

Building Technologies Program

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



US DOE Roadmap
Windows for Today and Tomorrow

AAMA Meeting, Minneapolis
June 7, 2011
Marc LaFrance

Energy Efficiency

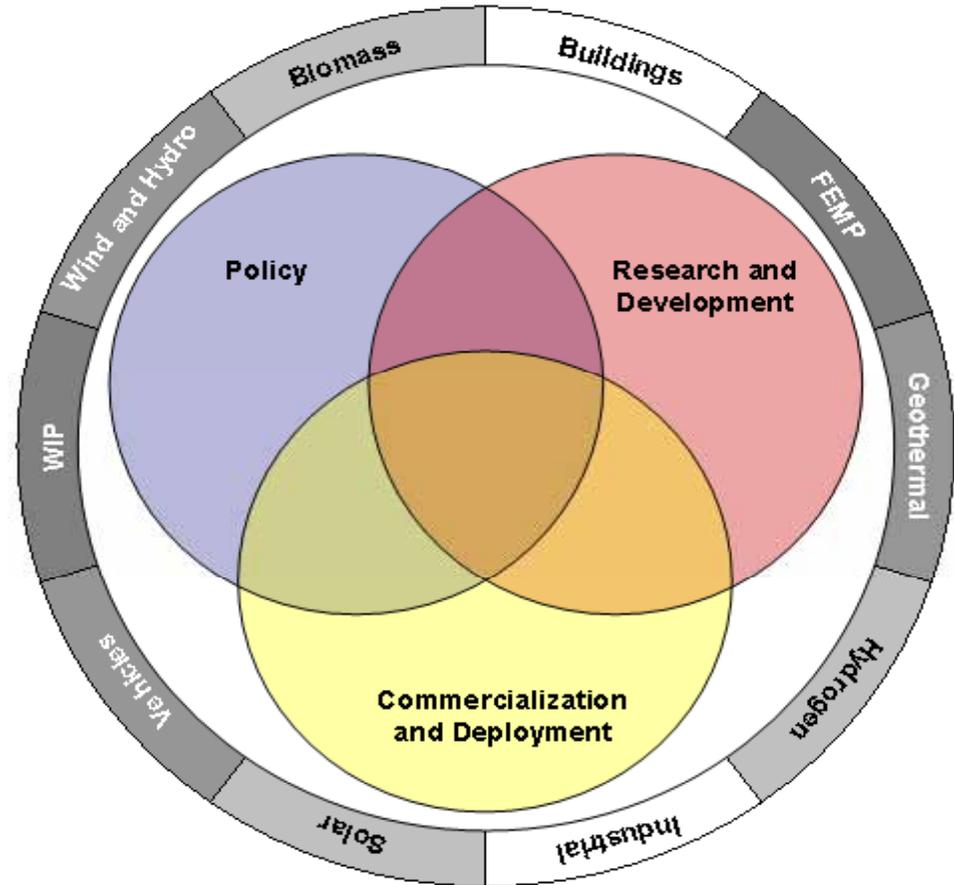
- **Buildings**
- Industrial
- Federal Energy Management
- Weatherization and Intergovernmental

Advanced Transportation

- Biomass
- Fuel Cells
- Advanced Vehicles

Electric Power Generation

- Geothermal
- Solar
- Wind
- Hydropower & Advanced Water Power

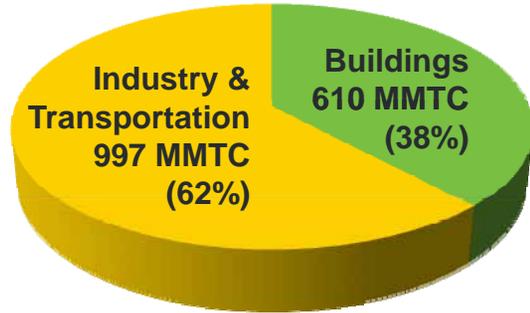


Mission Statement

To develop cost competitive technology, facilitate commercialization and deployment to the marketplace

