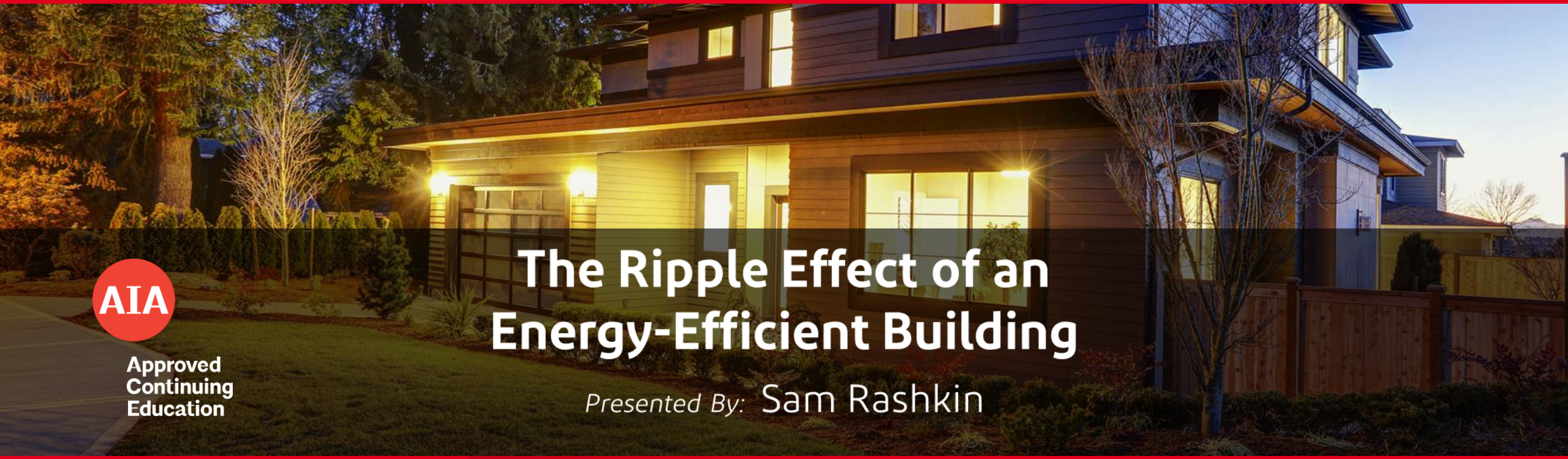
Thank you for joining today's webinar.
We'll begin momentarily.



The Ripple Effect of an Energy-Efficient Building

Presented By: Sam Rashkin

AIA Approved Continuing Education

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EDU HUB

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EDU HUB

Outline

- Energy-Efficient Building New Reality
- Energy-Efficient Building Ripple Effect
- Managing Energy-Efficient Building Ripple Effect:
  - Building Science Moisture Control
  - Comfort
  - Indoor Air Quality
  - Resilience
  - User Experience

Energy-Efficient Building New Reality

Energy-Efficient Building Has Left the Station

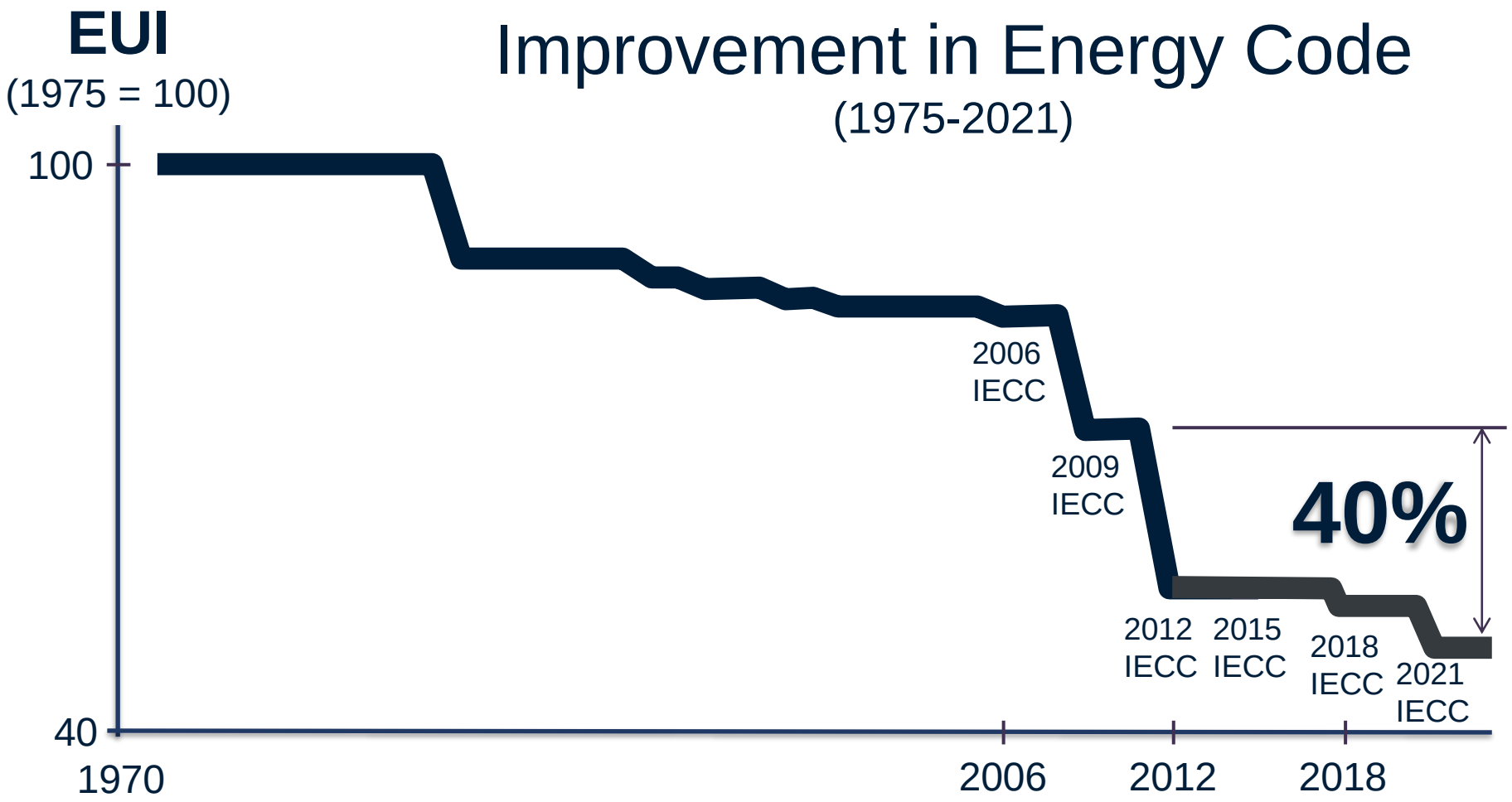


Image Basis: Building Energy Codes Program: National Benefits Assessment, 1992-2040, https://www.energycodes.gov/sites/default/files/documents/BenefitsReport_Final_March20142.pdf

