Students using vertical garden at a California school

A CALL TO ACTION

Climate Resilient California Schools

Safeguarding Children's Health and Opportunity to Learn in TK-12

Stanford MEDICINE
Sean N. Parker Center for Allergy & Asthma Research

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UNDAUNTED K12

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UNIVERSITY OF CALIFORNIA BERKELEY

Ten Strands
Connecting Education, Environment, and Community

About this report

This report was written under the leadership of Stanford University's Sean N. Parker Center for Allergy and Asthma Research, Center for Innovation in Global Health, Action Lab for Planetary Health (ALPHA) and the University of California, Berkeley's Center for Cities + Schools in collaboration with a diverse group of stakeholders and experts. Four statewide workshops were held, which gathered input and insights from state agency leaders, educators, students, and technical partners.

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Understanding climate change as the profound health and equity crisis of our time, the Stanford Climate, Health, and Equity Task Force at the Sean N. Parker Center for Allergy and Asthma Research seeks to advance solutions to climate change. We do this through interdisciplinary and intergenerational collaboration, building close ties with community partners and advocacy organizations, and translating our work for the public and decision-makers to ensure health and equity are being centered in climate policy as we work to rapidly transition off fossil fuels. https://med.stanford.edu/allergyandasthma/

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The Center for Cities + Schools (CC+S) at the University of California, Berkeley conducts high-quality, non-partisan research that offers decision-makers innovative strategies for creating environments where young people can thrive. http://citiesandschools.berkeley.edu/

UNDAUNTEDK12

UndauntedK12 is a national nonprofit focused on supporting America's public schools to make an equitable transition to zero carbon emissions while preparing youth to build sustainable futures in a rapidly changing climate. https://www.undauntedk12.org/

Ten Strands
Connecting Education, Environment, and Community

Every student in California can achieve environmental literacy, and all students deserve the opportunity to understand, interact, and connect with their environment in meaningful ways that promote learning and growth. Ten Strands acts as a connector, building partnerships and forging pathways to ensure that California's K–12 students receive a high-quality education with an environmental component. https://tenstrands.org/

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Context on Language Used in Report

Identifying words for race and ethnicity in this report, when a part of original language generated by the authors, follows the guidelines outlined by the Stanford Diversity, Equity, and Inclusion Style Guide. Otherwise, when evidence is presented by external authors, the identifying language for race and ethnicity reflects the categories the original authors chose to use in their work.

Contents

Introduction

Once again, California stands on the future's edge. As the Earth warms, Californians are confronting unprecedented heat, drought, wildfire, and flooding – among other impacts of climate change. In response, our state is stepping forward as a leader in a global campaign to reduce emissions of carbon and other greenhouse gasses. California's commitment to achieve carbon neutrality by 2045 is a visionary aim that compels both our technical ingenuity and our political will.

Yet even as we race to claw back the causes of climate change, our children are emerging into a world where its effects are already as close as the air they breathe.

In this urgent context, a statewide coalition of nearly 50 stakeholders – including doctors, medical and environmental health researchers, educators, youth and community groups, and other experts – convened in 2021 to examine the challenges of climate change from the perspective of children's health and education.

In this report, we present a transformative vision for California schools that are climate-resilient and sustainable, and we lay out a path to realize the vision.

We envision a future where schools help to mitigate both the causes and the impacts of climate change, and where schools are integral to their communities' overall climate resilience.

Wildfires burning in California

These are climate-resilient sustainable schools:

When extreme weather forces local utilities to cut power, schools remain online, powered by renewable energy that is generated and stored on-site.

When wildfire smoke fouls the air, school ventilation and filtration systems maintain clean cool air, providing respite for students – and their families.

When temperatures soar, children play on tree-sheltered schoolyards with pervious, heat-deflecting surfaces and drought-tolerant landscaping.

When students struggle to make sense and find balance in the face of uncertainty, their schools offer connection, competence, and hope in the future.

Importantly, we envision schools that ensure high-quality learning environments and support student success. To start, we must recognize that **California will neither achieve nor sustain carbon neutrality unless our elementary and secondary schools are transformed into sites of climate mitigation and energy efficiency.** Covering 125,000 acres of ground and encompassing 730 million square feet of buildings, the schools are a main part of the State's infrastructure that must be activated as part of our climate solution.

Nonetheless, **no matter how successful we are at reducing future emissions, climate change is, and will continue to be, a crisis of health and opportunity for California's children.** And because, in a typical year, our children spend at least 180 days at school, whether or not they are protected from climate-related hazards is largely determined by conditions on campus. We must ensure that schools can safely operate during periods of extreme heat, floods, during power blackouts, and when outside air quality drops to unhealthy levels.

Asphalt schoolyard

Heat and unhealthy air are most threatening, both as direct risks to children's health and because, if schools are not equipped to operate safely and provide shelter, then they must shut down, disrupting students' education and exposing them to ambient hazards. This is especially true for the 60% of California students considered socioeconomically disadvantaged, who disproportionately live in communities where environmental impacts of climate change are most intense. Disruption also harms children's mental health and impedes their readiness to learn.

Bottom line: schools that operate safely and reliably, provide shelter, and help children cope are schools where teachers can teach and students can learn. Therefore, **investments in climate-adaptive school infrastructure, which safeguard children's' health, are also essential investments in students' learning and achievement.**

Key aspects of school infrastructure include: energy production and storage systems; heating, ventilation, and air conditioning (HVAC) systems; water heating and cooking equipment; schoolyard surfaces and cover structures; and bus fleets. Our vision incorporates ways that these systems – and school facilities and grounds as a whole – can be made more healthful, safe, efficient, and sustainable.

For schools, however, climate adaptation cannot be limited to infrastructure and operations. To fulfill their mission, our **schools must also prepare students to live and lead in a world that is being fundamentally re-shaped by climate change.** This means developing students' basic climate literacy, engaging them in understanding, evaluating, and designing climate solutions, and preparing them to do – and to create – jobs in an emerging green economy.

In Parts 1 and 2 of this report, we survey the current realities.

- Part 1 demonstrates how climate change is impacting children's physical health, mental health, and access to educational opportunity.

- Part 2 assesses our schools' current capacity to operate safely and reliably, to safeguard students' health and wellbeing, and to develop students' climate literacy.

In Part 3, we lay out our vision for climate-resilient and sustainable schools. This part comprises three major sections:

- A section on the school **campus**, both buildings and grounds, and including critical systems such as heating, ventilation, and air conditioning.
- A section on the school **community**, including ways that schools can support students' mental health in the face of climate-caused trauma.
- A section on ways to adapt the educational **curriculum** to support students' climate literacy and preparation for climate-adaptive careers.
- These sections include specific recommended actions and investments. Wherever possible, we provide estimates of potential costs and savings that may be realized as the recommended actions take effect.

In Part 4, we propose a statewide Master Plan process, engaging key agencies and stakeholders, as an essential first step toward fully operationalizing the vision for climate-resilient and sustainable schools in the coming decade. This part comprises two major sections:

- The first section names the necessary elements of a Master Plan that will draw the necessary actions together in a coherent, powerful strategy.
- The final section identifies current and new funding streams that should be aligned in the Master Plan, and lays out a three-year timeline to drive the Master Plan into action.

Throughout the report, we celebrate many recent acts and ongoing programs of the state government that address climate change, support public schools, and begin to connect the two. We also take cues from the work of county offices of education, local school districts, and their community-based partners. All effort and every emergent climate solution, at any scale, deserves to be recognized.

Child in a diesel schoolbus

But let us also be clear: we cannot contrive a system of climate-resilient schools like a puzzle, cobbling it together from fragments of funding and pilot projects. Rather, every part of our solution must be managed at scale, so it touches every one of California's 11,000-plus elementary and secondary schools, creating both coherence and equity across the system.

What we are calling for – what we urge our State's leaders to embrace – is a strategic, generational investment in the future of public education.

Climate Change Is A Crisis For Our Children's Health And Education

Part 1 provides grounding for the remainder of the report by establishing what is at stake: our children's wellbeing, now and in the future. Here, we briefly summarize key evidence of harms to children's physical health, mental health, and academic development that are caused by environmental conditions associated with climate change and by climate-related disruptions to their schooling.

Heat, drought, floods, and wildfires threaten students' physical health

As climate change intensifies, worsening heat waves, wildfires, and drought will increasingly threaten students, as well as their teachers and school staff.

More frequent heat waves:
Internal temperatures in schools without air conditioning can soar quickly and create unsafe learning environments for children. Children are at risk for thermal burns or heat-related illnesses on unshaded playgrounds with asphalt or artificial turf.[1] On a 68-degree day, asphalt can reach 120°F.[2] Student athletes at play risk heat-stroke as temperatures increase.[3]

In September 2022, California experienced a record-melting back-to-school heat wave that brought 110°F Death Valley temperatures to San Jose and Sacramento. In years to come, intense late-summer heat will be increasingly common in much of the state.

More intense and frequent wildfires:
The amount of pollution generated by California wildfires in 2020 was 120 times more than the amount of pollution released by cars, trucks, and buses on the road that year.[4] Evidence-based models suggest that by 2050, the amount of smoke pollution will be 50% greater than current levels.[5]

Wildfire smoke is extremely toxic to children – up to ten times more toxic than other forms of air pollution.[6] Wildfire smoke exposure results in worsening childhood asthma, among a litany of other harms.

"As a pediatrician, I'm caring for more children struggling to breathe because their airways are clamped down from asthma triggered by wildfires. I worked a day in our hospital where the NICU reeked of smoke because the wildfires were so overwhelming [that] our filtration systems couldn't keep up, exposing our tiniest patients to harm. As a parent, I worry about the air my daughter is breathing in her public school [that has] no HVAC system. What will it mean for her and her peers' long-term health to be exposed to this year after year?"

