UND into STEM

Building Affordability

Nolan Hayes, PhD Oak Ridge National Laboratory









Context Affordability



"Three in five Americans live paycheck to paycheck" (LendingClub 2022).

"One in five American adults lives in a household that could not afford energy bill payments for at least 1 month in 2023" (US Census Bureau 2024). "Nearly one in three Americans cannot afford to pay a \$500 unexpected cost from their savings" (Board of Governors of the Federal Reserve System 2024).

"Between 2019 and 2023, housing costs increased much faster than wages" (O'Brien 2022).









Context **Rising Costs**



• New energy-efficient building technologies are costly

"Prices of new energy efficient building equipment increased 40% between 2020 and 2023" (Federal Reserve Bank of St. Louis 2023).

"The gross margins for deep energy retrofits are higher than average for the remodeling industry" (Less, Walker, and Casquero-Modrego 2021).

• To encourage widespread adoption, costs must be reduced









Context Building Equipment and Envelope





Building Equipment

Consumes or converts energy to provide occupants with comfort and other utilities (Goetzler, Guernsey, and Kassuga 2019)

Building Envelope

Insulates interior living conditions from exterior weather, slowing the transfer of heat (Harris 2021)













Motivation

Energy-efficient building technologies need to be more **affordable** to encourage widespread, equitable adoption. Innovation is needed to ensure the drivers of high costs are addressed directly.









High Costs of Energy-Efficient Technologies Building Types



New Buildings



Existing Buildings



Construction of energy-efficient envelopes for new buildings

Source: https://www.osti.gov/biblio/1821413

Drill-and-fill wall insulation retrofit The high costs of energy-efficient technologies affect the affordability of both new building construction and existing building retrofits.

- With proper planning and contractor training, the incremental cost of the new construction of energy-efficient zero-emission buildings can be minimal (Gagiuc 2023)
- The gross margins for deep energy retrofits are higher than average for the remodeling industry (Less, Walker, and Casquero-Modrego 2021)









High Costs of Energy-Efficient Technologies Stakeholders



 High costs prevent stakeholders—including building owners, the government, and low- to moderate-income communities—from benefitting from the reduced energy costs associated with energy-efficient technologies



Building Owners



Government



Low- to Moderate-Income Communities









High Costs of Energy-Efficient Technologies Barriers to Affordability



The following are examples of barriers to affordable energy-efficient technologies:

Lack of Capital



- Lack of capital makes it difficult to afford new or replacement technologies
- Many Americans consider replacing technologies only when something fails or a problem is discovered
- For replacements, the most readily available and least expensive option is commonly selected

High Soft Costs



- 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 passed along to the consumer

Unexpected Costs



- 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
- The cost of electrical upgrades required for new equipment is often unexpected

Transforming ENERGY









The Challenge

This challenge asks student teams to improve the affordability of energyefficient technologies by developing innovative solutions to reduce costs to stakeholders. Students must develop technical and holistic solutions to address the problem.











Additional Resources

ENERGY STAR

- <u>https://www.energystar.gov/saveathome</u>
- Building America Solution Center
- <u>https://basc.pnnl.gov/</u>
- Better Buildings Solution Center
- <u>https://betterbuildingssolutioncenter.energy.gov/</u>
- Energy Saver
- <u>https://www.energy.gov/energysaver/energy-saver</u>











References

Board of Governors of the Federal Reserve System. 2024. Economic Well-Being of U.S. Households in 2023. Washington, DC: Board of Governors. https://doi.org/10.17016/8960.

Federal Reserve Bank of St. Louis. 2023. "Producer Price Index by Industry: HVAC and Commercial Refrigeration Equipment, 2003-12-01 to 2023-05-01." https://fred.stlouisfed.org/series/PCU3334133341#0.

Gagiuc, A. 2023. "Building the Case for Passive House Standards." Multi-Housing News. https://www.multihousingnews.com/making-the-case-for-passive-house-standards/.

Goetzler B., M. Guernsey, and T. Kassuga. 2019. Grid-Interactive Efficient Buildings Technical Report Series: HVAC; Water Heating; Appliances; and Refrigeration. Washington, DC: US Department of Energy. https://www1.eere.energy.gov/buildings/pdfs/75473.pdf.

Harris, C. 2021. Opaque Envelopes: Pathway to Building Energy Efficiency and Demand Flexibility: Key to a Low-Carbon, Sustainable Future. DOE/GO-102021-5585. Washington, DC: US Department of Energy. https://doi.org/10.2172/1821413.

LendingClub. 2022. "Three in Five Americans Live Paycheck to Paycheck: More People Are Living Paycheck to Paycheck but Making Ends Meet Than Not Living Paycheck to Paycheck." https://ir.lendingclub.com/news/news-details/2022/Three-in-Five-Americans-Live-Paycheck-to-Paycheck-More-People-Are-Living-Paycheck-to-Paycheck-but-Making-Ends-Meet-Than-Not-Living-Paycheck-to-Paycheck/default.aspx.

Less, B. D., I. S. Walker, and N. Casquero-Modrego. 2021. Emerging Pathways to Upgrade the US Housing Stock: A Review of the HomeEnergy Upgrade Literature. Energy Technologies Area, Berkeley Lab. <u>https://doi.org/10.2172/1777979</u>.

O'Brien, C. 2022. "Despite Booming Labor Market, Incomes Are Not Keeping Up with Housing Costs Nationwide." Economic Innovation Group. <u>https://eig.org/housing-affordability/</u>.

US Census Bureau. 2024. "Phase 4.0 Cycle 01 Household Pulse Survey: January 9 – February 5." February 22, 2024. <u>https://www.census.gov/data-tools/demo/hhp/#/?measures=ENERGYBILL&areaSelector=040</u>.











Thank You!

www.jumpintostem.org