Energy-Efficient Building Has Left the Station

HERS Ratings in 2020: **299,755**

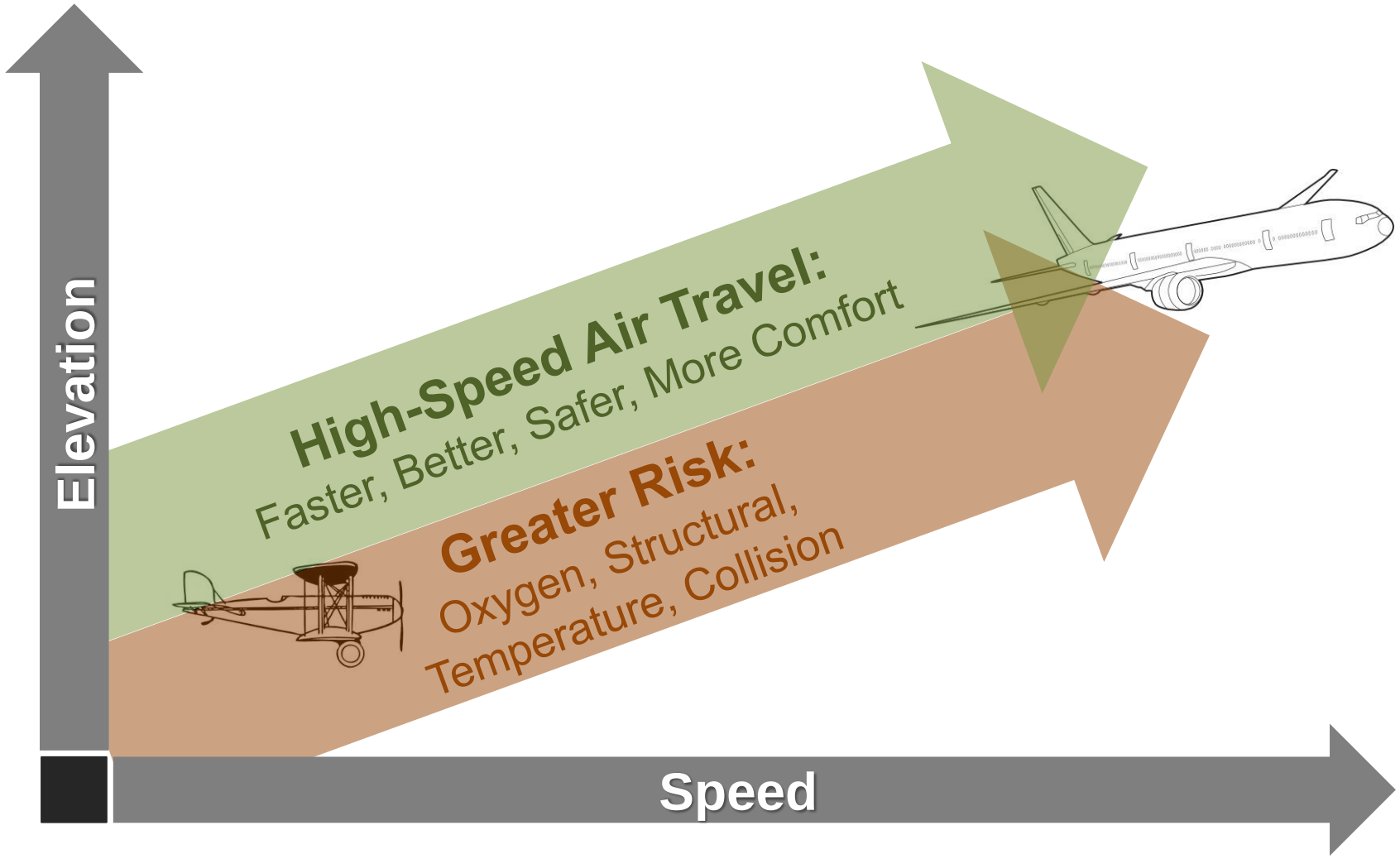
Avg. HERS Index: **58**

Avg. IECC Code Home HERS Index: **70**

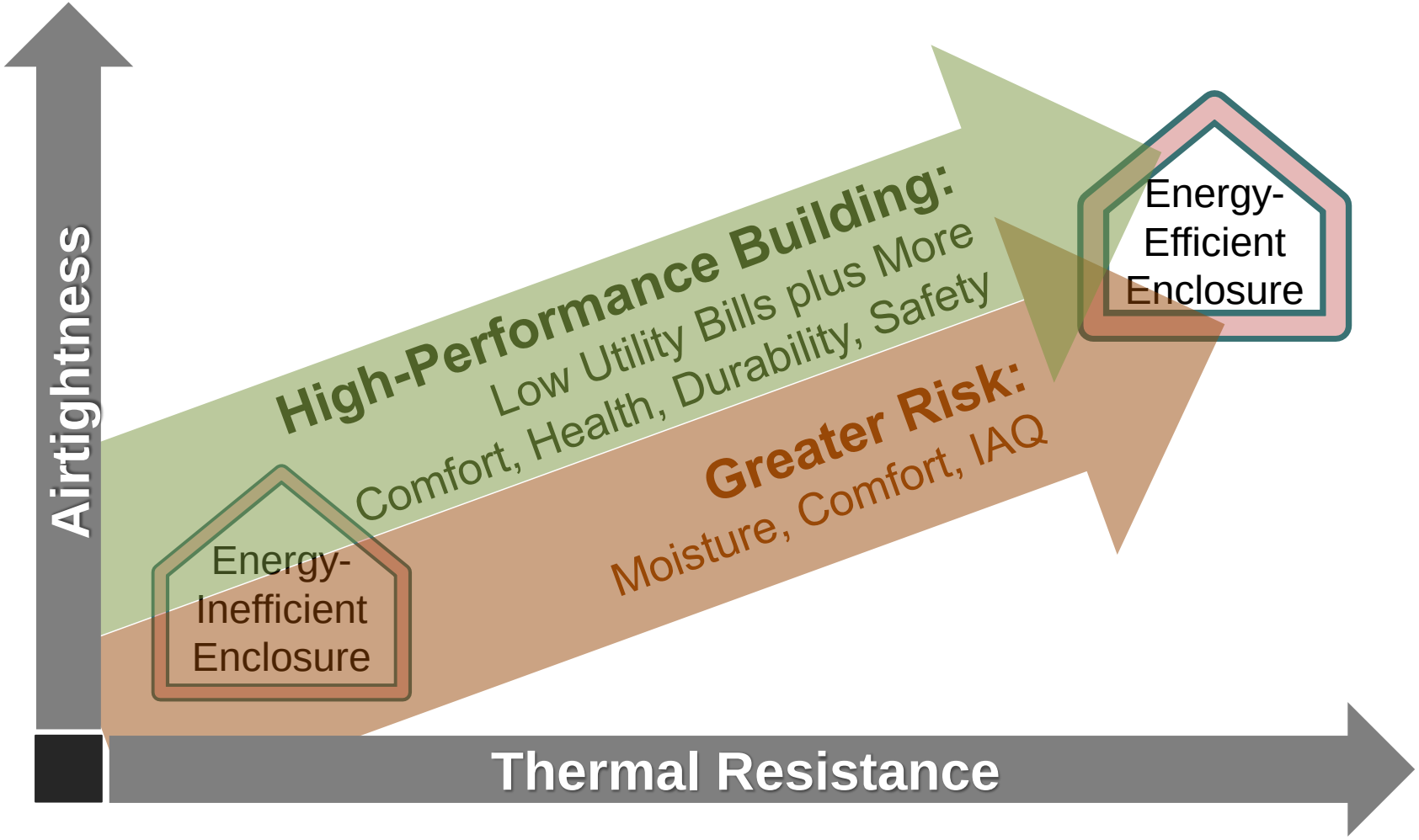
Source: "*Demand for HERS Ratings Grows by 24% in 2020,"* RESNET, Jan. 19, 2021

