

ET Summit 2024

Presented by

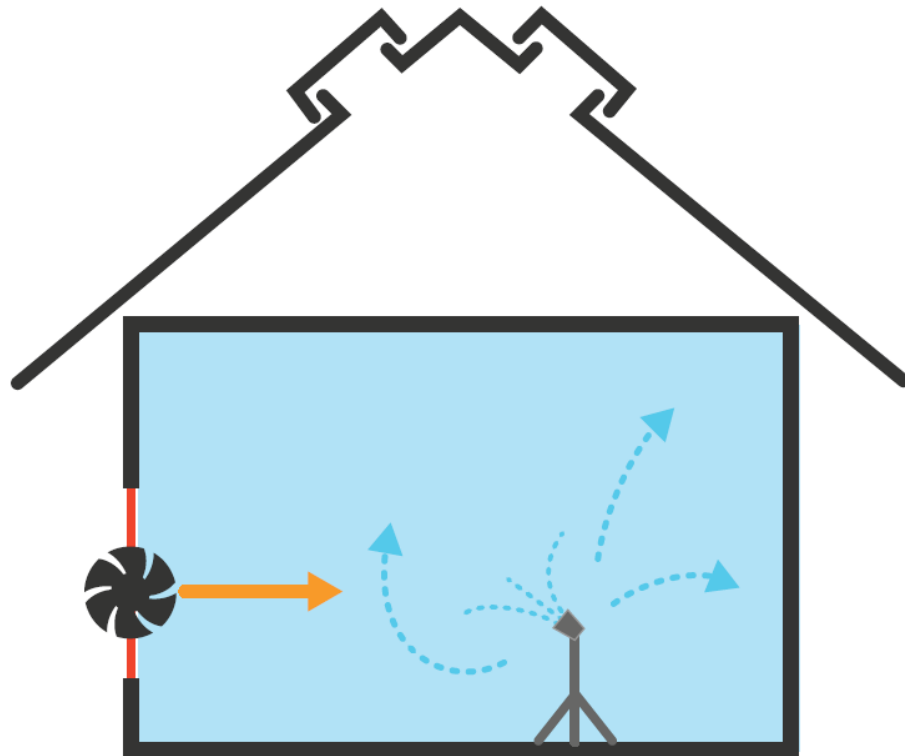


Envelope Retrofit Strategies for Existing Homes

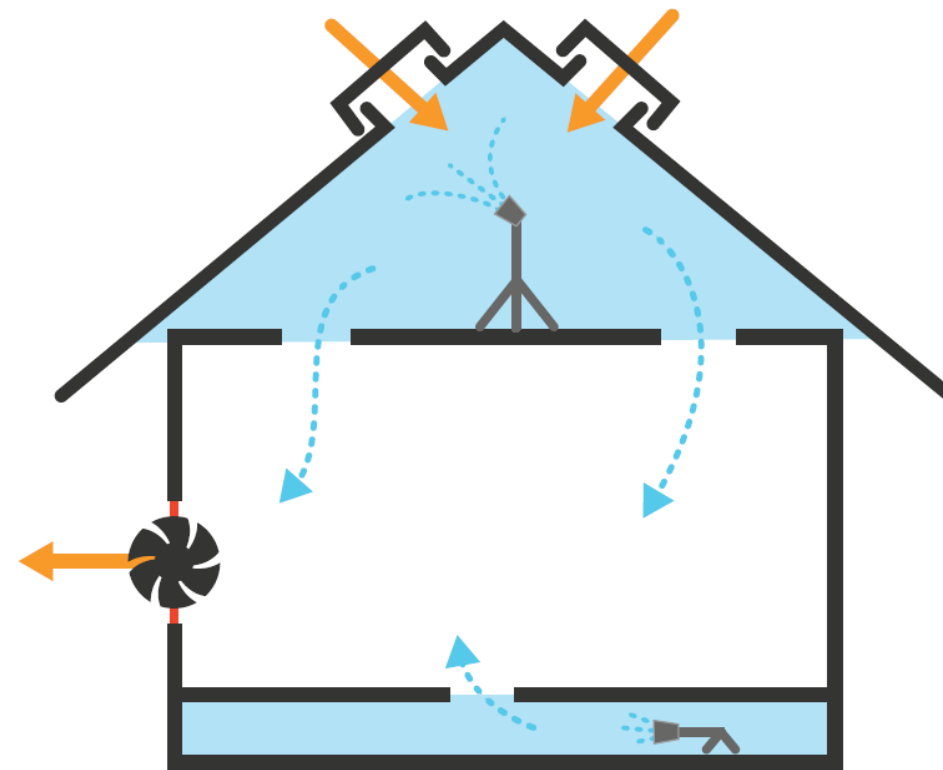


New Approach for Aerosol Sealing in Existing Homes

Traditional Process

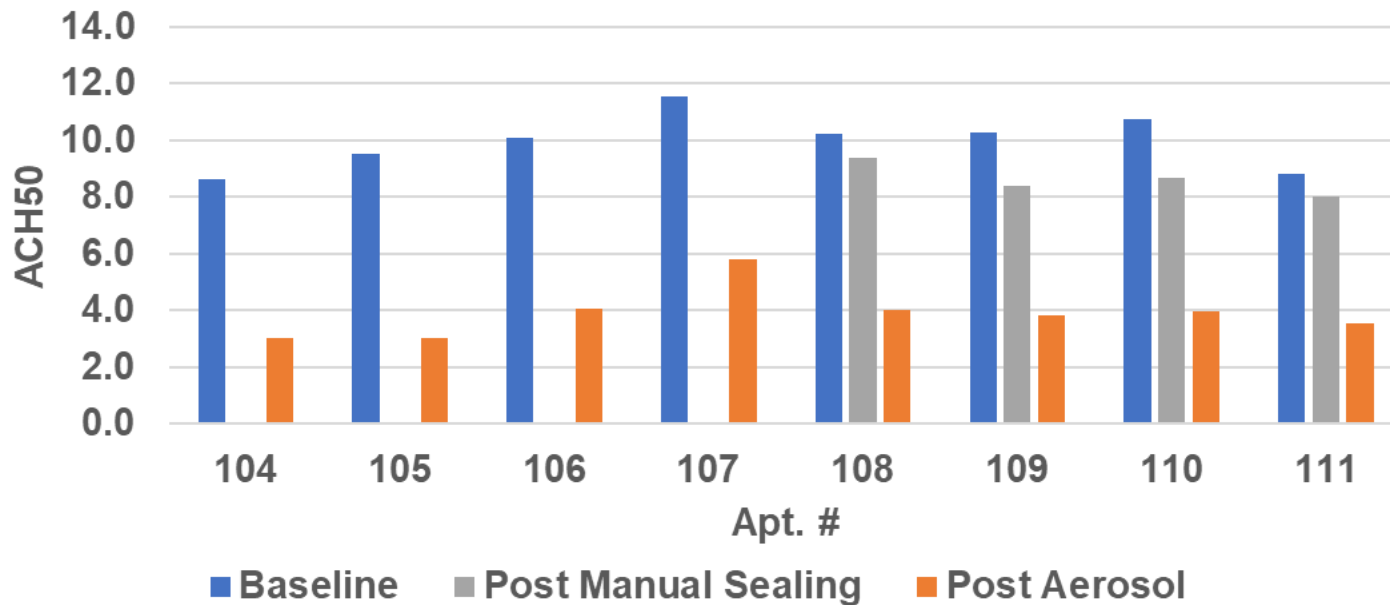


