# Building Envelope Technology Team Open House Team Meeting

November 9, 2016

3:00-4:00 pm EST

# Agenda

- Welcome and Introductions
  - Melissa Lapsa, Oak Ridge National Laboratory (ORNL)
  - Jordan Hibbs, Department of Energy's Building Technologies Office
- Overview of Building Envelope Technology Market Opportunities – Simon Pallin, ORNL
- Better Buildings Partner Retrofit Case Study Profile – Gregory Farley, Chesapeake College
- Discussion
- Invitation: Join the Tech Team

# Poll Question 1

## Which type of organization best describes you or the work you do?

- ❑ Building Owner/Manager
- ❑ Architect/Engineer
- ❑ Manufacturer
- ❑ Trade Association
- ❑ Researcher/Academia

***If your organization type isn't listed, please type into your chat window the kind of organization you represent.***

# Building Envelope: 5.81 Quads

The commercial **building envelope** is the **primary determinant** of the amount of **energy required** to heat, cool, and ventilate a building

**Table 2. Primary Energy Consumption Attributable to Fenestration and Building Envelope Components in 2010 (Quads)[6]**

| Building Component | Residential | | Commercial | |
|---|---|---|---|---|
| | Heating | Cooling | Heating | Cooling |
| Roofs | 1.00 | 0.49 | 0.88 | 0.05 |
| Walls | 1.54 | 0.34 | 1.48 | -0.03 |
| Foundation | 1.17 | -0.22 | 0.79 | -0.21 |
| Infiltration | 2.26 | 0.59 | 1.29 | -0.15 |
| Windows (Conduction) | 2.06 | 0.03 | 1.60 | -0.30 |
| Windows (Solar Heat Gain) | -0.66 | 1.14 | -0.97 | 1.38 |

*Source: Office of Energy Efficiency and Renewable Energy 2011b; Office of Energy Efficiency and Renewable Energy 2011d; Office of Energy Efficiency and Renewable Energy 2011e; Office of Energy Efficiency and Renewable Energy 2011g*

# Barriers Identified for Envelope Technologies

- **Cost:** uncertainties, high first costs, ROI hurdles
- **Supply issues**: product fragility, availability, volume
- **Installation issues:** workforce training, complex systems, quality control
- **Decision culture:** resistance to new products, risk averse, code minimum culture
- **Information gap:** real world case studies, data on long-term performance, communicating effectively

# *Kick-off:*
# Building Envelope Technology Team

## Connecting Better Building Alliance members with advanced building envelope technology solutions

- ✓ Demonstrations
- ✓ Specification documents
- ✓ Case studies and fact sheets
- ✓ Calculators and analytic tools

***Melissa Lapsa, M.B.A.***

**Building Envelope Technical Team Lead**

***Simon Pallin, Ph.D.***

**Building Envelope Technical Lead**

***Mahabir Bhandari, Ph.D.***

**Building Envelope Tech Team Support**

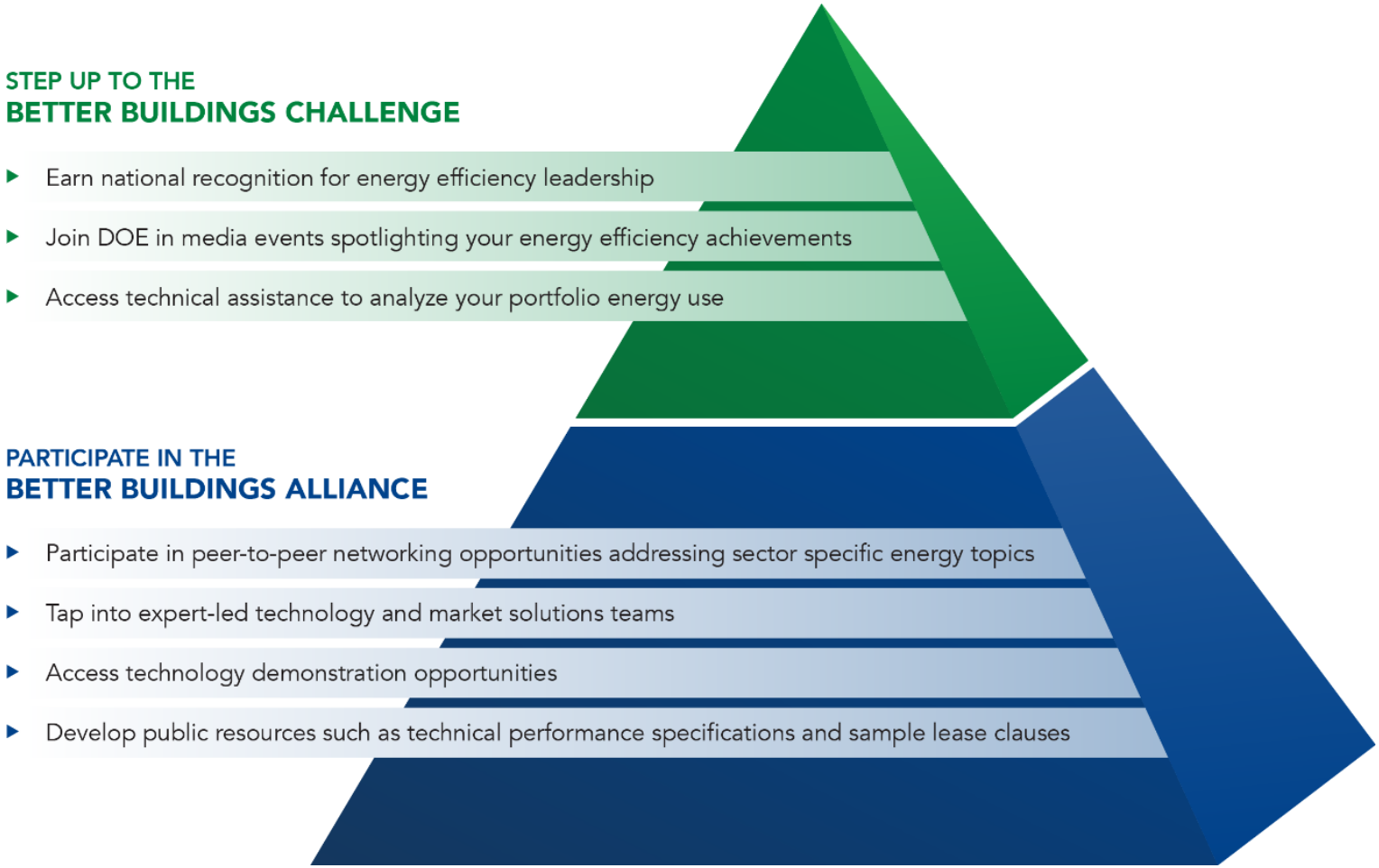
***Caroline Hazard, M.S.***

**Building Envelope Tech Team Support**

# Better Buildings Overview

U.S. DEPARTMENT OF ENERGY

# Join the Alliance; Step up to the Challenge



# Better Buildings Alliance Snapshot

| PARTNERSHIP | |
|---|---|
| **Number of Partners Organizations** | 213 *(174 partners, 39 affiliates)* |
| **Square Feet Represented** | 11 Billion |
| **Percent of U.S. Commercial Buildings** | 12% |

| RESOURCES | |
|---|---|
| **Energy Saving Resources Available to Partners** | 100+ |

# Better Buildings Solution Center


## Proven Solutions for:

- Large and small buildings
- All sectors
- Specific building types

## Search by:

- Your energy efficiency barrier
- Your sector
- Your city or state

betterbuildingssolutioncenter.energy.gov

# Better Buildings Alliance: How is it organized?

- **Commercial Real Estate**
- **Food Service, Retail, and Grocery**
- **Healthcare**
- **Hospitality**
- **Higher Education**

## MARKET SOLUTIONS TEAMS


Energy Efficiency Project Financing

Leasing and Tenant Build-Out


Energy Data Access


High Performance Property Valuation and Mortgages

## TECHNOLOGY SOLUTIONS TEAMS


Lighting & Electrical


Space Conditioning


Plug & Process Loads


Refrigeration


Energy Management Information Systems


Renewables Integration


NEW! Building Envelope

To join, contact Melissa Lapsa at lapsamv@ornl.gov

# Overview of Building Envelope Opportunities

- Building Envelope Market Potential
- Building Envelope Technologies
  - Air Barriers
  - Windows
  - Attachments
- Building Envelope Technology Solutions Website