- DR. LISA PATEL, STANFORD SCHOOL OF MEDICINE

Increasingly severe drought and flooding:
California is currently experiencing a mega-drought driven by climate change that is affecting 37 million Californians while concurrently experiencing historic flooding. These extremes can co-exist, representing the abnormals in climate change.[7] Drought results in critical water shortages and longer, more intense wildfire seasons, while atmospheric rivers cause massive damage in the form of mudslides, physical injuries, and damaged homes and roads.

Children are particularly vulnerable to these threats because their bodies are more sensitive to environmental hazards and have developed less ability to adapt, and because – perversely – they are more likely to be exposed to heat and smoke (see Figure 1). Heat and wildfires result in a host of adverse health outcomes, including asthma (see Figure 1).

On a population level, certain neighborhoods are exposed to more heat and pollution at baseline, which contributes to disparities in health outcomes. Historically "redlined" neighborhoods and areas of higher poverty are less likely to benefit from environmental amenities, such as tree canopy that lowers heat and sun exposure.[18] These urban neighborhoods are measurably hotter – an effect that is also well demonstrated on school grounds that encompass more asphalt than greenspace. Children of color are more likely, compared to their white peers, to live in areas with the highest baseline levels of air pollution, and this disparity worsens when wildfire smoke drives air quality to unhealthy levels.[19]

Children's asthma is one of the most disruptive harms to their learning, with an estimated 1.6 million school days lost per year from respiratory illness,[8] a figure that stands to grow as the climate continues warming. With worsening wildfire smoke, by mid-century we estimate a 40-50% increase in children's hospitalizations for respiratory complaints alone in California.[9]

Without equitable resources to adapt to and mitigate environmental hazards, schools in high-poverty communities leave students exposed to disproportionate risk. For example, schools in higher poverty neighborhoods have historically had less to invest in efficient HVAC (heating, ventilation, and air conditioning) systems; children in these schools will face compounded risk to their health from worsening air quality due to wildfires.[20]

Figure 1. Climate change and vulnerability

Table 1. Heat and Wildfires: Health Outcomes[10,11,12,13,14,15,16,17]

	Children	Adults
Heat	Coughing and asthma, renal disease from severe dehydration, heat-related illness, bacterial intestinal infections, ear infections, nervous system diseases	Cardiovascular disease, respiratory disease, dehydration, acute renal failure, heat illness Pregnant individuals are at added risk for adverse birth outcomes (premature birth, low birthweight infants)
Wildfires	Asthma, pneumonia, neuropsychological effects, possible higher lifetime risk of cancer	Cardiovascular disease, respiratory disease, diabetes, brain inflammation and neurodegeneration, certain types of cancer Pregnant individuals are at added risk for adverse birth outcomes (premature birth, low birthweight infants)

Climate-related disruptions harm students' mental health

In 2021, the American Academy of Pediatrics, Academy of Child and Adolescent Psychiatry, and Children's Hospital Association jointly declared a national state of emergency in children's mental health.[22] Anxieties aroused by the COVID-19 pandemic and by the national moment of reckoning with racial injustice, they said, had combined to cause "an acceleration of trends observable prior to 2020. Rates of childhood mental health concerns and suicide rose steadily between 2010 and 2020 and by 2018 suicide was the second leading cause of death for youth ages 10-24."

These alarming trends are also linked to climate-related disruptions and anxiety. Children displaced by climate disasters such as storms and flooding, wildfires, and extreme heat can suffer mental health repercussions, both from the frightful events themselves and during what is often a lingering, stressful period of recovery.[23] In Sonoma County, following a series of recent, devastating wildfires, a survey conducted by YouthTruth found that 77% of students who reported being personally affected by wildfires experienced feelings of stress, anxiety, and depression as significant obstacles to learning.[24] Repeated exposure to these events worsens post-traumatic stress, especially for younger children.[25,26]

In fact, children today are expressing unprecedented levels of anxiety related to the climate and environment. In the largest survey ever conducted on climate anxiety in young people, perspectives gathered from over 10,000 youth in over 10 countries found significant levels of psychological distress associated with climate change. Approximately three-quarters of young people felt that the "future is frightening," and about half reported experiencing climate anxiety to a degree that affected their daily lives.[27]

> "That morning, the most destructive fire in California history, the Camp Fire, had caught near their home in Paradise, California. Kyson and his family resettled in the city at the bottom of the hill, Chico, six people crammed into a 29-foot trailer. The middle school that got set up for the Paradise kids was not a school at all. It was a big-box hardware store that had gone out of business… It's also cold, 59 degrees, everyone's in coats. They've been heating the store with propane. But one day, someone smelled gas. The fire department showed up, and lots of the kids freaked out… Some went catatonic, others called their parents to pick them up. The smell brought them back to the day they'd evacuated Paradise and hearing the sound of propane gas tanks exploding one after another as they fled. After that, the administration just left the heat off."
>
> **-NATIONAL PUBLIC RADIO, "THIS AMERICAN LIFE"**

Unhealthy conditions impede students' ability to learn

Heat and wildfire smoke exposure do not only harm students' health; they can also negatively impact student performance in school. Hot days are associated with measurably poorer learning outcomes.[28] Inside the classroom, heat can impair cognitive functioning and worsen academic performance.[29] These concerns are elevated for low-income students and students of color who are more likely to be exposed to higher levels of heat and less likely to have access to air conditioning within their schools.[30]

New research is also connecting wildfire smoke exposure directly to negative cognitive impacts, especially among younger students, as measured through standardized test scores. An analysis of 11,700 school districts across the country modeled the effect of wildfire smoke on national test score data and found that during a year of severe smoke in 2016, average test scores decreased by 0.031% of a standard deviation, resulting in $1.7 billion of potential lost future income for students. While children in Western states showed the greatest effect in this analysis, children in other regions were affected as well, showing that spikes in unhealthy air quality from wildfire smoke can threaten children regardless of immediate proximity to the fire itself.[33]

Many schools have had to close for extended periods as a result of climate-related hazards that make school environments unhealthy or unsafe. In the 2018-19 academic year, more than 1,911 schools had nearly 3,893 total closure days due to wildfires, impacting 1.1 million students.[34] Some schools have had to close for more than three weeks at a time due to toxic ash and smoke from nearby wildfires – which now drive the vast majority of school closures and tend to last longer than school closures due to other causes.[35]

An estimated 5% of the gap in standardized test scores between Black and Hispanic students and their White counterparts can be attributed to disproportionate exposure to excessively hot classroom air.[31]

Lost school days have been shown to impact learning outcomes as measured by standardized test scores; in fact, each lost day of learning can be measured in decreased academic achievement.[39]

Precautionary power shut-offs – instituted by electric utilities at times of elevated wildfire risk – exacerbate these disruptions.[36] School districts throughout California are expected to see an increase in the number of hot days per school year that could require closing schools that do not have air conditioning or place a demand on the energy grid as more air conditioning is placed in schools, contributing to regional blackouts, which could be avoided for schools running on solar to battery storage back-up.[37,38]

School closures during the COVID-19 pandemic have widened learning gaps for Black, Hispanic, and Indigenous students, potentially affecting their lifetime of achievement and earnings.[40] These disparities will persist, and likely worsen, unless all schools across the state are prepared to mitigate climate-related hazards and continue to operate safely as conditions change.

Our Schools Are Not Equipped For Climate Resilience

In Part 2, we recognize ways in which the capacity of California's schools is limited by historic under-investment in their physical infrastructure and human resources. Operating within these boundaries, schools cannot readily adapt to emerging challenges – whether those challenges are educational or environmental. This is not for lack of effort on the part of teachers and administrators. As writer and naturalist Barry Lopez said, "The effort of the imagination is to turn the boundary into a horizon."[42] If our children's schools are something less than healthy and vibrant places, then we have not yet imagined all that schools can – and need to – be.

School facilities are outmoded

There are more than 11,000 public elementary and secondary schools in California, serving students from transitional kindergarten (TK) to 12th grade in facilities spanning more than 730 million square feet of buildings and grounds encompassing 125,000 acres of land.[43] The age and condition of these facilities and grounds vary widely. While the state government does not maintain an inventory of school facilities, an estimated 40% of California's public schools are more than 50 years old, as shown in Table 2.

> "Climate resilience is the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."[41]
>
> **- INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE**

Table 2: Estimated Ages of California's K-12 Public School Facility Infastructure, 2021

Age	Estimated Percent of Schools	Estimated Number of Schools	Estimated Square Feet of School Buildings
<=25 years	15%	1,658	109,510,919
25 to 50 years old	45%	4,973	328,532,757
>50 to 70 years old	30%	3,315	219,021,838
>70 years old	10%	1,105	73,007,279
	100%	11,050	730,072,793

Source: Estimates calculated by Center for Cities + Schools, University of California, Berkeley based on data provided by California Department of Education's Office of Learning Environments, State Allocation Board new construction apportionments provided by the Office of Public School Construction, and Microsoft Building Footprint spatial data.

