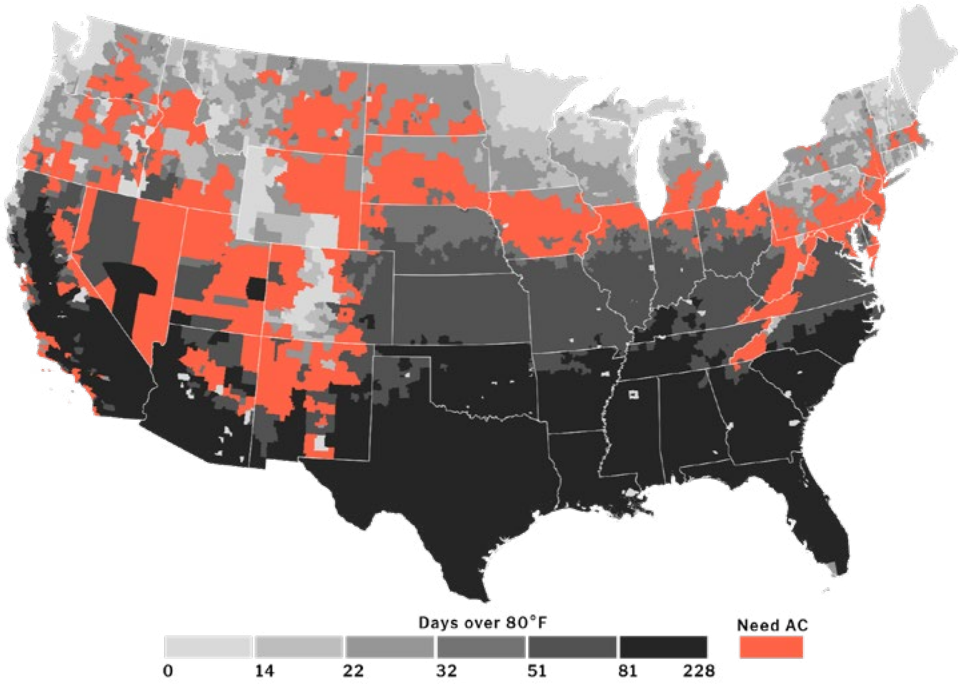
40 National Center for Education Statistics, Common Core of Data. (n.d.). Public Elementary/Secondary School Universe Survey Geographic Data 2018-2019 (EDGE), v.1a. *United States Department of Education*. https://nces.ed.gov/ccd/pubschuniv.asp

FIGURE 1: NATIONWIDE, THERE ARE MANY MORE SCHOOL DAYS OVER 80°F THAN IN 1970



Historic number of days over 80°F in 1970 (1955–1984 average) during the school year, compared to the projected number of heat days by 2025 (2010–2039 average) during the school year. Historic gridded temperature data are derived from Livneh et al. (2015). Projected temperatures are derived from LOCA (Pierce et al., 2014) and are binned based on the quantiles of the 1970 data. Both 1970 and 2025 illustrate the average number of days over 80°F by school district.

FIGURE 2: RISING TEMPERATURES SINCE 1970 HAVE CREATED A NEED FOR COOLING SYSTEMS IN PUBLIC SCHOOLS ACROSS THE COUNTRY

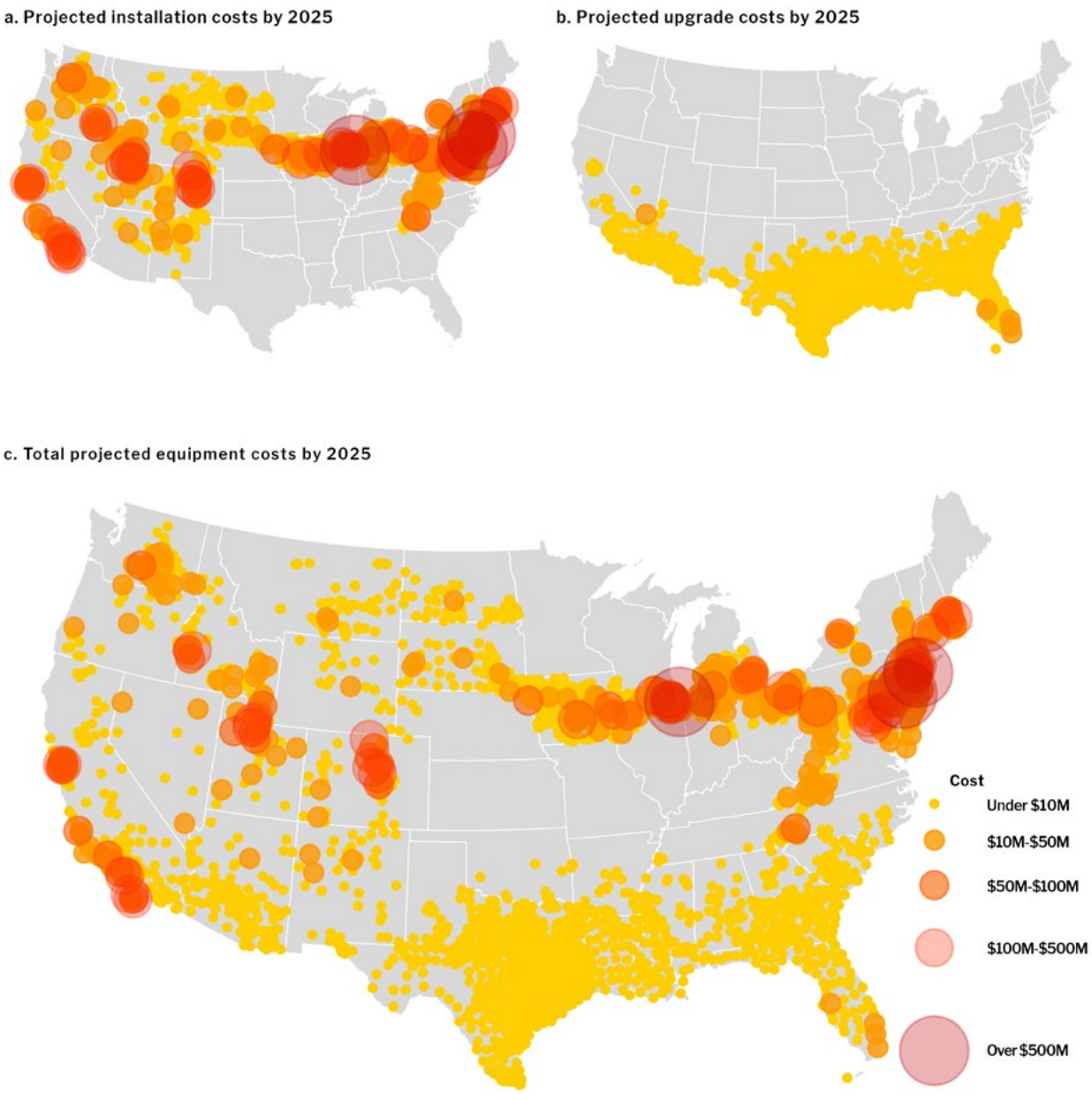


School districts across the contiguous U.S. that contain at least one school building in need of climate-driven cooling (red), layered atop projected hot days in 2025 (Figure 1).

EQUIPMENT COSTS

Our study finds that the total equipment cost (including *new* HVAC installations as well as *upgraded* systems) necessary to cool public schools by the year 2025 will be more than $40 billion (Table 1; Figure 3). By the year 2025, more than 15,000 public K–12 schools in the contiguous U.S. that had no climatological need for cooling systems in the 1970s will face new HVAC system installation costs of $40.5 billion (Table 1; Figure 3a). New York faces the greatest state cost of more than $6.9 billion in new HVAC installations by 2025 (Table 2). Additionally, 1,576 school districts will have needed to upgrade their existing HVAC systems due to a large increase in heat days, at a cost of more $415 million (Table 2; Figure 3b). Texas incurs the greatest state upgrade cost, facing over $162 million in upgraded HVAC systems by 2025 (Table 2).

FIGURE 3. SCHOOLS FACE BILLIONS IN CLIMATE-DRIVEN HVAC EQUIPMENT COSTS BY 2025

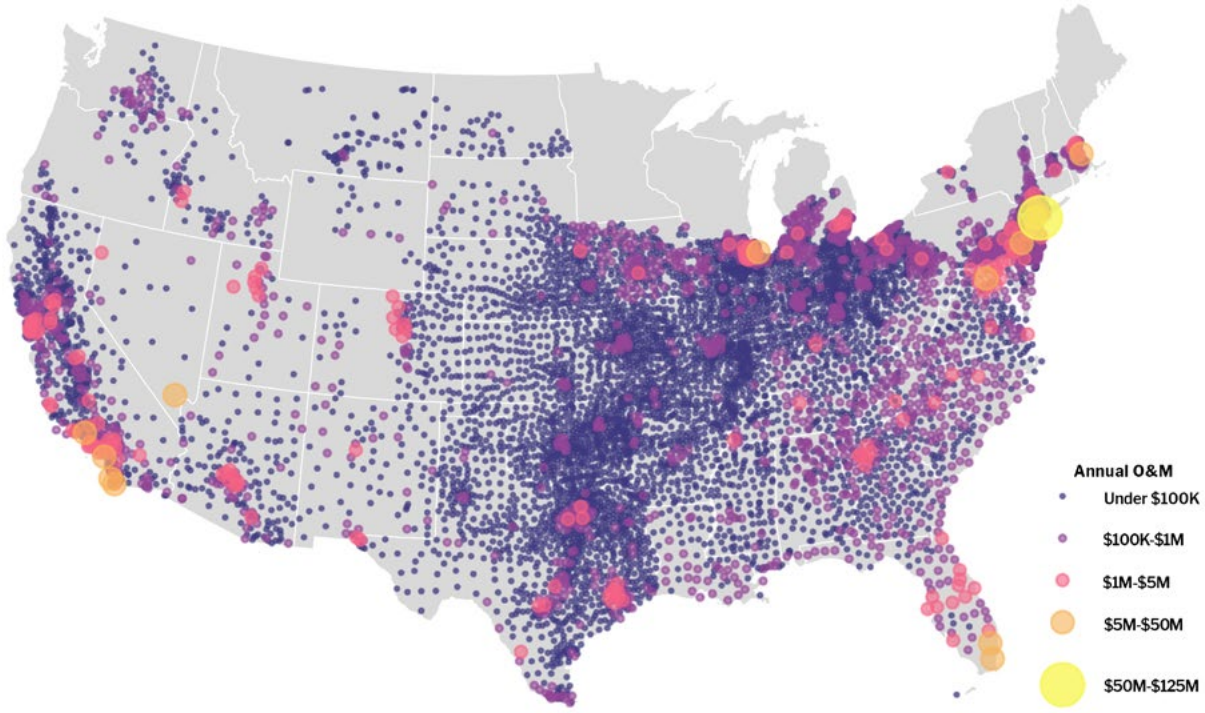


Projected costs of new HVAC installations (a), necessary upgrades (b), and total installations and upgrades (c).

