Renew America's Nonprofits
ROCKY MOUNTAIN REGION

RAN-RM Level I Energy Audit Information Series

February 6: Specifications for Windows

Brad Begin

Alpen High Performance Products

www.thinkalpen.com

What are we trying to do today?

ALPEN
HIGH PERFORMANCE PRODUCTS

Window Retrofit Technology Backgrounder

- Quick History of Window and Glass Technology
- Common Historic Approach to Window Retrofit Solutions
- Alpen Product Solutions

How to Use the Information Effectively

- Recognizing If Have a Window Problem
- Analyzing Options for Window Retrofit Approaches
- Important Considerations

Glass Technology Develops Slowly

ALPEN
CLEAR PERFORMANCE

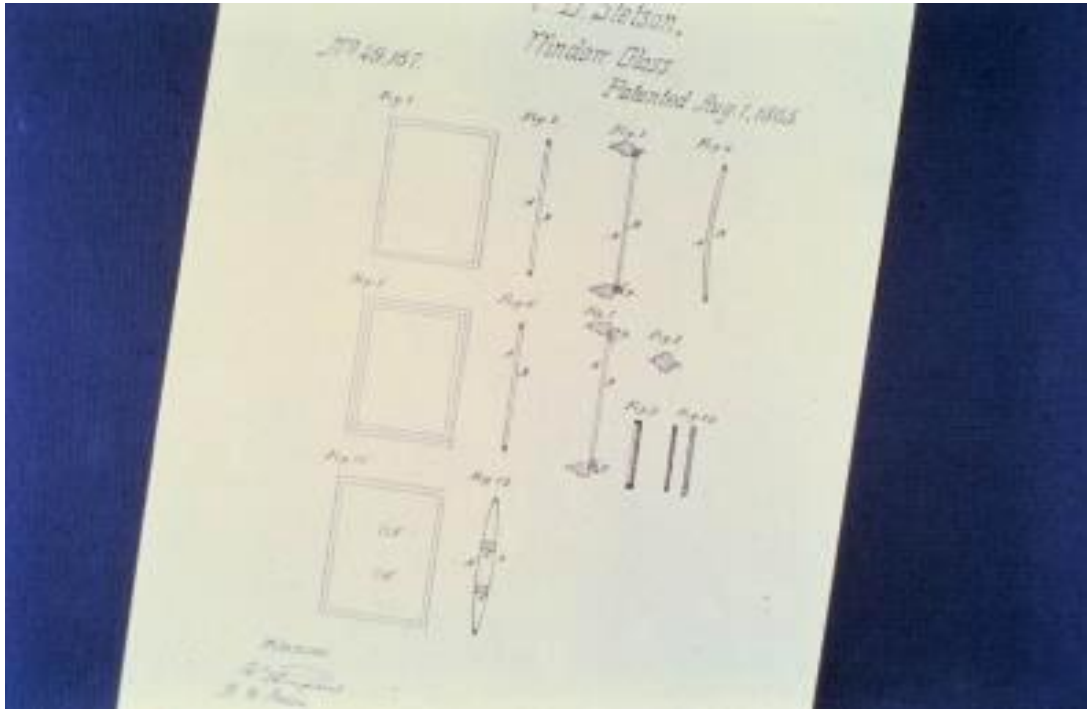
R Zero Windows

R1 Windows 100 A.D.

