U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building Envelope R&D

Sven Mumme, Technology Manager, Emerging Technologies

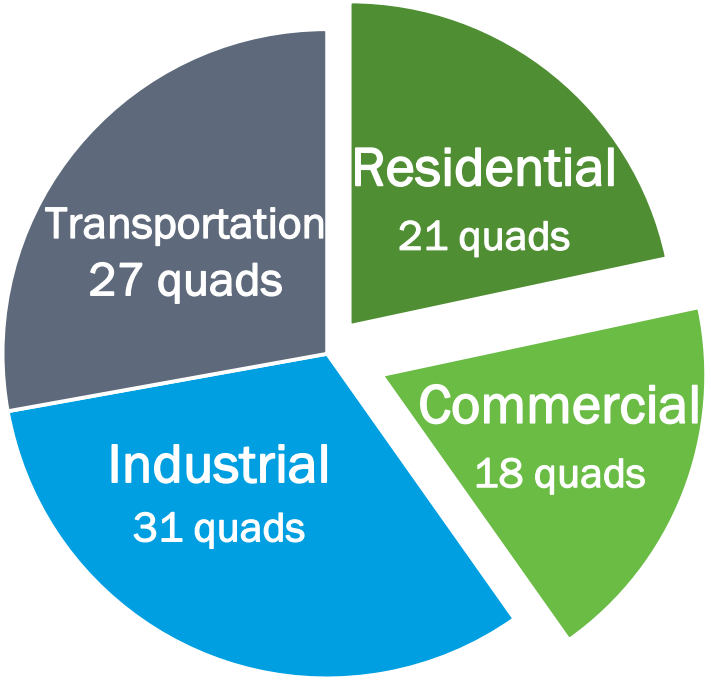
May 2, 2018

Envelope R&D Peer Review Session Agenda

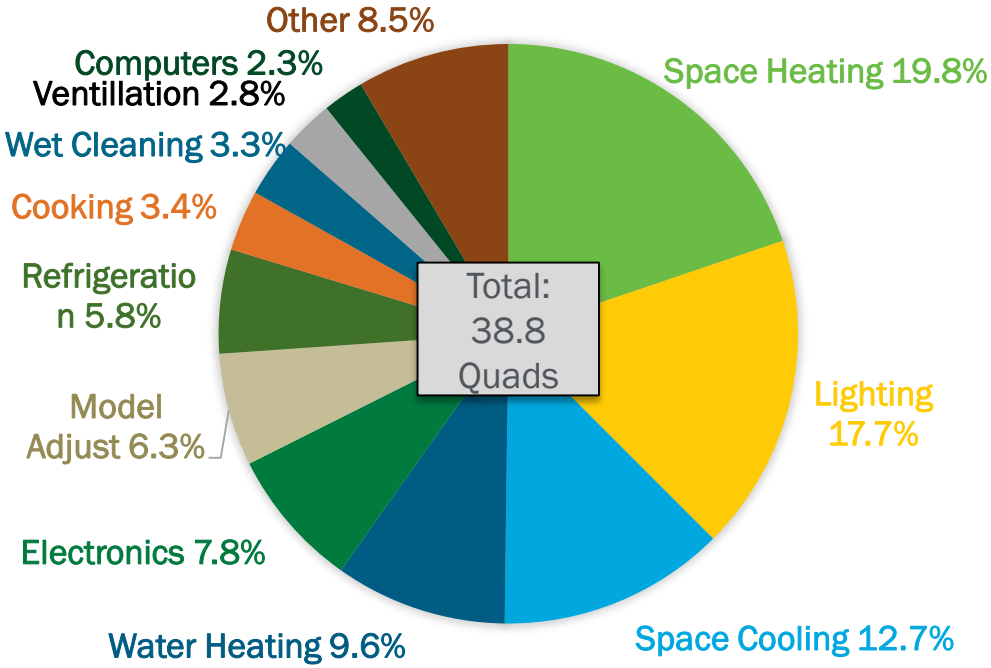
1:30-2:00	Introduction
2:00-2:30	Glint Photonics – Stationary Concentrator Daylighting System
2:30-3:00	Fraunhofer – Development of Low-Cost Isocyanurate-based Super Insulation
3:00-3:30	ORNL - Ultra-high R/inch VIP with novel fibrous core material
3:30-4:00	BREAK
4:00-4:30	LBNL – Robust Super Insulation at a Competitive Price
4:30-5:00	ORNL/CERC – Passive Envelope Advancement
5:00-5:30	Wrap-up with Reviewers

