Building Affordability

The objective of this challenge is to **reduce costs of high-performance, energy-efficient building technologies** to improve **affordability**, **equity**, and **accessibility.**

Background

Three in five Americans live paycheck to paycheck.[1] One in five American adults lives in a household that could not afford energy bill payments for at least 1 month in 2023,[2] and 32% of Americans cannot afford to pay a $500 unexpected cost from their savings.[3] Between 2019 and 2023, housing costs increased much faster than wages.[4] Under these conditions, Americans may struggle to afford high-performance, energy-efficient building technologies that have the potential to lower energy bills and improve occupant health and comfort. To make high-performance, energy-efficient building technologies equitable and accessible and to enable widespread adoption, research and development of new building technologies must focus on affordability.

Energy-related building technologies can be subdivided into two generic categories. Building equipment—including heat pumps, HVAC, dehumidifiers, appliances, water heaters, refrigeration systems, renewable energy sources, and advanced energy storage systems—consumes or converts energy to provide occupants with comfort and other utilities.[5] On the other hand, the building envelope—comprising the walls, roof, foundation, and windows—insulates interior living conditions from exterior weather, slowing the transfer of heat.[6] Both elements are critical in determining the energy efficiency of the building. As advanced technologies are researched and developed to improve energy efficiency, cost will be a major factor in their widespread adoption. To encourage rapid improvement of building energy efficiency in the United States, the development of new technologies and retrofit strategies must consider affordability.

For both new and existing buildings, the cost of high–energy efficiency technologies can prevent stakeholders—including building owners, the government, and low- to moderate-income communities–from benefitting from the reduced energy costs associated with these technologies. For new buildings, research predicts that, with proper planning and contractor training, the incremental cost of constructing energy-efficient zero-emission buildings can be minimal.[7] However, existing building retrofits and retrocommissioning present unique affordability challenges.[8] Low- to moderate-income households may struggle to pay the upfront cost or qualify for financing to install new energy-efficient technologies in their buildings. As an example, the prices of energy-efficient building equipment, a necessary technology to reduce energy costs, increased 40% between 2020 and 2023, resulting in new equipment being unattainable for many consumers.[9] Additionally, the cost remains high to install the necessary upgrades to electrical infrastructure such as wiring and panels to support new equipment. Contractors that install this equipment pass soft costs—such as the costs of finding customers, managing sales, and managing risks of service calls—along to the consumer, increasing prices. In fact, the gross margins for deep energy retrofits are higher than average for the remodeling industry.[10] For upgrades to the building envelope—such as new insulation, windows, and air sealing—unanticipated issues with building conditions such as structural defects, moisture issues, asbestos/lead abatement, and risky electrical infrastructure result in significant unexpected costs to stakeholders.[11] To reduce costs and drive affordability, technical solutions must aim to solve these issues.

To accelerate near-term deployment, incentive programs, contractor training, and other methods can be used to reduce costs and deliver lower energy bills to consumers. The Inflation Reduction Act provides rebates, tax credits, and financing to cut energy costs with enhanced incentives for underserved communities.[12] However, technical solutions are needed to address the source of high costs and remove barriers to stakeholders.

The main barriers to affordability affect stakeholders differently. For consumers, a lack of capital often makes it difficult for building owners to afford the first costs of installing new energy-efficient equipment or envelope technologies or of replacing old pieces of equipment or envelope technologies with new, more energy-efficient ones. Many Americans consider replacing building equipment or envelope components only when something fails or a problem is discovered. When replacing equipment or components in an emergency, the most readily available and least expensive equipment or components are commonly selected. For contractors, high soft costs of customer acquisition, customer management, project customization, and risk management drive up the costs of building-equipment and envelope-construction projects. These costs are often passed along to the consumer. When installing high–energy efficiency equipment, in many cases, electrical upgrades are necessary. The cost of electrical upgrades also creates a significant barrier for building owners seeking to electrify. Innovation is needed to ensure the drivers of these costs are addressed directly.

The Challenge

This challenge asks student teams to improve the affordability of energy-efficient technologies by developing innovative solutions to reduce costs to stakeholders. Students may consider solutions to improve the affordability of installing, retrofitting, operating, or maintaining high-efficiency building equipment or building envelopes. Students must develop technical and holistic solutions to address the problem. Students should include at least one nontechnical component in addition to the technical solution (e.g., an economic, policy, commercialization, codes, or standards component). However, solutions only considering stand-alone nontechnical components will not be considered.

Suggestions for the student teams include (but are not limited to) improving affordability by doing the following:

- Developing new, low-cost building appliances or equipment that can be easily incorporated into new construction or used to replace older equipment for building retrofits
- Developing new, low-cost insulation materials for building envelopes that can be easily incorporated into new construction or used to retrofit older buildings
- Developing new, low-cost active building envelope systems, such as thermal energy storage systems or hydronic systems, that better control the flow of heat through the envelope and that can be easily incorporated into new construction or integrated into existing buildings
- Developing proactive maintenance strategies that extend the service life of or reduce unexpected costs of building equipment or the building envelope
- Developing predictive analytical or automated decision-making tools to better predict energy demand and operate building equipment or active building envelope systems to reduce energy costs
- Developing advanced control methods for building equipment or active building envelope systems to reduce the peak energy demands of buildings and reduce energy costs

- Developing building construction methods that reduce cost and accelerate construction of energy-efficient buildings
- Addressing inefficiencies in the building construction process to reduce expected or unexpected costs or delays while maintaining high quality and energy efficiency
- Developing low-cost retrofit techniques or technologies that enable cost-effective improvements to the building envelope or upgrades to building equipment to improve the energy performance of existing buildings
- Developing technical, stepwise plans or processes to upgrade or retrocommission existing commercial building equipment or envelopes affordably while improving occupant comfort. Integration of upgrade plans into existing infrastructure, such as the US Department of Energy Better Buildings program, is desired.
- Integrating technical solutions with existing utility and energy rebate programs

Student submissions should do the following:

- Describe the scope and context of a current or emergent problem in the United States.
- Identify affected stakeholders and communities, making sure to research stakeholder backgrounds and understand the stakeholders' needs.
- Develop a novel technical solution to address the problem at the building scale; the solution must include technical aspects in addition to at least one nontechnical aspect such as economic, policy, commercialization, codes, or standards solutions. The solution may focus on improving the affordability of technologies for new or existing buildings in the residential or commercial sector.
- Discuss appropriate and expected impacts (including any unintended consequences) and the benefits of the proposed solution; include a cost analysis of the proposed solution.
- 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/or integration into the planning, design, or construction process.

References

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Additional Resources

- ENERGY STAR. Energy Savings at Home. https://www.energystar.gov/saveathome.
- US Department of Energy Building Technologies Office. Building America Solution Center. https://basc.pnnl.gov/.
- US Department of Energy. Better Buildings Solution Center. https://betterbuildingssolutioncenter.energy.gov/.
- US Department of Energy. Energy Saver. https://www.energy.gov/energysaver/energy-saver.