The Advantages of Continuous Insulation in Steel Stud Construction

AIA Course Number R012012

Thursday, June 21, 2018 10:30 AM – 11:30 AM

Learning Units 1 AIA HSW Credit and 1 GBCI CE hour

A'18 AIA Conference on Architecture 2018
June 21-23, New York City

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Acknowledgements/Credits

[Optional slide]

Speakers List

- Matthew Stevens, CSI

Course / Learning Objectives

- Understand building sustainability and longevity, and how professionals are adapting to meet increasing standards.
- Explore the science behind thermal, air, and moisture control for steel stud construction.
- Learn how to interpret the code requirements for building envelope design and performance
- Discover how polyiso not only meets requirements but outperforms traditional methods for optimum control.

Section 1

Building Sustainability and Longevity

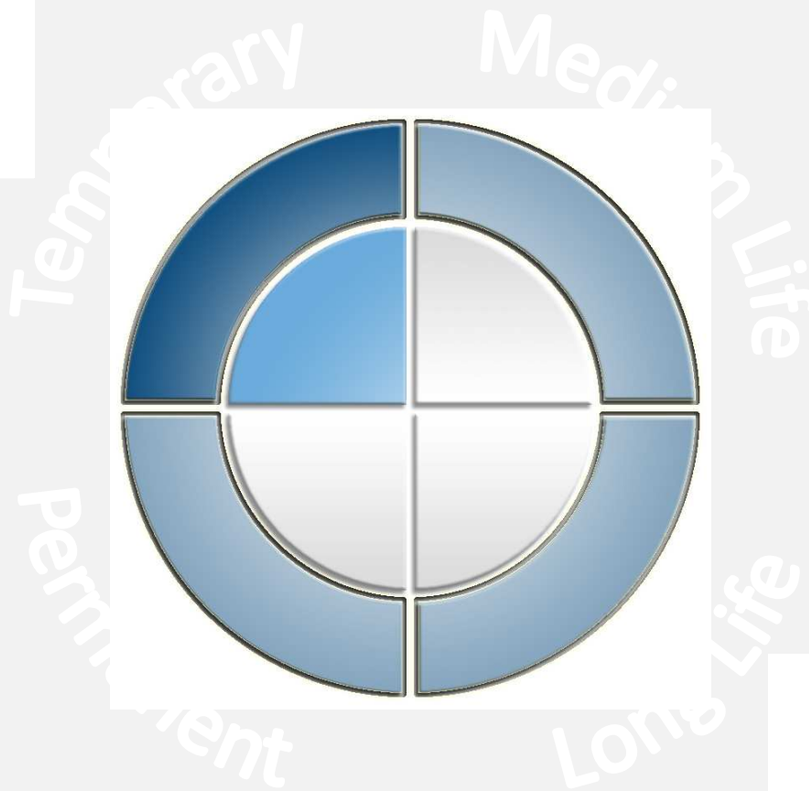
Building LIfe

Up to 10 years

Non-permanent construction buildings

25 to 49 years

Most industrial buildings and parking structures



100+ years

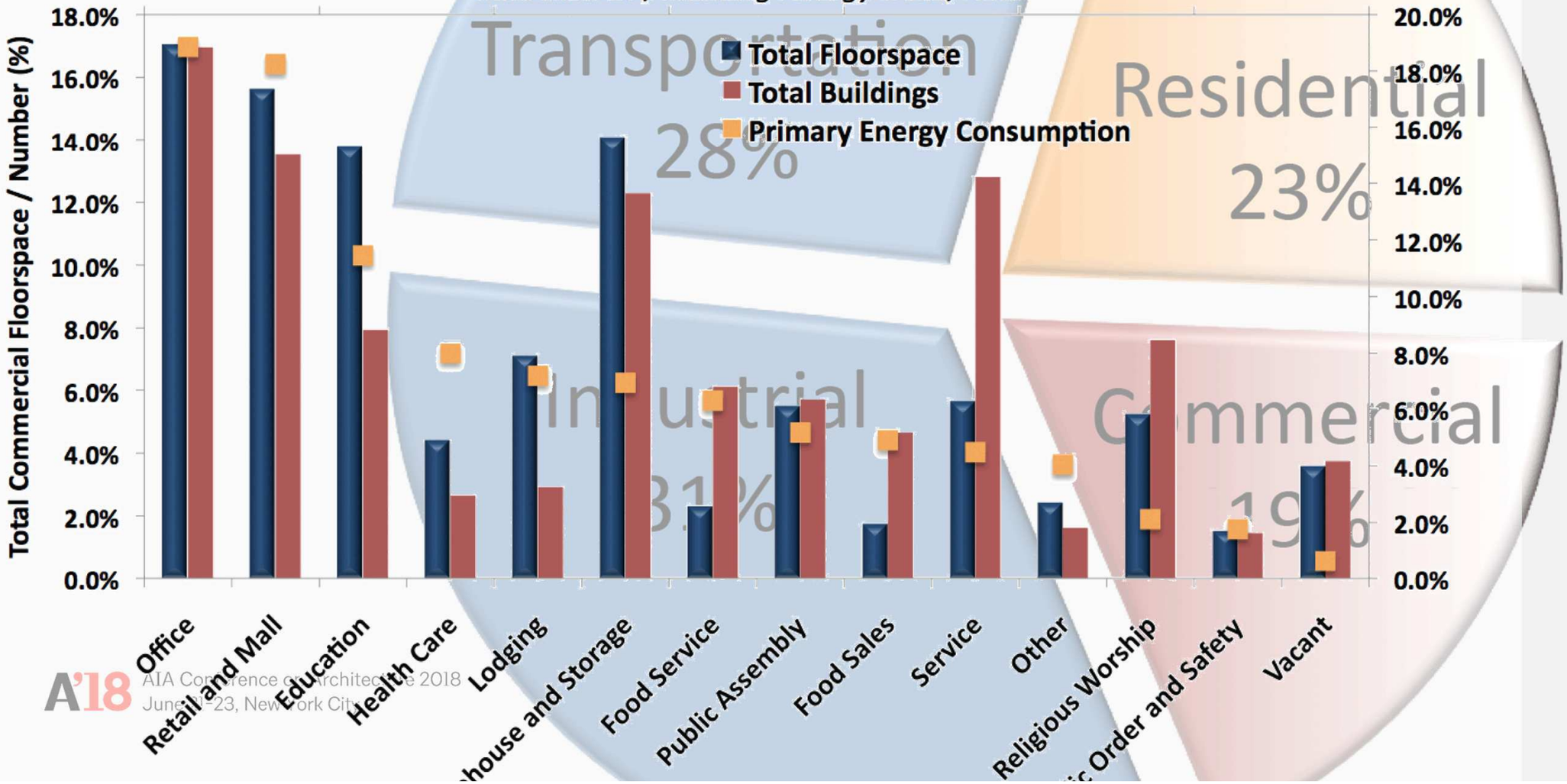