OPERATIONS AND MAINTENANCE

We calculate operations costs for every school that either required cooling systems in 1970 or will require a new HVAC equipment installation by 2025 due to rising temperatures. For schools that needed cooling systems in 1970, we estimate only the cost to operate HVAC for the marginal increase in heat days. Maintenance costs are calculated only for schools that require new installations. Though we calculated each separately, we present operations and maintenance (O&M) costs as a combined dollar amount. By 2025, we estimate that the total school HVAC operations and maintenance costs for the contiguous U.S. will be nearly $1.5 billion per year (Table 1). California incurs the greatest average annual state O&M costs, facing over $219 million per year by 2025 (Table 2).

FIGURE 4. CLIMATE-DRIVEN HVAC OPERATIONS AND MAINTENANCE ADD $1.5 BILLION TO ANNUAL SCHOOL COOLING COSTS BY 2025



Projected annual HVAC operating and maintenance (O&M) costs due to climate change since 1970. Many districts that will not incur climate-driven equipment costs by 2025 will still experience increased operating costs due to rising temperatures.

National Totals

Table 1: Schools in nearly every state have spent or will be faced with more than $40B on cooling equipment by 2025 in response to climate-driven warming.

	2025
EQUIPMENT[a]	**$40,869,054,000**
INSTALL[b]	$40,454,288,000
UPGRADE[c]	$414,766,000
ANNUAL O&M[d]	**$1,490,425,000**
# OF STUDENTS AFFECTED[e]	**38,282,930**
# OF STUDENTS AFFECTED BY INSTALLS	8,656,980
# OF STUDENTS AFFECTED BY UPGRADES	10,424,170
# OF STUDENTS AFFECTED ONLY BY O&M	19,201,780
# OF SCHOOLS AFFECTED[e]	**64,532**

a Combined projected HVAC installation and upgrade costs between 1970–2025.
b Projected HVAC installation costs between 1970–2025.
c Projected HVAC upgrade costs between 1970–2025.
d Projected annual operations and maintenance in 2025.
e U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.

State Totals

Table 2: Since 1970, climate change has raised the cost of cooling schools in nearly every state.

STATE	RANKED BY EQUIPMENT COST[a]	INSTALL[b]	UPGRADE[c]	ANNUAL O&M[d]	# OF STUDENTS[e]	# OF SCHOOLS[e]
AL	38	$0	$1,938,000	$14,721,000	736,710	1,325
AR	40	$0	$775,000	$6,895,000	461,500	966
AZ	26	$70,026,000	$38,856,000	$30,077,000	929,520	1,419
CA	5	$2,415,263,000	$39,135,000	$219,563,000	4,975,290	6,926
CO	10	$1,198,234,000	$0	$25,957,000	648,610	1,251
CT	31	$34,709,000	$0	$732,000	7,750	13
DC	42	$0	$0	$944,000	48,090	111
DE	18	$198,694,000	$0	$5,432,000	115,860	191
FL	24	$0	$129,026,000	$56,662,000	2,495,750	2,897
GA	35	$268,000	$9,299,000	$34,696,000	1,710,300	2,189
IA	9	$1,689,962,000	$0	$32,487,000	485,300	1,059
ID	13	$705,964,000	$0	$10,181,000	210,240	412
IL	2	$6,071,053,000	$0	$124,889,000	1,794,460	3,738
IN	14	$509,362,000	$0	$23,593,000	1,009,250	1,766
KS	42	$0	$0	$8,119,000	484,460	1,291
KY	37	$2,503,000	$0	$10,363,000	670,340	1,209
LA	32	$0	$12,184,000	$10,167,000	628,020	1,197
MA	7	$2,180,640,000	$0	$54,971,000	455,170	874
MD	12	$776,743,000	$0	$32,055,000	855,680	1,285
ME	42	$0	$0	$0	0	0
MI	6	$2,347,759,000	$0	$50,176,000	553,640	1,135
MN	42	$0	$0	$0	0	0
MO	42	$0	$0	$14,577,000	884,300	2,163
MS	39	$0	$1,077,000	$8,677,000	475,480	901
MT	23	$145,998,000	$0	$2,192,000	36,220	140
NC	25	$125,834,000	$571,000	$28,867,000	1,425,250	2,345

(Table 2, continued)

STATE	RANKED BY EQUIPMENT COST[a]	INSTALL[b]	UPGRADE[c]	ANNUAL O&M[d]	# OF STUDENTS[e]	# OF SCHOOLS[e]
ND	28	$72,595,000	$0	$1,041,000	17,730	102
NE	34	$9,736,000	$0	$4,225,000	329,290	971
NH	42	$0	$0	$0	0	0
NJ	3	$5,368,563,000	$0	$130,095,000	1,134,500	2,022
NM	20	$171,498,000	$335,000	$6,659,000	304,600	729
NV	30	$40,046,000	$14,680,000	$8,867,000	436,930	559
NY	1	$6,921,426,000	$0	$171,542,000	1,322,150	2,171
OH	8	$1,983,825,000	$0	$55,952,000	1,590,380	3,151
OK	41	$0	$22,000	$9,305,000	665,230	1,752
OR	21	$170,209,000	$0	$2,888,000	73,340	164
PA	4	$5,150,276,000	$0	$103,837,000	1,183,790	1,948
RI	42	$0	$0	$0	0	0
SC	36	$0	$3,971,000	$14,965,000	745,500	1,135
SD	17	$212,442,000	$0	$4,210,000	60,460	290
TN	33	$11,356,000	$125,000	$18,215,000	967,300	1,654
TX	22	$0	$162,652,000	$93,915,000	5,063,890	7,468
UT	11	$812,341,000	$118,000	$16,928,000	558,610	786
VA	19	$191,027,000	$0	$24,211,000	1,288,370	1,834
VT	42	$0	$0	$0	0	0
WA	15	$414,088,000	$0	$6,199,000	147,960	267
WI	29	$60,583,000	$0	$1,191,000	13,480	29
WV	16	$290,874,000	$0	$7,733,000	255,470	606
WY	27	$100,393,000	$0	$1,454,000	26,760	91

a Combined projected HVAC installation and upgrade costs between 1970–2025.
b Projected HVAC installation costs between 1970–2025.
c Projected HVAC upgrade costs between 1970–2025.
d Projected annual operations and maintenance in 2025.
e U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.

District Rankings

This study identifies two school districts that will face equipment costs greater than $1 billion by 2025 (Table 3), 30 districts with between $100 million and $1 billion (Table 4), and 78 districts with between $50 and $100 million (Table 5). An additional 4,180 districts will face equipment costs less than $50 million (data is downloadable from website). Over 200 school districts across the contiguous U.S. will face climate-driven annual O&M costs greater than $1 million. The 25 districts with the greatest O&M costs are listed in Table 6. The complete data set is available for download at www.coolingcrisis.org.

EQUIPMENT COSTS > $1 BILLION

Table 3: New York City and Chicago public schools face more than $1B in climate-driven cooling costs by 2025.

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
1	New York City Department of Education	NY	$4,551,955,000	$117,540,000	872,640	1,426	38	13
2	Chicago Public School District 299	IL	$1,553,743,000	$37,532,000	304,500	536	38	12

District Abbreviations: S.D. = School District

a Combined projected HVAC installation and upgrade costs between 1970–2025.
b Projected annual operations and maintenance in 2025.
c U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.
d Predicted days over 80°F during the school year in 2025. Red >= 64 days; Orange >= 32 days; Yellow < 32 days.
e Predicted increase from 1970–2025.

EQUIPMENT COSTS BETWEEN $100 MILLION & $1 BILLION

Table 4: Since 1970, school districts in 13 states have spent or will be faced with hundreds of millions in climate-driven cooling costs by 2025.

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
3	Philadelphia City School District	PA	$565,217,000	$14,717,000	124,380	211	**42**	14
4	Jefferson County School District R-1	CO	$268,330,000	$4,808,000	68,020	124	**43**	17
5	Detroit Public Schools Community District	MI	$209,144,000	$5,671,000	47,530	95	**34**	11
6	Capistrano Unified School District	CA	$203,162,000	$6,547,000	46,690	54	**43**	16
7	Newark City School District	NJ	$192,952,000	$5,831,000	35,540	61	**37**	14
8	San Diego City Unified School District	CA	$185,470,000	$7,945,000	92,440	151	**55**	17
9	Douglas County School District RE-1	CO	$182,025,000	$2,933,000	50,470	67	**44**	16
10	School District U-46	IL	$181,250,000	$2,724,000	37,800	56	**37**	12
11	Boston School District	MA	$172,542,000	$5,218,000	35,100	80	**33**	10
12	Montgomery County Public Schools	MD	$172,402,000	$6,475,000	163,190	207	**49**	14
13	Cleveland Municipal School District	OH	$168,440,000	$4,317,000	37,850	106	**43**	14
14	Sweetwater Union High School District	CA	$162,934,000	$8,065,000	32,940	20	**39**	16
15	Fremont Unified School District	CA	$159,133,000	$3,744,000	31,540	36	**37**	15
16	Elizabeth City School District	NJ	$150,802,000	$4,954,000	27,460	36	**40**	14
17	Yonkers City School District	NY	$143,650,000	$4,193,000	26,430	40	**41**	13
18	Meridian Joint School District 2	ID	$141,540,000	$2,234,000	38,860	49	**45**	14

District Abbreviations: E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.S.D. = Unified School District

(Table 4, continued)

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
19	NYC Special Schools District 75	NY	$138,080,000	$4,626,000	24,140	57	**38**	13
20	Indian Prairie Community Unit School District 204	IL	$135,898,000	$2,371,000	27,870	34	**42**	13
21	Rockford School District 205	IL	$135,733,000	$2,285,000	27,790	45	**38**	13
22	Des Moines Independent Community School District	IA	$128,301,000	$2,617,000	32,130	62	**42**	13
23	Paterson City School District	NJ	$117,681,000	$3,141,000	22,440	47	**39**	12
24	Baltimore County Public Schools	MD	$113,130,000	$4,292,000	112,000	162	**49**	15
25	Springfield School District	MA	$112,600,000	$2,597,000	24,170	59	**41**	12
26	Harford County Public Schools	MD	$110,545,000	$2,973,000	36,750	52	**46**	17
27	Poudre School District R-1	CO	$108,864,000	$1,822,000	27,620	43	**42**	17
28	Davis School District	UT	$108,805,000	$2,111,000	69,260	82	**46**	15
29	Carroll County Public Schools	MD	$104,283,000	$2,469,000	25,030	38	**43**	16
30	Frederick County Public Schools	MD	$104,235,000	$2,844,000	41,670	61	**48**	18
31	Granite School District	UT	$103,773,000	$2,221,000	63,550	83	**48**	16
32	Pittsburgh School District	PA	$102,298,000	$2,237,000	22,570	55	**39**	13

District Abbreviations: E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.S.D. = Unified School District

a Combined projected HVAC installation and upgrade costs between 1970–2025.
b Projected annual operations and maintenance in 2025.
c U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.
d Predicted days over 80°F during the school year in 2025. Red >= 64 days; Orange >= 32 days; Yellow < 32 days.
e Predicted increase from 1970–2025.

