

Next Generation Retrofit Wall Panels w/Integrated VIPs Phase 1 Overview – December 14, 2021

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What is the Innovation?

- Improve Insulating performance of existing wall system products by adding vacuum insulated panels (VIP).
- Wall Retrofits are the focus
- Consider Design Options
- Manufacturing & Fabrication
- Mock-Up Installation
- Quality Control
- Technical Results/Findings
- Phase 2 Next Steps





PROJECT OVERVIEW

Design & Computer Modeling

- Prototype Designs
- Computer Modeling



Exterior THERM Analysis

Interior

Fabrication & Manufacturing

- Ease of Manufacturing
- Fabrication & Assembly



Installation & Performance

- Mock-Up Installation
- Quality Control & Results







Existing products we considered...

Insulated Metal Panels

Nail-Based & EIFS

Insulated Concrete Panels















Home Innovation RESEARCH LABS

Three Prototypes were selected...

EIFS

6

- Exterior Insulation Finish Systems
- Incorporate VIPs into EIFS panel in combination with EPS

RIPs (Nail-base) w/ EPS

- Retrofit Insulated Panels
- Incorporate VIPs into RIPs panel in combination and as a replacement for portion of EPS

Nail-based w/Polyiso

- Retrofit Insulated Panels
- Incorporate VIPs into RIPs panel in combination or as a replacement for a portion of Polyisocyanurate















Prototype 1: VIP/Polyisocyanurate Composite Panel



Prototype 2: VIP/EPS Composite Panel



Prototype 3: VIP/EIFS Composite Panel



Dimensions of the VIP/EIFS composite board

CAK RIDGE National Laboratory

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VIPS/EIFS Composite Panel Assembly



CAK RIDGE SIP or nail base panels with VIP foam composite boards

SIPs panel

 SIPs (Structural Insulated Panels) is a building element used in new construction that is comprised of a foam core that is encased by interior and exterior sheathing boards to make a single or composite building element.

Option 1

- Replace std core w/ VIP/ polyiso composite board
- Benefit thickness reduction and increased insulation value
- Challenge adapt for retrofit

Option 2

- Replace std core w/ VIP/EPS composite board
- Benefit possibly easier and cheaper to produce
- Challenge adaption and durability

Option 3

- Replace eps with VIP/polyiso/EPS composite board.
- Benefit more VIPs
 protection
- Challenge now more adhered locations where shear matters



Home Innovation RESEARCH LABS New Panel System: 6 Panel Types



CAK RIDGE



Installation Process – The "Mock-Up" Installation

Components

- (6) Panel Configurations
- Use Standard RIP Practices



Installation Details

- Preparing the Wall
- Installation



Completion

• Mock-Up Installation





Quality Control/Assurance – Procedures

Kingspan Visual Inspection

• Visual Quality Control



Manufacturing Inspection

• Incoming material inspection



Post Installation Inspection

• Field Inspection



Technical Results/Findings

Performance Metric	VIP-Enhanced (RIP) ¹ w/EPS Foam and OSB (3.5")							
Test Method	Results							
ASTM C518 - R Value	47 R-Value (Core Material - [1"ESP/VIP-Optim-R/1" ESP] - nominal 3.5")							
ASTM C1363 - R Value	Indeterminant (Due to test sample size -or- Perhaps Damaged VIP)							
ASTM E283 - Air Leakage	4CFM (The Baseline Wall was 11CFM)							
ASTM E331 - Water Leakage	None Observed - Passes (no water present)							
Thermal Simulation	Therm Modeling Analysis - Complete for Prototypes							
Moisture Simulation	WUFI Modeling Analysis - Complete for Nutgrove and Creighton Storey							
Energy Simulation	REMRate Energy Modeling Analysis - Complete for Nutgrove and Creighton Storey							
Moisture Control Guidance	Yes - Provide with Retrofit Insulation Panel Guide/Buildng Code							
Moisture Management Plan	Yes - Provide with Retrofit Insulation Panel Guide/Buildng Code/WUFI							
Quality Assurance	Yes - Provided Step by Step QC/QA Procedures							
Design Panel Layout	Yes - New System of (6) Panel Types							
Installation ¹	Yes - Mock Up Installation Completed							
Constructability ²	Yes - Graphic Layout to Confirm Maximum Wall Area Coverage							

