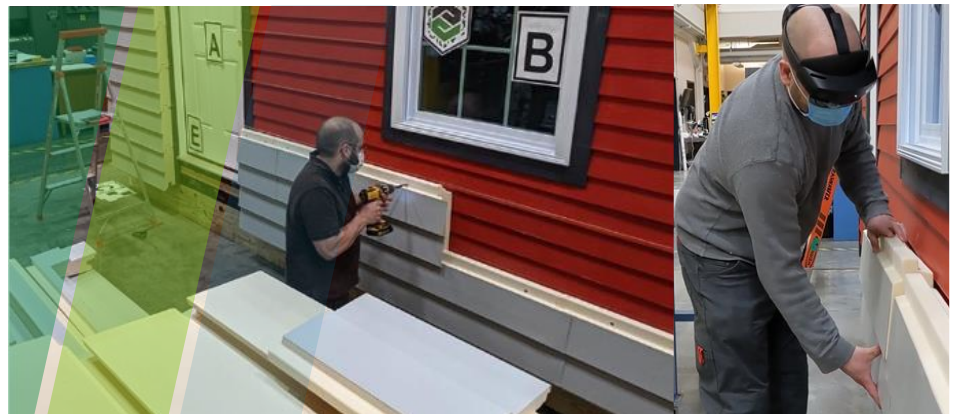


The Advanced Building Construction (ABC) Initiative, led by the Building Technologies Office (BTO), integrates energy-efficiency solutions into highly productive U.S. construction practices for new buildings and retrofits. The ABC Initiative is developing building technologies that can be deployed quickly with minimal onsite construction time, are affordable and appealing to the market, and leverage related efforts to increase the productivity of the construction industry.

Problem to Solve	Exorbitant cost and high skill required to non-invasively insulate exterior walls in DERs
Solution	Integrated deep energy retrofit (DER) solution
Location	Brookline, MA
Timeline	September 2022 – November 2026
Partners	<ul style="list-style-type: none">Fraunhofer USA (Lead)Green Building AllianceH C Fennell ConsultingMassCEC (AmplifyMass)Progressive Foam TechnologiesVEIC
Funding from DOE	\$4,900,000
Total Funding	\$6,100,000

Project Spotlight: Comprehensive Single-Family Home Deep Energy Retrofits with Prefabricated Panel-Block Wall Insulation



Fraunhofer USA's insulated panel block (PB) retrofit system digitizes the wall retrofit process to affordably and rapidly install super-insulated façades. The PBs integrate cladding and insulation, and install over existing cladding on wood-frame buildings.

Overview

Deep Energy Retrofits (DER) can play a key role in reducing energy consumption; however, the costs and prolonged site work preclude deployment at scale. This project focuses on the development and demonstration of an integrated process to produce low-cost, super-insulated external wall system that can be installed on 1-to-4 family homes by semi-skilled labor. This innovative solution comprises net-shape, prefabricated insulated panel blocks (PBs) and uses augmented reality (AR) to guide the installation process.

Project Goals

As part of a complete DER, the project aims to digitize the PB design, fabrication, and installation processes to: 1) pre-fabricate a wall PB and trim set customized for each building offsite using computer-aided manufacturing; 2) empower semi-skilled workers to enhance their productivity; and 3) ensure high-quality retrofits compatible with the business model of small contractors.

Impacts

The integrated process aims to deploy DERs of occupied 1-to-4-family buildings in less than two weeks, eliminating the cost and installation time and disruption barriers impeding deep energy retrofits. The DERs will significantly reduce energy consumption and improve indoor air and environmental quality.

Technology Impact

The project will demonstrate a pathway for implementing comprehensive electrified DERs at a cost of \$30/ft², including recladding. The DER package is expected reduce HVAC and DHW site energy consumption by 80%.

Market Impact

Validating the streamlined process for designing and implementing the DER solution with the PB system will enable semi-skilled workers to implement high-performance wall retrofits. By achieving an installed cost approaching that of uninsulated vinyl siding, this system would enable exterior wall insulation retrofits at scale.





MILESTONES

Summer 2023:

- Developed effective soffit and corner trim solutions
- Found DER pathways that achieve cost targets in buildings with existing ducts
- Finalized Technology-to-Market Plan

Fall 2023 – Developed:

- Insulated PB design
- Scalable anchoring solution for the AR experience
- Algorithms to convert building scan data to wall dimensions with required accuracy

Winter 2023-24 - Developed:

- Window trim design



LESSONS LEARNED

- Extracting dimensions from laser scans (scan-to-BIM) needs to overcome several limitations of scan data
- A simple, nonintrusive user interface is key to deliver an effective AR experience.
- If a furnace provides adequate pre-DER comfort, a DER with a cold-climate heat pump will usually provide adequate comfort.
- PB system viability requires a relentless focus on cost, customer value propositions and aesthetics.
- Simplifying trim installation helps ensure install quality.



NEXT STEPS

- Further refine the scan-to-BIM (Building Information Model) algorithms to achieve required accuracy for all key dimensions.
- Complete neural network training to accurately segment building façades.
- Refine our understanding of customer and contractor value propositions.
- Deepen discussion with potential commercialization partners.
- Enter into agreements with building owners to complete DERs.

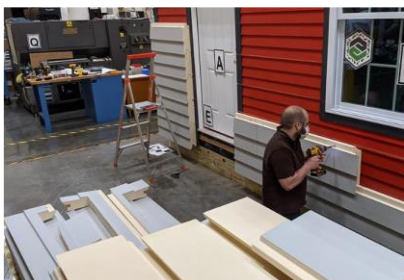
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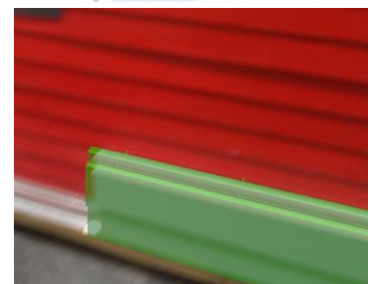
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The Exterior Wall Retrofit Process: 1) The insulated pre-clad panel block (PB) kit, 2) Analysis of building laser scans to extract façade dimensions, 3) Panelization algorithm calculates PB and trim set to clad the building, 4) CAM fabricates custom PB and trim set for each building based on outputs of panelization algorithm; 5) Augmented reality-assisted installation of PBs and trim.

Photo credits: Fraunhofer USA, U. Minnesota (image #1).



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