US Building Energy Use and Carbon Emissions

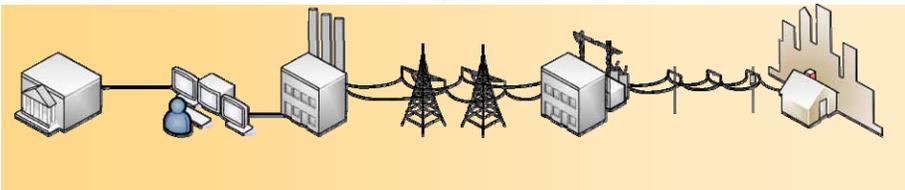
38% of U.S. Carbon Emissions



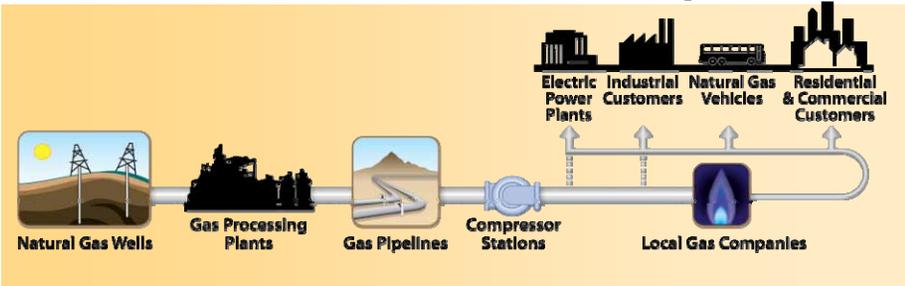
39% of U.S. Primary Energy Consumption



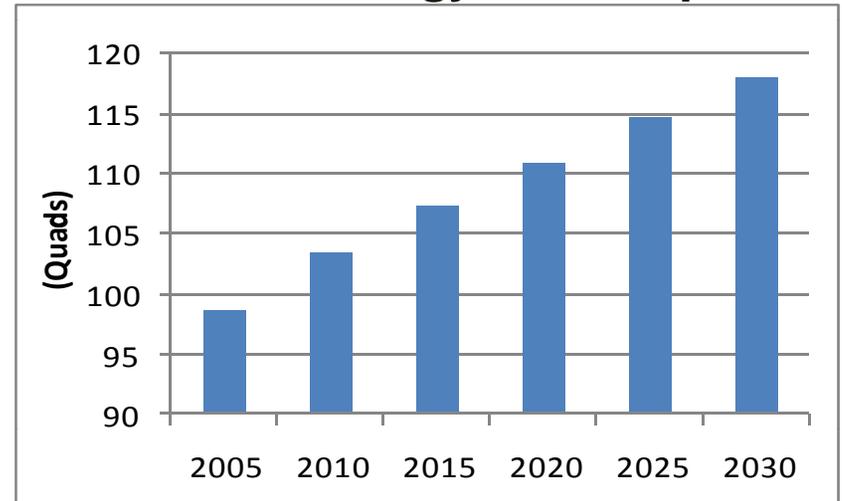
72% of U.S. Electricity Consumption



54% of U.S. Natural Gas Consumption



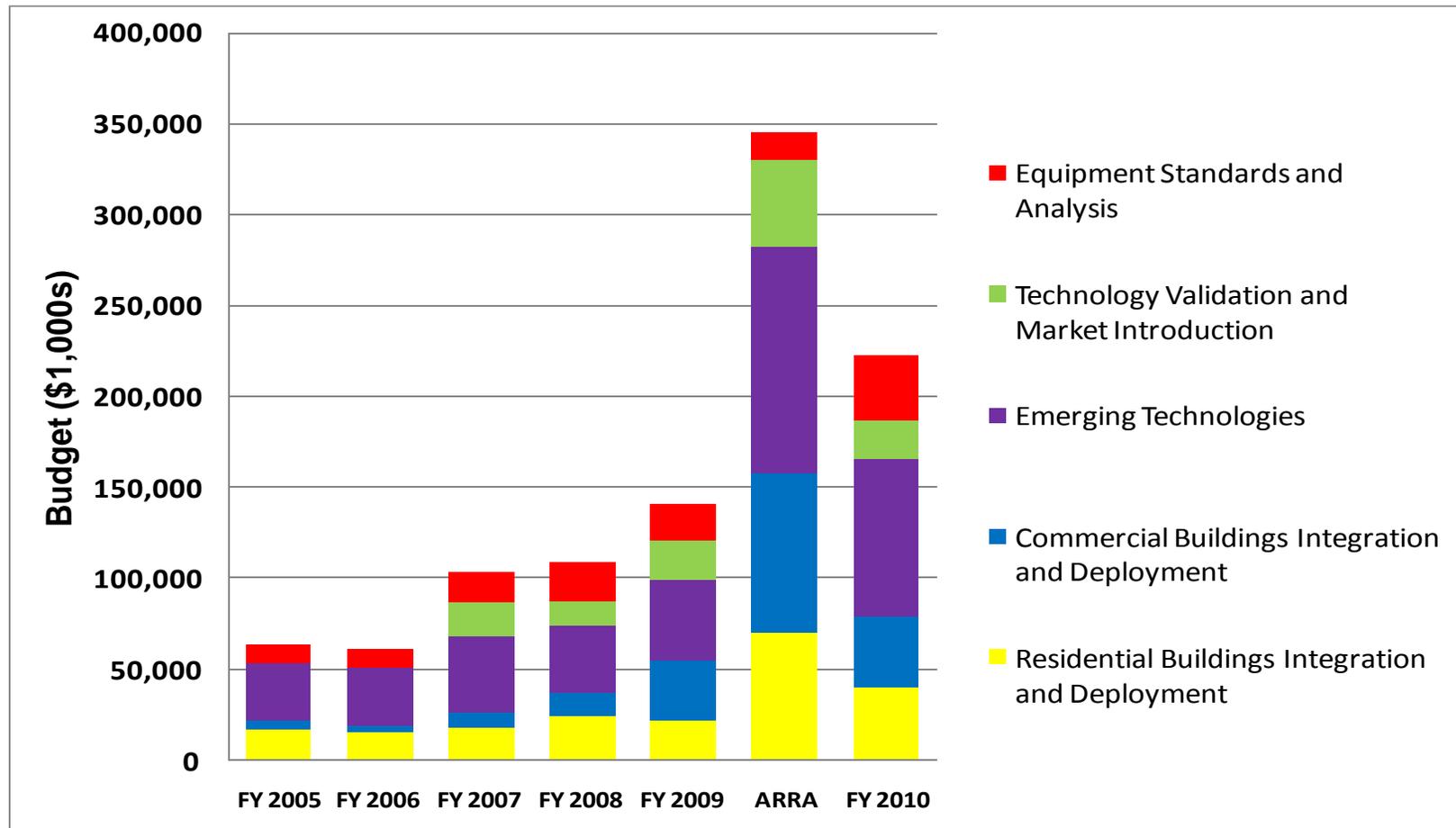
Total U.S. Energy Consumption



Sources: BED 2009; AEO 2010

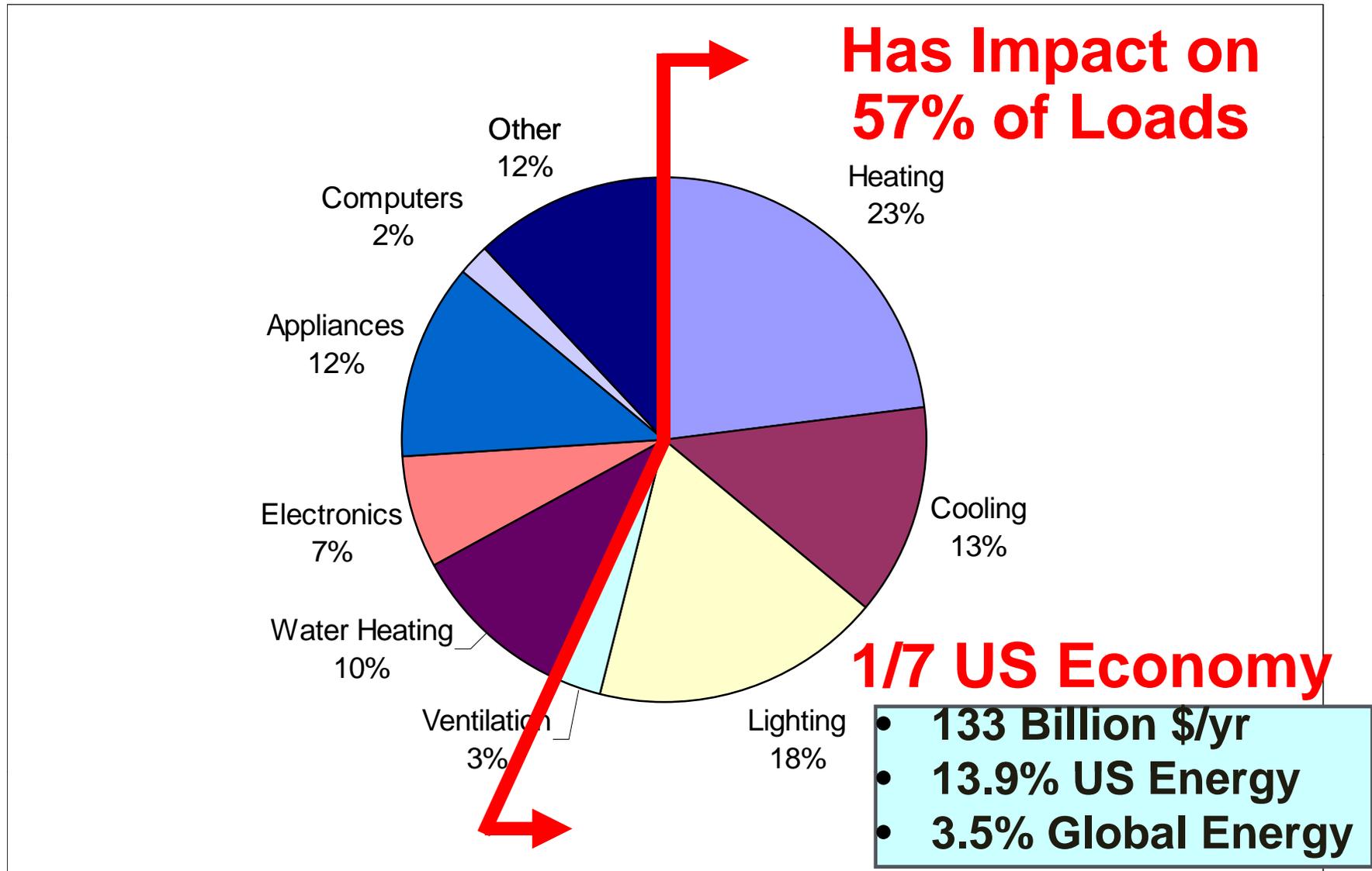
BTP's funding has increased dramatically over the past 5 years.

