Strategies for Enhancing Resilience and Minimizing Vulnerabilities to Extreme Heat Events

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This brief provides case studies and actionable guidance to help utilities, local governments, and community partners strengthen resilience to extreme heat events. It highlights strategies across three complementary pathways—utility-driven investments, locally led initiatives, and hybrid utility-community partnerships—that reduce heat exposure, maintain safe indoor conditions, and protect vulnerable populations. Key recommendations for coordinated action include the following:

- Utilities should lead programs to advance energy efficiency in buildings and deploy resources and technologies to reduce peak loads, maintain grid reliability, and support passive survivability during outages.
- Locally led programs should target heat-vulnerable households and neighborhoods, combining efficient cooling technologies, energy upgrades to existing buildings, and nature-based solutions to maximize equity and resilience benefits.
- Hybrid partnerships should integrate utility expertise with community-led operations, enabling emergency preparedness, resilience hubs, and locally tailored interventions that align system-wide goals with neighborhood-level needs.
- Stakeholders should coordinate investments across scales, align program design with local conditions and grid objectives, and embed heat resilience into routine planning and operations to ensure long-term effectiveness.

By applying these approaches, communities can protect residents most at risk, strengthen grid and building resilience, and scale high-impact interventions as extreme heat events increase in frequency and intensity.

Introduction

Extreme heat[1] is becoming one of the most harmful and widespread climate-related hazards in the United States. Between 1999 and 2023, the country experienced over 21,500 heat-related deaths, and mortality rates have risen sharply in recent years, with the past six years recording rates at or above the long-term average (Howard et al. 2024). Extreme heat events are expected to become more frequent. In Washington State, for example, average summer temperatures could rise by 3.7 °F by 2049 and by up to 10.5 °F by the 2080s, while some locations within King County (greater Seattle) are already experiencing temperatures up to 20 °F hotter than surrounding areas due to urban heat islands and a lack of shade (King County 2024).

Extreme heat is dangerous indoors as well as outdoors, making buildings and access to cooling critical to addressing health risks. In New York City (NYC), most heat-stress deaths occurred at home, and among

[1] Extreme heat refers to a period of high temperatures, often accompanied by high humidity, in which daytime temperatures exceed 90°F for at least two to three consecutive days (https://www.ready.gov/heat).

cases where access to air-conditioning (AC) was known, none of the individuals who died had or were using AC. Without cooling, indoor temperatures can exceed outdoor conditions and remain elevated for days after a heat wave (New York City Government 2025). Exacerbating these risks, heat waves are driving sharp increases in peak electricity demand, placing additional strain on the grid and potentially limiting reliable access to cooling (North American Electric Reliability Corporation 2025).[2]

These impacts are occurring against the backdrop of a broader increase in climate-driven disasters. Over the past three decades, the nation has faced more than 400 disasters that each exceeded $1 billion in damage, resulting in nearly 17,000 deaths and over $2.9 trillion in direct costs (Smith 2025). Many of these events—such as wildfires and severe storms—can cause power outages that coincide with extreme heat, leaving households and businesses without cooling or other essential services, and compounding heat-related illness and mortality. Despite these impacts, investment in resilience remains largely reactive rather than proactive. This reactive approach is costly for both utilities and ratepayers: Utilities face lost revenue, higher operational expenses, and regulatory penalties, while households and businesses incur higher energy costs, reduced productivity, and potential health-related expenses (Ghodeswar et al. 2024). By contrast, proactive investment is far more cost effective: Every $1 invested in hazard mitigation avoids $4–6 in future disaster-related costs, and buildings constructed to modern, resilient codes avoid an average of $11 in losses for every dollar invested (Came 2025).