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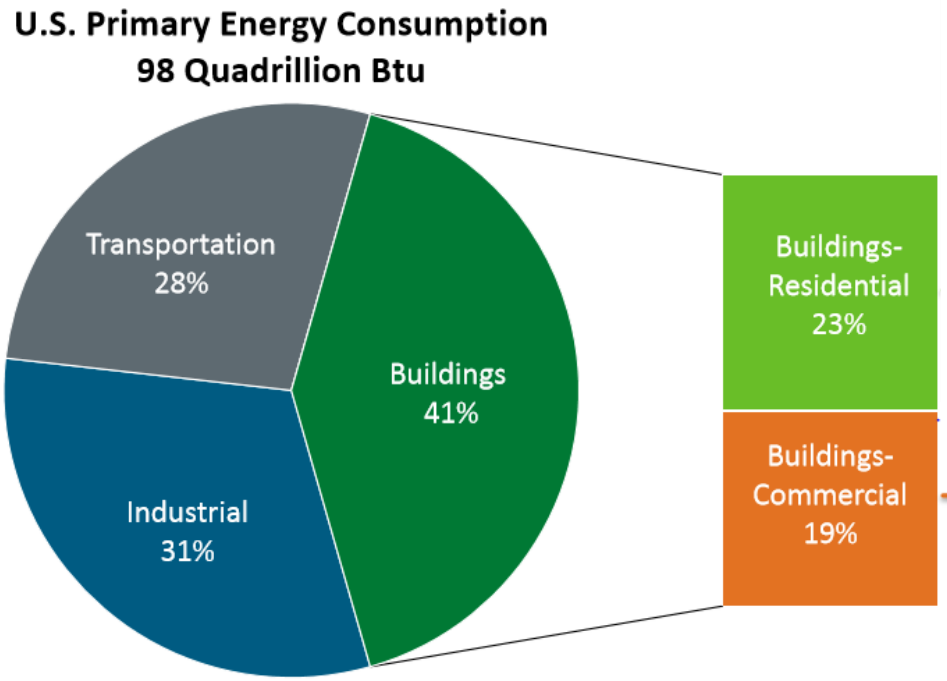
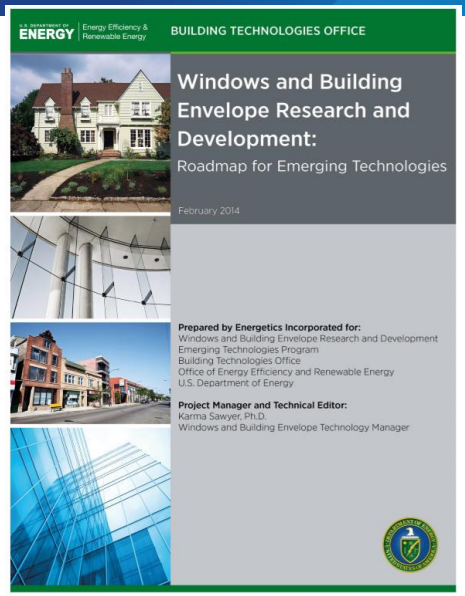
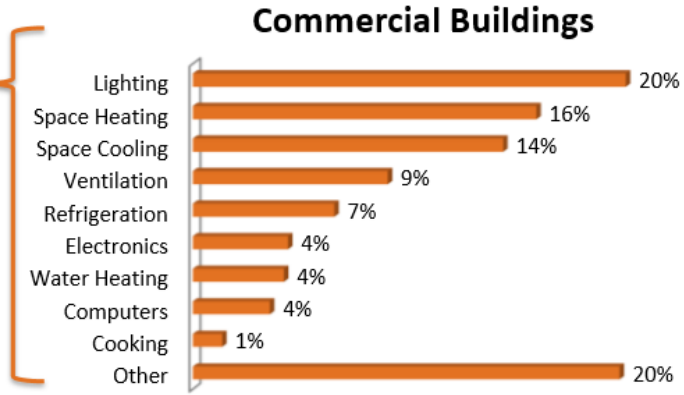
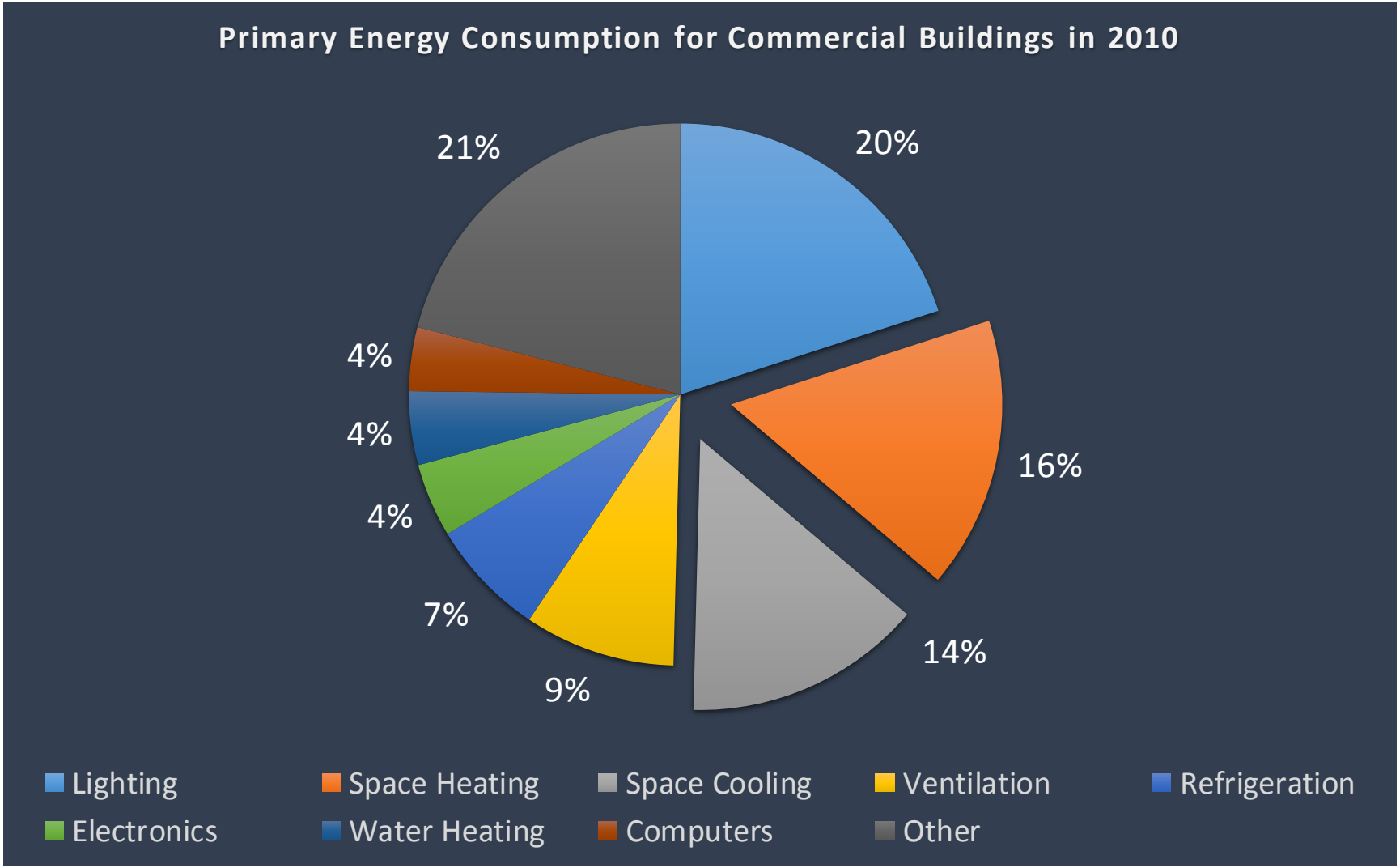
# Building Envelope Market Potential



