Building Technologies Office Window and Envelope Technologies Emerging Technologies R&D Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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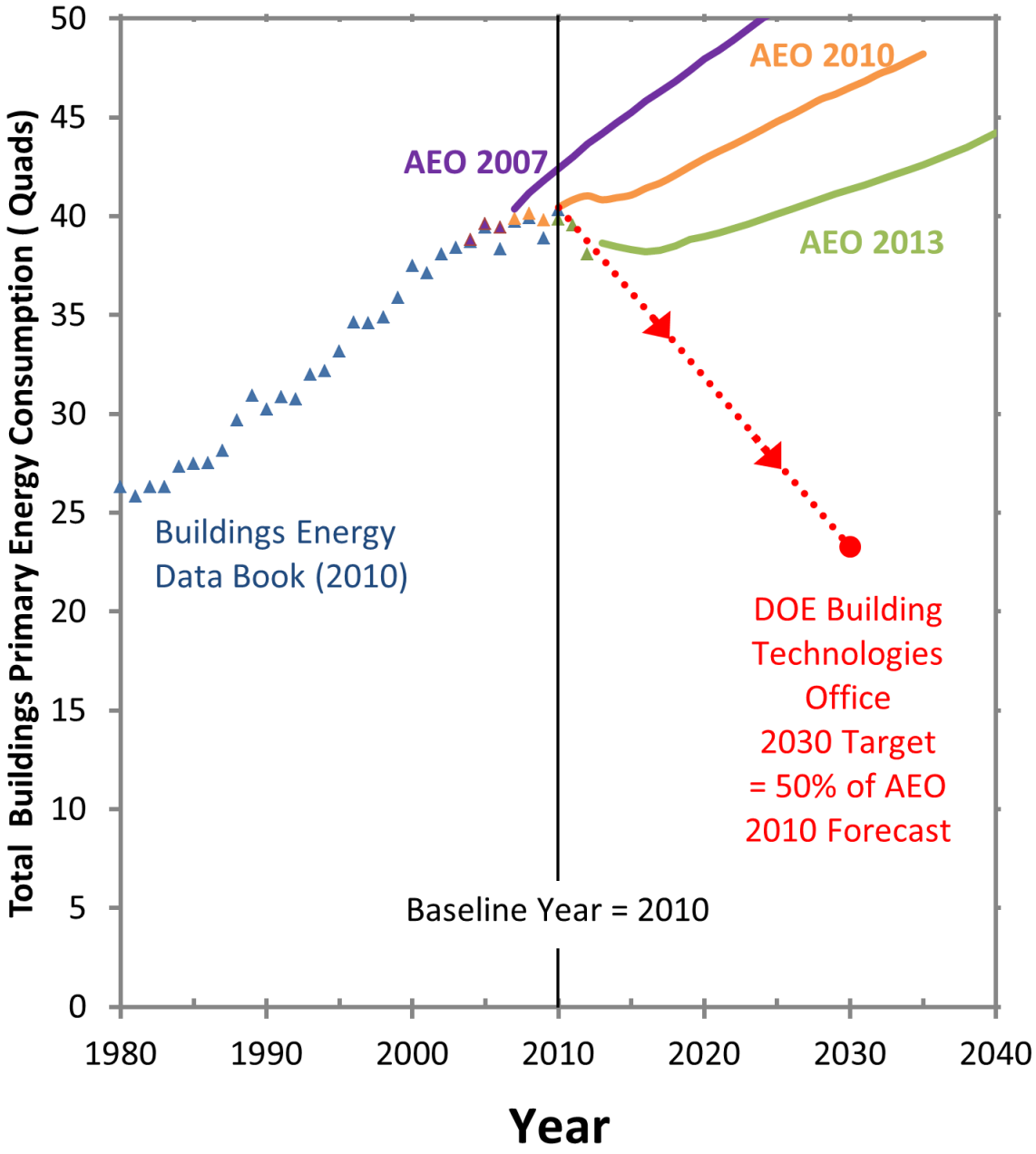
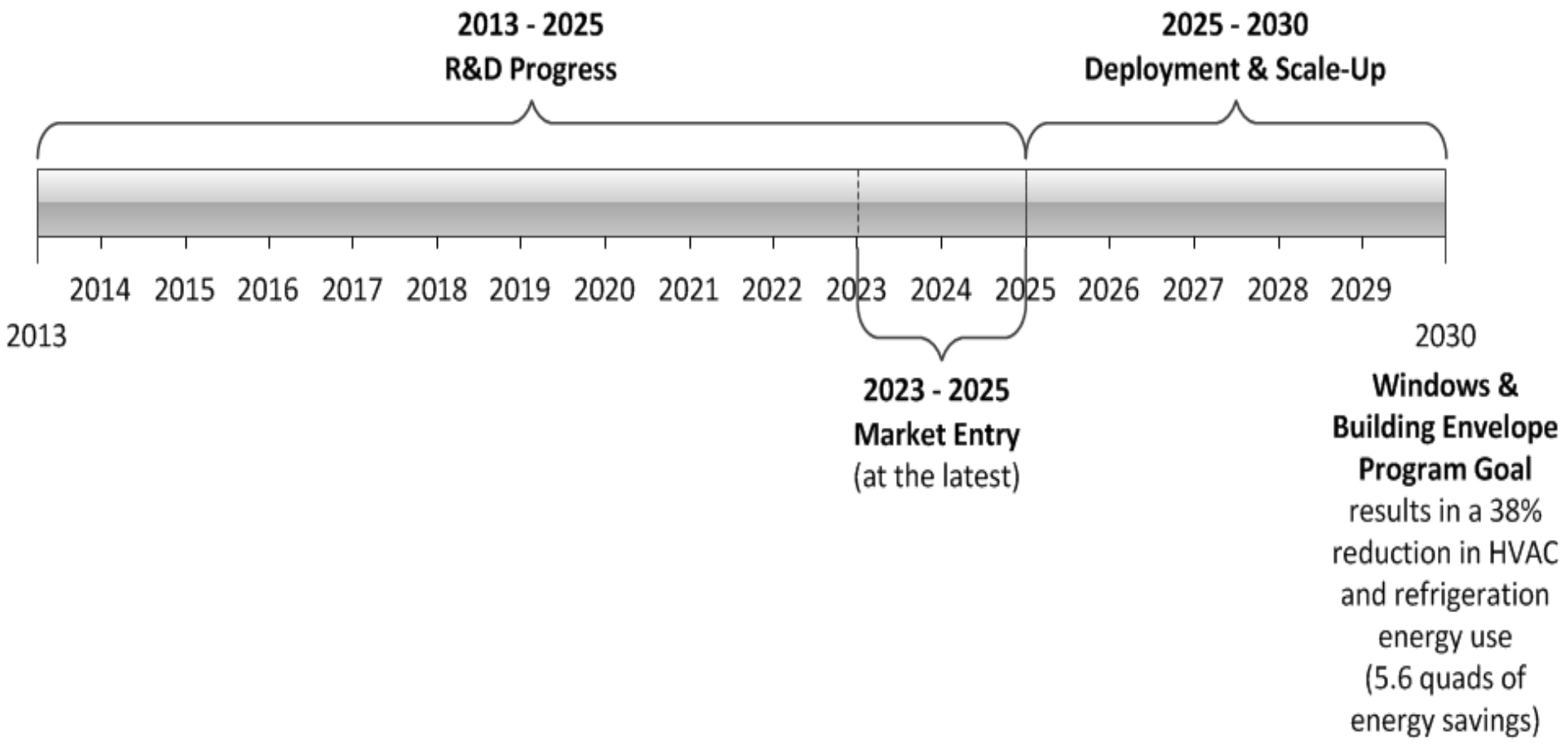
BTO Goal