Of course, just because a building is old does not mean it is in poor condition. Many schools have had classroom additions and some have had partial or full modernizations in recent years. But in general, older facilities require intensive maintenance to function as they were designed, and still more to function as newer standards require. Nonetheless, the U.S. Government Accountability Office finds that more than half of the nation's school buildings have deferred major capital improvements such as leaking roofs or failing heating systems, and California is hardly immune to this pattern.[44] In fact, the capital and operating needs of California's TK-12 public schools outpace their actual funding by $10.8 billion each year.[45] Only about 15% of California school districts are meeting industry standard benchmarks for annual spending on basic operations, upkeep, and renewal of their facilities.[46]

The impact of these under-investments is predictable: schools in disrepair. A 2020 analysis found that 38% of all California students attended schools that failed to meet minimum facility standards.[47] A 2022 statewide scan of local school district educational facility plans found that aging buildings and deferred maintenance – of entire facilities, and especially of critical systems – were the problems most commonly identified.[48]

Older schools often rely on antiquated technologies that can be a source of environmental hazards rather than a solution for them. Just in the 2021-22 school year, for example, multiple California schools were forced to evacuate due to gas leaks.[49,50,51,52] Fossil gas infrastructure also contributes to warming through leaky pipes emitting methane, a greenhouse gas that is 25 times more potent than carbon dioxide (CO_2).

About 4 in 10 California students attend schools that do not meet minimum facility standards.

Within the problem of under-investment in school facilities lies a problem of lagging priorities. Old as many of them are, California's public school buildings were designed to operate in a cooler, milder climate where extreme events, such as 100-degree heat and massive wildfires, were much rarer than they are today – and still rarer than they will be. So when school districts do have the opportunity to repair and upgrade their facilities, they may be extending their future reliance on systems that are already overmatched by today's needs.

Under-investment in school facilities also hinders expansion of early childhood education, which is counter to the State's plan to provide universal access to prekindergarten, announced with much fanfare in 2020. The developing bodies of children under five years old are highly susceptible to environmental stressors, including high temperatures and poor air quality.[54] To successfully expand early education and care, classrooms must be healthy environments, regardless of climate conditions outside. Achieving these conditions in new or expanded school sites will likely require significant renovation and upgrades.

Moreover, California's finance mechanism for public school facilities disadvantages schools in lower-wealth communities.

"Local funding and bonds are typically not enough, especially from an equity perspective. Local funding is easier to get in wealthier districts. And when the federal or state government does give more money to socioeconomically-disadvantaged communities, that money is specifically targeted toward student programs. There is an urgent need for the state to step in to remedy this gap and provide funding that simultaneously advances health and environmental aims."

- KEITH LOEWEN, DIRECTOR OF FINANCIAL SERVICES, WASHINGTON UNIFIED SCHOOL DISTRICT, FRESNO

San Francisco Bay Bridge in 2020 when the sky turned orange during wildfires

California's K-12 public school buildings produce an estimated 9% of all emissions from non-residential buildings in California, equivalent to 783,000 gas-powered cars on the road. Emissions from cars and buses going to and from schools add to the total.[53]

School districts raise funds to upgrade their facilities largely through bond measures that rely on local property taxes. As a result, how much a district can raise is determined by local property values. Three prominent recent analyses by the Public Policy Institute of California, the California State Auditor, and researchers at Stanford University all found that school districts in wealthier communities tend to raise substantially more revenue (from both local and state sources) to maintain and upgrade their school facilities compared to school districts in lower-wealth communities.[55,56,57]

Lastly, many school districts lack adequate staff to effectively track and manage building maintenance and operations. When budgets are tight, "M&O" positions are often the first to be cut back or eliminated,[58] and these patterns are often more pronounced in rural school districts and in smaller and mid-sized districts.[59] Relatedly, as building systems become more reliant on advanced technologies, maintenance and operations staff need new and different kinds of training to effectively maintain and operate school facilities;[60] nonetheless, in a survey of 520 California school principals, only 27% reported having someone on staff who coordinates sustainability efforts, and only 9% compensated the person for their time spent on such efforts.[61]

"Adapting to and addressing the climate crisis also requires expanding the duties of maintenance and facilities staff – for example, through developing and maintaining green schoolyards. Transforming asphalt playgrounds to carbon-sequestering, biodiversity-promoting, and health-sustaining fields and gardens can benefit both schools and their communities, but requires additional staff and training. Without a sustained workforce, many existing school gardens are not maintained, rendering initial investments moot."

- TIFFANY MOK, CALIFORNIA FEDERATION OF TEACHERS

School Indoor Air Quality Systems Are Lacking

Properly-functioning HVAC systems can protect against over 90% of indoor particulate matter in schools.[68] But, a 2020 study of California schools found widespread HVAC problems, and only 15% of classrooms studied met the ventilation standard.[69]

Of the many health risks associated with outdated and dilapidated school buildings, the most urgent – especially in a hotter and smokier California – is indoor air quality (IAQ). The best way to ensure healthy IAQ in schools is with effective HVAC systems. When properly installed, maintained, and adjusted to match conditions, efficient modern HVAC systems reduce the concentration of airborne pathogens such as SARS-CoV-2,[62] the virus that causes COVID-19, and filter particulate pollution that is especially elevated in wildfire smoke.[63] Of course, such systems also maintain a comfortable indoor temperature when outside heat rises to unhealthy extremes. Both factors – filtration and temperature regulation – affect the wellbeing and performance of students and teachers.[64]

Unfortunately, there is currently no statewide inventory of HVAC systems in public TK-12 schools. But HVAC systems in many schools across California have been found to be outdated, functioning incorrectly, or nonexistent.[65,66] A 2020 California study by researchers at the University of California, Davis and Lawrence Berkeley National Laboratory found that only 15% of classrooms – all of which had recently installed mechanical HVAC systems – met the State's fresh air ventilation standards.[67] The study also found that 30% of the teachers surveyed were dissatisfied or very dissatisfied with the temperature in their classroom, and about 10% said the temperature interfered a lot with the learning environment for their students.

There is every good reason to ensure all schools have functioning HVAC systems appropriate for their locale: Improving air quality and thermal comfort has been shown to have positive impacts on children, including decreased school absences, improved school performance, and reduced asthma morbidity.[70,71,72,73,74] In addition to creating safer and healthier learning environments, improving school HVAC systems by utilizing heat pump technology can also save energy and costs, and reduce emissions.[75,76]

HVAC system

Teacher and a classroom of students

Schools are not staffed in proportion to students' health needs

The presence of caring adults is the most effective safeguard for children's health and development. As students contend with elevated stress and anxiety related to climate change, the support of counselors and social workers, nurses, and psychologists becomes ever-more critical. Without support for their basic health and wellbeing, students are denied the opportunity to learn.

Beyond their direct support for students, school-based health professionals also support teachers to recognize and respond when students express trauma and distress in the classroom. Yet, California chronically under-funds school health and support staff positions, and many schools are unable to fill all the positions that are allotted. Amidst a continuing teacher shortage across the state,[77] counselors, at times, are pressed into service teaching classes, further reducing the availability of specialized mental health support for students throughout the school.[78]

As the climate crisis intensifies, schools will need enhanced support staffing and especially more staff who are trained in trauma-informed care, with the capacity to provide mental health and trauma therapy.[80] In California, it's recommended that each school counselor should support no more than 250 students, but the actual ratio is approximately one school counselor per 600 students.[81] The recommended caseload for school social workers also is 250 to 1, but the actual ratio is more than 7,000 to 1.[82] For school psychologists, the recommended staffing ratio is one adult per 500 students,[83] but California schools currently provide only one psychologist per 1,041 students.[84]

Commendably, California deployed a portion of its 2021 budget surplus to help schools hire more counselors; but, that one-time boost is not enough investment to close persistent, pervasive gaps across all categories of student-support staffing in our schools.[85]

Only 4% of California students attend schools where the counselor-to-student caseload is under the recommended 250 to 1 ratio.[79]

Hand-painted sign that reads "Save our planet."

Schools are not focused on preparing students for their climate future

California is a national leader in promoting outdoor learning and environmental education for children and youth, with far-sighted commitments expressed in the Blueprint for Environmental Literacy that was produced by the California Department of Education (CDE) in 2015 and through the activities of the California Environmental Literacy Initiative, a statewide coalition that was launched in 2016 and includes community-based organizations as well as schools, school districts, and county offices.[86]

Nonetheless, students report that they rarely learn about climate change specifically, and their opportunities to discuss environmental issues occur mainly in after-school or co-curricular club settings or in Advanced Placement (AP) Environmental Science courses in which relatively few students are enrolled.[87] As of 2020 only 29% of teachers reported that they had incorporated environmental principles and concepts into instruction.[88] On those occasions when the science of climate change is taught, students' inquiry rarely explores connections to broader social and health problems that are most likely to spark meaning for them and inspire their participation in exploring solutions.[89]

A key limiting factor here is teachers' own understanding and preparation to address climate topics – and this is true for science teachers, in their own ways, as it is for other teachers. While many school districts now offer professional development in regard to environmental literacy, and some require it, few districts are yet providing training on climate literacy specifically.

Climate change is a complex, emotionally resonant topic that must be explored using lesson designs and materials that are sensitive and age-appropriate. The Climate Change and Environmental Justice Program, created by AB 130 of 2021, is designed to generate freely-available materials for teacher professional development and instruction; however, the program is just getting started.

Envisioning Climate-Resilient And Sustainable Schools

In Part 3, we present a transformative vision for California schools that serve as adaptive resources for their communities – defending students' health, wellness, and educational continuity, promoting equity and opportunity, and inspiring resilience. Our vision is sweeping and bold, but it is grounded in appreciation for work that youth and community leaders, educators, and the state government are already beginning to do.[91,92]

We recognize that such a vision will only be realized through years of sustained initiative and investment. Accordingly, in Part 4 of the report we call for a master plan process to orchestrate and guide statewide effort in the coming decade. In this section, however, we keep our focus on the schools themselves. We name specific, top-priority solutions, and we urge decision-makers at all levels to use these recommendations as tools to build a movement for climate-resilient schools.

