CRRC Meeting in Washington

Buildings R&D and ZEBs

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Office of Energy Efficiency and Renewable Energy

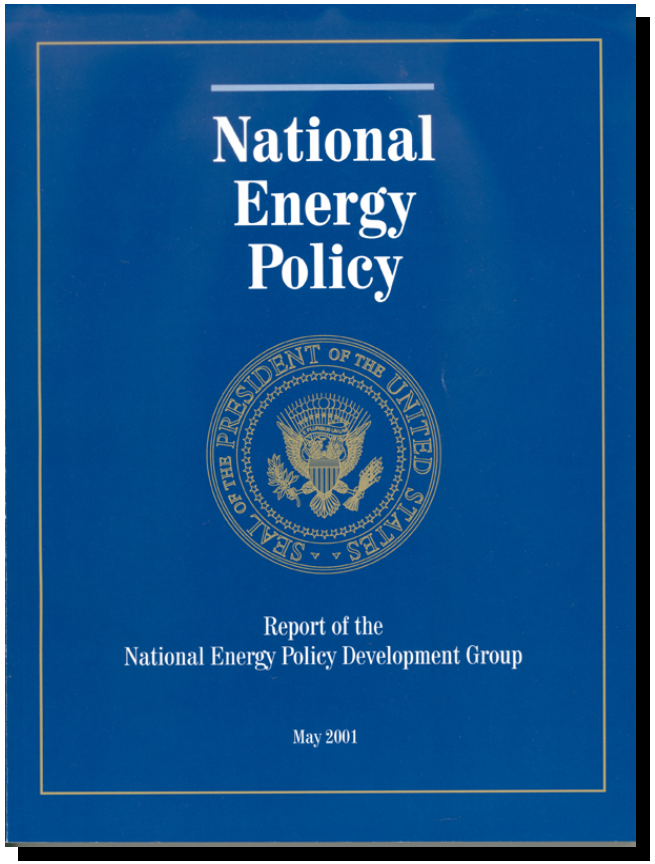
US Department of Energy

Presentation Overview

- Background on Office of Energy Efficiency and Renewable Energy
- Building Technology Program – Major Activities
- Windows and Envelope R&D

US National Energy Policy

- Reduce demand through energy efficiency
- Increase domestic supplies
- Maintain diversity of fuels
- Upgrade energy infrastructure
- Continue to protect the environment
- Provide a vision for a sound energy future

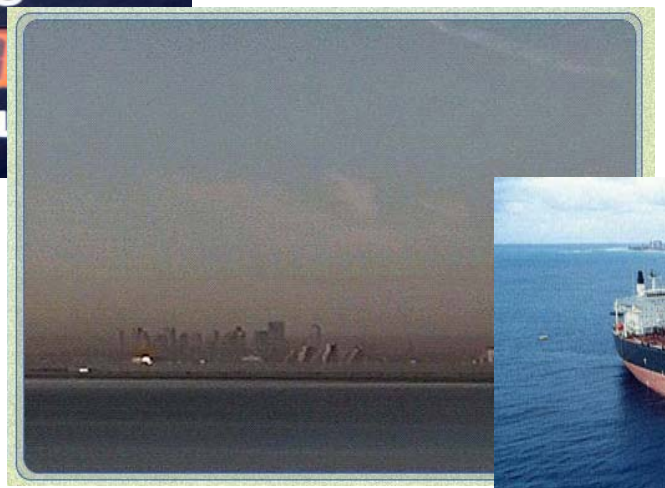


U.S. Department of Energy
Energy Efficiency and Renewable Energy

EERE Addresses Complex Energy Issues

- A vulnerable national energy infrastructure
- Rising fossil fuel prices

- Increasing dependence on foreign oil
- Environmental impacts associated with energy use



EERE Programs

- Biomass
- Building Technologies
- Distributed Energy
- Federal Energy Management Program
- FreedomCAR & Vehicle Technologies
- Geothermal
- Hydrogen, Fuel Cells & Infrastructure
- Industrial Technologies
- Solar Energy Technology
- Weatherization & Intergovernmental
- Wind & Hydropower Technologies

Building Technologies Mission

Its mission is to develop technologies, tools, and techniques for making residential and commercial buildings more energy efficient, productive, and affordable.

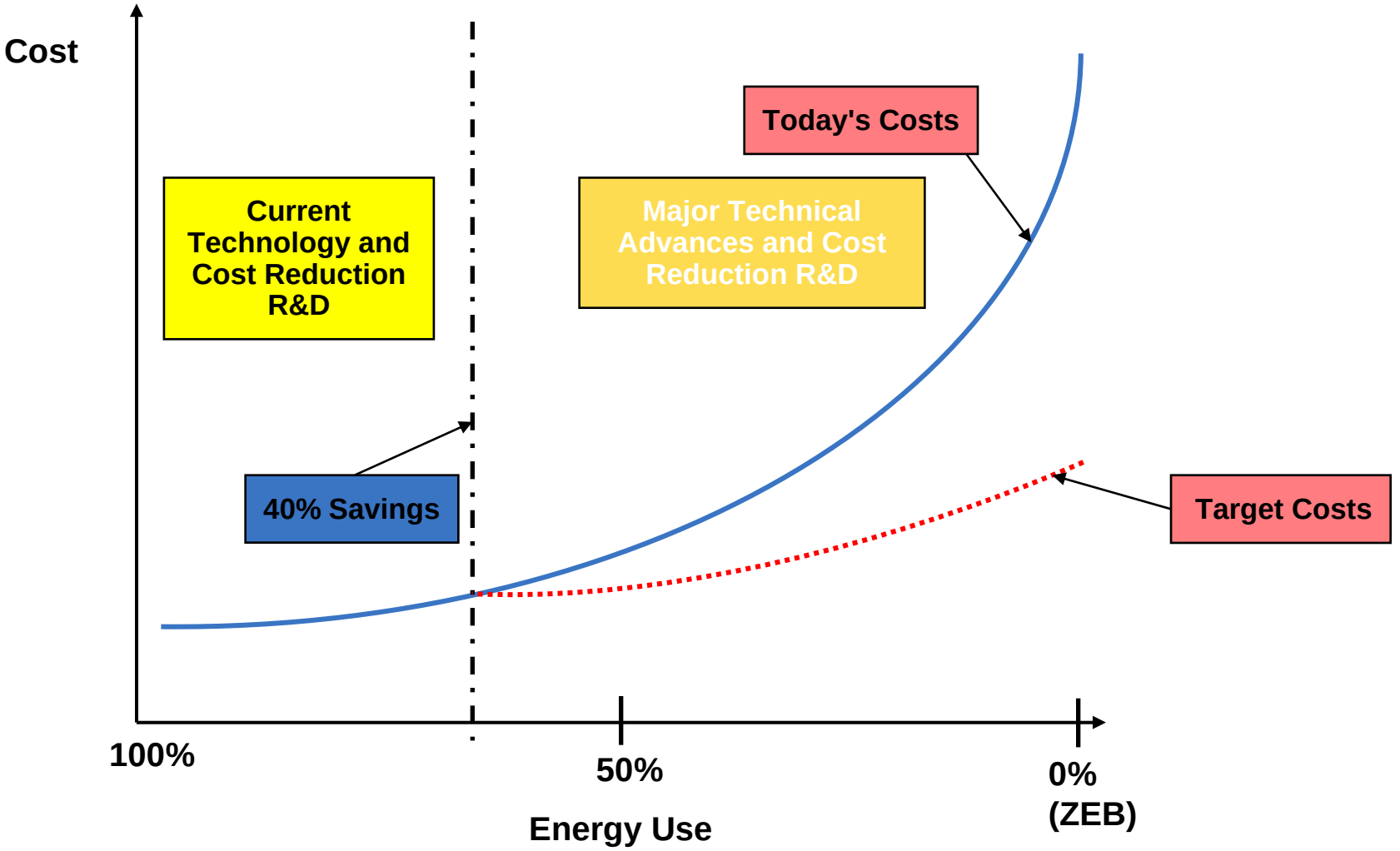
Building Technologies Goal

By 2025, the Building Technologies Program will create technologies and design approaches that enable the construction of net-zero energy buildings at low incremental cost.