Glass Technology Development Over Time

Patent Double Pane Glass Unit

Thomas Stetson 1865

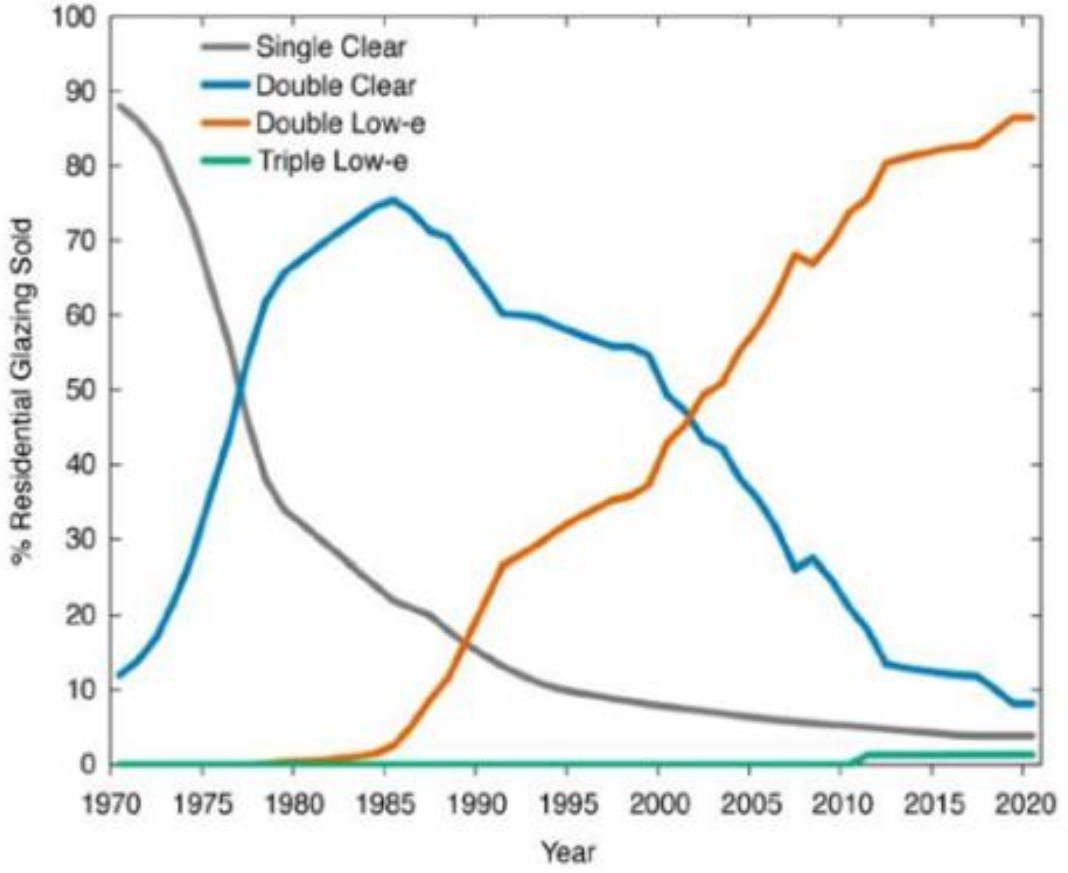


R2 Windows

Key Glass Milestones in US Window Industry

Double Pane 50%+ Only in 1977

Low E Glass 50%+ Only in 2003



R3 Windows

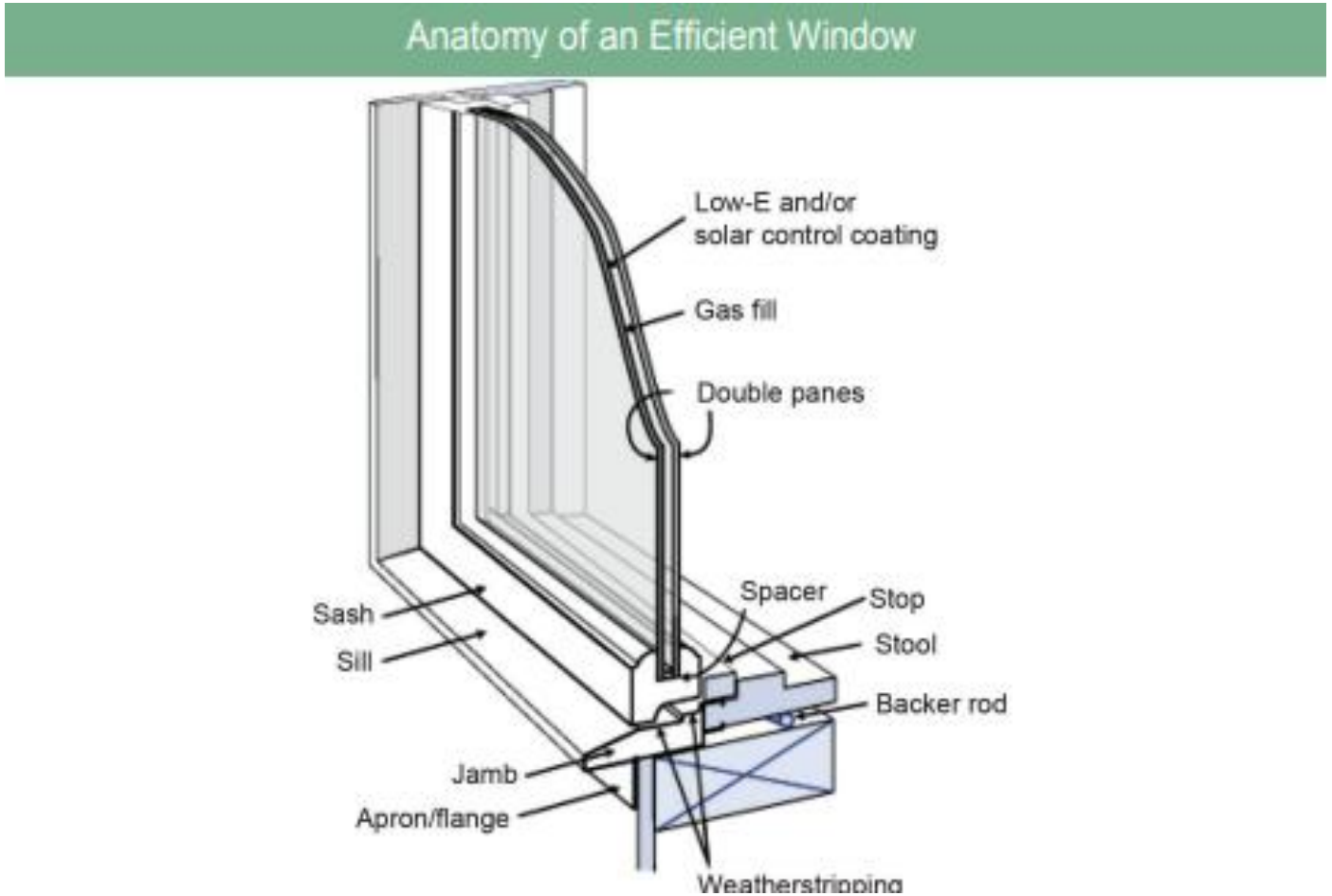
But US Window Designs Haven’t Changed Much

US Window Design
1700s

US Window Design
Today

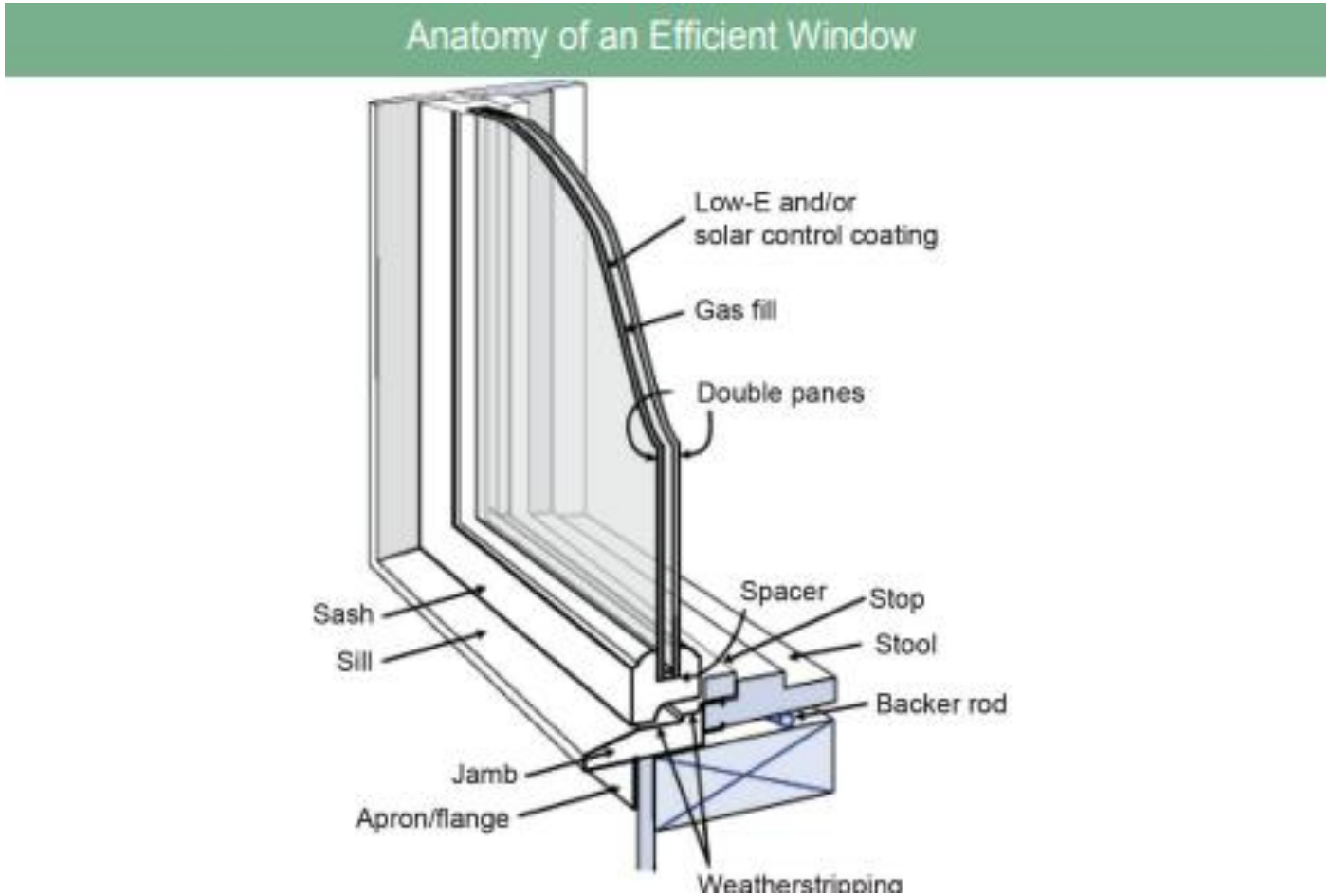
The Prototypical “Energy Efficient” Window Sold in the United States