U.S. Energy and Electricity Consumption by Sector

Energy Use



Building Energy Use

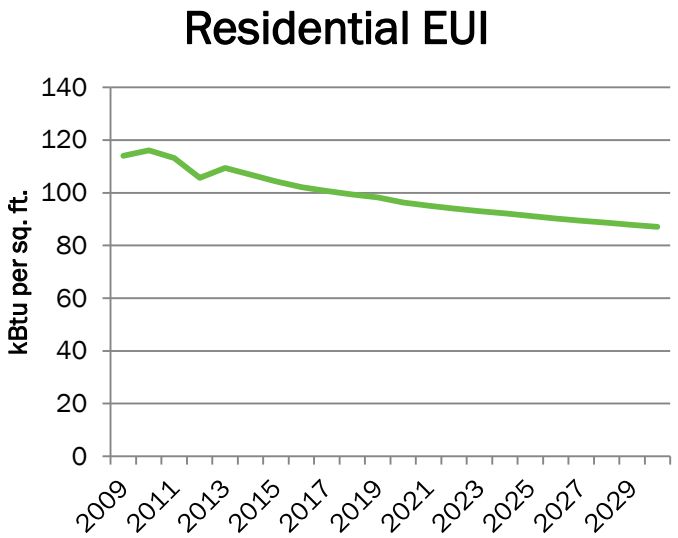


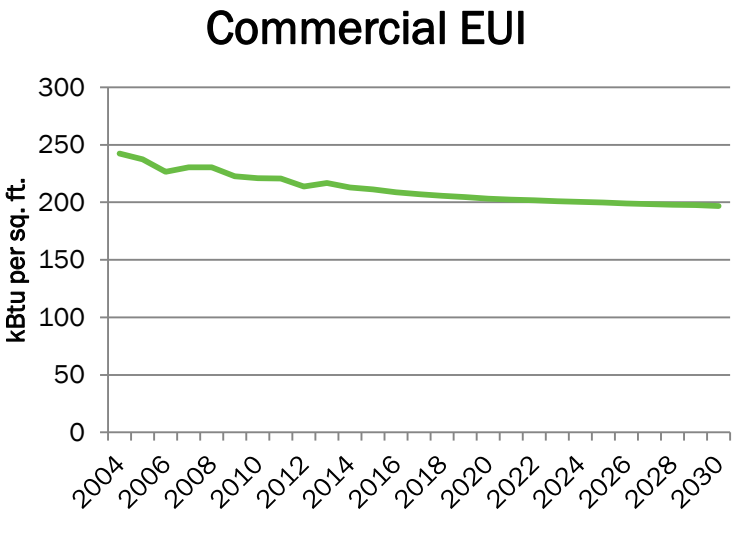
Buildings Energy Use: 40% of U.S. total

Buildings Electricity Use: 75% of U.S. total

U.S. Building Energy Bill: $395 billion per year

BTO Goal: Reduce Building Energy Use by 30% by 2030





2030 sector-wide goal: reduce energy use 30% per sq. ft.

Long term goal: reduce energy use 50% per sq. ft.

Metric: energy use intensity (EUI)

Baseline: 2010

Rationale: allows comparisons across fuel types, building types, building sectors, end uses, that are more internationally relevant.

Emerging Technologies

Goal

By 2030, develop cost-effective technologies capable of reducing a building's energy use per square foot by 45%, relative to 2010.