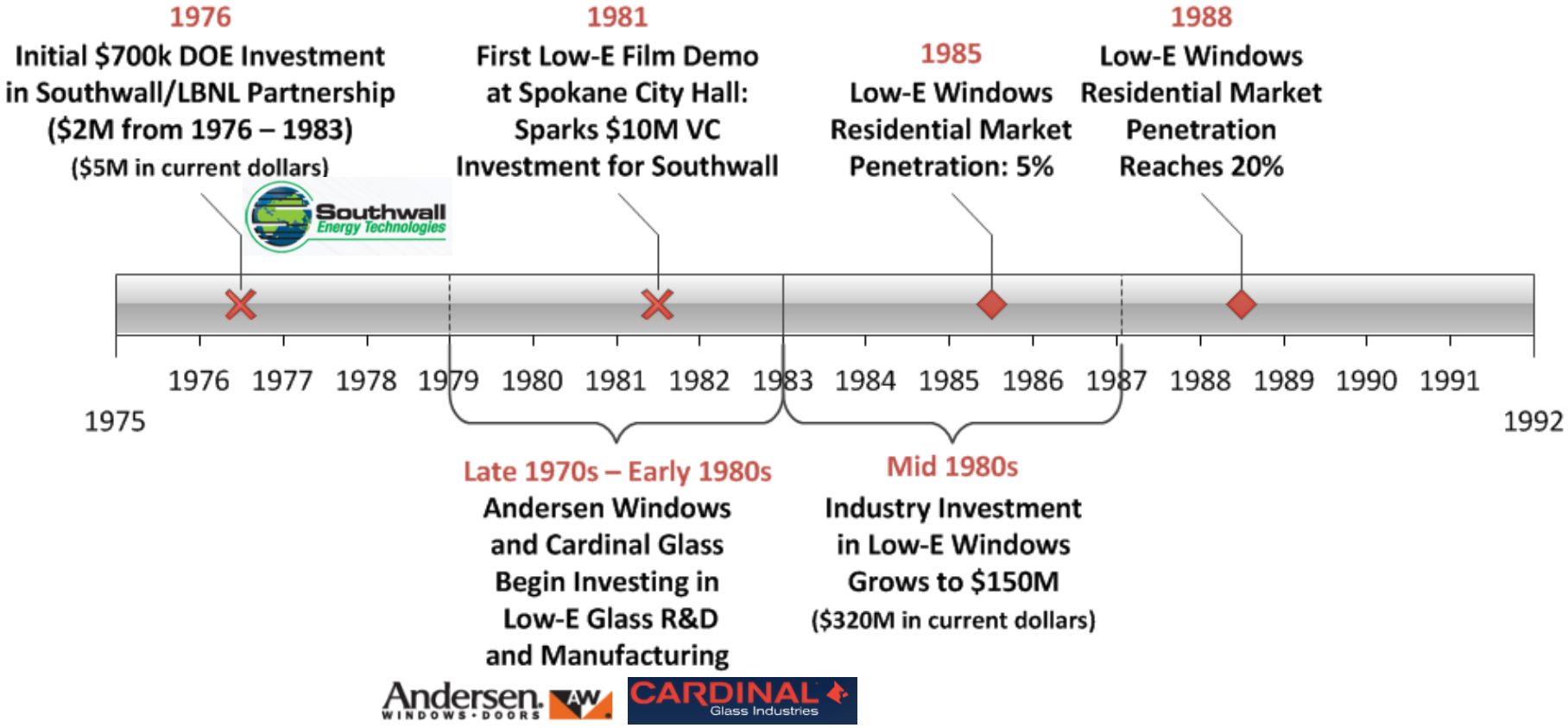
Reduce building energy use by 50% in 2030, compared to the "business-as-usual" energy consumption projected by the *2010 Annual Energy Outlook*



Notional Timeline for Windows & Envelope R&D



Timeline and Impact of R&D Investment: Low-E Windows



- **March 1998**: ENERGY STAR standards for Windows established
- **Today**, low-e windows U.S. market share is >80% of residential windows and >50% of commercial windows
- DOE-sponsored R&D investments helped stimulate net savings of more than $8 billion by 2000 ($10.7 billion in current dollars)

Source: American Energy Innovation Council Case Studies on the Government's Role in Energy Technology Innovation "Low-Emissivity Windows"

BTO's Integrated Approach

Research & Development

- Develop technology roadmaps
- Prioritize opportunities
- Solicit and select innovative technology solutions
- Collaborate with researchers
- Solve technical barriers and test innovations to prove effectiveness
- Measure and validate energy savings

Market Stimulation

- Identify barriers to speed and scale adoption
- Collaborate with industry partners to improve market adoption
- Increase usage of products & services
- Work through policy, adoption, and financial barriers
- Communicate the importance and value of energy efficiency
- Provide technical assistance and training

Codes and Standards

- Establish minimum energy use in a transparent public process
- Protect consumer interests
- Reduce market confusion
- Enhance industry competitiveness & profitability
- Expand portfolio of EE appliances & equipment
- Raise the efficiency bar

Energy Lost Through Building Enclosure Components

Building Component	Residential	
	Heating	Cooling
Roofs	1.41	0.05
Walls	1.81	0.03
Foundation	1.29	0.20
Infiltration	2.11	-0.14
Windows (Conduction)	1.54	-0.29
Windows (Solar Heat Gain)	-1.58	1.34

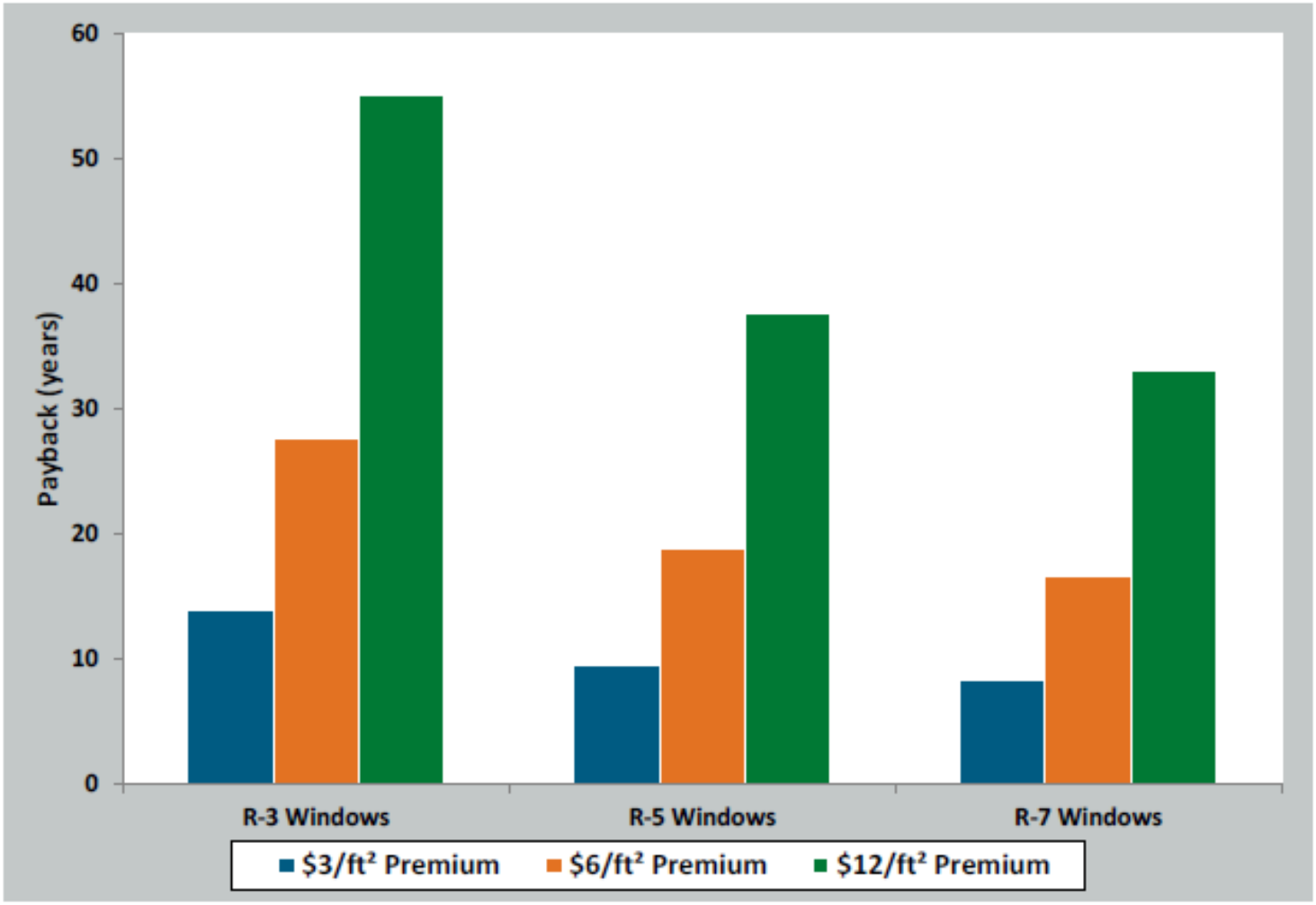
Number of Residential Buildings (millions)		
	Existing	New
2010	82.7	1.193
2035	104.85	1.114

Source: Office of Energy Efficiency and Renewable Energy 2011a; Office of Energy Efficiency and Renewable Energy 2011b; Energy Information Agency 2010; Energy Information Agency 2013

Windows R&D Priorities

Technology	2025 Cost Target	2025 Performance Target
Highest Priority R&D Area		
R-10 windows	Projected installed cost premium over 2010 installed base: Residential: ≤$6/ft^2 Commercial: ≤$3/ft^2	Residential: R-10; V_T>0.6 Commercial: R-7; V_T>0.4 Comparable weight and thickness to currently installed base
High Priority R&D Areas		
Dynamic windows	Projected installed cost premium compared to standard IGU: Windows: <$8/ft^2 Window Films: <$2/ft^2	1) ΔSHGC > 0.4 2) V_T bleached state > 0.6 (residential) and >0.4 (commercial)
Visible light redirection (Commercial only)	Projected installed cost premium <$5/ft^2 over standard window or blind installation including the cost of sensors and lighting controls	Reduce lighting energy use by 50% for a 50-ft floor plate

