Windows and Envelope Sub-Program Overview

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

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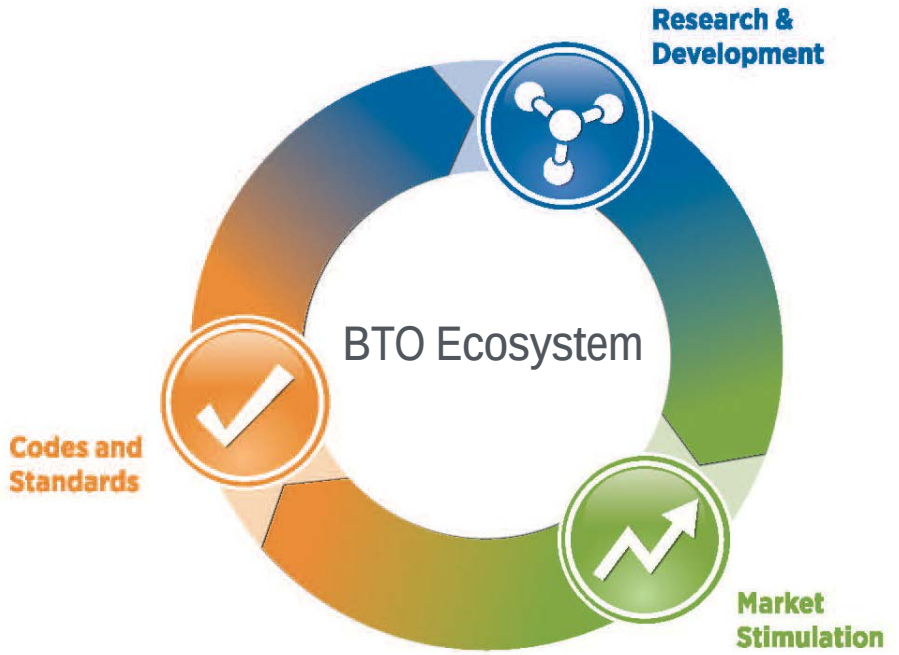
BTO's Integrated Approach

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

Priority areas for envelope R&D based on the roadmap

Technology	2025 Installed Cost Premium Target	2025 Performance Target
Highest Priority R&D Areas		
Building envelope insulation	≤ $0.25/ft^2	• ≥ R-12/inch thermal insulation material for retrofitting walls • Meets durability requirements • Minimizes occupant disturbance
Air-sealing technologies	≤ $0.5/ft^2 finished floor	• Residential < 1 ACH50 • Commercial: < 0.25 CFM75/ft^2 • Concurrently regulates heat, air, and moisture
High Priority R&D Area		
Highly insulating roofs (commercial)	≤ $1/ft^2 over standard roof costs	Energy use reduction equivalent to doubling current ASHRAE R-values