Strategy

- Use Scout to analyze building energy efficiency technology potential impacts
- Fund early-stage R&D through competitive solicitations and National Lab technical capabilities

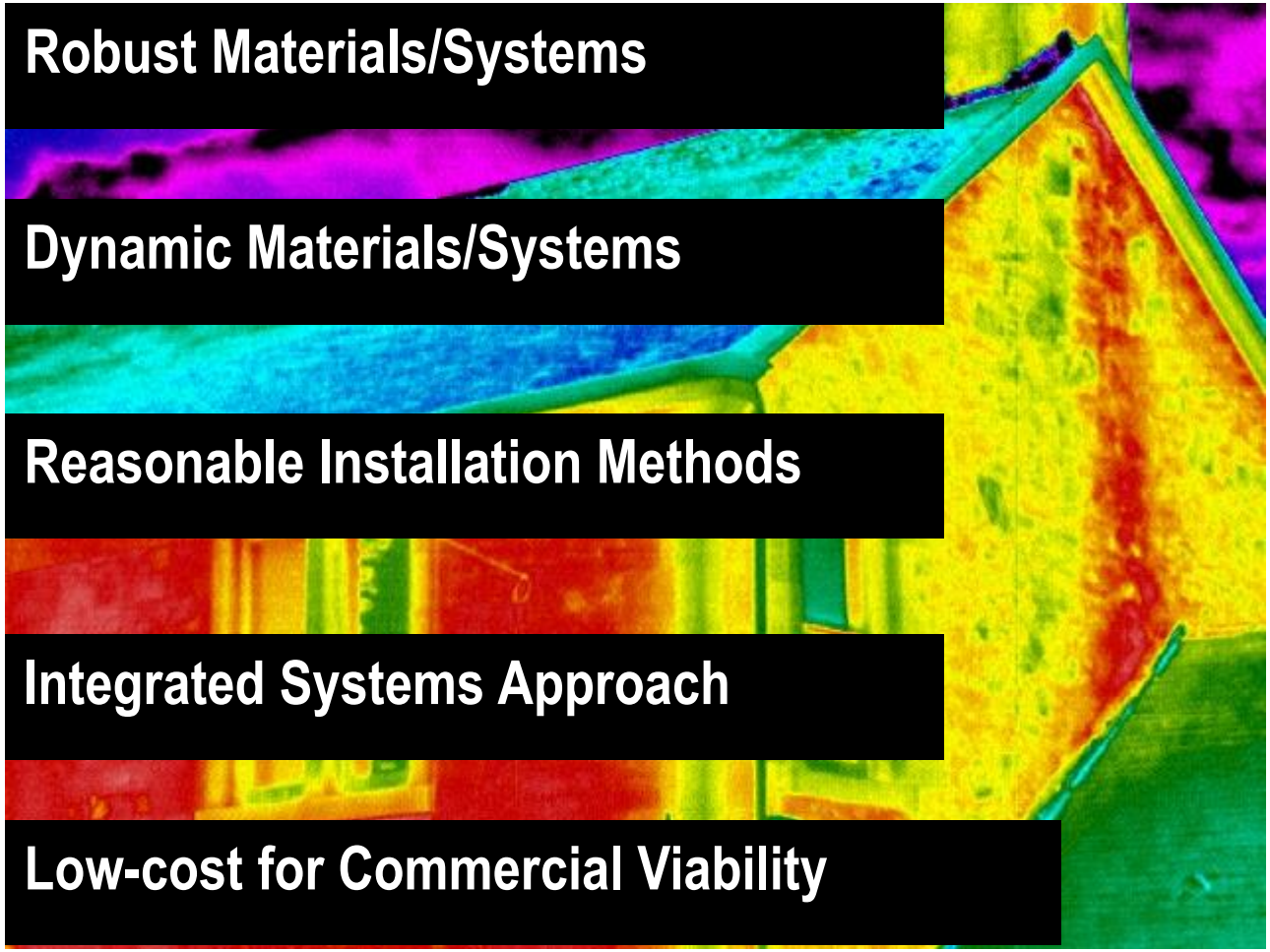
Technology Areas

Strategies for Reducing Energy Consumption

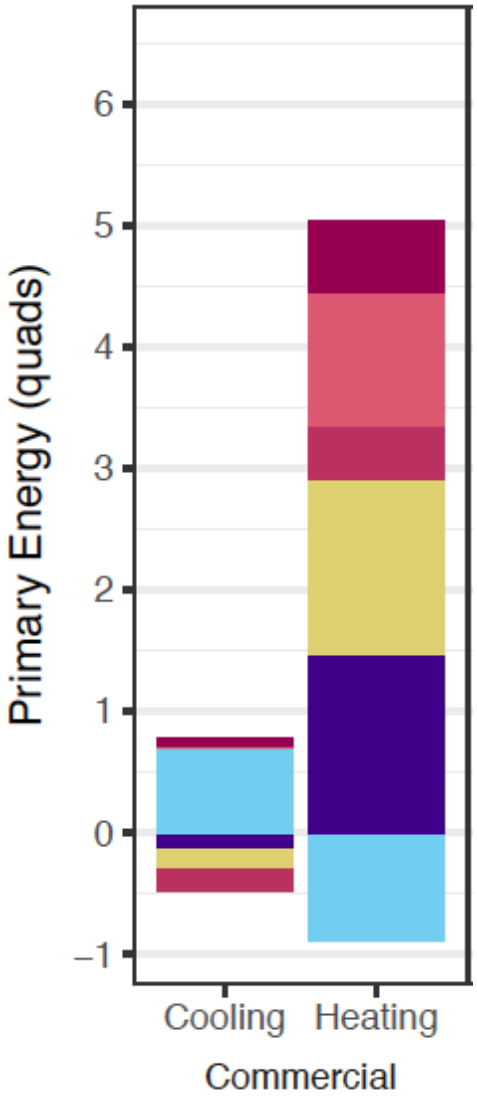
1. Make more efficient machines

Strategies for Reducing Energy Consumption

2. Be smarter about how we use energy



Energy Lost Through Building Enclosure Components



Building Component	Residential		Commercial	
	Heating	Cooling	Heating	Cooling
Roofs	0.84	0.40	0.58	0.06
Walls	1.25	0.28	1.10	0.01
Foundation	0.90	-0.18	0.43	-0.18
Infiltration	1.78	0.40	1.44	-0.17
Windows (Conduction)	1.68	0.02	1.46	-0.13
Windows (Solar Heat Gain)	-0.56	0.90	-0.89	0.70