Highly Insulating Commercial Windows



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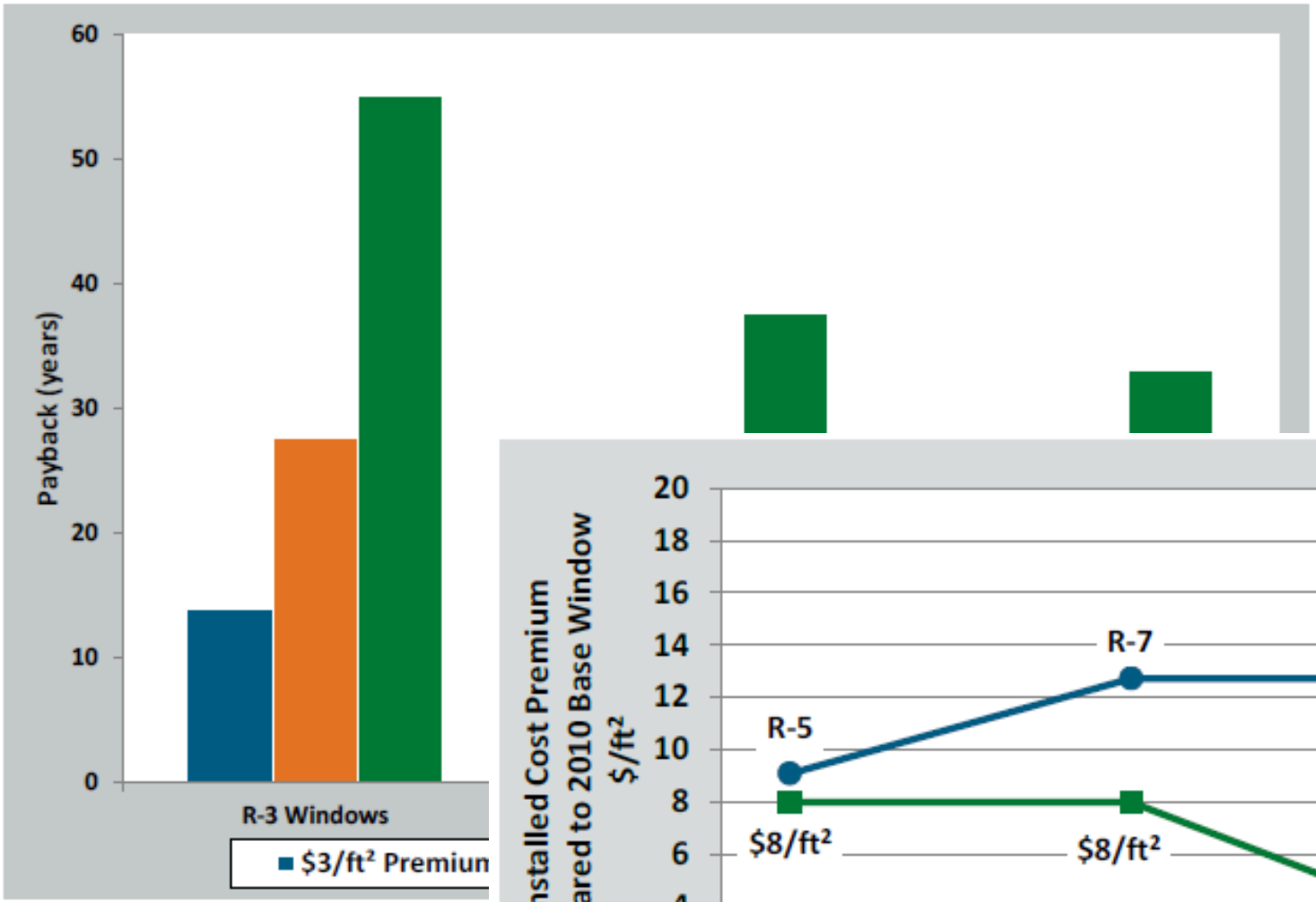

