ECOLOGICAL KEYNOTE
THE IMPACT OF BUILDINGS IN THE ENVIRONMENT

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The rising levels of greenhouse gasses (GHG) constitute the primary driver of global warming and today's climate crisis. According to the National Oceanic and Atmospheric Administration (NOAA),[1] carbon dioxide levels have increased by over one-third in the past two centuries. The built environment significantly contributes to this trend, with buildings accounting for 37% of greenhouse gas emissions globally, including operational and embodied carbon[2]. Moreover, from an energy perspective, buildings represent a substantial portion of overall consumption. In 2021, buildings accounted for 39% of the total energy in the United States, surpassing the transportation and industrial sectors.[3]

The current efforts aimed at decarbonizing the built environment by 2050, in line with the targets set by the Paris Agreement, reflect the building industry's crucial role in addressing this global challenge. According to the United Nations 2022 Global Status Report for Buildings and Construction,[4] the building sector has achieved approximately half of the required decarbonization. These statistics emphasize the importance of adopting sustainable practices within the construction industry and ensuring equitable access to clean energy. Designing high-performance buildings and enhancing the energy efficiency of existing structures require diverse skills and collaboration across disciplines, significantly impacting the architecture profession and discipline.

Illinois Tech's Department of Civil, Architectural, and Environmental Engineering (CAEE) has been offering a sequence of two design-based courses focused on high-performance building design and centered on the Department of Energy Solar Decathlon Design Challenge (SDDC) since fall 2016. This annual international collegiate competition tasks "interdisciplinary teams to create innovative and high-performance building designs that address real-world issues related to climate change, affordability, and environmental justice."[5] These courses are integral parts of Illinois Tech's Master of Engineering in Architectural Engineering and the Master in High Performance Buildings, both of which received the Zero Energy Design Designation from the U.S. Department of Energy. Since Spring 2021, this sequence is also offered within Illinois Tech's Interprofessional Projects Program (IPRO), expanding access to undergraduate students across different disciplines.

Over the years, student design teams have analyzed different project typologies ranging from small-scale residential buildings to mixed-use multifamily projects and commercial structures. Furthermore, they have explored new construction and retrofit projects. Each project incorporates a blend of passive and active design strategies, including orientation, natural ventilation, optimized access to daylighting, a well-insulated and airtight building enclosure design, high-efficiency equipment, appliances, and fixtures. The projects modeled EUI (Energy Use Intensity) values range from 25–30 kBtu/ft2 /yr, with each project predicting annual net zero energy consumption with the addition of on-site photovoltaics.

Improving the performance of existing buildings, addressing affordability, and environmental justice pose significant challenges to decarbonization efforts. Older structures often feature leaky and poorly insulated envelopes and require comprehensive retrofits, including upgrading the enclosure system, replacing HVAC systems with more efficient equipment, and introducing energy-efficient appliances and fixtures. Each intervention is typically "ad hoc" and presents its own set of unique challenges. Moreover, disparities in benefit distribution and access to clean energy disproportionately affect disadvantaged communities.

Examples of retrofit projects developed in these courses that illustrate the complexities of addressing these challenges include the renovation of Chicago's last-standing Phyllis Wheatley Home and the retrofit of a 100-year-old residence in Chicago's Woodlawn neighborhood. The former focused on preserving a historic Greystone facing the threat of demolition due to its deteriorating condition. Established as a safe place for Black women during the Great Migration, the Phyllis Wheatley Home holds significant historical value. The project consisted of a deep energy retrofit and repurposing of the mansion, aiming to preserve the structure while meeting modern needs and achieving the zero-energy target. Key focus areas included improving the envelope performance, addressing moisture issues in the masonry system, and preserving the facade — the building's primary architectural expression.

In 2023, the retrofit housing team took on the challenge of bringing to new life a nearly 100-year-old residence in Chicago's south side. Developed in partnership with the Housing Equity Initiative (HEI), the project aimed at promoting home ownership in the Woodlawn neighborhood, a community that has experienced a long history of inequities and disinvestment. In addition to reaching the zero-energy target, the project had the challenge of being deeply affordable.

Adopting high-performance design principles in new construction and retrofit projects, requires the integration of energy-related strategies into the architectural design. By fostering innovation and interdisciplinary collaboration, the built environment and our cities can achieve global goals and aim toward a more sustainable and equitable future.

References

1 https://www.climate.gov/media/14605

2 UN environment programme_2022 Global Status Report for Buildings and Construction

3 EIA August 2021 Monthly Energy Review Solar Decathlon Building Science Education_1-1 – The impact of Buildings Using Energy

4 UN environment programme_2022 Global Status Report for Buildings and Construction

5 https://www.solardecathlon.gov/2024/design-challenge.html