Envelope & Windows Impact Over 50% of Loads

Building Envelope R&D Sub-Program

Develop next-generation residential and commercial building envelope technologies that reduce the energy required to heat and cool a building (i.e., reduce the unintentional amount of air and moisture exchange and thermal losses and gains through the building envelope), contribute to improved occupant comfort, and have competitive product and installation costs to enable market adoption.

Commercial & Residential Sectors | New Construction & **Retrofits**

Meeting BTO's EUI reduction goals requires **next-generation** energy efficiency technologies that have the potential for low cost to enable mass-market adoption.

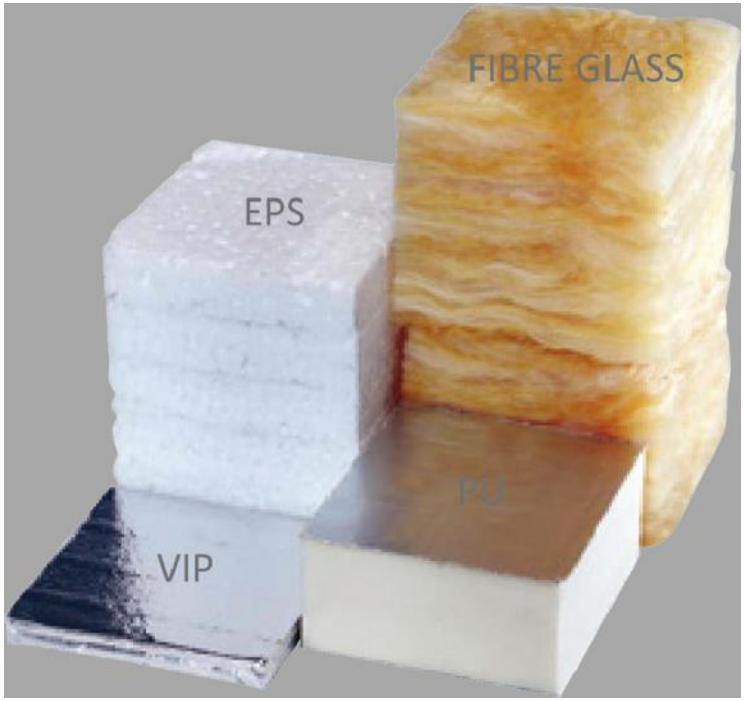
R&D Areas of Interest:

- High-R Insulation Materials
- Air Sealing Technologies
- Smart Building Materials

Building Envelope R&D Areas of Interest to BTO

Ultra-low Thermal Conductivity Materials

Insulation Materials – Innovation Opportunities



R-value (per inch)

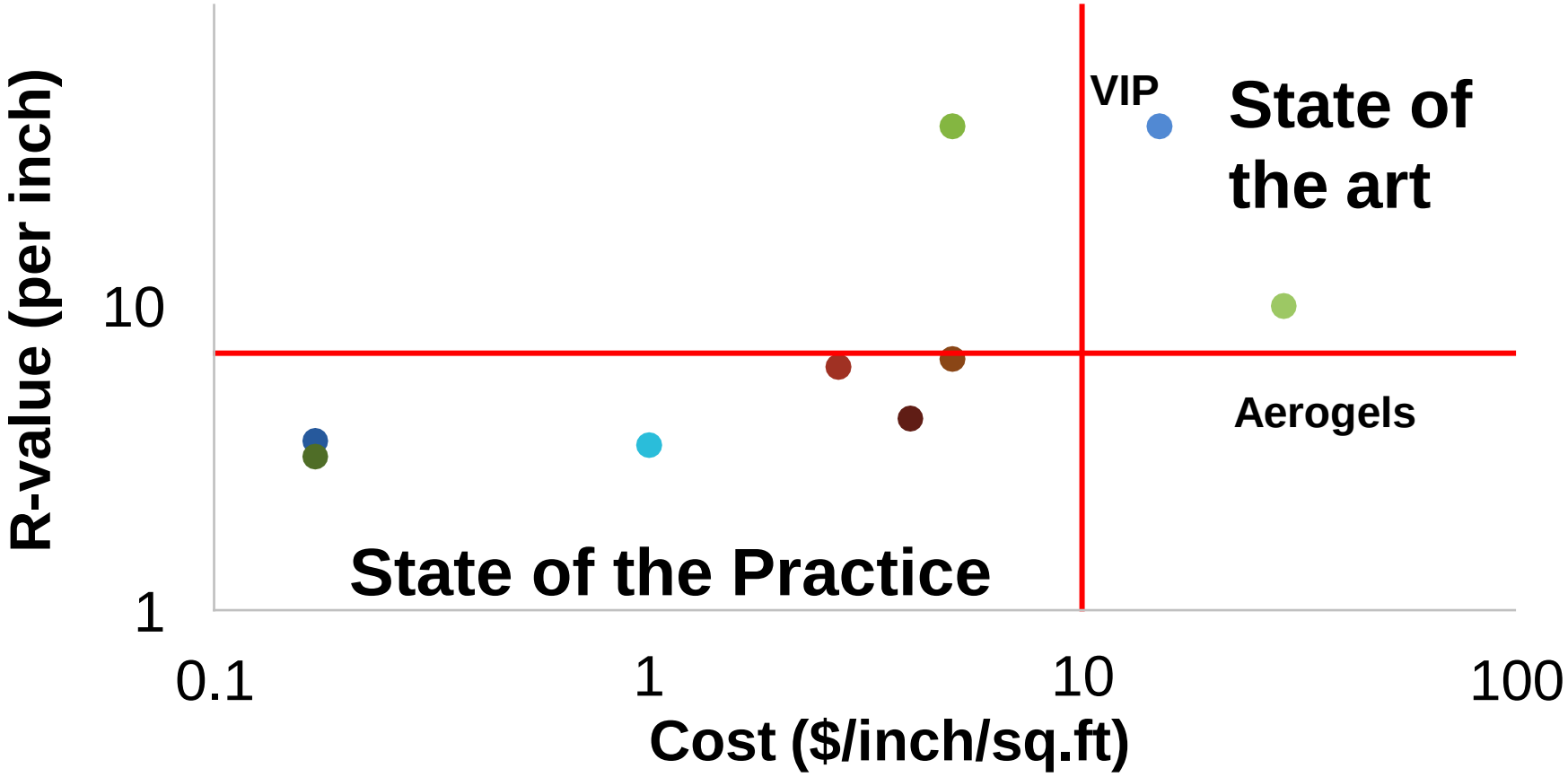
10

1

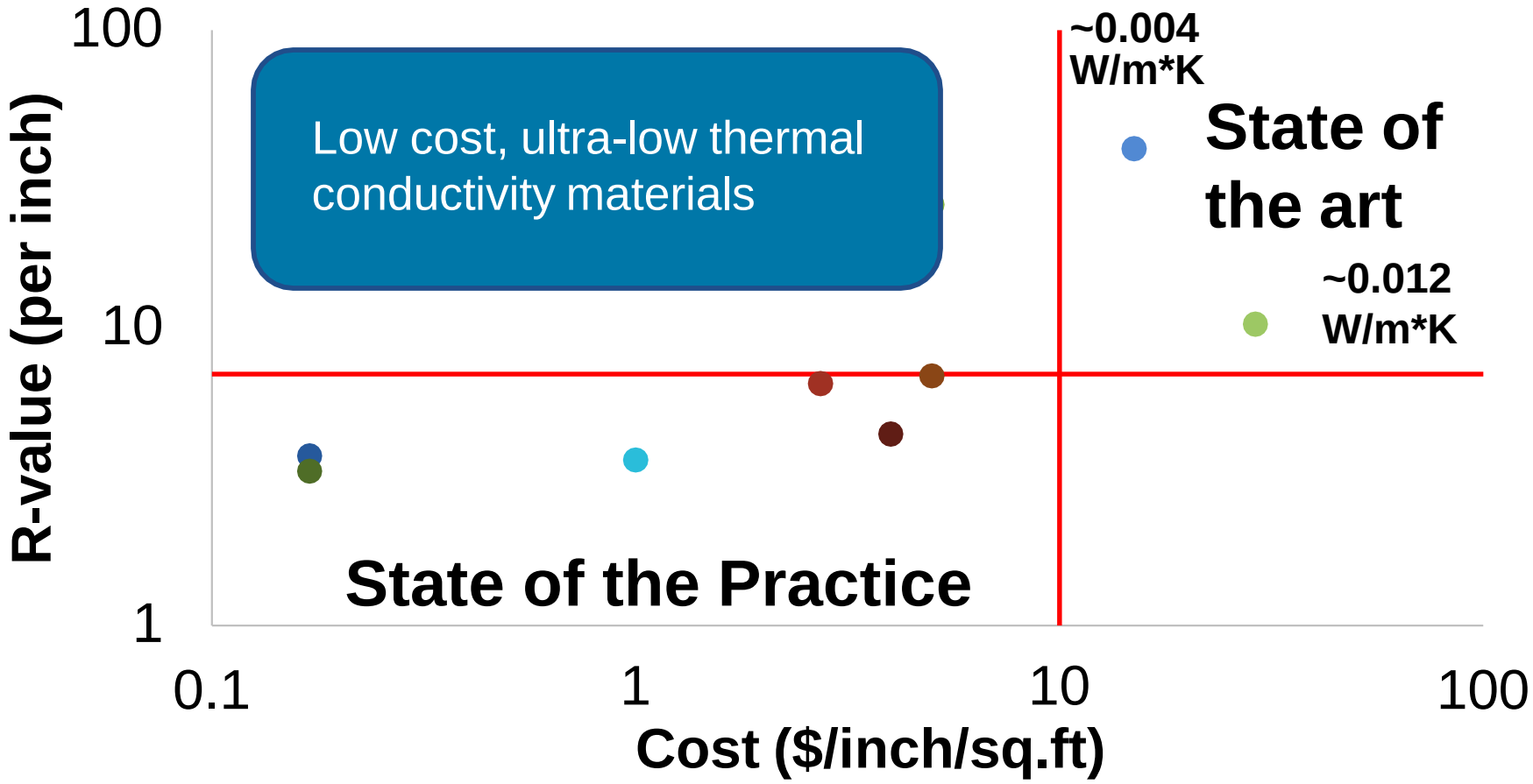
0.1 1 10 100

Cost ($/inch/sq.ft)

Insulation Materials – Innovation Opportunities



Insulation Materials – Innovation Opportunities



Building Envelope R&D Areas of Interest to BTO

Smart Building Envelope Technologies

The Building Envelope – A Different Approach

- Natural systems have evolved multifunctionality to control heat and mass transfer across interfaces.
- Can synthetic multifunctional materials be employed to control as well as take advantage of mass and energy flows through the building envelope?