Budget History



Source: U.S. DOE

Building Consumption – Envelope Relationship



Total Building Envelope and Window R&D Budget

| | Administration 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 | 10.5M Windows 5.5M Envelope | ARRA 27M |
| FY 11 | 10.5M Windows 8.5M Envelope | 10.5M Windows 5.5M Envelope | |
| FY 12 | 25 M (9M BIPV) | TBD | |

Next Generation of Windows

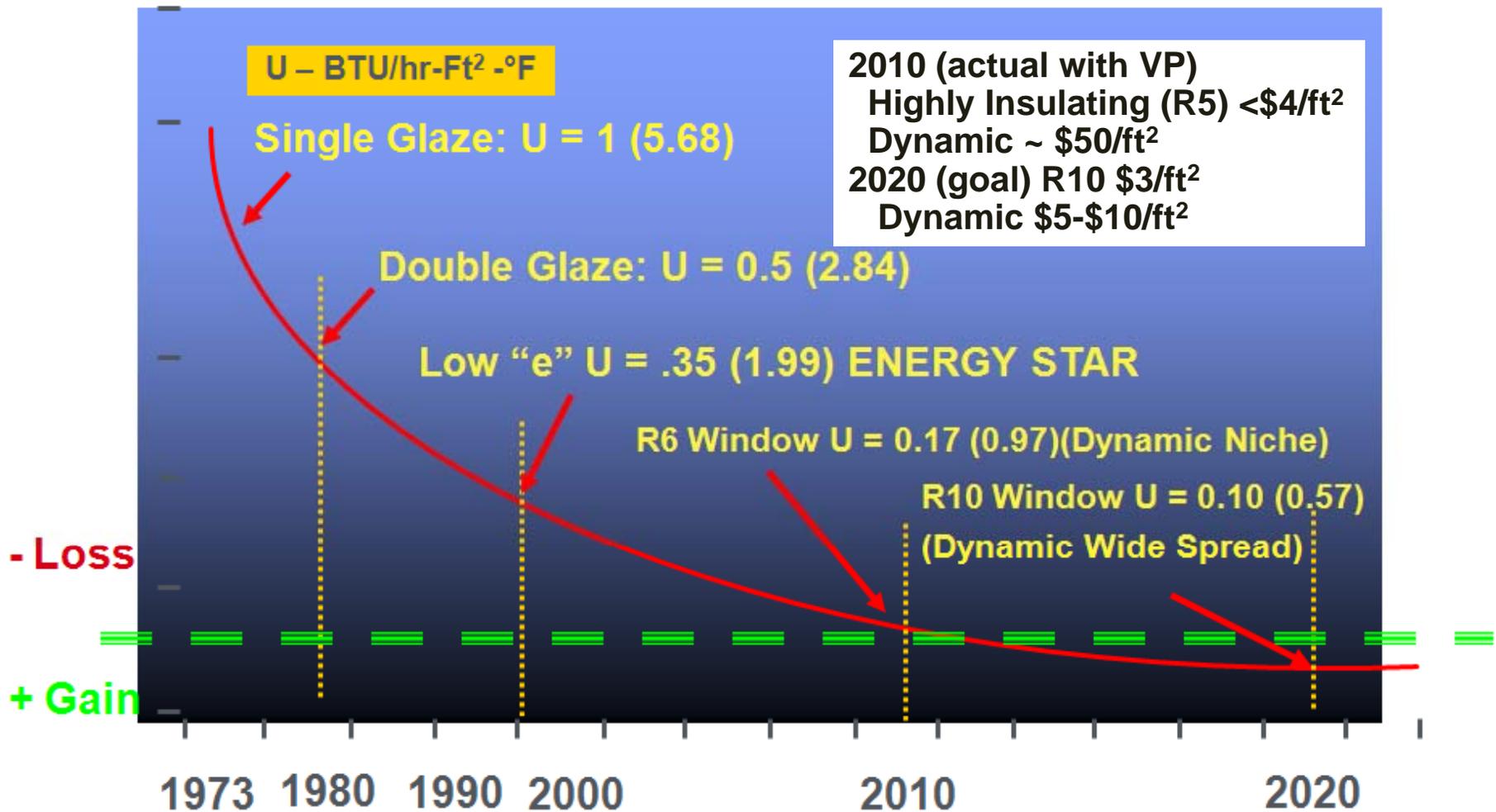
- **Highly Insulating**
 - Goal U value 0.10 (SI U value 0.56)
 - Vacuum glazing have the greatest potential for high light transmission
- **Dynamic solar control**
 - Passive heating and dramatic peak cooling reduction, SHGC 0.53 – 0.09
 - Market ready, prices will drop with more investment
 - Many 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**

Window Pathway

Advanced Windows Can Become Energy Producers
(US Mixed and Northern Climates)