¹The prototype VIP-Enhanced (RIP) design was used for testing (not the final V-RIP Product) ²Installation and Constructability Evaluation was completed graphically and then with the mock-up (not the final V-RIP Product)





In preparation for Phase 2 – The Field Study

- Surveying "Real" Multifamily Buildings
- Panel Layout: Maximizing Coverage
- Long-Term Monitoring
- Cost & Energy Savings Projections



Candidate Multifamily Building

Surveying "Real" Multifamily Buildings

Identify Candidate Multifamily Buildings (AHA) Conduct Comprehensive **Energy Audits**

Nutgrove Garden Apartments

- Control Building

- Test Building #1

- Upgrade Wall Insulation
- Reduce ACH
- Heating, Cooling, & Hot Water
- Consider Electrification Option

Creighton Storey Homes

- Control Building
- Test Building #2
- Upgrade Wall Insulation
- Reduce ACH
- Heating, Cooling, & Hot Water

- Test Building #3

- Upgrade Wall Insulation
- Reduce ACH
- Heating, Cooling, & Hot Water

Surveying "Real" Multifamily Buildings







Panel Layout - Multifamily Buildings



Nutgrove Garden Apartments - Albany, NY





Panel Layout - Multifamily Buildings



Creighton Storey Homes - Albany, NY



Preliminary Energy Savings

Building Characteristics

Building Characteristics		
Feature	Nutgrove 1980s	Creighton 1973
Dwelling Units, qty	18	15
Bedrooms, qty	29	31
Stories, qty	3	3
Ceiling height, FT	8	8
Conditioned floor area, SF	15,957	15,028
Infiltration volume, CF	127,660	120,224
Foundation perimeter, LF	373	388
Ceiling area, SF	5,319	5,009
Slab area, SF	5,319	5,009
Gross frame wall area excluding rim area, SF	5,968	6,208
Gross foundation wall area above grade	2,238	2,328
Rim area, SF	746	776
Orientation, front	West	North
Windows, front	664	368
Windows, rear	666	920
Window area, left	0	20
Window area, right	150	20
Window area, total	1480	1328
Window to floor area ration, %	9.3%	8.8%
Door area, front	56	160
Door area, rear	0	160