Monumental or heritage buildings

50 to 99 years

Most residential, commercial and office buildings

US Commercial Building Types: Floorspace, Number and Primary Energy Consumption

source: DOE, Building Energy Data, 2009



Transportation 28%
Residential 23%
Industrial 31%
Commercial 19%

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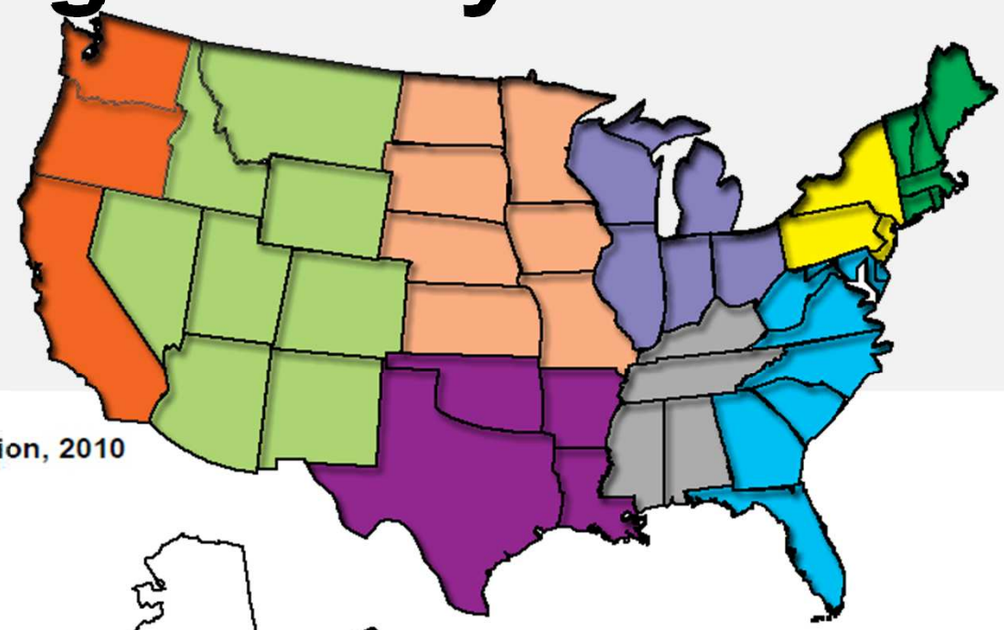
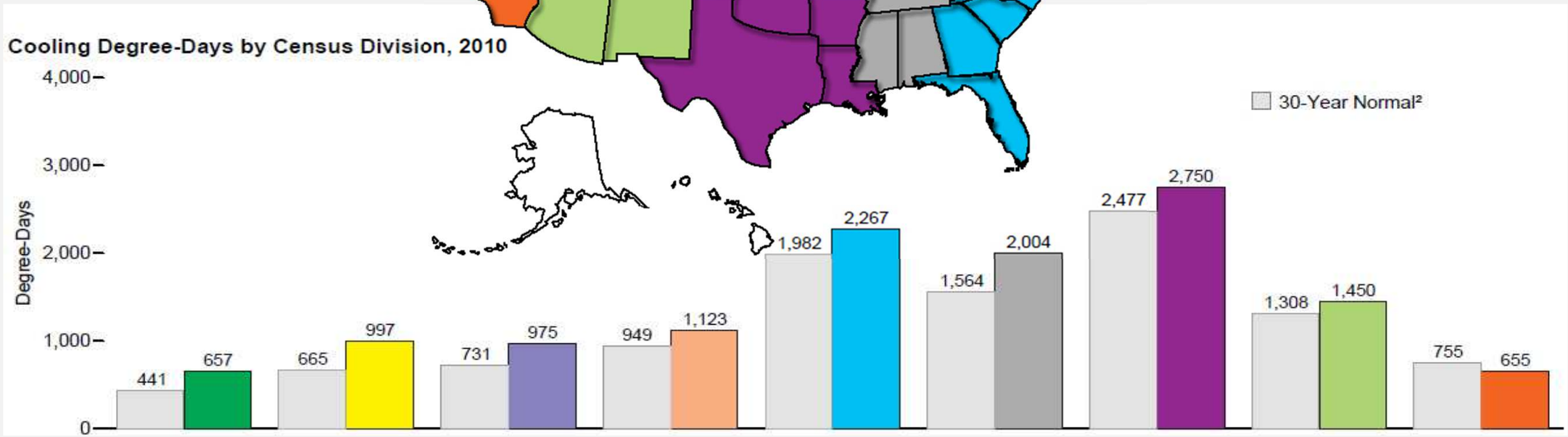
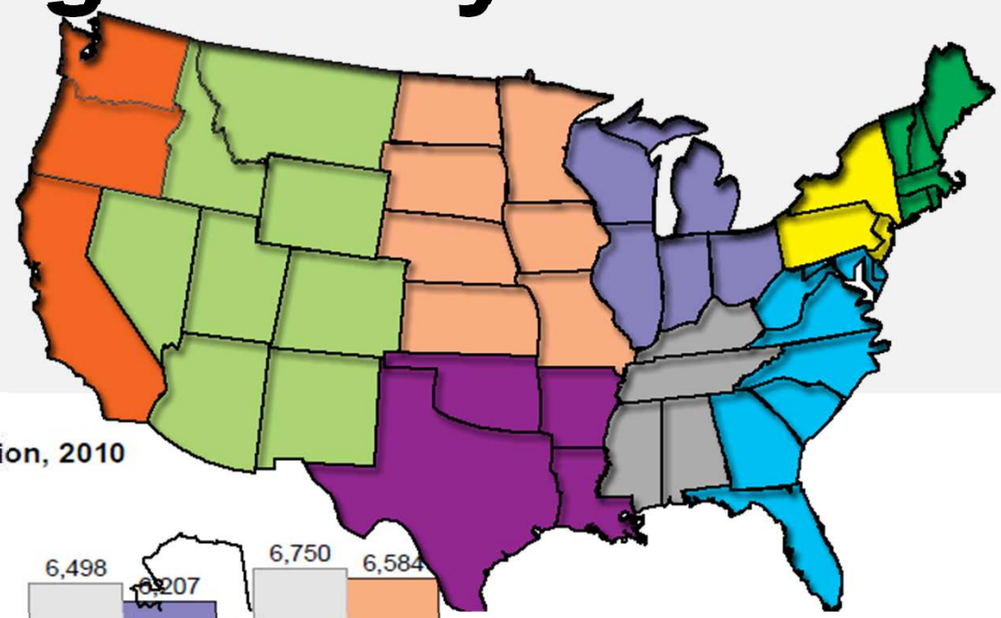
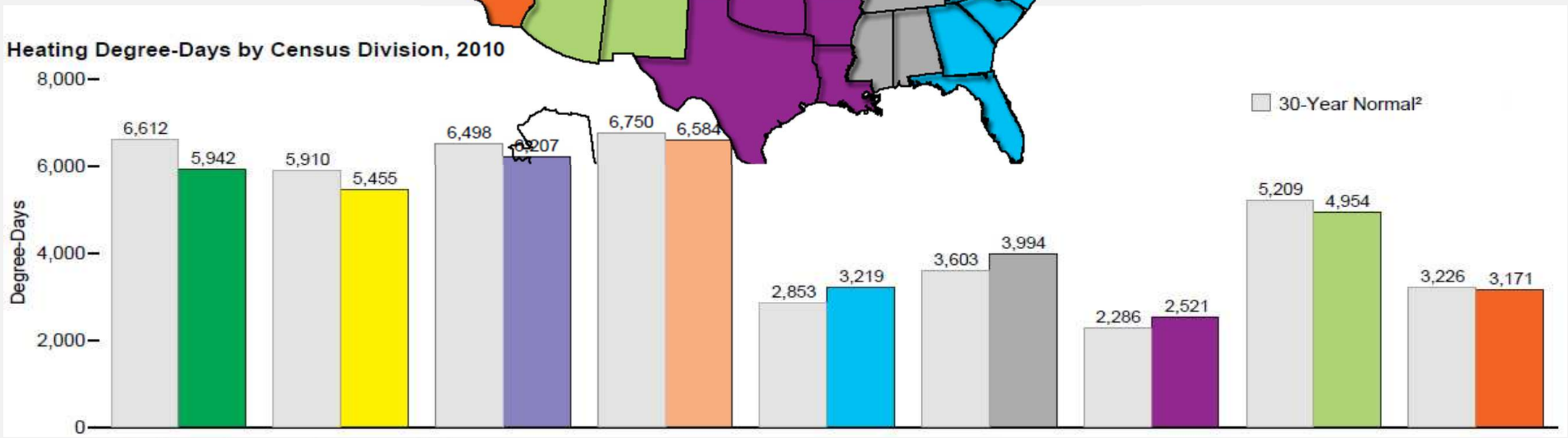
Cooling Degree Days



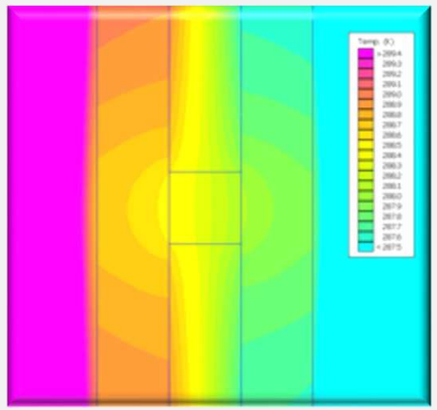


Heating Degree Days





Section 2



Thermal Bridging

Air Infiltration

Moisture Control

Factors Affecting Building Envelopes

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Temperature Gradients and Building Envelopes

The temperature existing at any point in a wall under any given exterior and interior temperature condition is of great significance in designing problem-free enclosures

Control of Rain Penetration

Gravity Flow
Capillary Action
Wind-Driven Rain
Advective Moisture Flow
Convective Moisture Flow