1995



The Prototypical “Energy Efficient” Window Sold in the United States

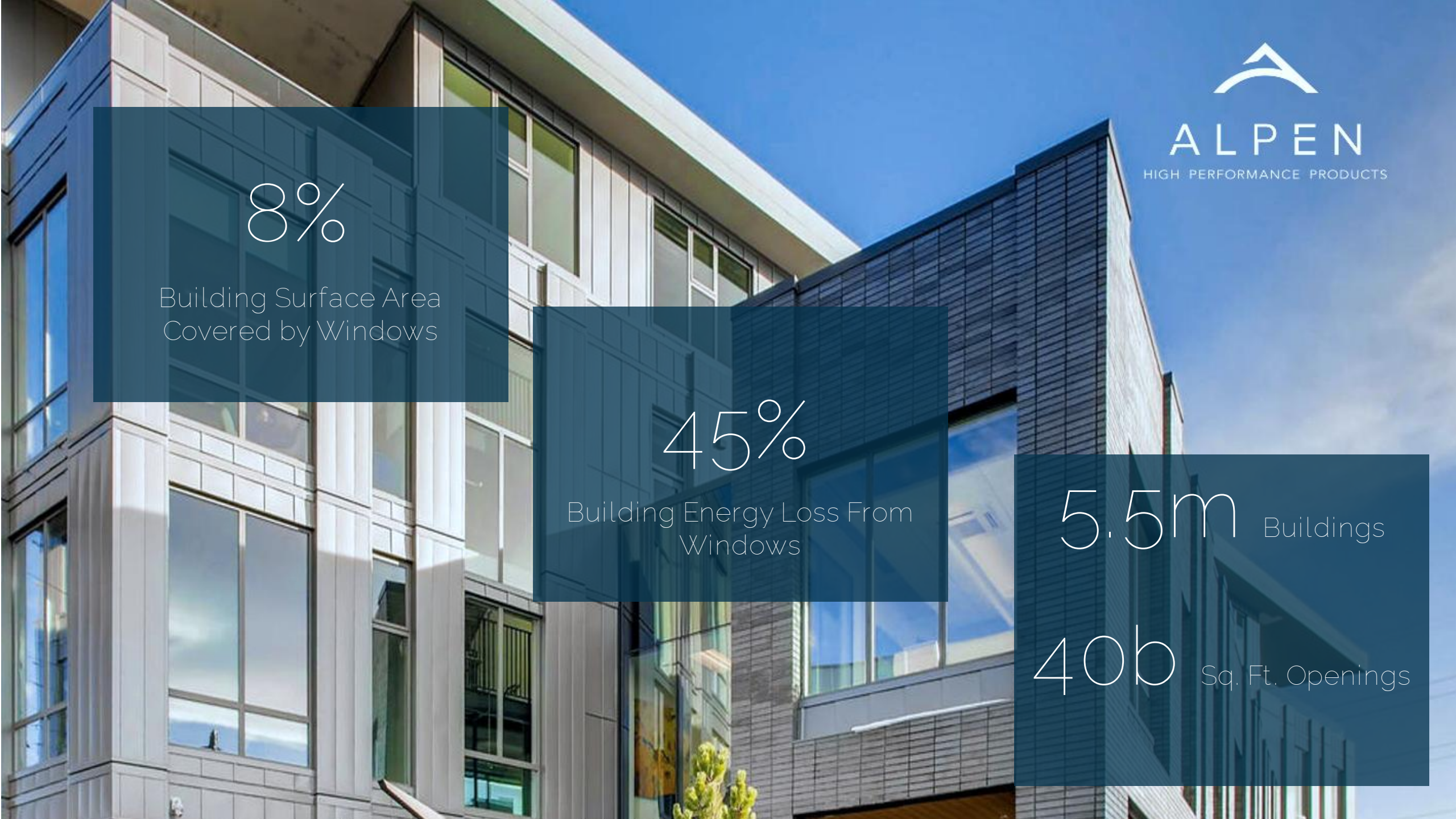
2024 R3.5



YOU: CUTE HISTORY LESSON IN WINDOWS. TICK TOCK, MAKE IT RELEVENT! SO WHAT?

ME: GETTING TO THAT PART.

In the non-residential "built environment," it is well undertood by far the biggest unsolved challenge to reducing energy intensity (read here: energy efficiency, operational carbon, sustainability or whatever phrase du jour you want to use) is ***poor performing windows*** . . . by a long shot.


ALPEN
HIGH PERFORMANCE PRODUCTS
8%
Building Surface Area Covered by Windows
45%
Building Energy Loss From Windows
5.5m Buildings
40b Sq. Ft. Openings

Facts That May Surprise You:

50% of existing commercial windows in the United are considered low performing

- 30% single pane
- 20% lower end non-thermally broken aluminum frames
- Poor thermal performance and leaky

By contrast, the vinyl (and other frame types) residential window replacement market is mature, well organized and ubiquitous

Of all the commercial building in all the country, less than 10% have ever had windows replaced

90% of all commercial building stock in 2050 is already in existence **today**

Why is this the case?

THE RETROFIT MARKET IS BROKEN

-5.5 million commercial buildings
-5.2 million multi-family residential buildings
-30% single-pane (4B+ sq. ft.)
-20% low-performing double-pane (2.5B+ sq. ft.)

Retrofitting windows is a headache to owners, so incumbents focus on new construction

BUILDING OWNERS

- High cost: $100-150+/square foot
- Lengthy and disruptive installation
- Uncertain/15+ year payback
- Engineering challenges (weight, etc.)
- Older buildings subject to historic standards

WINDOW COMPANIES

- Building owners wary of window retrofits
- Retrofit vs. new construction sales process
- Unpredictable installation complications
- Competing investment priorities
- Difficulty matching historic or aesthetic needs