	Site Ener	Energy Cost		
Creighton Storey Homes Configuration	MMBtu/yr	% saving	kBtu/sf	\$/yr
Baseline 1: R-7 walls, R-7 ceiling, R-0 slab, U-0.65 windows, 12 ach50;				
90.5 AFUE gas boiler, 8.5 EER through wall AC, 0.51 EF gas water	1014.6		67.5	\$27,396
he ate r				
Upgrade 1: R-40 VIP walls, 9 ach50	771.4	24.0%	51.3	\$24,423
Upgrade 2: Upgrade 1 + R-60 ceiling, U-0.25 windows, 3 ach50	413.0	59.3%	27.5	\$19,611
Upgrade 3: Upgrade 2 + 95 AFUE, 15 CEER, 0.95 UEF WH, 0.65 SRE HRV	330.3	67.4%	22.0	\$16,976
Baseline 2: Baseline 1 except 60 AFUE gas boiler	1343.9		89.4	\$31,540
Upgrade 1: same as above	998.6	25.7%	66.4	\$27,281
Upgrade 2: same as above	494.0	63.2%	32.9	\$20,630
Upgrade 3: same as above	330.3	75.4%	22.0	\$16,976
Baseline 3: Baseline 2 except R-0 walls	1731.4		115.2	\$36,329
Upgrade 1: same as above	1039.1	40.0%	69.1	\$27,763
Upgrade 2: same as above	532.0	69.3%	35.4	\$21,073
Upgrade 3: same as above	354.2	79.5%	23.6	\$17,258
Nutgrove Garden Apartments Configuration	MMBtu/yr	% saving	kBtu/sf	\$/yr
Baseline 1 : R-11 walls, R-19 ceiling, R-0 slab, U-0.50 windows, 10 ach50: 80 AEUE gas furnaces, 10 SEER AC, 0, 56 EE gas water beaters	960.1		60.2	\$28,330
Upgrade 1: R-40 VIP walls, 8 ach50	760.6	20.8%	47.7	\$25.776
Upgrade 2: Upgrade 1 + R-60 ceiling, U-0.25 windows, 3 ach50	479.9	50.0%	30.1	\$22,262
Upgrade 3: Upgrade 2 + 95 AFUE, 16 SEER, 0.93 UEF WH, 0.65 SRE HRV	323.7	66.3%	20.3	\$18,342
Baseline 2 : Baseline 1 excent R-7 walls R-13 ceiling IL-0.65, 12 ach 50	1130 5		70.8	\$30,984
Lingrade 1: R-40 VIP walls 9 ach50	868.8	23.1%	54.4	\$27,628
Upgrade 2: same as above	490.3	56.6%	30.7	\$22,388
Upgrade 3: same as above	330.2	70.8%	20.7	\$18,418
Baseline 3: Baseline 2 excent B-0 walls 11-0.98 windows	1526.3		95.6	\$36.274
Lingrade 1: R-40 VIP walls 9 ach50	981 7	35 7%	61 5	\$29.274
Ungrade 2: same as above	507	66.8%	31.8	\$22,2,4
Upgrade 3: same as above	348.1	77.2%	21.8	\$18.640
	0.011			<i><i><i>q</i>₂₀<i>,</i>0.0</i></i>

Estimated Cost of Construction:

- Creighton Storey Homes
- Nutgrove Garden Apartments

Estimated Cost of Construction: Rollup Table with Summary of Cost Details Provided in Tables Below, \$/building									
Component	Creighton	Nutgrove							
VIP walls	\$161,859	\$155,892							
VIP roofs (Creighton only)	\$158,590	na							
Ceiling insulation (Nutgrove) & air sealing (both)	\$9,803	\$39,066							
Windows	\$90,237	\$122,946							
Siding (fiber cement at Creighton; vinyl at Nutgrove)	\$82,515	\$57,168							
Heating	\$47,403	\$119,922							
Cooling	\$33,891	\$115,265							
Water heating	\$22,213	\$86,237							
Mechanical Ventilation	\$41,301	\$49,562							
Total per Building	\$647,812	\$746,059							



Building	\$ C	ost for Retrofit	No. of Units	\$ Cost per Unit		
Creighton Storey Homes	\$	647,812.00	15	\$	43,187.47	
Nutgrove Garden Apartments	\$	746,059.00	18	\$	41,447.72	
Creighton Storey Homes w/o Roof	\$	489,222.00	15	\$	32,614.80	