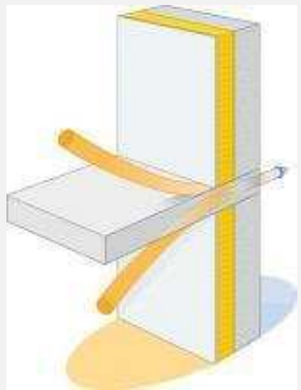
Air Leakage

Specific locations where holes and cracks are in the walls

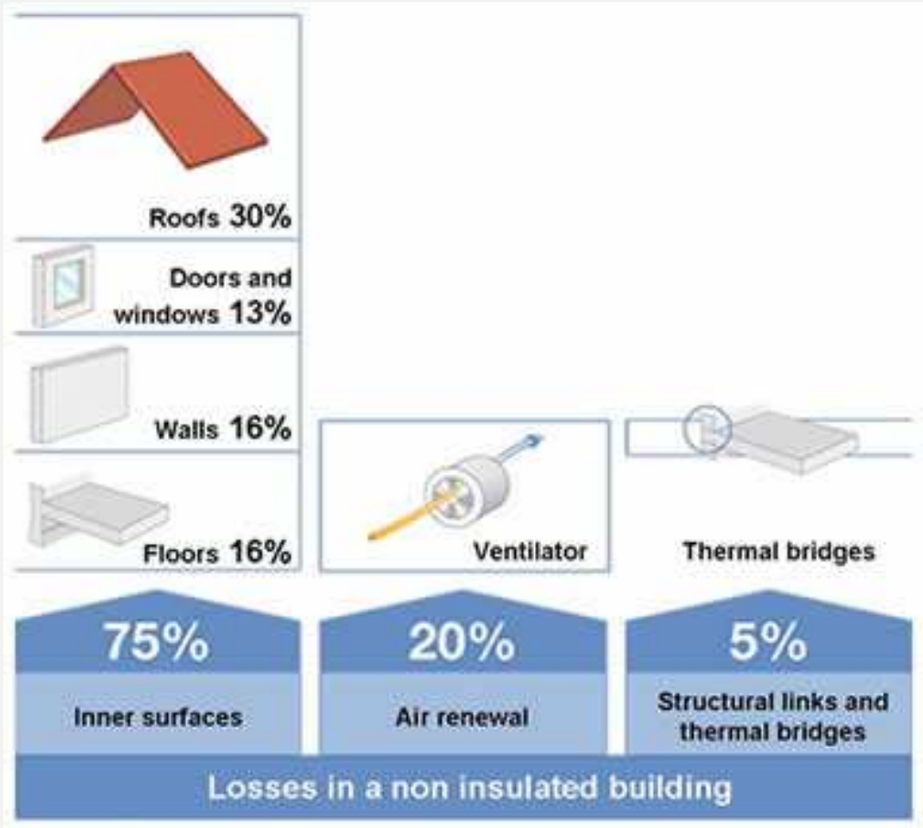
Air Flow

The stack effect, wind and mechanical ventilation

Poor Thermal Integrity



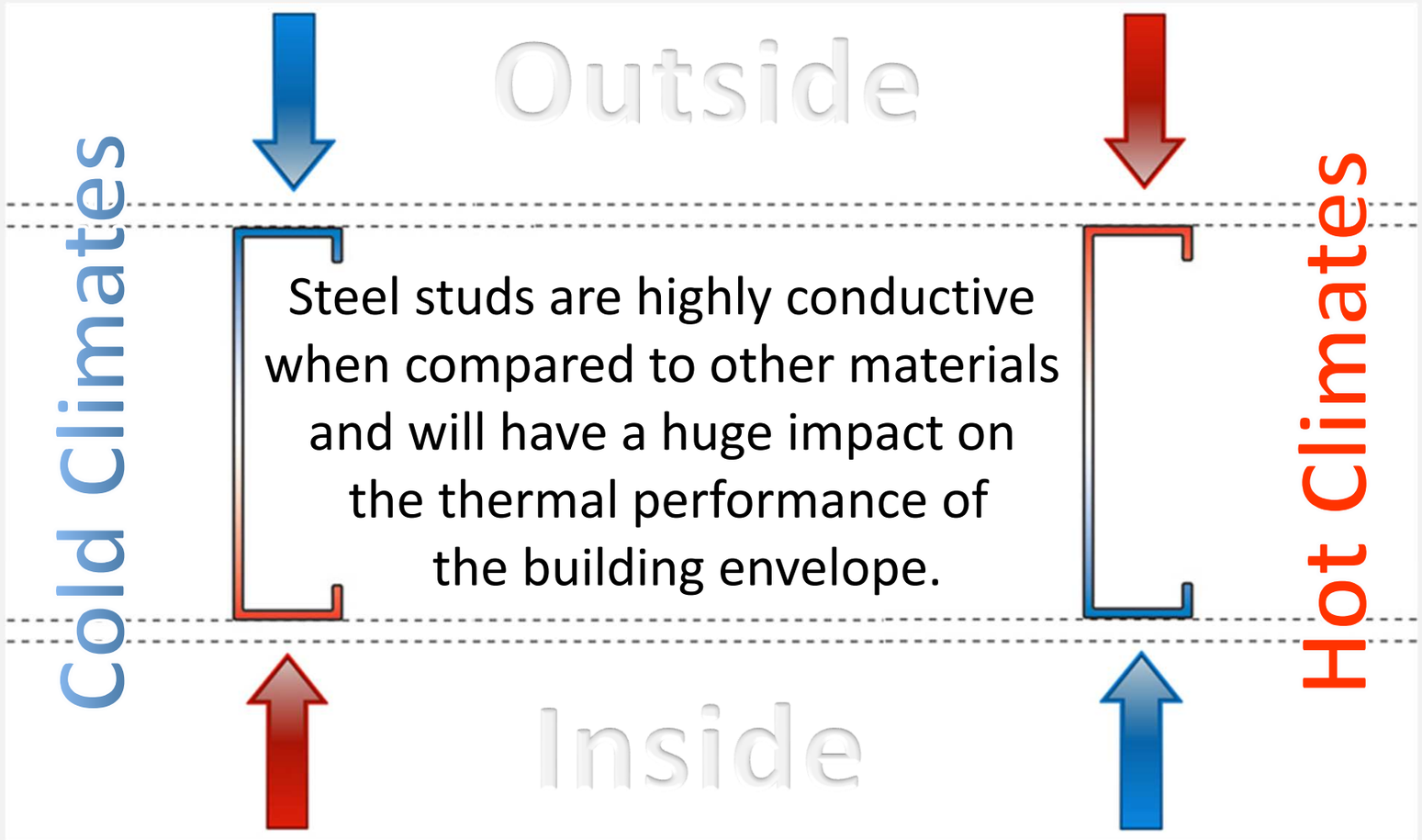
A thermal bridge occurs when there is a gap between materials and/or structural surfaces.



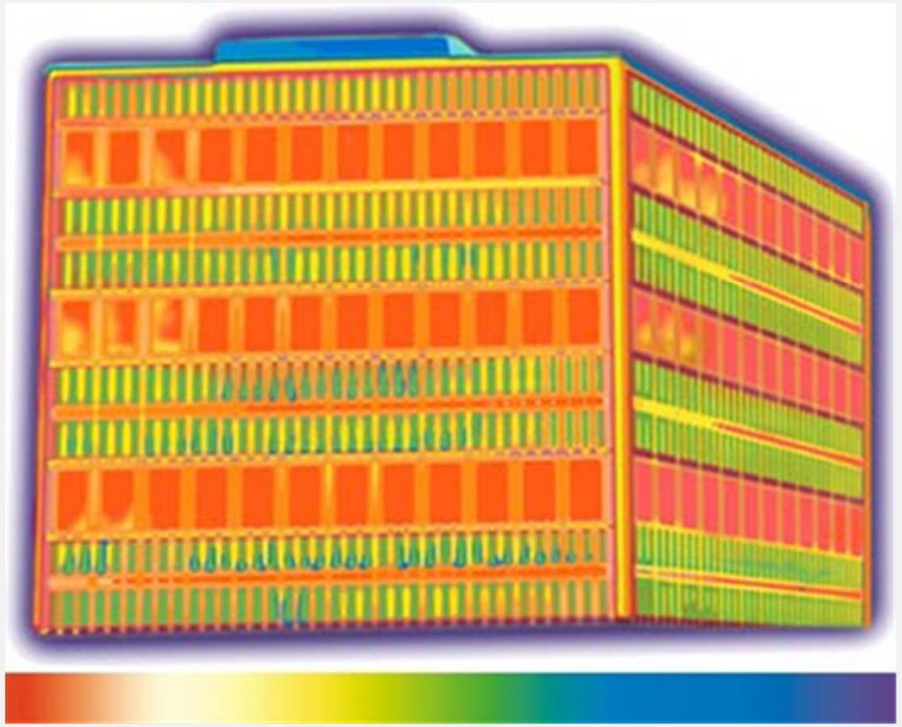
Choose construction processes and components that reduce surface losses as much as possible

www.isover.com/Q-A/Implementation/What-is-a-thermal-bridge

Path of Least Resistance



Poor Thermal Integrity



Yellow is Heat Loss
Through Framing

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Ghosting

What is Continuous Insulation (c.i)?

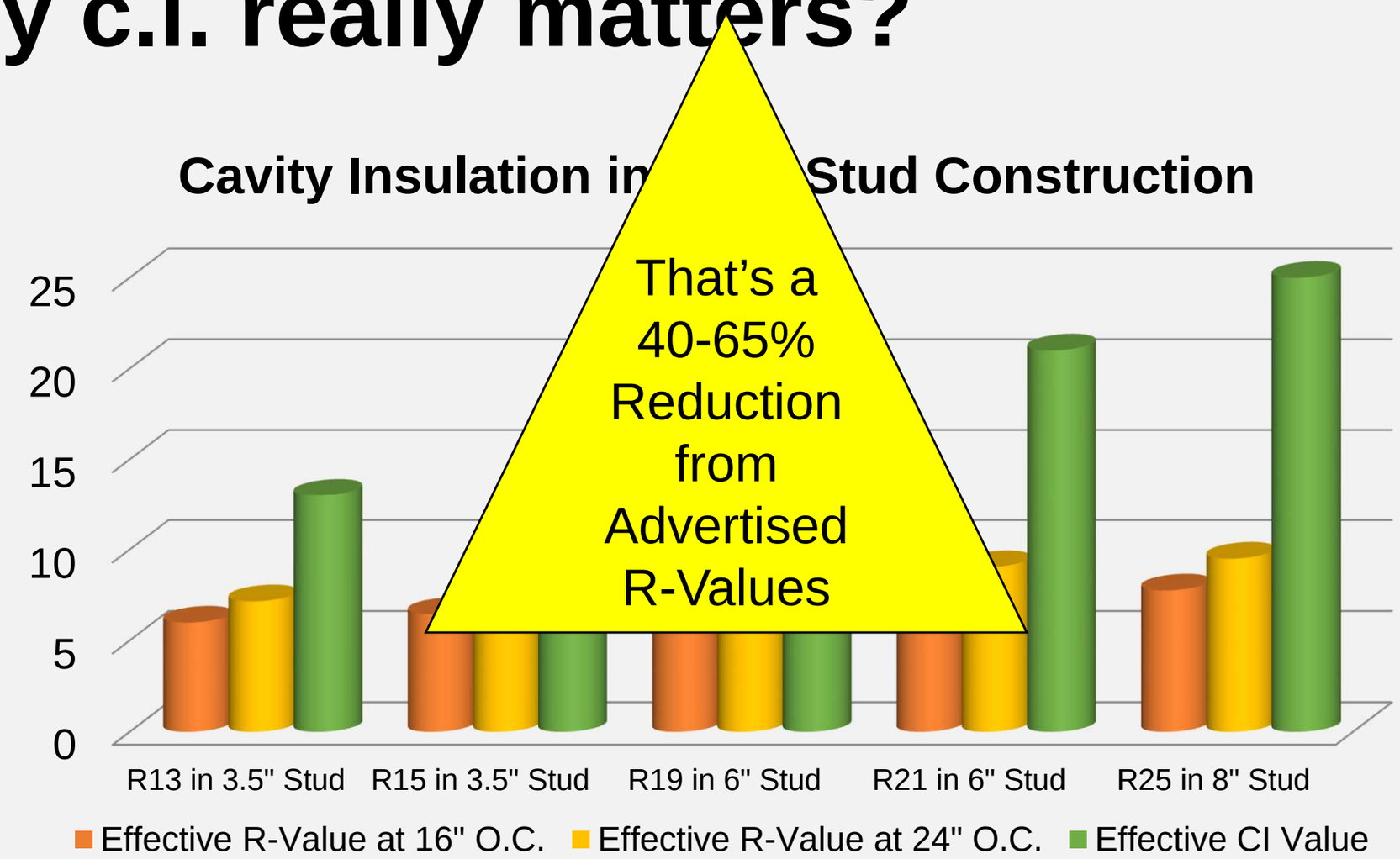
Continuous insulation is defined in ASHRAE 90.1 as

“insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior, exterior, or is integral to any opaque surface of the building envelope”

ASHRAE 90.1

Energy standard for all commercial buildings and for “high-rise” residential buildings

Why c.i. really matters?



ASHRAE 90.1-2013 (Table A3.3.3.1)

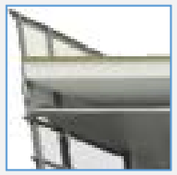
Air Barrier Materials

Defined by their air permeance and the amount of air that passes through them.

