School Decarbonization Strategy Spotlight: Resiliency

The Kathleen Grimm School for Leadership and Sustainability | Staten Island, NY
Credit: SOM

Schools designed and operated with resiliency in mind not only safeguard the health of students, but also serve the broader community in times of need. This resource presents the core components of resilient buildings and provides a roadmap to improve resiliency in schools, both in new construction projects and retrofitting existing buildings.

What Is a Resilient School and What Are the Benefits?

Resilient schools are designed and operated to defend against, and quickly bounce back from, natural or man-made disasters and other hazards like long-term climate change. In times of crises, community buildings (like schools) often become gathering places to provide shelter, information, supplies, and coordination for residents.

Resilient schools can benefit the entire community they serve by remaining operational during power outages and reduce lost learning days by keeping schools open during disasters or climate events like heat waves. They also keep occupants safe and secure during outages by continuing to provide light, heating and cooling, ventilation, and fire alarms.

Resilient schools come in many forms. Some key components of resilient schools are outlined below:[1]

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.

Basic Terms and Principles

Throughout this document several key terms related to resiliency are used: risk, vulnerability, adaptation, and mitigation.[2]

Risk refers to the likelihood of a hazard or threat occurring, and the magnitude of its impact.

Vulnerability refers to how susceptible a building is to the negative effects of natural and man-made disasters and hazards. For example, the age of the infrastructure will impact vulnerability.

Adaptation measures are actions taken to adjust to current or expected future conditions in a way that lowers overall risk.

Mitigation measures are actions taken to prevent or reduce risk. Reducing overall demand on drinking water to prepare for potential drought-induced water shortages would be an adaptation measure, while installing rooftop solar PV would be a mitigation measure.

Resistance measures protect and defend the building from being impacted by disasters and hazards. Measures that increase **resilience** improve the building's ability to "bounce back" when disasters and hazards do strike. Resilient buildings should also incorporate resistance measures.[3]

Resistance can be thought of as foundational building safety measures, like fireproof insulation and earthquake-proof design. The fundamental principles of resistance to consider when designing new buildings and assessing the resilience of existing buildings are:

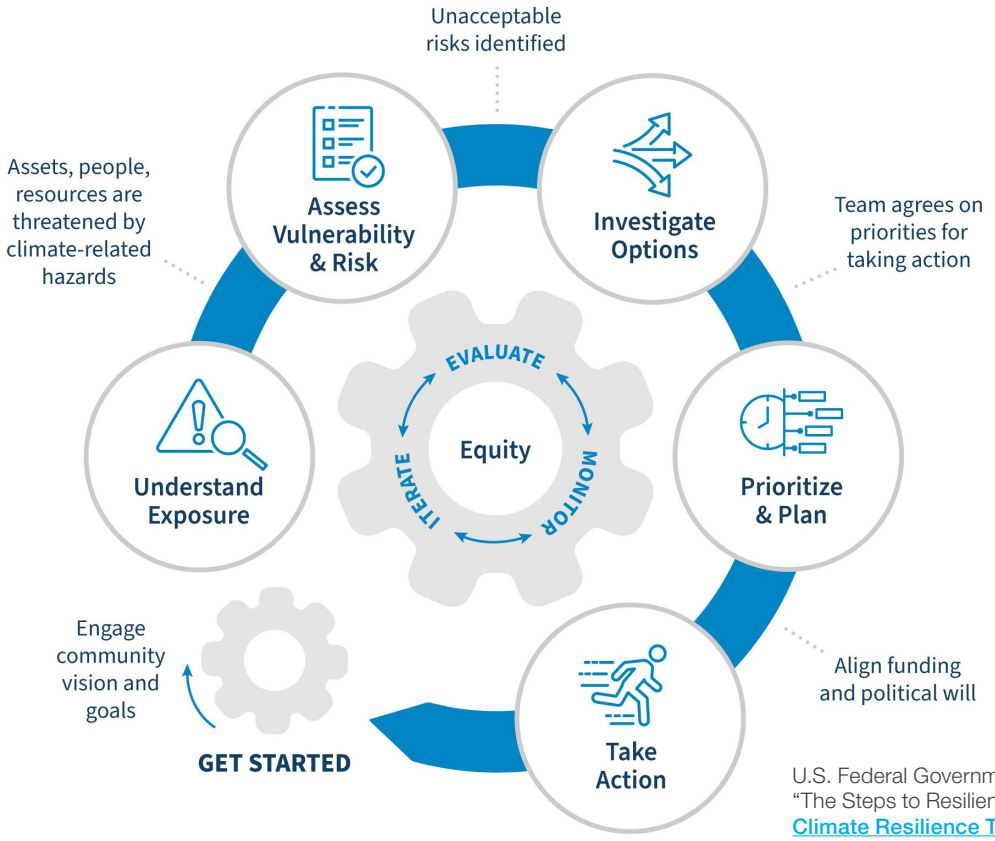
- ☑ **Plan for Fire Protection**
  Analyze all the building's components as a system to assess whole-building fire safety.
- ☑ **Protect Occupant Safety and Health**
  Implement measures related to indoor air quality, electrical safety, fall protection, ergonomics, and accident prevention.
- ☑ **Mitigate for Natural Hazards**
  Anticipate the infrastructure risks and potential damage associated with major natural disasters most likely for the region.
- ☑ **Provide Security for Building Occupants and Assets**
  Implement countermeasures to deter, detect, delay, and respond to attacks; implement measures that prevent catastrophic damage.

