

ET Summit 2024

Presented by



Demonstrating Thin Triple-Pane Windows in California



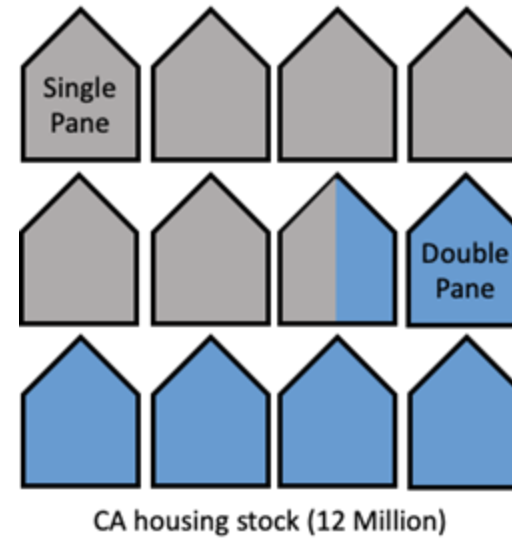
Robert Hart

Researcher

Lawrence Berkeley National Lab

CA Residential Window Installations

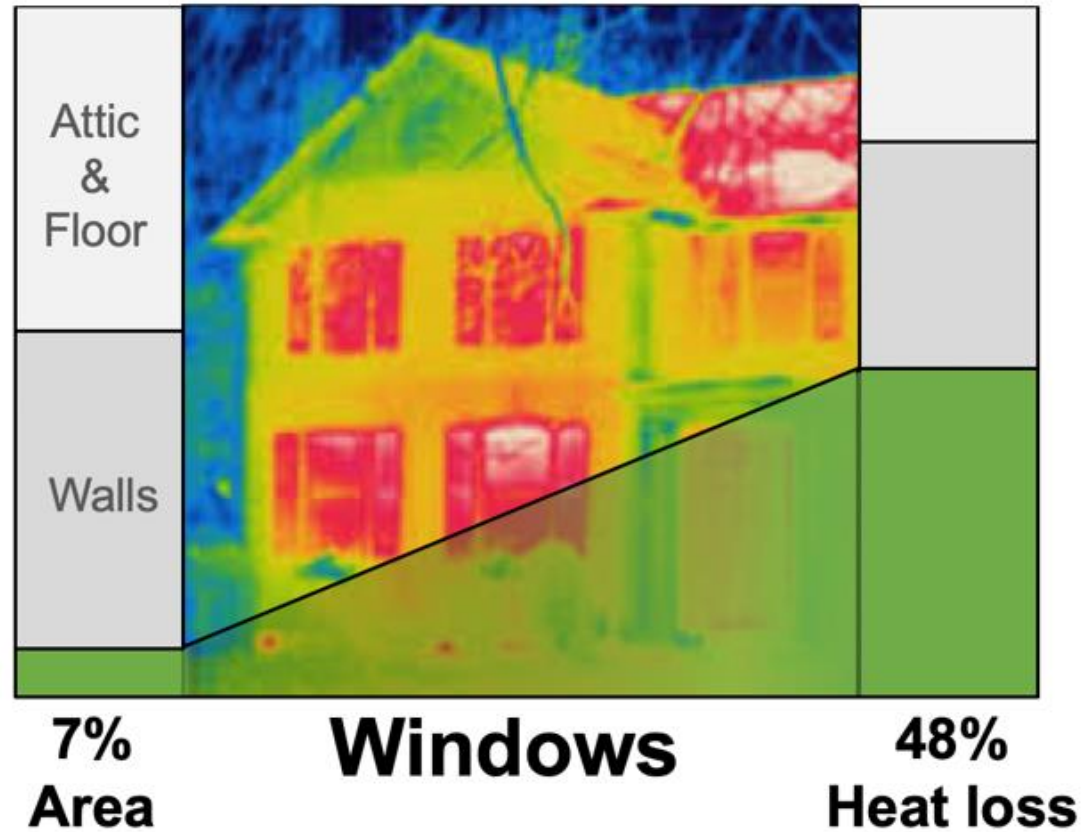
25+ years to retrofit all single-pane at current pace