Next Generation Retrofit Wall Panel: Creighton Storey Homes

					Source:	EIA 2015 Residential Energy Consumption Survey (RECS) Microdat						
		Characteristic	Filter									
Select Bui	Iding Characteristics:	Housing Type	(Multiple Items)	1								
		Census Division	(Multiple Items)									
		BA Climate Zone	Cold/Very Cold									
		Location Type	(AII)									
		Year Built	(Multiple Items)									
		Façade Type	(AII)									
		Heating Equipment	(Multiple Items)									
		Cooling Equipment	(All)									
			Summary		Total Site Energ	IV	Site En	ergy by End Use				
				Total Square Feet	Total Site Energ	y Site Heating	Site Cooling	Site Water Heating	Site All Other			
		Total Homes/Units	Total Buildings	(Millions)	(TBtu)	(TBtu)	(TBtu)	(TBtu)	(TBtu)			
sults:	Total	1,584,900	282,444	1,465	69	9.6 28.1	1.8	21.1	18.3			
	% of Total											
	Residential	1.3%	0.3%	0.6%	0.	.8% 0.7%	0.2%	1.2%	0.7%			
	All Residential	118,208,250	92,481,089	237,421	9,1	14 4,013.7	774.0	1,745.3	2,575.8			
	Provide below input		Technical Detect	tial Energy Cayloga								
	Provide below input	5:	Appuel Site	ual Energy Savings								
	% Total Site Energy		Energy Savings			Tech	nical Potentia	al Energy Savings				
	Savings	80%	(TBtu)	55.4								
			Annual Site		An	nual Site Other Saving (TBtu)	s					
	% Total Site Heating		Heating Savings			(1212)						
	Savings	87%	(TBtu)	24.5	An	nual Site Water Heatin	9					
			Annual Site			Savings (Tbtu)						
	% Total Site Cooling		Cooling Savings		Annu	al Site Cooling Saving	s					
	Savings	43%	(TBtu)	0.8		(TBtu)						
			Annual Site		Annu	al Site Heating Saving	8					
	% Total Site Water		Water Heating			(TBtu)						
	Heating	24%	Savings (TBtu)	5.0	Ann	ual Site Energy Saving	s					
			Annual Site			(TBtu)						
			other Savings									



% Total Site Other

0% (TBtu)

Next Generation Retrofit Wall Panels: Nutgrove Garden Apartment

					Source		EIA 2015 Resi	dential Er	nerav (Consu	nption S	Surve	(RECS)	Microdat
		Characteristic	Filter		oourco.							-		
Select Bui	Iding Characteristics:	Housing Type	(Multiple Items)	1										
	,	Census Division	(Multiple Items)											
		BA Climate Zone	Cold/Very Cold											
		Location Type	(All)											
		Year Built	(Multiple Items)											
		Façade Type	(AII)											
		Heating Equipment	(Multiple Items)											
		Cooling Equipment	(All)											
			Summary		Total Site	Energy		Site	o Ener	ay by i	End Lise			
			Summary	Total Square Feet	Total Site	Energy	Site Heating	Site Cool	ling	Site Wa	ter Hea	ting	Site All C	Other
		Total Homes/Units	Total Buildings	(Millions)	(TBtu)		(TBtu)	(TBtu)	(TBtu)			(TBtu)	
Results:	Total	1,584,900	282,444	1,465		69.6	28.1		1.8			21.1		18.3
	% of Total													
	Residential	1.3%	0.3%	0.6%	0.8%		0.7%	0.2%		1.2%		1.2%		0.7%
	All Residential	118,208,250	92,481,089	237,421		9,114	4,013.7	7	74.0		1,7	45.3	2,	575.8
	Provide below input	S:	Technical Potent	ial Energy Savings										_
			Annual Site				Techn	ical Pote	ential	Ener	gy Sav	ings		
	% Total Site Energy	770/	Energy Savings	50.0										H
	Savings	1170	(TDtu) Apprual Site	53.6		Annual	Site Other Savings							
	% Total Site Heating		Annual Site				(TBtu)							
	Savings	85%	(TBtu)	23.9		Annual	Site Water Heating							
			Annual Site			s	avings (TBtu)							
	% Total Site Cooling		Cooling Savings			Annual S	ite Cooling Savings							
	Savings	51%	(TBtu)	0.9			(TBtu)	1 - I						
			Annual Site Water			Annual S	ite Heating Savings							
	% Total Site Water		Heating Savings			Annual S	(TBtu)							
	Heating	48%	(TBtu)	10.1			The Freedom Continue							
						Annual S	TReinings Savings							
			-											
			Annual Site Other				(16ш)							



QUESTIONS?