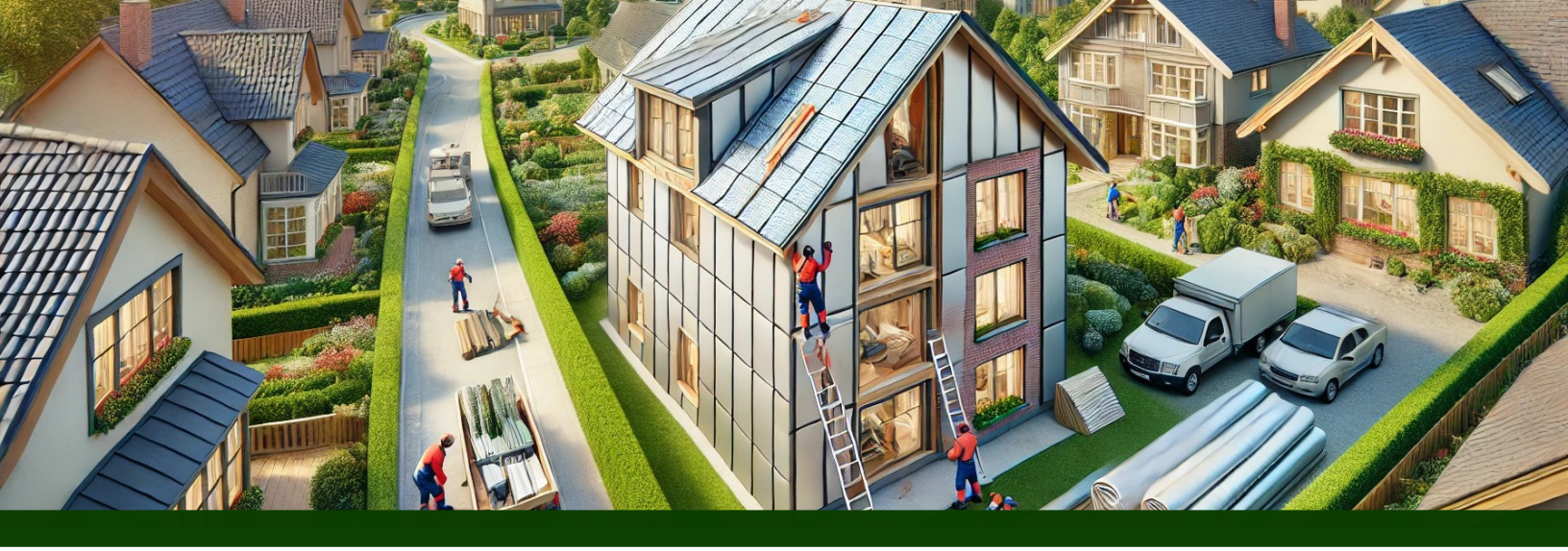

BEST Center Funded Research Summary

Flexible Insulated Panels for Retrofitting Existing Building Envelopes

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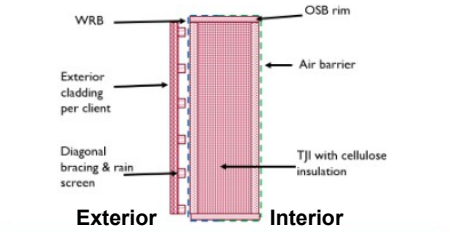
Motivation

This project explores the development and evaluation of flexible and easy-to-install insulated panels suitable for retrofitting opaque exterior envelope systems, including walls and roofs, for existing buildings with minimal disturbances to occupants. The insulated panels can be prefabricated to fit the need and geometry for individual building and envelope elements.

Methods

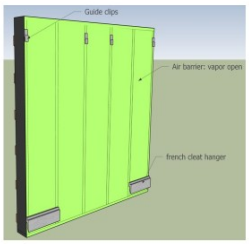
The project included three main tasks:

(i) **Design Development:** A design option for the architectural features of the insulated panels was finalized to consider detailed specifications for the insulation layers, as shown in Figure 1, and the connection systems with commonly existing facades for residential buildings, as outlined in Figure 2.