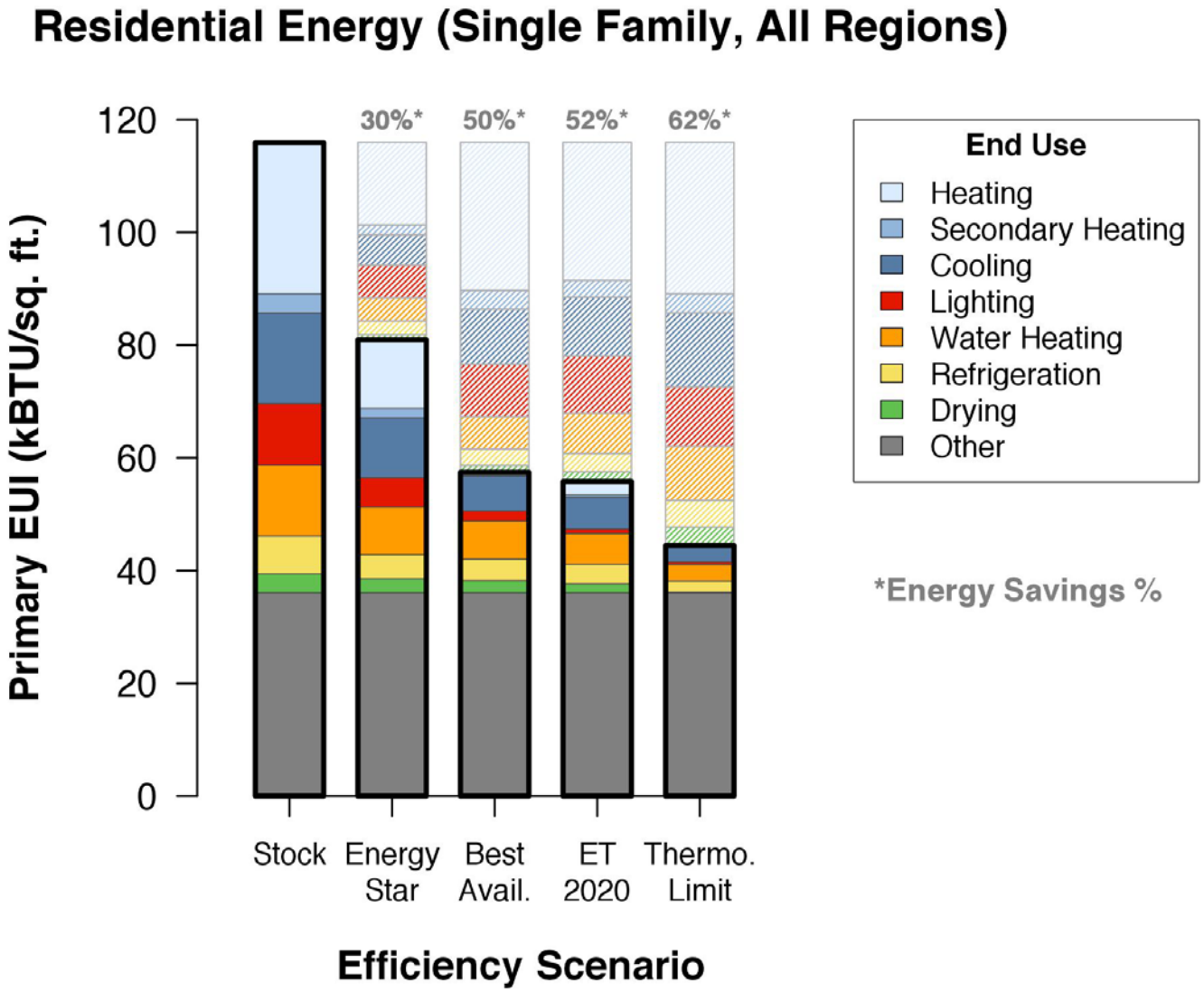
Priority areas for windows R&D based on the roadmap

Technology	2025 Installed Cost Premium Target	2025 Performance Target
	Highest Priority R&D Area	
R-10 Windows	Residential: ≤ \$6/ft^2 Commercial: ≤ \$3/ft^2 over typical 2010 windows	• 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	Windows: ≤ \$8/ft^2 Window Films: ≤ \$2/ft^2 over a standard IGU	• ΔSHGC > 0.4 • V_T bleached state > 0.6 (residential) and > 0.4 (commercial)
Visible light redirection (commercial)	≤ \$5/ft^2 over standard window or shade including lighting and controls costs	50% reduction in lighting energy use over a 50-ft floor plate