Traditional Commercial Window Retrofit Solutions

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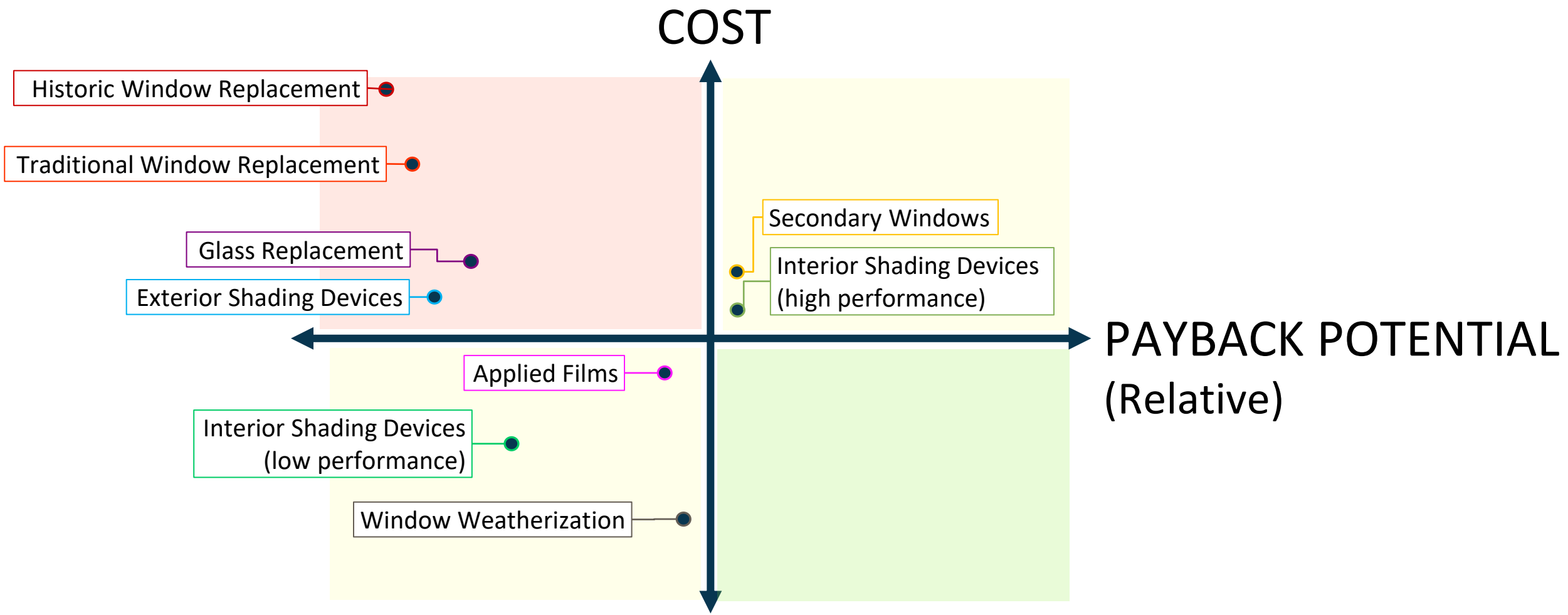
CLEAR PERFORMANCE

Retrofit Measure	Cost	Tenant Disruption Adder	Payback / ROI Potential	Hidden and Other Issues
Typical Window Replacement	$$$$	20%	30 – 40 years	Expensive
Historic Window Replacement	$$$$$$	20%	40 + years	Really expensive
Window Weatherization Sealing, Gasket Replacement etc	$-$$	2%	3 – 10 years	Focuses only on air infiltration
Secondary Windows - Aluminum Frame	$$	2% - 10%	8 – 15 years	Pretty good compromise, frame is typically hidden weak spot
Glass Replacement	$$	20% - 30%	10 – 30 years	Installation costs; water; Does not address frames
Applied Films	$	2%	3 – 5 years	No insulation improvement
Exterior Shading Devices Overhangs, rolling shutters etc	$$$	0%	varies	Not always practical on storefront and curtainwall
Interior Shades - low performance	$-$$	2%	varies	No air infiltration improvement
Interior Shades - high performance Solar shades, insulating shades	$$-$$$	2%	3 – 6 years	No air infiltration improvement

Traditional Commercial Window Retrofit Solutions



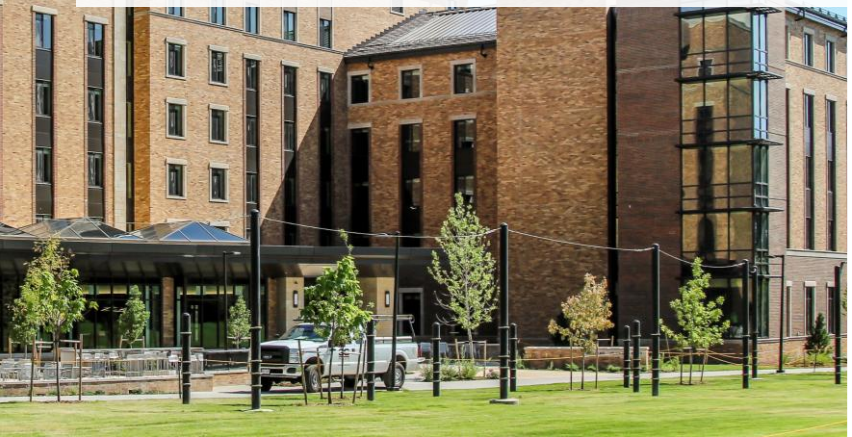
DEPRESSED YET?

ALPEN
CLEAR PERFORMANCE

Who is Alpen?

ALPEN
HIGH PERFORMANCE PRODUCTS

- 40+ year industry leader in high performance fenestration products
- First Manufacturer of suspended coated film products
- First R-10 window available in the U.S. market
- First to use "thin glass" in architectural applications
- Components certified to be compliant with highest standards for testing and certification
- DOE "Investing in America" grant awarded in 2024 to expand manufacturing capabilities



BUILDER

R10 WINDOWS HIT THE AMERICAN MARKET

The Alpen units insulate almost as well as some walls.

A new window from Alpen High Performance Products achieves an R value previously unheard of in the U.S.

The Zenith series ZR10 double-film fixed picture window insulates nearly as well as some walls, says Alpen CEO Brad Begin. Following certification by the National Fenestration Rating Council (NFRC), the company's Zenith Series ZR10 double-film fixed picture window design was verified to deliver a .10 U-Factor, which equates to an R10 insulating factor, says Begin.

Courtesy Alpen

Builder

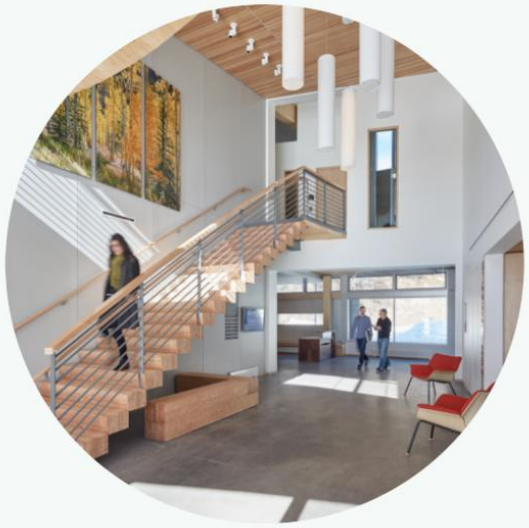
September 2016

Alpen Markets

RESIDENTIAL

North American and European style statement windows and doors.