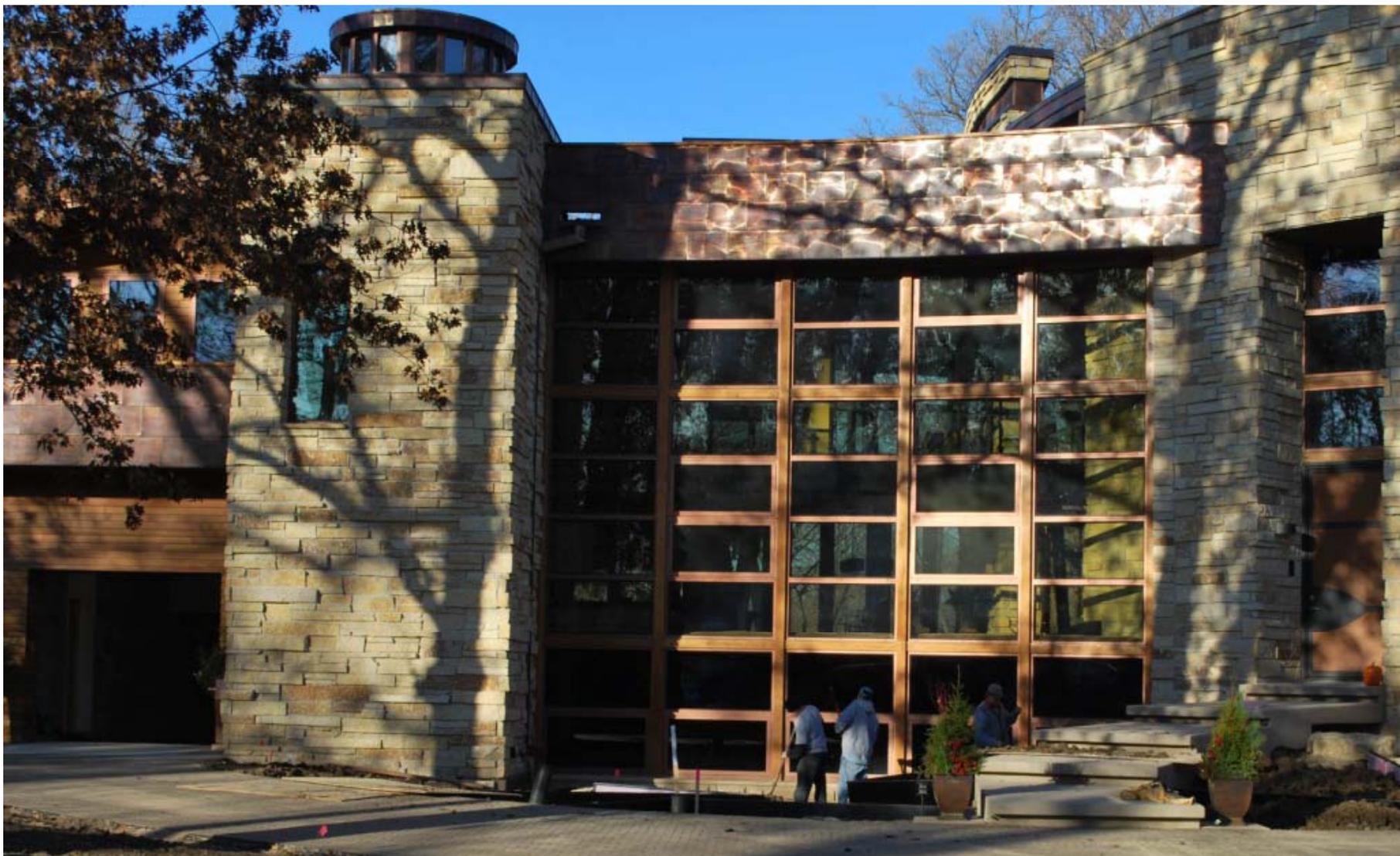
Dynamic Windows – Cost Neutral within 5 Years (No blinds < HVAC)

