Building Technologies Program

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

Window Roadmap Meeting

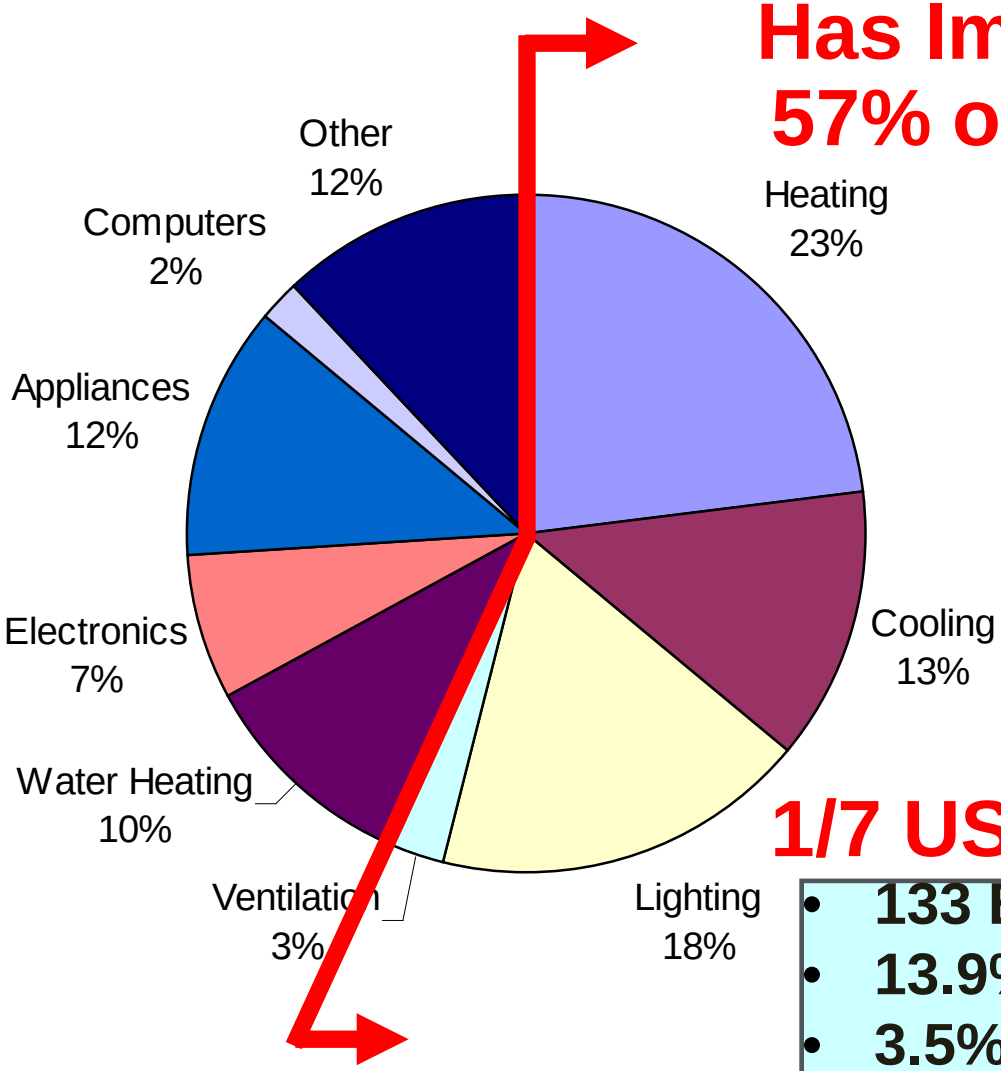
Overview of DOE Envelope R&D

WDMA, Minneapolis, MN

28 June 2012

Marc LaFrance

Building Consumption – Envelope Relationship



Has Impact on 57% of Loads

1/7 US Economy

- **133 Billion $/yr**
- **13.9% US Energy**
- **3.5% Global Energy**

Total Envelope Component Energy Impact

Quads	Residential	Commercial	Total
Windows	3.07	1.97	5.04
Infiltration/Fresh Air	2.20	2.79	4.98
Walls	1.46	0.61	2.07
Roofs	1.18	0.38	1.56
Foundations	1.08	0.42	1.49
Total	8.99	6.16	15.15

Source: Draft Report - Energy Savings Potential of Building Envelope and Windows Technologies, Winbuild, includes source contributions, see reference slides for more details.