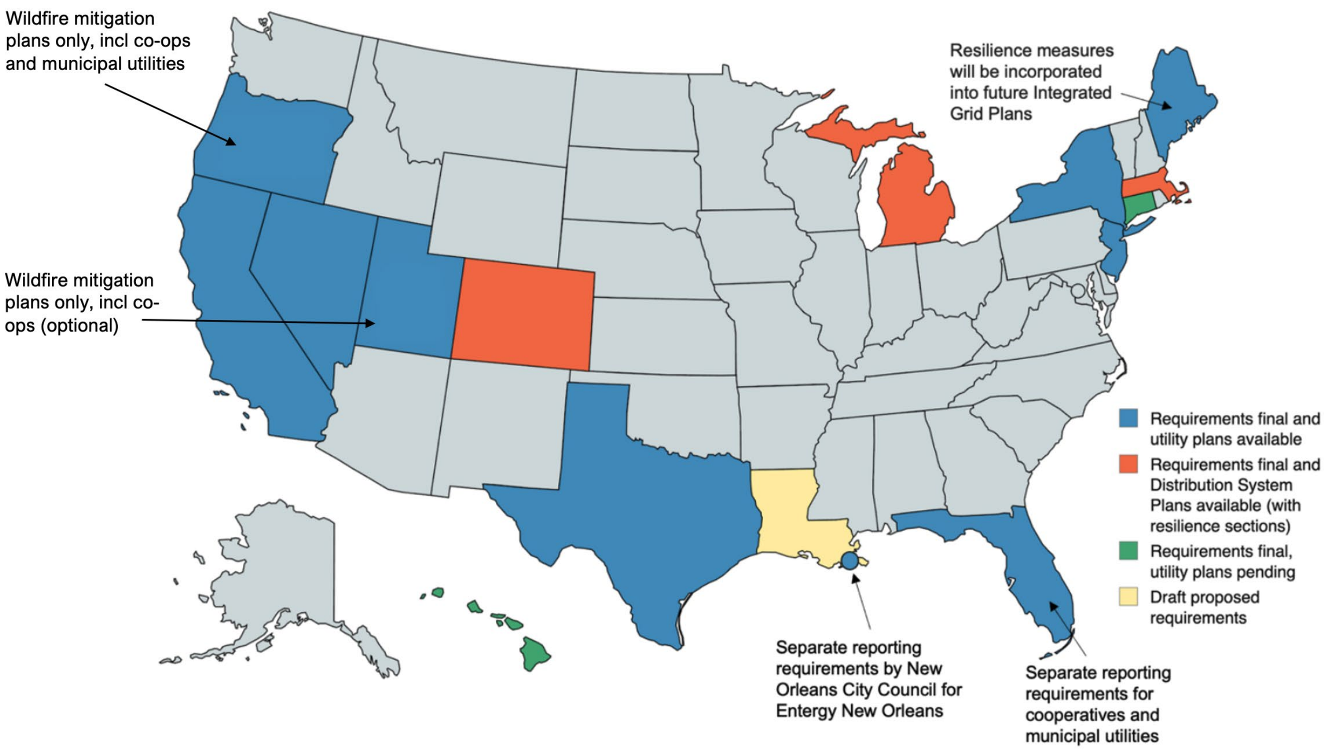

Figure 1. Resilience and planning requirements for regulated utilities (Schellenberg and Schwartz 2024)

Recognizing these trends, many cities and states have begun developing resilience plans and establishing community resilience hubs that specifically address extreme heat. Public utility commissions

[2] The North American Electric Reliability Corporation's (NERC) 2025 Summer Reliability Assessment forecasts that peak demand across its 23 assessment areas will increase by about 10 gigawatts compared with the previous summer—more than double the increase seen the year before—highlighting growing strain on the grid and the potential for energy shortfalls (North American Electric Reliability Corporation 2025).

(PUCs) in at least 14 states now require utilities to prepare resilience plans or climate vulnerability assessments (see figure 1), highlighting that while awareness is growing, formal regulatory requirements remain limited (Schellenberg and Schwartz 2024).

Utilities, along with state and local governments, are responding to the growing challenge of extreme heat by investing in a range of technologies and infrastructure upgrades that strengthen system reliability (withstanding disruptions) and resilience (surviving and recovering rapidly from extreme events)—but the scale of necessary investment is large (Srivastava et al. 2025). U.S. investor-owned utilities (IOUs) face a capital investment gap exceeding $500 billion to achieve the level of resilience needed to adequately address climate change, with approximately 60% of this gap attributed to the need for system hardening required to cope with rising temperatures and extreme heat events (Bruzgul and Weisenfeld 2021). Addressing this gap requires coordinated action across utilities, governments, and community organizations.

As extreme heat becomes more frequent, local governments, utilities, and community partners can proactively strengthen resilience by investing in strategies that reduce heat exposure, protect vulnerable residents, and bolster grid reliability. This brief outlines how stakeholders can coordinate investments to strengthen resilience through strategies such as energy efficiency upgrades to prepare buildings and reduce energy demand during more frequent and intense heat events, integrating heat resilience into planning and operations, and strengthening partnerships to expand reach and ensure equity.

Targeted, coordinated investments enhance resilience

Because heat risk is growing faster than any single sector can address it, resilience solutions are emerging through three complementary pathways that align grid capabilities, local planning, and community-based delivery:

1. Utility-driven investments
2. Locally led initiatives
3. Hybrid utility-community partnerships

This topic brief provides a framework of interventions that fit into these three pathways to build resilience against extreme heat. These interventions range from building energy efficiency and distributed energy resources to energy system upgrades, nature-based solutions, code readiness, and emergency preparedness. It is intended for policymakers, utilities, and program managers to help identify local needs and match them with high-impact strategies to guide investment. Building on the 2024 (Srivastava et al. 2024) and 2025 (Srivastava et al. 2025) ACEEE resilience reports—which highlighted that the resilience benefits of building energy efficiency are often undervalued—this brief focuses on the types of investments and strategies that can deliver reliability, passive survivability,[3] peak demand reduction, and reduced outage impact in the context of extreme heat. The methodology includes a literature review, analysis of utility climate and vulnerability assessments, expert interviews, and review of relevant program and policy documents.

[3] Passive survivability refers to the ability of a building to maintain critical life-support conditions for its occupants if services such as power, heating fuel, or water are lost for an extended period (https://www.buildinggreen.com/op-ed/passive-survivability).

Pathway 1: utility-driven investment in codes, distributed energy resources (DERs), and demand flexibility

1A. Utility-led code readiness and technical support

Code readiness programs are a form of technical support that help jurisdictions prepare for, adopt, and implement energy-efficient building codes that enhance resilience to extreme heat. Because building codes shape energy demand and impact ratepayer satisfaction—by helping ensure homes stay comfortable—utilities have a strong interest in accelerating their adoption. When led by utilities, these programs have unique advantages: Utilities can target code measures to reduce peak load during extreme heat events, align efforts with long-term grid planning, claim credited energy savings under regulatory mandates, and provide technical and financial support that accelerates adoption. Through these investments, utilities can help local governments and building owners integrate measures that maintain habitable indoor conditions during extreme heat events, reducing strain on the grid and protecting occupants. In addition to enhancing heat resilience, these measures can reduce energy use, lower utility costs for residents, and cut greenhouse gas emissions.

Research shows that stronger building codes can improve resilience to extreme heat by strengthening passive survivability during power outages that can occur when high temperatures strain the electricity grid. A 2023 Pacific Northwest National Laboratory (PNNL) modeling study found that homes built to the International Energy Conservation Code (IECC) 2021 code or Passive House standards remain habitable far longer during extended outages compared with typical homes. For example, in a modeled seven-day cold outage in Atlanta,[4] typical homes remained habitable for 1.4 days, code-compliant homes for 2.3 days, and Passive House homes the full seven days—an improvement of up to 409% relative to the baseline existing stock. The same study found that building to Passive House standards also reduces excess deaths (up to 93% in heat events) and lower property damage risks, such as foundation damage, mold growth, burst pipes, and other problems caused by power outages (Franconi et al. 2023).