Following the lead of climate-adaptive schools, districts, and county offices, we divide this part into three sections aligned with three essential dimensions of the school: the **campus**, the **community**, and the **curriculum**.[93,94,95]

Campus: How we can create climate-resilient, sustainable school facilities

Each school facilities project – be it new construction, retrofitting and repair, or replacement – is an opportunity to accomplish two essential goals: protect students and teachers from climate-related health hazards and disruptions; and move the school closer to Califronia's target of net-zero emissions. Accomplishing these goals at every school in California will require well-planned and coordinated actions to comprehensively modernize our school infrastructure, particularly across eight critical domains:

Adopt sustainable practices in construction

Planning for all new construction, renovation, and retrofitting of school buildings should be guided by sustainability criteria like those offered by Advanced Energy Design Guides, Leadership in Energy and Environmental Design (LEED),

Teacher teaching environmental education

"It's never been clearer that schools are the cornerstones of our communities and will find a way to build resilience, even in the face of a crisis. When COVID-19 exposed the fragility of public education, our schools adapted. We can, and should, harness that same spirit of resilience to fight the climate crisis."

- DEBRA DUARDO, LOS ANGELES COUNTY SUPERINTENDENT OF SCHOOLS & PEDRO MARTINEZ, CEO, CHICAGO PUBLIC SCHOOLS[90]

> "My ideal sustainable school would focus on changing the infrastructure of the school to implement more resource efficient appliances like solar panels, water conserving toilets, passive solar designs, more green areas, and invest more into climate education. Having a safe space for climate change discussions and education in classrooms can make students more inspired to be active."
>
> **- ALYSSA GOLDFIELD, STUDENT, ALAMEDA HIGH SCHOOL**

the Collaborative for High Performance Schools (CHPS), and Emerging Technologies Coordinating Council, which include building with non-toxic materials that are recycled or produced in a way that conserves raw materials. These measures can reduce cost while streamlining water and energy consumption and creating healthier conditions for learning. To support our world-class climate goals, however, California would need to regard national sustainability criteria as minimum desired baselines, not ultimate standards.

The Division of the State Architect (DSA) has proposed changes to the building codes for public schools through an initiative known as CALGreen Code Development, but the proposed changes would apply only to new construction and additions. To ensure that all schools are climate resilient and sustainable, the state must develop comprehensive criteria that are applicable to all types of projects – construction, renovation, retrofit, and replacement – across settings and contexts.

Electrify building energy systems

All indoor infrastructure – including HVAC systems, water heaters, and cooking equipment – should be electrified, ending schools' dependence on fossil gas-powered machines that emit greenhouse gasses and introduce health and safety hazards.

The Clean Energy Jobs Act (Proposition 39) K-12 Program helped provide momentum for California on improving energy use in schools. By implementing a change in the corporate tax code, Prop 39 generated $1.7 billion over 5 years to help schools plan and install energy efficiency upgrades and clean energy generation measures. Allowable upgrades included switching to LED lighting, replacing inefficient air-conditioning and heating units, and installing solar panels.

A relevant – and promising – initiative by the Division of the State Architect, in partnership with New Buildings Institute, is enabling school districts to develop plans to reach zero net energy and zero carbon across their portfolios. Districts participating in the Getting to Zero Over Time cohort are receiving one-on-one assistance as well as peer-to-peer opportunities to share lessons and strategies. Just 30 districts are currently participating, however, and scaling this high-touch, customized support throughout the state will require major new investments and capacity-building efforts.

Install solar power and battery storage

Schools can also decrease their carbon emissions and achieve energy independence – a key factor in climate resilience – by installing solar power paired with battery storage (solar + storage). When extreme wind, heat, or other dangerous conditions force utilities to shut down the power grid, local solar + storage can ensure that schools stay open and contribute to community emergency preparedness. School districts in most parts of California can readily contract with local providers to install solar + storage, and the payback period – the time it takes for cost savings to cover the cost of installation – could be as short as seven years.[96]

Moreover, the federal Inflation Reduction Act of 2022 provides incentives for schools to invest in solar + storage, including direct subsidy payments covering 30% of installation costs. Schools can qualify for additional 10% subsidies – up to 50% in total – if they use parts made in the US and if they are located in so-called "energy communities." (As of this writing, criteria defining such communities are still in development, but likely much of California, including most inland counties and the north coast, will qualify.)[97] Solar + storage could shrink the $1.5 billion California schools currently pay for electricity each year. Converting all schools to solar + storage could cut their total carbon emissions by 60% or more.[98]

Upgrade HVAC systems

Schools should install or upgrade and regularly maintain HVAC systems that reliably improve IAQ and support thermal comfort. Approved supplemental, portable air cleaners should also be deployed as schools on public school grounds.[110]

With HVAC upgrades, schools can realize cost savings through energy efficiency improvements; reduce student asthma rates, emergency department visits, hospitalizations, and long-term health impacts; decrease student absences and reduce school closures during smoke events; and contribute to improving student performance.[99,100,101,102,103]

transition to reliable HVAC systems and/or when outdoor air quality is especially hazardous; for example, as a result of wildfire smoke. On a typical day under today's climate conditions, some schools–those very near the coast, for example–may be able to maintain IAQ and thermal comfort without mechanical HVAC systems, but our goal must be to equip all schools to adapt as conditions change and extreme events become more common.

Because no state agency is charged to maintain an inventory of school facilities and systems, however, we can only estimate the number and scope of HVAC upgrades that will be needed to achieve these potent results. Based on stakeholder input from the field, we estimate that between 15 and 20% of California's TK-12 public schools – about 2,000 school buildings – have no functioning mechanical HVAC systems at all, and as many as another 10% of schools need major repair or replacement for their systems to function adequately.

As with solar installation, the federal Inflation Reduction Act provides incentives and subsidies that could make HVAC upgrades more affordable for schools. The state also is offering funds for this purpose under the California Schools Healthy Air, Plumbing, and Efficiency Program (CalSHAPE), which was established by AB 841 of 2020 and is administered by the California Energy Commission (CEC). The program enables schools to upgrade HVAC systems and plumbing systems. Through this effort, more than $600 million may be available to school districts through 2023. In the first round of applications for the CalSHAPE Ventilation Program, which closed in January 2022, 84 applicants received awards totaling about $51 million. However, this program does not provide funds for schools that need to install entirely new HVAC systems.

A recent bottom-line analysis by the Center for Climate Integrity concluded that more than $40 billion will be needed to install or upgrade HVAC systems and sustain healthy IAQ in all of California's TK-12 public schools. Moreover, once energy-efficient, modern HVAC systems are up and running in all schools, California school districts will need to spend an additional $220 million each year to operate, adjust and maintain them.[104] These are large figures, but they reflect the fundamental importance of HVAC systems in sustaining safe environmental conditions and ensuring students' opportunity to learn.

Create green schoolyards

A typical California school campus is largely covered by asphalt and little shaded by tree canopy. As a result, schoolyards absorb an extraordinary amount of heat. Reducing the amount of concrete and blacktop surfaces on school campuses, instead covering them with shade trees and native plants, can reduce this urban "heat island" effect, while also enhancing carbon sequestration and improving soil health and water retention.[106] Most importantly, a green schoolyard benefits students' health and education by supporting mental and cardiovascular health, social connectedness, and learning outcomes.[107,108]

Initial costs to develop a green schoolyard average $340,000 more than a traditional asphalt-covered yard, but a school could recover its investment through improved student attendance and achievement, teacher retention, and reduced energy costs.[109]

California has posted plans to rapidly scale the growth of green schoolyards. In August 2022, the Departments of Forestry and Fire Protection (CAL FIRE) and Education (CDE) announced an initial $1.5 million investment in the California Schoolyard Forest System, a statewide effort to increase tree cover on public school grounds.[110] Their goal is, by 2030, to plant trees

Electric charging station

that, when mature, will cover at least 30% of each school property, shading areas used most often by students during the school day. Priority is being given to districts and schools in under-served communities with the highest poverty levels, hottest climates, and least existing tree cover. In September 2022, Governor Newsom announced a historic allocation of $150 million over two years, to be made available to local governments, school districts, and nonprofits to plant trees, erect shade structures, and create gardens and other green spaces on school campuses using native or drought-tolerant vegetation.

As inspired as these investments are, they come only to around $15,000 per school, and of course not every school will be reachable within two years. To fulfill their purpose, these bold initiatives will need to be enriched and sustained over time.

Electrify bus fleets

California's school bus fleet is estimated at 23,650 buses, of which only 7.2% is currently committed to electrification.[111] Diesel buses are still the default technology. Diesel creates toxic exhaust that is linked to serious health risks, including respiratory illnesses and cancer,[112] and of course runs counter to the State's emission-reduction goal. Transitioning from diesel-powered to electric buses is therefore a critical piece of a comprehensive decarbonization strategy, one that carries significant health benefits and can also yield long-term cost reductions.

Electrifying a single bus can yield $7,600 per year in fuel cost savings and $4,400 per year in reduced maintenance costs, saving approximately $192,000 over the average 16-year lifespan of the bus.[113]

The recent commitment of $1.5 billion toward electric buses and charging stations will move California in the right direction, allowing electrification of some 3,000 buses, a substantial step forward.[114] Nonetheless, further and greater investment will be required to replace the remaining 72% of buses on the road from internal combustion to electric engines. California should move aggressively to take advantage of substantial new federal climate mitigation funds within the Bipartisan Infrastructure Law and the Inflation Reduction Act to rapidly electrify the school bus fleet.