DeHority Hall, Ball State University **Muncie, IN**

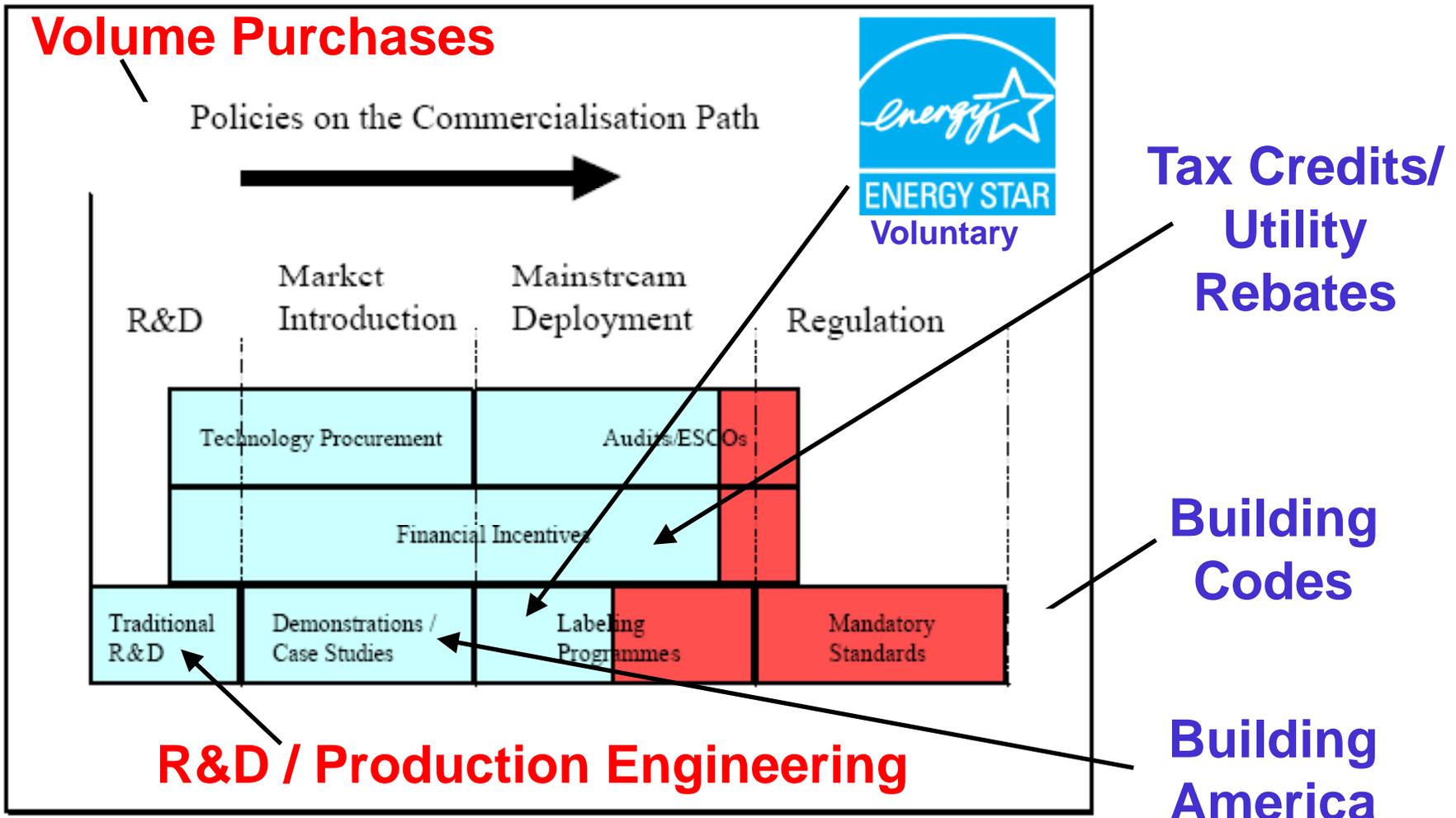


Courtesy of Sage

Commercialization of Highly Insulating Dynamic Window in FY10



South facing large residential home in MN – Courtesy Sage Electrochromics



Integrated Programs to Reduce Price of Highly Insulating Windows

Building America demonstrations/ production housing

High-performance specs in LEED for Homes & NGBS

Production Engineering RFP – 50%
Cost Share

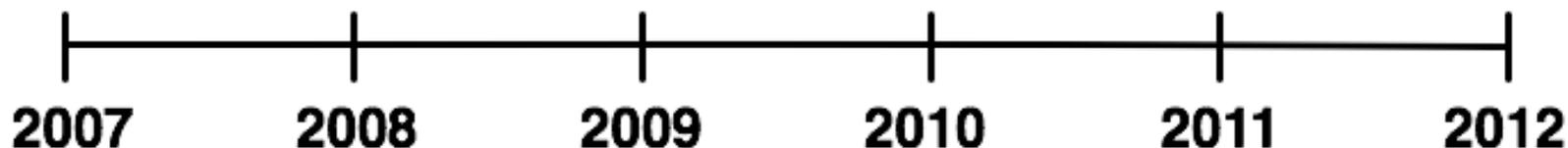
Technology Procurement/Volume Purchases
– Multifamily/Public Housing/Condo, Builders, etc

Develop
advanced utility
program specs

Utility programs for advanced
windows

ENERGY STAR spec revision

Phase II



Windows Volume Purchase Phase I R-5 (U=0.2-0.22) and Low-E Storm

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**Educate Buyer Groups
March 2009 – continuing**

**Develop Draft Solicitation
Specifications with Buyers and
Industry
July – November 2009**

Issue Solicitation – Dec 2009

Responses Due – Feb 2010

**Finalize Agreements with
Qualified Vendors April – 2010**

**Promote Qualified Products
June 2010 – continuing**

**40 Certified
Suppliers
(9 of 16 top window
companies by sales)**



Volume Purchase Program Specifications

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Final Windows and Low-E Storm Windows Specifications and Certifications

High Performance Windows

- U-factor: **0.20-0.22**
- Air leakage: **≤ 0.30 cfm/ft²**
- Certifications: **NFRC/NAFS**
- Warranty (yr): **20 glass/10 non-glass**
- NFRC label required
- NAFS 05: Performance Grade R25

Low-e Storm Windows

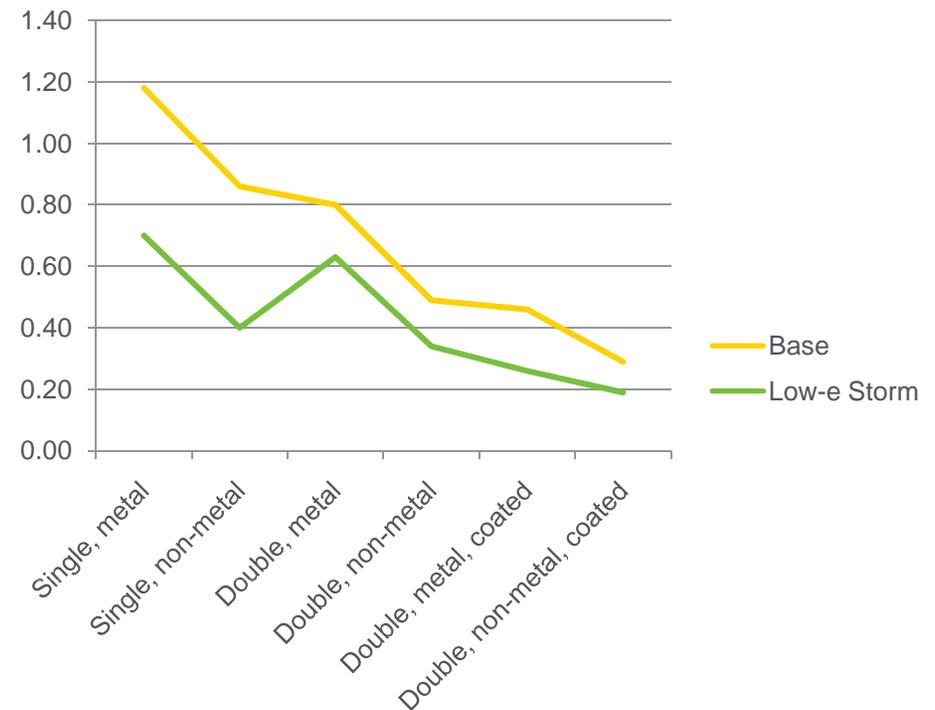
- Emissivity: **<0.22**
- Structural test: **ANSI/AAMA 1002.10-93**
- Registry: **IGDB (LBNL database)**
- Warranty (yr): **10 glass/non-glass**