The following strategies can help ensure utility-supported code readiness programs are effective:

- **Stakeholder engagement**: Align utilities, state agencies, and local governments on shared goals such as peak load reduction, passive survivability, and grid reliability during extreme heat events.
- **Implementation support**: Provide technical guidance, compliance tools, and incentives that accelerate adoption of high-performance envelope measures, efficient HVAC, and demand-flexible technologies.
- **Capacity building and training:** Equip designers, inspectors, and officials with tools and skills to implement updated standards effectively.
- **Equity-focused strategies**: Prioritize adoption in affordable housing and high-heat, high-vulnerability communities while leveraging incentives and standardized measures that lower upfront costs, reduce construction risk, and improve project economics for developers.

[4] Although the modeled scenario focused on cold conditions, the same building characteristics—high-performance envelopes and efficient systems—also create safe indoor conditions during extreme heat events.

Program in action: Pacific Gas and Electric's Code Readiness Program

The Pacific Gas and Electric (PG&E) Code Readiness Program is a utility-led initiative that accelerates the integration of advanced energy efficiency, electrification, and grid-stabilizing technologies into California's building codes and appliance standards. Its primary goals are to generate robust, real-world evidence to ensure emerging technologies are ready for market adoption and to develop clear compliance pathways that enable their integration into updated codes (Pacific Gas and Electric Company 2018).

To achieve these objectives, the program conducts research and field demonstrations evaluating technologies such as high-efficiency electric HVAC, and grid-interactive, solar-ready, and EV-ready construction practices. These activities generate evidence that directly informs the development of new California Title 24 code provisions and establishes how the measures should be implemented and verified once adopted (Pacific Gas and Electric Company 2023a). For example, a field monitoring project that evaluated dedicated outdoor air systems (DOAS) and variable refrigerant flow (VRF) heat-recovery systems in four commercial buildings found that ventilation heat recovery reduced summer peak electricity demand by up to 0.5 W/sf, while advanced control strategies, such as demand-control ventilation, improved system efficiency and helped maintain comfortable indoor temperatures. These findings were used to recommend new Title 24 provisions and compliance guidance that could reduce grid stress during peak heat demand, contributing to grid reliability.

By accelerating market readiness for high-efficiency and demand-flexible technologies, the program strengthens community heat resilience and improves grid stability during peak demand periods. With a five-year budget of $35–40 million under California Public Utilities Commission oversight, PG&E's Code Readiness program demonstrates how utilities can advance resilience by investing in technical assistance, market transformation, and codes-focused innovation (Pacific Gas and Electric Company 2023b). To date, the data collected through PG&E's Code Readiness Program have informed multiple Codes and Standards Enhancement (CASE) proposals submitted to the California Energy Commission to support the 2025 update to Title 24, including provisions for demand-responsive control strategies.

While utilities can play a unique role in advancing code readiness, state and local governments are also advancing code-based heat resilience strategies that highlight the role of building standards in reducing heat risk. Two prime examples are New York State's Extreme Heat Action Plan and Clean Energy Group's draft Connecticut Climate-Resilient Energy Code for Multifamily Affordable Housing (CT-CRE Code). Published in March 2025 as a voluntary overlay to the existing multifamily energy code, the CT-CRE Code would strengthen resilience to extreme heat by requiring high-performance insulation and windows, efficient ventilation with heat recovery, resilient HVAC and essential systems that can operate on emergency power or in energy-managed "resiliency modes," solar panels with battery storage, reflective and shaded surfaces, and backup power for critical functions. Modeling shows these measures would reduce electricity use by over 36,000 kWh annually in a typical 30-unit building, cut greenhouse gas emissions by nearly 15 metric tons per year, and deliver tenant savings of about $2,800 per unit over 20 years. Combined with solar generation and on-bill credits, the CT-CRE Code would generate roughly $840,000 in lifetime building benefits (Clean Energy Group 2025).

Local governments can also use voluntary standards like Leadership in Energy and Environmental Design (LEED) certification to strengthen building resilience. LEED v5 requires projects to assess climate hazards, including extreme heat, and encourages heat-island mitigation strategies—such as reflective surfaces, shading, and vegetation—to reduce exposure and improve indoor and outdoor conditions (U.S. Green Building Council 2025).

1B. Utility investment in community-based power and flexible demand

Extreme heat is increasing electricity demand and straining distribution systems, underscoring a critical need for both demand flexibility and localized energy resources that can maintain service during outages. Utilities can strengthen heat resilience by deploying community-based power—such as rooftop solar paired with battery storage—and supporting flexible demand technologies, including smart thermostats, managed and bidirectional electric vehicle charging, and direct control of water heaters. When deployed strategically, these strategies reduce peak demand, provide dispatchable flexible capacity during grid stress, and help maintain essential service during outages. In addition to reducing peak loads, community- and customer-based solar, storage, and demand-responsive technologies provide near-term flexibility that helps utilities manage periods of high demand or constrained infrastructure, maintaining reliability while avoiding costly short-term backup measures (DeBenedictis et al. 2025).

Utilities are uniquely positioned to lead these investments because they can analyze customer energy use and grid conditions to target efforts effectively, offer financial incentives that reduce barriers to adopting technology, coordinate flexible resources within grid operations, and implement programs at scale across their service territories. Examples include incentives for rooftop solar and battery storage, managed EV charging, and targeted demand response. These programs help customers adopt technologies while enabling utilities to reduce load during extreme heat events and minimize reliance on expensive peaking resources to limit outages.