ASTM E2178 Less than 0.02L/(s•m^2) @ 75Pa (0.004cfm/ft^2 @ 1.56psf)

Keep in mind that air permeance is the amount of air that migrates through materials and not through holes or gaps, i.e., it is not a system test.

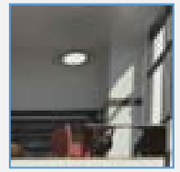
Potential Area for Air Leakage



Service Fenestration

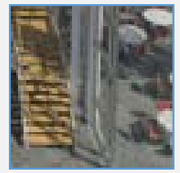
Roof/Wall Joints

Doors/Windows



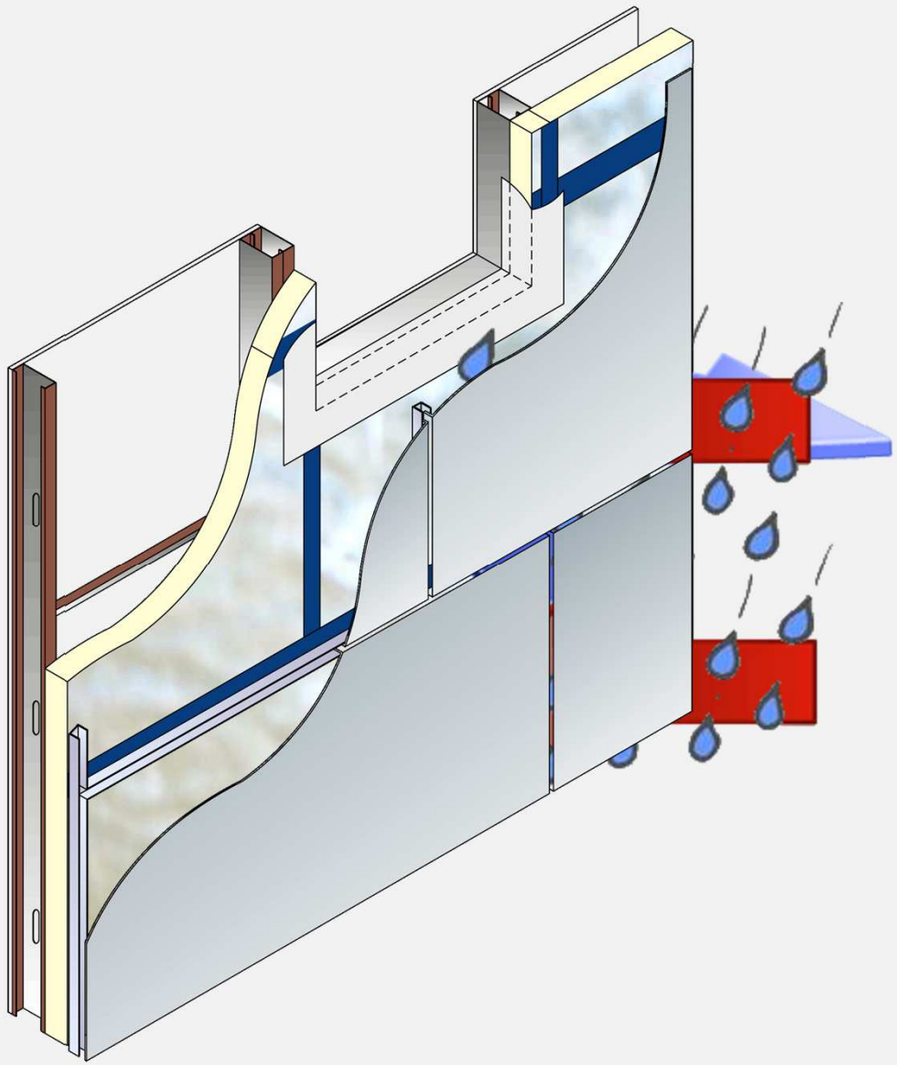
Outlets

Ducts/Vents/Grills



Baseboards

Thermal, Air and Water Protection



Provides water resistance and moisture control

Section 3

Building Envelope Design, Performance & Requirements

Energy Codes and Standards

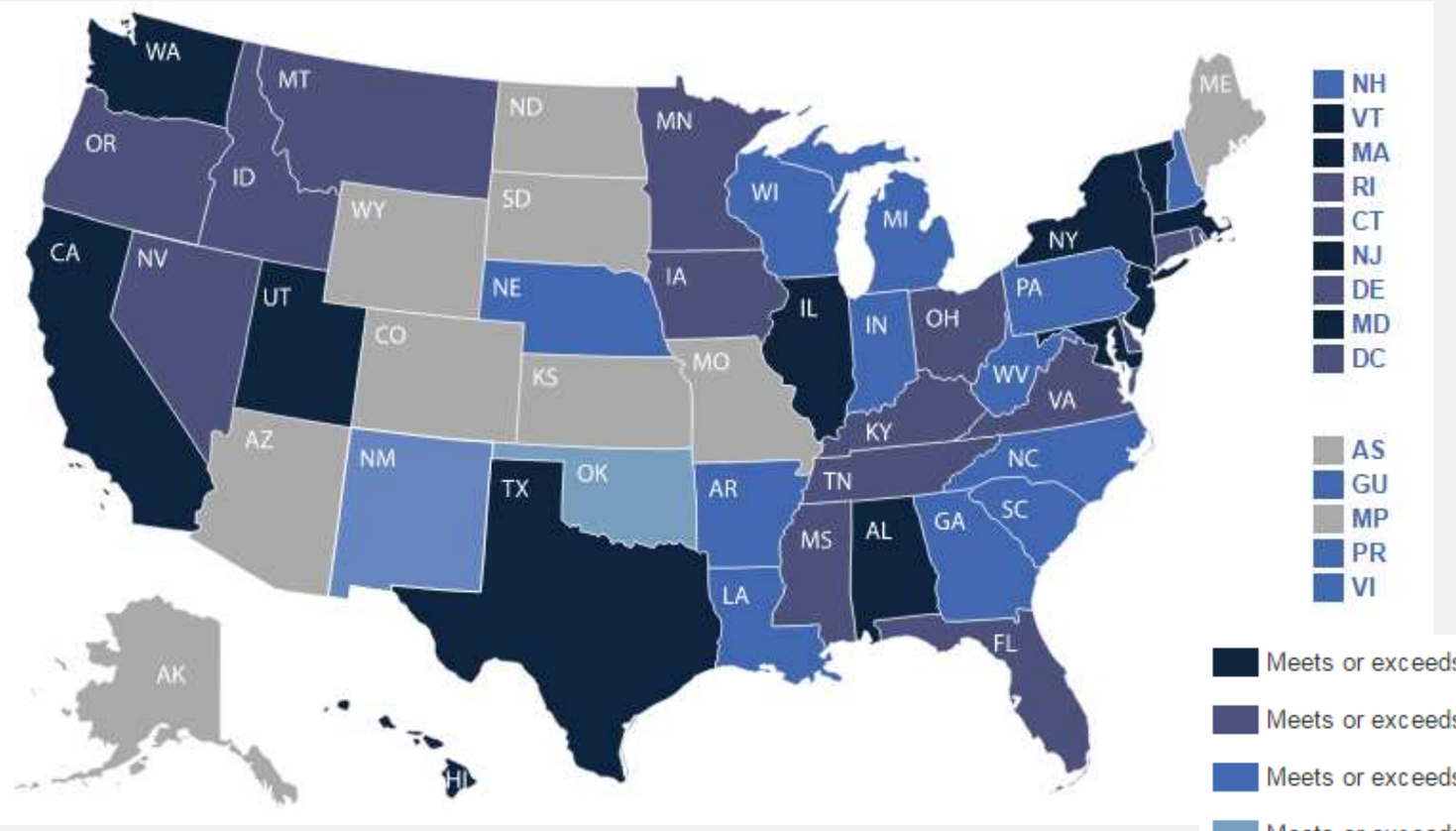
IECC = International Energy Conservation Code

IBC = International Building Code

ASHRAE = American Society of Heating, Refrigerating and Air-Conditioning Engineers

Building Codes Assistance Project

Where is your state in the energy code adoption race?



Map reflects ONLY mandatory statewide codes currently in effect.