Low-E Storm Window Performance Improvement

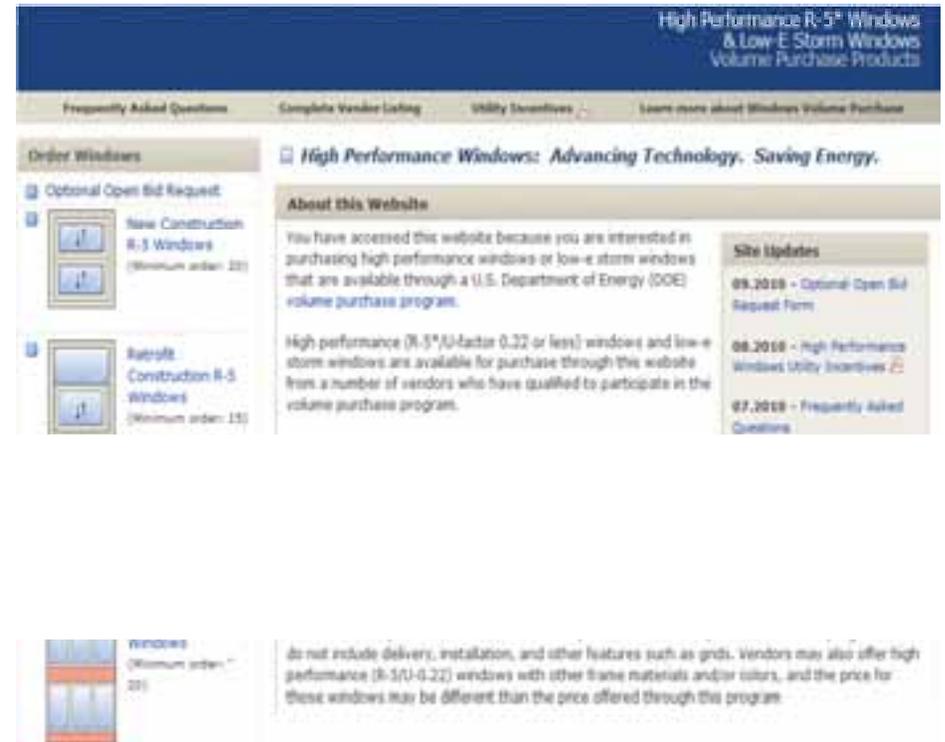
| Existing Window | Base | | With low-E Storm | |
|---|----------|------|------------------|------|
| | U-factor | SHGC | U-factor | SHGC |
| Single pane, metal frame (eg aluminum) | 1.18 | 0.78 | 0.70 | 0.61 |
| Single pane, non-metal frame (eg wood or vinyl) | 0.86 | 0.68 | 0.40 | 0.52 |
| Double pane, metal frame, no coating | 0.8 | 0.7 | 0.63 | 0.57 |
| Double pane, non-metal frame, no coating | 0.49 | 0.6 | 0.34 | 0.48 |
| Double pane, metal frame, low-e coating | 0.46 | 0.6 | 0.26 | 0.48 |
| Double pane, non-metal frame, low-e coating | 0.29 | 0.5 | 0.19 | 0.38 |

Effects of adding Low-e storm windows to existing windows



www.windowsvolumepurchase.org

- Cost effective residential R5 (U value 0.2) windows (~ \$2 to \$4 / sq ft price premiums), several < \$250 per 15 sq ft double hung
- Cost effective low e storm



R-5 Window Example

**A highly-insulating building envelope not only saves substantial energy...
but can allow for up-front savings in HVAC system costs.**

- High-performance windows are a critical link in the Building Envelope

Windows Area: 300 ft²
**Incremental Cost
for R-5 Windows:** *\$5/ft²
Total Cost: \$1500

Cost: \$1500

Savings: \$1000

Total: \$500

6-12 yr simple payback

*Consumer price premiums are
\$2-\$4 per sq ft, but wholesale base
cost to builders may be lower



**Reduced Duct
Savings:** \$450

**Reduced HVAC
Savings:** \$550

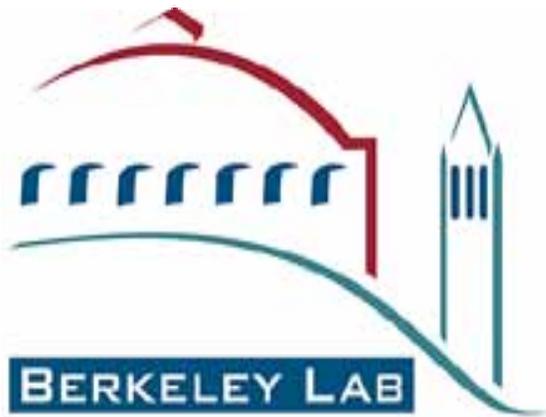
2000 ft² Home

Major Changes

- Commercial-grade products added
- Vendor's base bid prices to be shown
- Website to be redesigned including:
 - Searchable database
 - Descriptor box with distinctive features of products
- Optional pricing of smaller and larger quantities (20-49 is required bid quantity).

- January 24: Phase II solicitation released
- March 18: Priority deadline
 - Responses received after deadline will be processed in order received after bids meeting priority deadline have been processed.
- May 3: Phase II launch
- September 18: Deadline for entry into program.
- May 2012: End of Phase II

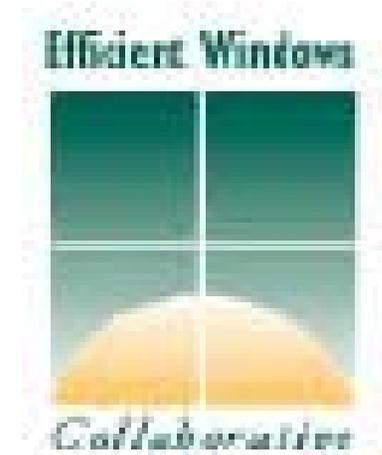
DOE Assists with Technical Support Activities