Because these localized resources depend on local grid conditions, utilities are also making grid upgrades to enable flexibility and support resilience, complementing investments in efficiency and community-based power by strengthening the infrastructure that allows these resources to operate during extreme heat events. Investments such as upgraded substations, heat-tolerant equipment, and advanced monitoring technologies help ensure solar, storage, and flexible demand can respond when conditions are most severe.

Program in action: Green Mountain Power (GMP) Resiliency Zone Program

The role of community-based power and flexible demand in reducing peak demand and improving grid flexibility was demonstrated during a June 2025 heat wave in New England. Record temperatures drove electricity demand to roughly 28.5 GW, and unexpected power plant outages reduced available generation by over 1 GW. Rather than relying exclusively on reserve resources or importing electricity, Green Mountain Power (GMP)—Vermont's largest utility—leveraged earlier investments in solar panels, batteries, and EV storage infrastructure to dispatch local resources and strategically shift load to cover the shortfall exactly when the grid was most stressed. This reduced the need for ISO New England to tap reserves, import electricity, or curtail exports, directly supporting reliability and lowering peak-related emissions.

GMP aggregates thousands of customer-sited solar panels, residential and community batteries, and EV storage systems into a coordinated network that functions as dispatchable capacity during peak demand events. The network, which began in 2015 with a 3.4-MWh solar-battery installation, expanded through pilot programs offering home batteries, drawing on stored energy in electric school bus batteries during peak energy times, and deploying community-scale storage in high-need areas. Today, the system provides 72 MW of dispatchable capacity from more than 5,000 participants, making it the utility's largest flexible resource.

During the heat wave, customer-sited solar throughout the ISO-NE region supplied approximately 4.4 GW of power, shaving peak demand and providing flexibility to the grid, which reduced reliance on fossil-fuel generation. Across ISO-NE, this contributed to an estimated $19 million in avoided wholesale electricity costs on the day of the heat wave (Berman and Dickerson 2025). Within Vermont, GMP estimates that its network of solar, batteries, and energy efficiency measures helped its 275,000 customers avoid approximately $3 million in peak power costs while strengthening resilience for rural and vulnerable communities (Giles 2025).

To further enhance resilience, GMP complements this flexible resource with distribution-system investments through its Zero Outages Initiative (ZOI). These investments—including undergrounding lines, storm-hardened overhead lines, and advanced system monitoring—strengthen sections of the grid that support participation by localized resources and improve performance under extreme temperatures (Green Mountain Power 2023). Vermont's Public Utility Commission approved $150 million for the first phase of ZOI as part of a two-year, $280 million plan with clear metrics tied to resilience, such as a 33% improvement in rural feeder reliability, battery performance targets, and improved outage tracking to guide investments. By pairing community-based power and flexible demand with grid upgrades, GMP provides a model for utilities seeking to improve heat resilience through localized, dispatchable capacity and strengthened distribution infrastructure (Green Mountain Power 2024).

Pathway 2: locally led initiatives reaching vulnerable residents

2A. Community-centered deployment of efficiency and cooling

Energy-efficient technologies reduce energy consumption at the building level, reducing building energy demand and helping to maintain safe indoor temperatures.[5] Their resilience impact, however, depends not only on the technologies themselves but on where—and to whom—they are deployed. Low-income, elderly, and medically vulnerable people often cannot purchase equipment on their own or face barriers to accessing upgrades through conventional programs. Programs that strategically target these populations for efficiency and cooling upgrades provide far greater resilience benefits (Schaaf et al. 2022).

Locally led initiatives are particularly effective because they combine knowledge of community needs with trusted implementation networks that can reach residents conventional programs can miss. By partnering with community-based organizations, tailoring equipment to housing conditions, and integrating outreach with existing social services, these programs can overcome participation barriers and ensure efficient cooling technologies reach those most at risk.

The Cooling Portland Program demonstrates how a community-centered deployment model can deliver efficient cooling directly to those most vulnerable, using trusted partners and tailored equipment installations to maximize reach and effectiveness.

[5] For example, replacing air conditioners and electric resistance heating with heat pumps, replacing electric resistance water heaters with heat pump water heaters, and installing improved insulation and windows.

Program in action: Cooling Portland Program

Launched in 2022 with Portland Clean Energy Community Benefits Fund (PCEF) support, Cooling Portland was created after the June 2021 heat wave exposed deep inequities in access to in-home cooling. The program's central success lies not only in distributing efficient cooling equipment but in its community-centered approach to identifying and serving vulnerable residents (City of Portland n.d.) Eligible households must reside within Portland city limits and have incomes at or below 60% of the Area Median Income (AMI), adjusted for household size. Priority is given to applicants age 60 or older, living alone, or with medical conditions increasing heat illness risk (City of Portland 2024).

The program equips qualifying households that lack cooling technology with energy-efficient portable heat pumps and AC units, tailoring equipment based on electrical capacity and other home constraints. The original goal was to distribute 15,000 units—due to the program's success, in December 2024, $10.3 million in new funding expanded the goal to 25,000 units by 2026 (Earth Advantage 2024).

The program reaches the most vulnerable residents through a community-centered delivery model by partnering with 15 Community Distribution Partners (CDPs). These are trusted, local organizations that identify eligible households, perform installations, and provide education and support. This approach improves cultural relevance, reduces barriers for households often wary of government programs, and ensures deployment of equipment where it is most needed. In 2024, three new CDPs were added, further expanding the program's reach.

To deepen impact, the program connects these vulnerable households with affordability and efficiency resources, such as support enrolling in utility bill assistance, and partners with the city's 311 system to simplify program applications, resulting in 6,000 new submissions in 2024 and significantly expanded access for underserved residents. The program's results demonstrate the strength of this targeted, community-driven model. By the end of 2024, 13,182 households had received equipment, achieving nearly 90% of the original goal in less than four years. Notably, 31% of units went to people living alone, and 48% of those recipients were over 60. Through its focus on equitable deployment and trusted community partnerships, Cooling Portland offers a model for delivering lifesaving, efficient cooling to those most vulnerable to extreme heat.