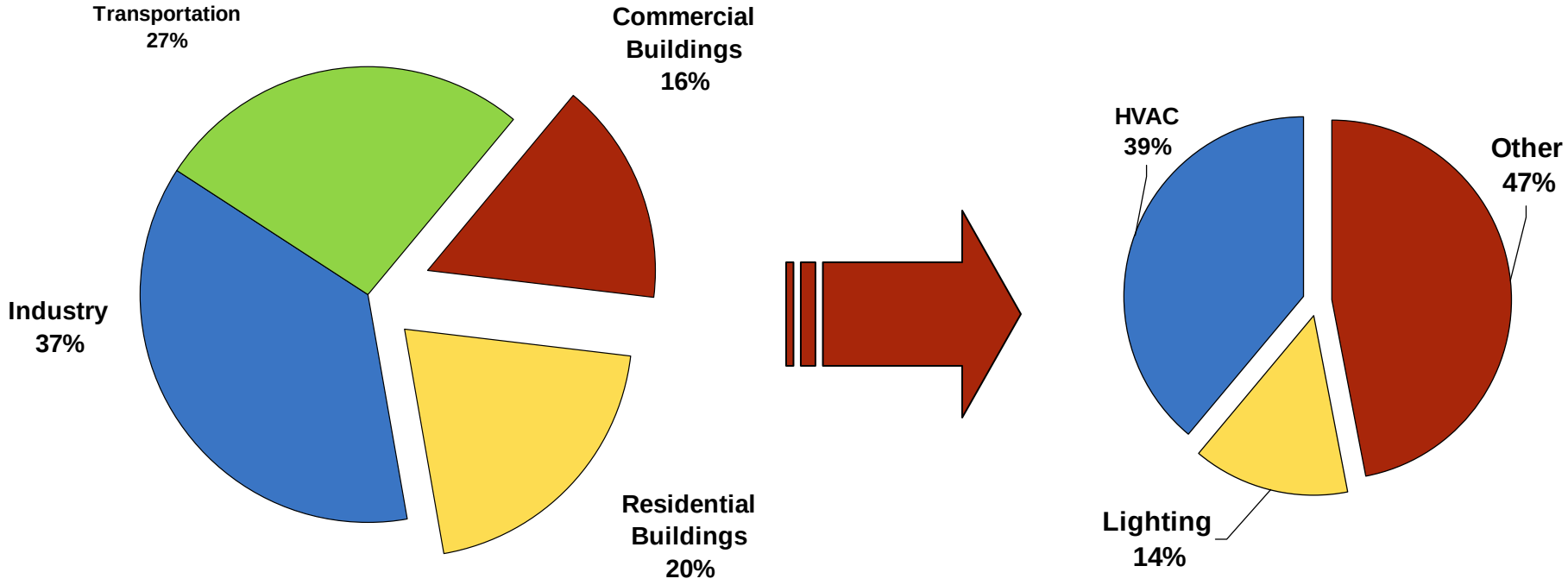
BT GOAL: Establish the technical capability combining conservation with renewables that enable the construction of net-zero energy buildings (ZEB) at low incremental cost.

1. **GOAL A: Residential:** Develop marketable advanced energy systems required to reduce residential energy use with the following performance milestones:
   - 40-50% Energy Use Reduction – 2004
   - 50-60% Energy Use Reduction – 2010
   - 60-70% Energy Use Reduction – 2015
   - Zero Energy Buildings – 2020
2. **GOAL B: Commercial:** Develop marketable advanced components and systems to reduce commercial energy use with the following performance milestones:
   - 25-30% Energy Use Reduction – 2004
   - 30-50% Energy Use Reduction – 2010
   - 60-70% Energy Use Reduction – 2020
   - Zero Energy Buildings – 2025

Moving to ZEB will require significant technical advances to meet performance and cost targets



US Energy Consumption in Buildings



Total US Building Envelope Energy Loss:

13.4 quads (Windows ~ 4.7 quads)

13.9% of Energy in US Economy and about 3.5% of the world.

Major Activities in the Buildings Program

Residential Buildings Activities

Residential Buildings

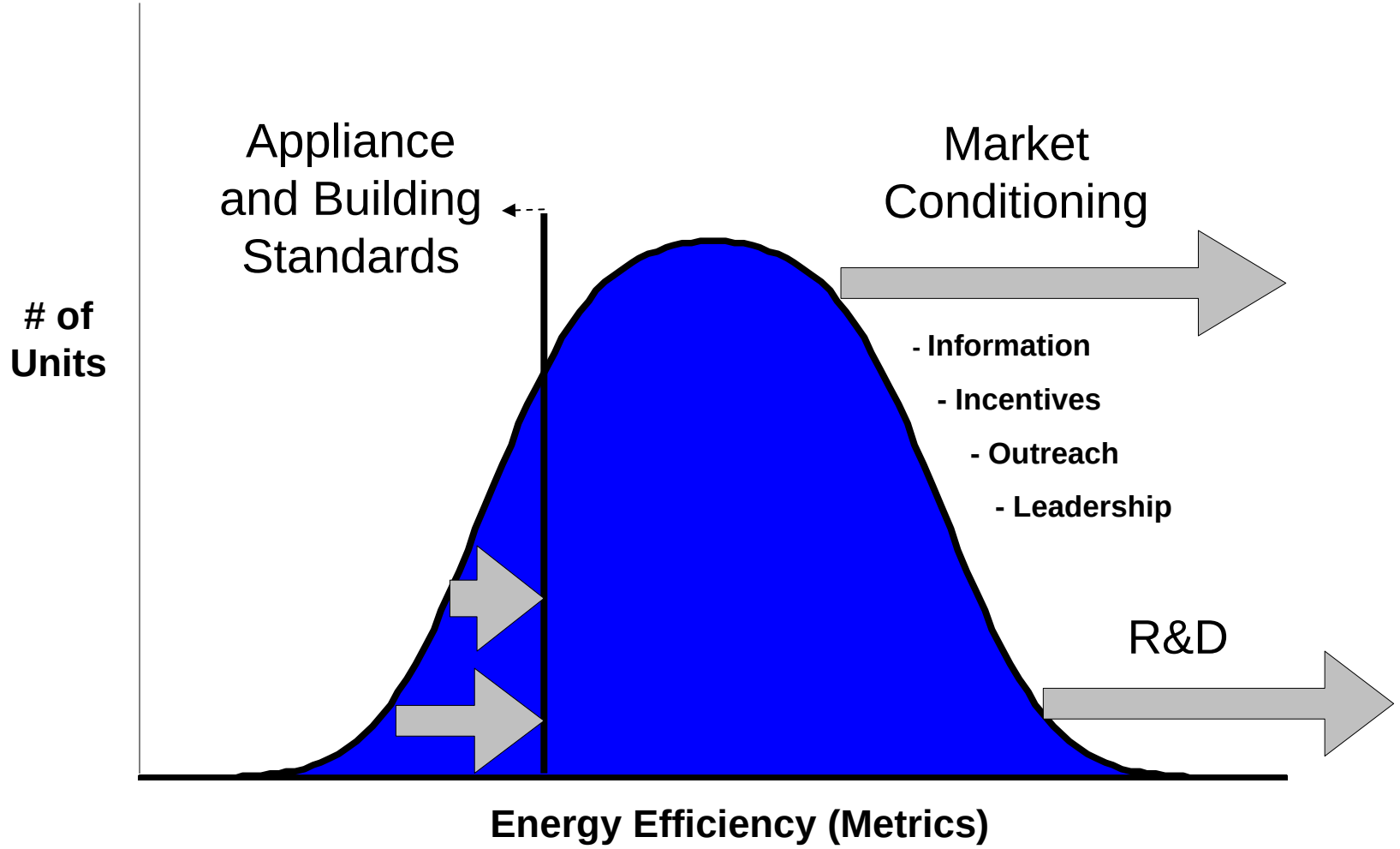
Research and Development -
Advancing the State of the Art