EQUIPMENT COSTS BETWEEN $50 MILLION & $100 MILLION

Table 5: Since 1970, school districts in 16 states have spent or will be faced with between $50 and $100 million in climate-driven cooling costs by 2025.

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
33	Boise City Independent School District 1	ID	$99,823,000	$1,454,000	24,380	45	**43**	14
34	Hayward Unified School District	CA	$99,294,000	$2,233,000	19,680	30	**34**	14
35	Jordan School District	UT	$99,245,000	$2,042,000	55,690	54	**49**	17
36	Community Unit School District 300	IL	$97,213,000	$1,557,000	19,960	26	**35**	11
37	Oswego Community Unit School District 308	IL	$87,481,000	$1,531,000	17,950	22	**42**	12
38	Edison Township School District	NJ	$87,395,000	$1,827,000	17,190	20	**41**	14
39	Dearborn City School District	MI	$87,334,000	$1,911,000	20,620	34	**37**	11
40	Akron City School District	OH	$86,049,000	$1,594,000	20,750	43	**44**	15
41	Cherry Creek School District 5	CO	$82,765,000	$2,021,000	54,030	63	**48**	16
42	Central Bucks School District	PA	$81,428,000	$1,433,000	18,710	24	**37**	13
43	Passaic City School District	NJ	$81,411,000	$2,457,000	14,850	18	**38**	12
44	Chula Vista Elementary School District	CA	$81,303,000	$1,130,000	21,320	38	**40**	17
45	Denver County School District 1	CO	$80,089,000	$1,998,000	68,500	130	**50**	17
46	Naperville Community Unit District 203	IL	$80,049,000	$1,424,000	16,420	22	**44**	14
47	Toms River Regional School District	NJ	$79,268,000	$1,756,000	15,370	18	**43**	14
48	Alpine School District	UT	$78,594,000	$1,886,000	78,060	78	**49**	16

District Abbreviations: C.U.D = Community Unit District; E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.D. = Unified District; U.S.D. = Unified School District

(Table 5, continued)

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
49	Reading School District	PA	$77,112,000	$1,299,000	17,720	19	**34**	12
50	Valley View Community Unit School District 365U	IL	$76,890,000	$1,421,000	16,190	20	**44**	13
51	Santa Maria-Bonita Elementary School District	CA	$75,612,000	$1,197,000	16,060	19	**33**	10
52	Jersey City School District	NJ	$74,670,000	$2,220,000	14,130	23	**32**	12
53	Ann Arbor Public Schools	MI	$72,972,000	$1,517,000	17,400	30	**35**	11
54	Plymouth-Canton Community Schools	MI	$72,760,000	$1,598,000	17,140	22	**37**	13
55	Allentown City School District	PA	$71,917,000	$1,347,000	16,220	21	**33**	12
56	Yakima School District	WA	$71,471,000	$867,000	15,930	21	**34**	9
57	Red Clay Consolidated School District	DE	$71,339,000	$1,504,000	15,230	25	**40**	12
58	Woodbridge Township School District	NJ	$70,394,000	$1,545,000	13,740	26	**42**	14
59	Schaumburg Community Consolidated School District 54	IL	$69,824,000	$796,000	15,730	29	**36**	11
60	Cache School District	UT	$69,375,000	$917,000	17,600	23	**39**	13
61	South Bend Community School Corporation	IN	$68,874,000	$1,318,000	16,990	31	**42**	12
62	Lowell School District	MA	$68,872,000	$1,677,000	14,530	26	**37**	13
63	Aurora East Unit School District 131	IL	$66,869,000	$1,140,000	13,800	20	**41**	13
64	Township High School District 214	IL	$66,747,000	$1,481,000	11,880	10	**35**	11
65	Lawrence School District	MA	$65,876,000	$1,684,000	13,660	25	**34**	12

District Abbreviations: C.U.D = Community Unit District; E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.D. = Unified District; U.S.D. = Unified School District

(Table 5, continued)

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
66	Township High School District 211	IL	$65,803,000	$1,436,000	11,710	7	**35**	11
67	Boulder Valley School District RE-2	CO	$65,156,000	$1,495,000	28,020	45	**47**	18
68	Newport-Mesa Unified School District	CA	$64,781,000	$2,128,000	14,480	21	**41**	14
69	Freehold Regional School District	NJ	$63,884,000	$1,887,000	10,670	6	**38**	12
70	Union City School District	NJ	$62,058,000	$1,419,000	12,230	14	**33**	12
71	Newton School District	MA	$61,208,000	$1,543,000	12,880	22	**35**	11
72	Hamilton Township School District	NJ	$60,526,000	$1,365,000	11,800	24	**42**	14
73	Community Unit School District 200	IL	$60,230,000	$1,034,000	12,410	20	**43**	14
74	Buncombe County Schools	NC	$60,062,000	$1,560,000	24,080	44	**48**	17
75	St. Charles Community Unit School District 303	IL	$59,892,000	$1,038,000	12,170	16	**38**	12
76	Sioux City Community School District	IA	$59,793,000	$1,068,000	15,020	22	**41**	12
77	Los Angeles Unified School District	CA	$59,511,000	$12,449,000	421,640	650	**88**	22
78	Trenton City School District	NJ	$59,458,000	$1,246,000	11,940	20	**43**	14
79	Livonia Public Schools	MI	$59,424,000	$1,357,000	13,900	25	**37**	12
80	Weber School District	UT	$59,330,000	$1,042,000	27,030	36	**44**	15
81	Thompson School District R-2J	CO	$59,245,000	$1,066,000	14,680	32	**47**	17
82	Nampa School District 131	ID	$59,206,000	$891,000	14,100	23	**45**	15
83	Aurora West Unit School District 129	IL	$58,689,000	$1,021,000	12,030	17	**41**	13

District Abbreviations: C.U.D = Community Unit District; E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.D. = Unified District; U.S.D. = Unified School District

(Table 5, continued)

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
84	Tooele School District	UT	$58,563,000	$1,015,000	15,050	25	**45**	18
85	Newburgh City School District	NY	$58,395,000	$1,280,000	11,140	12	**39**	11
86	New Haven Unified School District	CA	$57,402,000	$1,552,000	11,000	10	**38**	17
87	Cedar Rapids Community School District	IA	$56,887,000	$972,000	14,740	31	**38**	14
88	Greece Central School District	NY	$56,636,000	$1,081,000	10,800	17	**33**	11
89	Perth Amboy City School District	NJ	$55,708,000	$1,301,000	10,730	11	**41**	14
90	Upper Darby School District	PA	$55,627,000	$1,244,000	12,440	14	**40**	13
91	Davenport Community School District	IA	$55,452,000	$954,000	14,290	30	**39**	13
92	Downingtown Area School District	PA	$55,390,000	$1,096,000	12,370	15	**35**	12
93	New Rochelle City School District	NY	$55,166,000	$1,264,000	10,650	10	**42**	13
94	Bethlehem Area School District	PA	$55,128,000	$1,076,000	12,280	19	**34**	12
95	North Penn School District	PA	$54,935,000	$959,000	12,660	17	**36**	13
96	Wappingers Central School District	NY	$54,915,000	$1,030,000	10,600	14	**36**	10
97	Fremont Union High School District	CA	$54,851,000	$2,129,000	10,960	5	**48**	15
98	Saddleback Valley Unified School District	CA	$54,835,000	$2,102,000	26,400	32	**53**	18
99	Colorado Springs School District 11	CO	$54,393,000	$840,000	13,670	28	**34**	16
100	Clifton City School District	NJ	$54,356,000	$1,167,000	10,620	18	**39**	12

District Abbreviations: C.U.D = Community Unit District; E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.D. = Unified District; U.S.D. = Unified School District

(Table 5, continued)

RANK	DISTRICT	STATE	EQUIPMENT[a]	ANNUAL O&M[b]	# OF STUDENTS[c]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[d]	INCREASE IN HEAT DAYS[e]
101	Palatine Community Consolidated School District 15	IL	$54,327,000	$596,000	12,350	20	**34**	10
102	Plainfield School District 202	IL	$54,141,000	$1,206,000	26,390	30	**44**	11
103	Bayonne City School District	NJ	$53,675,000	$1,762,000	9,800	13	**37**	12
104	Iowa City Community School District	IA	$53,597,000	$971,000	14,250	26	**44**	14
105	West Chester Area School District	PA	$52,984,000	$1,030,000	11,960	16	**36**	12
106	Central Dauphin School District	PA	$52,113,000	$1,005,000	11,880	19	**37**	13
107	Palo Alto Unified School District	CA	$51,740,000	$1,424,000	11,930	18	**43**	14
108	Kalamazoo Public School District	MI	$51,571,000	$1,042,000	12,440	23	**41**	12
109	Troy School District	MI	$51,172,000	$1,040,000	12,220	19	**33**	11
110	Cicero School District 99	IL	$50,913,000	$694,000	11,460	17	**40**	12

District Abbreviations: C.U.D = Community Unit District; E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.D. = Unified District; U.S.D. = Unified School District

a Combined projected HVAC installation and upgrade costs between 1970–2025.
b Projected annual operations and maintenance in 2025.
c U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.
d Predicted days over 80°F during the school year in 2025. Red >= 64 days; Orange >= 32 days; Yellow < 32 days.
e Predicted increase from 1970–2025.

TOP 25 O&M COSTS

Table 6: More climate-driven hot days add millions to cooling system operating and maintenance costs.