Energy-Efficient Building Ripple Effect

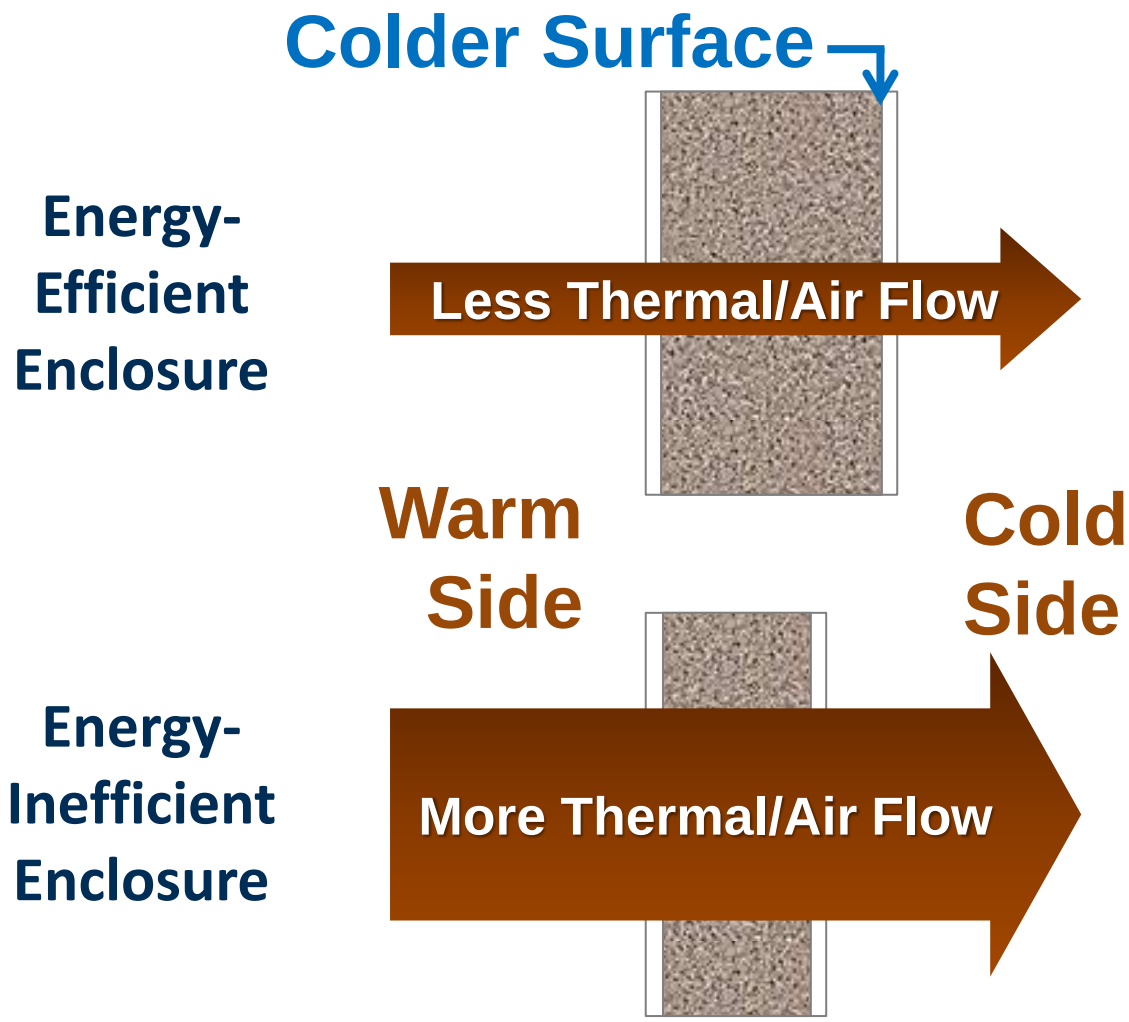
High-Performance = Greater Risks



High-Performance Building = Risks



Energy-Efficient Enclosure Moisture Risk



Why Moisture Risk:

- More Wetting Potential
- Less Drying Potential

Energy-Efficient Enclosure Comfort Risk

Energy-Efficient Enclosure

Warm Side

Cold Side

Energy-Inefficient Enclosure

Why Comfort Risk:

- Less Air Flow
- Shorter Cycles
- Longer Swing Seasons

Energy Efficient Enclosure IAQ Risk

Energy-Efficient Enclosure

Warm Side

Cold Side

Energy-Inefficient Enclosure

Why IAQ Risk:

- More Accumulated Contaminants

Energy-Efficient Enclosure: Future Readiness

Energy-Efficient Enclosure

Warm Side

Cold Side

Energy-Inefficient Enclosure

Future Readiness:

- Resilience
- Water Efficiency
- Electrification
- Embodied Carbon

High-Performance Home Building Blocks

Step One: Optimize Efficiency	Step Two: Manage Ripple Effects	Step Three: Ensure Future Ready
Enclosure	Moisture Control	Resilience
Equipment	Ensure Comfort	Water Efficient
Appliances/Lighting	Comprehensive IAQ	Electric Ready
		Embodied Carbon
		User Experience

Managing Energy-Efficient Buildings Ripple Effect:

Building Science Moisture Control

2nd Law of Thermodynamics = Driving Forces

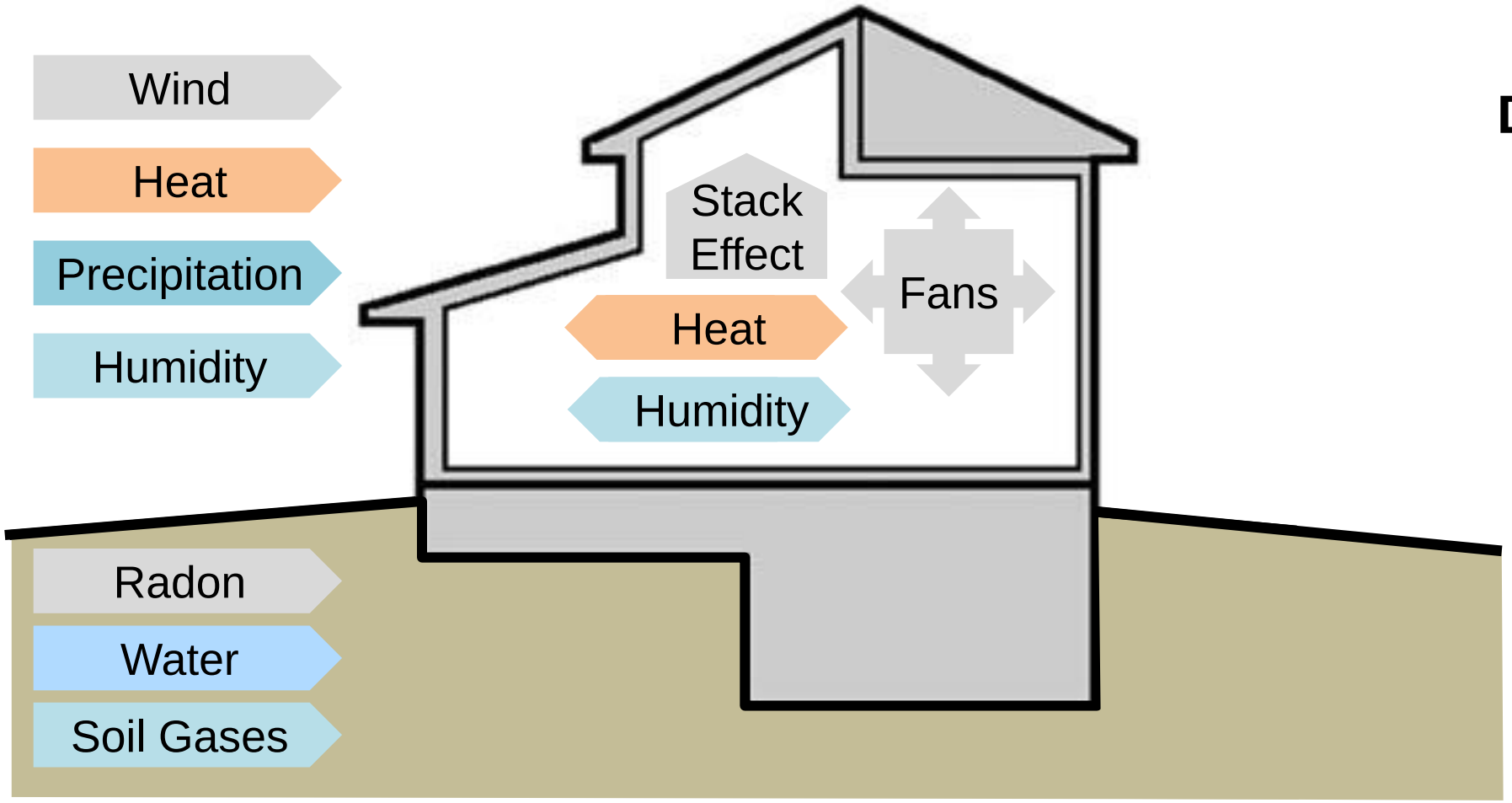
More to **Less**

Air Pressure
Heat
Moisture

Air Pressure
Heat
Moisture

We know the direction of flow that needs to be controlled for optimized performance