COMMERCIAL



World-class commercial window and door solutions.

EXISTING BUILDINGS

Quickly and affordably increase the efficiency of aging commercial buildings.

GLASS

Insulated glass units to help window companies meet rigorous energy standards.

New Construction & Replacement

Secondary Glazing

Reglazing & Fabricators

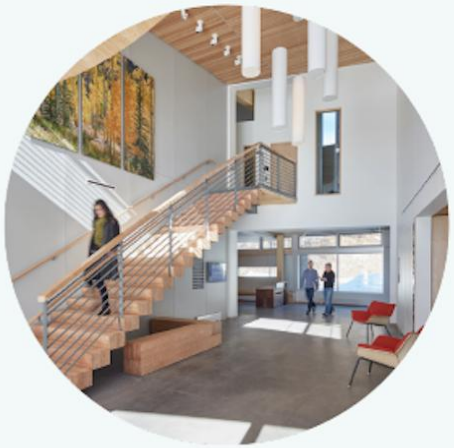
Alpen Products – "Thin Glass" Centric

ALPEN
HIGH PERFORMANCE PRODUCTS

RESIDENTIAL

North American and European style statement windows and doors.

COMMERCIAL



World-class commercial window and door solutions

SECONDARY WINDOWS

Quickly and affordably increase the efficiency of aging commercial buildings.

GLASS

Insulated glass units to help window companies meet rigorous energy standards.

ThinGlass

Image Credit: GSA.gov

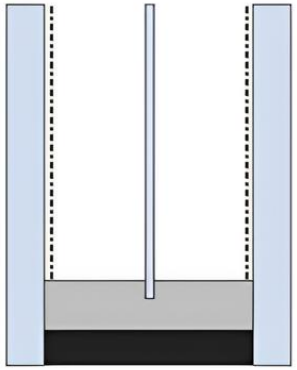
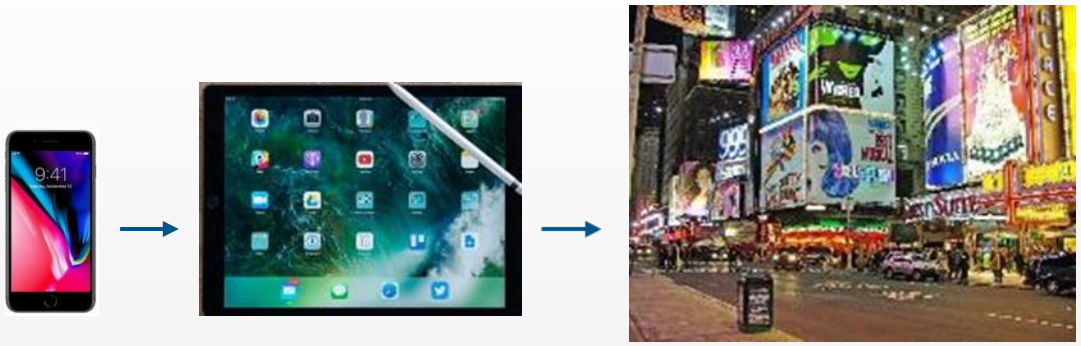


Image Credit: Berkeley Lab

ThinGlass Measures 0.5mm to 1.3mm

- 3-4 x Thinner than Residential Glass
- 6-8 x Thinner than Commercial Glass
- Up to 40% Lighter than Thick Triple Pane
- Reduction in Carbon Intensity
- Up to Quad Pane Glass = **R10** Total Unit Performance