RANK	DISTRICT	STATE	ANNUAL O&M[a]	# OF STUDENTS[b]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[c]	INCREASE IN HEAT DAYS[d]
1	New York City Department Of Education	NY	$117,540,000	872,640	1,426	**38**	13
2	Chicago Public School District 299	IL	$37,532,000	304,500	536	**38**	12
3	Philadelphia City School District	PA	$14,717,000	124,380	211	**42**	14
4	Los Angeles Unified School District	CA	$12,449,000	421,640	650	**88**	22
5	Sweetwater Union High School District	CA	$8,065,000	32,940	20	**39**	16
6	San Diego City Unified School District	CA	$7,945,000	92,440	151	**55**	17
7	Dade County School District	FL	$7,735,000	279,910	337	**228**	41
8	Clark County School District	NV	$6,916,000	324,980	339	**122**	18
9	Capistrano Unified School District	CA	$6,547,000	46,690	54	**43**	16
10	Montgomery County Public Schools	MD	$6,475,000	163,190	207	**49**	14
11	Newark City School District	NJ	$5,831,000	35,540	61	**37**	14
12	Detroit Public Schools Community District	MI	$5,671,000	47,530	95	**34**	11
13	Boston School District	MA	$5,218,000	35,100	80	**33**	10
14	Broward County School District	FL	$5,017,000	219,270	220	**228**	33
15	Elizabeth City School District	NJ	$4,954,000	27,460	36	**40**	14
16	Jefferson County School District R-1	CO	$4,808,000	68,020	124	**43**	17
17	NYC Special Schools District 75	NY	$4,626,000	24,140	57	**38**	13
18	Cleveland Municipal School District	OH	$4,317,000	37,850	106	**43**	14
19	Baltimore County Public Schools	MD	$4,292,000	112,000	162	**49**	15
20	Hillsborough County School District	FL	$4,257,000	194,230	224	**189**	24

District Abbreviations: E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.S.D. = Unified School District

(Table 6, continued)

RANK	DISTRICT	STATE	ANNUAL O&M[a]	# OF STUDENTS[b]	# OF SCHOOLS[c]	SCHOOL YEAR HEAT DAYS[c]	INCREASE IN HEAT DAYS[d]
21	Yonkers City School District	NY	$4,193,000	26,430	40	**41**	13
22	Orange County School District	FL	$4,116,000	191,910	194	**191**	25
23	Palm Beach County School District	FL	$3,893,000	173,040	168	**218**	28
24	Gwinnett County School District	GA	$3,840,000	177,480	133	**88**	20
25	Fremont Unified School District	CA	$3,744,000	31,540	36	**37**	15

District Abbreviations: E.S.D. = Elementary School District; P.S. = Public Schools; S.D. = School District; U.S.D. = Unified School District

a Projected annual operations and maintenance in 2025.
b U.S. Dept. of Education NCES Public School Characteristics for 2018-2019 school year.
c Predicted days over 80°F during the school year in 2025. Red >= 64 days; Orange >= 32 days; Yellow < 32 days.
d Predicted increase from 1970–2025.

Discussion

The costs presented in this report are planning-level estimates based on assumptions that rely on available climate models, engineering best practices, public health criteria, and our survey of the actual experiences of school systems across the country. These figures should not take the place of the calculations, needs, and considerations of any particular school district. Local variances in any one of our factors could result in the actual costs falling below or exceeding what this study projects.

Our model uses a moderate estimate of the rate of future emissions to project the number of school days that will exceed 80°F. It is widely acknowledged that the 2020s are the crucial decade to curb global emissions in order to avert the most catastrophic future warming scenarios. Failure to do so will result in a greater number of hotter school days, and drive these and other costs higher in 2025 and beyond.

This study does not provide a specific date at which a school district has installed, or will install, a cooling system. Rather, the model assesses the climatological need for school cooling at two points in time—the 1970 baseline and the 2025 projection—and does not identify precisely when in that 55-year time span a district exceeds the *hot day* threshold or when that district may respond to rising temperatures by installing new, or upgrading existing, cooling systems.

The analysis assesses the cost of installing only HVAC systems that meet current engineering and public health criteria. Due to budgetary constraints and the complexity of retrofitting older buildings, many urban school districts, such as Chicago and New York City—which we found lead the nation with more than $1 billion in needed HVAC installation costs each by 2025—have installed window unit air conditioners. This approach, while cheaper and easier up front, is costlier in the long run. Window units are more expensive to maintain, have about one-third the lifespan of a central HVAC system, do not provide adequate ventilation in classrooms, and often fail to cool other critical parts of the school like auditoriums, gymnasiums, offices, and cafeterias.

Finally, operating costs were calculated using estimated energy demand for HVAC systems during the school year and state-level energy pricing. Actual costs will vary depending on

when schools choose to engage cooling systems and are likely to be higher as COVID-19 has increased the need for year-round ventilation and summer programming. Maintenance costs were not assumed to increase with increased use, and thus were only included for schools with new installations—not schools that require equipment upgrades or that run existing systems more often.

Recommendations

Before the pandemic, many people took schools for granted. No more. After up to a year or more of remote learning that stressed many families to the breaking point, and meant a year of lost education for far too many children, no one is taking the value of keeping students in classrooms for granted anymore.

As the nation's students finally head back to class, the demands on schools in the wake of COVID-19 are greater than ever. Ensuring proper ventilation in classrooms now joins a long list of other capital priorities, including, as this report makes clear, cooling the nation's increasingly overheated classrooms.

COVID-19 made proper ventilation a priority, but climate change caused the cooling crisis in America's public schools. Global warming began producing increasingly hot school days decades before the pandemic, and schools across the country have been, or soon will be, forced to spend millions, and in some cases billions, to install and upgrade air conditioning systems in response to increasingly hot school days caused by fossil fuel-driven global warming.

These costs have been thrust on school systems by polluters who knew their products would cause climate change, and with it, enormous damage and costs to society, but who then lied about it in order to protect their profits.

Keeping classrooms at temperatures tolerable for learning is a bare minimum requirement for a functioning educational system. Polluters and executives who lied about their role in causing climate change for decades should pay to fix the damage. At a minimum, that means polluters paying their fair share of the costs to cool the nation's classrooms, particularly those in communities with more demands on available resources, in older urban locations, often serving communities of color.

Cooling older school buildings with HVAC systems is expensive, but the price tag should make the polluters' obligation even more compelling. As parents, elected officials, teachers, and taxpayers grapple with competing priorities and the growing price tag to keep schools at safe temperatures for students, we must remember who turned up the heat in these classrooms to

begin with. As any third grader can tell you: When you make a mess, you have to clean it up. Oil and gas executives and polluting corporations caused the problem. It's time they pay their fair share to fix it.

Works Cited

Alexander, D. & Lewis, L. (2014, March). Condition of America's Public School Facilities: 2012–13 (NCES 2014–022). *United States Department of Education National Center for Education Statistics*. https://nces.ed.gov/pubs2014/2014022.pdf

Argon, J. (2003–2009). Annual Official Education Construction Reports. *American School and University*. https://www.asumag.com/research

ASHRAE. (2004). Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings. ANSI/ASHRAE/IESNA Standard 90.1-2004. *American Society of Heating, Refrigeration, and Air-Conditioning Engineers*, Atlanta, GA.

ASHRAE. (2013). Climatic Data for Building Design Standards. ANSI/ASHRAE Standard 169-2013, *American Society of Heating, Refrigeration, and Air-Conditioning Engineers*, Atlanta, GA.

Bindoff, N. L., et al. (2013). Detection and Attribution of Climate Change: from Global to Regional, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by T. F. Stocker, et al., 867-952, Cambridge University Press, Cambridge, UK and New York, USA.

Dahl, K., Licker, R., Abatzoglou, J. T. & Declet-Barreto, J. (2019). Increased frequency of and population exposure to extreme heat index days in the United States during the 21st century. *Environmental Research Communications*, 1, 075002. doi:10.1088/2515-7620/ab27cf.

Economic Research Service. (2020, October 1). National School Lunch Program. *United States Department of Agriculture*. https://www.ers.usda.gov/topics/food-nutrition-assistance/child-nutrition-programs/national-school-lunch-program

Energy Information Administration (2020, November 2). State Electricity Profiles: Data for 2019. *United States Energy Information Administration*. https://www.eia.gov/electricity/state/

Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. (2018). Heat and Learning (NBER Working Paper No. 24639). *National Bureau of Economic Research, Cambridge, MA*. https://scholar.harvard.edu/files/joshuagoodman/files/w24639.pdf

Hayhoe, K., et al. (2018) Our Changing Climate, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, edited by Reidmiller, D.R., et al. U.S. Global Change Research Program, Washington, DC, USA, 72–144. doi:10.7930/NCA4.2018.CH2.

Livneh, B., et al. (2015). A spatially comprehensive, hydrometeorological data set for Mexico, the US, and Southern Canada 1950–2013. *Scientific Data*, 2, 150042. doi:10.1038/sdata.2015.42.

National Center for Education Statistics, Common Core of Data. (n.d.). Public Elementary/Secondary School Universe Survey 2018–2019, v.1a. *United States Department of Education*. https://nces.ed.gov/ccd/pubschuniv.asp

National Center for Education Statistics, Common Core of Data. (n.d.). Public Elementary/Secondary School Universe Survey Geographic Data 2018–2019 (EDGE), v.1a. *United States Department of Education*. https://nces.ed.gov/ccd/pubschuniv.asp

NEA News. (2020, August 8). School Ventilation Must Be Addressed in Reopening Plans. *National Education Association*. https://www.nea.org/advocating-for-change/new-from-nea/school-ventilation-must-be-addressed-reopening-plans

Office of Energy Efficiency & Renewable Energy. (2010). Commercial Reference Buildings. *United States Department of Energy*. https://www.energy.gov/eere/buildings/existing-commercial-reference-buildings-constructed-or-after-1980

Park, R. J., Behrer, A. P. & Goodman, J. (2020). Learning is inhibited by heat exposure, both internationally and withing the United States. *Nature Human Behavior*, 5(1), 19–27. doi:10.1038/s41562-020-00959-9.

Park, R. J., Goodman, J., Hurwitz, M. & Smith, J. (2020). Heat and Learning. *American Economic Journal: Economic Policy*, 12(2), 306-39. doi:10.1257/pol.20180612.

Pierce, D. W. et al. (2015). Improved bias correction techniques for hydrological simulations of climate change. *Journal of Hydrometeorology*, 16, 6, 2421-2442. doi:10.1175/JHM-D-14-0236.1.

Pierce, D. W., Cayan, D. R. & Thrasher, B. L. (2014). Statistical downscaling using Localized Constructed Analogs (LOCA). *Journal of Hydrometeorology*, 15, 2558-2585. doi:10.1175/jhm-d-14-0082.1.

R.S. Means. (2019). Building Construction Cost Data. *RS Means*, Kingston, MA.