Deployment -
Promotion of Efficient Technologies

Regulatory -
Building Codes and Appliance Standards

Residential Buildings Activities

Transforming the Market



Commercial Building Integration

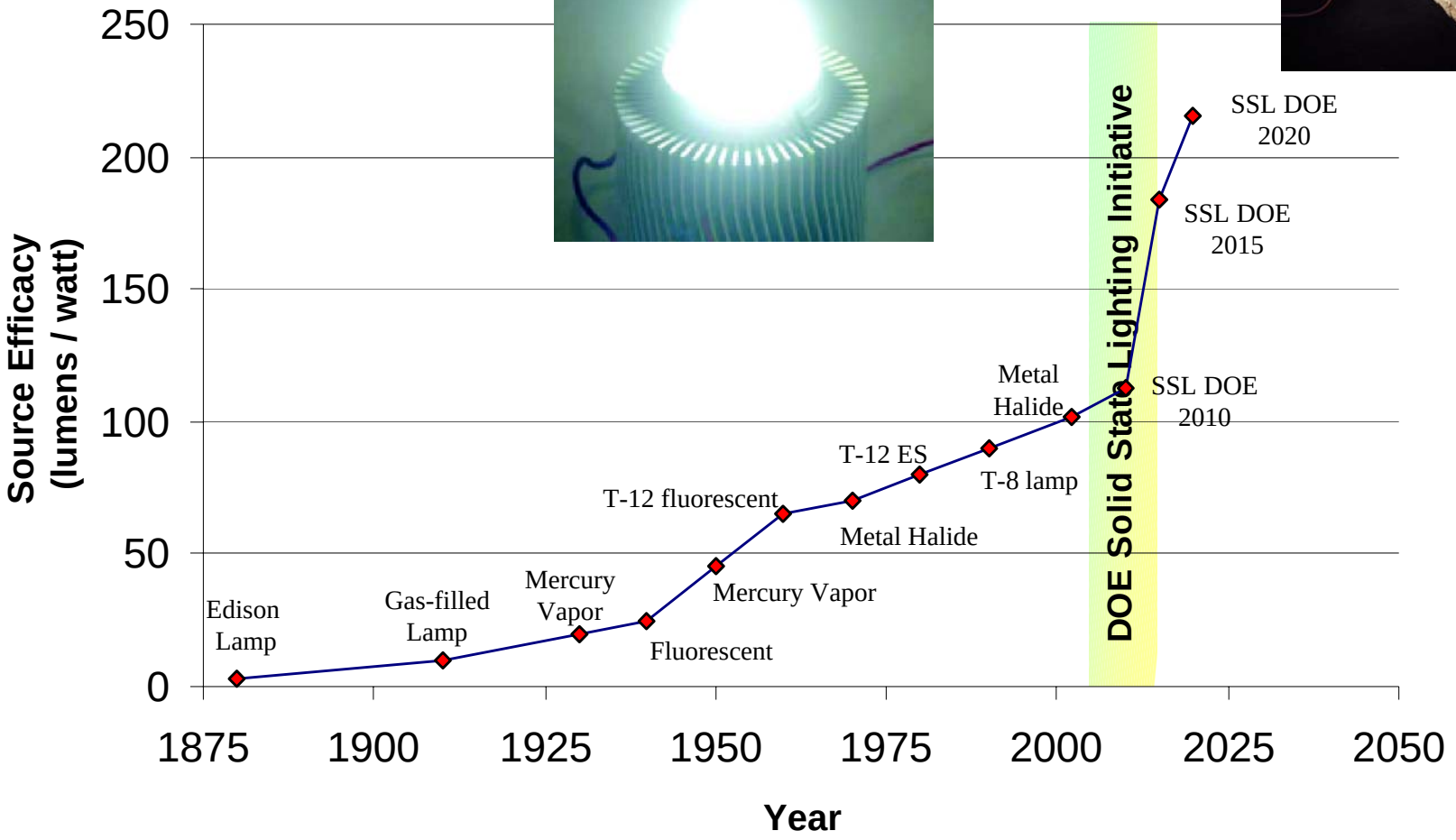
Major Thrusts:

- High Performance Buildings (40 to 70% less energy consumption) for ZEB
- Design Analysis Tools
- http://www.eere.energy.gov/buildings/highperformance/

EnergyPlus

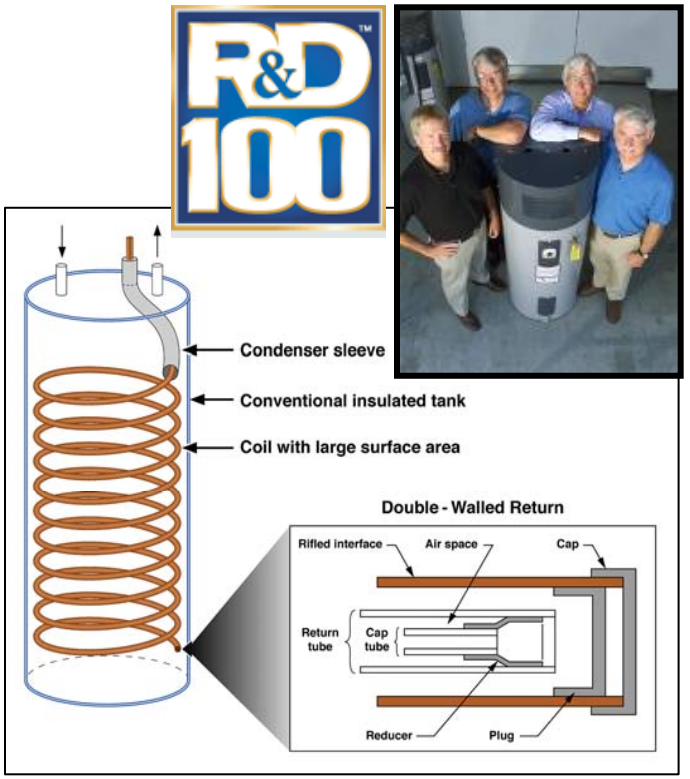
Solid State Lighting Initiative

Electric Lamp White Light Efficacy Improvement



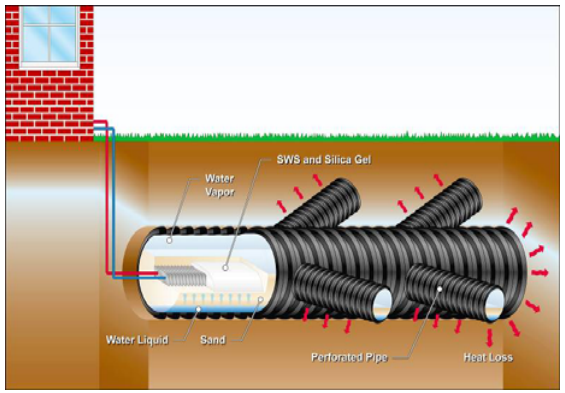
HVAC and Water Heating for ZEH

- Helix condenser for reducing cost of the award winning HPWH



- One integrated heat pump (IHP) for all ZEH energy service needs

- Supplementing conduction with water vapor migration for ground heat exchanger cost reduction



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Total Building Envelope and Window R&D Budget

	Administration Budget Request	Enacted Appropriations
FY 01	12.3 M	11.5 M
FY 02	4.4 M	11.5 M
FY03	5.1 M	8.3M
FY04	5.1M	8.2M
FY05	5.0M Windows 0 Envelope	5.8M Windows 2.8M Envelope
FY06	5.0M Windows 0 Envelope	*3.8M Windows 2.9M Envelope
FY07	4.7M Windows 2.4M Envelopes	4.7M Windows 2.4M Envelopes

*** Reduced by 1M internally at DOE due to Earmarks**

Window Technology Development

- Developing new technology in the laboratory and with private industry to introduce fundamental new technology
- Next generation window – highly insulating and dynamic
- Integrated commercial façade systems

Prototype – Concept Window (Highly Insulating and Dynamic)

Dynamic Window Field Trials

Project Results

- Cooling Energy Savings up to 20%
- Peak Demand Savings up to 26%
- Human factors evaluation