	2019 Sales*	ENERGY STAR	ES most Efficient
Retrofit	2.8M	83%	<2%
New Construction	1.6M	80%	<2%

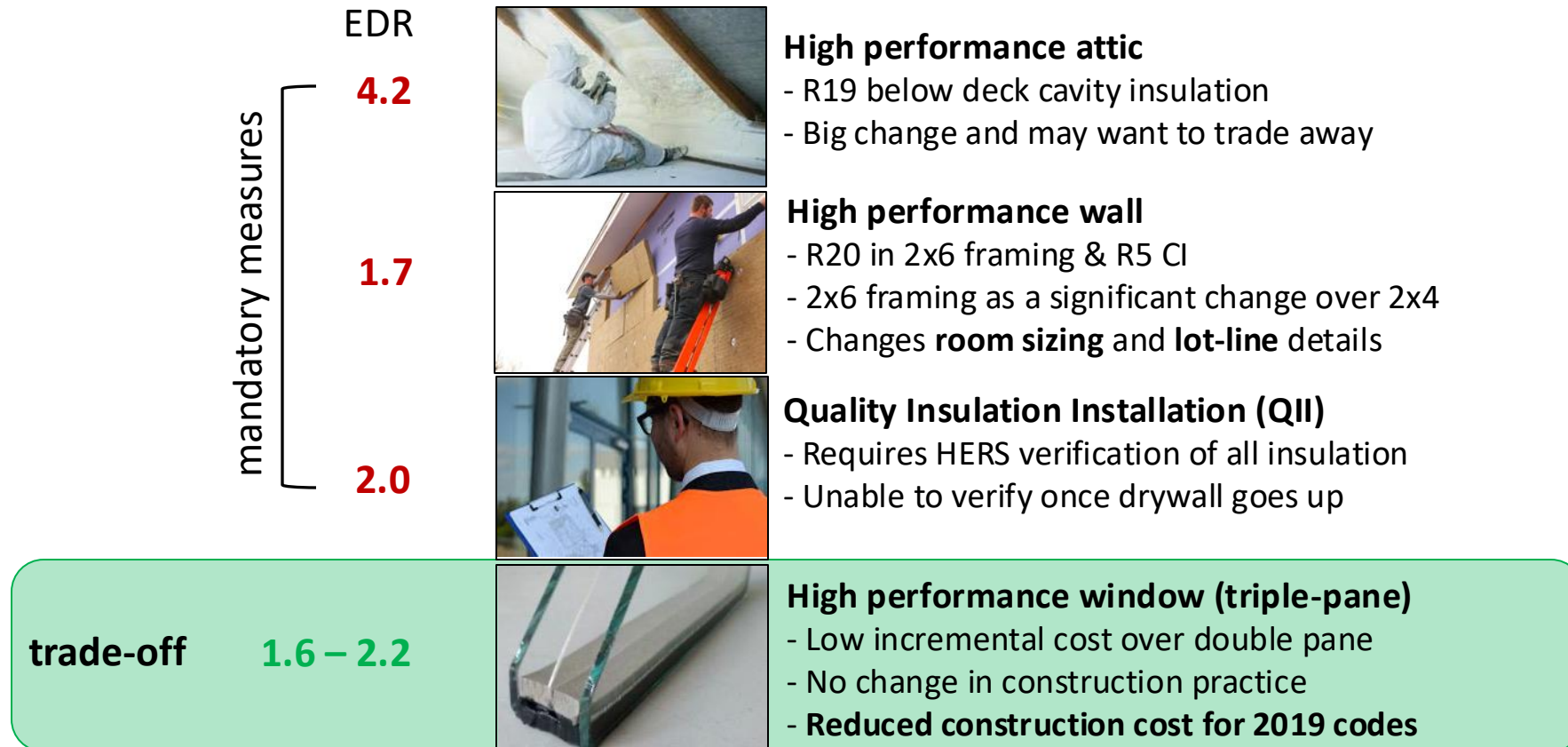
*Ducker 2019

Why High-Performance Windows?