TCF Education. (2020, July 22). TCF Study Finds U.S. Schools Underfunded by nearly $150 Billion Annually. *The Century Foundation*. https://tcf.org/content/about-tcf/tcf-study-finds-u-s-schools-underfunded-nearly-150-billion-annually/?agreed=1

The White House, Office of the Press Secretary. (2021, March 31). FACT SHEET: The American Jobs Plan. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

U.S. Census Bureau. (2018). Cartographic Boundary Files - Shapefile. *United States Census Bureau*. https://www.census.gov/geographies/mapping-files/time-series/geo/carto-boundary-file.html

U.S. Department of Education. (2021, January 5). Secretary DeVos Quickly Makes Available an Additional $54 Billion in COVID Relief Aid for K–12 Students, Teachers, and Schools [Press release]. https://www.ed.gov/news/press-releases/secretary-devos-quickly-makes-available-additional-54-billion-covid-relief-aid-k-12-students-teachers-and-schools

U.S. Government Accountability Office. (2020, June). K–12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement (Publication No. GAO-20-494). https://www.gao.gov/assets/gao-20-494.pdf

Wang, J. et al. (2021). Changing lengths of the four seasons by global warming. *Geophysical Research Letters*, 46, 6. doi:10.1029/2020GL091753.

APPENDIX: Community Profiles

Baltimore

> *NOTE: When it comes to our analysis of climate-driven air conditioning costs in public schools, Baltimore is the exception that proves the rule. The rule is our methodology, which identified 32 days over 80°F during the school year as the threshold at which air conditioning is installed in school classrooms, based on actual practice, public health criteria, and standard engineering protocols. The exception is Baltimore City, which had 35 days above 80°F during the school year in 1970 but did not and still does not have cooling systems in place in its public school system.*
>
> *This exception had consequences: Because heat days in Baltimore exceeded the 32-day threshold in 1970, our method assumes that the city had cooling systems in place and we assign no climate-driven cooling equipment costs to the city, even though Baltimore will see 15 more days over 80°F in 2025 than in 1970 (to 50 days total) and even though Baltimore schools have been battling a cooling crisis for many years, exacerbated by climate change.*
>
> *Simply put, our method is conservative, and it tends to understate the impact of climate change on the costs of cooling the nation's public schools.*

Baltimore City is lagging significantly behind the rest of Maryland when it comes to keeping classrooms cool. Twenty-four[41] of the city's public schools still do not have air conditioning, and they have been forced to close early on extremely hot days.

41 *Schools Without AC: Baltimore City Public Schools*. Schools Without AC | Baltimore City Public Schools. (n.d.). https://www.baltimorecityschools.org/ac

Baltimore City schools suffer from outdated infrastructure,[42] mold,[43] lead contamination,[44] and a lack of funding that has prevented many schools from installing both heating equipment and air conditioning—especially in its lower-income communities and communities of color.

These inequities are heightened by the fact that Baltimore's poorest neighborhoods are also heating up the fastest, according to findings from NPR and the University of Maryland's Howard Center for Investigative Journalism.[45] The study found that in recent years, residents from these low-income, fast-warming areas were admitted to hospitals at significantly higher rates than people living in cooler areas, and they presented a variety of heat-related illnesses.

That's especially worrisome as many Baltimore schools don't have the air filtration equipment necessary to protect students from the myriad air toxins to which they're exposed.[46] The city's air is polluted by a range of sources, including highways, trash incinerators, and fossil fuel and chemical manufacturing facilities.

"As our climate continues to warm and extreme heat days become more frequent and severe, students across the city of Baltimore—especially in low-income neighborhoods and communities of color already threatened in school by toxic air pollution nearby—are paying the price with their health and learning," said Delegate Stephanie Smith, who represents District 45 in Baltimore City.

In 2016, Gov. Larry Hogan and Comptroller Peter Franchot instructed both Baltimore City and Baltimore County to develop plans for installing air conditioning in all schools, and a divided state Board of Public Works voted to withhold millions of dollars in construction funding until

42 Rios, E. (2018, January 6). *It's not just freezing classrooms in Baltimore. America's schools are physically falling apart.* Mother Jones. https://www.motherjones.com/politics/2018/01/its-not-just-freezing-classrooms-in-baltimore-americas-schools-are-physically-falling-apart/

43 Meehan, S. (2019, June 19). *What's with the mold at some Maryland schools? 30 in Baltimore have been treated for spores since August.* baltimoresun.com. https://www.baltimoresun.com/maryland/bs-md-mold-in-schools-20180925-story.html

44 Dance, S., & Lumpkin, L. (2019, June 30). *State-mandated testing finds lead in water at two dozen local schools; Baltimore, Howard counties will test this year.* baltimoresun.com. https://www.baltimoresun.com/news/investigations/bs-md-sun-investigates-school-lead-testing-20180817-story.html

45 Anderson, M., & McMinn, S. (2019, September 3). *As Rising Heat Bakes U.S. Cities, The Poor Often Feel It Most.* NPR. https://www.npr.org/2019/09/03/754044732/as-rising-heat-bakes-u-s-cities-the-poor-often-feel-it-most

46 Noor, D. (2021, April 19). *Why Schools Should Be the Center of a Green New Deal.* Earther. https://earther.gizmodo.com/why-schools-should-be-the-center-of-a-green-new-deal-1846670571

the city and county complied.[47] While both districts moved forward with plans, the City warned that doing so would delay other projects like fire safety and roofing.

"City Schools does not have sufficient funds to address these needs or even to perform necessary basic and preventative maintenance with the frequency recommended under industry standards, including to critical mechanical, plumbing, electrical, and security systems," reads the district's February 2021 air-conditioning plan update.[48]

While the district originally planned to air condition all schools with window units and split systems by the 2022–2023 school year, it underestimated the overall costs to do so.[49] In 2019, the Baltimore Teachers Union collected donated fans to prepare for a sweltering September; prior to donations, teachers said they had no choice but to pull from their own paychecks.[50]

Ultimately, the district decided to install vertical package units (VPUs), which provide both heating and cooling, as a better and more cost-effective option given the lack of funds required to equip schools with central air. Still, the new date of completion will depend on the availability of Capital Improvement Program funds, which will be disbursed to a range of priorities for the district.

"Every child in Baltimore deserves the opportunity to learn in a comfortable and safe environment," Delegate Smith said. "Corporate polluters need to pay their fair share for the costs of addressing the dangerous climate impacts they knowingly caused."

Boston

In a city where most of the 56,000 public school students sit in classrooms without air conditioning, the growing frequency of hot and humid days at the start and end of the school

47 Wood, P. (2019, June 30). *State board withholds city, county school money over air conditioning dispute*. baltimoresun.com. https://www.baltimoresun.com/politics/bs-md-bpw-air-conditioning-20160510-story.html

48 Scott, B. M., Chinnia, L., & Santelises, S. B. (2021, January 28). *Baltimore City Public Schools' Air-Conditioning Plan: Update*. https://www.baltimorecityschools.org/sites/default/files/2021-03/CitySchoolsACPlan_Updated_3-3-21.pdf

49 Baltimore Sun Staff. (2019, September 5). *About 50 Baltimore schools without air conditioning dismiss early because of heat on second day of class*. baltimoresun.com. https://www.baltimoresun.com/education/bs-md-ci-schools-dismiss-20190904-re6e6tlcwrdatlln3kdubnxgfa-story.html

50 Richman, T. (2019, August 29). *Baltimore schools are so hot, teachers are collecting fans. Officials worry that'll strain electrical systems*. baltimoresun.com. https://www.baltimoresun.com/education/bs-md-hot-classrooms-btu-fan-drive-20190814-a3cwmmvlubattctxipjwpqcucu-story.html

year has not gone unnoticed. According to Jessica Tang, President of the Boston Teachers Union, only 37 out of 127 school buildings have HVAC.

"Every year, particularly in June but also in May and in the fall school starts, we get reports on classrooms that have extremely high temperatures," said Tang, who recalled putting paper on her windows to block the sun when she began teaching in 2004. Her classroom had neither air conditioners nor window shades. "As you can imagine, it's a huge distraction for students to be learning in that kind of environment, and even taking high-stakes tests and final exams in sweltering classrooms."

Many of Boston's public schools were built before World War II and suffer from aging or lacking infrastructure. Others built in the 1970s are in desperate need of retrofitting and repairs. According to a 2017 city report, more than half of Boston public schools have deficient air quality, which can trigger asthma attacks, a disease that plagues on average 16 percent of students across the district and 30% in some schools.[51]

"We have young people who come and they have heat rashes, we have young people who say they feel like passing out, and we have young people who have passed out because it's too hot," Jenny Fernandez, a youth program director at the Massachusetts Coalition for Occupational Safety and Health, told the *Boston Herald* in 2019.[52] Fernandez works with a group of volunteer teachers and students to track temperatures in Boston Public Schools.

The district does not currently have a plan to install more air conditioning in its buildings, and teachers like Michael Maguire at the Boston Latin Academy say the problem is getting worse. "It might've been just a couple of weeks in June in the old days, but starting in May, probably all the way to mid-October, the classroom is warm," Maguire said. "They just can't concentrate as much, their heads are down, it's harder to focus, they get irritated, and the message it sends the kids is that they're not important. It's frustrating."

The lack of cooling infrastructure has come up as an issue in contract negotiations with the

51 Vaznis, J. (2017, March 2). *Many Boston public schools are said to have bad air.* Boston Globe. https://www.bostonglobe.com/metro/2017/03/01/quality-air-schools-doubt/3bvfLoTzSepVGXvsL9HKhM/story.html

52 Cohan, A. (2019, September 28). *Students, teachers sweltering in Boston schools with no AC.* Boston Herald. https://www.bostonherald.com/2019/09/28/students-teachers-sweltering-in-boston-schools-with-no-ac/

Boston Teachers Union, according to Tang. The BTU is now partnering with the American Federation of Teachers and building trades to push for a Green New Deal for schools that would address the need to update facilities and build new schools, creating both union jobs and cost savings with more efficient energy use. "That's something that could go back into our communities and our schools," said Tang. "At the minimum it helps our students learn when they're in comfortable environments."

In 2019, State Rep. Joan Meschino and State Senator Patrick O'Connor cosponsored a bill that would authorize a study of the maximum and minimum allowable temperatures for classrooms, and would create a commission to evaluate the process of upgrading and installing air conditioning in public schools.[53] As of yet, the city is still unprepared to deal with extreme temperatures—including potential snow days that might extend the school year to late June—and when the COVID-19 pandemic struck, Tang says, the district's lack of air conditioning and ventilation problems delayed its reopening.