Total Building Envelope and Window R&D Budget

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	Budget Request	Enacted Appropriations
FY05	5.0M Windows 0 Envelope	5.8M Windows 2.8M Envelope
FY06	5.0M Windows 0 Envelope	*3.8M Windows (*earmarks) 2.9M Envelope
FY07 & FY08	4.7M Windows 2.4M Envelopes	4.7M Windows 2.4M Envelope
FY09	5.2M Windows 3.4M Envelopes	5.5M Windows 4.5M Envelope
FY 10	10.5M Windows 5.5M Envelope	Core 10.5M Windows 5.5M Envelope **ARRA ~ 25M**
FY 11	10.5M Windows 8.5M Envelope	10.5M Windows 5.5M Envelope
FY12	25M Both	10M Windows 6M Envelope
FY13	16M Both	**TBD - LARGE CUT EXPECTED 50 TO 80%; WHY? LESS FUNDS, EARMARKS, DOE PRIORITIES, etc**

Roadmap with Stakeholders

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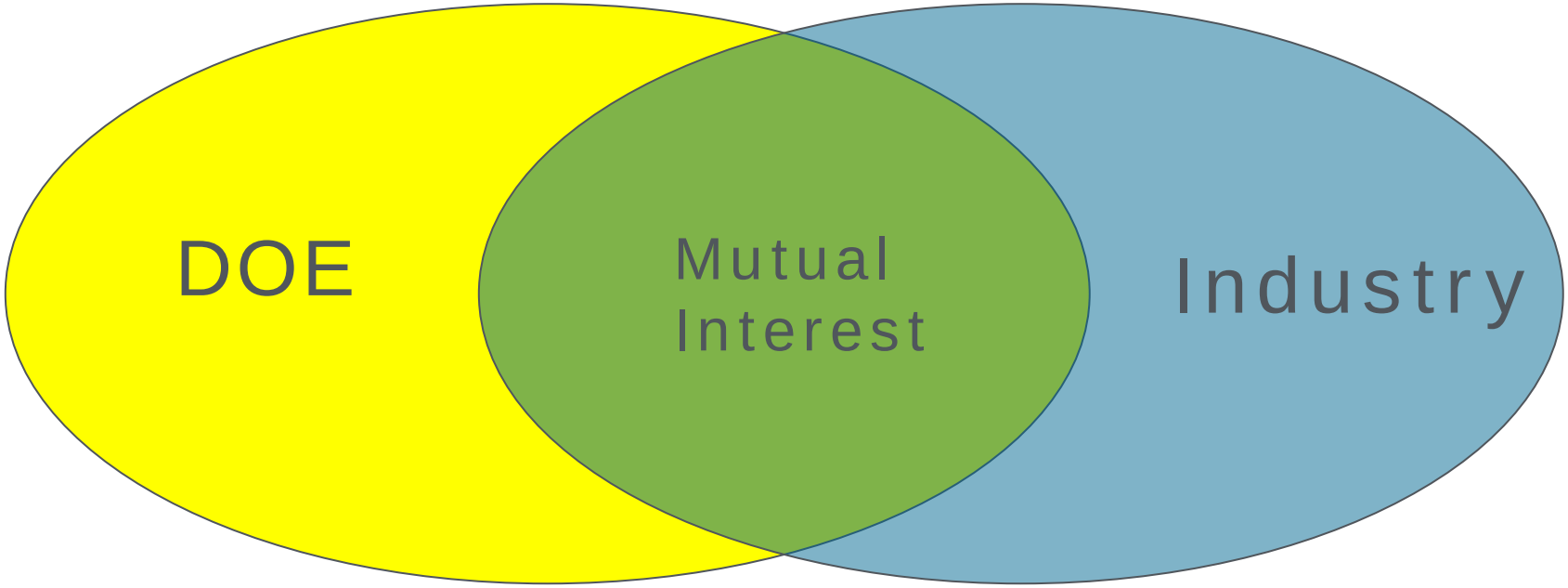
- DOE seeks input from stakeholders
- Scope related to envelope and window R&D
- Assessment of current projects
- Opportunity to provide your high priorities



Building Envelope – Macro Goals

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- Roofs:
  - Increase aged performance of roof coatings by 25%
  - Develop cost effective “cool-colored” asphalt shingles with no increase in 20 year life cycle cost by 2015
  - Next gen attic systems with 50% savings
- Windows:
  - Develop a cost-effective R-10 window
  - 0.1 U-Value windows at $3/sq ft price premium by 2020
- Insulation:
  - Dynamic insulation with over 20% peak load reduction
  - Dynamic annual performance of attics and walls with no increase in life cycle cost by 2015
- Building Integrated PV with higher PV output and min. 25% thermal load reduction