<http://windows.lbl.gov/software>



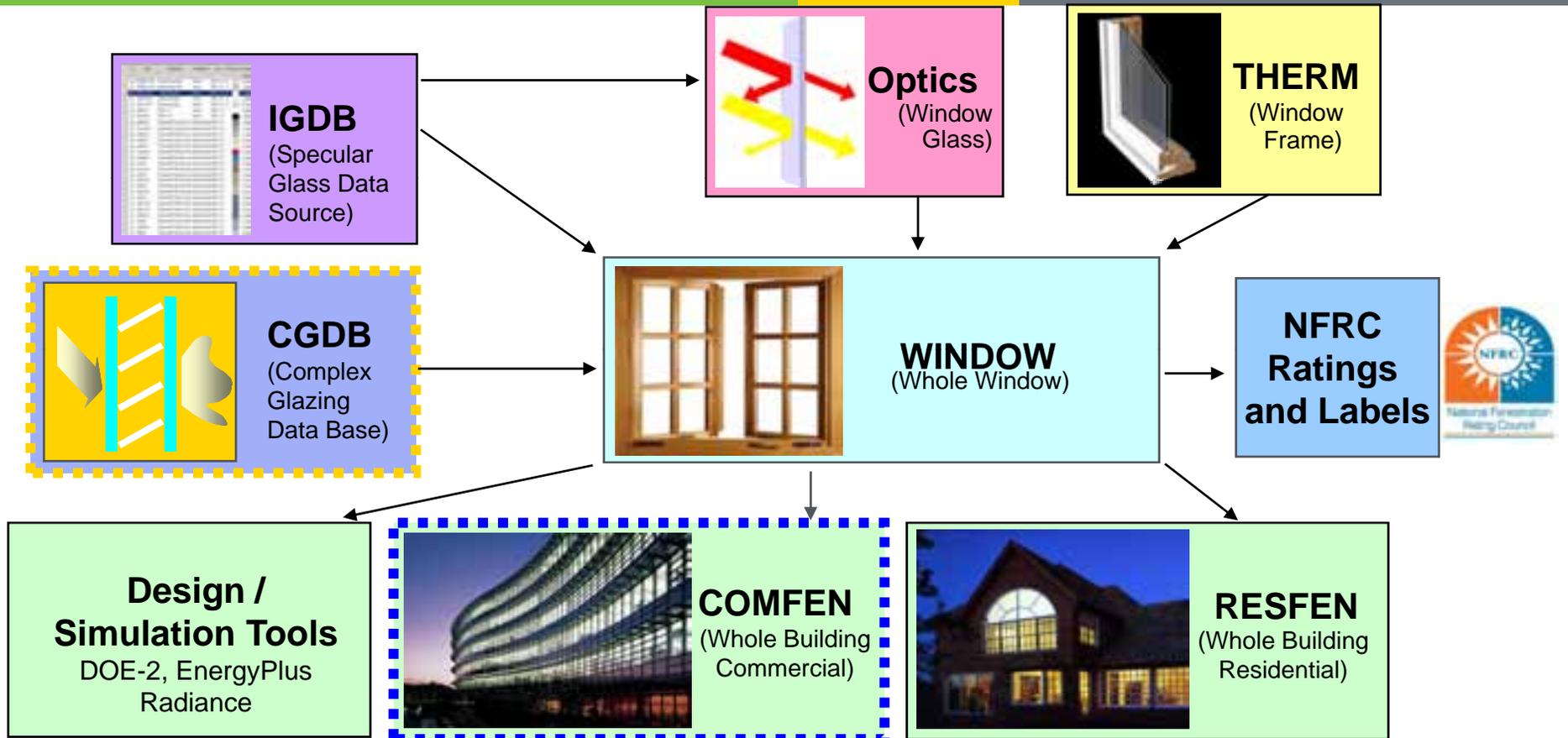
www.nfrc.org



www.efficientwindows.org

- Full range of software support tools, education materials and expansion to new product categories
- Continued financial support to assist industry in rating and promoting efficient products

WINDOW6 Software Suite



- Design tools for advanced products
- **ISO 15099 Compliant**
- **NFRC Ratings**

<http://windows.lbl.gov/software>



Window Film Retrofit Applications - energy, blast, hurricane, etc.

Look for new NFRC ratings



NFRC-Component Modeling Approach or CMA

- Calculates U-factor, SHGC and VT according to NFRC 100 and NFRC 200 as required by IECC and ASHRAE 90.1
- CMA is most efficient way to satisfy code for commercial fenestration
- Program launched in January 2010
- CMA software tool (CMAST) makes calculations using frame, glass, and spacer data
- Download software here:
www.nfrc.org/cmaprogram.aspx



Integrated Daylighting and Smart Window Demonstration in EE-1 Conference Room



Sophisticated Measurement of Interior and Exterior Blinds at LBNL



NY Times Building Automatic Blinds and Dimming Ballasts



Policy Example - Windows in NW ENERGY STAR Builder Option Packages

As of January 2011, the Northwest ENERGY STAR Homes Builder Option Packages include the following window performance requirements:

- U-factor requirements as stringent as 0.22
(for Washington homes with zonal electric, propane or oil heating)
- Minimum SHGC requirements for certain cases

| State | Heating type | U-factor | SHGC |
|---|------------------------------|----------------------|----------------------|
| WA | Natural gas, heat pump | ≤ 0.30 | ≥ 0.30 |
| | Zonal electric, propane, oil | $\leq \mathbf{0.22}$ | $\geq \mathbf{0.30}$ |
| MT, ID | Natural gas, heat pump | ≤ 0.30 | Any |
| | Zonal electric, propane, oil | ≤ 0.30 | ≥ 0.30 |
| OR | Natural gas, heat pump | $\leq 0.32/0.35^*$ | Any |
| | Zonal electric | ≤ 0.32 | > 0.42 |
| * For OR homes with gas furnaces or heat pumps, window requirements depend on other home design aspects | | | |

Key Policy Moving Forward ENERGY STAR (managed by EPA)

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- Phase II analysis should be based on new triple pane and double pane products
- Pursue window film and low e storm program for lower cost retrofit options – large disparity of products
- DOE to support EPA in moving ahead with Phase II ENERGY STAR criteria
- Most Efficient program to be pursued for 2012
- DOE originally proposed in 2008 a U value of 0.2 to 0.24 for Northern Climates with SHGC > 0.35 in the 2013 to 2014 timeframe

Key Policy Moving Forward

Tax Credits

- DOE does not have a “formal role” in tax credit formulation
- Last Congress Senator Bingaman and Snowe bill addressed modest criteria with modest monetary levels “Stimulus” and aggressive levels with large monetary levels “Energy Policy”
- DOE provides technical analysis and support for all types of policies when requested