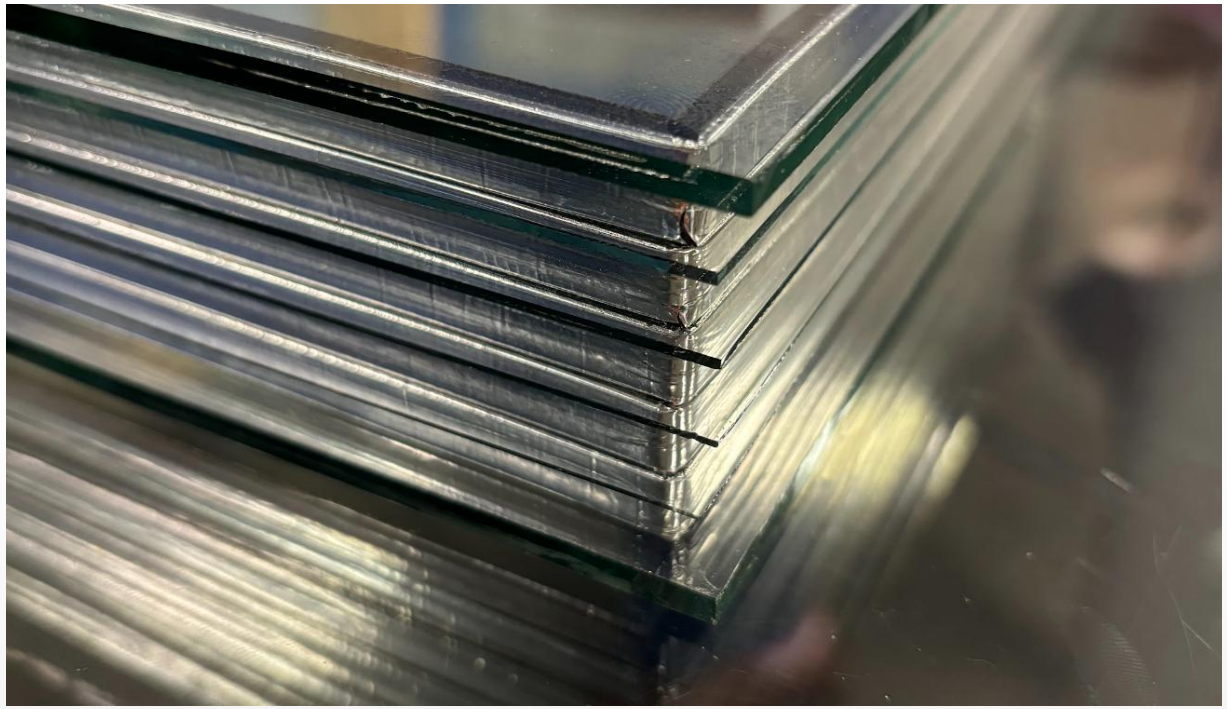


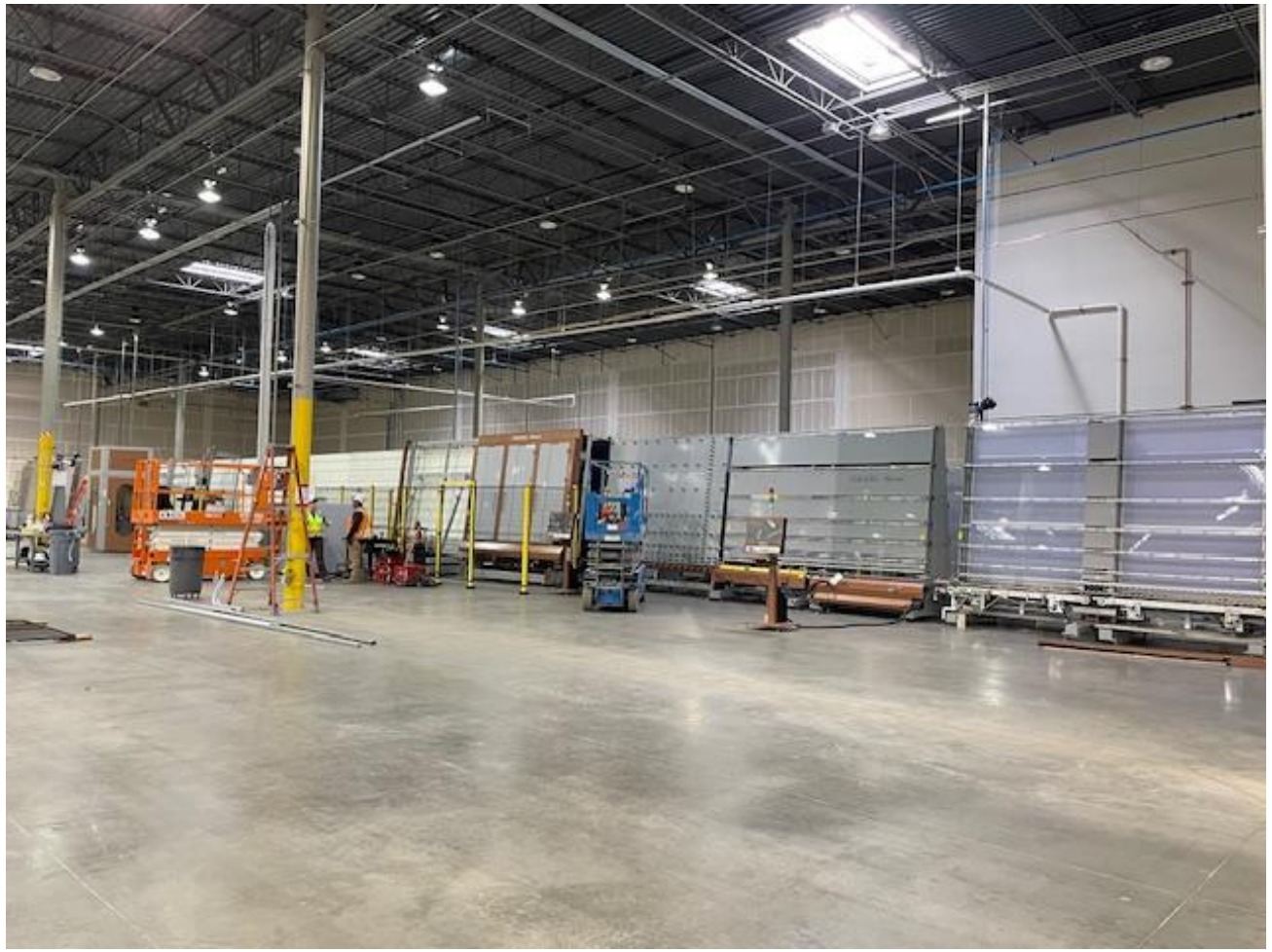
Image Credit: Waterproof Caulking & Restoration

THIN GLASS IS A REMARKABLE PRODUCT WE BELIEVE WILL REVOLUTIONIZE THE WINDOW RETROFIT MARKET

ALPEN WAS FIRST INNOVATOR TO USE THIN GLASS IN ARCHITECTURAL APPLICATIONS

2 MILLION SQAURE FEET IN THE MARKET

First of Two High Speeding Vertical Insulating Glass Lines Being Installed by Alpen



PART OF A $22 MILLION INVESTMENT IN ALPEN TO RAMP GLASS AND WINDOW PRODUCTION AS DEMAND GROWS RAPIDLY FOR HIGHER PERFORMANCE WINDOW PRODUCTS

ALPEN
HIGH PERFORMANCE PRODUCTS

High Performance Thin Glass

Typical Double Pane

Up to R5
(0.20 u-factor COG)
1/2” – 1”

ThinGlass Triple Pane

Up to R9
(0.11 u-factor COG)
3/4” – 1-1/4”

ThinGlass Quad Pane

Up to R15
(0.06 u-factor COG)
1” – 1-1/2”

Window Retrofit Option One: Replace Failed Glass with a Thin Glass Triple IGU

Figure 11. Thin triple-pane IGUs glazed into existing double-pane vinyl frames (Pasco, WA).

Laboratory and field validation of the performance benefits and costs of thin triple-pane windows in residential buildings

Patricia Gunderson, Edward Louie & Katherine Cort

https://doi.org/10.1080/23744731.2024.2357529

When to do it and why

- Good non-leaky existing frame; bad glass
- Existing glass pocket at least .75” wide
- Typically, not more than two stories or can be installed from inside
- Can be lowest cost option to upgrade windows and as inexpensive as 15% to 25% of a replacement window option
- Fast and non-disruptive
- Upgrade a poor or fair window to a high performance window
- Main challenge is it will typically requires a glazing contractor (mark ups?)

Window Retrofit Option Two: Window Replacement

When to do it and why

- Other low-cost solutions don't work and existing windows must be replaced
- Choice becomes one of price and performance
- Lowest cost options typically vinyl but vinyl not appropriate for all applications and buildings
- Huge range of prices but typically start at $750-$1000 each opening installed and can escalate dramatically if working with commercial aluminum, involves a challenging install or has historical implications
- Some installed sales options exist and some require the buyer to hire an installer
- Will have potential substantial occupant disruption

Alpen Window Systems

Zenith Series

Fiberglass American Style Windows

Outswing Casement, Awning, Fixed, Hung, Sliding

Certified by: phius Declare.