Other locally led cooling initiatives show how targeted, equitable deployment can maximize resilience benefits for heat-vulnerable populations. In San Antonio, the city partnered with philanthropic foundations and the housing authority to purchase approximately 2,400 air-conditioning units for public housing residents, while the local utility, CPS Energy, provided an energy credit to help cover operating costs (Wang 2019). Similarly, Orange County, Florida's Senior Climate Efficiency Program, administered through the county's Community Action Division, provides free air conditioner replacements, repairs, and efficiency upgrades—including smart thermostats and duct sealing—to low-income seniors aged 60 and older, with eligibility coordinated through existing programs such as the Low Income Home Energy Assistance Program (LIHEAP) and Weatherization Assistance Program (WAP) (Orange County Florida 2024). Like the Cooling Portland Program, these initiatives leverage trusted community partners and local networks to identify and serve those most at risk, demonstrating that community-centered deployment is essential for ensuring efficient cooling technologies reach households most vulnerable to extreme heat and that locally led programs can translate investments into meaningful resilience outcomes.

2B. Nature-based and passive solutions led by local government

Local governments play a unique and essential role in advancing nature-based and passive strategies to reduce heat exposure and improve neighborhood heat resilience. These strategies are distinct from utility-scale interventions because they rely heavily on local planning authority and long-term maintenance and stewardship. Because tree canopy, zoning and urban design, and investment in public spaces evolve over decades, they depend on local institutions that can coordinate across agencies, manage public assets, and respond directly to community priorities (Environmental Protection Agency n.d.).

Nature-based and smart surface[6] solutions—such as tree planting, depaving, green roofs, cool roofs, reflective pavements, reduced surface parking, and expanded green spaces—can significantly lower ambient temperatures and improve overall urban resilience. Smaller-scale interventions, like shade trees and passive building features, primarily reduce direct heat exposure for individuals in homes and public spaces, while broader canopy expansion and green infrastructure can moderate neighborhood-scale temperatures and mitigate urban heat-island effects. Streetscapes designed with shade corridors, planted medians, and cooling features further enhance comfort in public spaces and reduce heat exposure for residents.

Because tree canopies take years to mature, expanding and protecting urban greenery is a long-term investment in heat resilience. To achieve long-lasting benefits, communities must also build the workforce that maintains these systems, including arborists, foresters, and other professionals. Building-level strategies, such as shading, reflective surfaces, and improved envelopes, provide more immediate cooling benefits while reducing building energy demand.

Local-led strategies are often strengthened by collaboration with utilities and regional partners. For example, Con Edison supported the development of NYC's Urban Forest Agenda, which sets a goal of increasing tree canopy cover to 30% by 2035. As of 2021, tree canopy covers 23.4% of the city (City of New York 2025). The agenda highlights that the hottest, most heat-vulnerable neighborhoods in NYC, which are often low-income and communities of color, also have the least tree cover. Prioritizing these areas helps lower temperatures, prevent heat-related deaths, and reduce building energy use, generating millions of dollars in community benefits annually (Climate Central 2023).

[6] For more smart surface examples, visit https://smartsurfacescoalition.org/.

Program in action: King County, Washington, Extreme Heat Mitigation Strategy

Following the deadly 2021 Pacific Northwest Heat Dome, King County developed an Extreme Heat Mitigation Strategy to address long-term heat exposure and expand passive and nature-based cooling across the region. With average summer maximum temperatures in King County projected to rise about 3.7 °F by the 2030s (relative to 1980–2009), and with some neighborhoods already experiencing up to 20 °F higher temperatures than cooler areas due to urban heat-island effects, the county prioritized strategies that directly shape public spaces and the built environment where residents live, move, and are exposed to heat.

Developed in partnership with local and state governments, community organizations, and frontline communities, the strategy was created as the result of countywide heat-island mapping supported by public utilities. Utilities in the county, including Seattle City Light contribute technical expertise, conduct outreach, and help connect residents with energy efficiency and bill-assistance programs.

King County's approach centers on expanding and sustaining tree canopy, increasing shaded public spaces, and integrating passive cooling strategies[7] in buildings, especially in neighborhoods with low tree canopy and high vulnerability.

Key planned actions include the following:

- Private property tree care: Financial incentives, water bill subsidies, and renter-landlord agreements to support planting and maintenance, supplemented with workshops and technical assistance.
- Maximizing tree survival: Best practices for planting and watering, and training for city staff and community members to support long-term canopy growth.
- King County tree code toolkit: Guidance for jurisdictions to adopt stronger tree protection policies and integrate heat resilience into development regulations.
- Tracking equitable canopy cover: Countywide LiDAR (light detection and ranging) mapping to guide investments in high-heat neighborhoods.
- Open space and stormwater parks: Infrastructure-scale projects that expand shaded areas, depaved surfaces, and create stormwater parks that cool neighborhoods while improving drainage.
- Heat-smart parks and playgrounds: Community-amenity upgrades such as shade structures, splash pads, and mobile cooling stations with multilingual signage.
- Passive cooling measures: Expanding access to affordable, home-level passive cooling strategies to reduce heat gain, including shading devices, window films, cool roofing, and air sealing and insulation upgrades.

To complement passive and nature-based strategies, the county also provides near-term support such as portable ACs, bill assistance, high-efficiency heat pumps, and cooling centers, ensuring vulnerable residents stay cool affordably during extreme heat events.

Other jurisdictions are also advancing locally led nature-based and passive heat mitigation strategies that leverage municipal authority over streets, land use, and public space. For example, Phoenix has integrated reflective cool pavement into its street maintenance program to reduce surface temperatures and improve outdoor comfort, and its zoning code includes standards that require new developments to provide open space that is at least 50% shaded (City of Phoenix 2025; Federation of American Scientists 2025).