In the meantime, students' health and productivity will continue to suffer—especially for children of color, who make up the majority of the district's student population. A 2018 study from Harvard's Kennedy School of Government found that for every 1°F increase in school year temperature, the amount learned that year will be reduced by one percent—an impact that is nearly entirely offset by air conditioning.[54]

Chicago

In 2016, then-Mayor Rahm Emanuel told Chicago that the city's remaining 61 schools without air conditioning would receive it by the following spring, at a cost of $27 million in capital budget expenditures.[55,56] Over the six years prior, the city and school district spent $135 million cooling

53 Whitfill, M. (2019, June 7). *Mass. schools not ready for climate change, lawmakers say.* The Patriot Ledger, Quincy, MA. https://www.patriotledger.com/news/20190604/mass-schools-not-ready-for-climate-change-lawmakers-say

54 Goodman, J., Park, R. J., Smith, J., & Hurwitz, M. (2018, May 28). *HEAT AND LEARNING*. Harvard Kennedy School. https://www.hks.harvard.edu/announcements/when-heat-student-learning-suffers

55 WLS-TV. (2016, August 22). *All CPS classrooms to have air conditioning by spring*. ABC7 Chicago. https://abc7chicago.com/chicago-public-schools-cps-air-conditioning-mayor-rahm-emanuel/1479289/

56 Jr., J. P. (2019, May 15). *Emanuel defends CPS borrowing for air conditioning, other projects*. chicagotribune.com. https://www.chicagotribune.com/politics/ct-rahm-emanuel-air-conditioners-met-20160822-story.html

over 200 schools[57]—but with more frequent extreme heat days suffocating the city, there was much more work to be done.

But 2017 came and went, and as heat waves bore down on the city over the years following, the district instead found itself delivering thousands of fans to keep students cool. Parents and teachers were still reaching deep into their own pocketbooks to install portable air conditioners in scorching classrooms.[58]

Even in schools with air conditioning, many units are failing and in need of repair or complete overhaul. Since the spring of 2020, the district has spent $100 million upgrading its HVAC systems in public school buildings that are an average of 80 years old.[59] "It is impossible to learn or teach effectively in a sweltering school, yet that's exactly what many classrooms continue to confront, as CPS drags on addressing a $3.5 billion backlog of facilities repairs that the District has delayed for years," said Chicago Teachers Union President Jesse Sharkey.

"The real issue that I worry about is respiratory health," a teacher at Hancock College Prep said on the school's student-hosted podcast.[60] "Humidity can affect people who are asthmatic, as can changes in temperature. If a kid has an asthma attack, then they have to leave class. These problems aren't new… and we're put in a situation where there's nothing we can do."

The threats to health and learning are particularly acute for low-income families and students of color. According to UCLA professor R. Jisung Park, who coauthored a study on the impact of heat in unairconditioned classrooms, a 90°F school day has a negative effect on learning that is nearly two and a half times as severe for nonwhite students as for white students, owing to the disproportionate lack of air conditioning for schools in those neighborhoods.[61]

57 FOX 32 Chicago. (2019, August 22). *Mayor Emanuel, CPS announce every classroom will be air conditioned by spring 2017.* FOX 32 Chicago. https://www.fox32chicago.com/news/mayor-emanuel-cps-announce-every-classroom-will-be-air-conditioned-by-spring-2017

58 Dwyer, M. (2018, May 31). *Parents say summer heat inside West Loop school hits 'inhumane' levels.* WGN. https://wgntv.com/news/parents-say-summer-heat-inside-west-loop-school-hits-inhumane-levels/

59 Addonizio, M. (2021, April 2). *America gets a D+ for school infrastructure - but federal COVID relief could pay for many repairs.* The Conversation. https://theconversation.com/america-gets-a-d-for-school-infrastructure-but-federal-covid-relief-could-pay-for-many-repairs-156831

60 *Chicago Public Schools Students Discuss a Hot September without Air Conditioning.* SoundCloud. (n.d.). https://soundcloud.com/user-960232977/chicago-public-schools-students-first-month-of-school-without-air-conditioning

61 Park, R. J. (2019, August 15). *Heat wave: Air conditioned schools would narrow the racial achievement gap.* USA Today. https://www.usatoday.com/story/opinion/2019/08/15/heat-wave-students-need-air-conditioning-close-achievement-gap-column/1996394001/

These inequities are exacerbated by Chicago's warming climate, which means more frequent and severe heat waves for the city.[62] "Nine out of ten of our students are Black and Brown, so lack of a basic need like air conditioning in the face of climate change is fundamentally an equity issue," Sharkey said.

"If we want to see Black and Hispanic [kids] rise, why not simply fix the fact that we lack air conditioning?" asked a student at Hancock College Prep and one of the podcast's producers.

Cleveland

As brutal temperatures creep into the spring and fall, schools in Northeast Ohio still lack the air conditioning they need. In September 2018, near-100°F heat prompted several school districts to cancel classes for days.[63]

No schools in the Cleveland Metropolitan School District had air conditioning in late September 2017, but all but one stayed open during record-breaking temperatures, even as learning was stifled and teachers reported students falling ill.

"They're sweating in their rooms and it's just sad… they're not learning anything," a Cleveland Metro School District teacher told News5 at the time.[64] "They're too hot. I walked through the halls and no classroom is doing anything. The lights are off, the fans are blasting. They have popsicles and cold water, but the kids had to pay 75 cents for a cold water."

Under Ohio law, the district's superintendent decides whether or not schools should close during extreme heat days. And while factors like missed learning and working parents' availability must be considered, extreme temperatures can also be dangerous to students' health.

62 *Heat Stress, Chicago, IL, USA: Global Warming Effects*. Heat Stress, Chicago, IL, USA | Global Warming Effects. (n.d.). https://www.climatehotmap.org/global-warming-locations/chicago-il-usa.html

63 Mosby, C. (2018, September 4). *Extreme Heat Closes Schools Across Northeast Ohio*. Cleveland Heights, OH Patch. https://patch.com/ohio/clevelandheights/extreme-heat-closes-schools-across-northeast-ohio

64 Molina, T. (2017, September 25). *Cleveland teacher says students are too hot without air conditioning*. WEWS. https://www.news5cleveland.com/news/local-news/cleveland-metro/cleveland-teacher-says-students-are-too-hot-without-air-conditioning

"Certainly temperatures in the 90s for a prolonged period of time, like an entire school day, can put kids at stress and risk for heat related illness," Dr. Jerri Rose, a pediatrician emergency room physician at Rainbow Babies and Children's Hospital in Cleveland, told Fox8 in 2016.[65] "Kids can feel nauseous, headaches, vomiting, even they can be confused, even difficulty thinking."

Still, upgrading the electrical and plumbing systems that in some school buildings would be necessary to install air conditioning is cost prohibitive. In fact, many school districts across Northeast Ohio are weighing the cost of retrofitting old buildings against constructing entirely new ones.[66]

State Rep. Niraj Antani (Miamisburg), who in 2018 introduced legislation that would require a study of the cost to install air conditioning in every Ohio school, points out that it's not just an issue during the very beginning and end of the school year.

"Those are the days where they actually close or dismiss early," he told WOSU in 2019.[67] "Those are not the days where people are coming home with headaches, or struggle taking tests because of the heat."

65 Reid, M. (2016, September 8). *How schools without air conditioning decide if it's too hot for students*. Fox 8 Cleveland WJW. https://fox8.com/news/how-schools-without-air-conditioning-decide-if-its-too-hot-for-students/.

66 DeRoos, D. (2018, September 4). *Why can't they just put AC in my kids school in Northeast Ohio? The answer is extremely complicated*. https://www.cleveland19.com. https://www.cleveland19.com/story/39021799/why-cant-they-just-put-ac-in-my-kids-school-in-northeast-ohio-the-answer-is-extremely-complicated/.

67 Roth, C. (2019, October 1). *As Ohio Schools Close From Heat, Lawmaker Continues Push For Air Conditioning*. WOSU News. https://news.wosu.org/news/2019-10-01/as-ohio-schools-close-from-heat-lawmaker-continues-push-for-air-conditioning.

Denver

When temperatures skyrocketed in Denver during late August 2019, classroom teachers attempted a mix of creative solutions to help their students cope: closing the blinds during the day, turning off the lights, and even asking students to come up with their own room-cooling experiments.[68] But with un-air-conditioned classrooms reaching up to 98°F, it wasn't enough to keep kids learning.

That level of stifling heat can make it hard for students to stay engaged. It also poses a real threat to their health—especially in schools without a full-time nurse on staff. That August, a group of schoolteachers organized a rally outside the headquarters of Denver Public Schools to protest the hazardously hot conditions.[69]

"Teachers tend to be martyrs," Lisa Yemma, a teacher at Slavens K-8 School, told the Chalkbeat Colorado. "We say, 'This totally sucks, but we're going to do it anyway because it's for the kids.' But at this point, we are risking the health and safety of the kids."

The issue is widespread in Colorado's capital city: 55 Denver public schools lack air conditioning, and that's a big improvement from a decade ago. Over the past decade, Denver voters approved nearly $90 million in municipal bonds to pay for heat mitigation in schools.[70] The district says that in 2020, voters overwhelmingly approved a $795 million bond package that included a planned investment of $128 million over the next three years for air conditioning in 24 Denver public schools.

"In considering the trade-offs, there were many projects in areas such as critical maintenance, capacity, quality learning environments and others that did not receive funding through the bond," Jim Carpenter, interim chief operating officer/chief financial officer for Denver Public

68 Lopez, M. (2019, August 20). *60 Denver schools lack air conditioning as city heats up to 98 degrees*. The Denver Post. https://www.denverpost.com/2019/08/20/denver-schools-lack-air-conditioning-heat/.

69 Asmar, M. (2019, August 26). *Why teachers and parents are hot about these 60 Denver schools without air conditioning*. Chalkbeat Colorado. https://co.chalkbeat.org/2019/8/26/21108702/why-teachers-and-parents-are-hot-about-these-60-denver-schools-without-air-conditioning.

70 Asmar, M. (2020, February 21). *Too hot: Denver exploring a later start for schools without air conditioning*. Chalkbeat Colorado. https://co.chalkbeat.org/2020/2/20/21178593/too-hot-denver-exploring-a-later-start-for-schools-without-air-conditioning.

Schools, wrote in an email. According to Carpenter, installing air conditioning in the remaining 31 schools is expected to cost an additional $138 million.