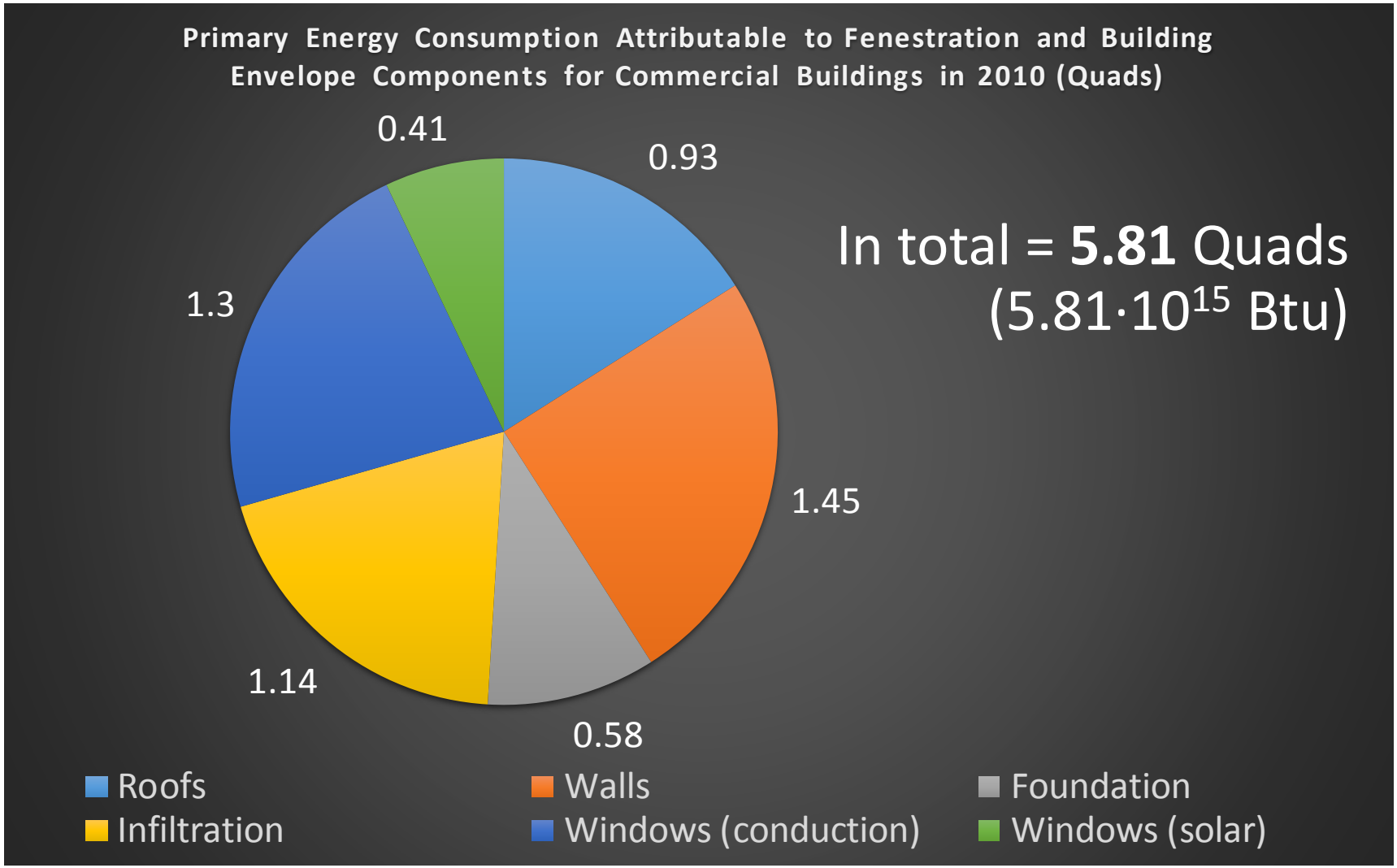



# Building Envelope Market Potential



# Building Envelope Market Potential



# Building Envelope Market Potential

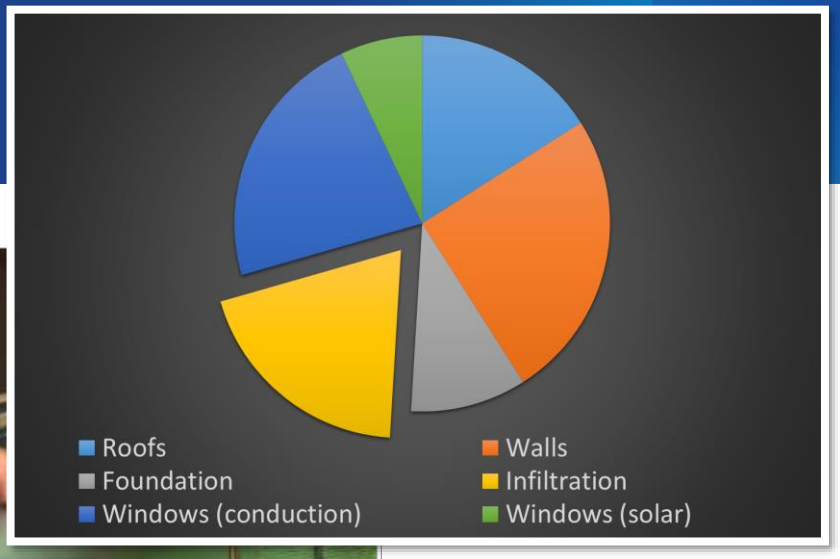
**Primary Energy Consumption Attributable to Fenestration and Building Envelope Components for Commercial Buildings in 2010 (Quads)**

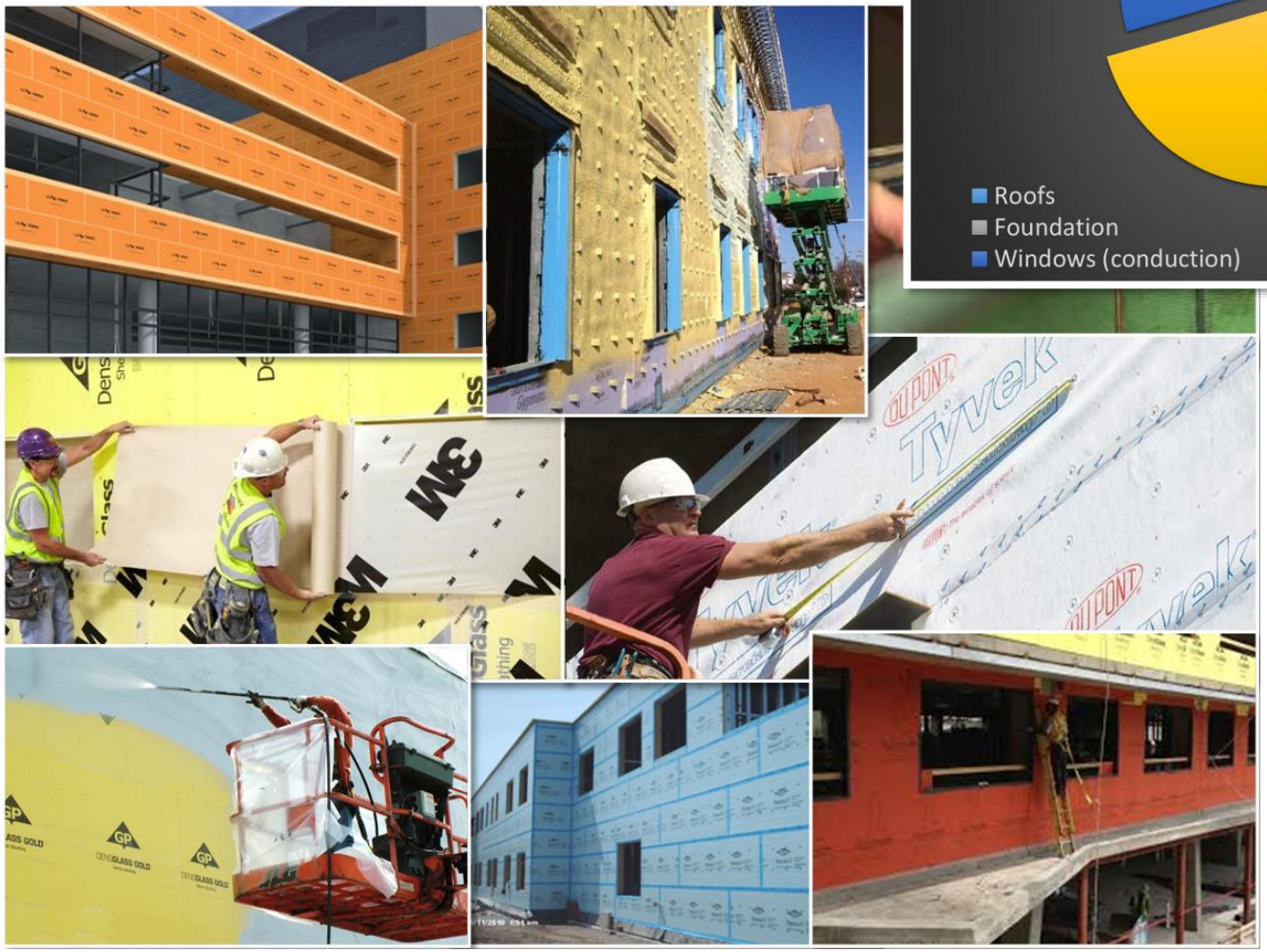
**209 million tons of coal**


**~ 1000 million barrels of oil**

- Roofs
- Walls
- Foundation
- Infiltration
- Windows (conduction)
- Windows (solar)