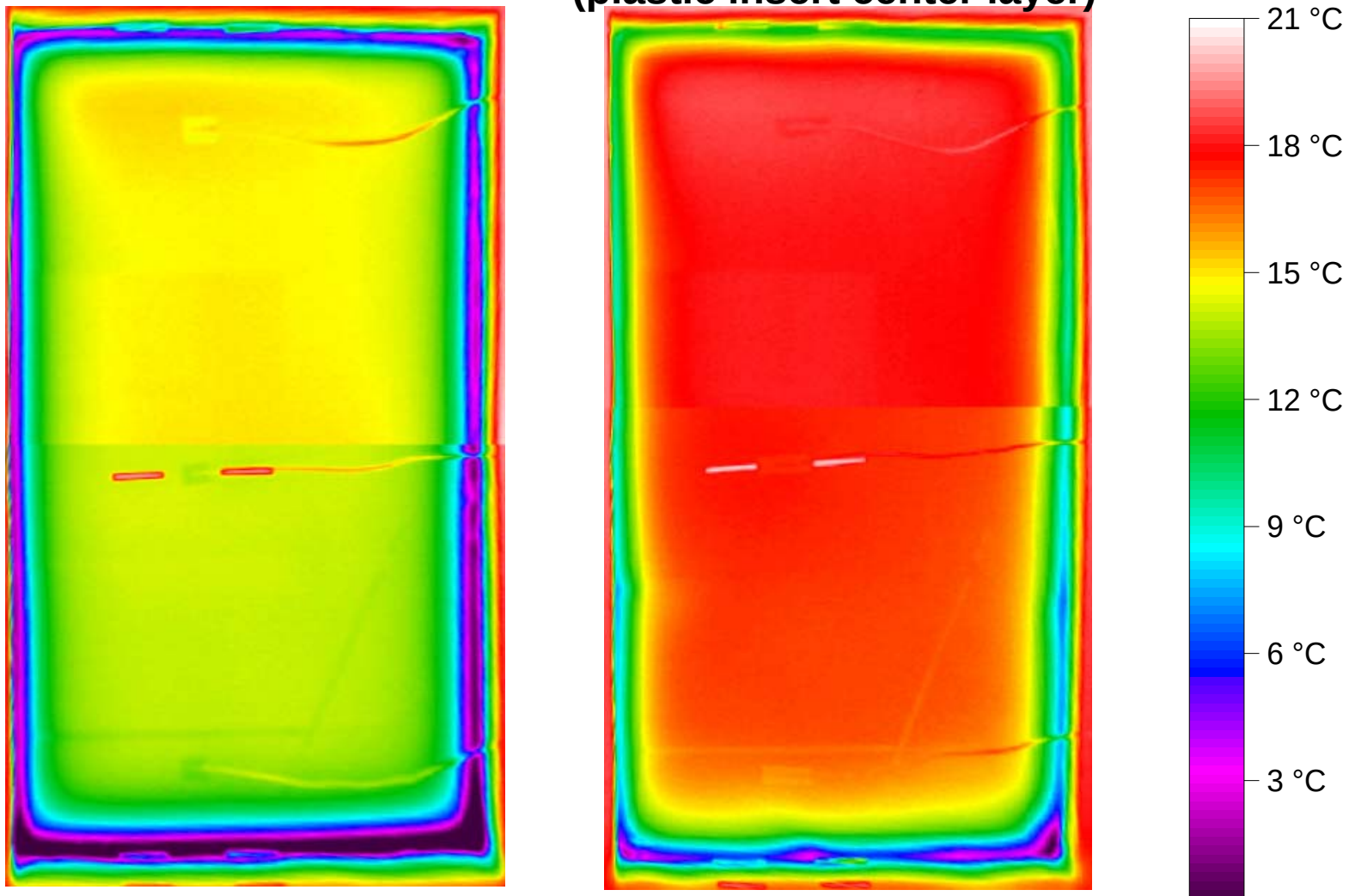
Commercial

Residential

Low Cost Highly Insulating Prototype Performance

Double Glazed Low-e, Krypton

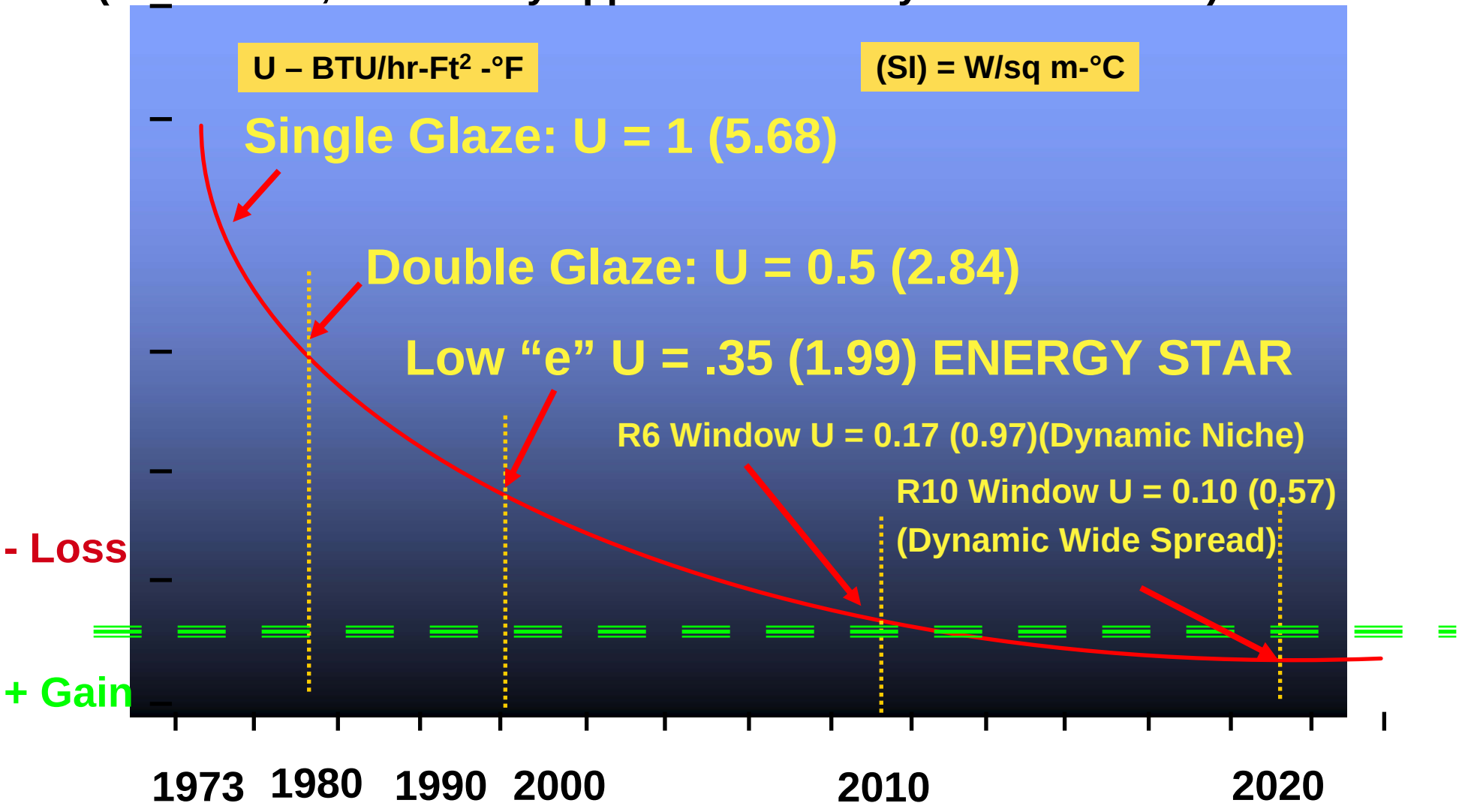
Triple Glazed Low-e, Krypton (plastic insert center layer)



Surface temperatures from infrared thermography
Test conditions: cold side -18°C, warm side 21°C)

Advanced Windows Can Become Energy Producers

(US Climate, most likely applicable to many areas of China)