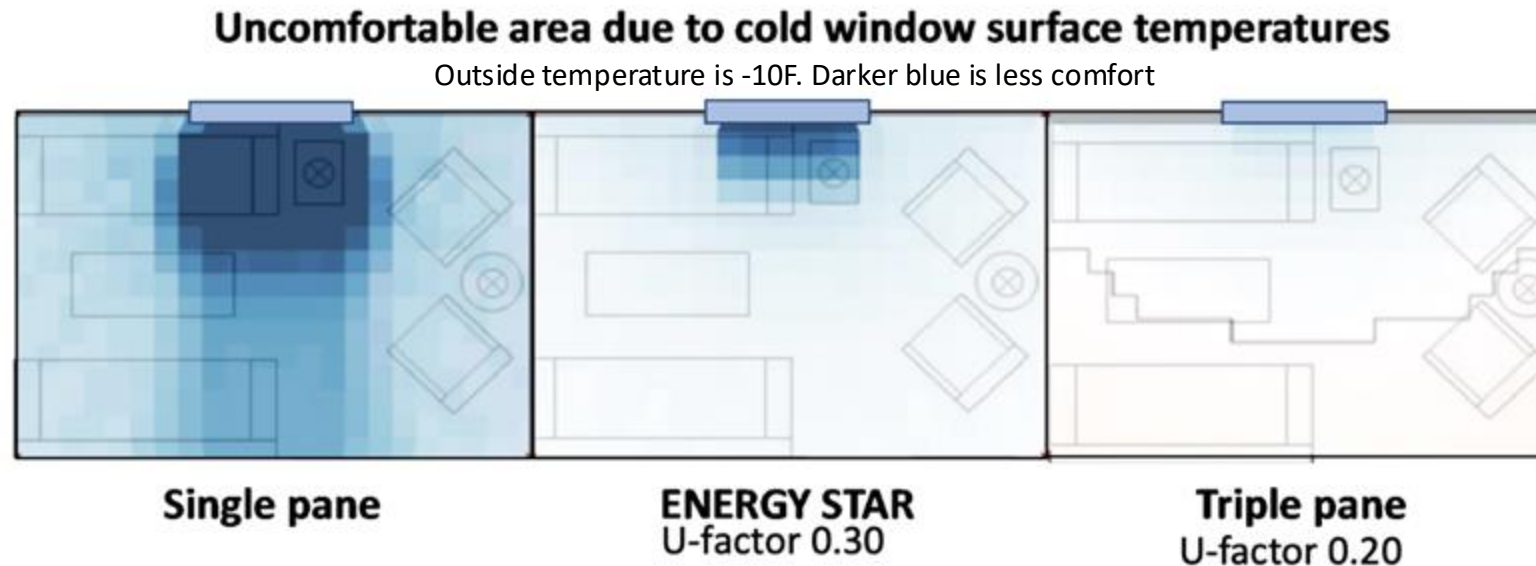
*Based on 2,000 sf 2-story house, IECC 2015

Model Path to Market with New Construction



HPW Non-Energy Benefits

Non-Energy Benefits - Comfort



Triple-pane windows increase comfort!
Single pane is uncomfortable even in mild climates

Hart, Robert, C. Curcija, S. Selkowitz. 2019. Determining the Value of Occupant Comfort from Highly Insulating Windows. Thermal Performance of the Exterior Envelopes of Whole Buildings XIV International Conference. Clearwater Beach, FL.

Non-Energy Benefits - Condensation



Condensation and ice buildup on existing double-pane



Window replaced with Thin-triple

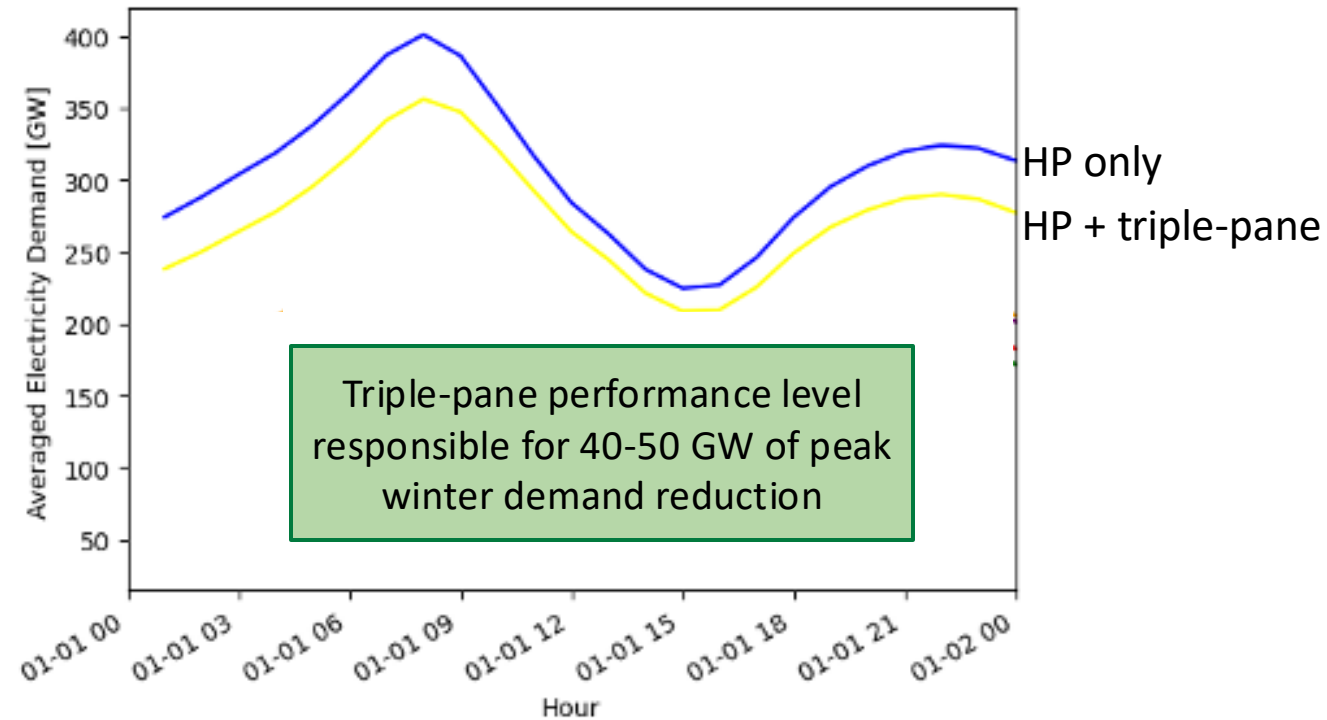
Helena, MT
March 2021
PNL led demonstration