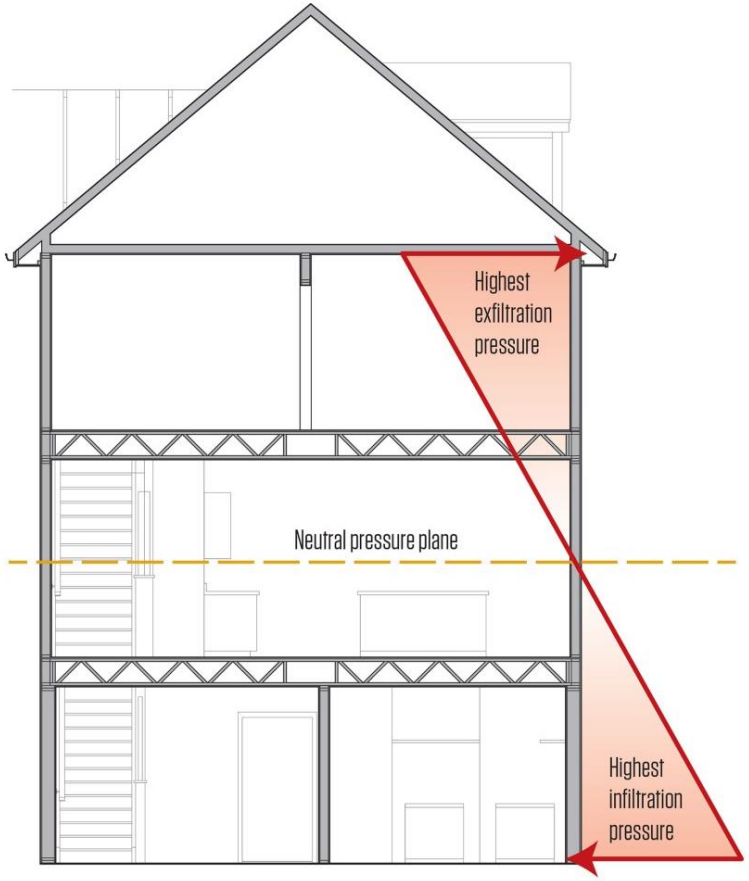
2nd Law of Thermodynamics = Driving Forces



Driving Forces:

- Air Flow (Pressure)
- Heat
- Moisture (Bulk)
- Moisture (Vapor)

2nd Law Thermodynamics = Driving Forces



Source: *'Air-Barrier Basics,'* Steve Bazcek, The Journal of Light Construction, January 9, 2019

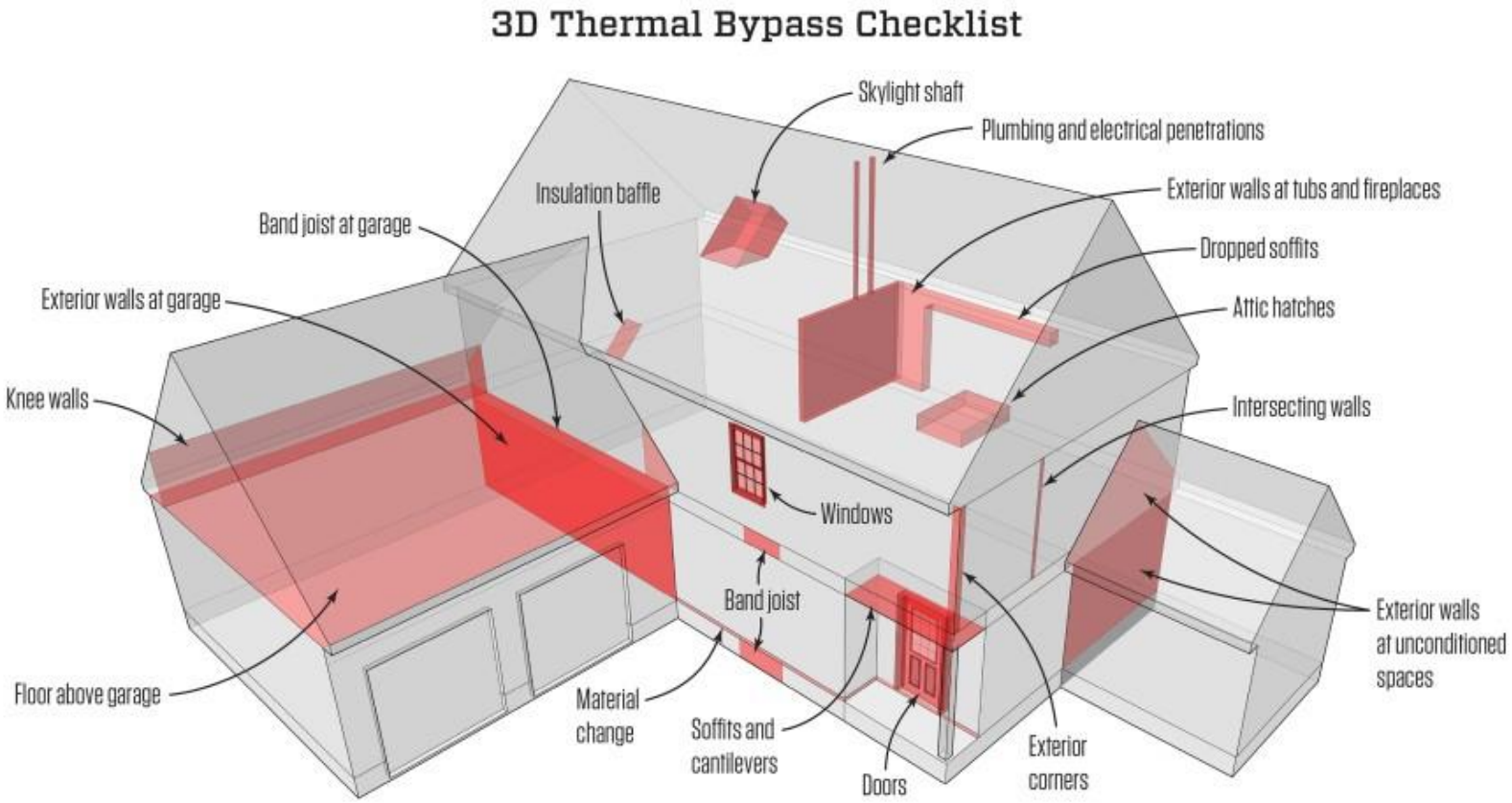
Building Science is About Controlling Driving Forces

Driving Force	Building Science Control Layer
Air Pressure	Air Flow
Heat	Thermal Flow
Moisture (Bulk)	Water Flow
Moisture (Vapor)	Vapor Flow

Air Flow Control Best Practices

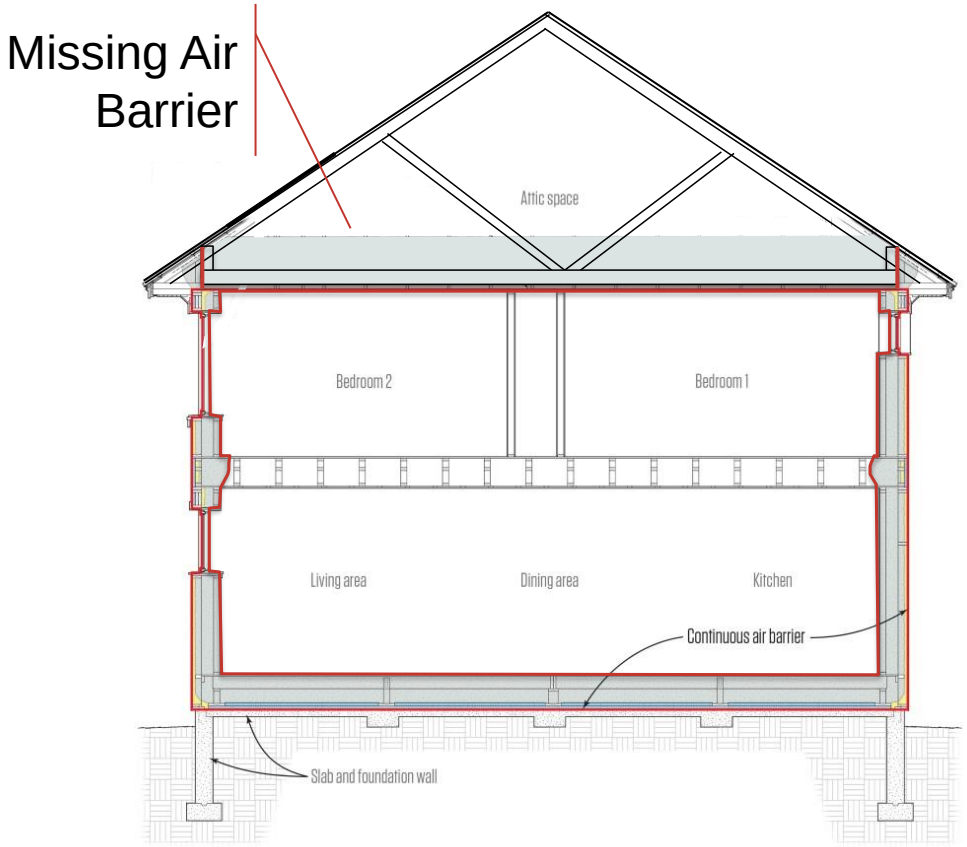
Best Practices	
Air Flow Control Layer	Complete Air Barriers
	Comprehensive Air Sealing
	Flashing Large Openings