Attic/crawlspace Method



Aerosol Sealing Case Study

- Sealed 8 apartments from attic
 - 4 aerosol only
 - 4 traditional foam followed by aerosol
- Guarded testing showed 46% leakage through attic

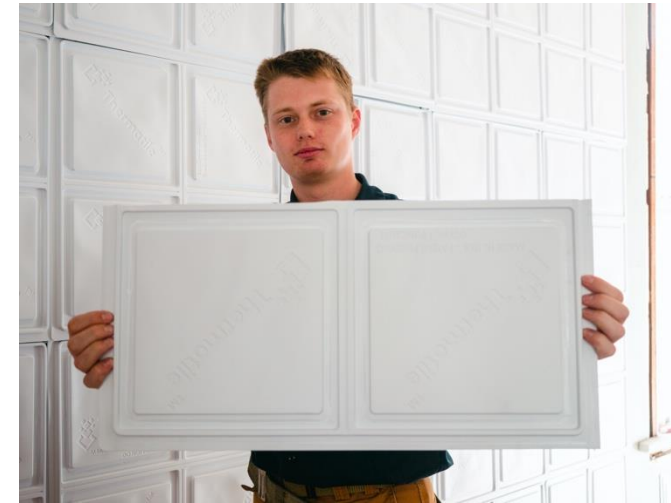
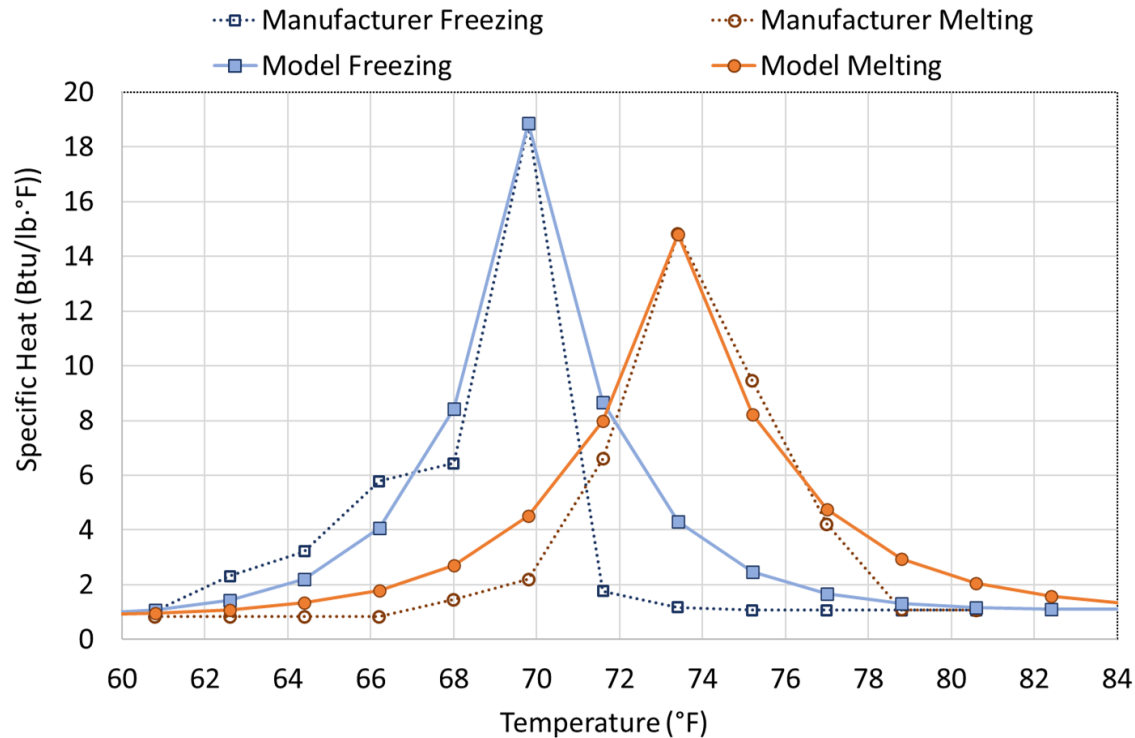