Resilient buildings expand upon the principles of resistance, using adaptation and mitigation measures to further minimize buildings' risk vulnerability. Decisionmakers should consider how each unique resilience measure contributes to the four key components of resilient buildings:

- ☑ **Robustness**
  The ability to maintain critical operations and functions in the face of crisis.
  Example: Building design and energy efficiency measures
- ☑ **Resourcefulness**
  The ability to skillfully prepare for, respond to, and manage a crisis or disruption as it happens.
  Example: Emergency preparedness plan
- ☑ **Rapid Recovery**
  The ability to resume normal operations as quickly and efficiently as possible after a disruption.
  Example: Trained operators
- ☑ **Redundancy**
  Back-up resources to support the originals in case of failure.
  Example: Onsite power generation and storage

Steps to Resiliency

The graphic[4] below outlines the high-level steps to increase building resilience. However, as the graphic shows, local risks, resiliency goals, project plans, and funding opportunities are all dynamic and the process will be iterative. Decision-makers can use the guiding principles and question prompts below to scope projects throughout the building lifecycle. More detailed guidance is linked in the References section.



U.S. Federal Government, 2023: "The Steps to Resilience." U.S. Climate Resilience Toolkit.

1. Get Started and Understand Exposure

What are the resiliency goals your school or district is trying to achieve, and how do these relate to other design or operational objectives? Consider reviewing the LEED Resilient Design credits[5] and/or the RELi™ Standard[6] to help select realistic and science-based targets for your project. To understand exposure, consider asking what is most important for your school or district to protect, and what are the most likely hazards.

2. Assess Vulnerability and Risk

What risks are applicable to your school or district? How likely are they to happen annually? Once every 10 years? Once every 50 years? What is the potential magnitude of loss? The U.S. Global Change Research Program's Climate Resilience Toolkit[7] and the World Bank's Rapid Assessment Tool[8] can help inform these conversations.

3. Investigate Options, Prioritize and Plan

What strategies are relevant to your geographic location and provide an acceptable return on investment? In the case of new construction or major renovations, will any certifications be pursued (e.g., LEED)?

a. **Center on equity:** Consider all populations that are served by the school. Remove barriers to access while promoting inclusive social, environmental, and economic benefits for the community.

b. **Take a systems approach:** Recognize interdependencies and potential unintended consequences, throughout the entire lifetime of the building.

4. Align Funding and Take Action

How will resiliency measures be funded? Use resources like the U.S. Department of Energy's factsheet on financing and implementing resilience projects.[9] Options include:

a. Incorporate into capital planning or bonds

b. Financing options such as PACE[10]

c. Energy service agreements

d. Incentives and programs (city, state, federal, or utility-run)

Once funding is secured, start implementing tasks in your plan(s). Monitor and review the outcomes, and share your results.

Resiliency Throughout the Building Lifecycle

The information above provides guidance on the overall approach to resiliency, but there are specific considerations that only apply to certain portions of the building lifecycle. Every school facilities project—new construction, retrofit, or repair—is an opportunity to protect students and staff from climate-related health hazards and disruptions, and the following list provides a high-level overview of how to best address resiliency for specific parts of the building lifecycle.