Sample advanced roof design applied to BIPV to be evaluated (50% reduction of roof thermal load)

Key Opportunities - Now and in the Future

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Technology Area	Ready Now – Enabling Research Can Help	Technologies for the Future
Commercial Windows	Integrated Design with Automated Shades, Lighting and HVAC Controls; Shading and Optimization of Window/Wall Ratio; Drive Low E Penetration	Dynamic Windows, Light Redirection Glazings, Highly Insulating for Cold Climates
Residential Windows	R5 (U value 0.2) for High HDD and Higher Energy Prices, Passive Heating with Fixed Overhangs	Low Cost R5, Affordable R7 to R10, Dynamic Highly Insulating to Harvest Passive Heating in Mixed and Cold Climate (Energy Producing Windows)
Existing Windows	Window Film, Low e Storms, Blinds, Cellular Shades, Exterior Solar Shades, Awnings, etc	More Viable Options – reduce condensation concerns, improve installation, promote automated user interface

Key Opportunities - Now and in the Future

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Technology Area	Ready Now – Enabling Research Can Help	Technologies for the Future
Roofs	R40 Insulation with Air Sealing, Comm Cool Roofs and Roof Deck Insulation, Radiant Barriers in Hot Climates	Next Generation of Attic/Roof System for Sloped Roofs, Asphalt Cool Roofs, Higher Reflective Comm Cool Roofs, BIPV
Walls	Exterior Insulation Finishing Systems, Exterior 1-2” Foam, Cavity Insulation, Interior Insulation	Lower Cost/Higher Performing Insulation, “Installation Proof” Cavity Insulation, Robust Interior Applications
Infiltration	New Construction Wide Array of Approaches; Retrofit Viable but Labor Intensive	New Approach – Higher Value added Products with Lower Installation Cost; More Attention on Retrofit
Foundations	Exterior Insulation for New Construction, Retrofit Problematic	More Robust Moisture Tolerant Interior Solutions, Slab Edge for Existing Buildings

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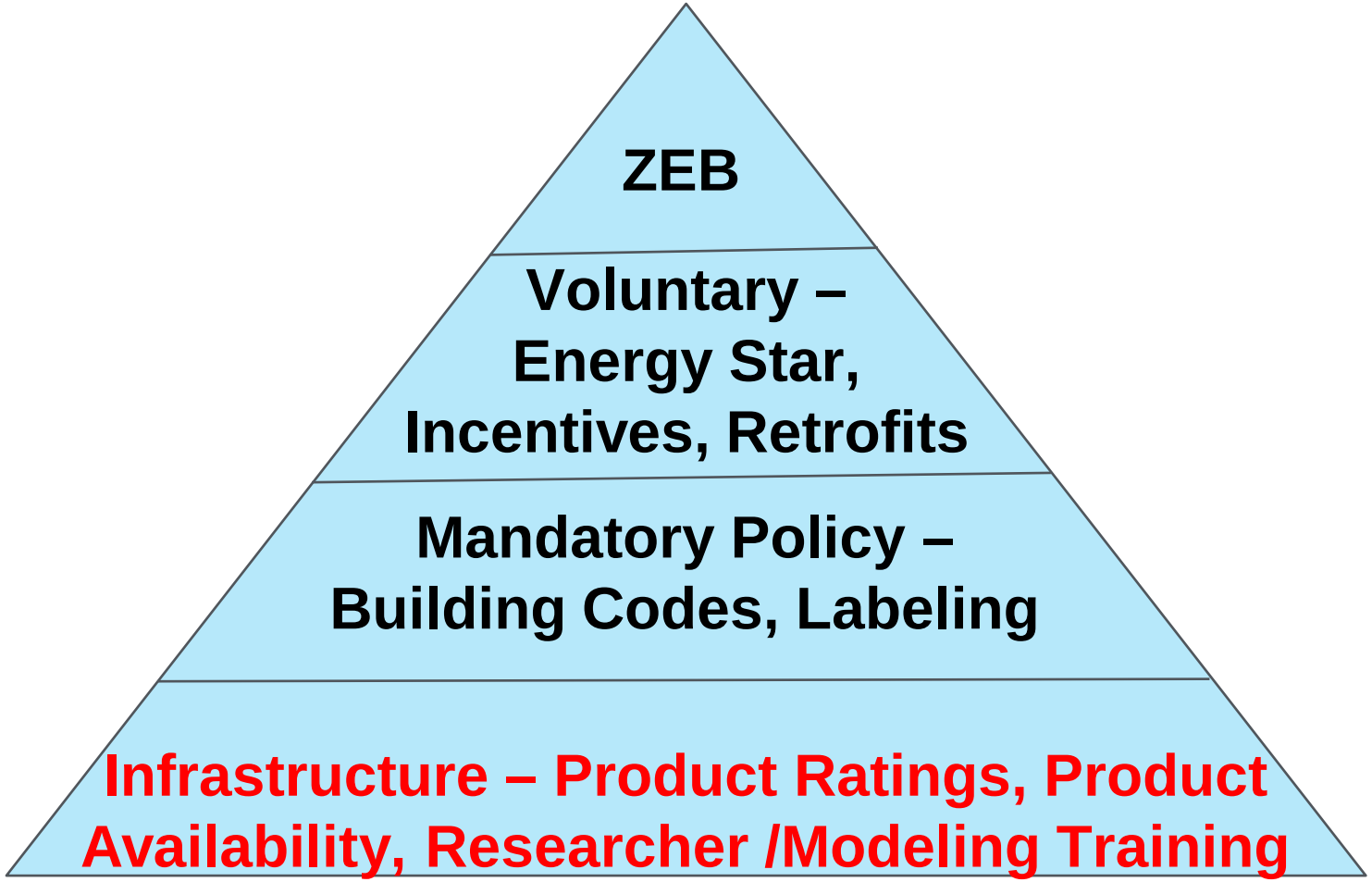
Major Policy Areas for Developing Countries – We forget about Infrastructure in the US since it is so developed