Method	% Sealed
Manual sealing	14%
Aerosol sealing (w/out manual)	39%
Aerosol sealing (after manual)	25%
Aerosol sealing + manual	39%

Barriers to Adoption

- Process is more invasive than manual sealing
 - Requires tenants to leave for 1-2 hours
- Higher cost than manual sealing
 - Increased labor and materials costs
- Requires removal of insulation (like other attic sealing methods)
- Still on the pathway to commercialization

PCM-Enhanced Envelope Retrofit



Project = EnergyPlus Modeling + Dynamic Laboratory Testing Wall Sections + Three Homes Retrofitted

Finding: The EnergyPlus object “phasechangehysteresis” does not work correctly. We instead compiled and used a model from Feng et al.¹

1. Feng, F., Fu, Y., Yang, Z., & O'Neill, Z. (2022). Enhancement of phase change material hysteresis model: A case study of modeling building envelope in EnergyPlus. *Energy and Buildings*, 276. Code at: <https://github.com/BE-HVACR/Energyplus-EnhancedPCM>

PCM-Enhanced Envelope Retrofit



1. Seal attic/crawl space



2. Insulate walls and plug holes



3. ½" Thick phase change material (PCM) panels + new ¼" drywall



4. Finish drywall

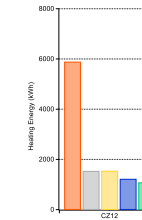
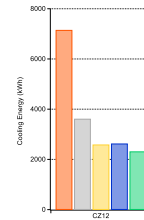
Order of Priorities



Order of priorities

- Attic Insulation
- Wall Insulation
- Summer Nighttime Ventilation (e.g. free cooling) + Sealing
- Phase Change Material

Payback <10 years (whole package)
in CZ 07-16



Equivalent “R-Value” from PCM

Climate Zone	HVAC Energy, R-15 Wall (kWh)	HVAC Energy - R-15 Wall + PCM (kWh)	HVAC Energy Savings from PCM (kwh) (%)	Equivalent R-value (ft ² ·°F·h/Btu)
CZ01	1443	1306	138 (10%)	18
CZ02	1944	1703	242 (12%)	28
CZ03	825	677	148 (18%)	35
CZ04	1964	1747	217 (11%)	32
CZ05	730	539	190 (26%)	56
CZ06	1107	903	204 (18%)	NA
CZ07	925	781	143 (15%)	NA
CZ08	2550	2315	235 (9%)	60
CZ09	2650	2357	294 (11%)	53
CZ10	3665	3408	258 (7%)	30
CZ11	4619	4298	320 (7%)	21
CZ12	3184	2939	245 (8%)	23
CZ13	4963	4679	284 (6%)	20
CZ14	4294	3923	371 (9%)	24
CZ15	8259	8022	237 (3%)	18
CZ16	3359	3111	248 (7%)	19

Challenge: Diminishing return of increased insulation on energy savings

PCM is energy storage, NOT insulation. We can calculate the R-value for an “equivalent” wall assembly without PCM

Example: A wall with R-15 insulation plus ¼” PCM is energy-equivalent to an R-23 wall in CZ 12

These projects were funded by the California Energy Commission and CalNEXT

For more information you can contact me or find project reports at the following:

<https://www.energy.ca.gov/publications/2024/phase-change-material-enhanced-insulation-residential-exterior-wall-retrofits>

<https://www.etcc-ca.com/reports/search> (report coming)

Closing Remarks

- Deep energy retrofits in homes can be invasive and can have long payback times
- Improving the envelope will reduce the broad impact of electrification on the grid
- Incentives are likely needed to spur adoption

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