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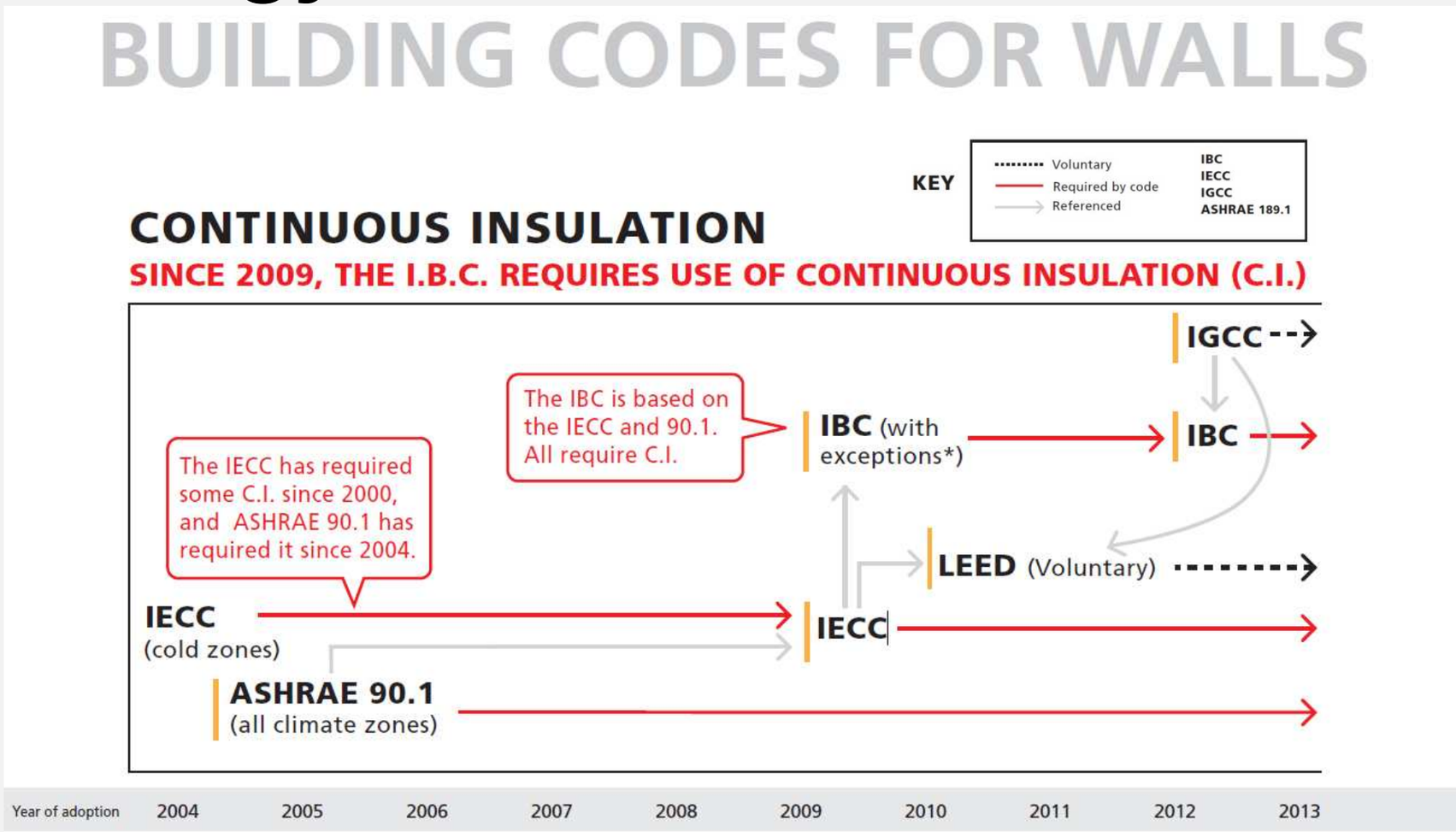
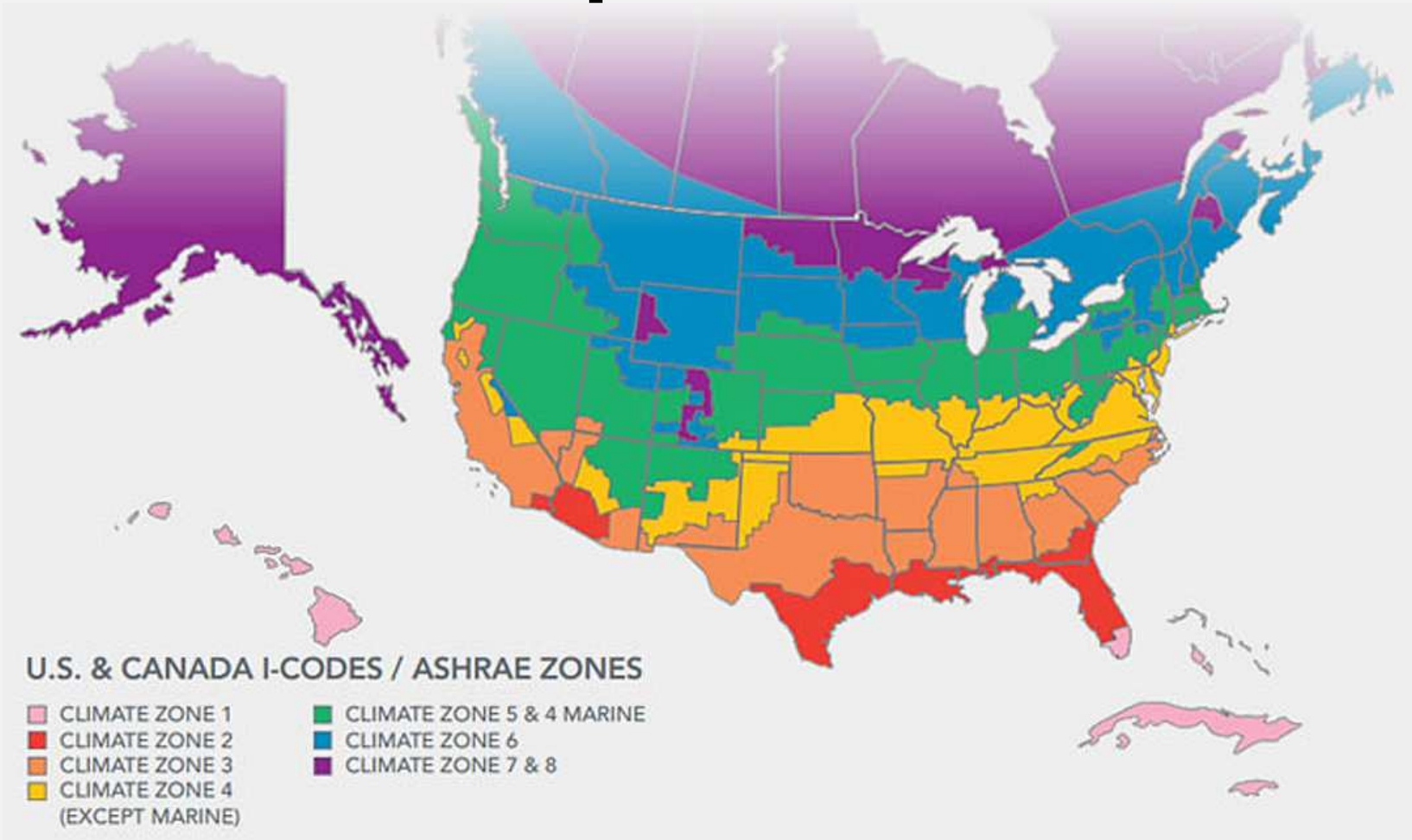
Energy Codes and Standards



Climate Zone Map



Contact Information

Building Envelope Requirements								
Climate Zone	1	2	3	4	5	6	7	8
Commercial Steel-Framed Walls, Above Grade								
ASHRAE 90.1 2007 & 2010	R-13	R-13	R-13+ R-3.8 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.
IECC 2012 IECC 2015	R-13+ R-5 c.i.	R-13+ R-5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.	R-13+ R-7.5 c.i.
Equivalent Thickness of POLYISO (c.i.)*								
ASHRAE 90.1-2010	n/a	n/a	0.625”	1.25”	1.25”	1.25”	1.25”	1.25”
IECC 2012/2015	0.75”	0.75”	1.25”	1.25”	1.25”	1.25”	1.25”	1.25”

*Approximate thicknesses, consult manufacturers for actual values
ci = continuous insulation

What About Fire?

Monte Carlo Hotel Fire - 2008

NFPA 285 - Overview

- National Fire Protection Agency
- Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
- Simulates the “full-scale” fire performance
- Assembly test **NOT** a component test!

NFPA 285 – Test Method

Mock-up of Multi-Story Building

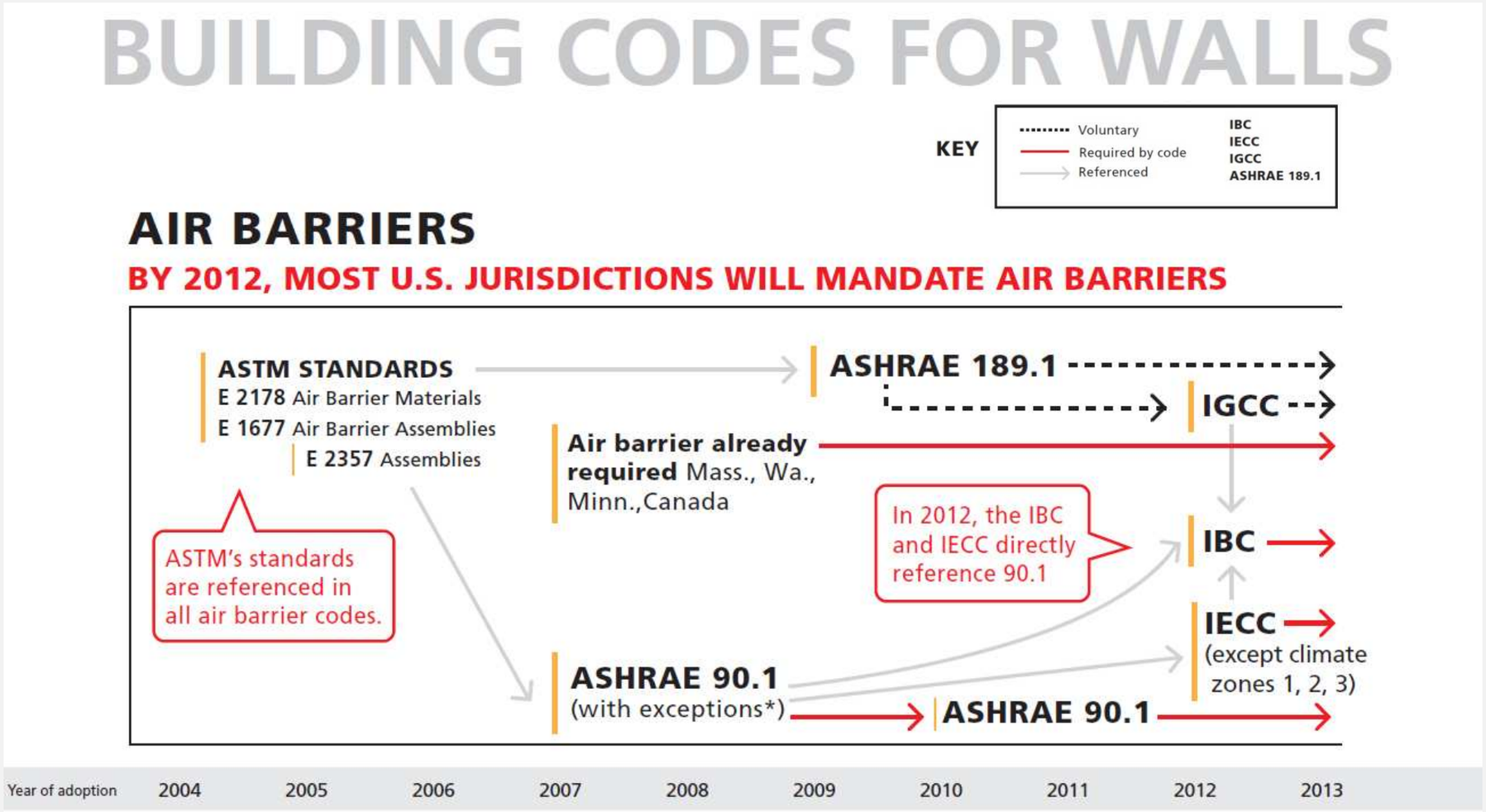
- Two rooms, one above the other
- Lower room contains a window opening
- Two burners
  - Inside lower test room
  - Exterior side of window opening
- Over 65 thermocouples throughout