Key Elements are Interrelated and Work to Achieve Results

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Code Development

- Sends a strong message to economy
- Sets goals to strive for

Infrastructure

- Needed to assess key building components
- Likely starting point, but hard to get interest w/o codes

Enforcement

- Key issue to achieve results, but often not investigated deep enough
- Core problems include lack of product ratings, product availability, lack of knowledge

Major Accomplishments

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Envelope and Windows Major Program Accomplishments (2002 – Present)	
Validate Global Radiation Benefit of Cool Roofs	Numerous New ARRA Products on Market
Major Contribution to DOE Wide Cool Roof Policy	Commercialization of Cost Effective R5 Windows
Cool Roof Selection Guidelines	Commercialization of Cost Effective Low E Storms
New Integrated Cool Roof Calculator	Implementation of PA Priority List for Windows
New Attic/Roofs Designs for Hot Climates	Commercialization of High R Dynamic Windows
Initiation of Whole House PCM Studies	Opening of India Window Rating and Test Center
New Moisture Modeling Capability	Commercialized Dynamic Windows
Vapor Barrier Code Requirements	NFRC Labels for Window Film & Dynamic Windows
Aged & Reduced ASTM Insulation Values	Window Design Tools (Used by 80% of Industry)
Developed Sealed Crawl Space Designs	Developed Major Commercial Glazing and Daylight Tools
In-depth Cool Roof Case Studies	Comprehensive Dynamic Window/Daylight Demos
R30 Wall Solutions (EIFS Validation)	Extensive Studies – Driving Policy for High SHGC in North
Commercialized Dynamic Insulation	New Commercial Façade NFRC Rating Program
ASHRAE 160 Moisture Design Standard	Showcase Highly Insulating Dynamic Window Prototypes

Envelope and Windows Blog – Have You Registered Yet?

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www.eereblogs.energy.gov/buildingenvelope

All Workshop Materials and Significant Program Content

Building Envelope and Windows R&D Program Workshop Agendas Released!

Posted by Webmaster on 1. June 2012 15:33

Two draft agendas have been released for the upcoming Building Envelope and Windows R&D Program Workshops: Building Envelope Technology Roadmapping Workshop in San Antonio, TX on June 26th, 2012 Building Envelope Workshop Meeting Agenda (Draft) Windows Technology Roadmapping Workshop in Minneapolis, MN on June 28th, 2012 Windows Technology Meeting Agenda (Draft).pdf (119.09 ... [More]

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Windows Technology Roadmapping Workshop on June 28th Announced!