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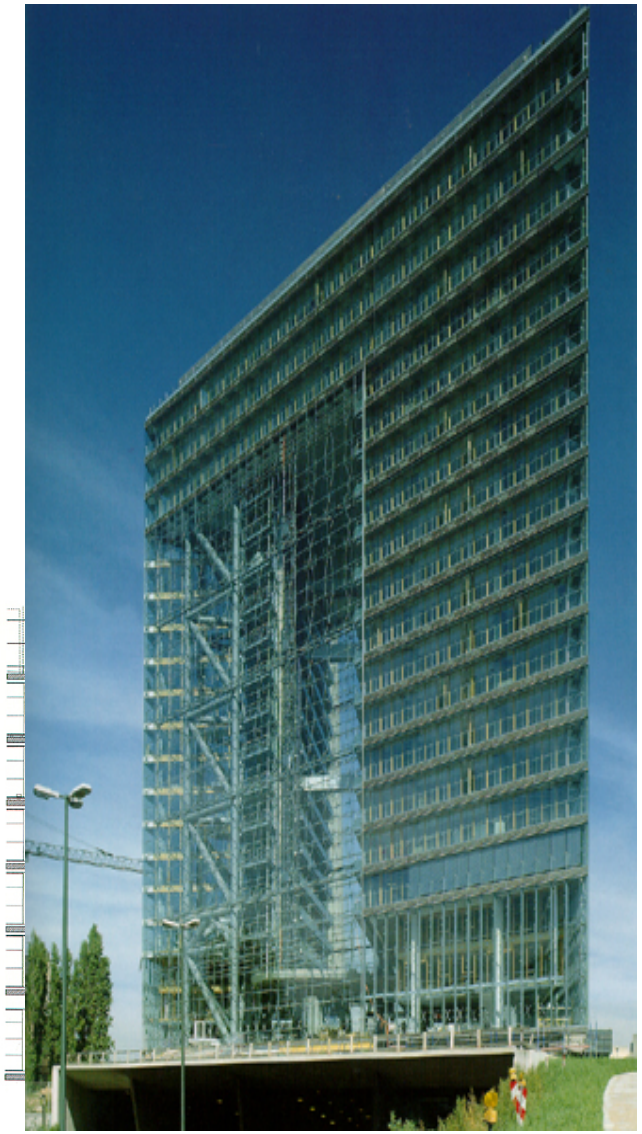
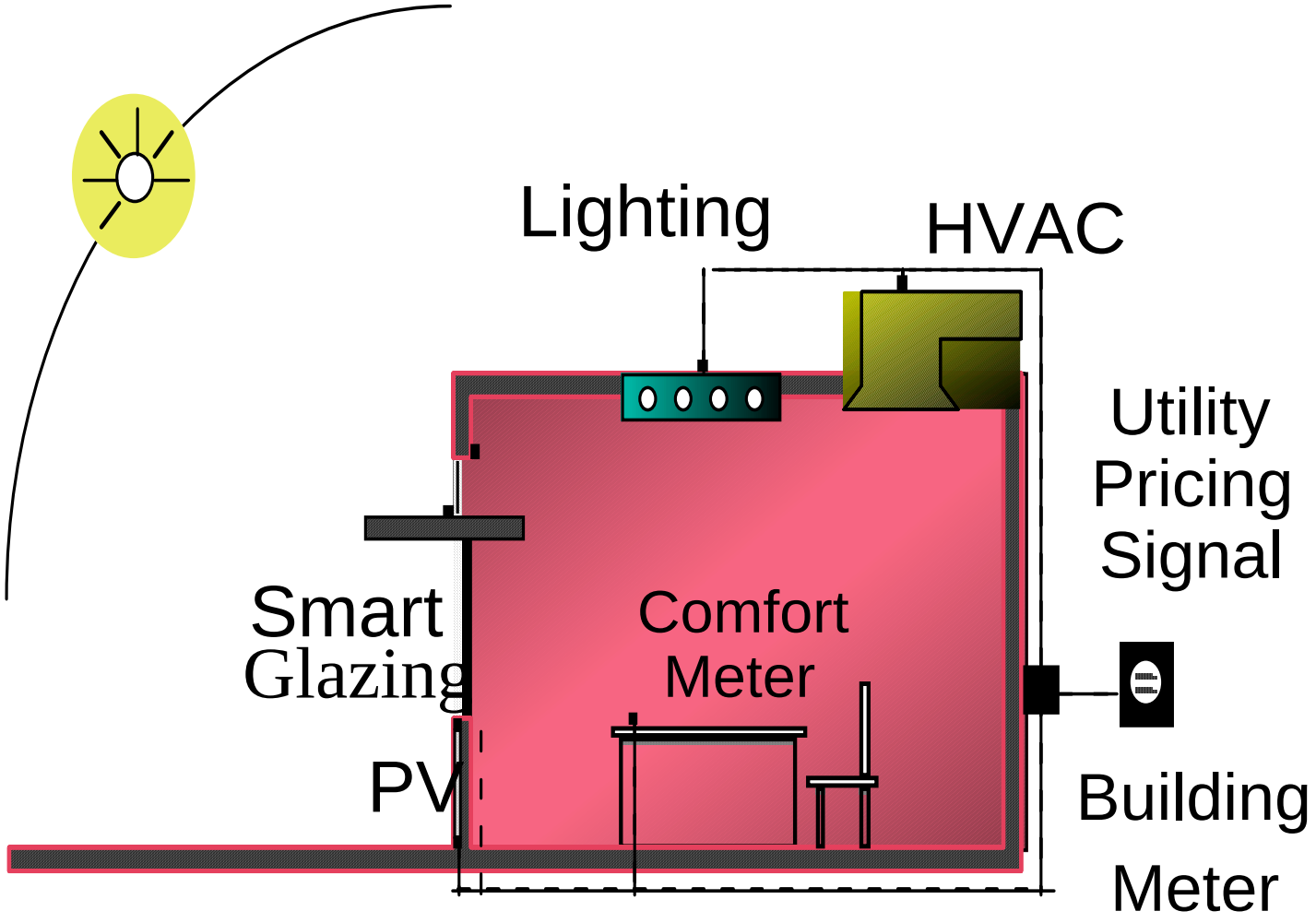
Daylight, Glare and Solar Control in “Transparent” Buildings

Façade, Dimming Ballast and Space Conditioning Optimization



Conceptual Design for Future

Low Energy, Integrated Building Facade System

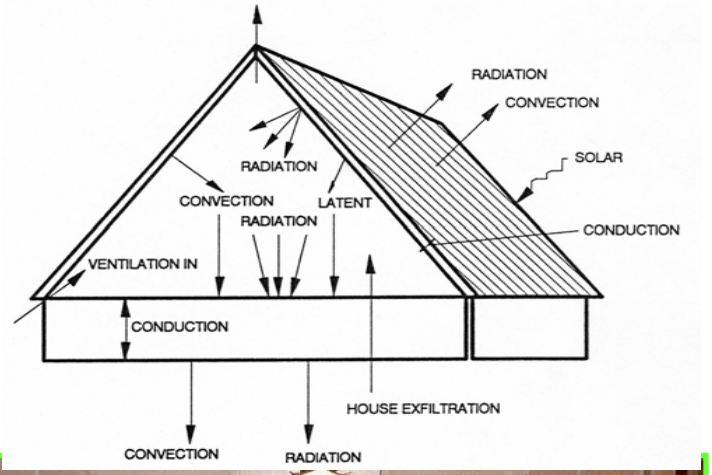


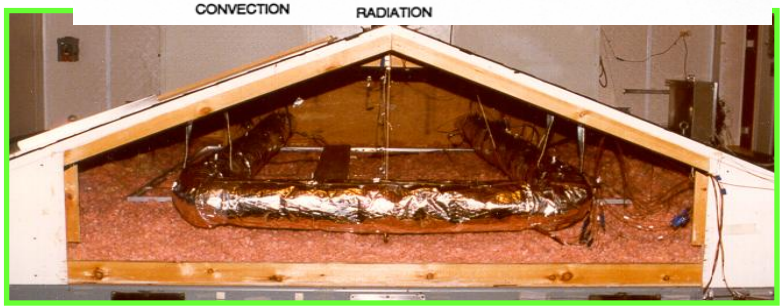
Window Technical Support Activities

- **Tools**
  - Rating/Design Software
  - Decision tools, RESFEN & COMFEN
  - Residential Handbook
  - Commercial Handbook
- **Industry Support**
  - International Optics Database
  - Assistance with tools to users
  - Durability studies
  - NFRC Documentation
  - NFRC, ASHRAE, ASTM, & ISO participation/leadership
  - International Std. Harmonization
- **Knowledge Base (Education)**
  - Efficient Windows Collaborative
  - Education to manufacturers/consumers
  - Commercial web page
  - Evaluation of commercial tools by users (builders, designers, suppliers,etc)

Thermal Envelope R&D

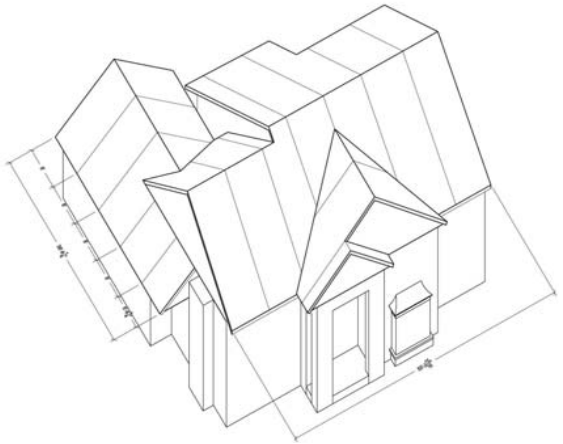
- Advanced walls to reach R 20 in 3.5” cavity and exterior insulation systems
- Next Generation of Attic/Roof System to save 50 Percent Energy
- New Material Development
  - Phase change insulation
  - Higher performing foams
  - Dynamic membranes