Thin-triple window reduced sound infiltration by ~10 dB
(6-10 dB reductions are typically perceived as reducing sound by half)



Non-Energy Benefits – Electrification Enabler

- Peak Load reduction
- Backup heating reduction
- HVAC rightsizing



10 GW of national peak summer demand reduction

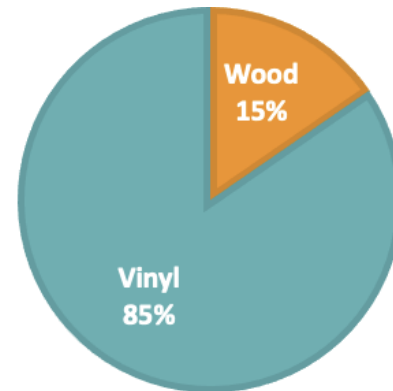
Market Transformation

Window Market Characterization

Dream

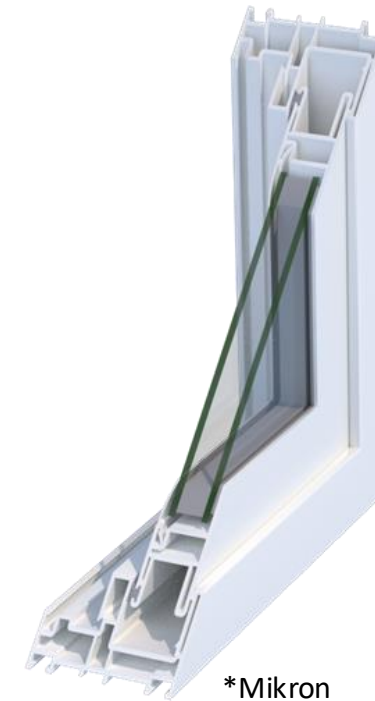


- High-performance new-construction
- Low U-factor and low air infiltration
- Cost and size limit use