Together with the King County example, these efforts demonstrate how locally led planning, targeted investment, and partnerships among local governments, community-based organizations, and other key stakeholders can reduce heat exposure, strengthen community resilience, and deliver multiple co-benefits including improved air quality, recreation, and workforce development.

Pathway 3: hybrid utility-community partnerships

Hybrid approaches highlight programs where utilities provide technical, financial, or infrastructure support while communities retain operational control and drive priorities for local benefits. These partnerships enhance resilience during extreme heat while delivering broader community benefits such as improved grid reliability and access to social services.

3A. Hybrid emergency preparedness solutions

Emergency preparedness protects people, communities, and critical services during heat events. Utilities and communities can enhance preparedness by coordinating with local governments and community partners to identify vulnerable populations, ensure homes have reliable electricity and energy-efficient cooling, provide backup power, use alert systems to reduce electricity demand during grid emergencies, and leverage partnerships to expand program reach (Berman and Dickerson 2025). Investments can include infrastructure such as resilience hubs, microgrids, or facilities designed to provide cooling and refuge during heat events.

[7] Passive cooling refers to any cooling approach that uses significantly less energy than a standard air-conditioning system. Some approaches use no energy at all (https://basc.pnnl.gov/resource-guides/passive-and-low-energy-cooling#edit-group-description).

Program in action: Xcel Energy resilience hubs

Xcel Energy's Resilient Minneapolis Project (RMP) demonstrates how utilities can partner with community organizations to create resilience hubs that maintain safe indoor temperatures and essential services during extreme heat and grid outages. The program established three resilience hubs: North Minneapolis Community Resilience Hub (Minneapolis Public Schools), Sabathani Community Center, and the Minneapolis American Indian Center (MAIC) (U.S. Department of Energy 2024). These hubs are designed to provide cooling access, backup power, refuge, and communication during heat events, ensuring that residents remain safe and supported.

The hubs integrate rooftop solar, battery energy storage systems (BESS), and microgrid controllers to enable independent operation during outages. These systems provide essential emergency services during heat events, such as safe gathering spaces, cooling, refrigeration for essential needs, and heat alerts, strengthening passive survivability by maintaining critical services and safe indoor conditions for residents. During normal grid conditions, they also support reliability by reducing peak demand, shifting load, and relieving stress on local distribution infrastructure (Xcel Energy 2024).

RMP is financed through a combination of Xcel ratepayer investments, federal and local grants, and tax credits (Balyan 2025), illustrating how multiple funding streams can support infrastructure that improves both day-to-day grid reliability and emergency resilience. The program also demonstrates a flexible ownership and operation model, with responsibilities varying across sites to balance community needs with utility expertise. This flexibility allows the utility to handle grid-facing technical needs—such as interconnection, system design, or operational support—while community partners manage the trusted services residents rely on during normal times—such as food banks, social services, and educational activities—and coordinate those services during extreme weather events to ensure the hubs remain responsive to local needs.

3B. Utility-community partnerships for heat relief

Several utilities in Arizona are partnering with a community organization to support heat-related interventions. For example, UniSource Energy Services and Tucson Electric Power contribute funding to the Heat Relief Initiative, a partnership with the nonprofit Wildfire and other local utilities to repair or replace nonfunctioning air conditioners for low-income residents during extreme heat (UniSource Energy Services 2024). Arizona Public Service (APS) similarly partners with Maricopa County, the City of Phoenix, nonprofits, and community organizations to expand heat relief efforts, including supporting air conditioner repairs and replacements, and funding emergency cooling stations for vulnerable populations (National Association of Counties 2025).

Together with the Xcel Energy resilience hubs, these examples show how hybrid utility-community partnerships can combine technical expertise, infrastructure investment, and community-led operations to deliver heat resilience, protect vulnerable residents, and provide ongoing grid and community benefits.

Next steps: scaling heat resilience through three complementary pathways

Communities, utilities, and governments all play a crucial role in enhancing community resilience to extreme heat. Working together, they can accelerate heat resilience by leveraging all three pathways—utility-led investments, locally led initiatives, and hybrid partnerships. Drawing on lessons from current programs, coordinated efforts can protect building occupants during extreme heat events, reduce peak electricity demand, and strengthen the grid. The five key principles described in table 1 can be implemented through any of the three pathways, depending on local conditions and institutional capacity:

Table 1. Key implementation strategies for scaling heat resilience across sectors

Strategies	Actionable guidance	Key stakeholders	Program connections
1. Prepare buildings and systems for more frequent and intense heat events	Reduce heat risk by improving building performance today while locking in stronger performance for the future. Accelerate long-term resilience in new construction through code readiness programs, pilot projects, and research that enable higher-performing, heat-resilient building practices. Support existing buildings through near-term, customer-facing interventions—such as energy efficiency upgrades—to ensure homes remain safe and habitable during heat events while reducing system stress.	**Utilities**: Lead code readiness programs, deploy DERs, leverage incentives to support building upgrades, and navigate regulatory approvals to scale interventions. **Local governments**: Adopt and enforce codes, facilitate pilot projects, incentivize or require above-code building standards, and provide building and community data to inform planning.	**PG&E Code Readiness Program**: Supports adoption of higher-performance codes through research, pilot projects, training, and field studies that enable adoption of heat-resilient construction practices. **Cooling Portland Program**: Expands access to efficient cooling technologies and installation support in historically underserved markets, improving near-term household safety while building long-term adoption pathways.
2. Coordinate investments at multiple levels	Integrate building-level upgrades, community-scale resilience programs, and system-wide energy and infrastructure investments to deliver flexible, scalable solutions. Ensure programs work together across building, community, and grid levels to strengthen reliability, reduce heat exposure, and maximize resilience benefits for communities most at risk.	**Utilities**: Align building- and community-scale upgrades with grid operations; ensure programs meet system reliability goals. **Local governments**: Facilitate interagency coordination and provide local data and planning alignment.	**Xcel Energy Resilience Hubs**: Connects community-scale assets to broader grid operations, ensuring building-level resilience (cooling and essential services) during heat events. **GMP Resiliency Zone Program**: Aggregates building-scale DERs to function as a system-wide reliability asset when deployed to reduce peak load during extreme heat. **King County Extreme Heat Mitigation Strategy**: Deploys neighborhood-scale passive cooling investments that complement household-level