Tyrol Series

uPVC European Style Windows

Inswing Tilt-Turn, Hopper, Fixed

Certified by: phius Passive House Institute BUILD AMERICA BUY AMERICA

Aspekt+ Series

uPVC American Style Windows

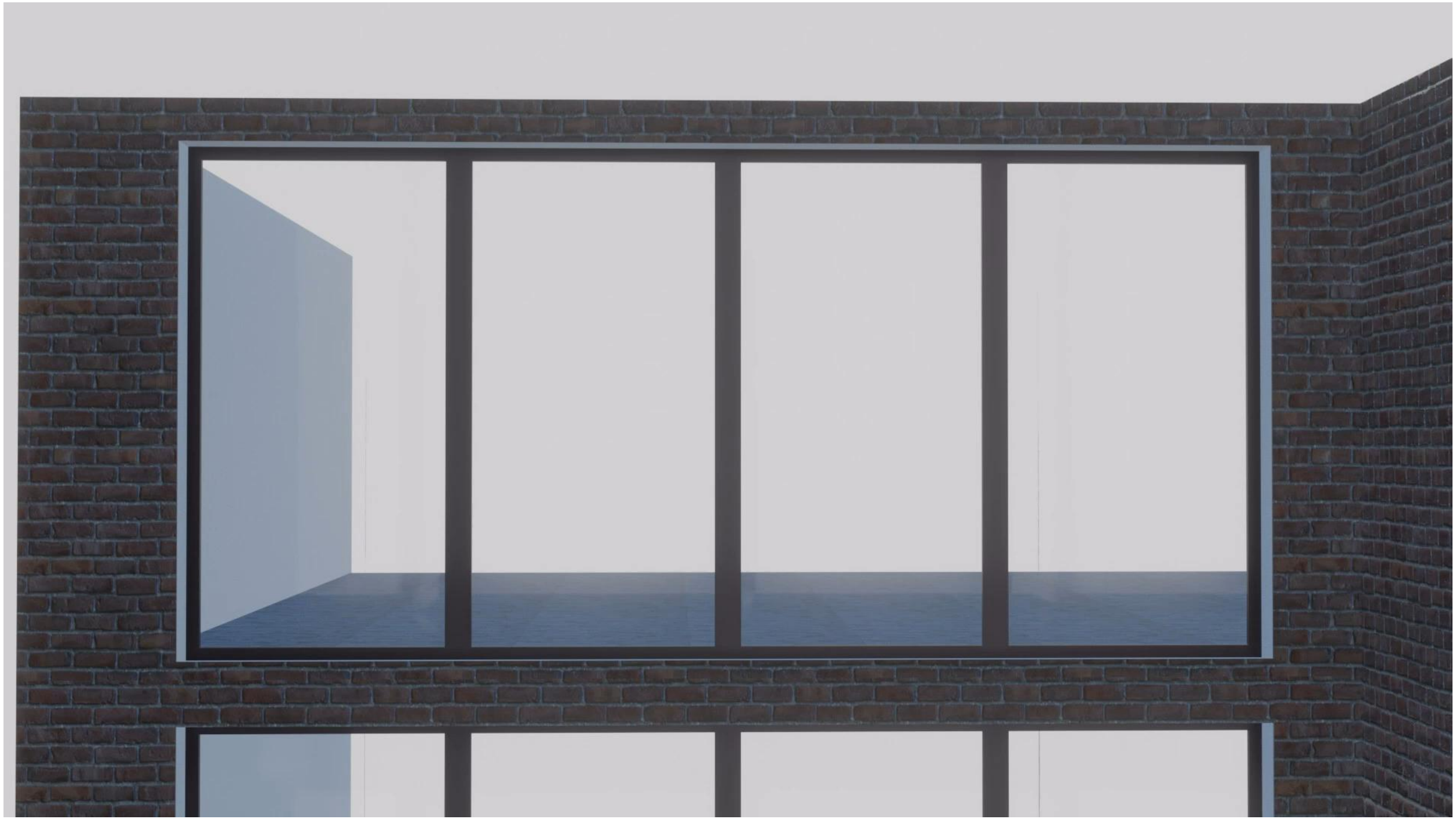
Casement, Awning, Fixed

Certified by: phius BUILD AMERICA BUY AMERICA

Window Retrofit Option Three: High Performance Secondary Windows

When to do it and why

- Bad glass/window with 1” of unobstructed vertical space to inside of existing windows, usually offers the best overall solution
- Similar in cost to thin triple glass replacement and effective
- Can be installed with minimal supervision and training by handy layman
- Almost zero occupant disruption
- Major air infiltration improvement
- Limits with currently obstructed areas to inside of window or opening requiring operability (until 4Q25)



Virtually Invisible--R1 up to R6

ALPEN
HIGH PERFORMANCE PRODUCTS

Alpen's WinSert Product

Patented lightweight high performance secondary window

- *Installed to interior of primary windows*
- *Can be installed in single window*
- *Can be installed in mulled combinations*
- *Unlimited colors*
- *Multiple attachment options*
- *Fixed or operable*
- *Customizable*

Inserted into Single Window or Combination Windows Conditions

WinSert

Transforming the CARBON IMPACT of the BUILT ENVIRONMENT

FEATURES

- Single- or double-layer thin glass
- High performance insulated frame
- Lightweight (1-3 lbs. / sq. ft.)
- Affordable - easily installed (5-10 min.)

ADVANTAGES

- Lowest embodied carbon solution
- Complimentary electrification integration
- Chassis for cutting edge technologies
- Custom color matching
- Patent issued May 2021

RESULTS

Efficiency Benefits

- Up to 6x greater performance than existing
- Decreased solar heat gain
- Decreased air infiltration

Occupant Benefits

- Reduced noise
- Reduced condensation
- Reduced draftiness
- High indoor air quality
- Better indoor temperature control

WinSert™ Secondary Windows

Innovative use of ‘thin’ glass with laminated performance films

High Performance Pultruded Fiberglass Frame

Super-Insulated Frame Cavity

Customizable Low-e Coating Configurations

Inert Gas Fill

Warm-Edge Spacer

Gasket-Edged, Dual Perimeter Seal

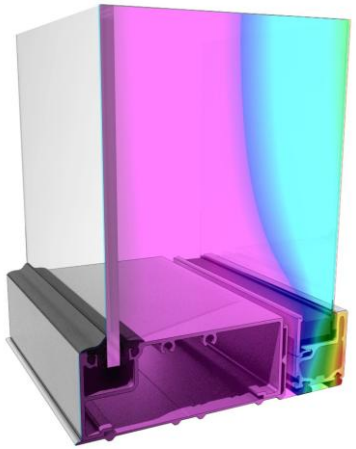
WinSert™ Secondary Windows

EXISTING WINDOW

Non-Thermally-Broken
Aluminum Single Pane

U-Value: 1.12

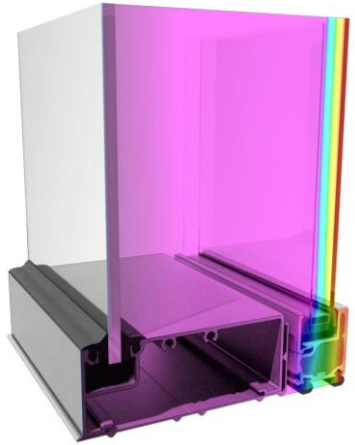
SHGC: 0.72



EXISTING WINDOW + WinSert Lite

U-Value: 0.47 — Improved by 2.4x!

SHGC: 0.41 — Reduced 43%!



EXISTING WINDOW + WinSert Plus

U-Value: 0.19 — Improved by nearly 6x!

SHGC: 0.30 — Reduced 58%!