As a stopgap, the district proposed a revised school calendar, starting later in the year. But the proposal could cause another dilemma for working families, as most summer camps and childcare providers won't continue their programs past the usual start date.[71]

In order to prevent the spread of COVID-19, the district committed $4.9 million[72] to air-conditioning upgrades and ventilation repairs for the fall of 2020. Climate change will speed up the process as well: a recent report from the University of Colorado found that "all climate projections indicate that heat waves will substantially increase in frequency and severity in Colorado as the summer climate becomes warmer."[73]

Denver's teachers are contending with this reality and the impacts it will have on their classrooms. "In the future, as the climate gets warmer, this is an issue we do need to solve," Yemma told the Chalkbeat Colorado.

Detroit

In May 2018, Detroit Public Schools Community District school board member Sonya Mays found herself at Michigan's largest annual political event, pleading with business and political leaders for financial support. The school district faces infrastructural problems it can't afford to repair—roof leaks, corroded sewage infrastructure, dangerous mold, broken boilers and fire alarm systems, and a lack of air conditioning in aging buildings that leaves classrooms boiling.

"We have several decades of poorly maintained buildings, deferred maintenance and tons of vacant buildings for which there is no clear purpose," Mays told the audience. "I don't know that

71 Asmar, M. (2020, February 21). *Too hot: Denver exploring a later start for schools without air conditioning*. Chalkbeat Colorado. https://co.chalkbeat.org/2020/2/20/21178593/too-hot-denver-exploring-a-later-start-for-schools-without-air-conditioning

72 Asmar, M. (2020, July 10). *Denver schools to get ventilation upgrades to help stem spread of coronavirus*. Chalkbeat Colorado. https://co.chalkbeat.org/2020/7/10/21320390/denver-schools-ventilation-upgrades-coronavirus.

73 Lukas, J. (2018). (rep.). *Climate Change in Colorado: Recent Trends, Future Projections and Impacts An Update to the Executive Summary of the 2014 Report*. Retrieved from https://wwa.colorado.edu/climate/co2014report/ExecSummary_Climate_Change_CO_Report_update_August2018.pdf

I can overstate how much of a hurdle that has become in consistently educating and providing a safe environment for our students."[74]

That month, Detroit schools closed 106 mostly unairconditioned buildings early for three days in a row as an unrelenting heat wave descended on the city. The district didn't always get so hot, but with each year rising temperatures[75] and pollution from local oil refineries put Detroit's school children—especially those suffering from asthma—at increased risk.

Aside from closing schools early on hot days, the district has also canceled afternoon sports activities and reduced summer school program offerings at schools without A/C.[76,77] COVID-19 precautions add an additional complication to keeping kids cool. Packing students into the city's few air-conditioned locations poses concerns, as does public school transportation to those locations, since over a quarter of Detroit households do not own cars.[78]

In the summer of 2020, the community identified improved air conditioning and filtration in schools as a priority project for local oil refiner, Marathon Petroleum, to fund as part of a consent agreement proposed by state regulators after numerous air quality violations.[79]

"Children are particularly vulnerable to air pollution," Nicholas Leonard, attorney for the Detroit-based nonprofit Great Lakes Environmental Law Center, told the Detroit Free Press in 2020. "Air filtration systems have been shown to be a really effective way to limit their exposure to air pollution, as they spend quite a bit of time at school."

74 Taylor, K. H. (2018, May 31). *'Sweatbox' conditions close aging Detroit schools a third day as board member seeks help.* Chalkbeat Detroit. https://detroit.chalkbeat.org/2018/5/31/21105110/sweatbox-conditions-close-aging-detroit-schools-a-third-day-as-board-member-seeks-help

75 Adler, B. (2015, June 9). *Think Detroit has it rough now? Just wait 'til climate change gets ahold of it.* Grist. https://grist.org/cities/think-detroit-has-it-rough-now-just-wait-til-climate-change-gets-ahold-of-it/

76 Chen, G. (2011, July 28). *The Heat is On and Summer School is Out at Public Schools in Midwest.* Public School Review. https://www.publicschoolreview.com/blog/the-heat-is-on-and-summer-school-is-out-at-public-schools-in-midwest

77 Chambers, J. (2017, September 25). *Heat forces Detroit schools to shorten day on Tuesday.* The Detroit News. https://www.detroitnews.com/story/news/local/detroit-city/2017/09/25/detroit-schools-half-day-due-heat/105992496/

78 Sivak, M. (2014, January 23). *Hitchin' a ride: Fewer Americans have their own vehicle.* University of Michigan News. https://news.umich.edu/hitchin-a-ride-fewer-americans-have-their-own-vehicle/

79 Matheny, K. (2020, July 29). *EGLE deal with Marathon refinery over air pollution violations called 'egregious.'* Detroit Free Press. https://www.freep.com/story/news/local/michigan/wayne/2020/07/29/egle-deal-marathon-refinery-air-pollution-violations-panned/5530309002/

Until polluters help pay, the district will struggle to maintain its crumbling infrastructure as millions of dollars in repairs pile up. Because the district has already borrowed the maximum amount under Michigan law to pay for capital improvements, it can't issue any more debt to fund necessary construction, including installing and upgrading air conditioning.[80]

And while some Michigan school districts have asked taxpayers to fund air-conditioning installation through municipal bonds, lower-income districts can't always afford to do so[81]—leading to gaping inequities between the services and learning environments provided to students.

"If you live in a community that has not asked the community for a bond to improve facilities... you may be in a building that would be difficult to support extended summer learning opportunities for students because the building's not going to be very comfortable for students," Steve Matthews, superintendent of the Novi Community School District, told the Detroit Free Press in 2021.[82]

A 2018 assessment by engineering consulting firm OHM Advisors found that if DPSCD waited another 10 years to take action, its infrastructure costs could reach nearly $1.5 billion total.[83]

Newark

As summers in the city of Newark get longer and hotter, air conditioning for all the district's schools could become a necessity.

The Garden State's average annual temperature has already increased 3.5°F since 1895—and that increase could double by midcentury, according to a report released by the New Jersey

80 Chambers, J. (2019, April 30). *Detroit schools face tough choices with too many repairs, not enough money.* The Detroit News. https://www.detroitnews.com/story/news/local/detroit-city/2019/04/29/detroit-schools-face-tough-choices-too-many-repairs-not-enough-money/3232674002/

81 Levin, K. (2021, February 5). *Many Michigan schools lack air filters that would help fight COVID-19.* Chalkbeat Detroit. https://detroit.chalkbeat.org/2021/2/5/22268927/michigan-school-air-filter-hvac-covid

82 Altavena, L. (2021, March 24). *Michigan school buildings without AC face pricey problem amid plans for summer school.* Detroit Free Press. https://www.freep.com/story/news/2021/03/24/michigan-schools-summer-class-air-conditioner/4747764001/

83 (2018). (rep.). *FACILITIES ASSESSMENT & SCHOOL FACILITY PLANNING.* Retrieved from https://www.detroitk12.org/site/handlers/filedownload.ashx?moduleinstanceid=15090&dataid=16065&FileName=ExecutiveSummary_FINAL-2018-08-08.pdf

Department of Environmental Protection in 2020.[84] Heat waves are particularly severe in parts of the city with less tree cover and more asphalt, which tend to house more of Newark's low-income communities and communities of color, thanks to long-standing housing inequities and a legacy of redlining.[85]

The question is whether the school district can afford the equipment and updates necessary to keep classrooms cool. Steve Morlino, director of Facilities Management at Newark Public Schools, says that while the district has discussed the installation of air conditioning throughout the district, "there is no specific timeline as this is a major funding issue and electrical upgrades and environmental remediation is needed to accomplish this in many of our schools."

Because Newark's schools were built between 1848 and 2016, buildings with air conditioning feature various mixes of window units and rooftop HVAC depending on their year of construction. Many schools have only partial air conditioning, and others have only the heating and ventilation portions of their HVAC functioning due to budgetary constraints. Thirty-two of the district's schools have no mechanical ventilation at all.

"Air conditioning is not an option for everyone because of the cost," said Assemblywoman Mila M. Jasey, the lead sponsor of a 2018 bill that would've set temperature control policies and standards for local schools, after a heat wave canceled classes throughout New Jersey that year.[86] "It's very uneven, in terms of where there's air conditioning and where there's not."

For now, the lack of cooling across the entire district has ripple effects beyond impacting learning during the school year; summer school locations are limited to schools with air conditioning, limiting the infrastructural maintenance work that can be done at those facilities during the summer and sometimes delaying projects indefinitely.

84 Barr, H., Orlando, P., Kettig, R., Barry, R. C., Karmarkar-Deshmukh, R., & Kamel, M. (2020). (rep.). *NEW JERSEY'S GLOBAL WARMING RESPONSE ACT.* New Jersey Department of Environmental Protection. Retrieved from https://www.nj.gov/dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf

85 Sol Warren, M. (2020, September 29). *Climate change and concrete turn up heat on vulnerable communities in New Jersey's cities*. Climate Central. https://www.climatecentral.org/news/climate-change-and-concrete-turn-up-heat-on-vulnerable-communities-in-new-jerseys-cities

86 Jennings, R. (2018, September 6). *Kids are sweating in school, and many aren't getting AC anytime soon.* nj.com. https://www.nj.com/news/2018/09/its_the_first_day_of_school_but_still_too_hot_to_h.html

Energy costs have also become a greater concern during the COVID-19 pandemic. Morlino says the district reset its existing air-conditioning units to run 24/7 and has provided air processors for every classroom.

In February 2021, the New Jersey Senate approved legislation to establish the School & Small Business Energy Efficiency Stimulus Program within the Board of Public Utilities.[87] The program would help fund infrastructure improvements in New Jersey schools, including better air-conditioning systems to ensure the safety of students during the COVID-19 pandemic. As of this report, NJ S3033 is still pending in the New Jersey General Assembly.

Philadelphia

Philadelphia's summers are getting longer and hotter, and its low-income neighborhoods are paying a disproportionately high price. The city's communities that suffer from a history of racist redlining policies, like Cobbs Creek, Point Breeze, Strawberry Mansion, and Hunting Park,[88] are experiencing as much as 10°F more in increased average daily temperatures in comparison to their wealthier neighbors in Philadelphia, according to a 2020 study published in the journal *Climate*[89]—but lack the funding and resources they need to keep themselves cool.

Philadelphia's under-resourced schools, many of which were built in the 1940s, are plagued by crumbling infrastructure, leaks, asbestos, mold, rodents, and a lack of air conditioning that many say wouldn't be tolerated in richer, whiter school districts in the suburbs.[90,91] But because Pennsylvania's schools are largely funded by local property taxes and the city's tax base is strained, the challenge of wiring old buildings and installing air conditioning can be insurmountable.