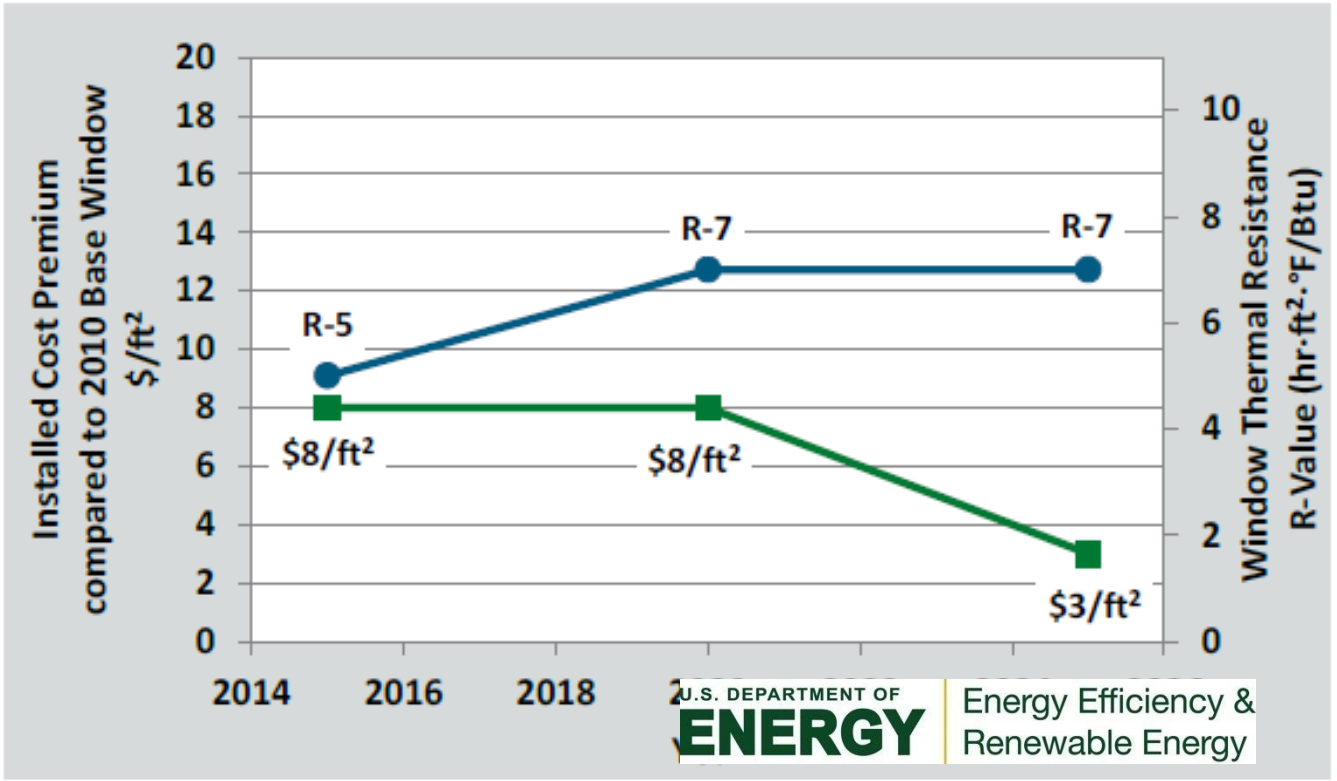

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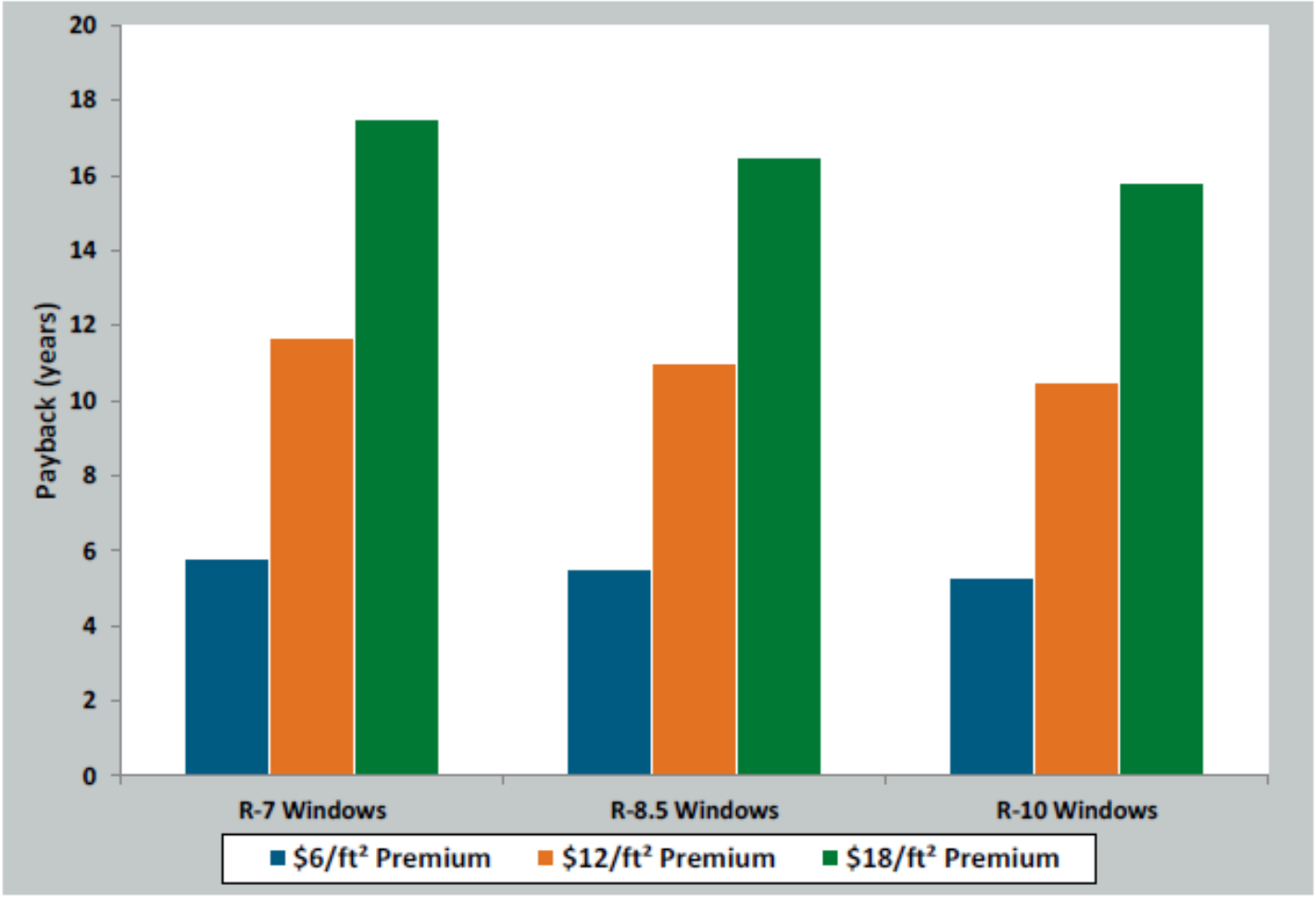
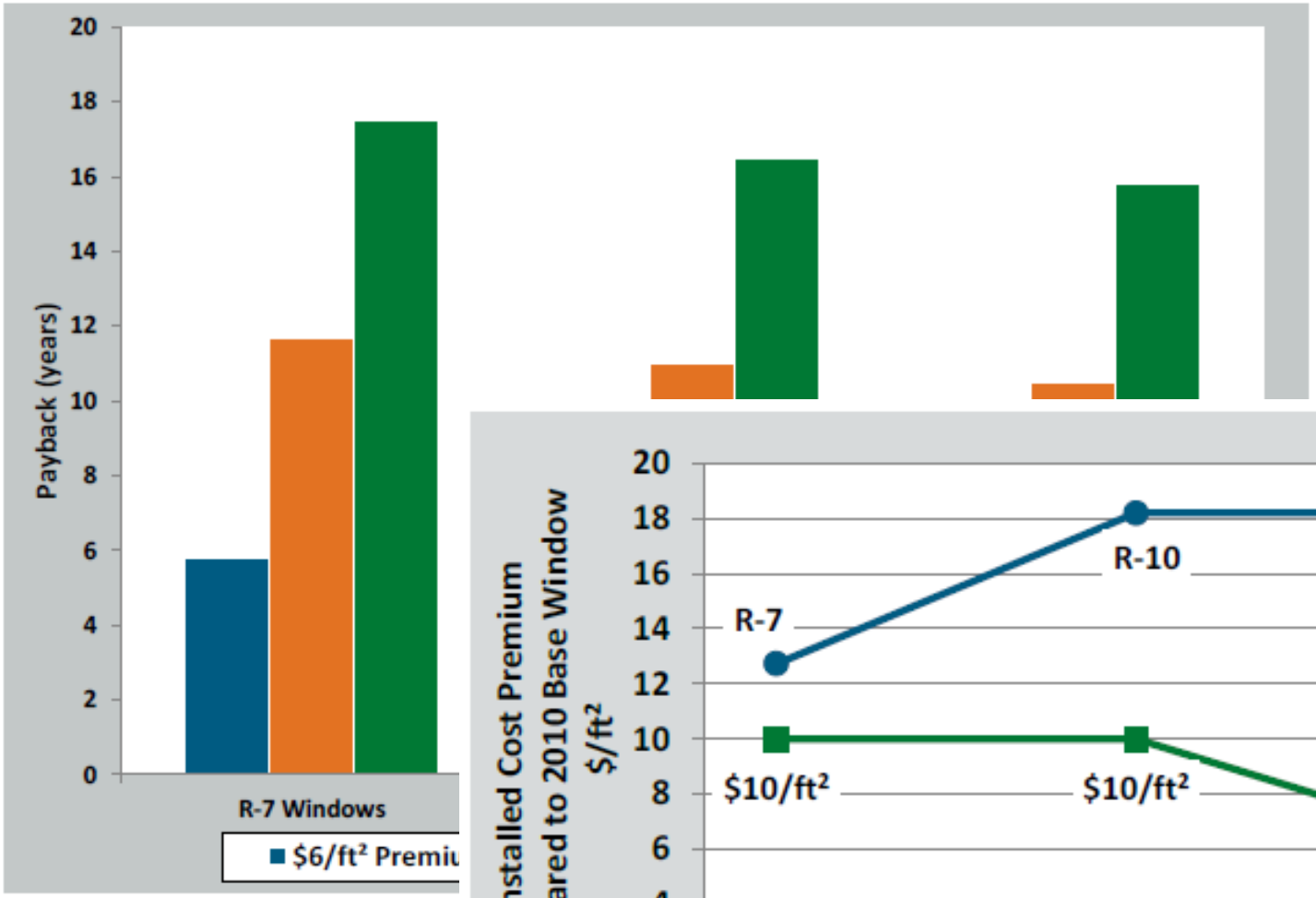
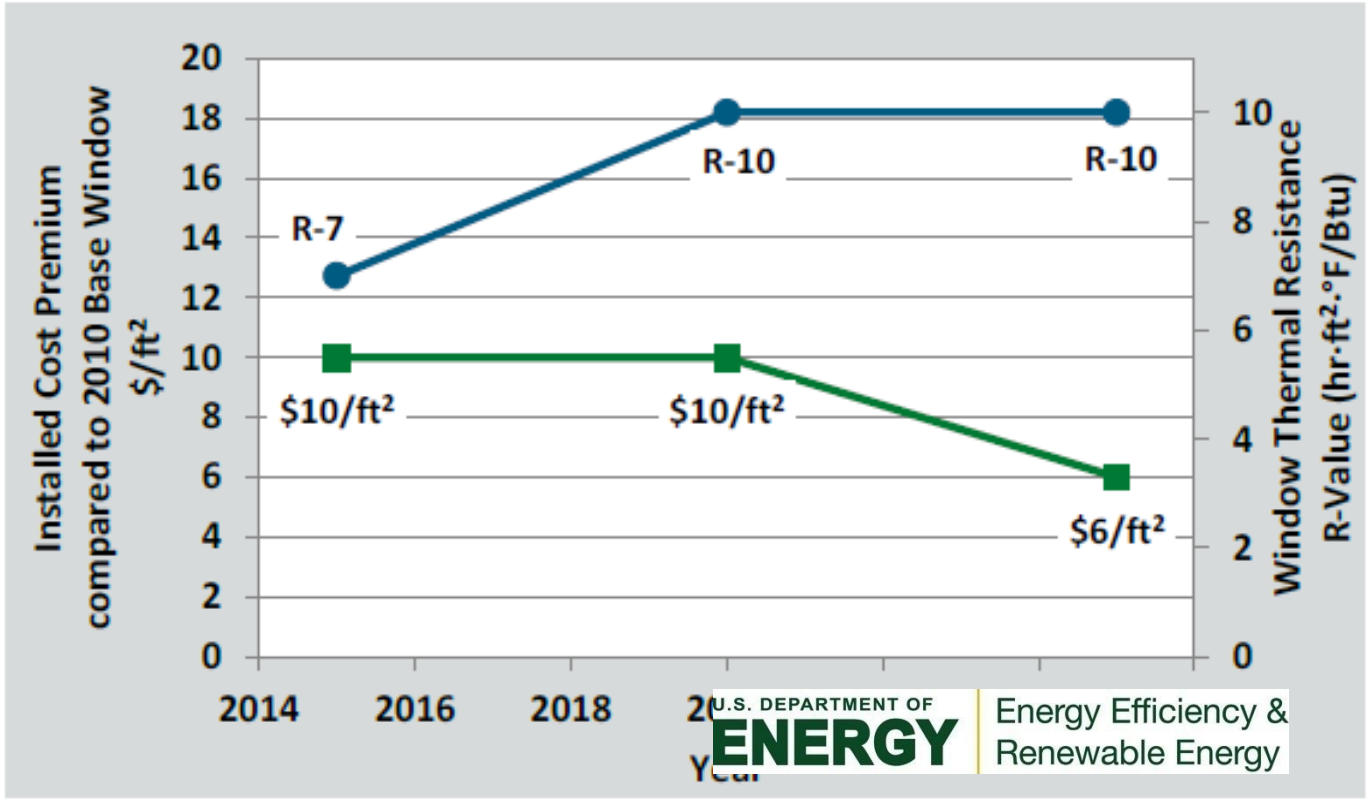
Highly Insulating Residential Windows