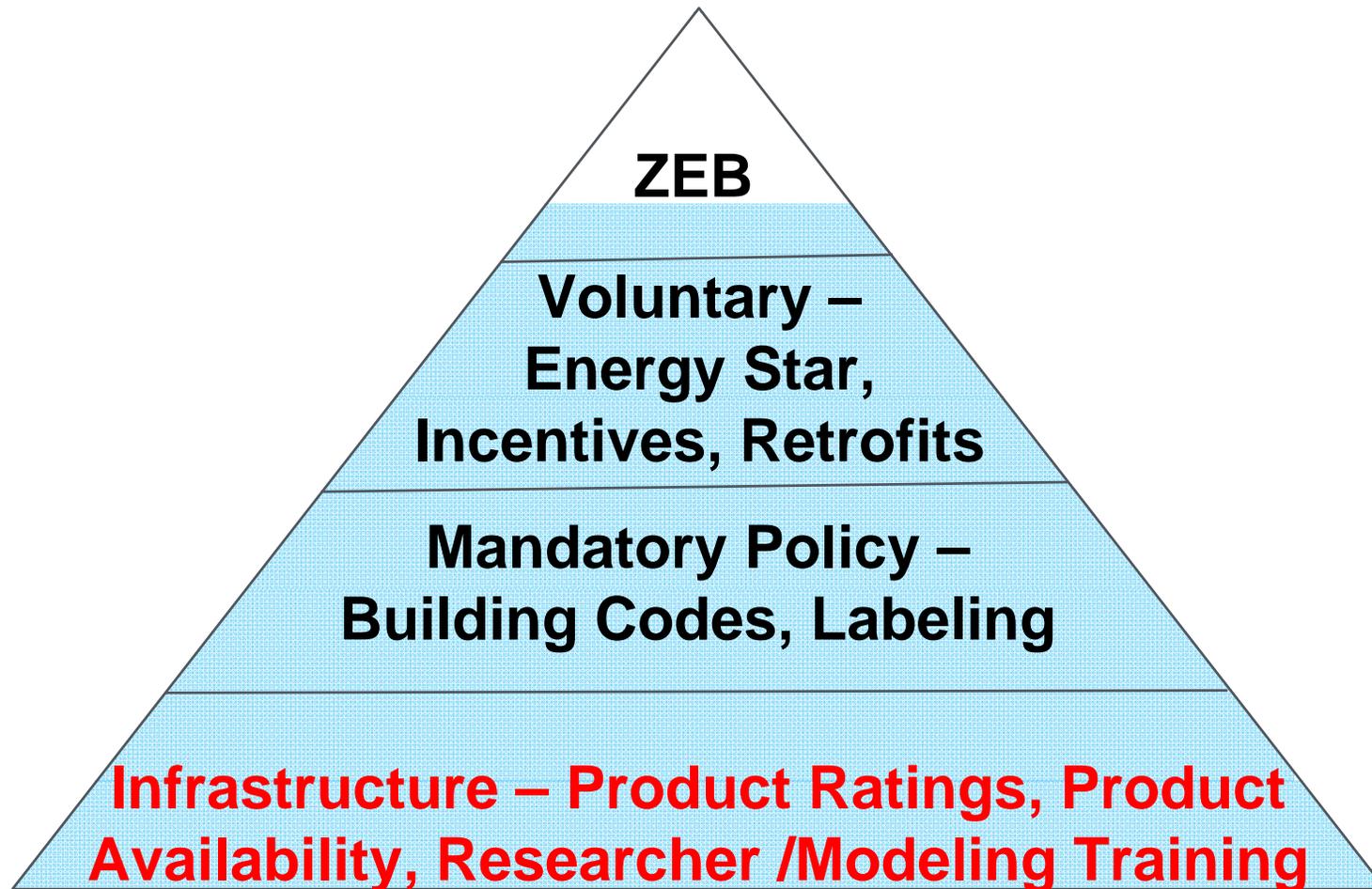
ARRA Major Effort Over the Next Two Years

- 23M for BTP1 and 4M for SBIR, total value with cost share is approximately 44M
- Major areas of new projects
 - Dynamic Windows
 - R10 Highly Insulating Windows
 - New Daylighting and lower emissivity window films
 - R5 commercial window production engineering
 - Demonstration of thermochromic windows and low e storm windows in commercial and hotter climates
 - High Performance Insulation and Wall Systems
 - Innovative Cool Roof static and dynamic new materials
 - Lower cost phase change materials

Window and Daylighting Technology Development

- **Soladigm, Inc.:** Low-Cost, High-Energy Savings, Solid State Dynamic Windows
- **Southwall Technologies, Inc.:** Low-Cost R10/High SHGC Heat Mirror® Window Development
- **Applied Materials, Inc.:** Technology for Low-Cost Electrochromic Dynamic Windows
- **EverSealed Windows, Inc.:** High Reliability R10 Using High Windows Using
- **SAGE Electrochromics, Inc.:** Electrochromic Glazing Technology: Improved Performance, Lower Price
- **Quanta Technologies, Inc.:** Low-E Retrofit Demonstration and Educational Program
- **Traco Delaware, Inc.:** Production Engineering for R5 and Higher Windows
- **3M:** Polymeric Multilayer Infrared Reflecting Mirrors
- **Pleotint LLC:** Demonstration with energy and daylighting assessment of Sunlight Responsive ThermoChromic (SRTTM) Window Systems
- **CPFilms, Inc.:** Low-Emissivity Energy-Control Retrofit Window Film

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



- Significant investment in envelope technologies in US, Canada and Northern Europe
- Huge global opportunity for envelope even in a highly developed country such as Japan that has invested mostly in high performance mechanical equipment
- Opportunity for major developing economies, China, India, APEC, etc
- US leads the world in envelope product testing and rating systems, NFRC and CRRC
- Major progress with window rating system implementation, Australian, South Africa, India, and China (in partnership with industry)
- Areas with developing interest, South East Asia, Jordan/Middle East, Brazil, Mexico
- Significant collaboration with Japan, ZEB Low Carbon Buildings, Hawaii-Okinawa Initiative – Obama Agreement

Infrastructure Required to Support Voluntary Programs & Building Codes

- Encourage environment to foster investment in clean technology
- Cannot effectively implement policies without robust product rating and certification programs
- Best to promote ISO standards (e.g. windows ISO 15099), however effort is needed to develop one comprehensive standard integrating 10077 and 15099
- Goal is to achieve 100 percent low e glass sales globally

Key Elements are Interrelated and Work to Achieve Results

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 deeply enough
- Core problems include lack of product ratings, product availability, lack of knowledge

www.eereblogs.energy.gov/buildingenvelope

Building Envelope and Windows R&D Program Blog
Advancing Technology, Saving Energy

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Thursday, December 06 2010

Draft Roof and Attic Design Guide now Available for Review

Posted by Eric Jones on 1 December 2010 10:55

NOW ACCEPTING COMMENTS: A draft of our New Roof and Attic Design Guide for Hot Climates is now available for review. These guidelines give homeowners and builders the tools to make informed decisions on the most economical and best practices for renovating a home's roof and attic. The guide includes information on new designs and conventional strategies for saving money by improv. [\[More\]](#)

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DOE Building Envelopes Roadmap Workshop at Buildings XI

Posted by Walter Zalk on 18 November 2010 17:51

Workshop Alert! Please join members of the Building Envelope R&D Program as Oak Ridge National Laboratory hosts the 11th International Conference on Thermal Performance of the Exterior Envelopes of Whole Buildings on December 3-5, 2010 in Clearwater Beach, Florida. This conference focuses on both the research principles and practical applications of building technologies. DOE's envelope. [\[More\]](#)

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Draft Cool Roof Roadmap Now Available for Review!

Posted by Walter Zalk on 18 November 2010 13:25

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Major Accomplishments

| FY10 Major Accomplishment | |
|---|--|
| 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 |

| Envelope and Windows Major Program Accomplishments (2002 – 2009) | |
|--|---|
| 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 |

- Feedback on DOE priorities for technology development and enabling research – what is important?
- Industry’s perspective on allocation of resources – what should the portfolio look like?
- Industry’s perspective on DOE supporting effort that directly helps industry sell energy efficient product – why is this DOE’s role?
- Improved communications with government policy developers and impacted industry – what should DOE do differently?

Contact Information

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