Can We Manage the Heat Differently?

- The building envelope is not spatially and temporally invariant.
- Why do we manage heat that way?

Thermal Management Using Anisotropy

Reducing Unwanted Heat Flows Through Building Envelopes

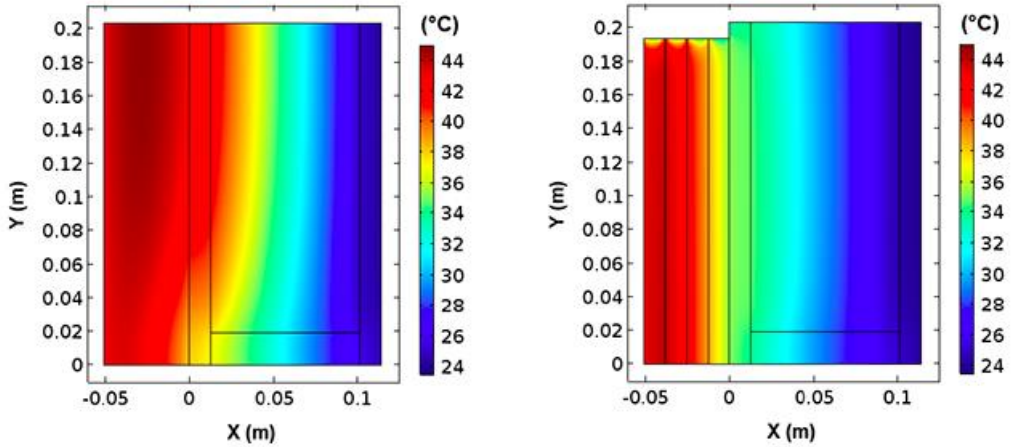
ORNL is investigating directional heat dissipation using anisotropy for reducing unwanted heat flows through the building envelope.

Anisotropic Materials and Composites

Anisotropic composites can be created by alternate layering of isotropic materials, with differing overall thermal conductivities (k) along different axes.

Simulations Show Potential for Reducing Unwanted Heat Gains

Calculations showed annual reductions of 9-69% in internal heat gains through a west-facing wall compared to the isotropic exterior insulation case



Calculated temperature distribution in the wall section with exterior insulation (left) vs. anisotropic composite and heat sink (right)

Smart Building Envelope Materials

- Self-Healing and Remediation Materials: Development of materials that can retain, repair, or restore performance following a failure event, installation error or defect, or facilitate the detection of performance deficiencies.
- Directional Heat Transfer Technologies: Development of alternate thermal management technologies, beyond static insulation, that can significantly reduce the energy consumption attributed to building envelopes.
- Variable Heat and Mass Transport Materials: Optical, hygroscopic, and insulation materials that can be tuned to allow for selective flow of moisture, air, and heat, as well as dynamically adjusting their properties in anticipation of future environmental variables.
- Tunable Thermal Storage in Building Envelopes: Controllable and on demand thermal storage to enable shaving peak energy use, boost resilience in extreme heat events, and increase envelope and building performance.

Projects being reviewed today

Glint Photonics – Stationary Concentrator Daylighting System

- Chris Gladden

Fraunhofer – Development of Low-Cost Isocyanurat-based Super Insulation

- Jan Kosny

ORNL - Ultra-high R/inch VIP with novel fibrous core material

- Kaushik Biswas

LBNL – Robust Super Insulation at a Competitive Price

- Ravi Prasher

ORNL/CERC – Passive Envelope Advancement: Integrated Design, Construction, and Industrialized Buildings

- Diana Hun

Sven Mumme

Technology Manager, Emerging Technologies
DOE Building Technologies Office
sven.mumme@ee.doe.gov