Cross-cutting challenges for windows and envelope

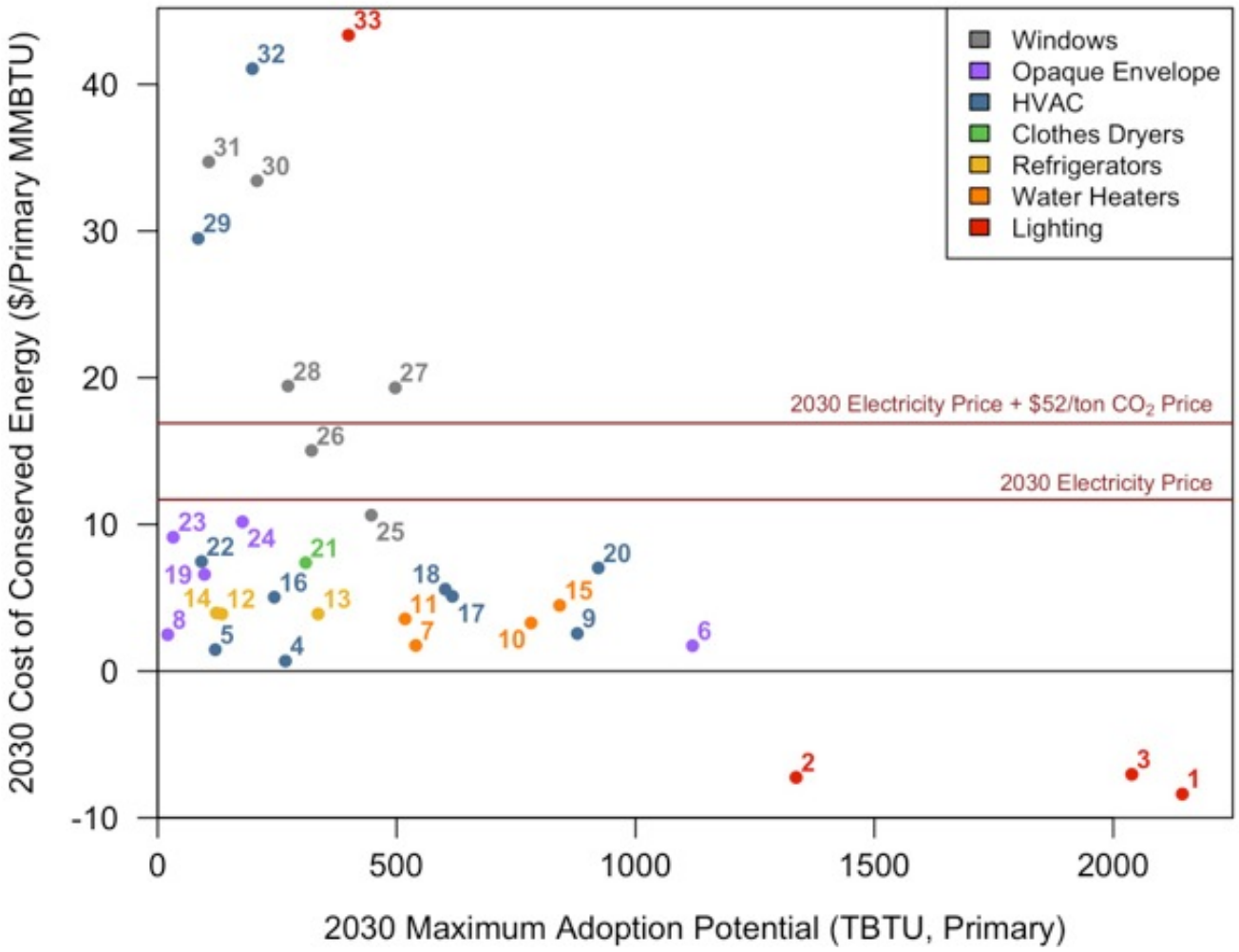
- "Seamless" interfaces/transitions between functional areas (e.g., roof-walls, walls-windows)
  - Air and moisture infiltration, installation cost, construction errors
- Simple, accurate, low cost methods for evaluating envelope air sealing
- "Soft" costs as a fraction of total installed costs
- Advanced manufacturing methods for windows
  - Reduce costs, increase quality, reduce lead times
- Products and methods that reduce retrofit cost and complexity