Grow regenerative food systems

Campus food systems should focus on fresh, locally-produced foods, with priority given to plant-based meals. The collective purchasing power of public school districts can provide critical market leverage for smaller local growers who adopt regenerative and climate-smart practices that

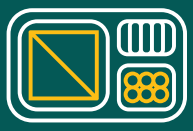
Sustainable farming

minimize energy-intensive transportation and processing and boost local economic resilience.[115] Centering plant-based foods offers additional benefits for children's health and the environment.[116] California recently made vital first steps, such as investing $60 million in an incubator program and developing a master plan to accelerate and scale farm-to-school programs; still needed, however, are reliable estimates of the total investment needed to take these efforts to scale.[117]

Install water-efficient systems

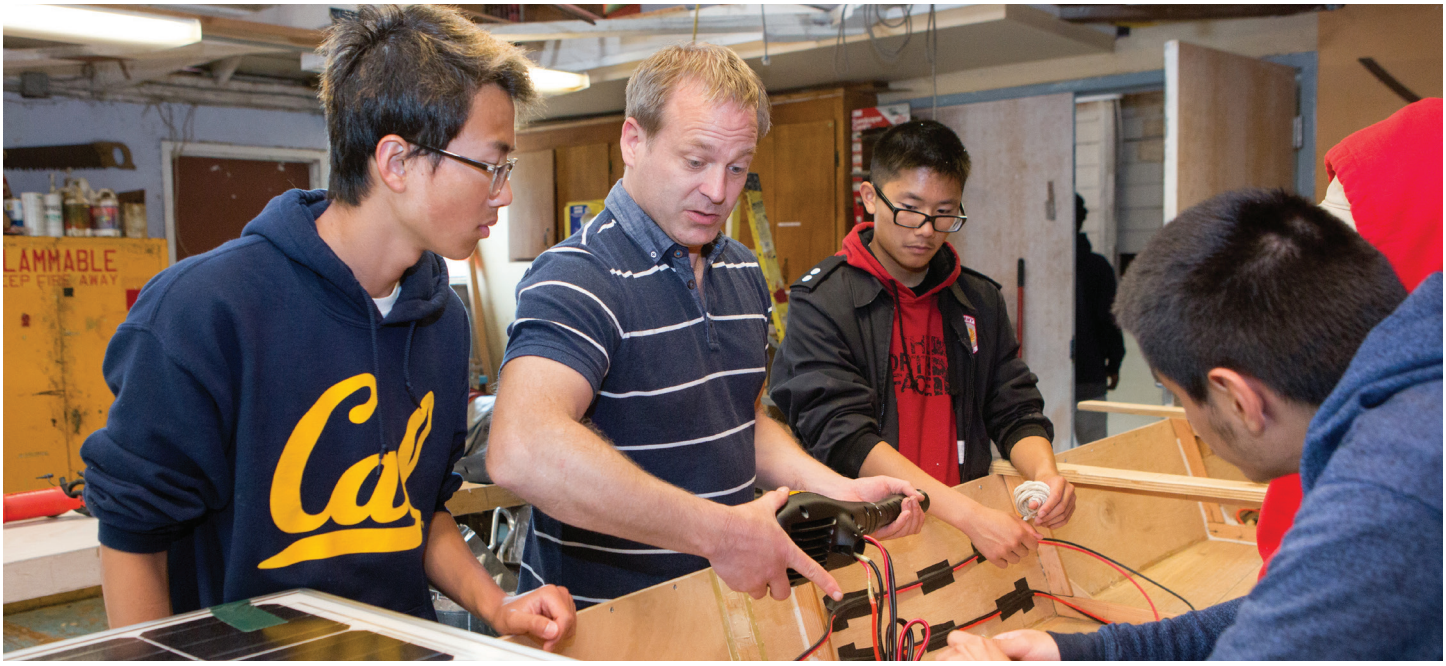
Decreasing school campuses' environmental footprint – especially in a state subject to droughts – also requires installing water-efficient systems. Schools' highest water use happens in its restrooms, landscaping, and HVAC systems, each of which have the opportunity for implementing water-efficient systems. Installing water-efficient plumbing systems and appliances alone can help reduce energy use by 15%. Schools can also explore greywater systems and stormwater capture to reduce overall water usage.

The state is supporting upgraded plumbing fixtures and water supply systems in schools through the CalSHAPE, administered by the California Energy Commission (CEC). In the first round of funding for this program, which closed in December 2021, CEC awarded nearly $10 million to 43 applicants. Additionally, AB 1343 of 2017 encourages schools to reduce their water use by authorizing school districts to enter into Go Low Flow Water Conservation partnerships with their public water utility, allowing those utilities to provide cost-rebates to schools that implement water-saving measures.



"California schools serve approximately one billion meals a year to over six million students, who on average receive more than a third of their calories at school. Improving the quality of these meals can yield enormous benefits both for students' health and for local regenerative food systems that support climate and sustainability goals."

- ALEXA NORSTAD, CENTER FOR ECOLITERACY



Students learning about solar energy

Community: How we can develop a culture of resilience in and around schools

On a climate-resilient campus, not only teachers and students, but also families and neighbors can find shelter and respite. Moreover, climate-adaptive improvements in school infrastructure and grounds could provide models for the development and renewal of other community sites. In the 2021-22 state budget, $100 million was made available to set up Community Resilience Centers across the state; but, while schools are eligible to receive those funds, bureaucratic barriers make it difficult for schools to apply successfully, and few have done so. To activate schools as resilience centers, the state will need to carve out funding specifically for schools and provide technical assistance to ensure that schools can safely and effectively open their facilities to the broader community.

As much as a school campus is a landmark and a material resource, a neighborhood school is also a place where the social fabric and feeling of a community is made. Amid the uncertainty of climate change, schools must be places of social-emotional support as well as physical shelter for their students, staff, and communities.

Staff schools with students' mental health in mind

If our schools are going to respond to and redress the generational crisis of mental health that is facing California's youth, then the schools must be fully staffed by health professionals including counselors, social workers, psychologists, and nurses that themselves are climate-literate. Student wellness centers should be established on every school campus to provide routine mental health screenings and broad-based support programs, and to respond when individual students are in need.

Respond directly to students' climate anxiety

The COVID-19 pandemic removed any doubt that prolonged anxiety is a type of trauma, and it helped accelerate the broad inclusion of trauma-informed practices – already familiar to schools and communities recovering from wildfire or other disasters – throughout the fields of public health, social service, and education. Schools can continue on this beneficial learning curve by integrating climate resilience as a goal of trauma-informed mental health support.[120]

With the 2021 launch of the Children and Youth Behavioral Health Initiative, California has already made a historic $4.4 billion investment in youth mental health. Ensuring new counselors and psychologists are trained in climate

Children playing outdoors in the soil

change and mental health provides an opportunity to ensure climate resilience is at the center of students' learning and growth.

Connect students with climate allies in the community

Climate anxiety in children and youth is exacerbated by their sense that responsible adults and institutions are failing to act on an imminent threat.[121] About half of young people in a 2021 survey reported feeling ignored or dismissed when discussing climate change.[122]

Engaging with adult allies to work toward change in their communities can serve as a powerful antidote to students' climate anxiety.

Participating in environmental and civic stewardship projects and organizing around issues that affect their lives contributes to students' sense of wellbeing and efficacy, especially as a salve for eco-anxiety and other disruptive emotions.[123,124] California's 2021 State Seal of Civic Engagement guidelines provide a framework for recognizing the productive roles that students can take in their communities. One example is Y-PLAN, an initiative of UC Berkeley that fosters relationships between civic leaders and young people and has effectively engaged students and their teachers in planning for resiliency in their own schools and cities.[125] Regional youth leadership programs such as San Mateo County's Youth Climate Ambassadors Leadership Program also can provide an arena for youth to gain a sense of belonging and purpose as they work toward climate solutions.[126]

"Schools played a critical part in bringing the Paradisians together and provided a sense of community even beyond families who had kids attending schools. Following the fire, the damage, closure, and disruption of the schools' community activities created an additional layer of loss for everyone in the community beyond the students and the staff. Therefore, reopening the schools in Paradise became a priority not only for restoring the educational services but also for encouraging residents and businesses to return and for restoring the sense of community."[119]

- HAMIDEH ET. AL. 2021

Curriculum: How we can prepare climate-literate leaders for tomorrow's California

Each generation must prepare the next ones to live in a world they cannot fully imagine; but, the challenge we face today is extreme. Sooner or later, we know climate change will change everything, including where and how future generations will be able to live and develop their livelihoods. Many of the understandings, skills, and technologies they will rely on are unknown, or just emerging. To continue to adapt and innovate, and ultimately to thrive, our children will need to be climate-literate. This means that study of the environment must become central to their educational experience and career preparation.

Drive implementation of environmental education

By incorporating thoughtful climate-oriented discussion into lessons across the curriculum, schools can better prepare students for post-secondary study in fields related to sustainability and for careers in the emerging green economy.[127] Instruction that is oriented around problem-based, solutions-focused experiential learning can ensure that students gain multiple opportunities to develop relevant knowledge, values, and skills.[128] Linking the curriculum to ongoing campus improvements – such as energy generation, air quality monitoring, green schoolyards, and regenerative food systems – can transform schools into real-time, hands-on laboratories for climate learning.

California was an innovator in environmental education and has sustained its effort for nearly two decades; however, with only 29% of current teachers reporting that environmental concepts are explored in their lessons, the state must renew and re-focus its commitment to ensure that all students are engaged in cultivating climate literacy.[129]

In 2003, the Calfiornia legislature directed CDE to establish a curriculum framework and model teaching units to advance standards-based environmental literacy in TK-12 education. The resulting Education and Environment Initiative (EEI) curriculum was approved by the State Board of Education in 2010, and California committed $10 million to support implementation. In 2017, the California Regional Environmental Education Community Network (CREEC) was strengthened and revamped with SB 424 to support statewide efforts.