NFPA 285 – Acceptance Criteria

Performance characteristics evaluated through visual observations and temperature data

- Flame propagation over the exterior face of the system
- Vertical flame spread within the combustible core components from one story to the next
- Vertical flame spread over the interior (room side surface of the panels from one story to the next)
- Lateral flame spread from the compartment of fire origin to adjacent spaces

Air Barrier Codes and Standards



Air Barrier Requirements

IECC Compliance Options:

Materials

Use materials with an air permeance of ≤ 0.004cfm/ft^2 @ 0.3" H_2O (0.02L/s.m^2 @ 75Pa) tested per ASTM E2178

Assemblies

Use assemblies of materials and components with an air leakage of ≤ 0.04cfm/ft^2 @ 0.3" H_2O (0.2L/s.m^2 @ 75Pa) tested per ASTM E2357, E1677 or E283

Building Test

Show performance of building to have an air leakage rate of ≤ 0.40cfm/ft^2 @ 0.3" H_2O (2.0L/s.m^2 @ 75Pa) tested per ASTM E779 or equivalent method approved by the code official

Vapor Retarders

Defined by Three Classes

Based on testing per ASTM E96 (desiccant method)

Class I	Class II	Class III
< 0.1 perm	> 0.1 and ≤ 1.0 perm	> 1.0 perm
Example: Non-perforated aluminum foil	Example: Kraft faced fiber glass batts	Example: Latex or enamel paint

Water- Resistive Barriers

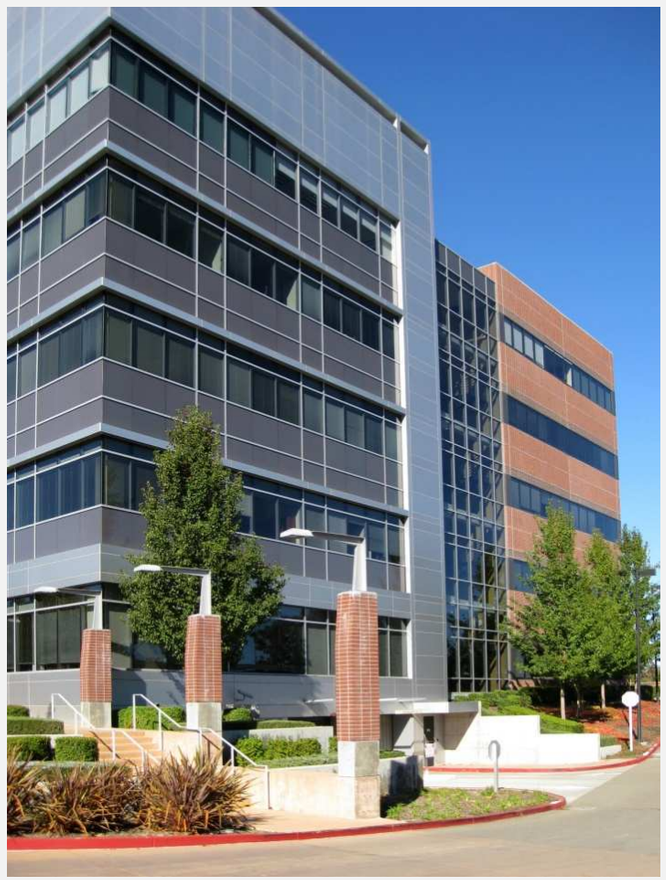
IBC 2015 Section 1404.2

Minimum of one layer of No. 15 asphalt felt, complying with ASTM D226 for Type 1 felt or other *approved* materials, shall be attached to the studs or sheathing, with flashing as described in Section 1405.4, in such a manner to provide a continuous *water-resistive barrier* behind the *exterior wall* veneer.

Acceptance Criteria	Material Evaluated as Water-Resistive Barrier (Weather-Resistive Barrier)
AC38	Sheet Materials (generic)
AC71	**Foam Plastic Sheathing Panels**
AC209	Trowel-, Spray- or Roller-Applied Water-Resistive Coatings Over Exterior Cementitious Wall Coverings
AC212	Water-Resistive Coatings Over Exterior Sheathing
AC310	Water-Resistive Membranes Factory-Bonded to Wood-Based Structural Sheathing
AC382	Laminated Fibrous Board Sheathing Material

Section 4

Design Building Envelopes Utilizing POLYISO with Steel Studs

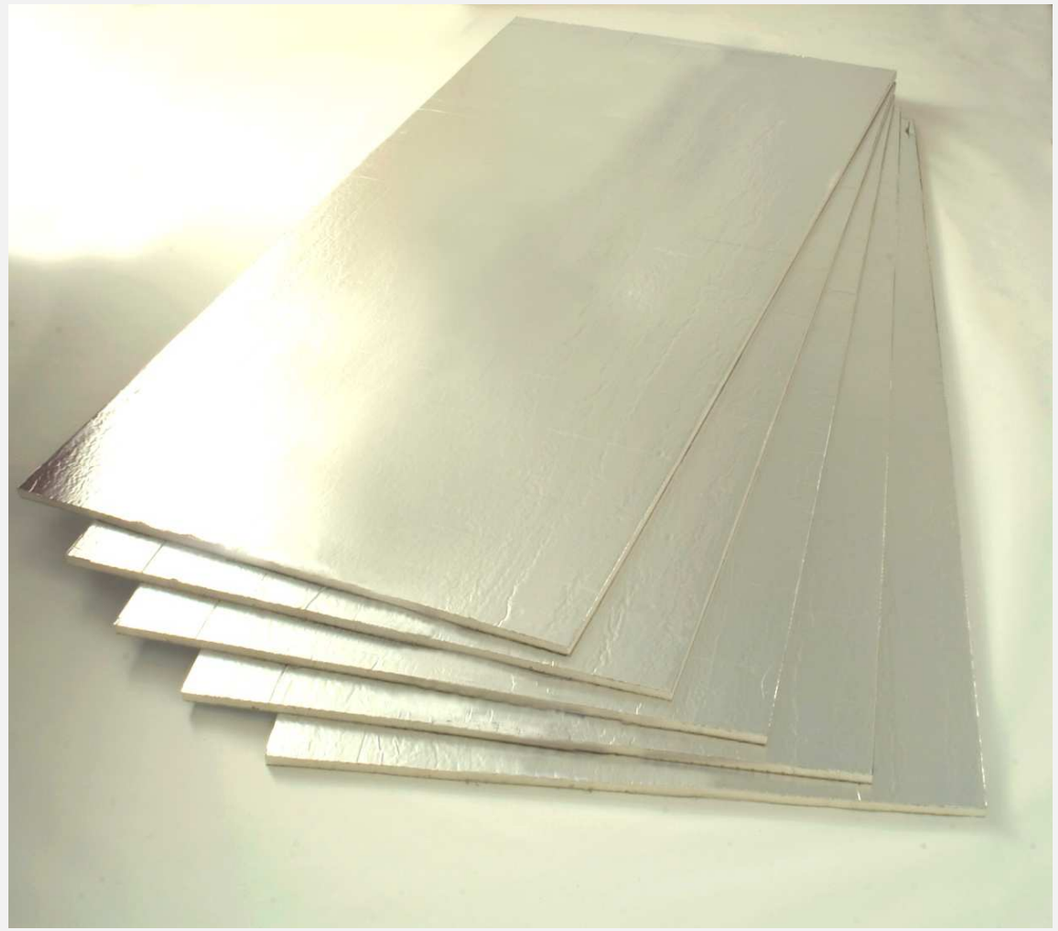


What is Polyisocyanurate Insulation?

Often referred to as “POLYISO”, it is a closed-cell, rigid insulation board consisting of a foam plastic core sandwiched between two facers.

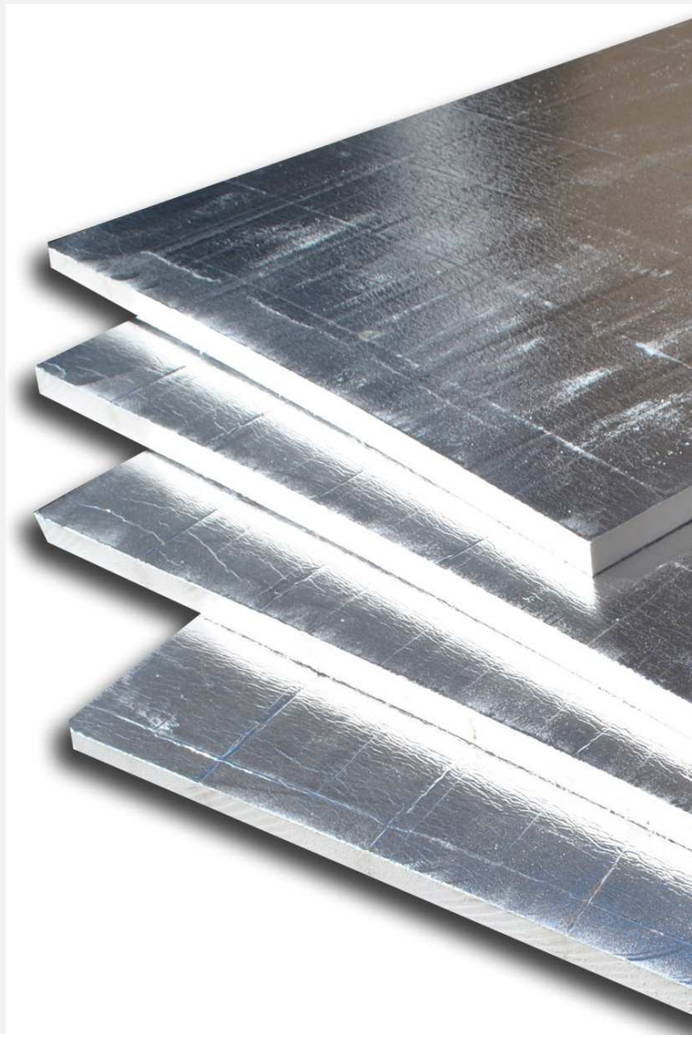
The facers are composed of various inorganic and organic materials, usually aluminum foil, glass fiber or paper mats.