Air Flow Control: Key Air Barriers

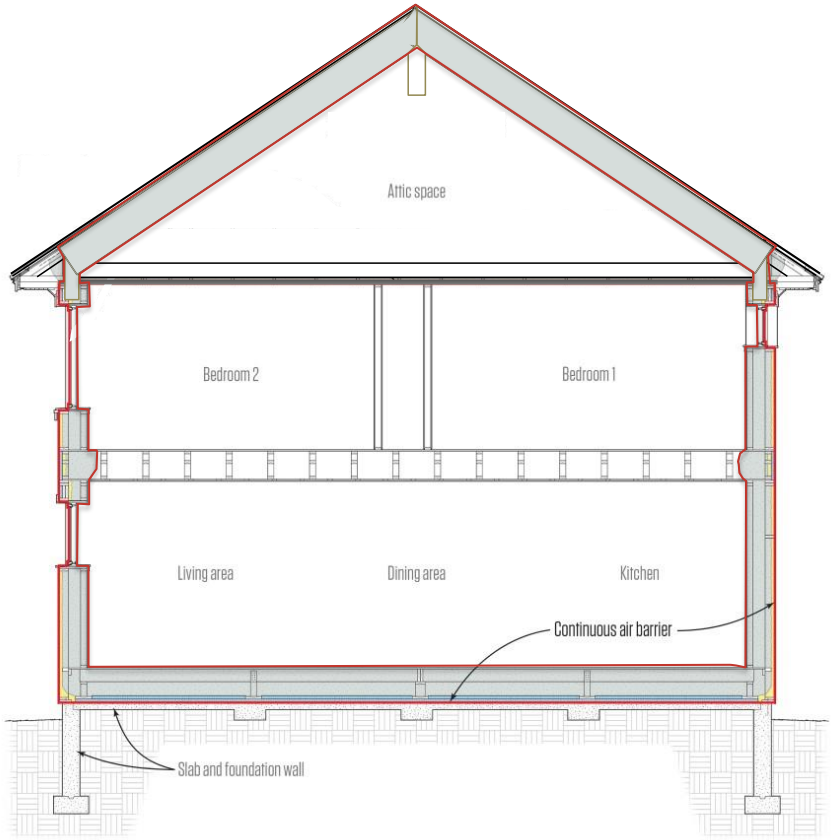


Source: *'Air-Barrier Basics,'* Steve Bazcek, The Journal of Light Construction, January 9, 2019

Air Flow Control: Air Barrier Red Line Test



Conventional Framing



SIP Roof/Closed Cell Foam

Source: *'Air-Barrier Basics,'* Steve Bazcek, The Journal of Light Construction, January 9, 2019

Air Flow Control: Air Barrier Checklist

Conditions Adjoining Exterior or Unconditioned Spaces:

Walls

- ❑ Showers and Tubs
- ❑ Fireplaces
- ❑ Attic Knee Walls
- ❑ Skylight Shaft Walls
- ❑ Adjoining Porch Roof
- ❑ Staircase Ext. Walls
- ❑ Double Walls
- ❑ Rim/Band Joists

Floors

- ❑ Floors Above Garage
- ❑ Cantilevered Floor
- ❑ Unconditioned Floor (Basement/Crawl Sp.)
- ❑ Floor Framing Extending into Garage