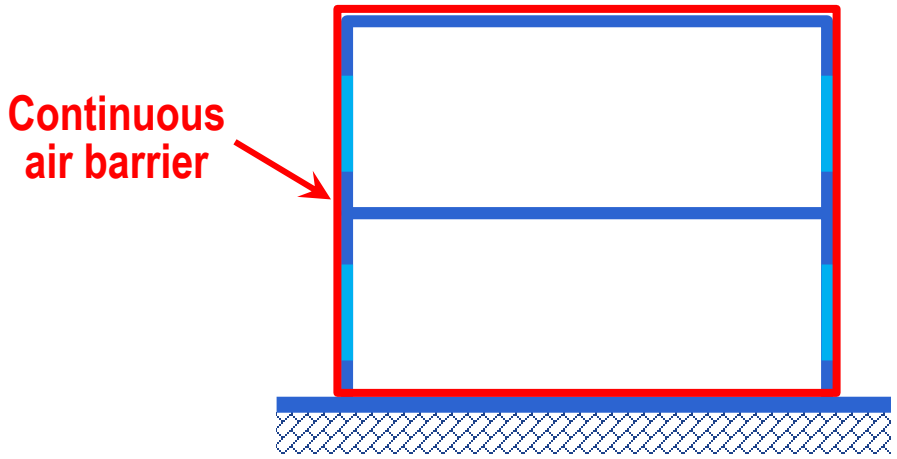
# Air Barriers



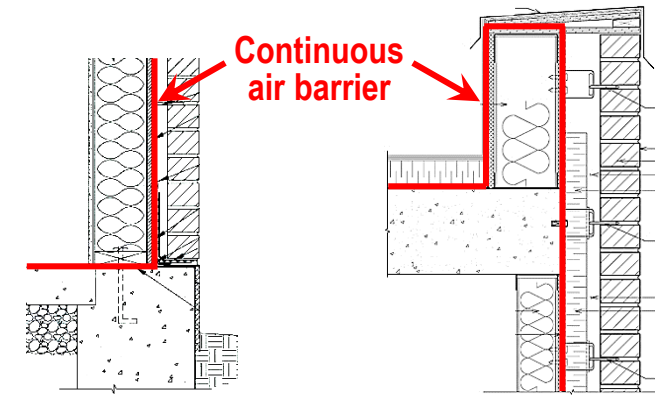



# Air Barriers

- First appearance
  - ASHRAE 189.1 – 2009
  - ASHRAE 90.1 – 2010
  - 2012 IECC




- Air barrier system
  - Prevents airflow through envelope
  - Continuous over the entire envelope
    - Seal gaps around penetrations
    - Seal wall-to-roof joint
    - Seal wall-to-foundation joint
  - Withstands forces during and after construction
  - Durable over expected lifetime of building




Wall-to-foundation

Wall-to-roof

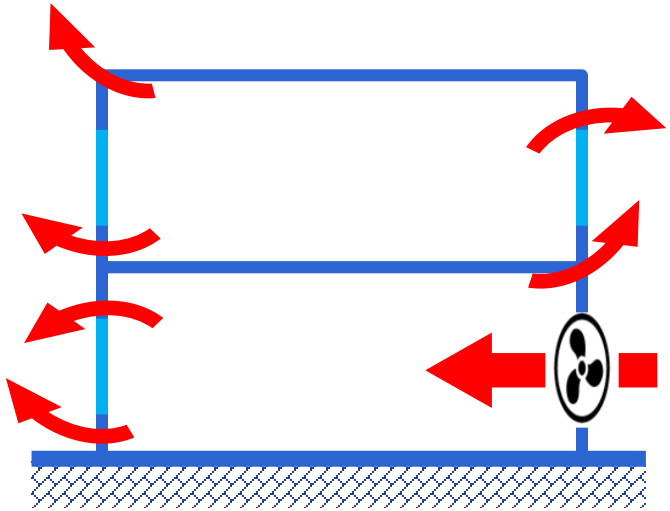
# Air Barriers

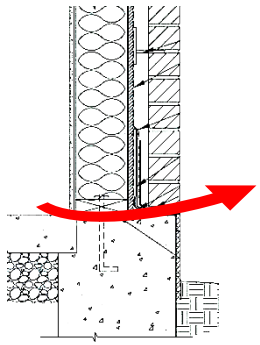
- Three paths to compliance
  - Material < 0.02 L/s·m$^2$ @ 75 Pa
  - Assembly < 0.2 L/s·m$^2$ @ 75 Pa
  - Envelope < 2 L/s·m$^2$ (0.4 cfm/ft$^2$) @ 75 Pa

Lab Tests (ASTM E2178, E2357)

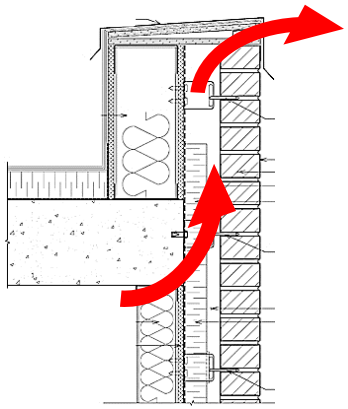
Field Test Blower Door Test (ASTM E779, E1827)

- Blower door test indicates actual air barrier performance



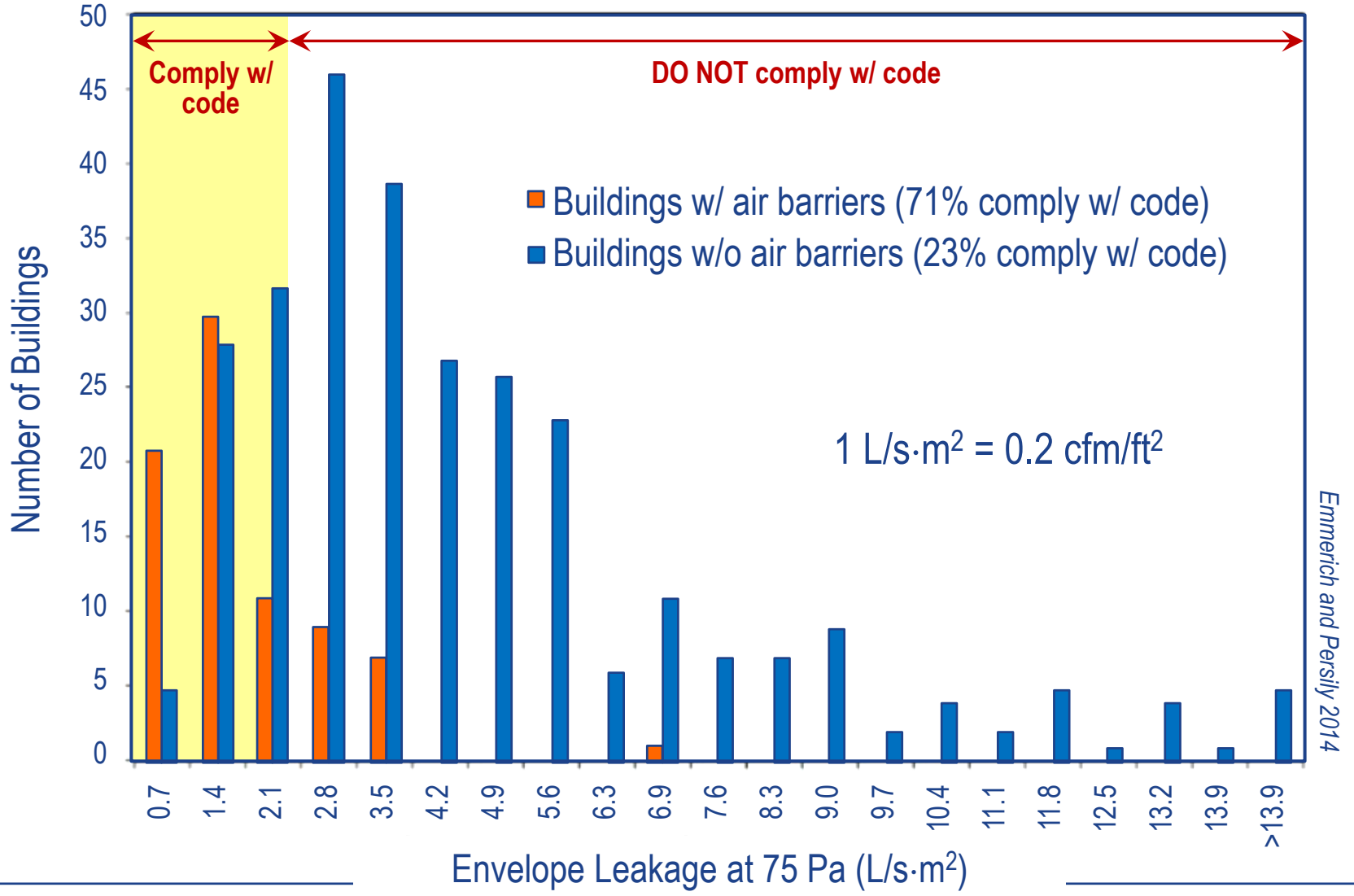


Wall-to-foundation



Wall-to-roof

# Air Barriers

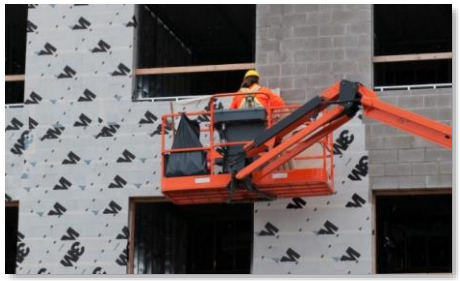


# Air Barriers

- Similarities
  - Can serve as air and water barrier and drainage plane
  - Many manufacturers require installation training
- Differences
  - Material cost
  - Installation
    - Procedure, training, workmanship skills, time, cost
    - Temperature
    - Location: interior or exterior side of wall cavity
  - Water vapor permeance
  - Thermal resistance