Posted by Webmaster on 26. April 2012 16:29

DOE-BTP's Building Envelope R&D Program, in association with the Window and Door Manufacturers Association (WDMA) has announced a "Windows Technology Roadmapping Workshop this summer in Bloomington, Minnesota! The workshop will take place at The Hotel Sofitel Minneapolis on June 28th from 10:00am-2:00pm in conjunction with the WDMA Annual Technical Conference. All windows technology stakehold... [More]

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Final Remarks

- The USA had initiated unprecedented investment in envelope and window research, this will decline sharply, could end up with less than 25 percent labor buying power compared to 2002
- New technology will be essential to achieve low carbon, low energy buildings, and to develop more affordable solutions for existing building stock
- Envelope investment has essential role to reduce HVAC loads and has a longer life cycle – lost opportunity if not done now!
- Stakeholder input is highly valued, has played major role in the past

Contact Information

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www.eere.doe.gov

www.eereblogs.energy.gov/buildingenvelope

Reference Material

Window Pathway

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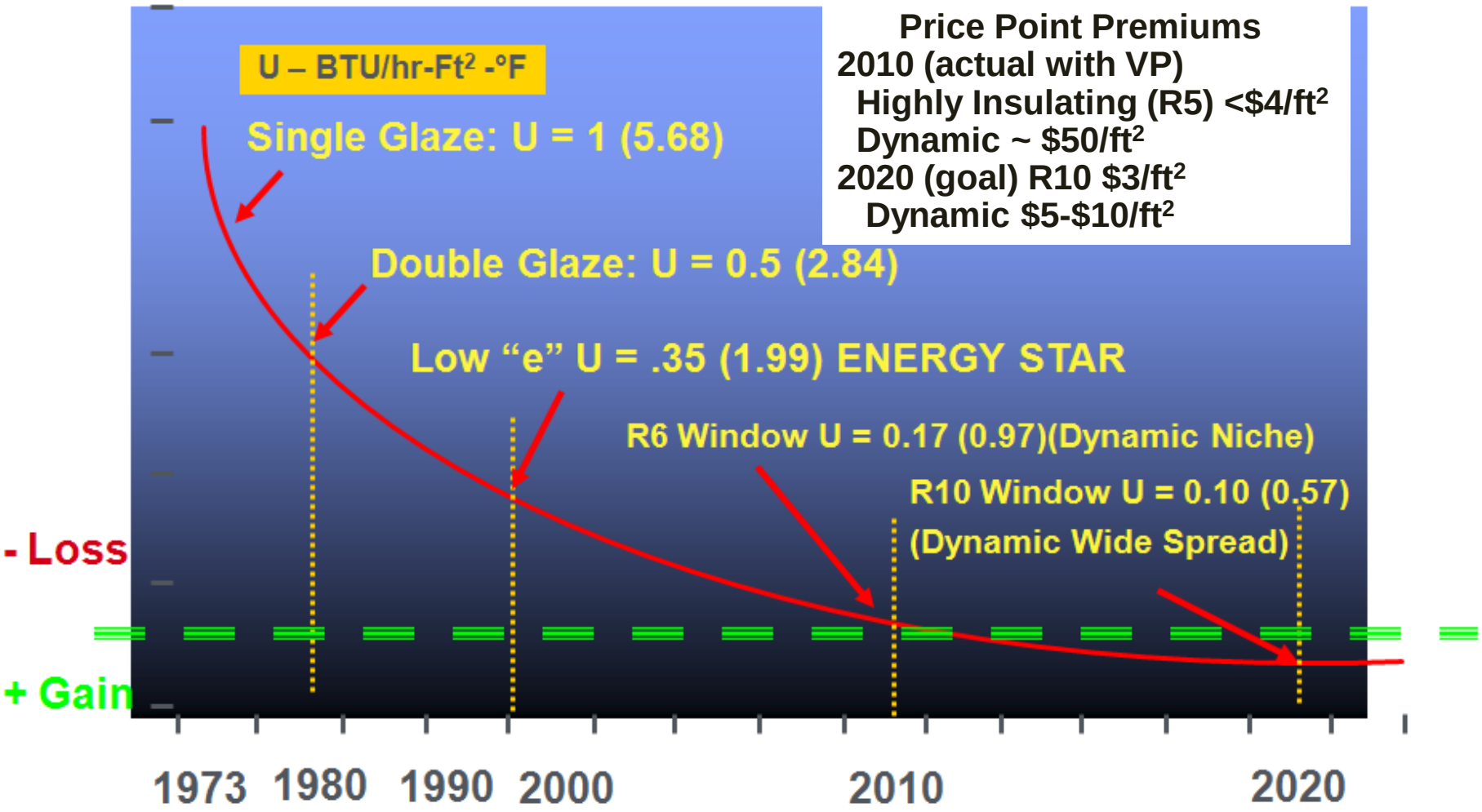
Advanced Windows Can Become Energy Producers

