

OPPORTUNITY

Windows are responsible for how much energy use?

34% OF COMMERCIAL BUILDING HVAC ENERGY IS LOST THROUGH WINDOWS¹

An improved building envelope minimizes HVAC loads and contributes to Net-Zero goals

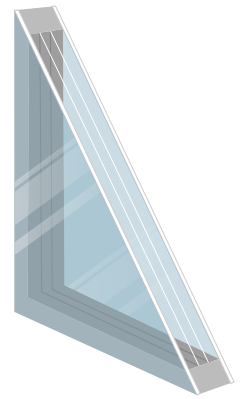
TECHNOLOGY

How are Lightweight Quad-Pane Windows made?

4 PANES IN INSULATED FIBERGLASS FRAME WITH WARM-EDGE SPACERS & KRYPTON GAS

R-8 RATED FULL-FRAME INSULATING VALUE

2 configurations: 2 outer panes of low-e glass containing either 2 panes of thin glass or 2 layers of suspended film



M&V

Where did Measurement and Verification occur?

NATIONAL RENEWABLE ENERGY LABORATORY (NREL) assessed quad-pane windows provided by Alpen High Performance Products at the Denver Federal Center. One option used thin glass and one used suspended film.

RESULTS

How did Lightweight Quad-Pane Windows perform in M&V?

24% AVERAGE HVAC SAVINGS*

SUSPENDED-FILM CONFIGURATION SAVED 1% MORE ENERGY THAN THIN GLASS OPTION²

*Compared to high-performance double-pane window

HVAC CAPITAL SAVINGS

REDUCES REQUIRED SIZE OF HVAC EQUIPMENT; MODELING ESTIMATES \$120K IN EQUIPMENT SAVINGS FOR A 498K SF BUILDING³

SAME INSTALLATION

IDENTICAL THICKNESS, COMPARABLE WEIGHT, ~10% MORE EXPENSIVE THAN HIGH-PERFORMING DOUBLE-PANE⁴

Positive Return on Investment Across Climate Zones

New construction payback < 3 years at average GSA utility rates, \$0.11/kWh and \$7.43/MMBtu⁵

Location		Savings from High-Performance Double-Pane to Quad-Pane Thin Glass*					
CLIMATE ZONE	CITY	HEATING kBtu/ft2/yr	COOLING kBtu/ft2/yr	FAN kBtu/ft2/yr	TOTAL %	PAYBACK* YRS	SIR positive ROI if >1
1A	Miami, FL	0.64	2.29	1.61	19%	1.7	12.1
2A	Dallas, TX	1.09	2.36	1.59	20%	1.5	12.9
2B	Phoenix, AZ	1.13	2.16	2.00	25%	1.5	13.3
3A	Atlanta, GA	1.97	2.31	1.65	24%	1.4	14
3B	Las Vegas, NV	1.54	1.82	2.08	27%	1.6	12.7
3C	San Francisco, CA	1.95	2.00	1.78	33%	1.5	13.1
4A	Washington, D.C.	3.25	2.48	1.66	28%	1.3	15.5
5A	Chicago, IL	4.40	0.56	1.21	23%	2.5	7.9
5B	Ogden, UT	3.62	0.68	1.43	23%	2.4	8.3
6A	Minneapolis, MN	4.96	0.55	1.17	20%	2.5	8.1
AVERAGE SAVINGS		2.46	1.72	1.62	24%	1.8	11.8

*Optimized for climate zones: 1A-3C SHGC 0.20, 1A-3C SHGC 0.46.

\$32.38/ft² double-pane \$34.87/ft² quad-pane with thin glass \$36.87/ft² quad-pane with film.

Higher-efficiency windows can reduce HVAC capacity requirements and should be factored into the economics of any new construction or major renovation project.

DEPLOYMENT

Where does M&V recommend deploying Lightweight Quad-Pane Windows?

**ALL NEW CONSTRUCTION
END-OF-LIFE WINDOW REPLACEMENT**

Thin-glass configuration is more cost-effective. Suspended-film version offers versatility in low-e coatings, meets tempered glass requirements, and is about 1 lb lighter per square foot than the thin-glass configuration.

¹Low-e Applied Film Window Retrofit for Insulation and Solar Control, Charlie Curcija, Howdy Goudey, Robin Mitchell, LBNL, February 2017, p. 10

²Demonstration and Evaluation of Lightweight High Performance Quad-pane Windows, Kosol Kiatreungwattana, Lin Simpson (NREL), October 2021, p.17 ³Ibid, p.28 ⁴Ibid, p.28 ⁵Ibid, p.21