What Are Potential Hazards Buildings Can Futureproof Against?[11]

Related to climate change, geophysical, hydrological, and man-made events

- Drought
- Wildfire
- Flooding
- Tornado
- Extreme heat waves
- Earthquakes
- Landslides
- Tsunamis
- Terrorism
- Accidents
- Intense storms
- Sea level rise

Design and Construction

1. Complete a climate vulnerability assessment to understand hazards. There are a variety of approaches to complete this; the U.S. Climate Resilience Toolkit[12] offers an in-depth guide.
2. Incorporate all feasible adaptation measures into the project design. Start with the Collaborative for High Performance Schools' Criteria,[13] which provides building design and

construction strategies tailored to high performance schools.[14] The RELi™ Standard[15] also provides design ideas, metrics, and measures that focus on resilience. Decisionmakers looking to receive certification can explore three LEED Resilient Design pilot credits,[16] which reference the RELi™ Standard.

3. Work with an electrician or engineer to plan for any future electrical infrastructure needs, such as electrical transformer/panel/wiring for more electrification, PV panels, and EV charging.
4. Maximize strategies that reduce the amount of energy needed to run the building overall and increase building usability even if onsite energy runs out. This could include a highly insulated envelope, natural ventilation (operable windows), daylighting, and even building orientation, for new construction projects.
5. Ensure there is adequate backup power and energy storage (onsite batteries or generators) to cover critical services like maintaining healthy ventilation and enough lighting for safety. Work with a facilities manager, electrician, or engineer to assess your building loads and explore your options to meet backup power goals, (e.g., maintaining ventilation and lighting for four hours in the gym).
6. Make sure there is a back-up plan for potable water disruptions.

Operation and Maintenance

1. Keep systems optimized through proper maintenance and repairs.
2. Develop emergency preparedness plans. SchoolSafety.gov offers a comprehensive guide to emergency planning strategies and resources.[17]
3. Seek to reduce electricity use during the hours when the local electric grid is most stressed, and costs are highest (peak grid hours). The electric utility can provide information about when peak grid hours are.
4. Ensure operators are trained on disaster recovery protocols, which should be covered in the emergency preparedness plans. This may include information such as how to run a generator or energy storage system in the case of a power outage.
5. Plan for upgrades and replacements to avoid emergency replacement decisions that do not prioritize efficiency. The **BETR Schools Report** offers guidance on this approach.

Retrofits and Renovations

1. If one does not already exist, complete a climate vulnerability assessment.[12]
2. Develop mitigation strategies that reduce risk. Examples are shown in the table below. Some strategies that are appropriate for new buildings (described in “design and construction,” above) may also be an option, such as adding energy storge and backup power.
3. Prioritize and implement retrofit investments and develop policies to guide future decision-making, such as climate action plans or policies that enforce adherence to specific design specifications for new buildings.

Turkey Foot Middle School | Edgewood, KY
Credit: Piaskowy and Cooper

Types of Resilient Retrofits

The DOE's Better Buildings Solution Center[18] organizes resilient retrofit projects into three categories, shown below. To understand the best design strategies for your specific climate risk types, see Urban Land Institute's "Resilient Retrofits: Climate Upgrades for Existing Buildings."[19]

Structure Hardening

Mitigate property damage, injury, and system outages in the event of disaster.

Examples:

- Seismic retrofits
- Wind-resistant roofs and windows
- Flood mitigation

Resource Conservation

Reduce the energy and water demands of a building, increasing how long it can operate on backup power and reducing the impact of disruptions.

Examples:

- Efficient lighting and HVAC
- Water efficiency measures
- Building envelope improvements

Energy Supply

Ensure that critical building systems can continue operating during a grid or fuel supply interruption.

Examples:

- Renewable energy
- Battery storage
- Backup generation
- Electric vehicle charging

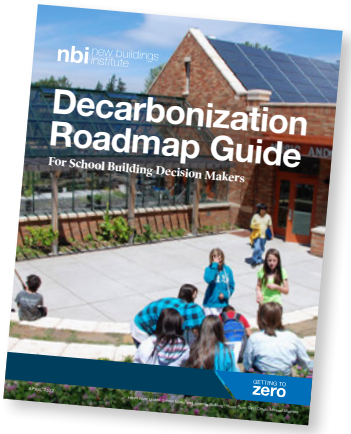
Playa Vista Elementary | Los Angeles, CA
Credit: NAC Architecture

Conclusion

Resilient school buildings provide a safe haven for students and are a valuable community resource. Incorporating resiliency measures requires planning ahead but is achievable for both existing schools and new buildings.