Strategies	Actionable guidance	Key stakeholders	Program connections
			interventions and align with grid/energy objectives.
3. Target investments to both local needs and system goals	Prioritize neighborhoods and populations with the highest heat exposure and lowest access to resources. Tailor programs to local conditions, including housing type, urban heat patterns, and grid constraints. Align investments with broader system objectives, such as peak load reduction, grid reliability, and long-term efficiency targets.	**Utilities**: Use energy and load data to identify priority neighborhoods, deploy DERs, and align incentives with vulnerable populations. **Local governments**: Map high-risk areas, provide social and demographic context, and enable local implementation. **Community/partner organizations**: Identify vulnerable populations and guide deployment of efficiency and cooling programs.	**King County Extreme Heat Mitigation Strategy**: Tailors investments to local heat-island patterns, housing conditions, and vulnerable populations to yield greater community system-wide benefits. **Cooling Portland Program**: Targets high-risk neighborhoods to improve resilience outcomes while enabling more efficient use of program resources and system benefits.
4. Strengthen partnerships that expand reach and ensure equity	Extend program reach and ensure support for vulnerable populations. Hybrid partnerships that combine utility technical capabilities with local knowledge and trust can maximize impact while improving adoption of emerging technologies and building practices.	**Utilities**: Provide technical expertise, funding, and operational support. **Local governments**: Align programs with policies, planning, and community engagement. **Community/partner organizations**: Manage program delivery, maintain trust, handle outreach and education.	**Cooling Portland Program**: Collaboration with community-based organizations and local agencies enables outreach, program enrollment, and sustained support for vulnerable households. **King County Extreme Heat Mitigation Strategy**: Partnerships between government agencies and community organizations expand reach and scale. **Xcel Energy Resilience Hubs**: Utility-community coordination accelerates adoption of building practices that protect against extreme heat.
5. Integrate heat resilience into core planning and operations	Integrate heat resilience into everyday operations, capital planning, and community services to ensure access to reliable electricity, affordable cooling, and critical support during extreme heat events. Incorporate these protections proactively, rather than as emergency-only measures, to strengthen grid reliability and protect residents.	**Utilities**: Embed resilience into capital planning, operations, maintenance, and performance monitoring; ensure regulatory compliance. **Local governments**: Integrate heat preparedness into emergency management and community services.	**GMP Resiliency Zone Program**: Embeds DERs, storage, and peak management into system planning, delivering benefits during normal operation and protection from extreme heat. **Xcel Energy Resilience Hubs**: Integrates critical services into everyday planning, supporting community needs during outages while enabling demand management and cost savings during normal conditions.

Achieving heat resilience at scale requires policymakers, utilities, and community organizations working together to leverage these complementary actions across all three pathways. Utility-led investments upgrade energy systems, expand DERs, and strengthen infrastructure to maintain reliable service during extreme heat events. Community-led models reach residents who struggle to engage with utilities. Hybrid partnerships combine the technical strengths of utilities with the trust and reach of local organizations and governments. By strategically deploying these pathways—individually or in combination--communities can protect residents most at risk from extreme heat while strengthening local resilience and grid reliability.

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References

Balyan, B. 2025. “Minneapolis Resilience Hubs.” June 3. https://lims.minneapolismn.gov/Download/RCAV2/50569/Resilience%20Hub%20Staff%20Presentation.pdf.

Berman, N., and J. Dickerson. 2025. *Grid Action Report—June Heat Wave Clean Energy Provides Savings, Boosts Grid Reliability*. Acadia Center. https://acadiacenter.org/wp-content/uploads/2025/07/Fact-Sheet-June-30-2025-Grid-Action-Report-June-Heat-Wave.pdf.

Bruzgul, J., and N. Weisenfeld. 2021. *Resilient Power: How Utilities Can Identify and Effectively Prepare for Increasing Climate Risks*. ICF. https://www.icf.com/-/media/files/icf/white-paper/2021/icf_resilience-power-report.pdf?rev=9128fc2a91c94cf3a7c117c4ec5fd89c.

Came, F. 2025. “The Cost of Resiliency.” Buildingresiliencecoalition.Org, August 25. https://buildingresiliencecoalition.org/the-costs-of-resiliency/.

City of New York. 2025. “New York City Urban Forest Plan.” https://www.urbanforestplan.nyc/#reports.

City of Phoenix. 2025. *Cool Pavement Program.* Cool Pavement Program | City of Phoenix.

City of Portland. 2024. “Groundbreaking Cooling Portland Program Expands to Help More Portlanders.” https://www.portland.gov/bps/cleanenergy/climate-investment/news/2024/12/11/groundbreaking-cooling-portland-program-expands.

City of Portland. n.d. “Cooling Portland: A PCEF-Funded Climate Resilience Program.” https://www.portland.gov/bps/cleanenergy/cooling-portland.

Clean Energy Group. 2025. *Connecticut Climate Resilient Energy Code for Multifamily Affordable Housing*. https://www.cleanegroup.org/wp-content/uploads/CT-Climate-Resilient-Energy-Code-for-Multifamily-Affordable-Housing-Draft.pdf.