QTR results reflect the potential benefits of envelope R&D



ET 2020 – ET Multi-year Program Plan Targets for 2020

QTR results include cost-effective envelope technologies



6: Air sealing (R)

8: Insulation (C)

19: Air sealing (C)

23: Roof insulation (C)

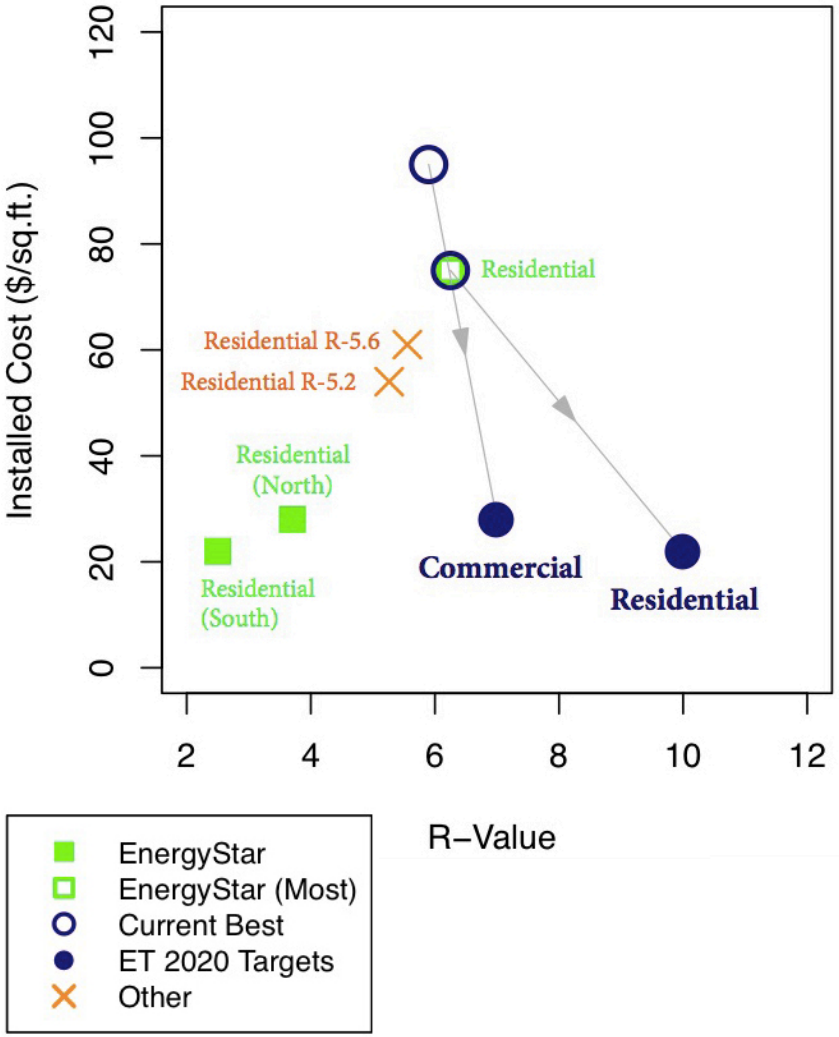
24: Insulation (R)