Highly Insulating Residential Windows



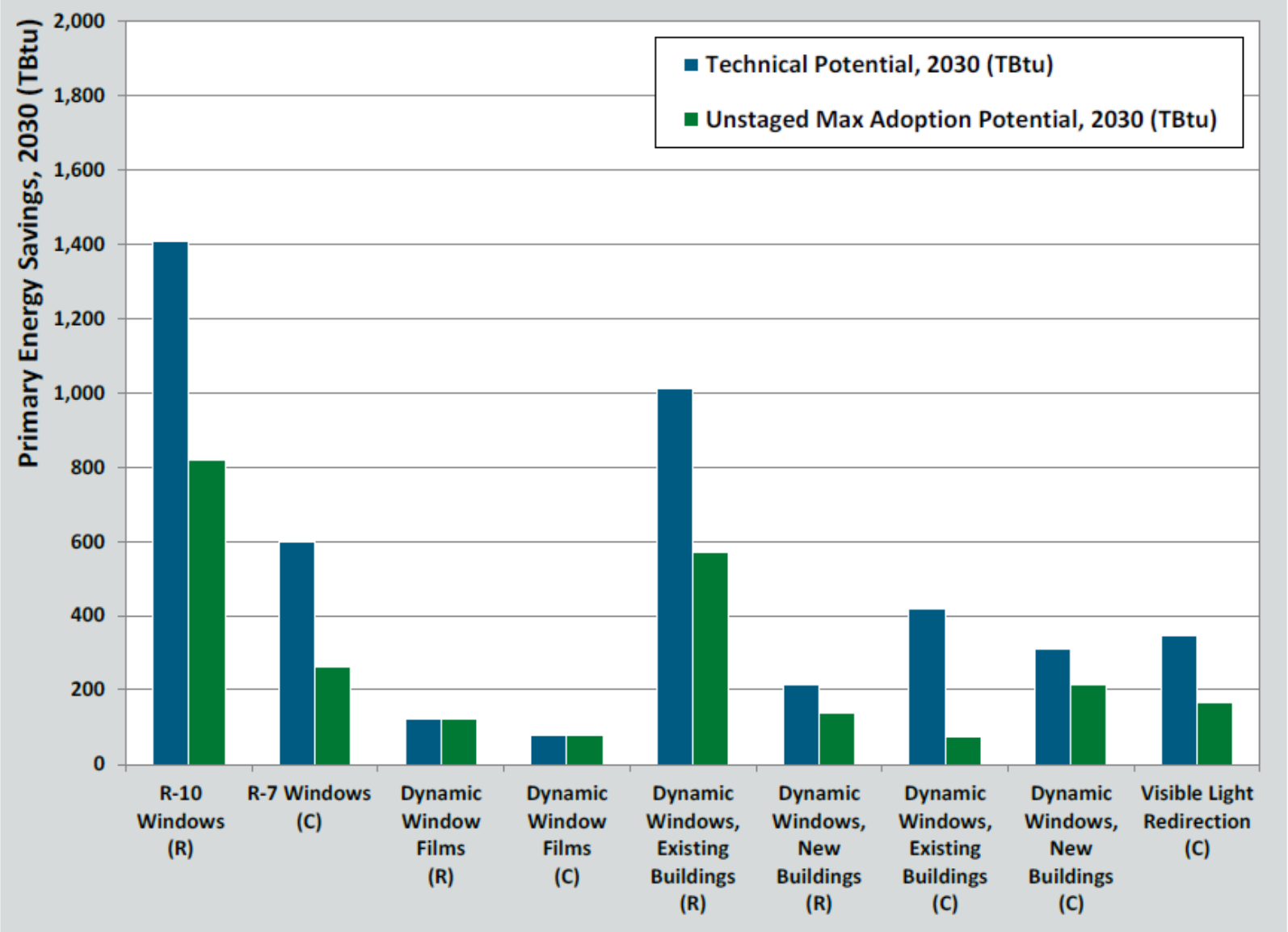


Highest Priority R&D Area: Highly Insulating Windows

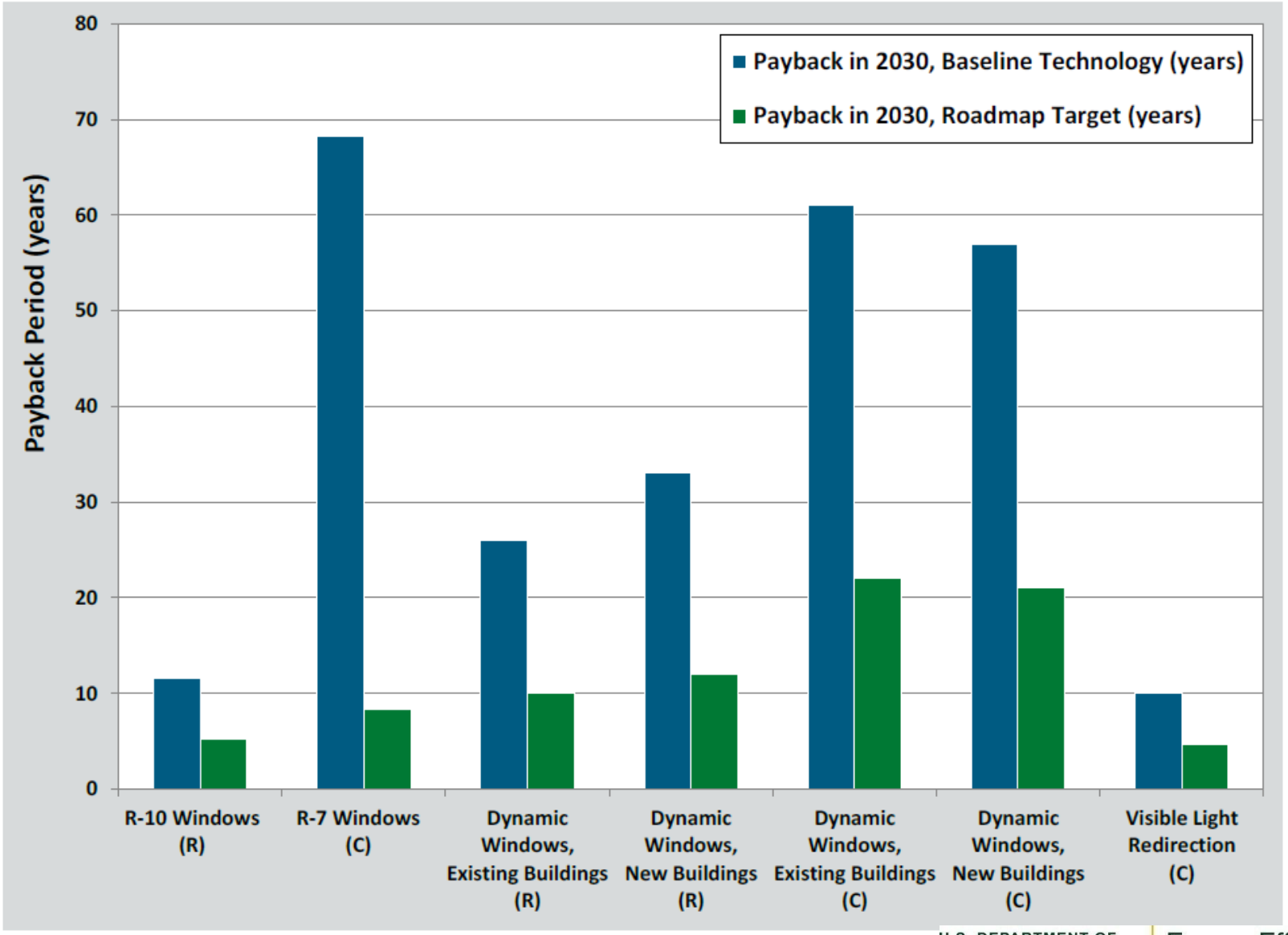
R&D Barriers	Manufacturing Barriers
Low-cost, inert gases for multilayer insulated glazings	High-precision, automated equipment
Cost-effective, improved performance vacuum insulated glass (VIG)	
Novel materials and designs for aesthetically pleasing windows and window films	
Improved performance framing materials	Manufacturing processes capable of handling custom- and large-sizes
Amenability to retrofits	
Simplified window installation	

Market/Deployment Barrier
Inadequate codes and code enforcement
Lack of information for consumers