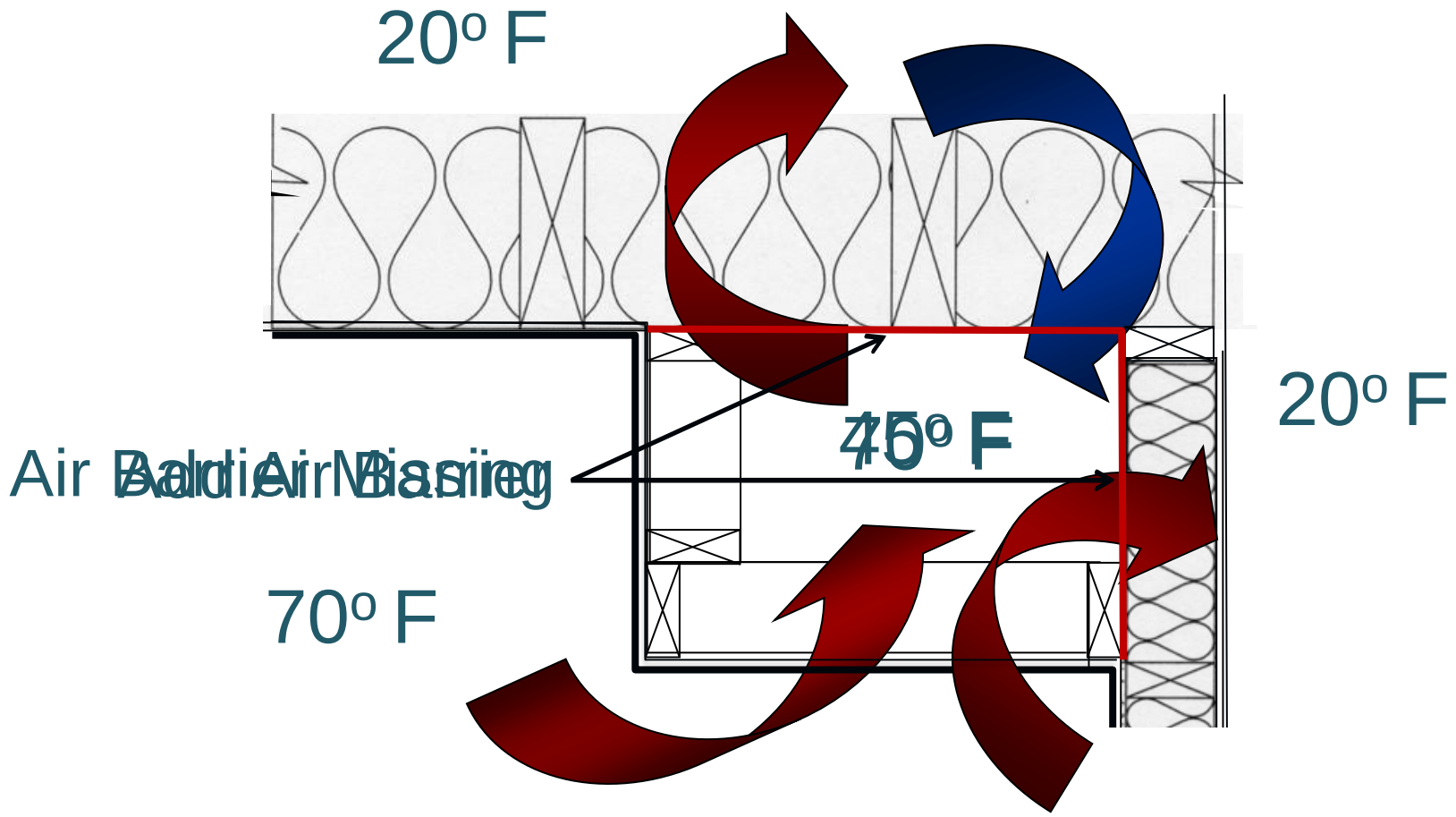
Shafts

- ❑ Duct Shaft
- ❑ Piping Shaft
- ❑ Flue Shaft

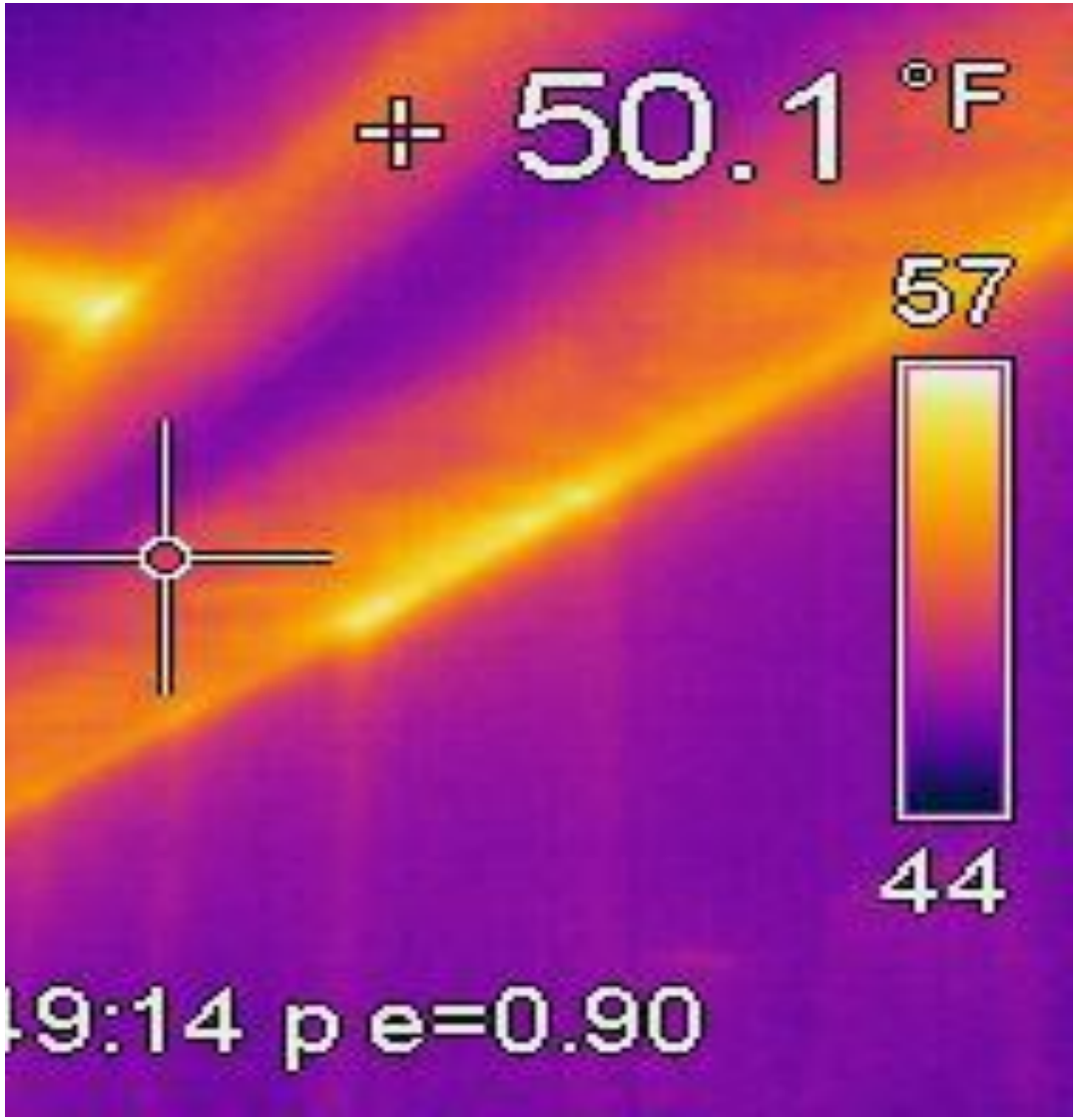
Attic/Ceiling

- ❑ Attic Access Pnael
- ❑ Attic Drop-Down Stair
- ❑ Raised Ceilings
- ❑ Dropped Ceilings
- ❑ Wind Baffles at Eaves
- ❑ Recessed Lights
- ❑ Whole-House Fan

Air Flow Control: Air Barrier at Dropped Ceiling



Air Flow Control: Air Barrier at Dropped Ceiling



Air Flow Control: Air Barrier at Dropped Ceiling

Air Flow Control: Air Sealing Target

Climate Zones	ACH50 Requirements/Targets			
	Zero Energy Ready	ENERGY STAR V3	2012 IECC	Passive House
1-2	3.0	6.0	5. 0	0.6
3-4	2.5	5.0	3.0	0.6
5-7	2.0	4.0	3.0	0.6
8	1.5	3.0	3.0	0.6

Air Flow Control: Air Sealing Checklist

Penetrations:

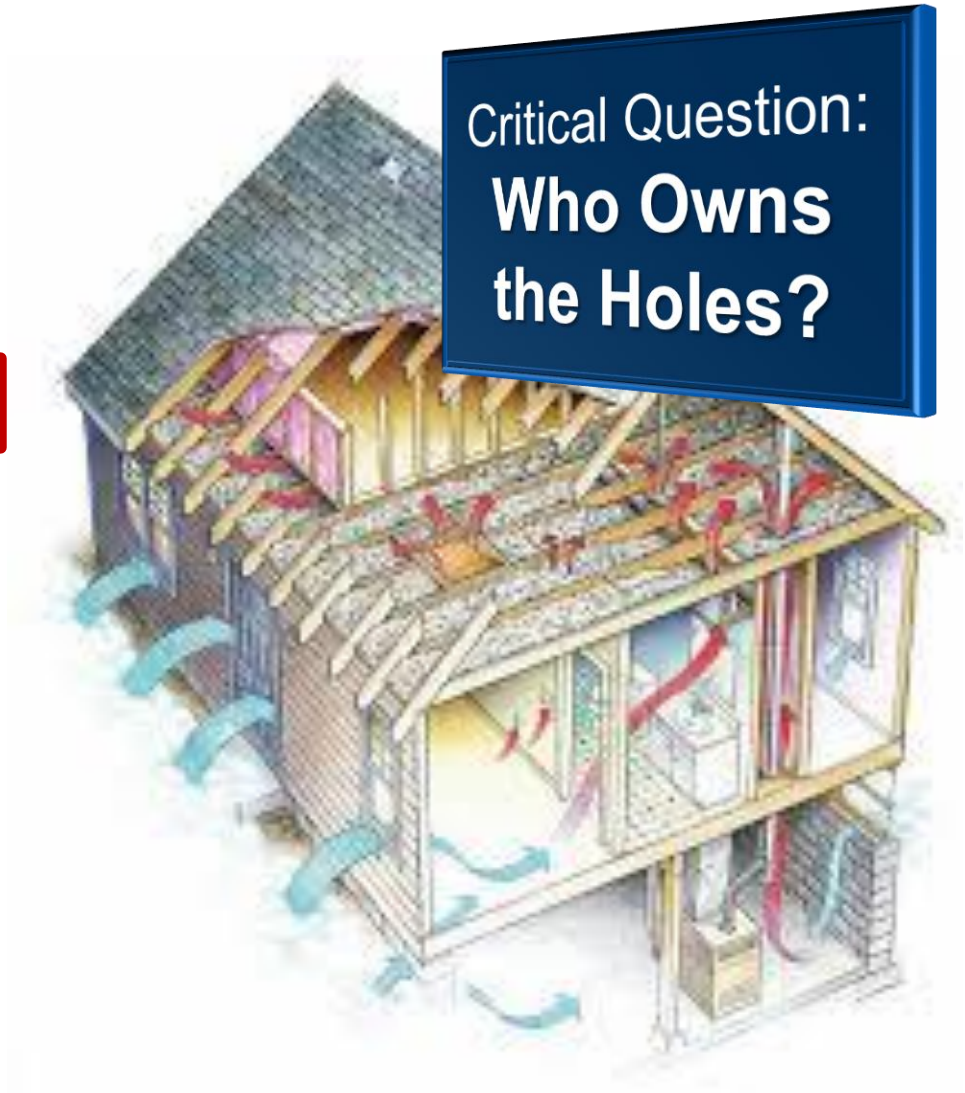
- ❑ Plumbing
- ❑ Wiring
- ❑ Recessed Lights
- ❑ Vents
- ❑ Flues
- ❑ HVAC Duct Boots

Odd Geometry:

- ❑ Cantilevers
- ❑ Knee-walls

Cracks:

- ❑ Sill Plates
- ❑ Windows & Doors
- ❑ Drywall at Top Plate
- ❑ Access Panels
- ❑ Sheathing Joints
- ❑ Foundation/Framing
- ❑ Air Barriers (see Air Barrier Checklist)