(US Mixed and Northern Climates)



Price Point Premiums

2010 (actual with VP)

Highly Insulating (R5) <$4/ft²

Dynamic ~ $50/ft²

2020 (goal) R10 $3/ft²

Dynamic $5-$10/ft²

Next Generation of Windows

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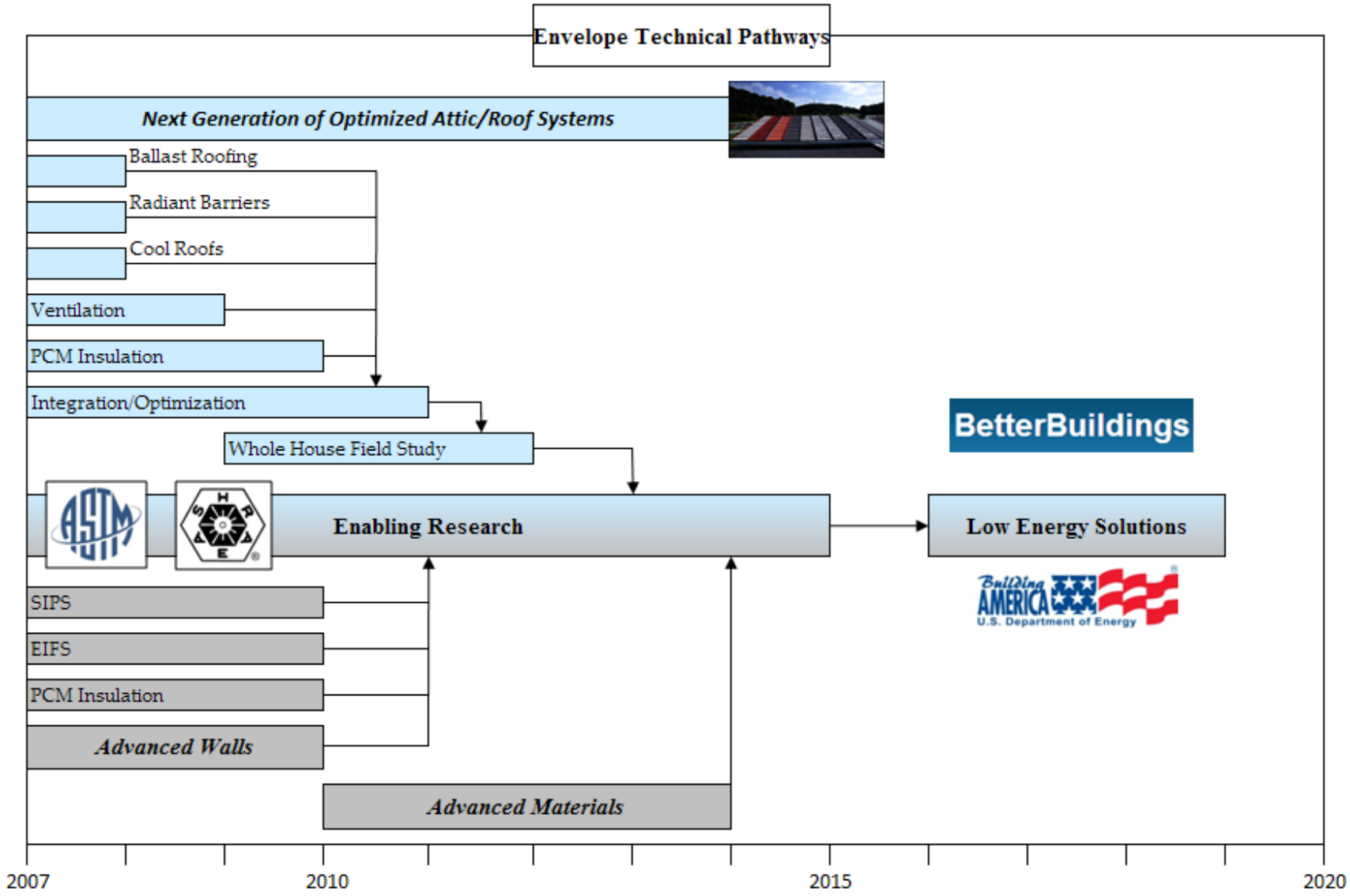
- Highly Insulating
  - Goal U value 0.10 (SI U value 0.56)

  Vacuum glazing have the greatest potential for high light transmission
- Dynamic solar control
  - Passive heating and dramatic peak cooling reduction, SHGC 0.53 – 0.09