Climate Central. 2023. *The Power of Urban Trees*. https://assets.ctfassets.net/cxgxgstp8r5d/32ijJSeRXMnSkG2OhjavzF/0e4e0fd63f67f00328e60f13280d55a6/FINAL_Power_of_Urban_Trees_2023__EN_.pdf.

DeBenedictis, A., A. Solfest, S. Kinser, H. Platter, S. Greszczuk, I. Riu, L. Mettetal, E. Cutter, B. Webster, C. Goldenberg, and K. Ebinger. 2025. *DER-Iving Local Value: Distribution Grid Services in the Commonwealth of Massachusetts*. Energy and Environmental Economics. https://www.ethree.com/wp-content/uploads/2025/10/E3_MassCEC_Grid_Services_Roadmap.pdf.

Earth Advantage. 2024. *Cooling Portland Annual Report: 2024*. https://www.portland.gov/bps/cleanenergy/documents/cooling-portland-report-year-3-2024/download.

Environmental Protection Agency. n.d. “Local Governments and Trees.” https://www.epa.gov/heatislands/local-governments-and-trees.

Federation of American Scientists. 2025. *Too Hot Not to Handle: State and Local Policy Options to Protect People from Extreme Heat.* https://fas.org/wp-content/uploads/2025/08/AUGUST_2025-Too-Hot-not-to-Handle.pdf.

Franconi, E., E. Hotchkiss, T. Hong, and M. Reiner. 2023. *Enhancing Resilience in Buildings through Energy Efficiency*. Pacific Northwest National Laboratory. https://www.energycodes.gov/sites/default/files/2023-07/Efficiency_for_Building_Resilience_PNNL-32727_Rev1.pdf.

Ghodeswar, A., Bhandari, M., and Hedman, B. 2024. *Quantifying the economic costs of power outages owing to extreme events: A systematic review*". https://doi.org/10.1016/j.rser.2024.114984. https://www.osti.gov/servlets/purl/2474779.

Giles, A. "Batteries Are Playing a Bigger Role in Keeping the Lights on during New England Heat Waves." 2025. https://www.vermontpublic.org/local-news/2025-07-09/batteries-playing-bigger-role-keeping-lights-on-new-england-heat-waves.

Green Mountain Power. 2023. "Green Mountain Power Launches First in Nation 2030 Zero Outages Initiative." https://greenmountainpower.com/news/green-mountain-power-launches-first-in-nation-2030-zero-outages-initiative/.

Green Mountain Power. 2024. *2024 Integrated Resource Plan*. https://greenmountainpower.com/wp-content/uploads/2025/01/2024-12-10-GMP-218c-Integrated-Resource-Plan.pdf.

Howard, J., N. Androne, and K. Alcover. 2024. "Trends of Heat-Related Deaths in the US, 1999–2023." *Journal of the American Medical Association* 332 (14). https://doi.org/10.1001/jama.2024.16386.

King County. 2024. *King County Extreme Heat Mitigation Strategy*. https://cdn.kingcounty.gov/-/media/king-county/depts/executive/climate-office/documents/241220_13570m_kc-extreme-heat-strategy_web.pdf?rev=cf72954b6e34421282f7ae583a39b09b&hash=3BA98B0465C570A096D75A04305F7F38.

National Association of Counties. 2025. "APS Expands Heat Relief Efforts in Maricopa County, Arizona." APS Expands Heat Relief Efforts in Maricopa County, Arizona | National Association of Counties.

Pacific Gas and Electric Company. 2018. *PG&E Residential Code Readiness Project: Redding, California Site Monitoring Report*. https://title24stakeholders.com/wp-content/uploads/2019/06/final_code_readiness_report_redding.pdf.

Pacific Gas and Electric Company. 2023a. *Code Readiness: Dedicated Outdoor Air System Field Assessment Results, Project ET18PGE1902*. https://www.etcc-ca.com/reports/code-readiness-dedicated-outdoor-air-system-field-assessment-results.

Pacific Gas and Electric Company. 2023b. *PG&E Bid Opportunity COA RFP 147261 CS Code Readiness*. https://www.pge.com/content/dam/pge/docs/about/doing-business-with-pge/2023-COA-RFP-147261-CS-Code-Readiness.pdf.

Schellenberg, J., and L. Schwartz. 2024. *Grid Resilience Plans: State Requirements, Utility Practices, and Utility Plan Template*. Lawrence Berkeley National Laboratory. https://eta-publications.lbl.gov/sites/default/files/grid_resilience_plans_template_report_20240723.pdf.

Smith, A. 2025. "2024: An Active Year of U.S. Billion-Dollar Weather and Climate Disasters." Climate.Gov, https://www.climate.gov/news-features/blogs/beyond-data/2024-active-year-us-billion-dollar-weather-and-climate-disasters.

Srivastava, R., L. Fadali, and E. Garfunkel. 2025. *Beyond the Building: Strengthening Neighborhood Resilience through Energy Efficiency Programs*. American Council for an Energy-Efficient Economy (ACEEE). www.aceee.org/research-report/b2505.

Srivastava, R., E. Garfunkel, and A. Wood. 2024. *Valuing Resilience Benefits in Utility Building Retrofit Programs*. ACEEE. www.aceee.org/research-report/b2402.

UniSource Energy Services. 2024**.** *UniSource Partners with Wildfire to Support Heat Relief Initiative.* https://www.uesaz.com/news/unisource-partners-with-wildfire-to-support-heat-relief-initiative/.

U.S. Department of Energy. 2024. *Examples of Other Community Energy Resilience Initiatives*. https://www.energycodes.gov/sites/default/files/2024-04/PNNL_Resilience_Case_Study_042024_examples.pdf.

Xcel Energy. 2024. *Resilient Minneapolis Project Annual Report*. https://efiling.web.commerce.state.mn.us/documents/%7BE0F98893-0000-CC34-A3C6-B1057FF65D7F%7D/download?contentSequence=0&rowIndex=2.