Air Flow Control: Air Sealing Missing at Top Plate

Air Flow Control: Air Sealing Top Plate Options

Sill Sealer

Construction Adhesive

Spray Foam

Air Flow Control: Digital Air Sealing - Homes

Thermal Flow Control Best Practices

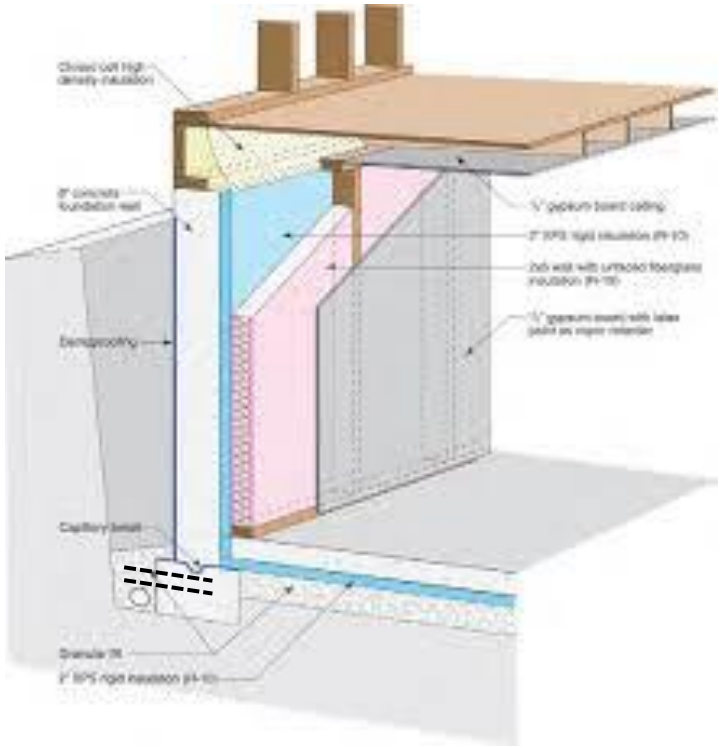
Best Practices	
Thermal Flow Control Layer	Optimize Insulation Quantity
	Quality Installed Insulation
	Minimize Thermal Bridging
	Optimize Windows
	Radiant Barriers

Thermal Flow Control: Greater Accountability

Insulation Adequate Quantity: IECC R-Values

Climate Zone	Slab, Depth			Floor R-Value			Basement/ Crawl Space			Ceiling			Wood Frame Wall		
	2015	2018	2021	2015	2018	2021	2015	2018	2021	2015	2018	2021	2015	2018	2021
1	0			13			0			30			13 or 0+10 for 2021		
2										38		49			
3	0		10 / 2ft.	19			5/13						20 or 13+5 or 0+15 for 2021		
4 except Marine	10 / 2 ft.		10 / 4 ft.	19			10 /13			49		60	20 or 13+5		20+5/ 13+10
5 & Marine 4				30			15/19 or 13+5 for 2021						20+5 or 13+5		
6	10 / 4 ft			30			15/19 or 13+5 for 2021						20+5 or 13+10		30/ 20+5/ 13+10/ 0+20
7 & 8				38			15/19 or 13+5 for 2021								

High-Efficiency Enclosure: Foundations



Concrete Wall/Footing

(Poured Concrete, Concrete Block)

Precast Concrete

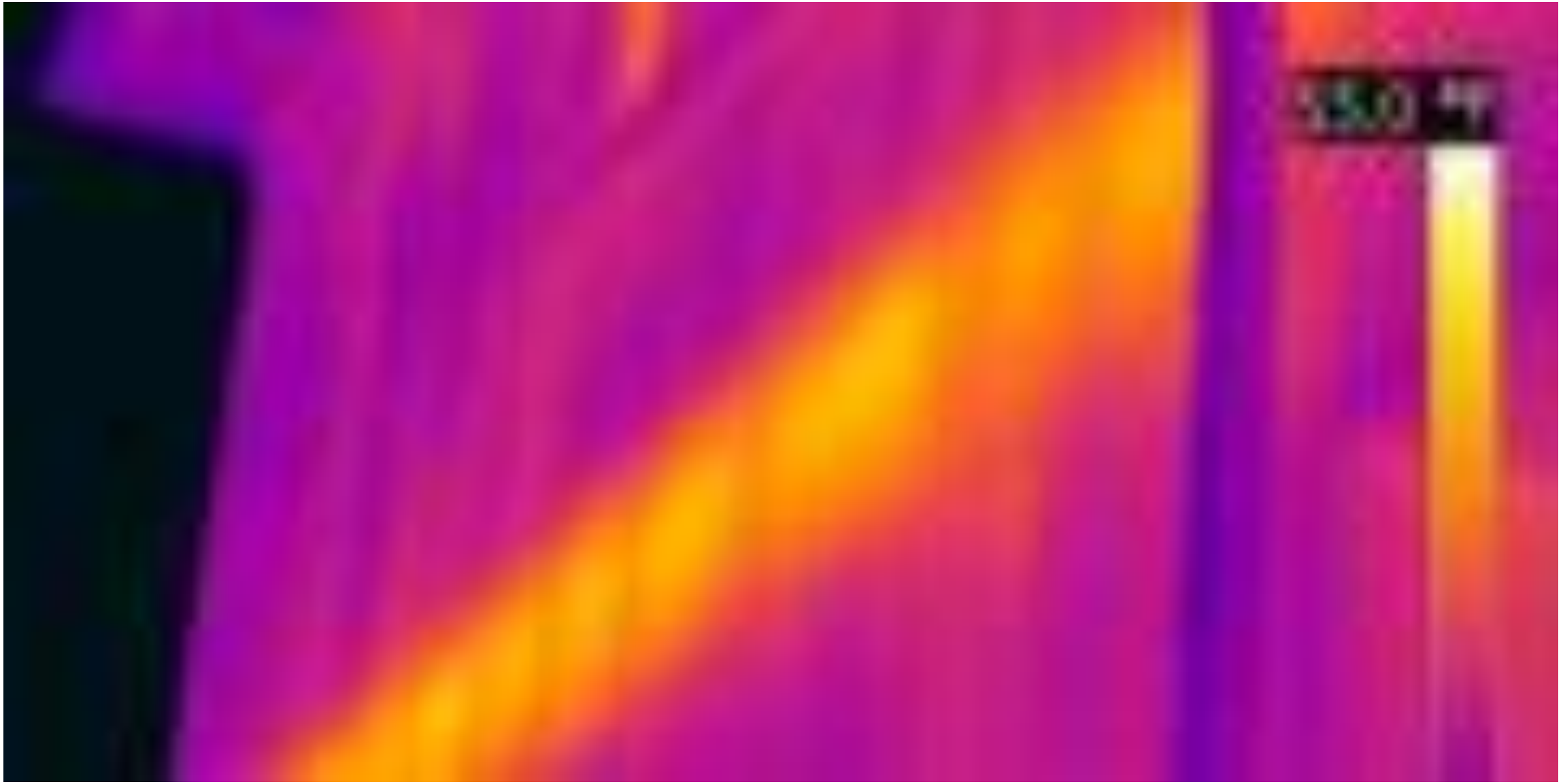
(R-10 Rigid + Cavity)

Precast Conc. Benefits:

- Strength
  - Effective Bond Beam
- Moisture Protection
  - 5,000 psi Concrete
  - Clear Path to Drain Tile
- Cycle Time
  - One-Day Installation
  - Integrated Insulation
  - Integrated Furring
- Dimensional Accuracy
- Resource Efficiency
  - ~70% Less Concrete
  - More Usable Space