  Market ready, prices will drop with more investment
  - Many new projects underway, competitive market in 2012 - 2014

Prototype – Concept Window (Highly Insulating and Dynamic U Value 0.18 (SI U value 1.0) SHGC 0.04 – 0.34) Low cost unsealed center lite

Envelope Pathway



Thermal Envelope R&D

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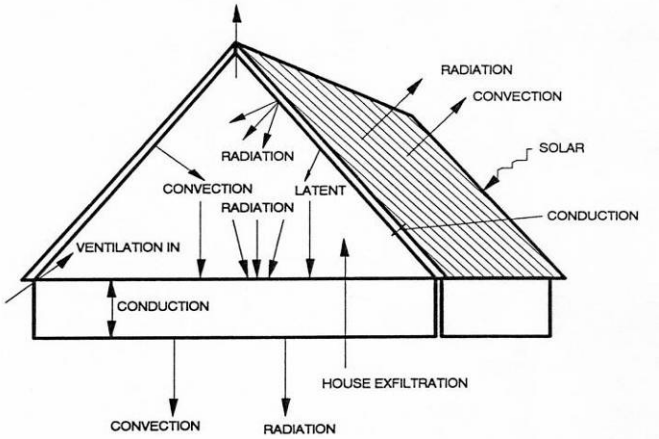
- Next Generation of Attic/Roof System to save 50 Percent Energy
- Advanced walls to reach R20 (U = 0.28 SI) in 3.5" (9cm) cavity, exterior insulation systems, R30 (U = 0.19 SI) total wall exterior insulation systems
- New Material Development
  - 100 R&D Award in 2009 for phase change insulation
  - Higher performing foams and aerogels
  - Dynamic membranes
  - Advanced cool roofs



Recent Financial Opportunity Announcement Technical Targets

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High Performance Thermal Insulation	
Requirements	**Targets**
R-value/inch (°F·ft^2·h/Btu-in)	≥ 8
Material cost	≤ \$0.08/ft^2 per *R* value
Installation cost	Equal to or less than installation cost for comparable solutions
Appearance	Aesthetically attractive (if visible) < 1" thickness

Advanced Roof/Attic Solutions	
Requirements	**Targets**
Energy Consumed for Roof/Attic System (reduction in roofing related thermal load)	35 percent less than 2009 IECC Building Code
Installed Cost per Square (100 sq ft)	≤ \$300 per 100 ft^2
Ease of Installation	Less time than conventional roofs

Highly Insulating Windows	
Requirements	**Targets**
U-value (1/*R*-value)	0.14 – 0.10 Btu /°F·ft^2·h (R-7 to R-10 in °F·ft^2·h/Btu)
SHGC (no dynamic control) SHGC (with dynamic control)	≥ 0.30 ≤ 0.18 and ≥ 0.45
Price premium (highly insulating only) Price premium (highly insulating with dynamic control)	≤ \$5/ft^2 ≤ \$12/ft^2·

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Estimated Residential Load and Impact by Component

Quads	Residential Load			Source Contributions	Combined Total
	Heating	Cooling	Total		
Windows	1.55	1.02	2.57	0.50	3.07
Infiltration	1.70	0.50	2.20		2.20
Walls	1.16	0.30	1.46		1.46
Roofs	0.75	0.44	1.18		1.18
Foundations	0.88		0.88	0.20	1.08
Total	6.04	2.25	8.29	0.70	8.99

Source: Draft Report - Energy Savings Potential of Building Envelope and Windows Technologies, Winbuild.