25: Dynamic window films

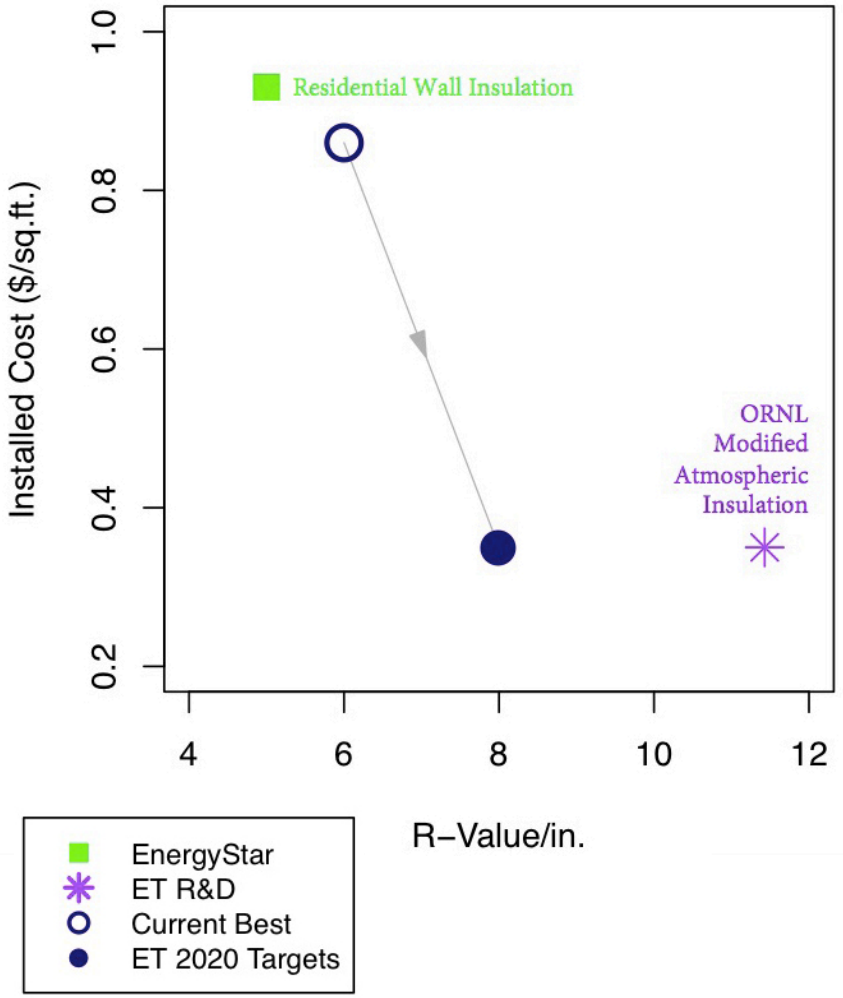
26: Dynamic windows

R&D is needed to successfully reach program targets

MYPP Target: Highly Insulating Windows



MYPP Target: Envelope Retrofit



Projects to be reviewed today

- Windows
  - **ORNL:** Low-cost Haziness-free Transparent Insulation
  - **WCMA:** Attachments Energy Rating Council (AERC)
  - **LBNL:** Fenestration Attachments Quantitative Evaluation
  - **PPG:** Fabricate-on-demand Vacuum Insulated Glazings
  - **Alcoa:** Novel Thermal Break with Simplified Manufacturing for R-7 Commercial Windows
- Envelope
  - **ORNL:** R-25 Polyisocyanurate Composite Insulation Material
  - **Fraunhofer:** Bio-based, Inexpensive, Non-corrosive, Non-flammable Phenolic Foam for Building Insulation
  - **LBNL:** CBERD Building Envelopes R&D

Two exciting panel discussions

- 12:05 PM – Additive Manufacturing for the Building Envelope
  - Roderick Jackson, Building Envelope Systems Research Group, Oak Ridge National Laboratory
  - Sneh Kumar, Business Technology Lead for Building and Construction Systems, Alcoa
  - Uday Vaidya, Chief Technology Officer, Institute for Advanced Composites and Manufacturing Innovation
  - Lucas Tryggestad, Associate Director, Skidmore, Owings, and Merrill
- 3:05 PM – Customer Perspectives on Envelope R&D Opportunities
  - Doug Anderson, ENERGY STAR Project Manager, US Environmental Protection Agency
  - Yves Gauthier, Senior Associate, Perkins+Will
  - Geoffrey Eddy, Senior Engineer, Arup
  - Dean Potter, VP Quality and Home Production, K. Hovnanian Companies

David Cohan – BTO Codes Program

- Findings from the Residential Energy Code Field Study