>50% vertical sliders
*2021 FGIA

Reality

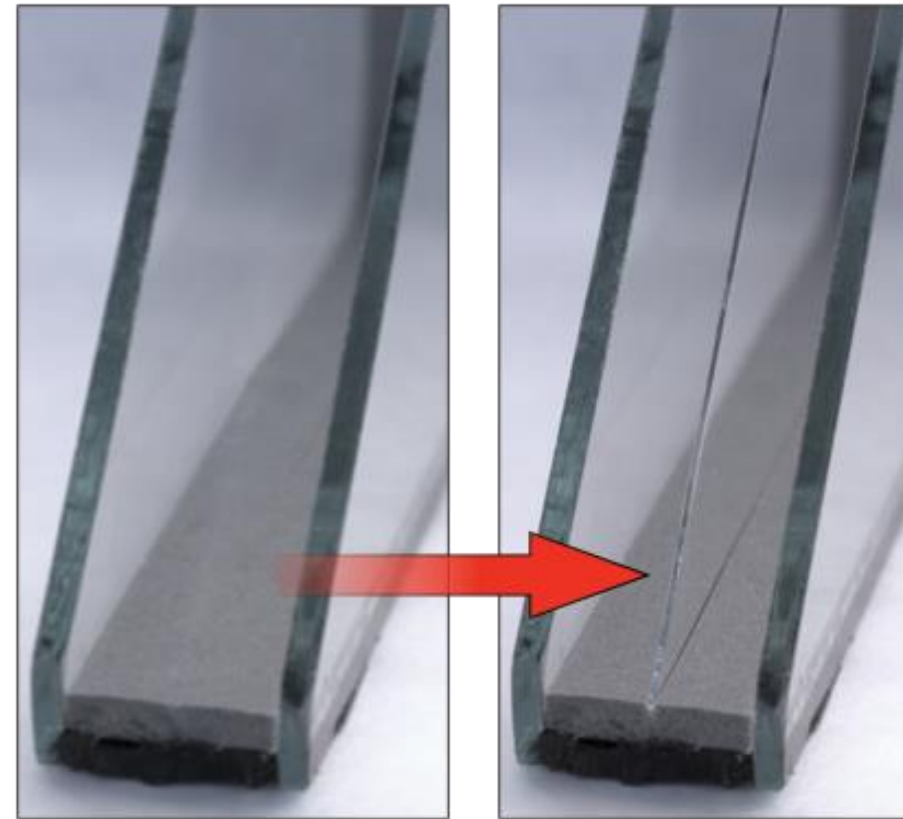


- Vinyl slider
- $\frac{3}{4}$ " IGU thickness
- Designed to minimize cost

Why Thin-Triple

Key Benefits

- R-5 (U-0.2) with Double Hung windows
- No significant weight increase over double pane
- Incremental cost comparable to equivalent wall or attic upgrades
- Uses existing window frame designs
- Retrofit existing windows is possible



Double-pane

Thin-triple

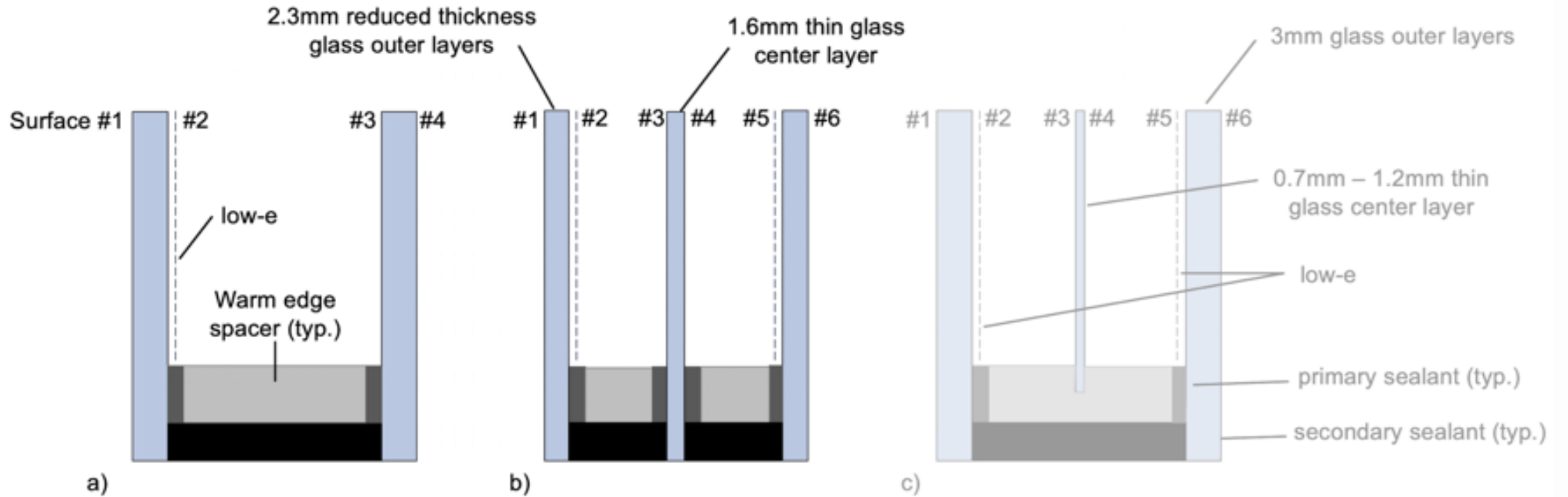
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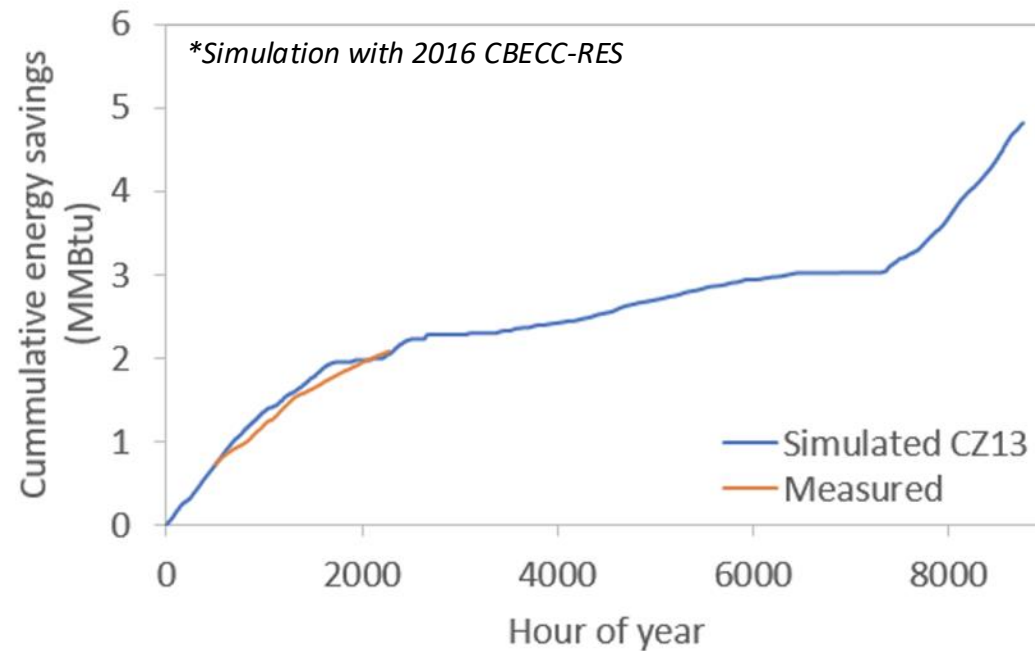
What is Thin-Triple