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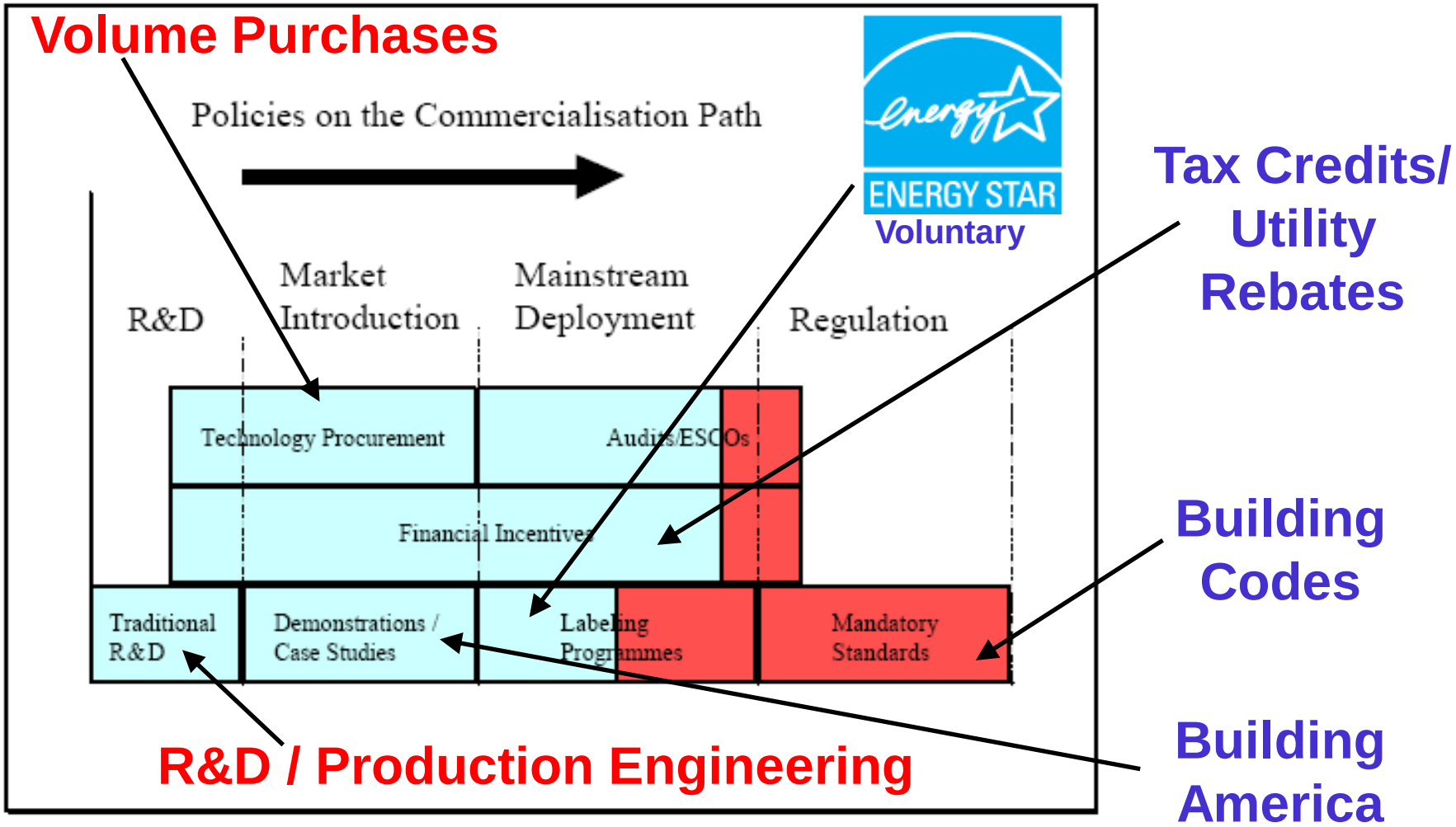
Estimated Commercial Load and Impact by Component

Quads	Commercial				Source Contributions	Combined Total
	Heating	Cooling	Ventilation	Total		
Windows	0.64	0.79		1.44	0.53	1.97
Infiltration	0.52			0.52	0.07	0.59
Walls	0.59			0.59	0.01	0.61
Roof	0.35	0.03		0.38		0.38
Foundations	0.32			0.32	0.10	0.42
Fresh Air	0.44		1.68	2.12	0.08	2.20
Total	2.86	0.82	1.68	5.36		6.16

Source: Draft Report - Energy Savings Potential of Building Envelope and Windows Technologies, Winbuild.

Integrated Policies to Push Technology (Window Example)



Conduct Enabling Research

- Test protocols
- Design guidelines
- Modeling tools
- Industry standards
- Education Materials

Knowledge Base for Stakeholders

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Efficient Windows Collaborative

www.efficientwindows.org

NFRC

National Fenestration Rating Council

www.nfrc.org

Windows for High Performance Commercial Buildings

www.commercialwindows.org/

High Performance Volume Purchase Program

www.windowsvolumepurchase.org

Window Attachments

www.windowattachments.org/

www.eereblogs.energy.gov/buildingenvelope

High Quality Performance Impacts of Innovative Products

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Measurement of Interior and Exterior Blinds at LBNL

NY Times Building Automatic Blinds and Lighting

Exterior Insulation Finishing Systems (EIFS)

Air Barriers at Syracuse University