Building Consumption – Envelope Relationship

Has Impact on 57% of Loads

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

1/7 US Economy
## Total Building Envelope and Window R&D Budget

<table>
<thead>
<tr>
<th>Year</th>
<th>Administration Budget Request</th>
<th>Enacted Appropriations</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY04</td>
<td>5.1M</td>
<td>8.2M</td>
</tr>
<tr>
<td>FY05</td>
<td>5.0M Windows 0 Envelope</td>
<td>5.8M Windows 2.8M Envelope</td>
</tr>
<tr>
<td>FY06</td>
<td>5.0M Windows 0 Envelope</td>
<td>*3.8M Windows (*earmarks) 2.9M Envelope</td>
</tr>
<tr>
<td>FY07 &amp; FY08</td>
<td>4.7M Windows 2.4M Envelopes</td>
<td>4.7M Windows 2.4M Envelope</td>
</tr>
<tr>
<td>FY09</td>
<td>5.2M Windows 3.4M Envelopes</td>
<td>5.5 Windows 4.5 Envelope</td>
</tr>
<tr>
<td>FY10</td>
<td>10.5M Windows 5.5M Envelope</td>
<td>Core ARRA ~ 25M</td>
</tr>
<tr>
<td>FY11</td>
<td>10.5M Windows 8.5M Envelope</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Thermal Envelope R&D

• Advanced walls to reach R20 in 3.5” cavity, exterior insulation systems, R30 total wall – major EIFS activity

• Next Generation of Attic/Roof System to save 50 Percent Energy

• New Material Development
  – 100 R&D Award in 2009 for phase change insulation
  – Higher performing foams and aerogels
  – Dynamic membranes
  – Advanced cool roofs
Conduct Enabling Research

- Test protocols
- Design guidelines
- Modeling tools
- Industry standards
- Education Materials
What is a Cool Roof?

CRRC only looks at **surface** properties:

- Solar Reflectance
- Thermal Emittance

CRRC does **not** set minimum requirements
A low-sloped roof (pitch less than or equal to 2:12) must be designed and installed with a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council program, or with a minimum 3-year aged solar reflectance index (SRI) of 64 in accordance with ASTM Standard E1980-01. Steep-sloped roofs (pitch exceeding 2:12) must have a 3-year aged SRI of 29 or higher.

Requires R30 insulation
Low-Flammable PCM-Enhanced Cellulose Insulation

Recycled Paper Waste

Polymer coating

Bio-Based PCM
Fp: ca. 80F
Δ H: 170 J/g

5 - 25 µm
Next Generation of Windows

• **Highly Insulating**
  – Goal U value 0.10 (SI U value 0.56)
  – Possible vacuum glazings

• **Dynamic solar control**
  – Passive heating and dramatic peak cooling reduction, enables daylighting, 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
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
- Glass thickness: 3 mm minimum
- Structural test: ANSI/AAMA 1002.10-93
- Registry: IGDB (LBNL database)
- Warranty (yr): 10 glass/non-glass
- Registration in International Glazing Database (LBNL)
Volume Purchase Program
Results/Plans

- Cost effective residential R5 (U value 0.2) windows (~$2 to $4 / sq ft price premiums)
- Cost effective, low e storm windows (~$7 to $9 / sq ft)
- 40 certified partners
- Phase II beginning now – expand to commercial punched openings and will have product categories for very high structural requirements
- See PNNL/Energetics at Greenbuild (DOE Building America booth)

www.windowsvolumepurchase.org
DOE Assists with Technical Support Activities

- 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

Design / Simulation Tools
DOE-2, EnergyPlus Radiance

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

http://windows.lbl.gov/software
Façade Design Tool

http://www.commercialwindows.org
Performance Impacts of Products

Sophisticated Measurement of Interior and Exterior Blinds at LBNL

NY Times Building Automatic Blinds and Dimming Ballasts
Integrated Daylighting and Smart Window Demonstration at DOE Headquarters
ARRA Will Be a Major Effort to Manage Over the Next Three 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 Vacuum Insulating Glass Units
- 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
Envelope Technology Development

- **Dow Chemical**: Advanced Insulation for High-Performance, Cost-Effective Wall, Roof and Foundation Systems
- **Syntroleum**: Development of Low-Cost Bio-Based Phase Change Material
- **Industrial Science & Technology Network, Inc.**: Advanced Building Insulation by CO2 Foaming Process
- **United Environment & Energy LLC**: Bio-Based Thermochromic Intelligent Roof Coating
- **Technova Corporation**: Shape-Stable and Highly Conductive Nano-Phase Change Materials
- **Nanotrons Corporation**: Nano-Enabled TiO2 UV Protective Layer for Cool-Color Roofing Application
Roadmap Stakeholder Workshop

- Buildings XI - Exterior Envelopes of Whole Buildings Conference on December 5-9, 2010 in Clearwater Beach, FL
- Envelope and Windows Roadmap Workshop, December 9, 2010, 1 – 5 PM
- Release of new Cool Roof Roadmap, update of Multi-Year Plan for other activities

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