Windows Roadmap Targets: Energy Savings



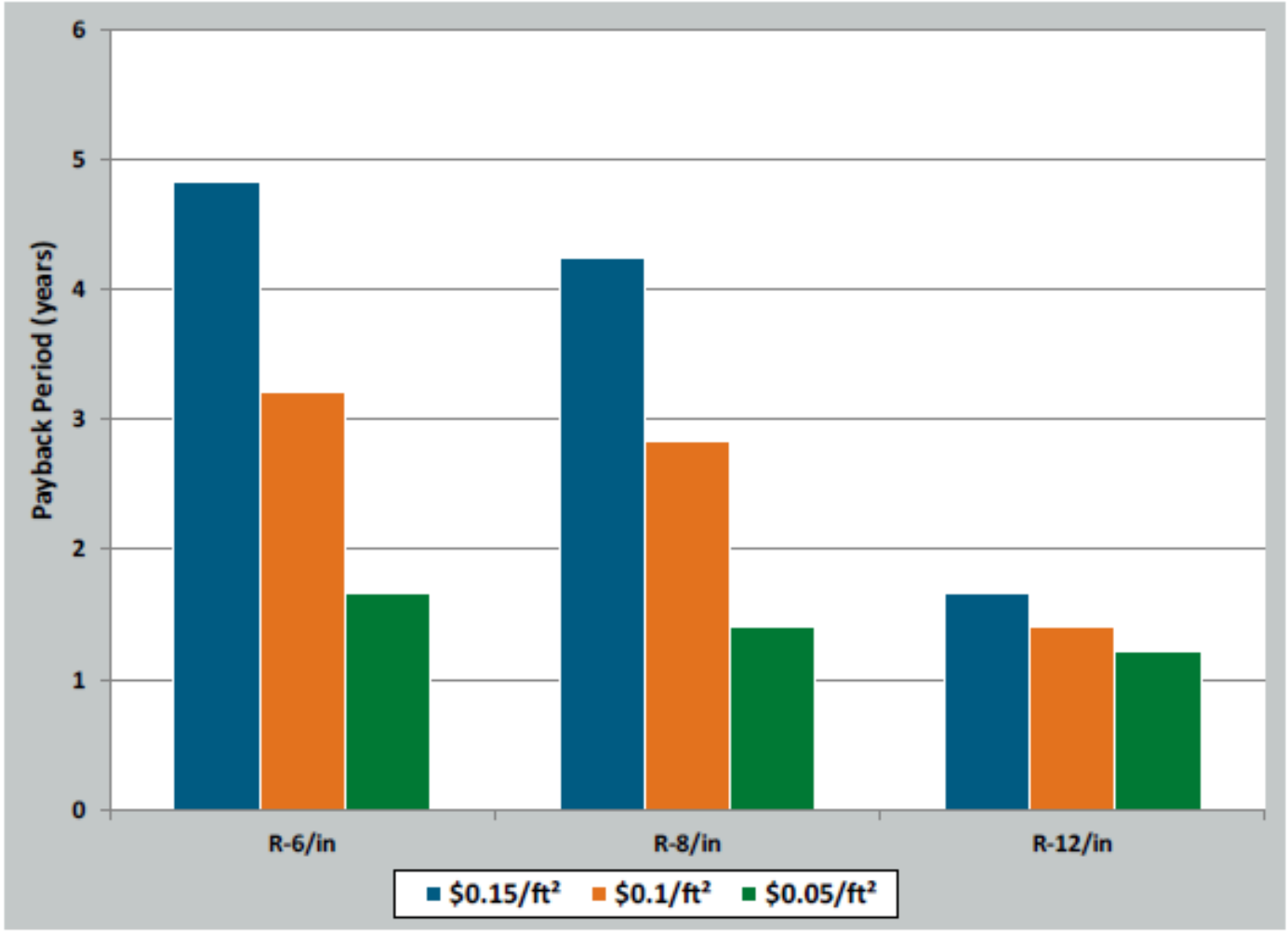
Windows Roadmap Targets: Payback



Building Envelope R&D Priorities

	2025 Cost Target	2025 Performance Target
	<$0.25/ft^2 projected installed cost premium, including material and labor.	• R-12/inch thermal insulation material for retrofitting walls. • Meets durability requirements. • Minimizes occupant disturbance.
	<$0.5/ft^2 finished floor projected installed cost	A system capable of concurrently regulating heat, air and moisture flow to achieve: • Residential: <1 ACH50 • Commercial: <0.25 CFM75/ft^2 (5-sided envelope)
	Projected installed cost increase <$1/ft^2 over standard roof costs	Energy use reduction equivalent to doubling current ASHRAE R-values

Thermal Insulation Material



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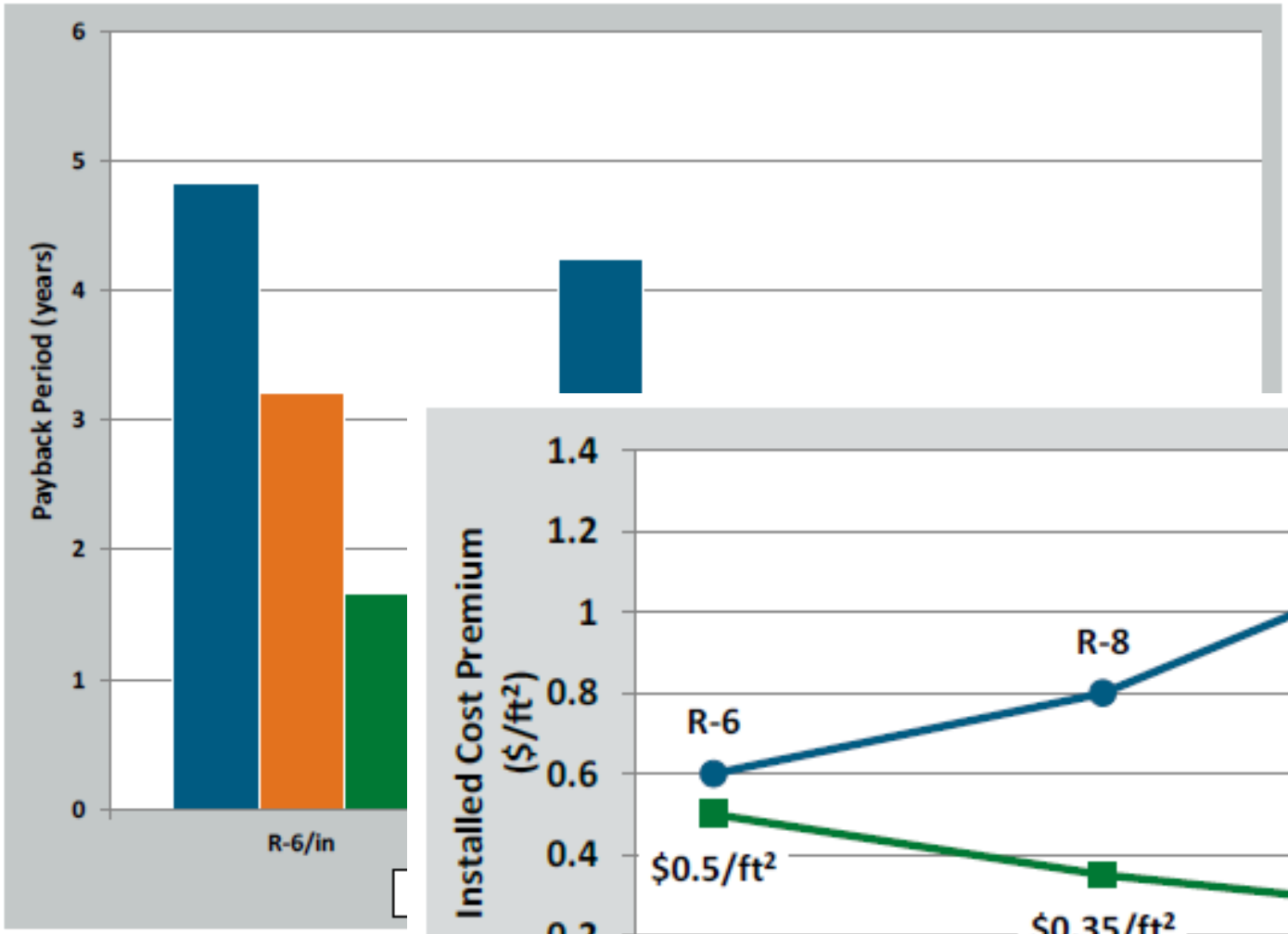
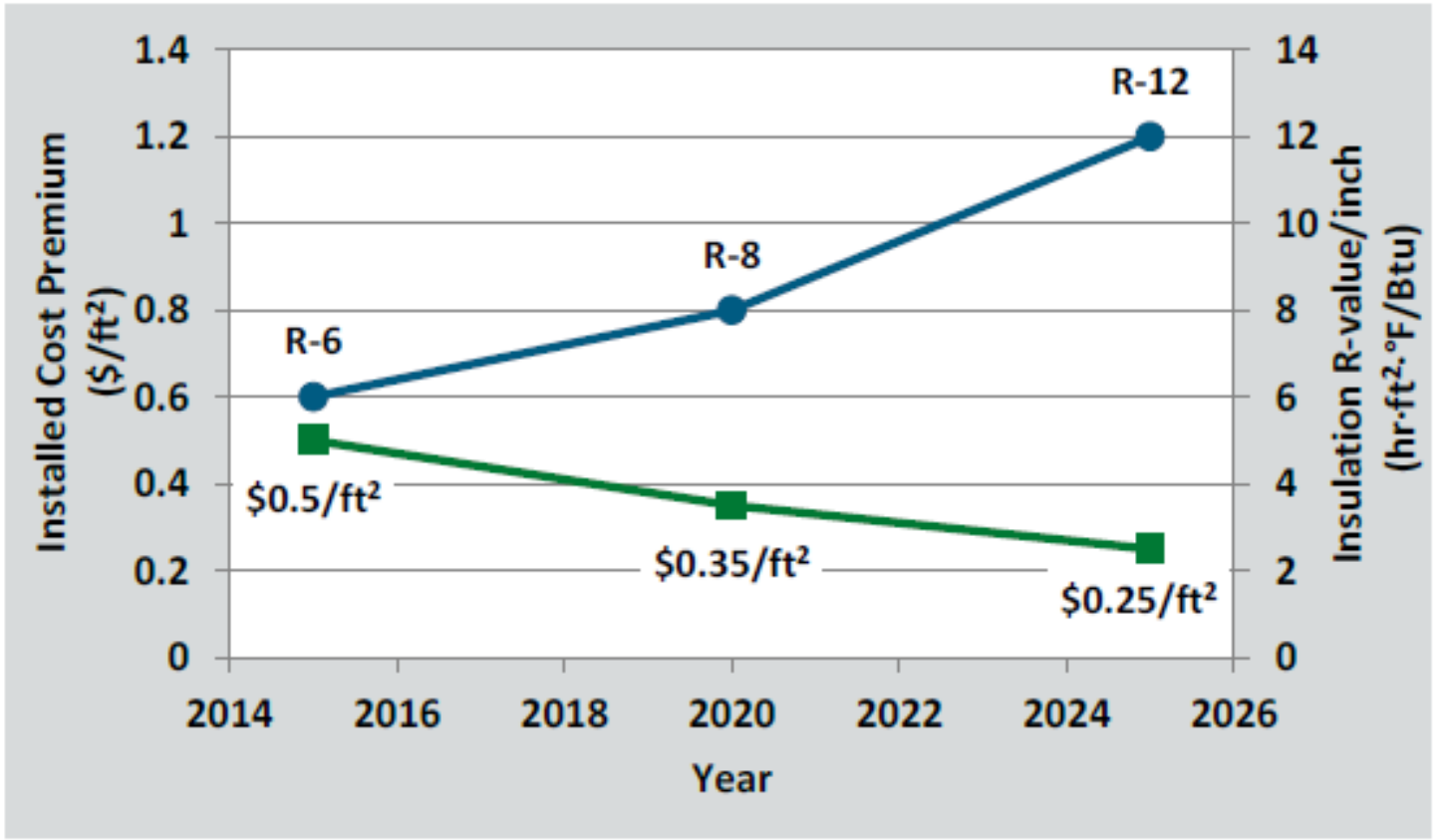