# Air Barriers – Latest Technologies

## Primer-Less Self-Adhered Membranes



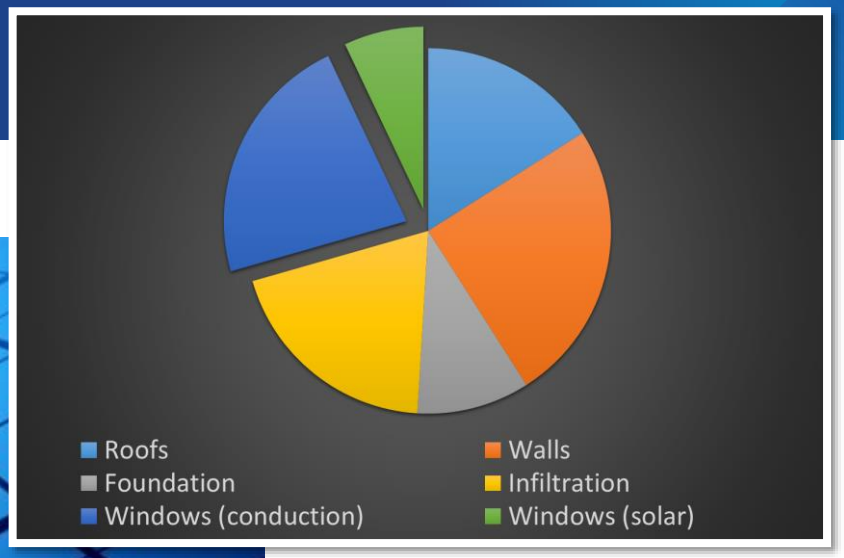
## Exterior Gypsum Sheathing Integrated w/ Air and Water Barrier

## Liquid Flashings

Installed with gun and putty knife or spreader

Spray applied

# Windows





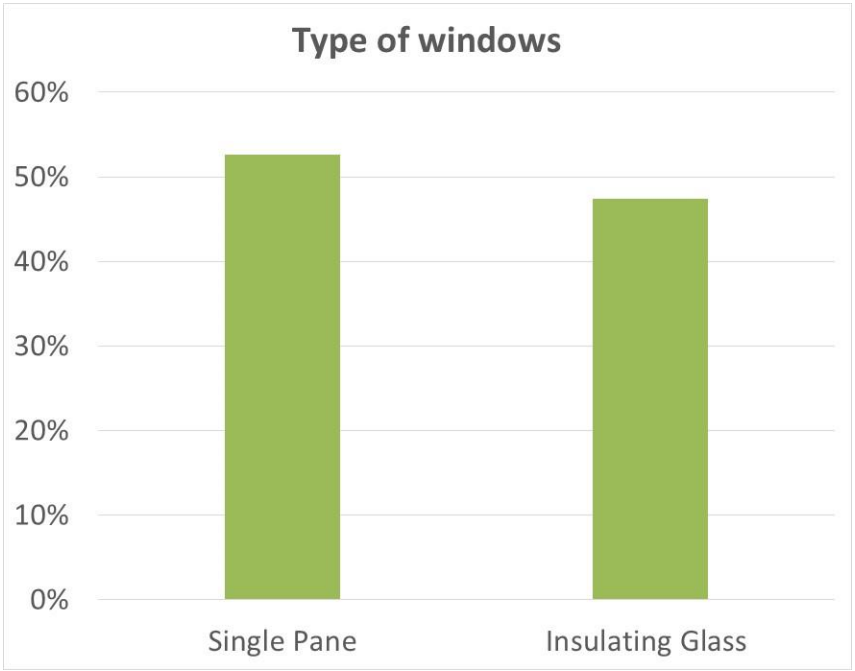


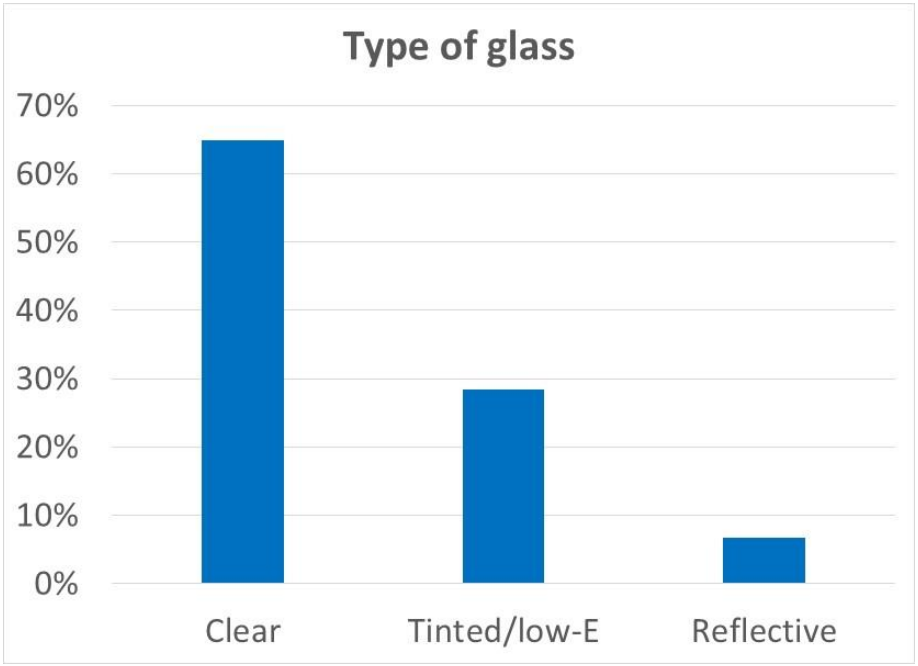
Source: New Institute of Building Sciences

# Windows

## Entire U.S. Commercial Sector – 5.6 Million buildings

## (Window stock by % of Buildings)




*Source: Table 5.2.7 - Building Energy data Book, March 2012*

# Windows

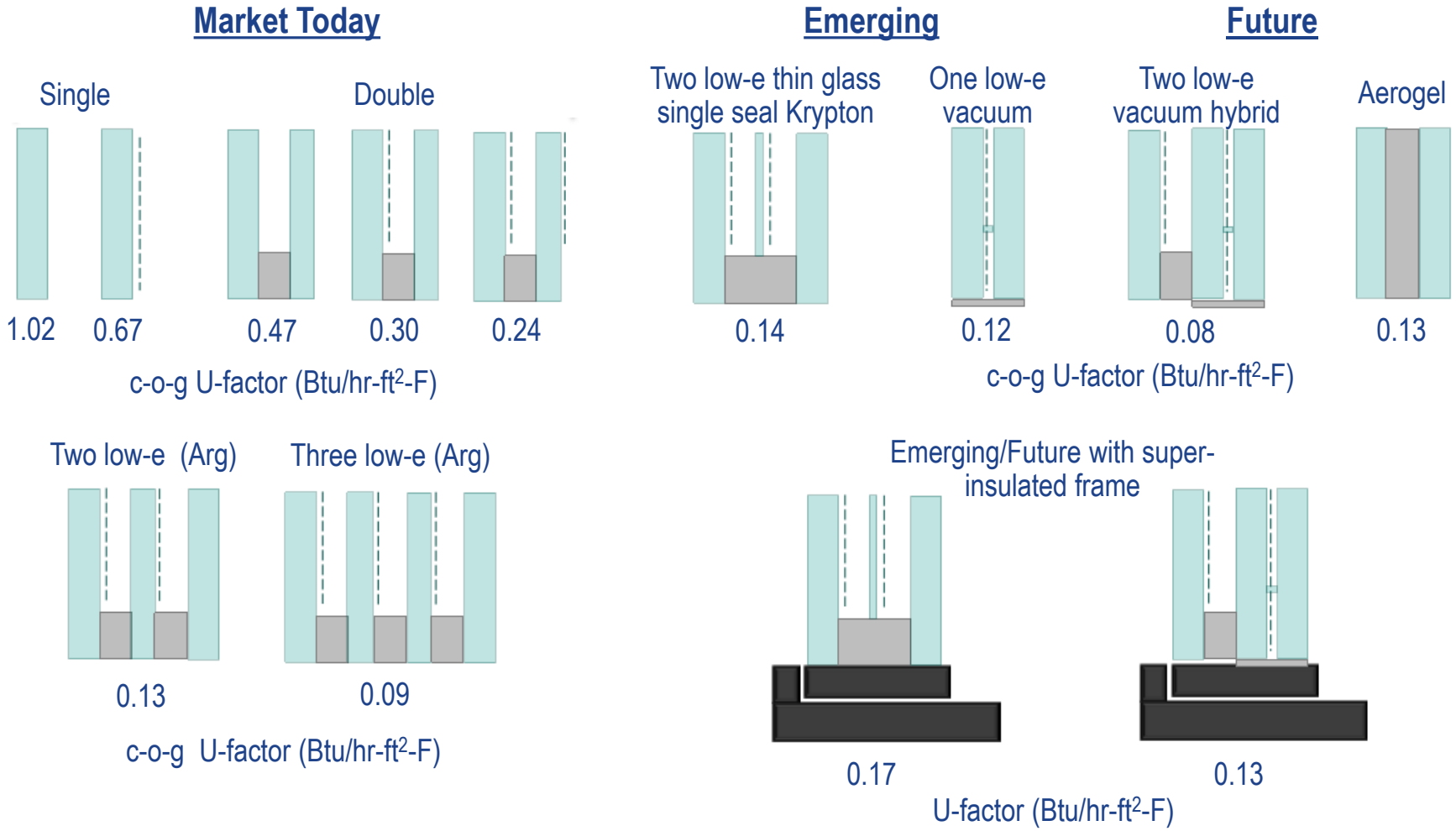
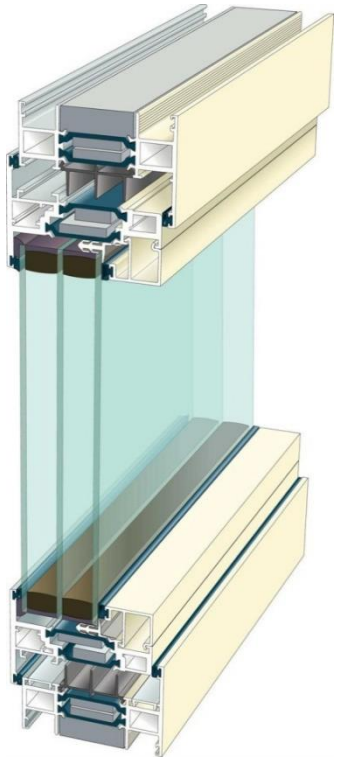