The boards are typically manufactured in 4’x8’ panels, however, custom sizes are usually available.



Why Use POLYISO Wall Insulation?

1. High R-value per inch
2. Fire resistance
3. Thermoset material
4. Permeability range
5. Additional properties
6. Easy to specify and install



Higher R-Value

Insulation Comparison			
c.i. R-Values			
Thickness	**1"**	**2"**	**3"**
EPS*	4.0	8.0	12.0
XPS*	5.0	10.0	15.0
Mineral Wool	4.2	8.4	12.6
POLYISO*	6.5	13.1	20.3

*Approximate thicknesses, consult manufacturers for actual values

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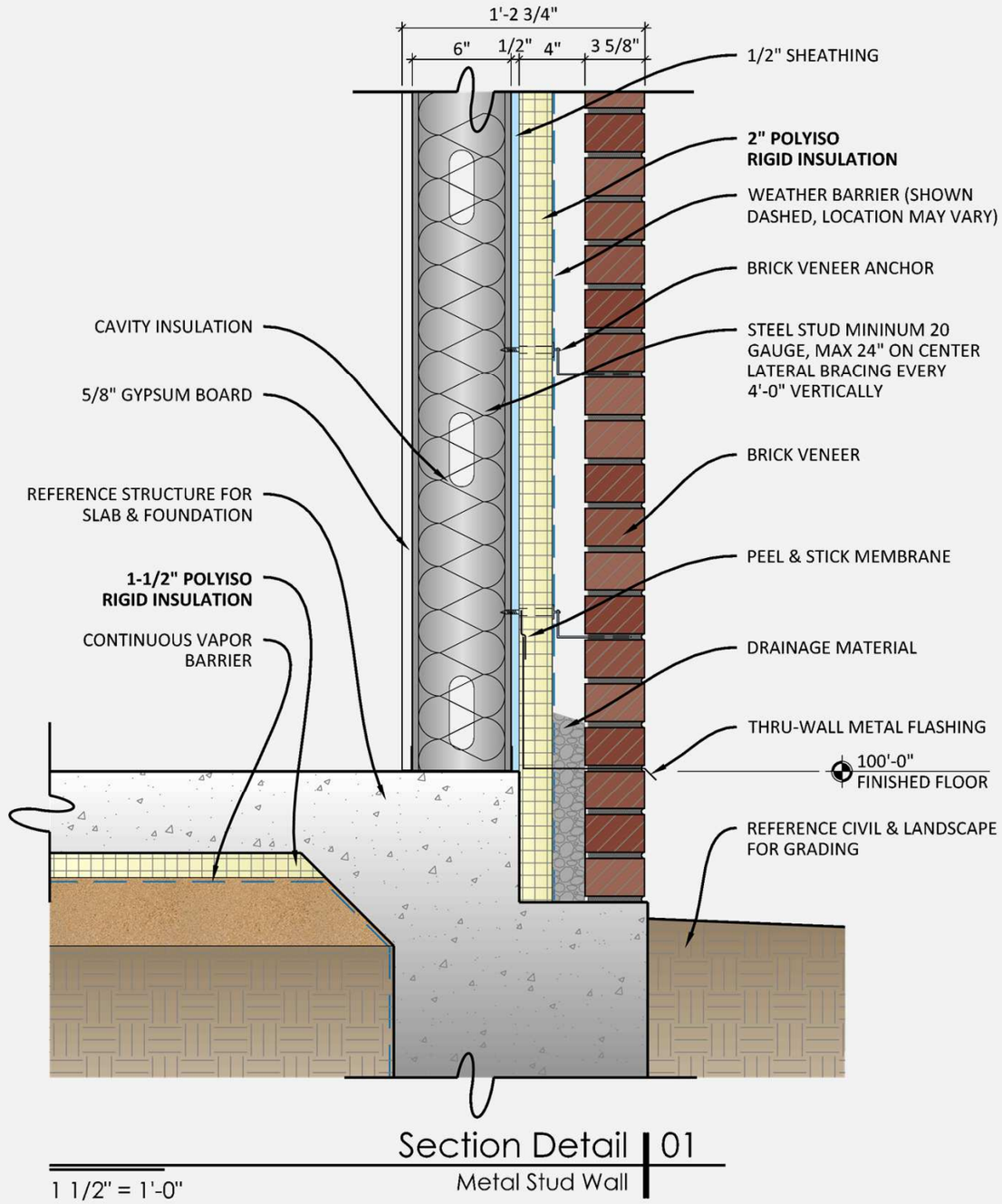


Total Effective R-Value for Wall Design

For example:

- A wall with 6" steel studs
  Spaced at 16" on center
  R-21 fiberglass batt cavity insulation
  Top and bottom track

has a framing factor of approximately 0.35

Making the total wall system's effective R-value = 7.4

Fire Resistance – ASTM E 84

	Flame Spread	Smoke Developed
Class A	<25	<450

While XPS claims to meet a **Class A**…

The ASTM E84 standard states…
"Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place."

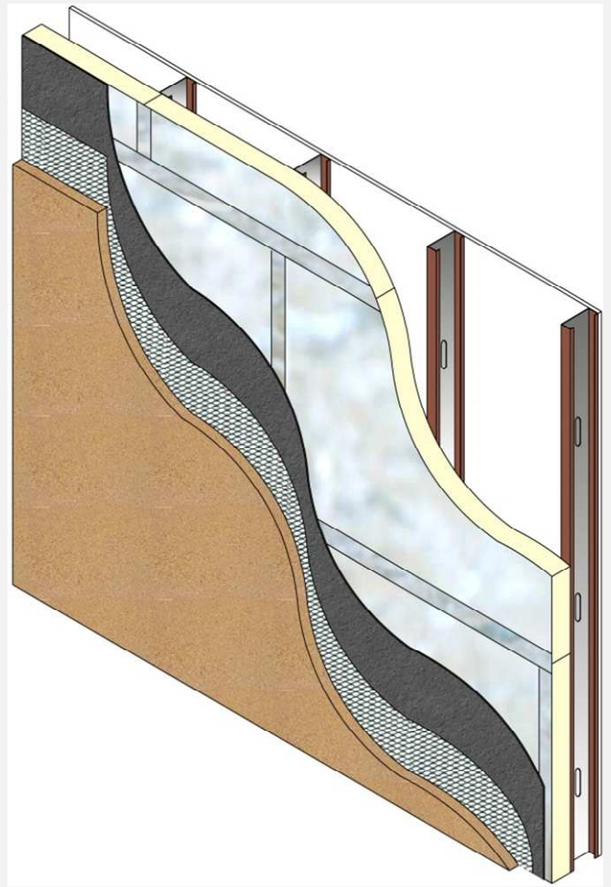
	Flame Spread		Smoke Developed	
	EPS	XPS	EPS	XPS
Ignored	10-20	5-20	55-400	140-300
Not Ignored	80-140	75-140	"over 500"	"over 500"

Fire Resistance – NFPA 285

- Additional exterior veneers beyond Brick, Stone and Stucco, <u>including open joint/rain screen type applications</u>
  - ACM/MCM
  - Terracotta
  - Metal Skins
  - Cement Board Siding
- Exterior gypsum can be optional
- Mineral wool fire-stops around all

  header openings are usually <u>NOT</u> required

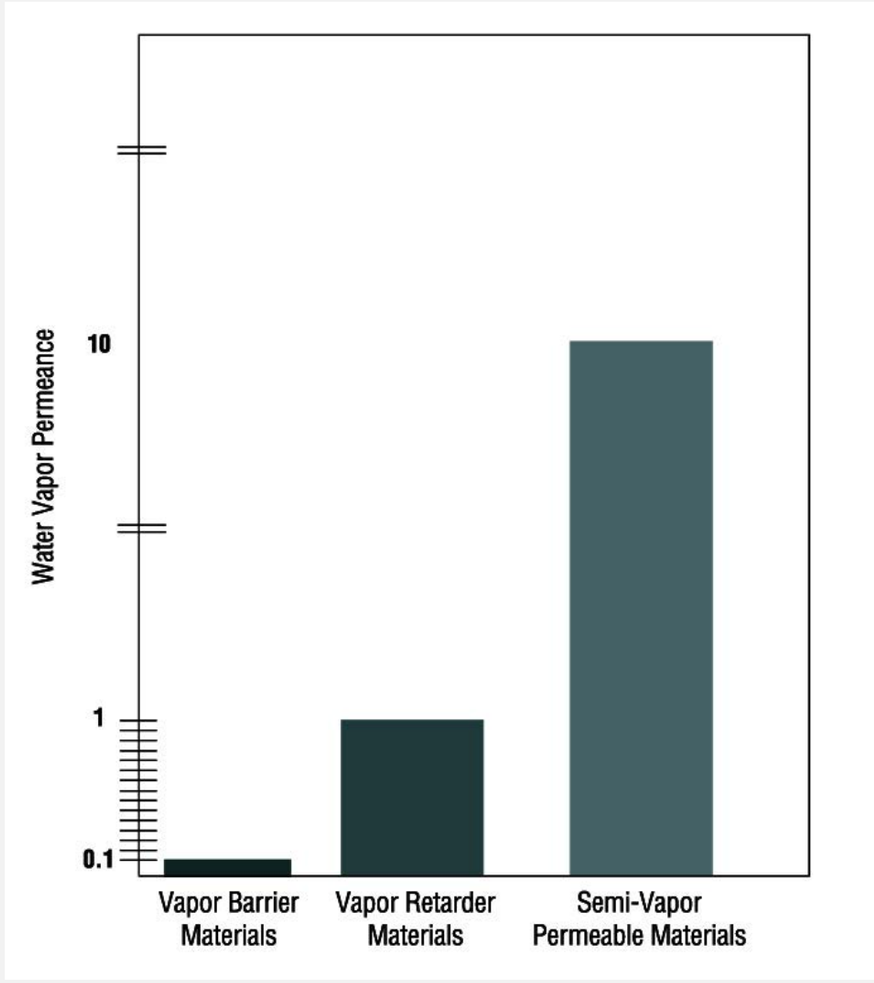
- These are commonly NOT the case for XPS