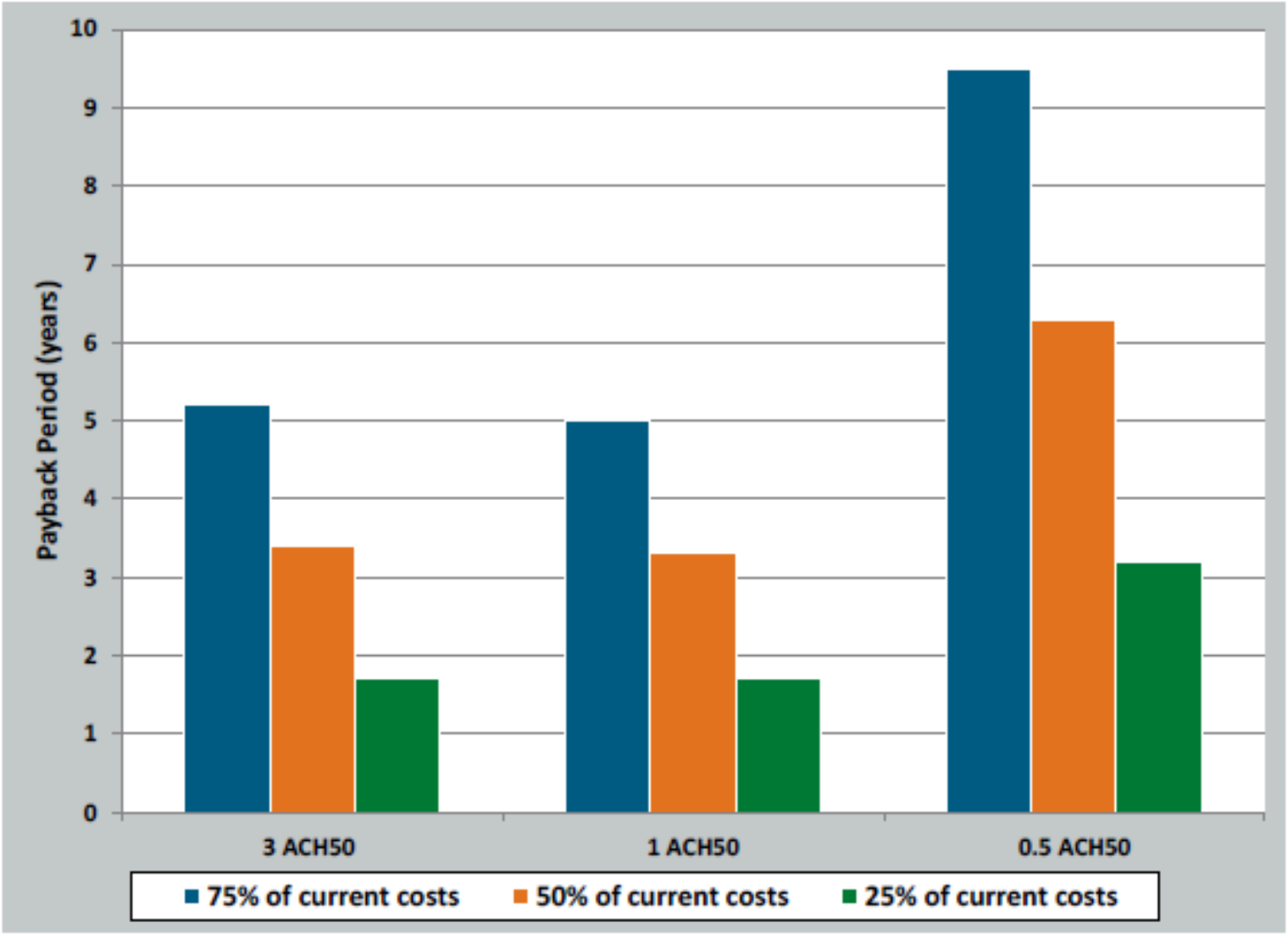


Highest Priority R&D Area: Building Envelope

R&D Barriers	Manufacturing Barriers
Development of low-cost materials with exceptional moisture/mold control	Integrated supply chain of materials
IR radiation control	
Understanding material failure modes and service-life test protocol	Modular manufacturing and standardization

Market/Deployment Barrier
System integration to envelope
Standardization of sizes
Software tools
Moisture management
Blowing agent restrictions
Lack of third-party verification of capabilities and flammability
Lack of clear performance criteria and metrics for homeowners

Air Sealing System: Residential (pre-2010 buildings)