Effective R-value	Thickness	Weight	Cost
~R-29	10-1/4"	5.59 lbs./ft²	$3.53/ft²

Figure 1. *Section for a proposed exterior insulated retrofit panel. From interior to exterior, the wall assembly includes an air barrier, wood I-joist studs, cellulose or wool insulation, weather-resistant barrier (WRB), rain screen, and the desired exterior cladding/ façade. If lighter weight is desired for the panel, then wool insulation is recommended. However, cellulose should be considered for lower cost.*



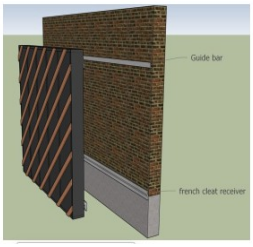


Figure 2. *Connections of the insulated retrofit panel with the building façade. The full weight of the panel rests on French cleats. The guide clips, attached on the back, are used only to assist in installation of the panel. The panel is supported by the French cleat receivers installed on the exterior façade with L-brackets used to secure the top of the panel to the existing structure. Air sealing should be applied between installed panels using vapor-open adhesives and caulks.*

About the BEST Center

The Building Energy Smart Technologies (BEST) Center is a partnership between the University of Colorado Boulder and City College of New York operating using the NSF's industry-university cooperative research center model. The center fosters interdisciplinary collaborations between the building industry and university research to advance energy systems through university-industry partnerships to engineer the intelligent and efficient cities of tomorrow.

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(ii) **Prototyping and Testing:** A basic prototype was evaluated in the Larson HVAC Laboratory to determine the energy performance of the insulated exterior panels when attached to an existing wall using an innovative experimental set-up illustrated in Figure 3.

Figure 3. *Testing set-up for the insulated retrofit panel using a unit cell conditioned by a heat pump*

(iii) **Impact Analysis:** A modeling analysis was carried out to assess the energy performance of the insulated panels for four prototypes of existing US residential buildings, as illustrated in Figure 4. The four residential buildings include:

(a) a two-story single-family detached home (PNNL SF)
(b) an L-shaped single-family 1-story house (L-shape)
(c) a single-family ranch house (SF Ranch)
(d) a multifamily townhouse with three floors (Townhouse)

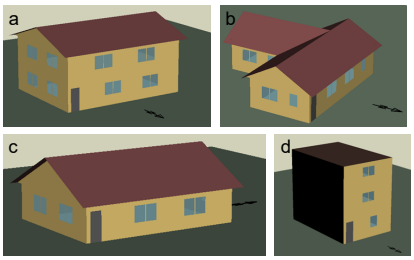

Figure 4. *Energy models for four prototypes of residential buildings: (a) PNNL SF, a two-story single-family detached home, (b) L-shaped single family home, (c) SF Ranch, a single-family ranch house, and (d) a townhouse. The characteristics of the four energy models are described in Biega and Krarti (2024).*

Results

The analysis indicates the insulated panels can achieve between **14% and 36%** reduction in heating, ventilating, and air conditioning energy end-use when applied to uninsulated walls, depending on the residential building type and the US climate as shown in Figure 5.

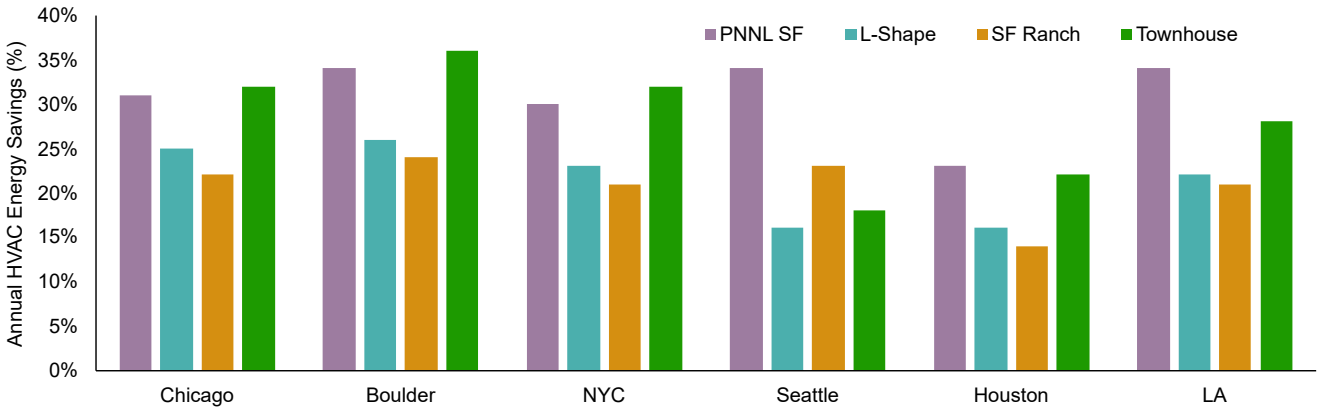

Figure 5. *Potential maximum annual HVAC energy savings due to adding R-50 insulated panels to exterior uninsulated walls of four housing prototypes located in six US cities.*

Next Steps

An application for a patent is being processed for the insulated panel. In addition, funds from the Department of Energy are being requested for further testing of the panels using real buildings.

Research Products

1. Biega, K., Krarti, M., Evaluation of Exterior Insulated Panels for Residential Deep Energy Retrofits. Energies 2024, 17(16), 3988; https://doi.org/10.3390/en17163988.