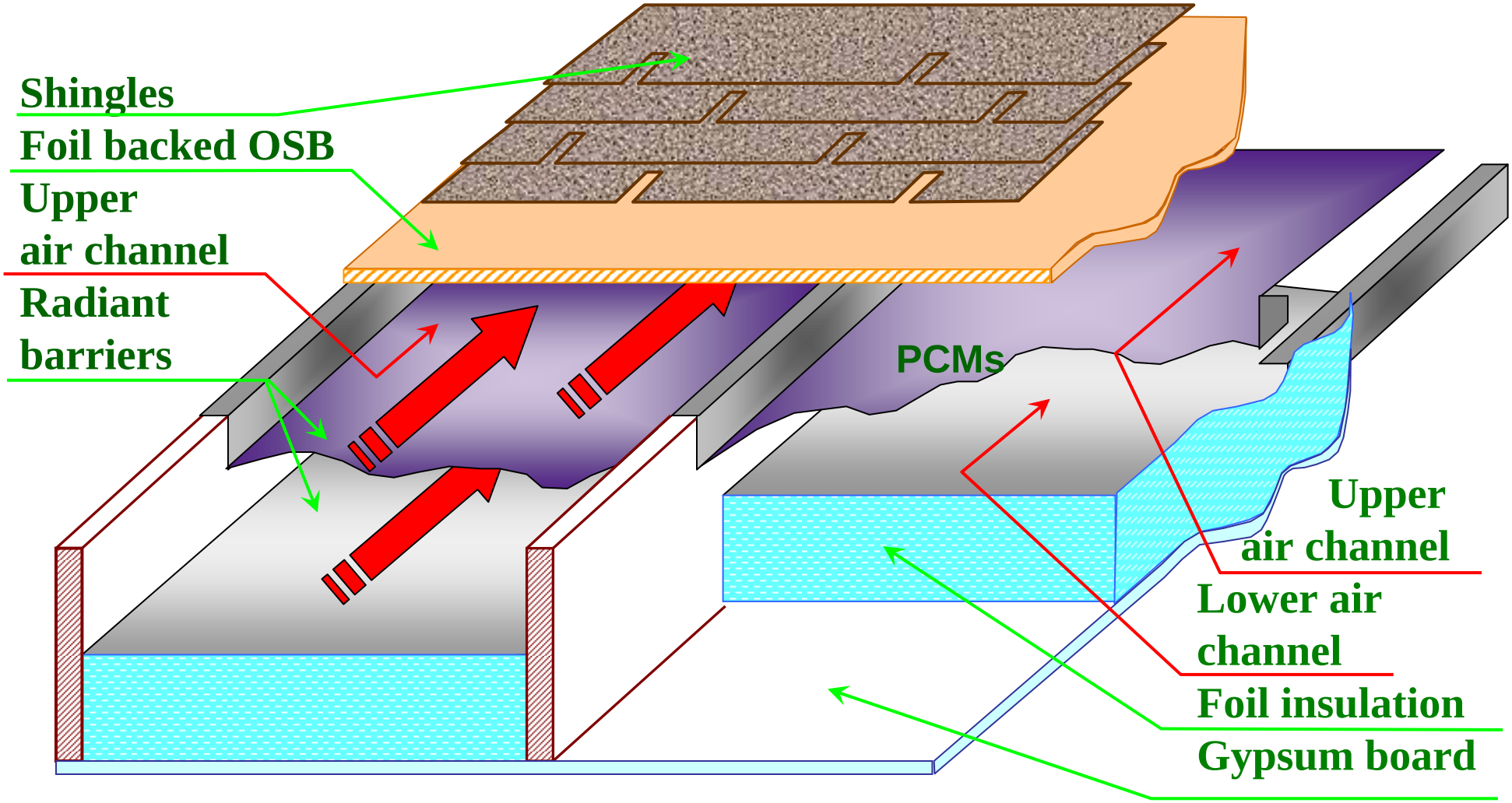


Next Generation of Roofing/Attics

- Integrated solutions for building type and climate
- Key elements to develop and integrate
  - Cool Roofs (lighter colors and infrared (IR) Blocking Pigments)
  - Thermal Mass
  - Above Deck Ventilation
  - Radiant Barriers
  - Location and Higher Performing Insulations