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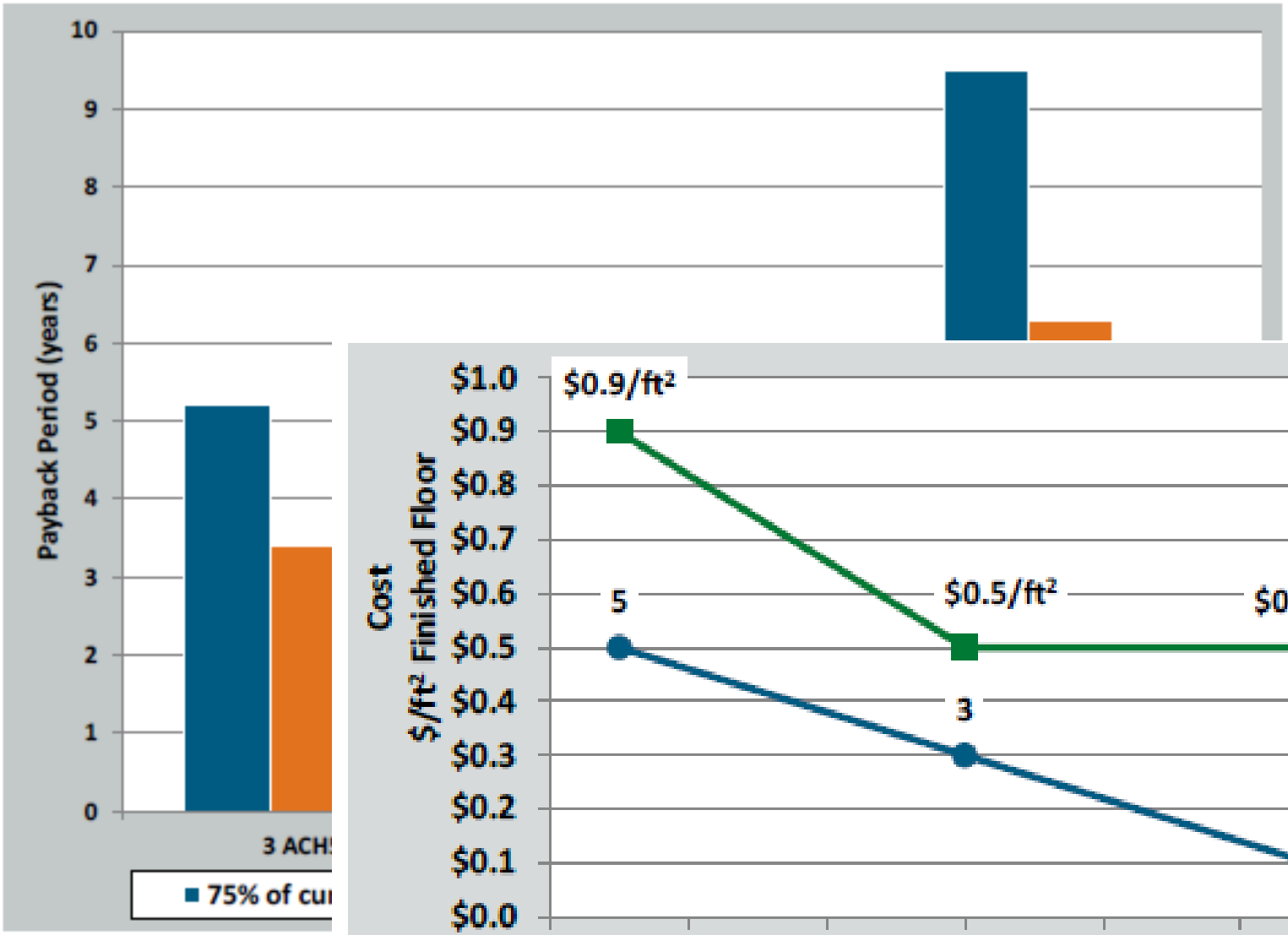
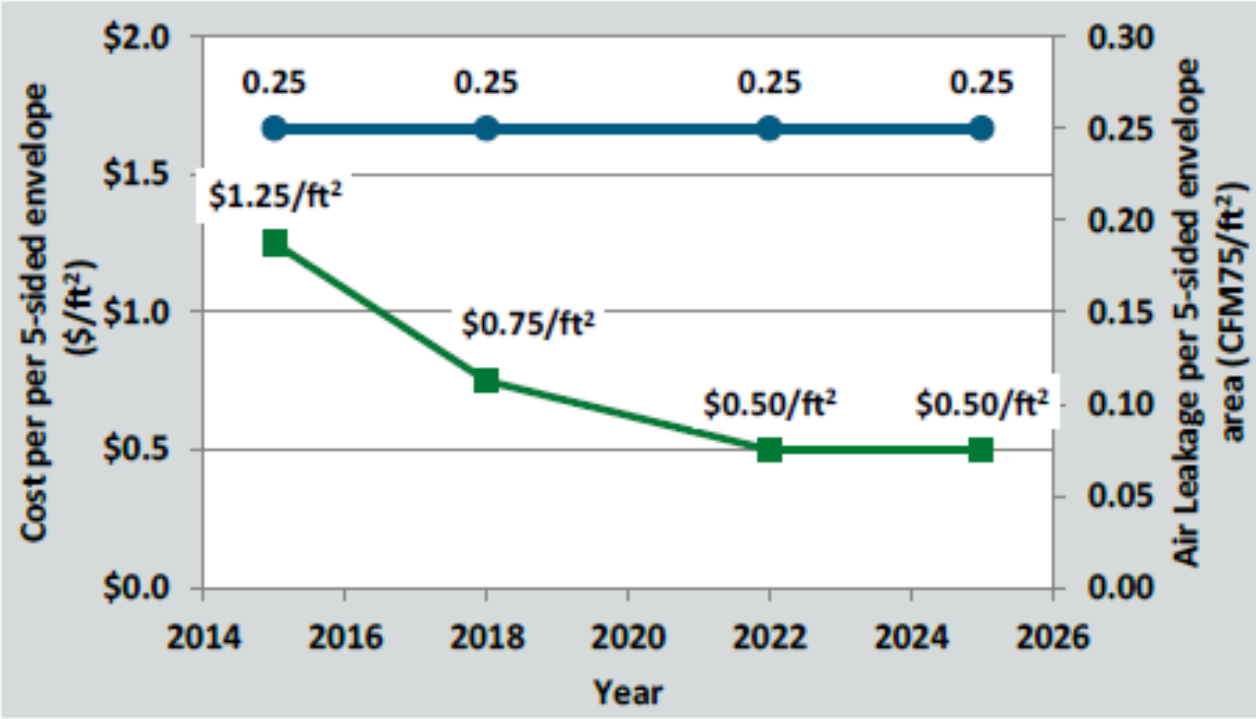


Air Sealing System: Commercial

Air-Sealing System Technology Performance Target	Market Size (TBtu)	Technical Potential, 2030 (TBtu)	Unstaged Max Adoption Potential, 2030 (TBtu)
Commercial Building Sector, New and Existing Buildings			
1.24 CFM75/ft^2	982	44	44
0.25 CFM75/ft^2	982	805	805



Highest Priority R&D Area: Building Envelope

R&D Barriers	Manufacturing Barriers
System simplification	Manufacturing quality control to ensure performance
Selective sealing with spray-applied adhesives	Poor coordination of building trades involved in installations
Inadequate quality control and verification of completeness during application process, inadequate identification of installation flaws	Inability to install and seal the system immediately after or during construction
Sealing solutions need to be added a la carte, depending on installation environment	

Market/Deployment Barrier
System must show added value over individual components
Builder vary in product preference
Inadequate inspector training

Current BTO Windows & Envelope Projects

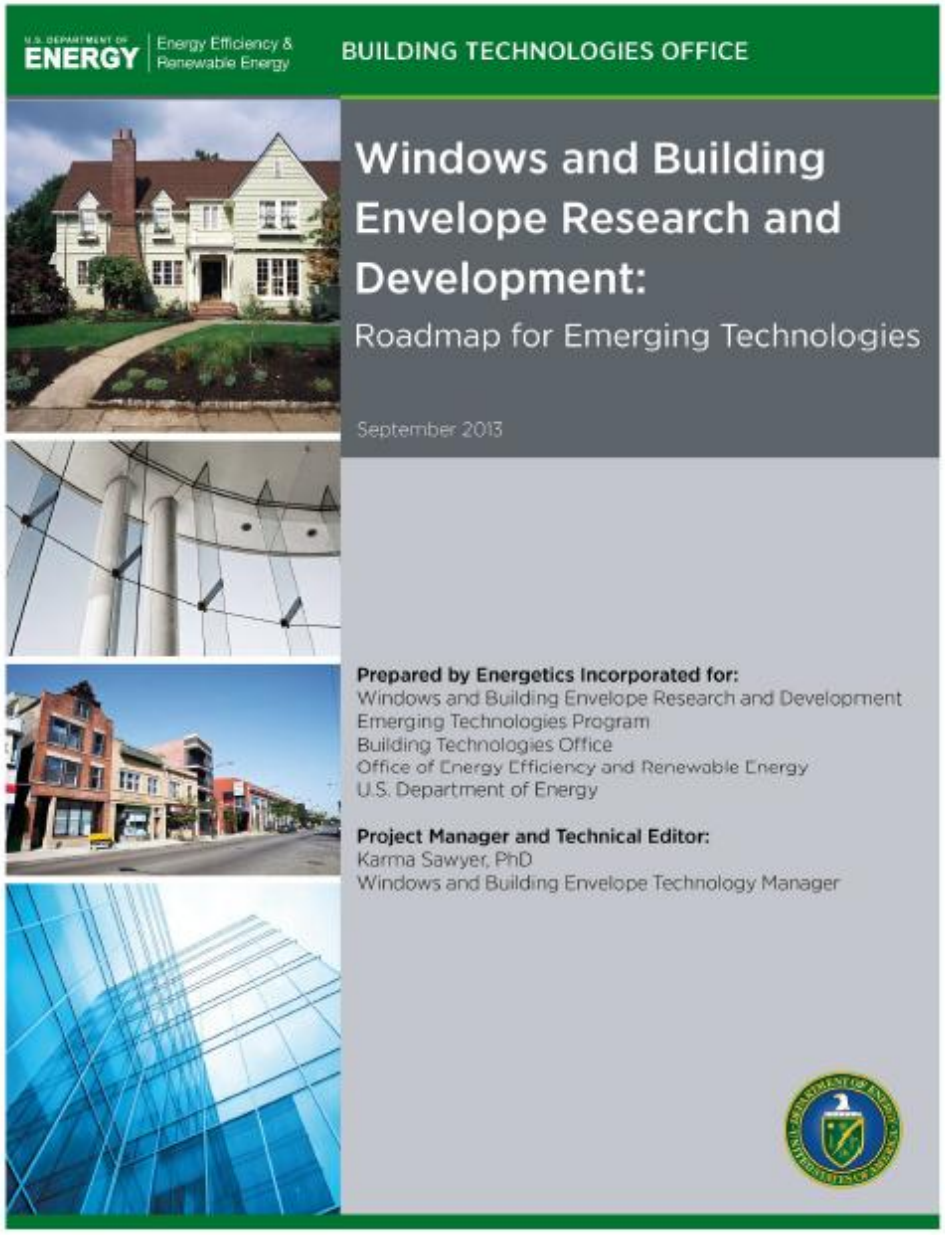
1. Core capabilities (not competed)
   a) Unique and critical resources held by DOE National Labs to support industry and R&D community.
   b) Intellectual and physical assets with high start up and/or shut down costs.
2. On-Roadmap: Awarded by Funding Opportunity Announcement to industry, academia or national labs.
3. Off-Roadmap: Early stage or one-off projects

BENEFIT FOA Currently LIVE

Area of Interest 4: Highly Insulated Building Components

(This is all that I will say!)

Check out the Windows & Envelope Roadmap



I like to push the envelope…
both opaque and fenestration.

Thank you!

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