Demonstrations

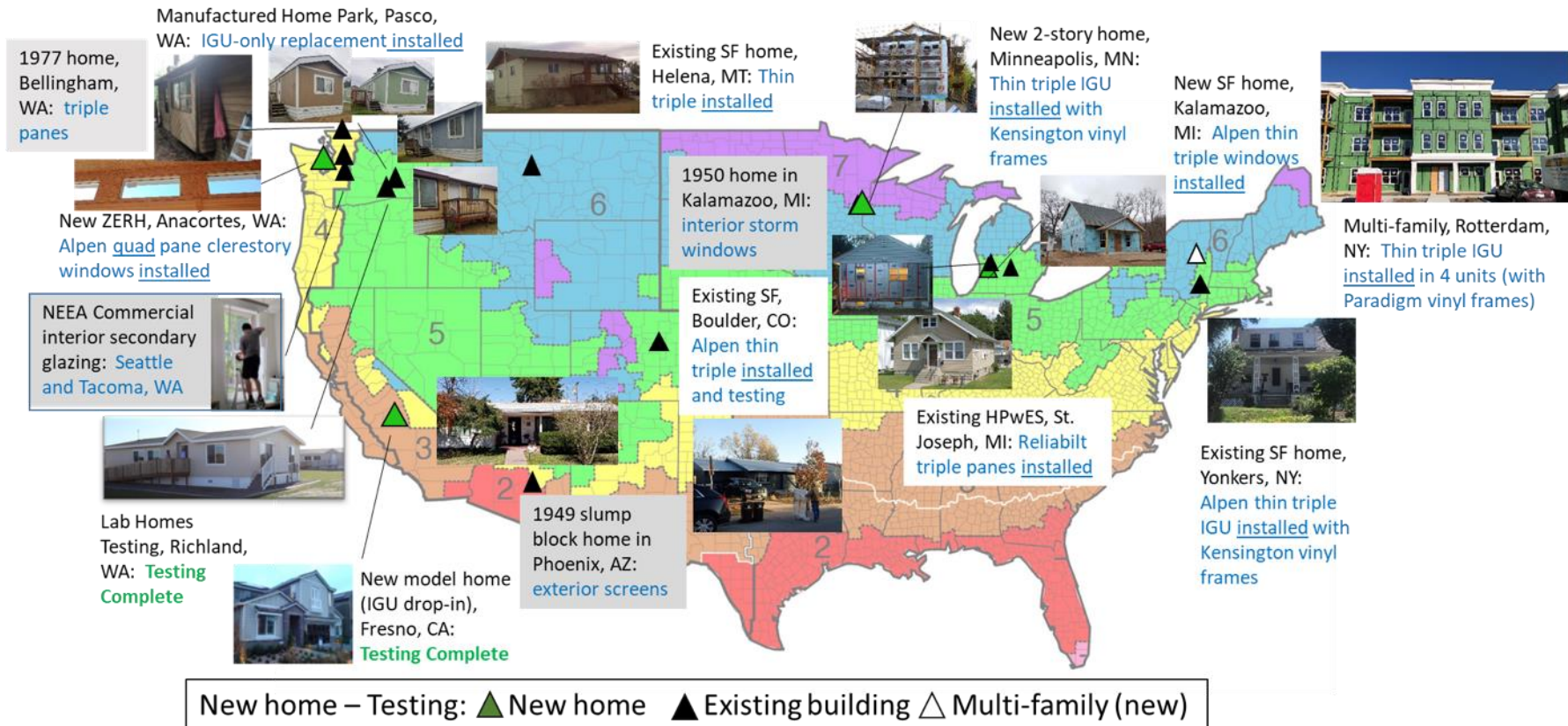
Thin-Triple Retrofit Concept Demonstration

Fresno, Ca



High Performance Window Demonstrations

Field Testing Sites (triple/quad panes, secondary glazing, shades):
Status as of March 2022



CEC GFO 19-307



“Testing and **demonstrating** new building envelope measures with the goal of **reducing costs** and **increasing** energy **performance** for **retrofits** to existing low-rise **multifamily** and **single-family** residential buildings...”