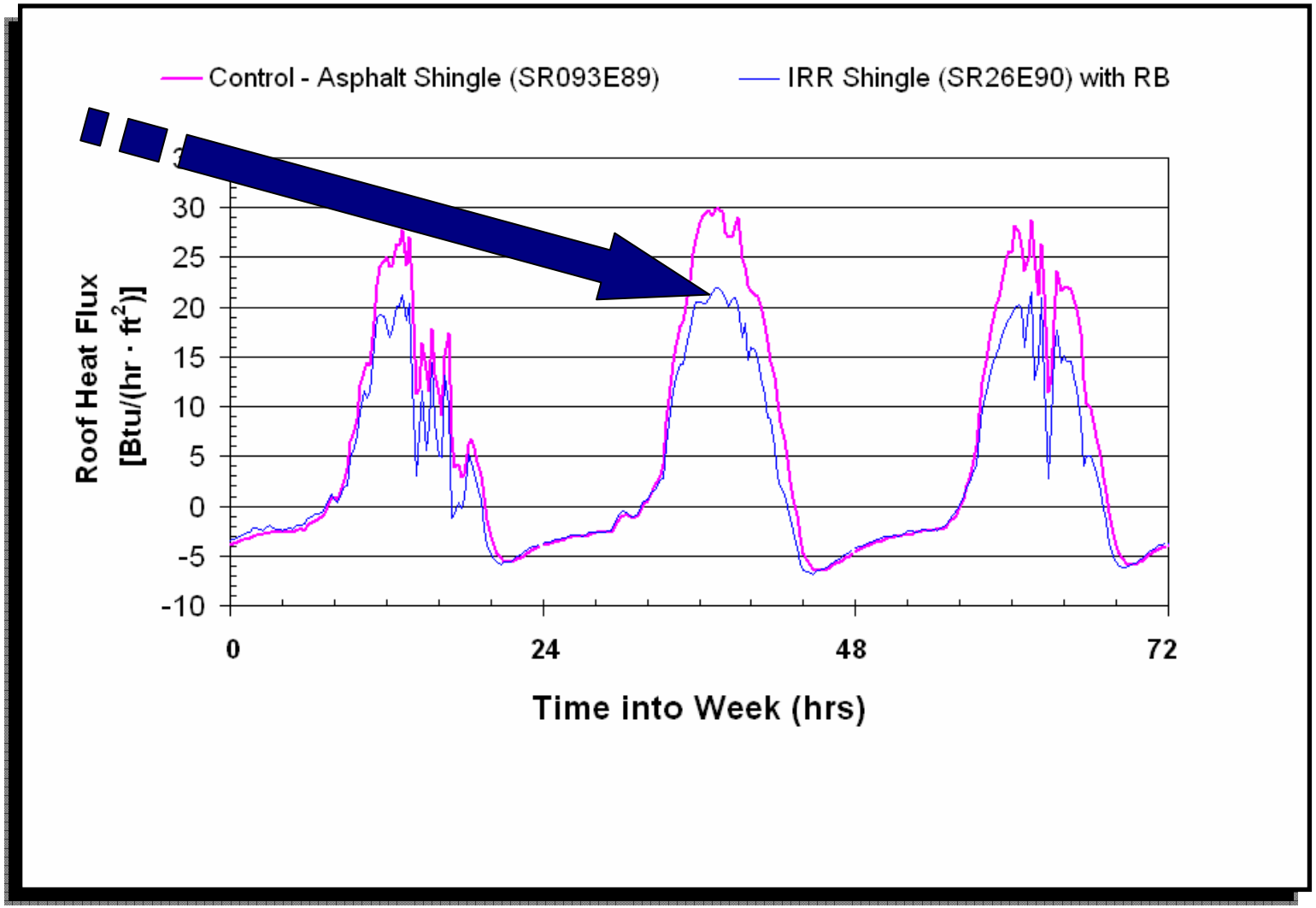


Next Generation Roof/Attic



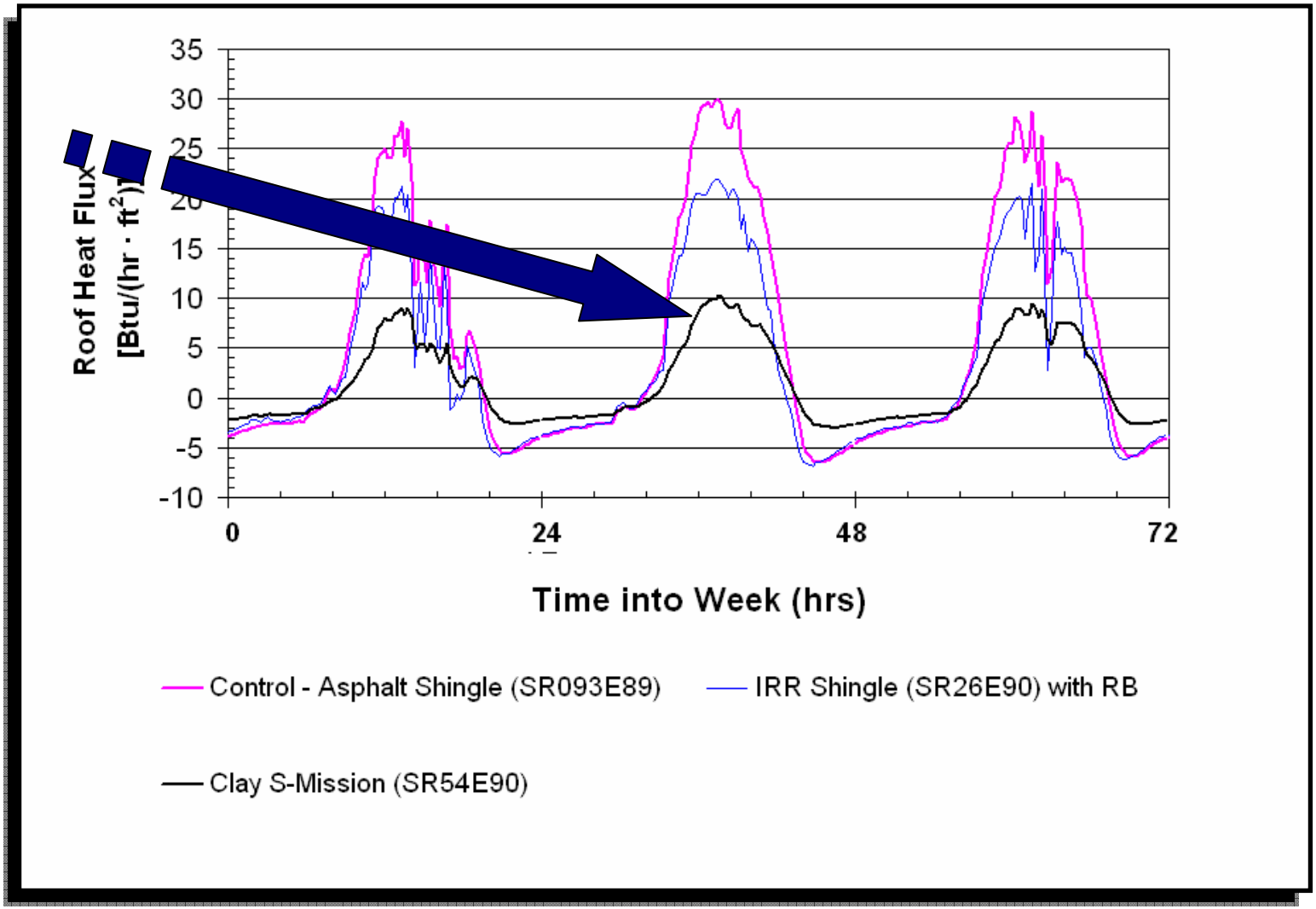
Integrated Roof Testing at ORNL

Effect of Low-ε RB facing Attic and IRR Asphalt Shingles



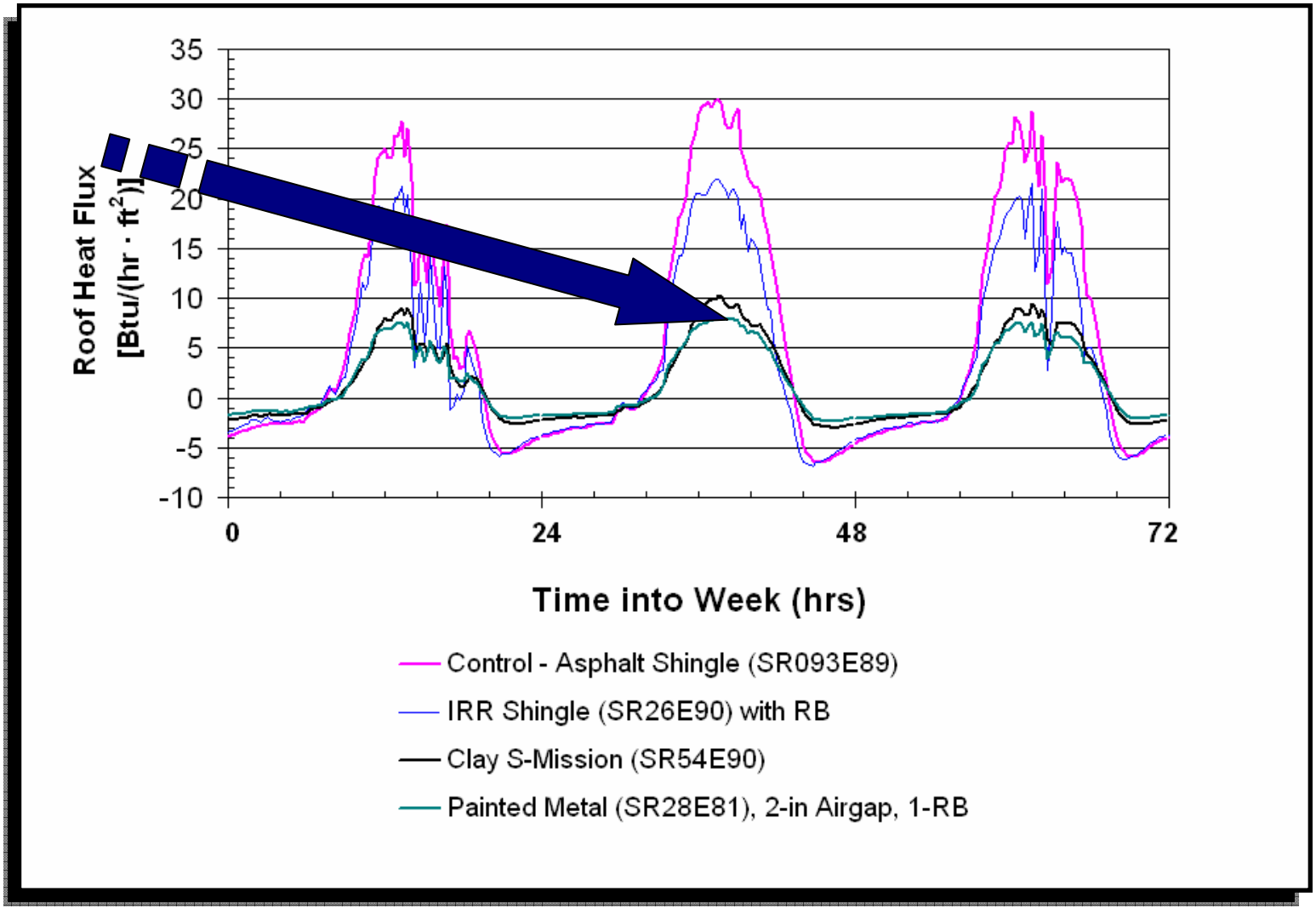
July 28, 2006

Effect of Cool Color, Above-Sheathing Ventilation and Traditional Thermal Mass



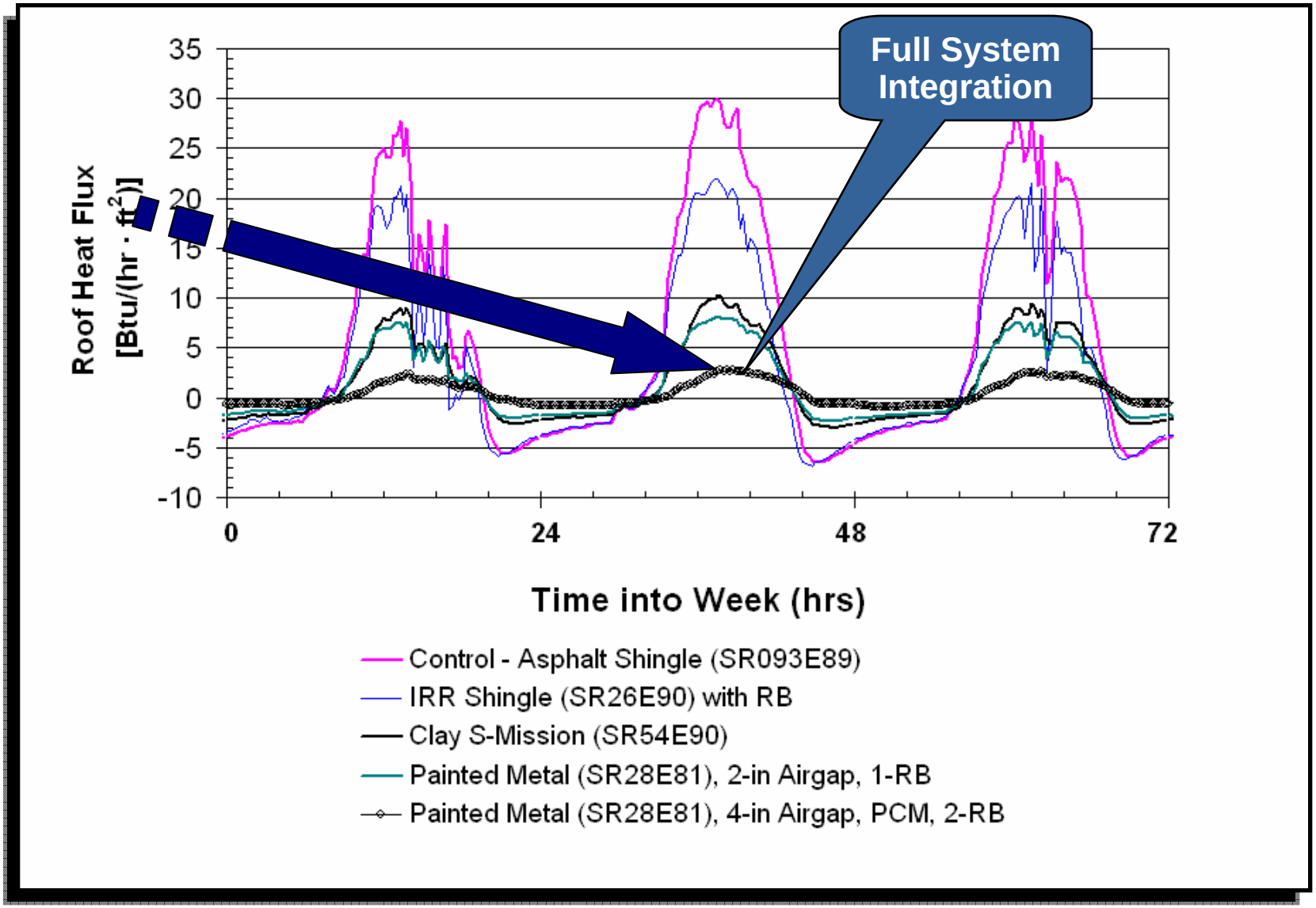
July 28, 2006

Effect of Cool Color, Above-Sheathing Ventilation and Low-ε Reflective Insulation



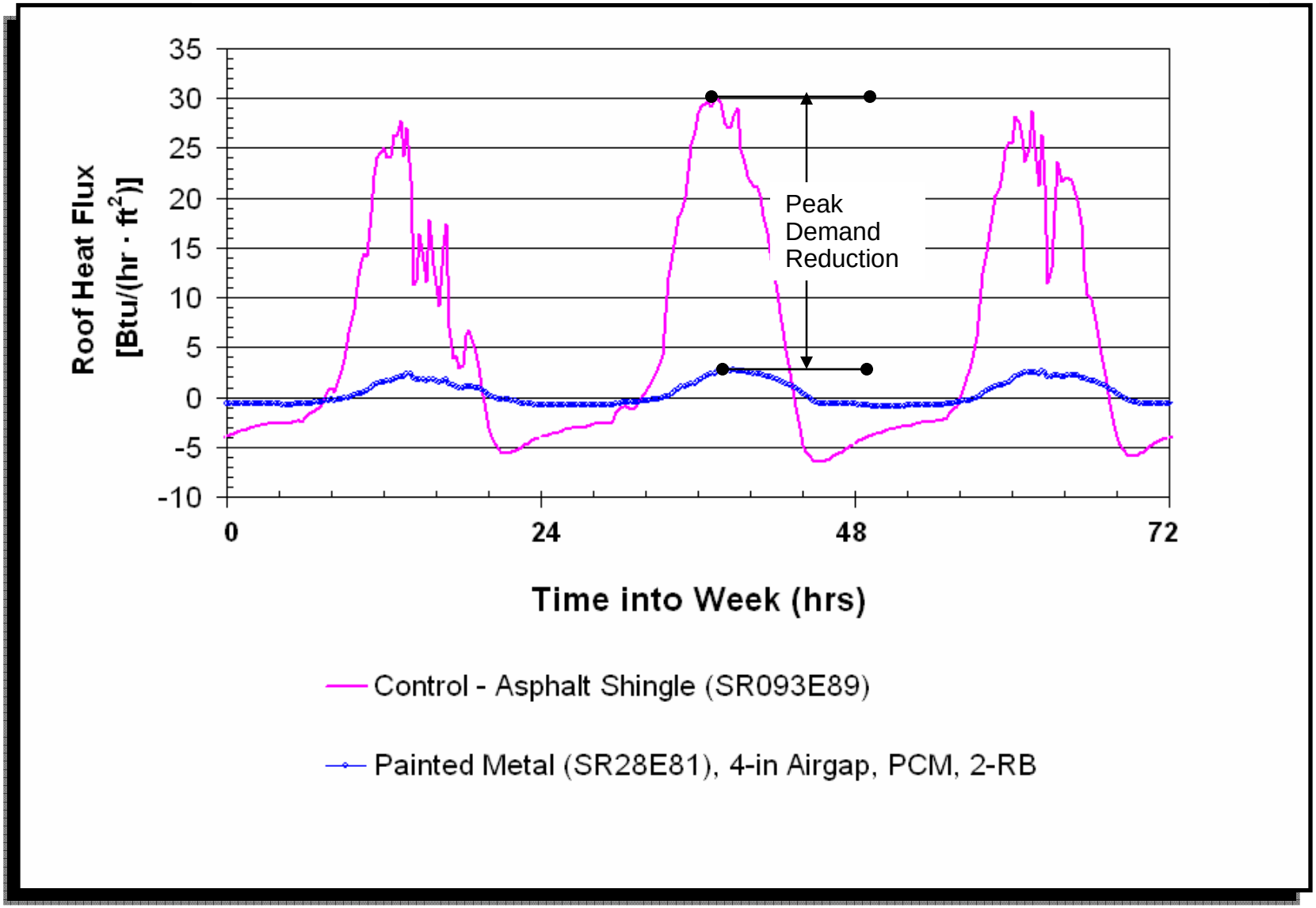
July 28, 2006

Effect of Cool Color, Above-Sheathing Ventilation, PCMs, and Low-ε Reflective Insulation



PCM Shaves Peak Demand and Reduces Night Sky Losses

Potential to Reduce Peak by 90 Percent



Roof Calculator Activity

- Attempted to build industry participation group for voluntary contribution
- Process extremely slow
- Current joint funding from CEC and DOE with LBNL and ORNL as key performers
- Strong DOE/EPA cooperation to replace existing calculators with one consolidated calculator
- Draft plan on web for comment, see www.govforums.org/e&w/

Key Conclusions

- Roofing is currently underinvested in for energy efficiency
  - Large energy consumption (residential ~ 2 Quad)
  - Mostly inexpensive asphalt with 15 year life
- Integrated Attic/Roof systems will be a major contribution to achieve ZEB
- New roofs for commercial buildings should consider the full cost of operation and address a complete system approach, adequate insulation, reflective, durability, etc

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