By following the roadmap to resiliency, decision-makers can use the guiding principles and question prompts to scope projects throughout the building lifecycle. Every school facilities project—new construction, retrofit, or repair—is an opportunity to protect students and staff from climate-related health hazards and disruptions.

This document is part of the Decarbonization Roadmap Guide for School Building Decision Makers toolbox, [download the full document](#).



References

1 Climate Ready Schools Coalition, "Climate-Resilient California Schools: A Call to Action," 2023. https://www.climatereadyschoolscoalition.org/ourwork/climate-resilient-schools-report

2 An expanded glossary of resilience-related terms can be found here: The Environmental Finance Center at Sacramento State, "Resilience Planning: Tools and Resources for Communities," November 2020. https://www.efc.csus.edu/reports/resilience-planning-tools-and-resources-for-communities.pdf

3 Office of Energy Efficiency and Renewable Energy, "Building Science Education: Disaster Resistance and Resilience," 2023. https://bsesc.energy.gov/training-modules/disaster-resistance-and-resilience

4 U.S. Federal Government, 2023: "The Steps to Resilience." U.S. Climate Resilience Toolkit. https://toolkit.climate.gov/steps-to-resilience/steps-resilience-overview

5 U.S. Green Building Council (USGBC), "Revised LEED Resilient Design pilot credits now available," February 20, 2019. https://www.usgbc.org/articles/revised-leed-resilient-design-pilot-credits-now-available

6 C3 Living Design, "RELi / ADAPT + Resilient Design." https://c3livingdesign.org/reli-resilientdesign/

7 U.S. Federal Government - U.S. Climate Resilience Toolkit, "Climate Mapping for Resilience and Adaptation," 2023. https://resilience.climate.gov/

8 The World Bank, "Climate and Disaster Risk Screening Tools: Rapid Assessment Tool." https://climatescreeningtools.worldbank.org/rapid-assessment-tool

9 U.S. Department of Energy Better Buildings Solution Center, "Financing and Implementing Resilience Projects," June 2020. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Financing_and_Implementing_6-20.pdf

10 U.S. Department of Energy State and Local Solution Center, "Property Assessed Clean Energy Programs." https://www.energy.gov/scep/slsc/property-assessed-clean-energy-programs

11 U.S. Green Building Council (USGBC), "LEED v4.1 Credit: Resilience Planning." https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-50?return=/pilotcredits/new-construction/v4

12 U.S. Federal Government - U.S. Climate Resilience Toolkit, "Assess Vulnerability & Risk," 2021. https://toolkit.climate.gov/steps-to-resilience/assess-vulnerability-risk

13 Collaborative for High Performance Schools (CHPS), "CHPS Criteria," https://chps.net/chps-criteria

14 Section II C7.1 of U.S. CHPS 2.0 summarizes best practices. https://chps.net/chps-criteria

15 C3 Living Design, "RELi / ADAPT + Resilient Design." https://c3livingdesign.org/reli-resilientdesign/

16 U.S. Green Building Council (USGBC), "Revised LEED Resilient Design pilot credits now available," February 20, 2019. https://www.usgbc.org/articles/revised-leed-resilient-design-pilot-credits-now-available

17 SchoolSafety.gov, "Emergency Planning Strategies and Resources," 2023. https://www.schoolsafety.gov/sites/default/files/2023-09/Emergency%20Planning%20Strategies%20and%20Resources-508.pdf

18 U.S. Department of Energy Better Buildings Solution Center, "Resilience." https://betterbuildingssolutioncenter.energy.gov/resilience/about

19 Urban Land Institute (ULI), Resilient Retrofits: Climate Upgrades for Existing Buildings," 2022. https://knowledge.uli.org/en/Reports/Research%20Reports/2022/Resilient%20Retrofits

The Decarbonization Roadmap Guide for School Building Decision Makers identifies cost effective strategies and approaches to help school districts achieve healthy, efficient, and decarbonized school facilities. This content was developed by New Buildings Institute.

With Sponsorship From

SOUTHERN CALIFORNIA EDISON®

nbi new buildings institute

New Buildings Institute (NBI) is a nonprofit organization driving better energy performance in buildings to make them better for people and the environment. We work collaboratively with industry market players—governments, utilities, energy efficiency advocates, and building professionals—to promote advanced design practices, innovative technologies, public policies, and programs that improve energy efficiency. Visit the **NBI Getting to Zero in Schools** webpage to learn more.