Resilience for All in the Wake of Disaster

The objective of this challenge is to develop holistic solutions to improve the resilience of the built environment, making equity a central focus of the proposed solution by strengthening the ability of communities—especially those that are underserved, marginalized and vulnerable—to adapt, persist, and recover in the event of natural or manmade disruptive events.

Background

People across the globe are experiencing an increased frequency and severity of disruptive events,[1] including record-setting heatwaves, winter storms, extreme rainfall, floods, drought, wildfires, earthquakes, tornadoes, hurricanes, chemical and biological hazards, and fires. These events—natural or manmade— cause damage to natural and built environment and infrastructure, and threat to public health, safety and well-being. They result in interruptions or loss of essential services that adversely impact access to potable water, sanitation, food, energy, safe air, livable indoor conditions, communication, and transportation. The heatwave in the Pacific Northwest, the wildfires in California, the 2021 winter storms, and the COVID-19 pandemic are just a few of the recent examples.

Communities that are **underserved, marginalized and vulnerable** typically face a significantly larger challenge in the event of such stresses and often lack the capacity to recover. These communities include those that experience barriers to social, economic, political, and environmental resources due to ethnic and racial discrimination, low socioeconomic status, disadvantaged background, illness, or disability; communities located in rural areas or impoverished urban sectors; and populations at a higher risk for poor health. Globally, between 1996 and 2015, 68.3% of all the people who died due to natural hazards belonged to lower-middle and low-income groups.[2,3]

Resilience is the ability to adapt to, persist in the face of, and rapidly recover from a potentially disruptive event.[4] **Resilient design** is the intentional design of buildings, landscapes, communities, and regions in response to these stresses.[5] **Equitable resilience** brings together the strategies for resilient design that account for the social distribution of those stresses and responses and aims to also strengthen the resilience of disadvantaged communities.[6]

Strategies to improve the resilience of buildings, communities, and infrastructure focus on robustness, resourcefulness, rapid recovery, and redundancy. **Robustness** is the ability to maintain critical operations and functions in the face of a crisis. This includes the building itself, the design of the infrastructure (office buildings, power generation, distribution structures, bridges, dams, levees), or system redundancy and substitution (transportation, power grid, communications networks).

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[1] Harvey, Chelsea. 2018. “Extreme Weather Will Occur More Frequently Worldwide.” *Scientific American.* February 15, 2018. https://www.scientificamerican.com/article/extreme-weather-will-occur-more-frequently-worldwide/.
[2] Massachusetts Institute of Technology, School of Architecture + Planning. 2021. “Equitable Resilience, 2018-2021.” https://lcau.mit.edu/equitableresilience.
[3] United Nations International Strategy for Disaster Reduction. 2016. “Poverty and Death: Disaster and Mortality, 1996-2015.” https://www.preventionweb.net/files/50589_creddisastermortalityallfinalpdf.pdf.
[4] National Infrastructure Advisory Council. 2009. *Critical Infrastructure Resilience: Final Report and Recommendations by National Infrastructure Advisory Council (NIAC).*
[5] Resilient Design Institute. 2021. “What is Resilience?” https://www.resilientdesign.org/what-is-resilience/.
[6] Norman B. Leventhal Center for Advanced Urbanism. 2019. “Equitable Resilience: A Necessary and Under-Investigated Aspect of Sustainable Urban Systems.” https://lcau.mit.edu/conference/equitable-resilience-necessary-and-under-investigated-aspect-sustainable-urban-systems.

Resourcefulness is the ability to skillfully prepare for, respond to, and manage a crisis or disruption as it unfolds. This includes identifying courses of action and business continuity planning; training; supply chain management; prioritizing actions to control and mitigate damage; and effectively communicating decisions. **Rapid recovery** is the ability to return to and/or reinstitute normal operations as quickly and efficiently as possible after a disruption. Components of rapid recovery include carefully drafted contingency plans, competent emergency operations, and the means to get the right people and resources to the right places. **Redundancy** means that there are back-up resources to support the originals in case of failure.[7]

Strategies for improving resilience of buildings include all aspects of building structure, enclosure, energy systems, operations, and building use.[8] Community-level strategies require a multipronged approach, using a combination of mandatory upgrades, incentive programs, funding mechanisms, and education/outreach programs to develop more resilient building stock. These may also include smaller or more incremental strategies to gradually improve resilience or institute larger-scale coordinated programs to respond to critical deficiencies. Depending on the hazards, these strategies may also include redefined functions of buildings and creating community facilities (resilience hubs) that can serve during emergencies and interruptions to services.[8]