Best-in-Class Lightweight Retrofit Solution

Under 1 lb per square foot

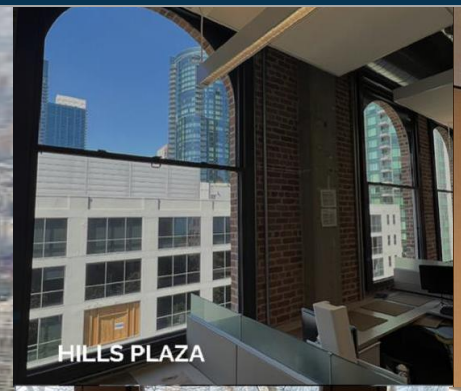
Beautiful aesthetics, clean lines, and color match.

WinSert

Minimal Sightlines & Architectural Appeal

Empire State Building

1301 Avenue of the Americas



HILLS PLAZA

VA HOUSTON

RAILSPUR HOTEL

SANTA CRUZ

SERA ARCHITECTS

2020 K STREET

ALPEN
HIGH PERFORMANCE PRODUCTS

Proven. Third-party validated. Whole building energy savings
WinSert

ROI

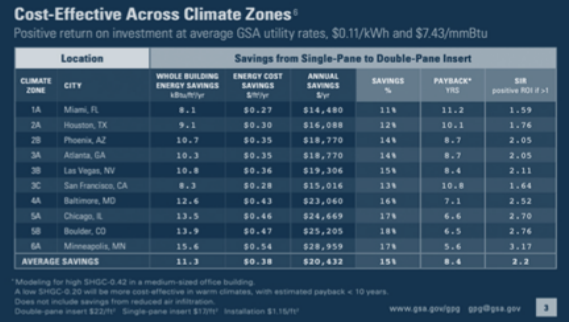
- Most **Climates**
  - 3-8 Year simple payback
  - GSA/DOE verified
- Amplified Return Opportunities
  - HVAC upgrade or retrofit
  - Thermostat controls
  - Complimentary technology

32%

Improvement in Building Envelope Performance. Building Envelope Campaign (Oak Ridge National Lab)

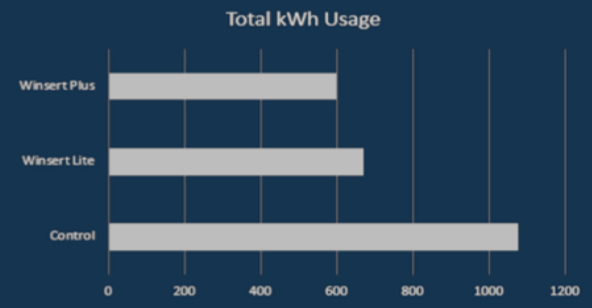
15%

Whole-Building Energy Savings U.S. General Services Administration (GSA) Green Proving Ground



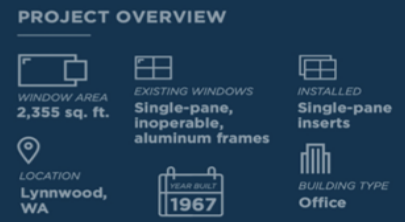
45%

Reduction in HVAC and Fan Load Energy Use for Plus. 38% for Lite Vancouver BC



12%

Reduction In Annual Energy Costs Better Bricks Crane Aerospace and Electronics



You've Never Seen A Window Insert Like Winsert

WinSert Case Studies

ALPEN
HIGH PERFORMANCE PRODUCTS

915 Broadway, Vancouver WA

- https://files.thinkalpen.com/hubfs/Case%20Studies/Broadway%20St%20Winsert%20Case%20Study.pdf
- https://www.youtube.com/watch?v=rhrmYCMXwc0

VA Administration Building, Houston TX

- https://files.thinkalpen.com/hubfs/Case%20Studies/VA%20Regional%20Office%20Winsert%20Case%20Study.pdf

WinSert Case Studies

ALPEN
HIGH PERFORMANCE PRODUCTS

Crane Aerospace, Lynnwood WA

- https://files.thinkalpen.com/hubfs/Case%20Studies/Crane%20Aerospace%20Winsert%20Case%20Study.pdf

GSA Green Proving Ground, Denver, CO

- https://www.gsa.gov/system/files/Applied_Research/NREL-79112-Lightweight%20Secondary%20Windows.pdf

Other Window Retrofit Options: The More Traditional Stuff

When to do it and why

- Window treatments, solar control films and caulking guns are often the other option
- Huge range of options and can still be quite expensive
- Little insulating improvement and little air infiltration improvement or frame performance improvement
- Similar in cost to glass replacement and secondary windows

Traditional Retrofit Solutions

Final Thoughts for Modelers

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HIGH PERFORMANCE PRODUCTS

- Find credible data for “whole window” performance
  - Windows
    - Use NFRC certified data (https://nfrc.org/certified-product-directory)

      Zenith NFRC:
      https://cdn.prod.website-files.com/66a0d107af4de533f9222dba/67a3fe8b845946857089864c_zenith%20Full%20frame%20nfrc%20data.pdf

      Tyrol NFRC:
      https://cdn.prod.website-files.com/66a0d107af4de533f9222dba/67a3fe62ee94ef57c45a6c11_TYROL%20Full%20Frame%20NFRC%20Data.pdf
  - Glass Replacement
    - Use LBNL’s Windows 7.6 for accurate glass values and use LBNL’s whole window modeling software for accurate whole window performance (don’t forget frame and edge of glass) (https://windows.lbl.gov/software-tools)
  - Secondary windows
    - Rely on accurate whole window test results on AERC website for credible installed comparative and accurate reliable data for secondary windows –don’t rely on manufacturer's claims (https://aercenergyrating.org/commercial/commercial-secondary-windows)

      WinSert AERC:
      https://cdn.prod.website-files.com/66a0d107af4de533f9222dba/66ef3c948816db5c38984be8_AERC-Data-Table--WinSert-ALL--2022-02--v2.pptx.pdf

Final Thoughts for Modelers and Owners

ALPEN
HIGH PERFORMANCE PRODUCTS

- Always consider two other critical inputs in energy models when considering the impact of window upgrades
  - Pre- and post-install air infiltration performance (modeled or measured by blower door test or both)
    - Air infiltration results from upgrades for windows and secondary windows can be enormous
    - There is a big difference between tight windows (and window types) and less well-made windows
    - Alpen publishes air infiltration results for windows on our website (https://www.thinkalpen.com) and for WinSert on the AERC website listings shown on the prior page)
    - Certain types of windows have tighter seals (outswing or inswing is tighter than vertical or horizontal sliding windows)
  - Realistic thermostat set point adjustments (if you are upgrading windows and not changing set points for thermostats in you model, you are dramatically underestimating energy savings as you will be changing behavior for HVAC equipment)
- It is perfectly OK to consider occupant comfort in financial decisions
- Finally, improve the shell before upgrading HVAC (you can pay for much of the shell upgrade if you do) by reducing loads—the most common mistake and often repeated regret
- Where possible, don't settle for cheap; good quality is never as expensive as people think; do your homework

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Questions or Follow Up?

ALPEN HIGH PERFORMANCE PRODUCTS

WWW.THINKALPEN.COM

303-834-3600

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