Building Energy Codes

Resilience and Codes

Buildings serve as a first line of defense for communities facing threats from man-made or natural disasters. Modern building energy codes offer states and territories the ability to become more resilient. In 2016, 40 leading design and construction organizations, committed to improving resilience in the built environment, came to an agreement on the definition of resilience from a buildings design and industry construction perspective[1], using the terminology put forth by the National Research Council: "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events."[2] This overarching definition can be subcategorized to define more specific facets of resilience including economic, community, ecological, or even social resilience.

The Growing Need for Resilient Buildings

The National Oceanic and Atmospheric Administration (NOAA) estimates that since 1980 there have been 376 disaster events exceeding over $1 billion in damages and over that forty year period damages totaled over $2.655 trillion.[3] Of these, 173, or 54%, have occurred in the last decade.

A 2024 study completed by the Federal Emergency Management Agency (FEMA) study marked 30 states, D.C., Guam and America Samoa (see Figure 1) with the lowest ranking for adopting hazard-resistant building codes, meaning less than 25% of their jurisdictions were covered by the latest hazard-resistant code.[4] Slow adoption of hazard-resistance building codes in these states and territories has economic consequences, with expected annual losses (EAL) of over $13.1 billion to total building value. Five of these states are classified as having relatively or very high EAL (Alabama, Illinois, Missouri, North Carolina, and Oregon). However, many jurisdictions are making progress to close this gap, and in 2023 alone, state legislatures introduced approximately 99 bills related to the energy-resilience nexus to strengthen community resilience, covering resilience related to the grid, reliability, redundancy, energy efficiency, electrification, and renewable energy.[5]

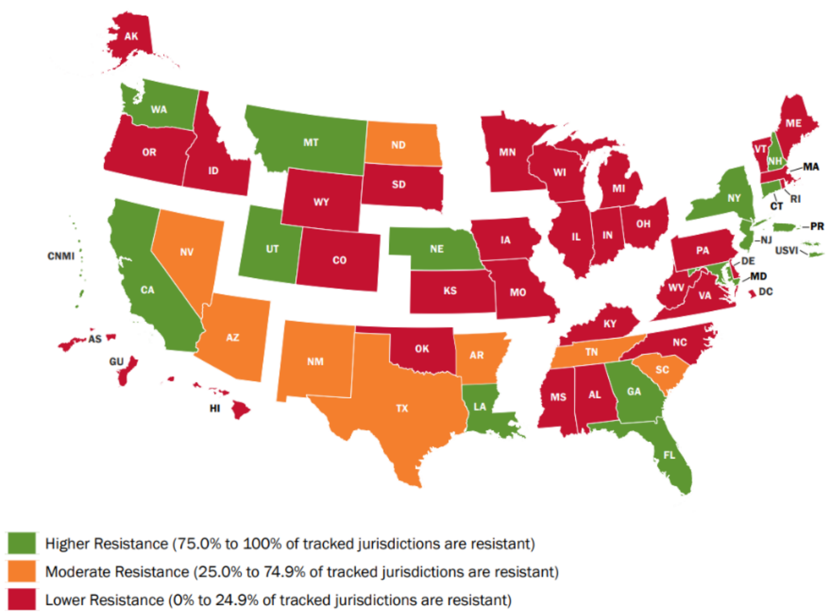

Figure 1: Lower, Moderate, and Higher Hazard-Resistance *Source: FEMA.gov/BCAT*

Developing Energy Resilient Buildings through Codes

Holistic building strategies that can be incorporated in building codes and standards can contribute to resilience within a community. Specifically, *building energy resilience* is "the ability to operate building energy services, such as heating, cooling, ventilation, critical plug loads, and shelter, during and in response to a major disruption...".[6] Energy resilience is driven by two considerations: *passive survivability*[a] and *grid resilience*.[b] Providing a functioning energy service in a community during and after a disaster event eases the recovery burden by maintaining access to essential services and allowing businesses to continue operating.

[a] Passive Survivability: the ability to maintain safe indoor conditions in the event of extended energy outage or loss of energy supply.
[b] Grid Resilience: the degree of efficiency, flexibility and demand load shifting a power system can exhibit when facing failure

Additionally, improving a building's thermal envelope, either through retrofitting existing buildings or incorporating efficiency measures during the design and construction process, can help maintain safe indoor conditions in the event of a power outage or extreme temperature event and provide passive survivability.

One direct method of strengthening energy resilience is making improvements to existing structures or using modern codes that are inherently more resilient than their predecessors. Homes built to the 2021 International Energy Conservation Code (IECC) are designed to be 9.4% more energy efficient than the 2018 IECC. Commercial buildings built to ASHRAE 90.1-2022 are estimated to be 9.8% more energy efficient than ASHRAE 90.1-2019.[7] Energy efficient buildings use less energy overall, alleviating electric grid strain and minimizing the required capacity of backup generation systems during an event. Approaches to building energy resilience will vary regionally based on the likelihood and type of disaster facing a community, but there are a variety of common approaches:

- **Thermal envelope construction** supports a comfortable indoor environment year-round, during extreme heat or cold, and if power is lost. Adoption of current building codes can extend habitability between 40% to 50% during extreme temperature events through proper insulation and cool roofing.[8] Prior to a disaster event, a more efficiently insulated home or building will also use less energy to heat and cool, lowering monthly utility bills.
- **Air tightness and mechanical ventilation** support healthy indoor air quality, which is essential during events that elevate poor outdoor air quality, such as during wildfires. These systems also contribute to the overall energy efficiency of a building, lowering HVAC system costs and reducing monthly utility bills.
- **Electrical systems** that include renewable energy resources, batteries, or other alternative back-up generation can provide access to electricity during and after events that render the grid incapacitated (e.g., downed power lines/blackouts).
- **Increasing system efficiency** and "right-sizing" HVAC, lighting, and other internal loads reduces overall power demand of a building, relieving stress on the grid and reducing the necessary size of onsite back-up energy sources.[9]

Days of Safety and Lives Saved: The Effect of Modern Energy Codes on Resilience

In July 2023, the DOE Building Technology Office partnered with three national laboratories (PNNL, NREL, and LBNL) to publish a report titled: *Enhancing Resilience in Buildings Through Energy Efficiency: Standardized Methodology and Resulting Analysis Demonstrating the Value of Codes and Above Code Measures to Hazard Resilience*. The analysis included quantifying resilience metrics to determine the value that modern energy codes have on habitability, excess mortality, property damage, and cost effectiveness. Specifically, the study assessed energy efficiency effects from both current code (IECC 2021) and beyond-code requirements consistent with the Passive House Institute U.S. (PHIUS). Overall, the results indicated that meeting or exceeding modern energy codes can improve passive efficiency to save lives during extreme temperature events. New single family and multifamily buildings realized benefit-cost ratios (BCRs) from 2 to over 7 when utilizing current codes, while existing buildings mostly (except climate zones 5A and 6A) realized a BCR less than 1 because of the higher first costs. However, in nearly every situation, improving passive efficiency by meeting or exceeding modern energy codes will ultimately save lives and improve habitability during extreme temperature events.[10]

Opportunities for Federal Assistance

DOE has over $1.2 billion available to support states adopt and implement modern energy codes. In 2021, the Bipartisan Infrastructure Law (BIL) appropriated $225 million to the U.S. Department of Energy (DOE) for the Resilient and Efficient Codes Implementation (RECI) program "to enable sustained cost-effective implementation of updated building energy codes" through a competitive grant process.[11] Shortly after, in 2022, the Inflation Reduction Act (IRA) appropriated $1 billion to DOE to support the adoption of the latest and zero building energy codes, available through both formula and competitive funding.[12] Both programs support key activities to adopt, implement, and train the workforce on updated energy codes, which in turn, can help improve resilience in those states and jurisdictions.

Another agency with a direct impact on building codes is FEMA, which manages the Building Resilient Infrastructure and Communities (BRIC) program that includes a directive to "*support the adoption and enforcement of building codes, standards, and policies*" to help states improve resilience. The 2022 IRA expanded FEMA's relevant authorities by allowing project funding for "costs associated with low-carbon materials" and "incentives that encourage low-carbon and net-zero energy projects."[13] FEMA also operates other programs that impact building resilience, including the Public Assistance Program, Community Disaster Loans, and the Hazard Mitigation Grant Program.[14]

The U.S. Department of Housing and Urban Development (HUD) funds resilient buildings in states through the CDBG Disaster Recovery (CDBG-DR) and Mitigation (CDBG-MIT) programs, which have aided 137 communities in recovering from and preparing for disaster events.[15] Other federal programs that offer funding for building resilience include the NOAA Emergency Coastal Resilience Fund, U.S. Department of Agriculture (USDA) Rural Energy for America Program, and the Bureau of Indian Affairs Tribal Climate Resilience Program.

Additional Resources

Many additional resources exist on building resilience, depending on your specific need. Information on key resources has been categorized here to provide guidance on which resources may be most pertinent to various users and roles in developing and implementing actions for increased resilience.

Name	Source	Subject	Intended User
Building Codes Toolkit for Homeowners and Occupants	FEMA	Building codes for resilient homes against natural hazards	Residential stakeholders, homebuilders, building engineers
Resilient Building Codes Toolkit	HUD	Guide on resilient buildings intended to educate different stakeholders	Elected officials, all participants from code development to code enforcement
Better Buildings Solution Center	DOE	Resilience building through energy efficiency measures, grid outages, and reducing disaster risk	State and local governments, policy makers, code and standard developers, building engineers, residential and commercial stakeholders, industrial manufacturers
Achieving Hazard-Resilient Report	NOAA	Natural coastal hazards building resilience	Residential and commercial stakeholders in coastal communities
Hazard Mitigation Methodology	NIST	Build resilience against Wildland-Urban Interface (WUI)	Architects, building engineers, residential and commercial stakeholders in communities prone to WUI fires
Building Resilient Communities	NEEP	Building energy resilience through building performance standards and energy codes	Residential and commercial stakeholders, code and standard developers
Community Resilience Benchmarks	ANCR	Evaluating a jurisdiction level of resilience	Residential and commercial stakeholders, local government
Resilient Project Process Guide	AIA	Design approach for integrating resilience into building projects	Architects, homebuilders, building engineers, building owners

Table 1. Resources on the Benefits, Design Process, and Policy Approaches to Resilience in Buildings

Building Energy Code Program (BECP) Technical Assistance

If you need help finding additional resources on resilience or supporting resilient code adoption and implementation in your state or jurisdiction, consider connecting with the technical assistance network or using the fully staffed Help Desk to make a detailed technical assistance request. Reach out directly to the PNNL Regional Representative or REEO supporting your state, or simply find the Help Desk icon on the energcodes.gov homepage and click the learn more link.

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