Water Vapor Transmission - ASTM E96

Vapor Barrier Materials: 0.1 perm or less
rubber membranes, polyethylene film, glass, aluminum foil, sheet metal, foil faced POLYISO

Vapor Retarder Materials: 0.1-1 perm
asphalt-backed kraft paper, vapor retarding paint, oil-based paints, vinyl wall coverings, foil faced POLYISO, extruded polystyrene, plywood, OSB



www.buildingscience.com

Additional Properties

Environmental Benefits

- CFC, HCFC and HFC Free Blowing Agent
- Zero Ozone Depletion Potential (ODP)
- Negligible Global Warming Potential (GWP)
- Recycle Content

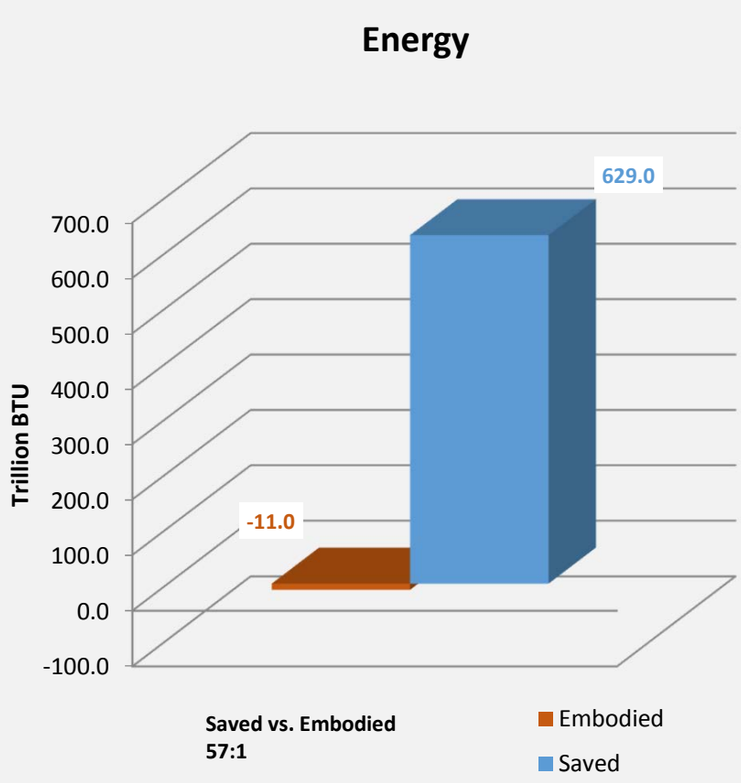
Physical Properties

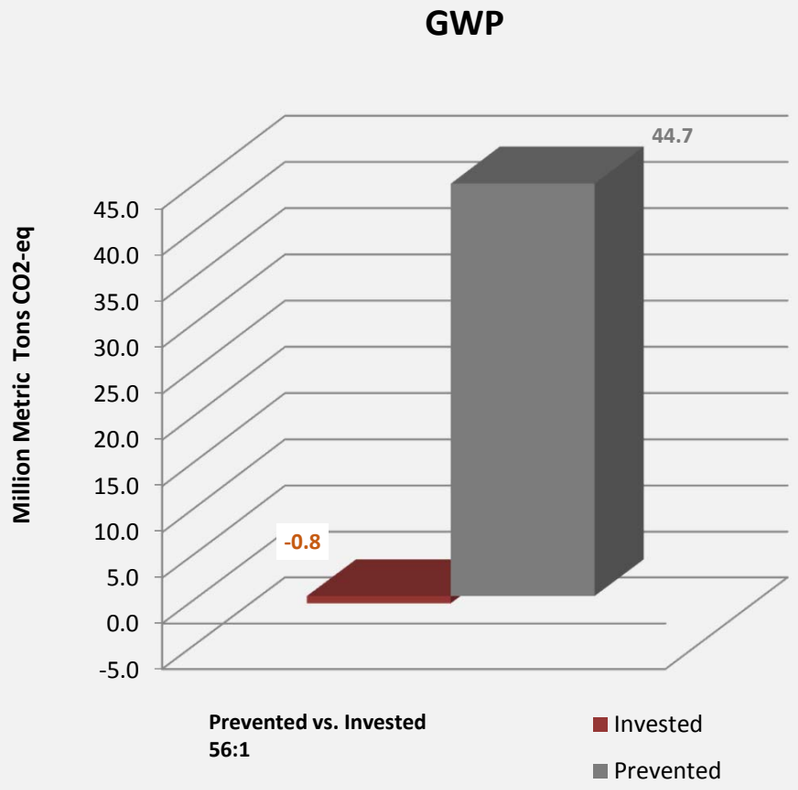
- Compressive Strength
- Dimensional Stability
- Moisture Resistant

  <1% Water Absorption

Environmental Impact

New Construction – Exterior Walls
ASHRAE 90.1 2010P vs. ASHRAE 90.1 2004





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Courtesy of Bayer MaterialScience

Easy to Specify and Install

- Achieves continuous insulation (c.i.) requirements
- Increase interior square footage with thinner profile (out to out)

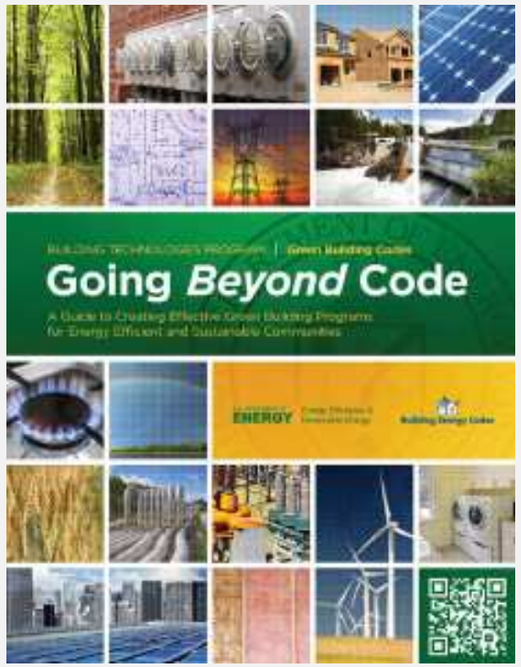
-OR-

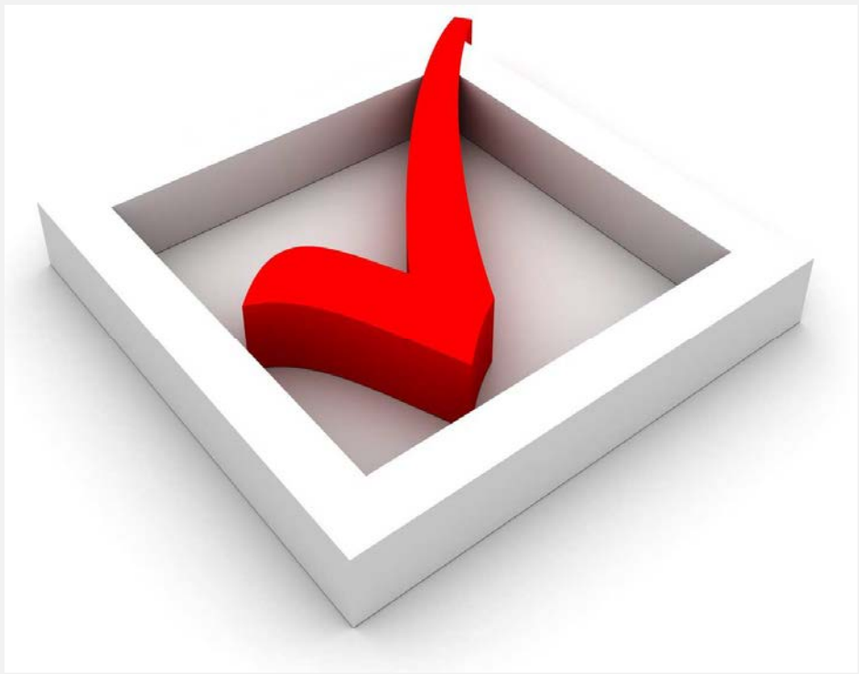
More R-value on same square footage

- Wide range of thicknesses available
- Lightweight, nominally 2pcf
- Easy to cut & fit around openings/penetrations
- Various installation methods
- Governing Material Specification – ASTM C1289 Type I, Class 1

Looking Forward

Beyond the Code





Building codes play a major role in determining which products can be used in a building. Mandatory building codes set minimum performance thresholds for new construction and existing buildings including energy, air quality, fire protection and other areas to ensure safe and effective building operations.

Energy codes determine MINIMUM insulation levels.

What is the Driving Force?

Laws, Codes and Regulation

Energy Awareness, Marketing, Advertising, Incentives, LEED, etc.

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2030 Challenge

- Carbon-neutral in 2030

OWP/P

HMC Architects

Vanderweil Engineers

TLC Engineering for Architecture

BNIM

WSP Flack + Kurtz

Veronica Stanley, Omniplan, Inc.

River Architects

Lee Kennedy

SAK arquitetera design

Jerde Partnership

Human Factor Research and Consulting

Mazzetti Nash Lipsey Burch

HDR Architecture, Inc.

DLR Group

SHW Group

EMAD Taylor & Gaines

KMD Architects

Ebert Consulting

Schneider Electric

HKS Inc.

Carbon Design

PSA-Dewberry

Cousins Ltd.

Cosentini Associates

Ellerbe Becket

Syska Hennessy Group

Are You?

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Who's on Board

Future Increases:

70% in 2015
80% in 2020
90% in 2025

Baseline Standard: 2003 CBECS National Average Source Energy Use and Performance Comparisons by Building Type

www.architecture2030.org

Thank you!

Matt Stevens
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214-632-7578
Booth #

Project examples - Commercial