87 *Senate Panel Approves Sweeney-Singleton Bill to Upgrade Water & Ventilation Systems*. Insider NJ. (2021, February 11). https://www.insidernj.com/press-release/senate-panel-approves-sweeney-singleton-bill-upgrade-water-ventilation-systems/

88 Phillips, S. (2020, January 16). *Redlining's ongoing harm: Intensifying impact of climate change, new study says*. WHYY. https://whyy.org/articles/redlinings-ongoing-harm-intensifying-impact-of-climate-change-new-study-says/

89 Hoffman, J. S., Shandas, V., & Pendleton, N. (2020, January 13). *The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas*. MDPI. https://www.mdpi.com/2225-1154/8/1/12/htm

90 Laker, B., Ruderman, W., & Purcell, D. (2019, May 13). *Toxic City: Read the full series by the Inquirer exposing environmental hazards facing Philly children*. https://www.inquirer.com. https://www.inquirer.com/news/inq/toxic-city-philadelphia-inquirer-investigation-lead-asbestos-schools-20170618.html

91 Newall, M. (2018, September 5). *How Philly's overheated schools show disregard for our students: Mike Newall*. https://www.inquirer.com. https://www.inquirer.com/philly/columnists/mike_newall/philadelphia-school-district-air-conditioners-early-dismissal-helen-gym-heat-wave-20180905.html

Hannah Zieve taught in an unairconditioned high school classroom in Northwest Philadelphia for five years before going remote during the pandemic. The school where she worked couldn't afford to make the upgrades necessary for its electrical system to handle new air conditioners, she said, and they weren't alone. Zieve said she doesn't know any other teachers in the district who have worked in a fully air-conditioned building.

"There were lots of days where it was 85°F for many days in a row, so not hot enough according to the district to release early—and it was miserable," Zieve said. "Having a classroom that is starting at 80°F and then is filled with 30 teenage bodies is just horrifying. You would see over the course of the day students getting more and more lethargic, exhausted."

The flip side is that when students are released early, learning time is sacrificed. During a late-summer heat wave in 2018, Philadelphia students were dismissed early five times over a two-week period. "Our children had to see their school days shortened, struggling through heat indexes of 100, while children in the wealthiest parts of our state—Lower Merion, Radnor—went to full-day learning," Philadelphia City Councilwoman Helen Gym said during a 2018 press conference where she and other local officials called on the state to fund a dormant reimbursement program for school construction projects, including repairs to older buildings.[92]

That year, approximately one-quarter of Philadelphia public schools had air conditioning. Officials estimated in 2018 that it would cost $145 million to install air conditioning in every Philadelphia classroom—but in districts with tight budgets, outdated buildings, and electrical systems that aren't equipped for air conditioning, that money is often siphoned toward other needs, like school security. "Should we put the money into air-conditioning or safety? Usually, safety's going to win out on that," Mark DiRocco, executive director of the Pennsylvania Association of School Administrators, told the *Philadelphia Inquirer* in 2018.[93]

Today, the challenges posed by COVID-19 have made this dire situation all the more complicated. In February 2021, Philadelphia school district officials announced that they would attempt to ventilate un-air-conditioned buildings, some of which are over 100 years old, by

92 Graham, K. A., & Hanna, M. (2018, September 8). *Old schools, hot buildings: A 'public health concern'?* The Philadelphia Inquirer. https://www.inquirer.com/philly/education/old-schools-hot-buildings-public-health-concern-philadelphia-yeadon-20180908.html

93 Graham, K. A., & Hanna, M. (2018, September 8). *Old schools, hot buildings: A 'public health concern'?* The Philadelphia Inquirer. https://www.inquirer.com/philly/education/old-schools-hot-buildings-public-health-concern-philadelphia-yeadon-20180908.html

adding window fans to 1,100 of the city's classrooms. But some teachers and parents feel that isn't good enough[94]—especially since so many of the district's buildings have poor air quality to begin with.

Even once the brunt of the COVID-19 crisis passes, climate change means schools will need to find a fix other than fans, water bottles, and canceled classes. "As the climate crisis worsens and severe weather events, including extreme heat waves, increase in frequency, we need to ensure that our school buildings are safe places to learn. In Philadelphia, where many of our schools have sorely needed repairs for years, this mandate is even more urgent," said Philadelphia Councilmember Kendra Brooks.

"What's clear is that we can't ensure that every school has adequate heating, cooling, and ventilation systems with the funding that our public schools currently have. It will take massive investments in our school building infrastructure to give our kids the learning environments they deserve, and working-class taxpayers should not have to foot the bill alone."

Pittsburgh

As Pittsburgh Public Schools planned to return to in-person class in the fall, the system faced a dire question: With only about 12 of 55 buildings equipped with air conditioning, and both students and teachers wearing masks all day, how would teachers and students fare in the heat?[95]

The stumbling block is cash. The district has estimated that installing new cooling systems could cost $1.5 to $7 million per school, and the entire process could take more than a decade.[96]

94 Graham, K. A. (2021, February 4). *Window fans may be Philly's fix for schools with poor ventilation. But teachers and parents are saying no way.* https://www.inquirer.com. https://www.inquirer.com/education/philadelphia-school-district-ventilation-fans-reopening-20210202.html

95 CBS Pittsburgh. (2020, July 13). *Pittsburgh Federation Of Teachers Raises Questions About Wearing Masks All Day If Return In Fall.* CBS Pittsburgh. https://pittsburgh.cbslocal.com/2020/07/13/pittsburgh-federation-of-teachers-raises-questions-about-wearing-masks/

96 Behrman, E. (2018, September 5). *Pittsburgh Public: Installing air conditioning in schools would cost millions.* Gazette. https://www.post-gazette.com/news/education/2018/09/05/Pittsburgh-Public-Schools-air-conditioning-students-buildings-summer-heat-Pam-Capretta/stories/201809050159

"We couldn't sustain that on our current revenue sources," Pamela Capretta, chief operations officer for the district, told the *Pittsburgh Post-Gazette*. "We have limited dollars and we like to put most of our money into instructional needs."

There's no easy answer, but the district will need to start thinking. Even after the brunt of COVID-19 passes, higher temperatures[97] could pose a real danger to students and staff. In 2018, multiple schools across the district were forced to close early or cancel classes during an extended heat wave in early September[98]—a first for the district. The start of that same school year was delayed due to mold and air quality issues caused by heavy summer rains.[99]

In 2018, Pennsylvania spent an estimated $261 million on climate-related costs, according to a report by the state's auditor general.[100] The report's section on projected costs includes millions of dollars to install air conditioning in public schools in response to rapid warming.

San Diego

Climbing temperatures are baking San Diego as its school districts search for solutions. Data provided by National Weather Service lead forecaster Dan Gregoria, and cited by the *San Diego Union-Tribune*, shows that the average temperature from June to October in San Diego has risen 5 degrees since records began being kept in 1874.[101]

The San Diego Unified School District says it has finished installing air conditioning at all but one of its schools in 2019 as part of the Board of Education's September 2015 decision to implement districtwide air conditioning in classrooms and campus support spaces. The cost of

97 Pulver, D. V. (2020, August 3). *Pennsylvania sees hotter-than-normal year so far.* Ellwood City Ledger. https://www.ellwoodcityledger.com/story/news/local/2020/08/03/pennsylvania-sees-hotter-than-normal-year-so-far/112825534/

98 CBS Pittsburgh. (2018, September 4). *Thousands Of Students Will Be Dismissed Early Due To Heat.* CBS Pittsburgh. https://pittsburgh.cbslocal.com/2018/09/04/pittsburgh-area-schools-high-heat-early-dismissal/

99 CBS Pittsburgh. (2018, August 28). *Mold, Air Quality Postpones School For Thousands Of Area Students.* CBS Pittsburgh. https://pittsburgh.cbslocal.com/2018/08/28/western-pennsylvania-school-districts-mold/

100 *PA Auditor General: State's Unfocused Efforts on Climate Change Crisis Risk Lives, Drive Costs to Taxpayers, Economy: Group Against Smog and Pollution.* pgh.org. (n.d.). https://gasp-pgh.org/2019/11/13/pa-auditor-general-states-unfocused-efforts-on-climate-change-crisis-risk-lives-drive-costs-to-taxpayers-economy/

101 Warth, G. (2017, October 31). *More school air conditioning on the way in San Diego Unified.* Tribune. https://www.sandiegouniontribune.com/news/education/sd-me-school-ac-20171025-story.html

doing so was estimated at $429 million in 2018, and was financed with taxpayer dollars through municipal bond measures.[102]

The job was made all the more necessary by warming temperatures.[103] When most of the district's schools were originally built close to 50 years ago, extreme heat was rarely an issue and air conditioning wasn't considered essential—especially for schools near the coast.

"A number of studies indicate that human function, attention span, and learning capacity begin to decrease as temperatures rise above 78°F as the human body function works to cool itself," wrote San Diego Unified District Spokesperson Jamie Ries in an email.

Ries says that despite installing air conditioning throughout the district in response to rising temperatures, San Diego Unified has actually reduced its total net energy consumption over the last five years by increasing its renewable energy production with new solar energy systems and energy efficiency projects, including HVAC systems. "We estimate that our solar energy systems alone save $4.5 million in utility costs and offset 8,100 tons of CO2 emissions annually," she wrote.

The project of installing air conditioning across the city's schools was expedited after above-95°F temperatures cut school days short and brutal conditions led to reports of children falling ill.[104]

"If all of my kids were animals, you could all be arrested for inhumane treatment," Jill Schenk, a physical education teacher at San Diego High School, told the Chicago Tribune in 2015.[105] "People don't consider gyms and locker rooms as classrooms—they are."

Ries says that San Diego High School is the district's single remaining school without HVAC, but it will receive it by 2024 as part of a Whole Site Modernization.

102 Taketa, K. (2018, August 27). *Hundreds of San Diego classrooms still lack air conditioning*. Tribune. https://www.sandiegouniontribune.com/news/education/sd-me-air-conditioning-20180827-story.html

103 Jennewein, C. (2019, July 17). *Report: San Diego County Will Face 90-Degree Highs 77 Days a Year by Mid-Century*. Times of San Diego. https://timesofsandiego.com/tech/2019/07/16/report-san-diego-county-will-face-90-degree-highs-77-days-a-year-by-mid-century/

104 Magee, M. (2018, June 9). *SD schools face hot question about how many schools should be air-conditioned.* chicagotribune.com. https://www.chicagotribune.com/sdut-sd-schools-consider-air-conditioned-schools-2015sep16-story.html

105 Magee, M. (2018, June 9). *SD schools face hot question about how many schools should be air-conditioned.* chicagotribune.com. https://www.chicagotribune.com/sdut-sd-schools-consider-air-conditioned-schools-2015sep16-story.html