Sustainable and Resilient

The objective of this challenge is to develop novel technical solutions to improve the resilience and sustainability of the built environment and identify ways for each proposed solution to enable underserved communities to adapt, persist, and recover from extreme weather and persistent stress, such as those caused by climate change.[1]

Background

People around the world are experiencing an increase in the intensity and frequency of extreme weather events[1] and persistent stresses on the environment, society, and economy.[2] Extreme weather events are not always singular or isolated; they can occur in complex combinations and/or rapid succession.[3] Depending on the exposure (i.e., presence of people, livelihoods, assets, buildings, services, infrastructure, etc.) and vulnerability of the affected region and communities, an extreme weather event may become a disaster; damage the natural and built environment and infrastructure; and pose a threat to public health, safety, and well-being.[4] The impact of extreme weather and persistent stress is significantly greater on **underserved, marginalized, and vulnerable** communities, which often lack the resources and capacity to recover.[5] Climate change will increase the number of extreme weather events.[6] There is an urgent need to design more resilient and sustainable buildings and infrastructure that mitigate the impact of extreme weather events, especially in disadvantaged communities.[7]

The core idea of **sustainability** is to reduce negative impacts on the environment. Sustainability focuses on improving quality of life through practices that minimize damage to the environment.[8] **Resilience** relates to adaptation to change and focuses on disaster preparedness, mitigation, and recovery.[9] *Resilience is typically viewed as the response to low-probability, high-impact events, whereas sustainability is the response to high-probability events for which the impacts are spread out over the infrastructure life cycle.*[10] A resilient and sustainable design focuses on the response of systems to both extreme weather and persistent stress utilizing sustainable design principles.

Building-scale strategies for improving resilience can address one or more aspects of building structure, enclosure, systems, operations, and building use.[11] Community-level strategies for improving resilience of building stock and infrastructure may require a multipronged approach, including mandatory upgrades, incentive programs, funding mechanisms, and education/outreach programs.[12]

Many emerging technologies focus on improving 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 automatically improve efficiency and reliability in distributing electricity.[13] Microgrids[14] with distributed energy resources[15] include small-scale units of power generation that operate locally and can be connected to a larger power grid at the distribution level, thereby improving the quality and reliability of service.[16] Grid-interactive efficient buildings use an optimized blend of energy efficiency, energy storage, renewable energy, and load flexibility technologies enabled through smart controls.[17]

It is important to recognize the potential opportunities and challenges in integrating resilience and sustainability goals. In most cases, resilience and sustainability objectives complement each other. For example, systems that are more resilient can better achieve and maintain sustainable operation. Systems that are more sustainable lose less critical functionality and recover more quickly in response to economic, environmental, and social disturbances. However, resilience and sustainability objectives can also compete with each other. For example, oversizing a system for extreme weather conditions may result in non-optimal system performance. Resilience strategies focused on rapid recovery may not achieve long-term sustainability.[10,18] Therefore, balanced solutions are needed to optimize both resilience and sustainability.

The Challenge

Addressing this challenge requires understanding the vulnerability that various communities face from extreme weather and persistent stressors and then addressing that vulnerability by comprehensively considering equity, resilience, and sustainability. Students may consider strategies for improving resilience and sustainability of buildings and infrastructure at the building or community scale for new construction, existing buildings, or communities. The solutions must have resilience as the primary objective with sustainability as a component of resilience and must justify trade-offs considered for reconciling any divergent goals of resilience and sustainability.

Suggestions for student teams include (but are not limited to) the following:

- Develop innovative design and construction solutions for improving the resilience of buildings
- Develop smart controls for improving the resilience of building infrastructure and the electricity grid
- Develop integrated technical and planning solutions for improving community resilience.

Student submissions should:

- Describe the scope and context of the problem based on a current or emergent problem(s) in the United States
- Identify affected communities, making sure to include underserved, marginalized, and/or vulnerable communities
- Develop a novel technical solution to address the problem at a clearly defined building or community scale; the solution must include technical and nontechnical aspects such as policy or economic solutions and may focus on new or existing buildings or planned or existing communities
- Discuss how issues of equity are incorporated into strategies to improve resilience and sustainability
- Discuss appropriate and expected impacts (including any unintended consequences) and benefits of the proposed solution; these may include quantifiable and nonquantifiable benefits[19] such as health and safety of the affected population, size of the community affected, number of households relocated, avoided cost of losses, loss of businesses, and loss of lives
- Develop a plan that describes how the team envisions bringing its idea from concept to implementation, such as 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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