Pile of books

More recently, SB 720 of 2018 updated California's Education Code to integrate topics related to climate change and environmental justice, and AB 130 of 2021 provided $6 million over two years to create model lessons and instructional materials on climate literacy and environmental justice. The goal of this program is for every student at every grade level to have a minimum once-a-year, in-depth experience addressing climate-related environmental issues that impact their own communities and the world.

The project got underway in Spring 2022, driven by a coalition of community-based organizations and curriculum development experts working together to design, write, and field-test materials. By Summer 2024, these curriculum units are meant to be released as free, open education resources available to teachers throughout the state. To fulfill its goal, this program will need to be sustained, expanded, and scaffolded with ongoing investments to keep the curriculum updated, and to ensure that the rollout and training for teachers is equitable and inclusive.

Expand climate-related Career Technical Education (CTE) pathways

A broad TK-12 environmental literacy curriculum should open portals to more specific and equitable opportunities for middle and high school students to pursue higher education and career preparation for the green economy. Through the coming decade, for example, the number of jobs associated with wind turbine technologies is expected to grow much faster than the overall economy.[130] In addition to the energy sector, pathways and industries of special concern include transportation, agricultural technology, natural resource management, and manufacturing.[131]

California has made significant investments in Career Technical Education (CTE). The 2022-23 state budget includes $700 million to create the Golden State Pathways Program, aiming to boost enrollment in high school college-and-career academies that fulfill the requirements for admission to California public colleges and universities, including dual-enrollment programs where students can earn college credits while still in high school. Science, technology, engineering, and mathematics (STEM)-based study linked to climate resilience is a recognized domain within the Golden State Pathways Program, along with education, health care, and computer science. To align with other California TK-12 curriculum frameworks, however, the State's model curriculum standards for these and all CTE programs should be updated to incorporate key environmental principles and to prioritize skills and mindsets that drive accomplishment in climate-adaptive industries.

Enhance teacher education and professional development

School districts will need support to build their capacity and guidance to provide adequate staffing and resources for teachers to plan and develop effective environmental and climate literacy programs. Teachers can work from available "solutionary" frameworks that engage students in analyzing environmental problems, recognizing their causes, and considering how solutions may affect different community members.[132] Place-based regional networks including school districts and community-based partners may be an important strategy to support thoughtful implementation of these frameworks, as members of the CREEC Network are beginning to demonstrate.

Other existing state initiatives also will need to be sustained and brought to scale, including the Environmental and Climate Change Literacy Projects, which support teacher education through UC and CSU Schools of Education; environmental education certification programs through the California Community Colleges system and the Association for Environmental Outdoor Education; and the Climate Change and Environmental Justice Program, which supports creation of new instructional materials for climate and environmental literacy.

> "Given the uncertain and tumultuous nature of our current times, it is of the utmost importance that high school students graduate with an actionable college and career plan, and be able to use an environmental lens that allows them to see a direction more clearly and how they must function within the workforce."
>
> **- DORON MARKUS, CAREER AND STEM SUCCESS COORDINATOR, SAN MATEO COUNTY OFFICE OF EDUCATION**

Launching A California Master Plan For Climate-Resilient And Sustainable Schools

Inspired by the State's clarion call for carbon neutrality by 2045, communities throughout California are making significant investments in climate adaptation and mitigation. So far, however, most school districts have been left to do climate planning on their own. State policies that require or incentivize cities and counties to reduce greenhouse gas emissions do not consistently engage public school districts. This is contrary to the State's own action plan for extreme heat, which recognizes the importance of climate-smart planning for schools, and despite a plea from the Legislative Analyst's Office for state agencies "to collaborate and develop statewide guidance for ways school facilities could be modified to be more resilient to climate change."[134]

School districts are neither being compelled nor supported to act on a date-certain timeline to eliminate fossil fuel-dependent systems and equipment from their campuses.

Schools are beginning to gain state government support through initiatives such as the Getting to Zero Over Time cohort described in Part 3. But if California is serious about becoming carbon neutral by 2045, then these and other solution-paths must be rapidly opened. Few of California's nearly 1,000 school districts have the staff capacity to manage climate adaptations without the sort of concerted, expert assistance that the 30-member Getting to Zero cohort is drawing upon.

Regarding investment, California has enjoyed surpluses in the last two budget years, and – to the credit of state leaders – appreciable one-time funding has been directed toward school construction and modernization projects. The 2022-23 state budget included $4.2 billion over three years to support new construction and modernization projects through the School Facility Program, as well as $1.2 billion over two years to construct and retrofit existing facilities for preschool, transitional kindergarten, and full-day kindergarten.

However, the funding all schools will need to modernize their facilities and ensure resiliency across the state far outstrip these one-time funds. In fact, considering the scale and urgency of the climate crisis, relatively little state funding is targeted specifically to help schools develop climate resilience and move toward zero emissions of greenhouse gasses. Recent studies estimate the current capital needs of California's TK-12 public school facilities to be about $15 billion per year.[135,136] This level of investment (which should leverage local, state, and federal funds) over a decade, to the tune of $150 billion, will catch up on accumulated deferred maintenance, include needed educational enhancements, and cover much of the "green retrofitting" needed to achieve carbon neutrality and climate resilience.

> "State leadership must articulate a vision for how we ensure every school performs its most critical function — to provide safe and inspirational spaces for children to learn without disruption and better support and prepare them for a world shaped by climate change."
>
> **-DR. MARY ANN DEWAN, SANTA CLARA COUNTY SUPERINTENDENT OF SCHOOLS**

We urge the governor, legislature, and state agencies to take three vital actions:

1. Develop a Master Plan for Climate-Resilient and Sustainable Schools.
2. Launch a concerted, decade-long campaign to marshal school facility and infrastructure funds and ensure that all counties and districts are equitably resourced to build climate resilience.
3. Ensure that all school funding is aligned with California's climate and health goals, whether that funding is from state appropriations or other sources and whether it is for infrastructure or other needs.

The first action – creating a Master Plan for Climate-Resilient and Sustainable Schools – is key to fulfilling the others. A plan is not a panacea; but by making the effort to plan, we will give ourselves the best chance to harness the learning and marshall the resources that we need to achieve our goals. We will need to craft many new tools, but a Master Plan is one wheel we need not re-invent. Instead, the planning process can mirror recent examples touching on other state priorities, such as the recent master plans for early learning and child care, higher education, and the expansion of farm-to-school food programs.

What should be in the plan

Clear priorities, benchmarks, and milestones

The Master Plan should present a comprehensive statewide framework incorporating and expounding on the recommendations expressed in this report. The Master Plan should establish as priorities actions to build climate-resilient, sustainable school facilities (campus), to develop cultures of resilience in and around the schools (community), and to prepare climate-literate leaders for tomorrow's California (curriculum).

Within each priority, the Master Plan should express a manageable set of impact benchmarks and developmental milestones, supported by protocols that will enable decision-makers and stakeholders to track progress in each school district and county, and in aggregate across the state. These data should be collected and monitored under the sponsorship of one or more state agencies, which could then recognize and celebrate progress, lifting up examples of local and regional innovation.

The road to carbon neutrality in schools will involve new construction, major modernization, retrofits, and system replacements, as illustrated in Figure 2.

> "Good data on school infrastructure is not collected systematically in California. Making sure all schools are healthy, equitable learning environments requires better understanding the gaps that need to be filled. We need good information to guide our investments."
>
> **- JEFF VINCENT, CENTER FOR CITIES + SCHOOLS, UNIVERSITY OF CALIFORNIA, BERKELEY**

Budget projections and guidance for ongoing state investment

The Master Plan should include a comprehensive, multi-year budget framework, reflecting both current state appropriations and a prospectus that agencies can use to forecast, design, and manage their spending. To ensure that schools no longer miss out on funding opportunities for which they are eligible – including both state and federal infrastructure programs – the Master Plan should clarify and streamline eligibility guidelines and application processes.

Recommended language to align state and local investments with the priorities

An assessment of past and present State climate investments should inform design standards for future measures. This element

Figure 2: Getting to Zero in Schools: A Decarbonization Roadmap Guide for School System Decision-Makers
Source: New Buildings Institute

of the Master Plan will provide a resource to the Governor's office and the legislature, intended to help these leaders steer education infrastructure spending into fuller alignment with the State's climate goals and initiatives.

Promising opportunities for alignment and leverage include the California Clean Energy Jobs Act (Proposition 39 of 2012), which supported schools to make energy efficiency upgrades and to plan clean energy generation projects in school facilities, and the California Schools Healthy Air, Plumbing, and Efficiency Program (CalSHAPE, authorized by AB 841 of 2020), which currently supports schools to upgrade their HVAC systems.

It is equally important that local investments and initiatives align with state-level climate goals, so the Master Plan should also include guidance and sample language that can be used by county and school district leaders to develop local funding measures.

Capacity and coordination across state agencies

A dedicated team of climate resiliency and sustainability coordinators should be distributed across key state agencies to ensure that each agency is provided with the necessary capacity to do its part in enacting the Master Plan and that the state as a whole provides consistent, robust communication and support for local education leaders. Participating agencies could include the Energy Commission, the Governor's Office of Planning and Research, the Department of Education, the State Board of Education, the State Allocation Board, the Natural Resources Agency, the Department of General Services, the Division of the State Architect, and the Air Resources Board.

Capacity and coordination in County Offices of Education and local school districts

To fulfill the vision for climate-resilient schools, we must rally a generational cohort of professionals who are prepared to master emergent domains of knowledge and practice. The Master Plan should anticipate a pipeline of training and

capacity-building for sustainability managers and technical trade workers, school mental health providers, and climate literacy educators.