Multi Family Field Demonstrations (CEC GFO 19-307)

Minimum of 8 Units Per Site (Fairfield and Santa Rosa)

- 8 units with Triple pane upgrades, 1-3 units with double pane control
- 12 months pre-retrofit measurements (HVAC, temperatures, utility bills)
- 12 months post retrofit measurements (HVAC, temperatures, utility bills)
- Occupant Comfort Surveys
- Disadvantaged Communities/Low Income per Cal EnviroScreen 3.0



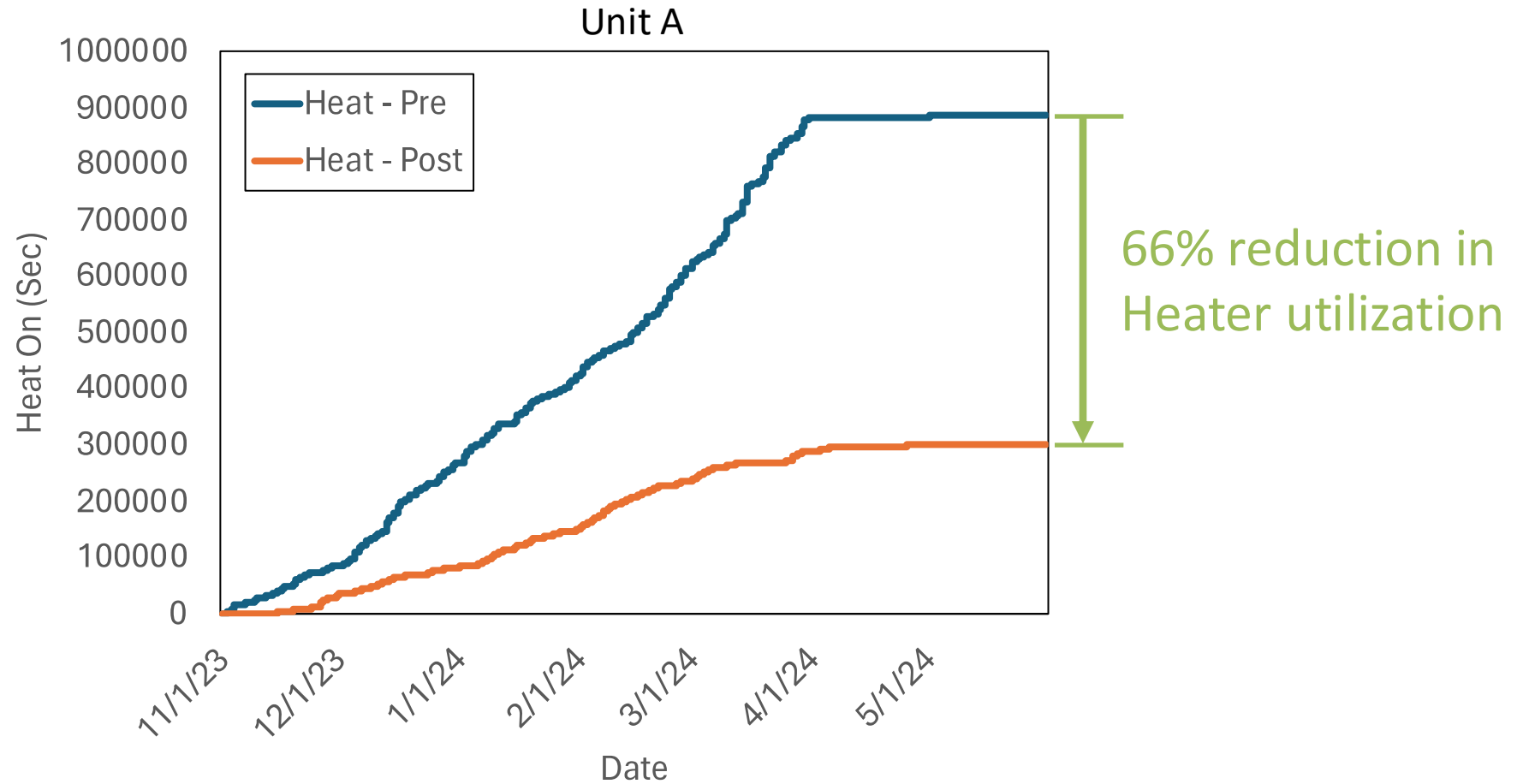
Ideal Characteristics

- Single glazed or ‘bad’ double glazed units
- With AC (not swamp coolers)
- Community Engagement
 - Equity in receiving benefits
 - Engage other community organizations
- Isolated from other retrofits
- Consistent Occupants during Pre and Post Retrofit
- Units with similar orientation and size