*Image credit (without U factors): Steve Selkowitz, LBNL*

# Windows – Latest Technologies

- An **industry first – R5 insulation** on an aluminum frame
- **40% better thermal performance** compared to other high-structural windows
- An **Architectural (AW) structural rating**, the highest structural rating for windows
- Durable, passed blast and hurricane impact testing



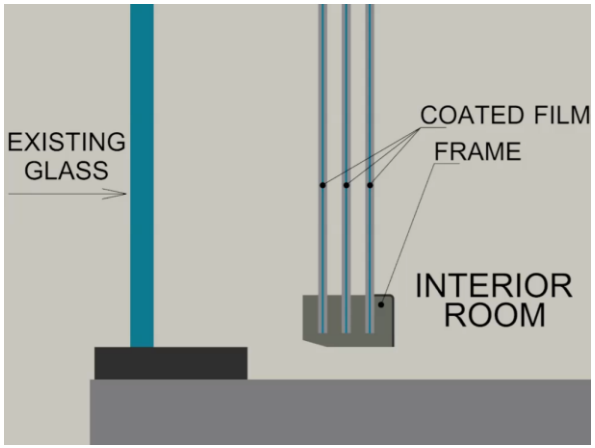
# Windows - Attachments

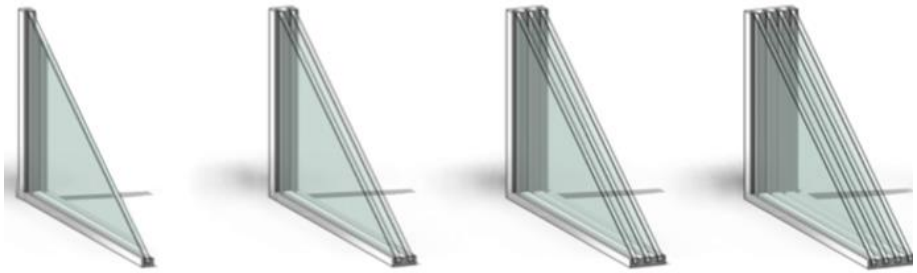
- A great option when a full window replacement is not possible, nor the best suited solution in terms of cost, timing, and historical preservation perspective.
- Attachments provide excellent glare control, daylight management and may also add insulation.
- An analysis conducted by BTO determined that the insulated and reflective window attachments have the potential to save nearly **800 TBtu by 2030** across residential and commercial sectors.

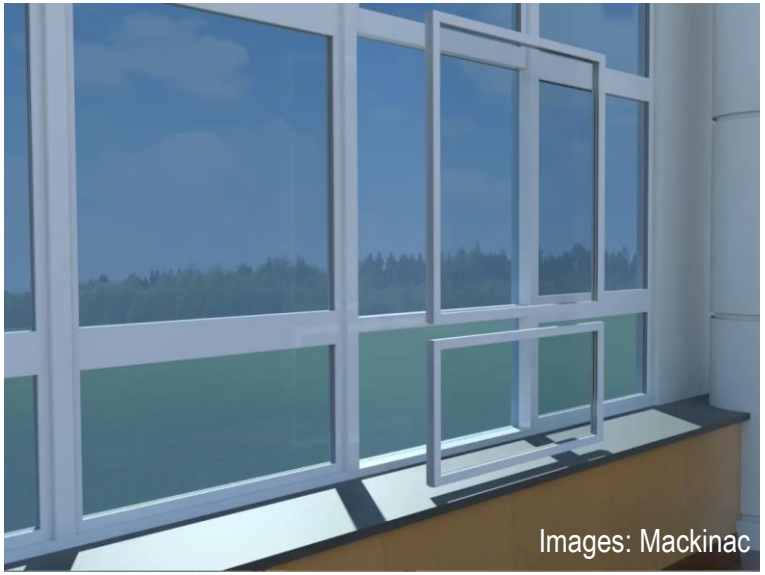
# Windows - Attachments

## Polymer storm window

- Light weight
- Transparent
- Window cover
- Goal is to transition to commercial operation in about two years



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Better Buildings Initiative » Better Buildings Alliance » Building Envelope

# Technology Solution: Building Envelope

The building envelope, which includes the walls, windows, roof, and foundation, forms the primary thermal barrier between the interior and exterior environments. With envelope technologies accounting for approximately 30% of the primary energy consumed in residential and commercial buildings, it plays a key role in determining levels of comfort, natural lighting, ventilation, and how much energy is required to heat and cool a building. Members of the Envelope Technologies Solutions Team collaborate with DOE's national laboratories to deploy high performance envelope design solutions for space conditioning load reduction and to facilitate the construction of durable and high performing envelope technologies.

# Poll Question 2

**Have you completed projects with any energy-saving building envelope technologies?**

- ❑ Yes
- ❑ No
- ❑ I am not sure

***Please type into your chat window what type of project or technology.***



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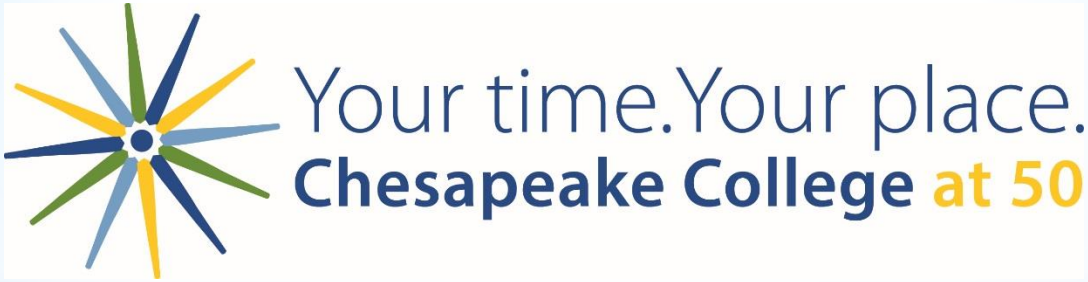
# Poll Question 3