The Master Plan should suggest staffing models, position descriptions, and other specifications to help county offices and school districts add, organize, and support the staff they will need to make and manage effective climate resilience and sustainability plans. Some county offices have already begun to roll out robust environmental literacy and sustainability initiatives, and their plans and reflections can be offered as resources to help scale similar, locally-adapted efforts across the state.[137,138]

The Master Plan should recommend training programs, network structures, and other opportunities to boost capacity in county offices and local school districts and raise awareness of the priorities, benchmarks and milestones, and funding opportunities.

Differentiated technical assistance for County Offices of Education and local school districts

To achieve meaningful impact benchmarks of climate-resiliency and sustainability, school districts will need to conduct needs assessments, asset mapping exercises, and energy audits, among other self-evaluations, and they will need to develop technically sound decarbonization and resilience plans. County offices already provide technical assistance to districts on a broad range of issues, and they will likely need the partnership of state agencies and community-based organizations to extend their range in these new ways. The Master Plan should anticipate a cohort of advisors and providers including engineers, energy auditors, designers, developers, and managers who can help schools liaise with contractors.

The DSA already advises local decision-makers and ensures compliance with the CALGreen building standards for schools. And of course, the CDE assists schools with facilities and transportation planning, promotes sustainability through the Green Ribbon Schools recognition program, and provides schools disaster and emergency management assistance. The Master Plan should incorporate these and other existing

Solar panels on rooftop

supports, and recommend ways to align and expand them within the sustainability plans developed by city, county, and state agencies and, where applicable, in collaboration with non-governmental entities developing useful resources and tools in this arena.

Equity criteria identifying climate-vulnerable communities for priority investment

The Master Plan should identify and utilize criteria that equitably identifies needs and risks, such as the California Healthy Places Index developed by the Public Health Alliance of Southern California, the Climate Change and Health Vulnerability Indicator developed by the California Department of Public Health (CDPH), CalEnviroScreen developed by the Office of Environmental Health Hazard Assessment, or similar tools.

These tools allow geographic cross-referencing between areas where climate-related hazards such as heat indices and air pollution are elevated, and where there are schools serving concentrated populations of students who may be especially vulnerable to stresses and disruptions, including socioeconomically disadvantaged students, students of color, English Language Learners, and students with disabilities.

How we can drive the plan into action

Now is the moment to raise up a scaffold that will support the necessary transformation of our schools. A Master Plan process is the start of a generational, statewide effort that will continue through 2045 – and on toward the next horizon.

Because the Master Plan will guide coordination and investment across the state, it is critical that the process has the full support of the governor, legislature, and relevant state agencies. While the process could be run by one state agency, such as the California Energy Commission, it will require funding to enable the necessary research, cross-agency collaboration, and stakeholder engagement. See Appendix 4 for a list of suggested participants and relevant groups.

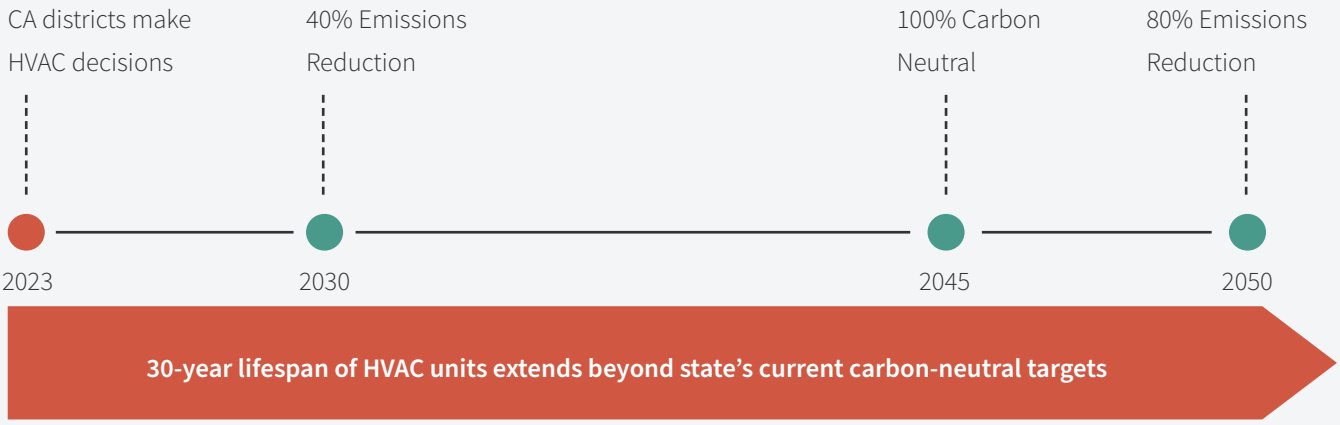
To make that start, we propose the two-year launch period that is summarized in Table 3 below.

Students writing observations about nature

Table 3: Overview of a California Master Planning Process and Investment Timeline for Climate-Resilient, Sustainable Schools.

	Year 1	Year 2-3
Master Plan	• Launch Master Plan either through prioritization of already budgeted dollars or through legislative action • Release preliminary Master Plan report to inform Governor's next budget proposal	• Release final Master Plan report in Year 2
Investment in technical infrastructure to support local school district efforts	Budget action to: • Ensure County Offices of Education have capacity to support climate-ready school operations and education • Engage districts and schools within regional climate resilience and sustainability networks • Launch grant programs for districts to develop and enact decarbonization and climate-resilience plans	Budget action to: • Continue support for technical assistance to support district implementation toward decarbonization and climate resilience in school buildings and grounds
Next generation statewide programs and investments	• Budget action to enhance previous state budget allocations for school HVAC upgrades and electrification and schoolyard greening • Legislative action to give state voters opportunities to consider next statewide school infrastructure bond	• Budget action to invest in climate-resilient schools based on recommendations from the Master Plan • Policy action to align with recommendations from the Master Plan • California voters consider next school infrastructure bond, which is aligned with goals from the master planning process

Figure 3: Illustrative timeline of HVAC system lifespan relative to CA climate goals



Capital-intensive school infrastructure projects, such as new school construction, modernizations of older buildings, full campus renovations, and even more narrowly-targeted maintenance projects such as replacements of school HVAC systems can have lifespans of 30 years or more. As a result, Local bond measures will be necessary but not sufficient to meet districts' needs. California will have to drive investment in implementing the Master Plan, especially on behalf of school districts serving lower-wealth communities and those with lower property tax bases. State appropriations across the next three budget cycles can be highly leveraged in the event of a successful statewide school bond measure, which is likely to be proposed in an upcoming legislative session. The impact of those early investments will then ripple through succeeding decades.

Current state and federal funding opportunities are priming the system to make efficient use of future investments, but these programs could also be better aligned and more vigorously marketed to ensure that the greatest number of eligible schools can take advantage. These programs include:

- California Climate Investments funds under the California Air Resources Board's Cap-and-Trade program
- Federal ESSER III Funds and CalSHAPE Program for upgrading and repairing school HVAC systems
- Federal and state funds to electrify school bus fleets under the Bipartisan Infrastructure Law the Hybrid & Zero-Emission Truck & Bus Voucher Incentive Project

how school districts decide to handle such projects in the 2020s will determine what part the schools will play in meeting the State's climate goals in the run-up to 2045. Figure 3 illustrates how fossil-gas powered HVAC installed today will pollute beyond state's goals for carbon neutrality.

- State grants for partnerships between county mental health agencies and local education agencies to deliver school based mental health services under the Mental Health Student Services Act
- Funds to augment community climate resilience through the Strategic Growth Council
- Incentives for solar, battery storage, and electric heat pump HVAC systems in the Inflation Reduction Act

As they come online, new state funding programs supporting climate-resilient and sustainable schools will need to be designed to provide flexibility and ensure equity, recognizing the wide variability among school districts in regard to costs, capacity and resources, and to the current condition of their buildings and campuses.

If school districts make decisions from a position of resource scarcity, in a mindset of expediency, then we will have missed a mission-critical opportunity to activate our schools in response to climate change.

Small child standing on sand with arms outstreched

Conclusion

As Californians, we are heirs to vast resources and a tradition of innovation that includes, in our own time, bold enterprises and far-sighted public initiatives that aim to alleviate climate change. Even as this report was being written, for example, the State laid down new rules banning the sale of gas-fired home furnaces and water heaters after 2029 and requiring, by 2035, that all new passenger cars and light trucks must be electric or other emissions-free models.

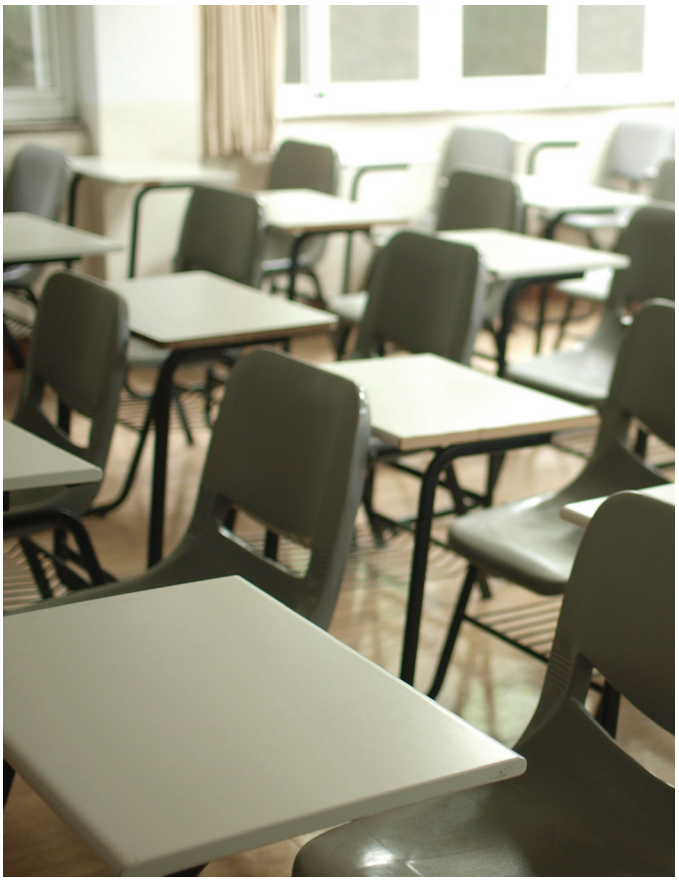
We must be no less audacious about remaking our elementary and secondary schools than we are in regulating the appliances in our homes and the vehicles on our roads.