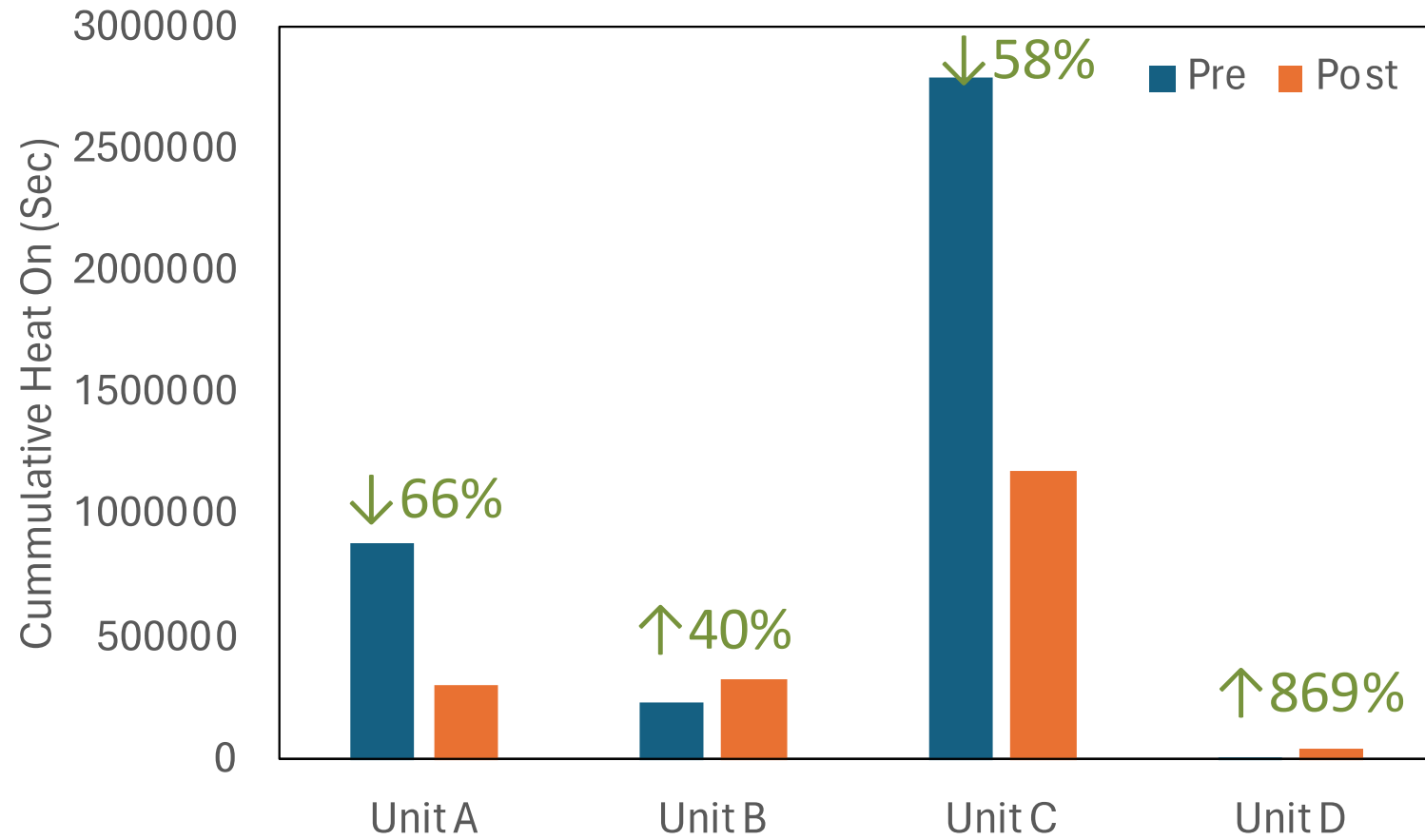
Performance Metric	Baseline Performance	Target Performance
Installed cost (per window)	\$350 - \$600	\$450 - \$650
U-Factor (Btu/h·ft ² ·°F)	Sliding: 0.30 Fixed: 0.28	Sliding: 0.20 Fixed: 0.19

Preliminary Results - Heating

Preliminary Results - Heating



Preliminary Results - Heating



This project was funded by
California Energy Commission under GFO-19-307

For more information, contact Amir Ehyai at amir.ehyai@energy.ca.gov

The project summary and status can be found at:
www.energizeinnovation.fund/projects/demonstrating-benefits-highly-insulating-thin-triple-window-retrofits-california



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