**Have you started or completed projects with any of these technologies?**

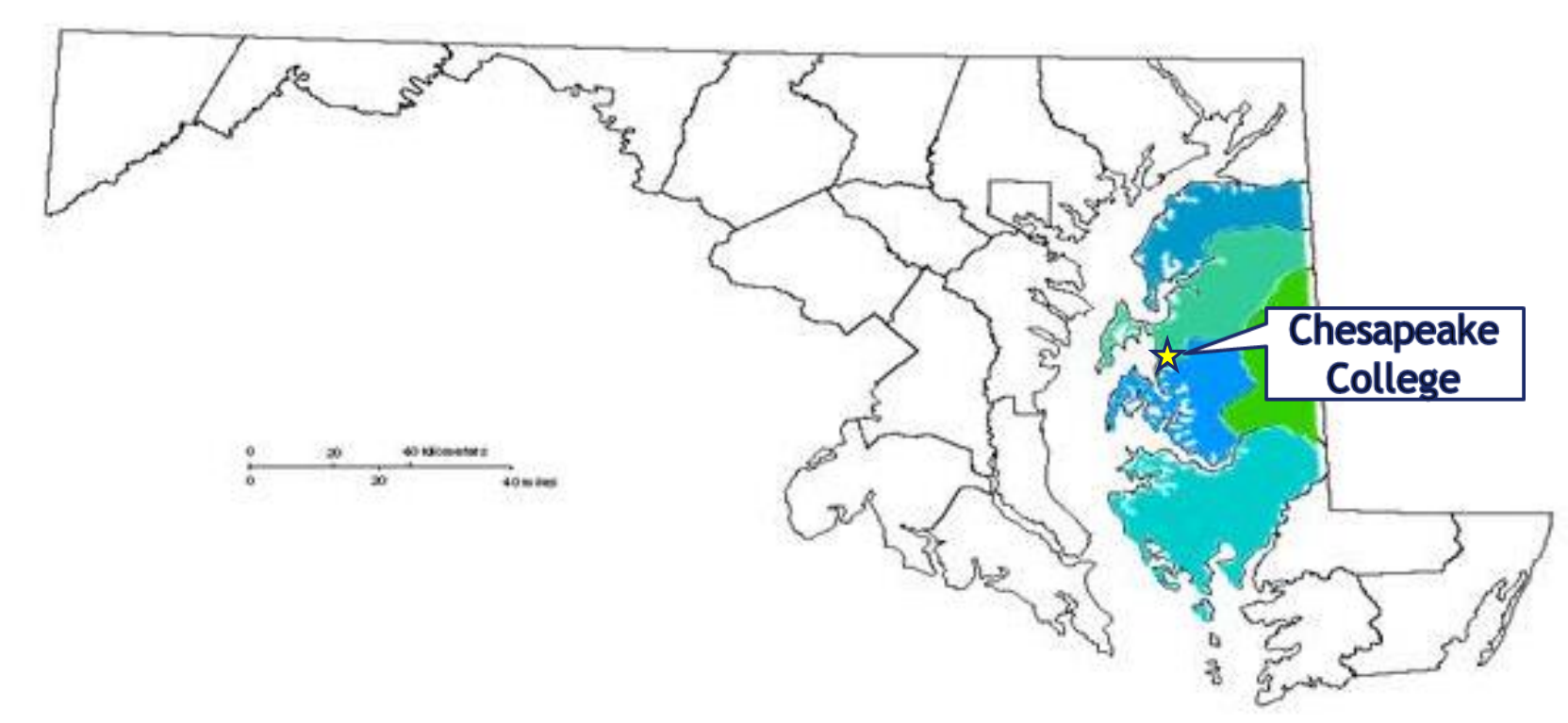
***(click all that apply)***

- ❑ Dynamic Windows (electrochromic & chromogenic)
- ❑ Air Sealants (sprayables, primer-less membranes, etc.)
- ❑ R-5 Windows
- ❑ Vacuum Insulated Panels (VIPs)

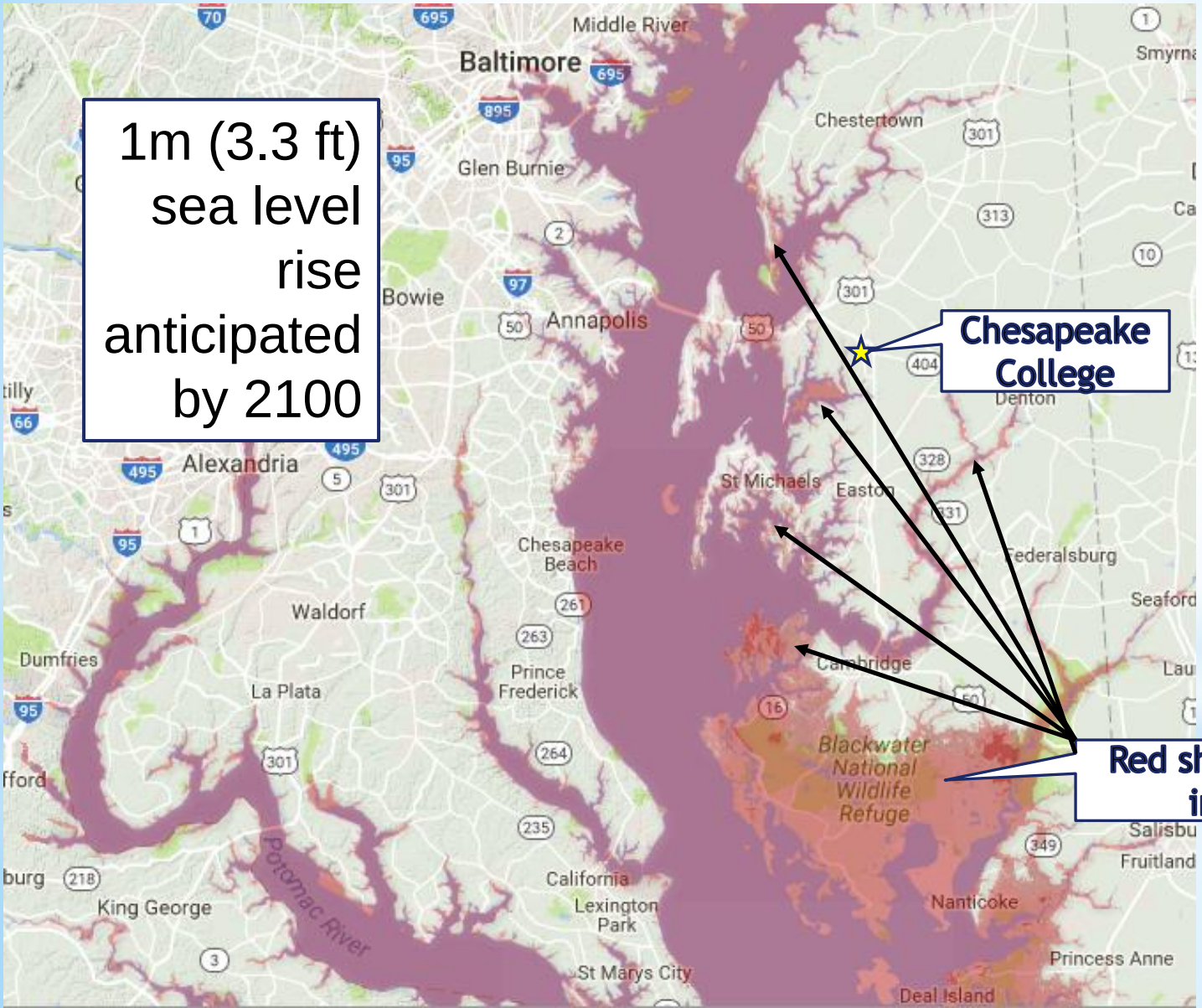

Your time.Your place.
Chesapeake College at 50

# Chesapeake College Basics

* Serves 5 counties on Maryland's Eastern Shore
* 20% of MD land area; 3% of MD population
* 2000 students in a typical semester
* Rural, ecologically sensitive