A Transformative Investment in Climate-Resilient Schools is Needed

California school districts spent about $7 billion per year in recent years on capital expenditures for new construction and facility modernizations and upgrades, deploying a combination of local and state funding.[46, 154] Yet, it is clear that many schools need more significant upgrades to be climate resilient.

To face the climate future forthrightly and ensure that all school facilities and campuses will be safe, healthful, and carbon neutral by 2045, California – meaning the state and local communities together – will need to double annual investment over the next decade: to about $15 billion per year, $150 billion in total.[46, 154] This level of investment will be transformative for schools and communities across California by taking care of long-standing deferred maintenance, provide needed educational enhancements to schools, and fund the "green retrofitting" needed to achieve carbon neutrality and climate resilience.

Climate change threatens our children's health and their opportunities to learn undisrupted and achieve their undiminished potential. These threats, which we cataloged in the first parts of this report, are more than foreseeable: they are present today, already affecting students and schools. It's essential that schools protect their students from harm – and they can do more than that. By streamlining their operations and making climate resilience a central part of their 21st-century mission, schools can play a vital role in our overall climate solution.



Desks in an empty classroom

This situation demands that we redouble our commitment to public education – even as we reimagine how our schools are built, how they operate, and how they prepare our youth to engage the future. No matter how much money we are prepared to spend, we cannot secure our children's future by educating them in yesterday's schools.

Every education dollar we commit today or pledge tomorrow must be considered as an investment in sustainable transformation.

As demonstrated in the middle sections of this report, investments in climate resilience and sustainability can return savings for school districts – through lower energy costs and improved attendance, for example – as well as improvements in health and education outcomes for students. And, like producing electric vehicles, installing household solar systems, and other burgeoning climate-adaptive enterprises, the effort to make our schools climate-resilient and sustainable will put Californians to work in green, growing, future-facing sectors of the economy.

Investment in Climate-Resilient Schools Will Create Good Jobs

Strategic investment in climate-resilient schools will also yield major economic benefits for all Californians. A transformative investment for climate resiliency in California's school facility infrastructure of $150 billion over the next decade will create nearly 150,000 new jobs.[155] These will be well-paid jobs in growing industries, advancing green technologies, and building a sustainable 21st-century California economy.

In the latter parts of this report, we proposed a comprehensive strategy for action, including design specifications for climate-resilient, sustainable schools and a policy blueprint – the Master Plan process – to launch and guide the work. To sustain this generational effort, we will need sponsorship and investment from every part of the state government, supported by robust partnerships with philanthropies, businesses, and social sector agencies. And we will need to activate and connect county and local education leaders, teachers and counselors, community-based organizations, parents and

Our children's climate future will not wait; so let us begin.

Appendices

Appendix 1: Methodology for estimating health impacts

By Sam Heft-Neal, Stanford Center on Food Security and the Environment

Wildfire Smoke

Wildfire smoke is expected to dramatically worsen air quality over the coming decades. Recent estimates suggest that by 2050 smoke pollution along the West Coast will be 50% higher than current levels.[139] Drawing on historical data we estimate that from 2006-2010 the average child in California was exposed to 11 smoky days per year with AQI greater than 50.[140] However, between 2016 and 2020 this average more than doubled to 24 days per year. The impact of these changes are also being seen in child health. A recent study of pediatric respiratory visits to emergency and urgent care centers in San Diego found that for every 10 ug/m3 increase in PM2.5 attributable to wildfire smoke, visits increased by 30%.[141]

We estimate that between 2006 and 2017 the average child in California was exposed to only 3.6 ug/m3 of wildfire smoke PM2.5 per year. However, in the high fire years of 2018 and 2020, the average exposure increased to more than 15 ug/m3. Extrapolating results from the pediatric respiratory emergency study to these recent exposures statewide suggests a more than 30% increase in pediatric respiratory hospitalizations. Further taking into consideration the 50% increase in wildfire smoke projected by 2050 suggests that bad wildfire years in midcentury could lead to upwards of a 40-50% increase in pediatric respiratory visits at average exposure levels with even larger impacts in the more affected parts of the state.

Heat

The impact of climate change on temperatures in California has already caused widespread impacts[142] and future temperatures are expected to further increase. Over the past 20 years average daily maximum temperature in California has been 72°F. Under RCP4.5 (moderate emissions scenario) daily maximum temperature is forecast to increase by 2.4°F and under RCP8.5 they are forecast to increase by 3.6°F.[143] Temperature extremes are an important driver of health with recent estimates finding that extreme temperatures were responsible for 31% of child heat related emergency department (ED) visits and 12% of all-cause child emergency department visits across the U.S. during the warm season.[144] Taking into account the 2-4°F projected rise in maximum temperatures across California suggests that by 2050 extreme temperature could account for more than 1-in-3 heat related ED visits and nearly 1-in-5 all-cause ED visits in California during the summer.

Appendix 2: Methodology for estimating the carbon footprint of Califonia's public schools

By Reilly Loveland, New Buildings Institute

Estimated CO2e emission reductions are based on analysis of data from a variety of sources, with methodology described below.

The California Commercial End-Use Survey (CEUS)[145] provides an estimate of the electricity use of K-12 schools as a percent of all electricity use in California, and the percentage of education buildings that are K-12 schools. These percentages can be applied to CARB's estimate of the CO2 emissions associated with electricity and fuel consumption statewide and by sector (e.g., education buildings) to determine the share of emissions of K-12 schools.[146]

The California Department of Education provides an estimate of the number of TK-12 students in California (with charter school students excluded).[147] The Federal Highway Administration's data on mode of transport to and from school was then used to create an estimate of the number of children riding the bus and riding in a passenger vehicle in California.[148] EPA assumptions[149] on passenger vehicle and school bus CO2 emissions were used along with assumptions of fuel efficiency,[150] commute distance,[151] and total number of California school buses[152] to estimate the total CO2 emissions associated with TK-12 school-related transportation. This estimate was compared against CARB's total on-road vehicle emissions in California to determine TK-12 schools' share of emissions.

Appendix 3: Methodology for estimating solar plus storage microgrid installations needed for California public schools

By Patrick Murphy, Physicians, Scientists, and Engineers for Healthy Energy

We estimate potential for solar and solar plus storage (solar+storage) at California's K-12 public schools to offset utility bills, replace grid energy with renewable energy, and to provide some resilience during grid outages. Using California Department of Education 2018-19 data on school locations, we identified a sample of 3,988 school campuses (out of the total 10,003 active schools in the CDE data). For these, we: (1) determined the school's location (latitude and longitude); (2) estimated roof space available for solar panels; (3) estimated hourly energy use for a year; and (4) estimated electricity cost per kilowatt hour (kWh). To inform resiliency potential we also identified/estimated: (5) a target electricity outage duration; and (6) the hourly energy use during the outage. With these factors, we use the National Renewable Energy Laboratory's ReOpt[153] tool to simulate the economic and resilience operations for each school in our sample.

A more detailed description of these methods can be found here: https://www.psehealthyenergy.org/our-work/publications/archive/climate-resilient-california-schools/

Appendix 4: Suggested master plan process participants

(Note - this includes potential participants but is not fully comprehensive)

- Governor Gavin Newsom
- California Energy Commission
- California Department of Education
- Division of State Architect
- State Allocation Board
- California Natural Resources Agency / CAL FIRE
- California School Finance Authority
- Governor's Office of Planning and Research
- California Health and Human Services Agency
- Strategic Growth Council
- California Air Resources Board
- California Environmental Literacy Initiative
- County Offices of Education
- Local Education Agencies
- Youth representatives
- Family/parent/caregiver representatives
- Education representatives
- Environmental justice representatives
- Labor representatives
- Healthcare representatives
- Technical assistance practitioners
- Design and engineering practitioners

Appendix 5: Methodology for estimating job creation associated with recommended investments

By Kira McDonald, Climate + Community Project

We estimate that our proposed infrastructure investments in California schools will result in 1,402,110 new job-years in California, or 140,211 new jobs over a 10-year spending period.

This was estimated using the RIMS II input-output model from the Bureau of Economic Analysis (BEA). Using the RIMS model requires estimating demand shocks from new investments across economic sectors, using North American Industry Classification System (NAICS) industries.

We allocated the proposed investments in school greenyards, electric school buses, HVAC systems, solar, and general building retrofit work across NAICS industries using "composite weights" that mapped renewable energy investments to NAICS industries. For HVAC, solar, and building retrofits, we adapted weights from Heidi Garrett-Peltier 2017 to our proposed investments. For electric school buses and greenyards, we estimated the investments across sectors ourselves.

Appendix 6: Workshop participants

The authors are grateful to the following individuals who contributed their knowledge and insight to the development of this report.

Aaron Davis, *California School Boards Association*
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Veronica Wilson, *Labor Network for Sustainability*

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Wildfire plumes of smoke above a forest

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