Many technologies are emerging to improve the resilience of the U.S. building infrastructure and electricity grid. For example, smart grid technologies use communication and information technology to collect information on the behavior of customers and to automatically work to improve efficiency and reliability in distributing electricity.[9] Microgrids[10] with distributed energy resources[11] include small-scale units of power generation which operate locally and are connected to a larger power grid at the distribution level, thereby improving the quality and reliability of service.[12] Grid-Interactive Efficient Buildings have an optimized blend of energy efficiency, energy storage, renewable energy, and load flexibility technologies enabled through smart controls.[13]

The idea that resilience is a positive trait that contributes to sustainability is widely accepted. Yet some recent studies identify situations where promotion of resilience for some locations may come at the expense of others,[14] or enhancement of resilience at one scale, such as the level of the community, may reduce resilience at another scale, such as the household or individual.[15,16] Equity concerns often arise due to uneven patterns of resilience. Therefore, additional work is needed to identify ways that these

[7] Whole Building Design Guide. 2018. "Building Resilience." https://www.wbdg.org/resources/building-resiliency.
[8] Boston Green Ribbon Commission Climate Preparedness Working Group. 2013. *Building Resilience in Boston: Best Practices for Climate Change Adaptation and Resilience for Existing Buildings*. https://www.greenribboncommission.org/archive/downloads/Building_Resilience_in_Boston_SML.pdf.
[9] US Department of Energy. 2021. "The Smart Grid: An Introduction." https://www.energy.gov/oe/downloads/smart-grid-introduction-0.
[10] US Department of Energy. 2014. "How Microgrids Work." https://www.energy.gov/articles/how-microgrids-work.
[11] US Department of Energy. 2021. "Distributed Energy Resources for Resilience." https://www.energy.gov/eere/femp/distributed-energy-resources-resilience.
[12] US Department of Energy. 2021. "Solar Integration: Distributed Energy Resources and Microgrids." https://www.energy.gov/eere/solar/solar-integration-distributed-energy-resources-and-microgrids.
[13] Rocky Mountain Institute. 2021. "Grid-Interactive Energy-Efficient Buildings (GEBS)." https://rmi.org/our-work/buildings/pathways-to-zero/grid-integrated-energy-efficient-buildings/.
[14] Pike A, Dawley S, and Tomaney, J. 2010. "Resilience adaptation and adaptability." *Cambridge Journal of Regions, Economy and Society* 2010, 3:59-70.
[15] Adger, W, Arnell, N, and Tompkins, E. 2005. "Successful adaptation to climate change across scales." *Global Environmental Change* 15:77-86.
[16] Sapountzaki, K. 2007. "Social resilience to environmental risks: a mechanism of vulnerability transfer?" *Management of Environmental Quality: An International Journal* 18:274-297.

research and implementation efforts penetrate to the underserved communities and do not reinforce existing inequities or create new ones.[17]

The Challenge

The first step to meeting the equitable resilience challenge is to understand the vulnerability that various communities face, and then address the vulnerability for equity and resilience cohesively. Students may consider strategies for **achieving resilience at the building scale or community scale** for new construction, existing buildings, or communities. A community could be a small neighborhood or a geographic region of any scale. Students may develop solutions guided by the Resilient Design Principles[18] and utilize available resilient design tools[19,20].

Students should develop a problem statement related to building or community resilience that includes a challenge for making resilience more equitable. Student submissions should:

- Describe the scope and context of the problem based on a real problem(s) in the United States.
- Identify affected communities, making sure to include underserved, marginalized and/or vulnerable communities.
- Develop a holistic solution to address the problem at a building scale or a community scale. The solution should include technical aspect as well as non-technical aspects such as policy or economic solutions. At a building scale, solutions may focus on new building designs or existing building retrofits.
- Discuss how issues of equity are incorporated into strategies to promote resilience.
- Discuss appropriate and expected impacts and benefits of the proposed solution. These may include quantifiable and nonquantifiable benefits,[21] such as health and safety of affected population, size of community affected, number of households relocated, avoided cost of losses, loss of businesses, loss of lives, etc.
- Develop a plan that describes how the team envisions bringing its idea from concept to implementation. For example, a technology-to-market plan for a commercially viable, market-ready product for real buildings and communities, and/or integration into the planning and design process.

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[17] Liechenko, R. 2011. “Climate change and urban resilience.” *Current Opinion in Environmental Sustainability* 3:164–168.
[18] The Resilient Design Institute. 2021. “The Resilient Design Principles.” https://www.resilientdesign.org/the-resilient-design-principles/.
[19] National Oceanic and Atmospheric Administration. “US Climate Resilience Toolkit.” https://toolkit.climate.gov/.
[20] US Green Building Council. 2018. “Resilient by Design: USGBC Offers Sustainability Tools for Enhanced Resilience.” https://www.usgbc.org/sites/default/files/2018-USGBC-Resilience-Brief-041118.pdf.
[21] Whole Building Design Guide. 2020. “Consider Non-Quantifiable Benefits.” https://www.wbdg.org/design-objectives/cost-effective/consider-non-monetary-benefits.