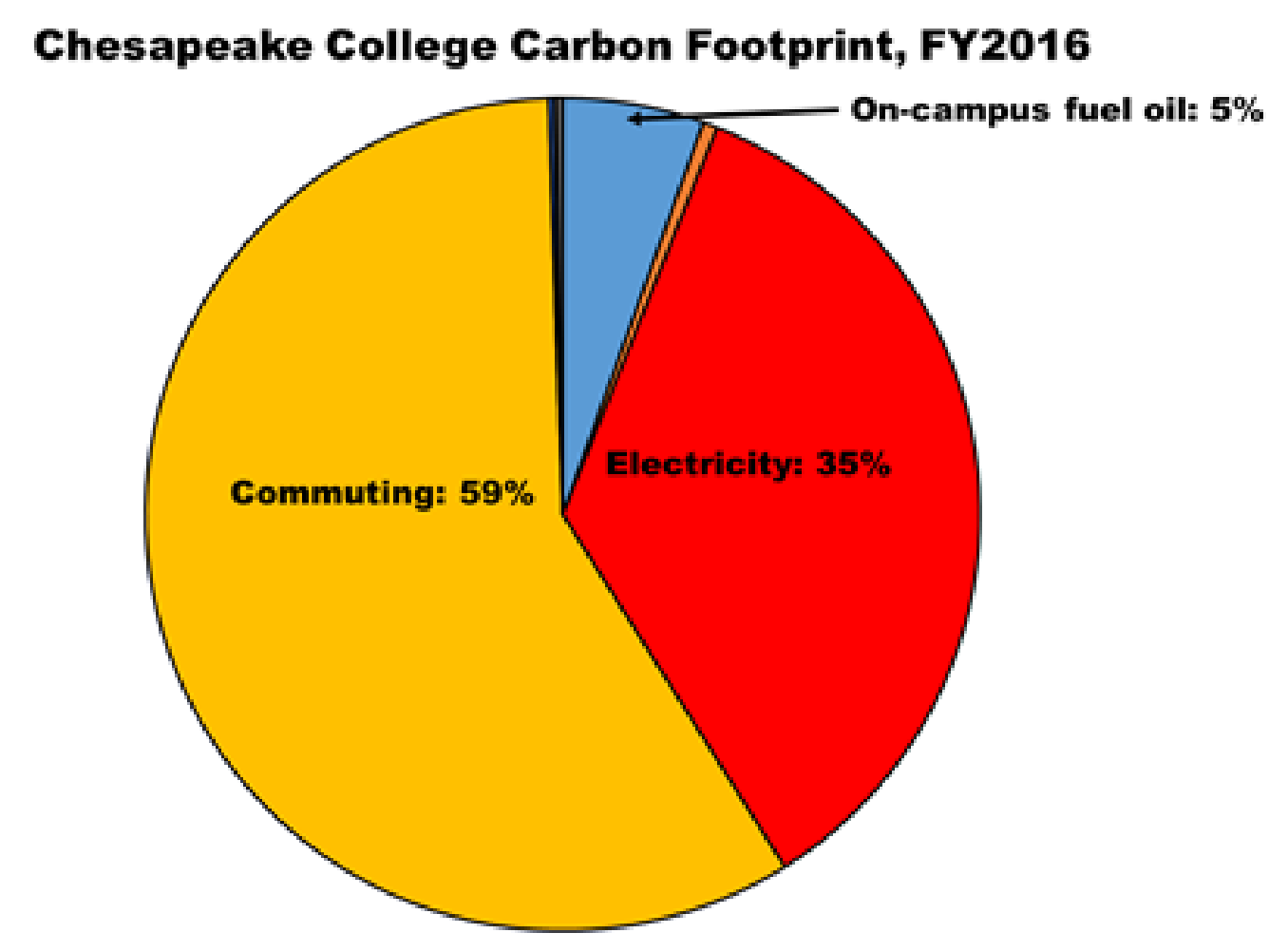


# Ecological Sensitivity



# Chesapeake College Basics

* $CO_2$ footprint:  6773MT
* Energy costs $500,000/yr



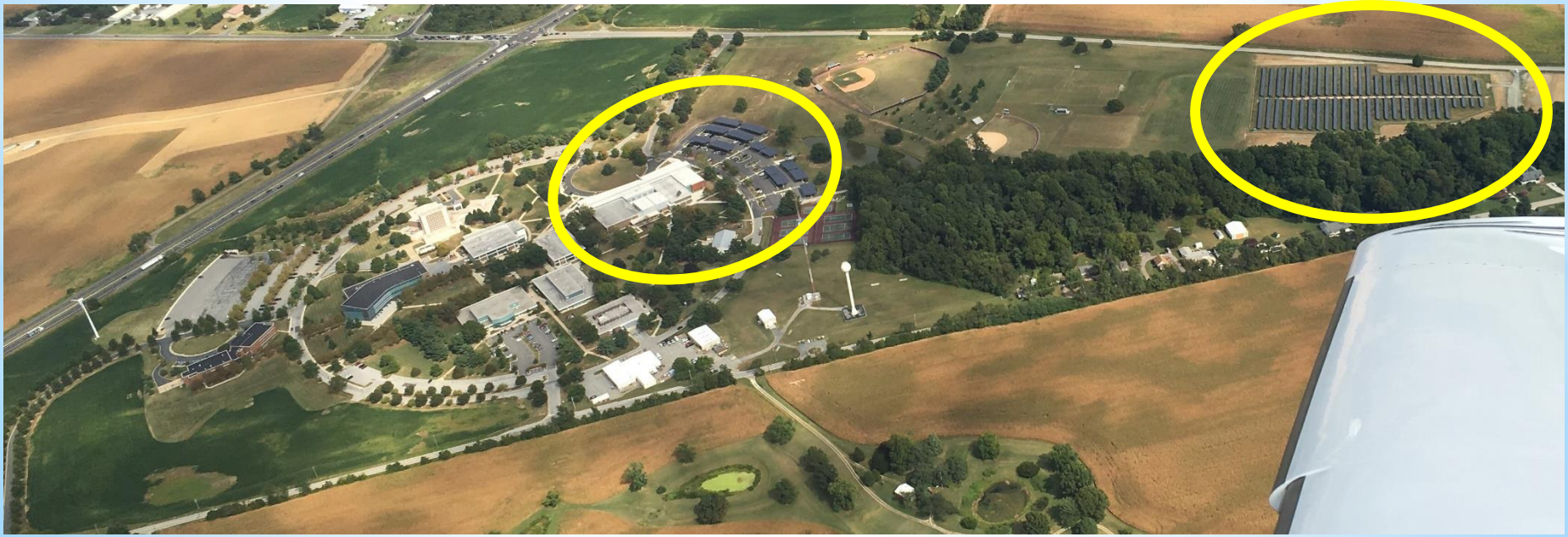
# On-Campus Energy Installations

* Wind Turbine
  * Endurance E-3120
  * 50 kW nameplate
  * 120’ to hub, 150’ to blade tips
  * Makes ~ 70,000 kWh ($7,000) /year

* Conservation: 20% of energy costs

# On-Campus Energy Installations

* 1.75 MW Solar PV
  * 1.5 MW Ground-mounted
  * 250kW parking lot canopy
  * 14 EV charging stations
* 2MWh Battery
  * *Coming soon!*



# Health Professions & Athletics Center

* Originally a Gymnasium
  * 1967-68
  * Pool added 1974(?)
  * Pool had a solar hot-water loop!

# Health Professions & Athletics Center

* Envelope technology
  * High performance insulating glass, including integral ceramic shading patterns in areas with direct sunlight exposure
  * Building geometry and massing, including a) new construction wrapped around the pre-existing, uninsulated building, and b) opaque exterior components overhang glass areas to provide shading
  * Exterior walls feature metal or terracotta rain screen skins over minimum R-18 insulation

# Health Professions & Athletics Center


* Roof has a light-colored, high-SRI surface membrane over minimum R-25 insulation
* Central heat recovery air handlers are used for the building exhaust systems; fresh air is provided through energy recovery ventilators with heat wheels that condition 100% of outside air
* Central building energy management system is integrated into the overall campus management system

Your time.Your place.
Chesapeake College at 50

# Chesapeake College

Share

SHOWCASE PROJECT
Health Professions and Athletics Center

ENERGY PERFORMANCE
View details on Chesapeake College's progress to date

CHALLENGE COMMITMENT

311

Thousand Square Feet

GOALS

20%

Reduction in Energy Intensity

PROGRESS

19%

Cumulative (vs. Baseline)

Share

# Showcase Project: Health Professions and Athletics Center

**SECTOR TYPE**
Education

**LOCATION**
Wye Mills, Maryland

**PROJECT SIZE**
100,000 Square Feet

Your time.Your place.
Chesapeake College at 50

## Annual Energy Use

(Source EUI)

Baseline (ASHRAE Standard) — 180 kBtu/sq. ft.

Expected (2016) — 124 kBtu/sq. ft.

Actual

**28.6 (based on 9 months of data)**

Energy Savings:

**84%**

## Annual Energy Cost

Baseline (ASHRAE Standard) — $161,000

Expected (2016) — $71,000

Actual

**$84,679 (estimate, based on 9 months of data and $.10/kWh)**

Cost Savings:

**$134,240 (estimate)**

# Poll Question 4

**Which of the following resources would help you moving forward with energy-saving envelope projects?**

***(Click all that apply)***

- ❑ Technology performance specifications
- ❑ Decision analysis tools (e.g., calculators, simulation, etc.)
- ❑ Demonstration opportunities
- ❑ Case studies
- ❑ Installation guidance

# Discussion

# Envelope Tech Team: What's Next

- 2017 Plans and Team Priorities
  - Demonstrations: R-5 windows, sprayable sealant technologies, and envelope air sealing strategies
  - Case studies and fact sheets
  - Specification documents
  - Webinars on available energy efficient technologies
  - Installation guidance and heat and moisture analysis

**Tech Expert/POC**

Melissa Lapsa
lapsamv@ornl.gov

# Get involved with the Envelope Tech Team

- Join the Better Buildings Alliance or Challenge
- Participate in Envelope Tech Team Meetings
- Collaborate on demonstration projects
- Access new solutions and tools
  - Technical specifications for dynamic windows
  - Air sealing strategies
  - Emerging technologies

Email Melissa Lapsa:
lapsamv@ornl.gov