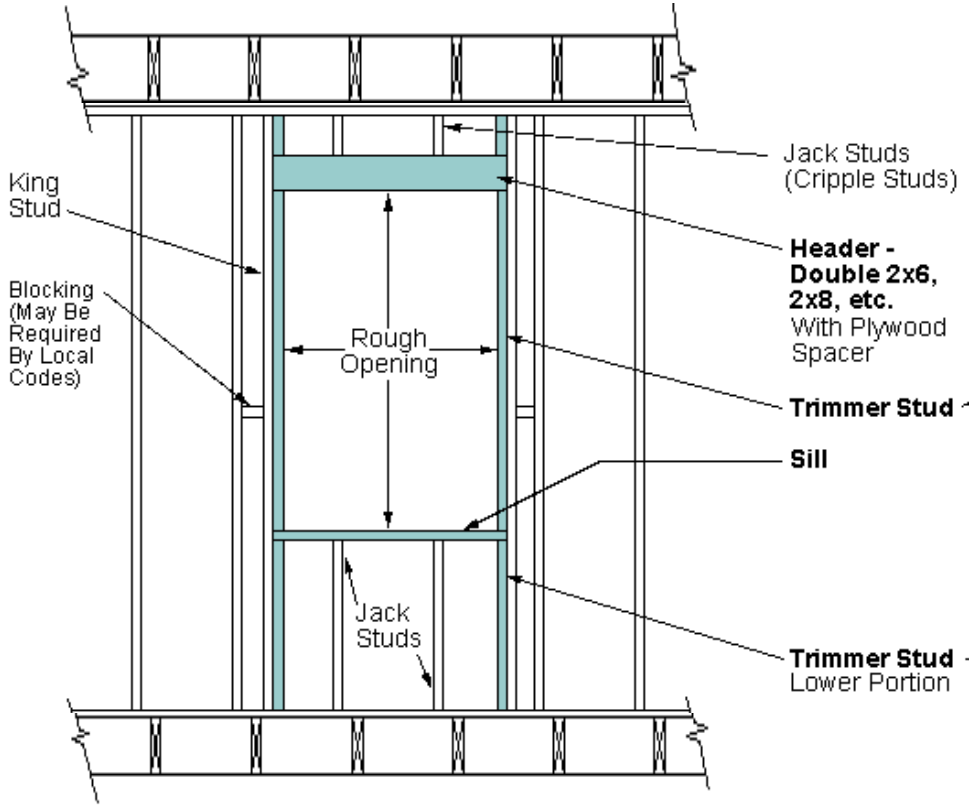
Insulation Quality Installation Problems

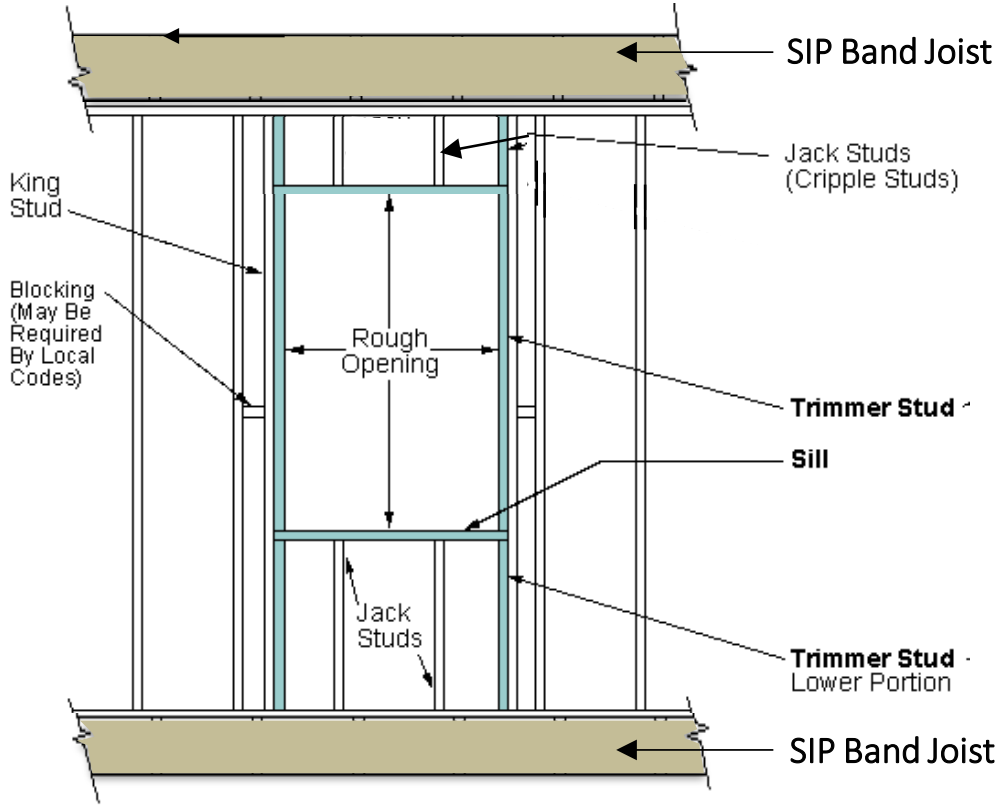
Insulation Quality Installation Band Joist Problem



Insulation Quality Installation Band Joist Solution

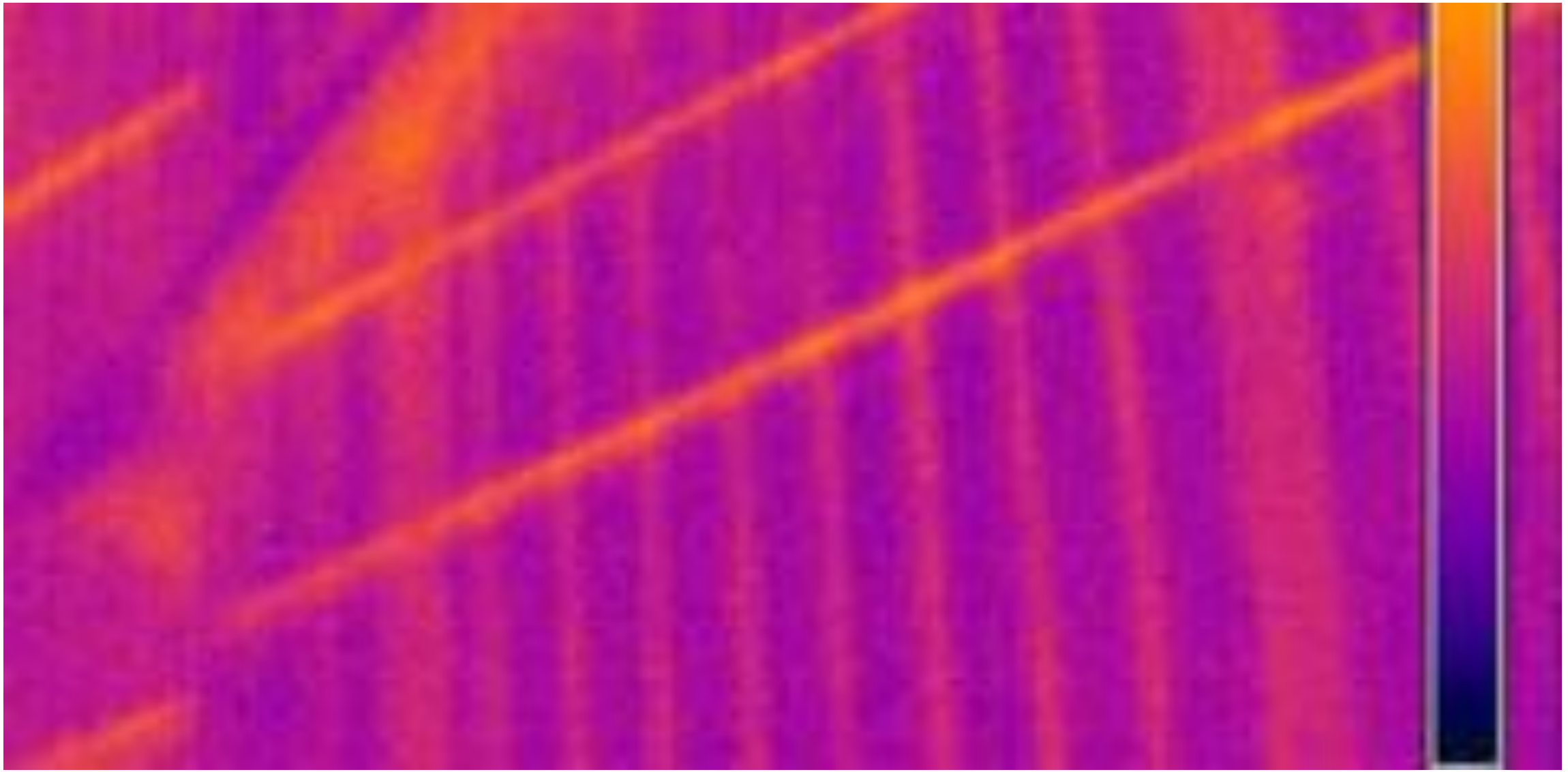
Insulation Quality Installation Band Joist Solution



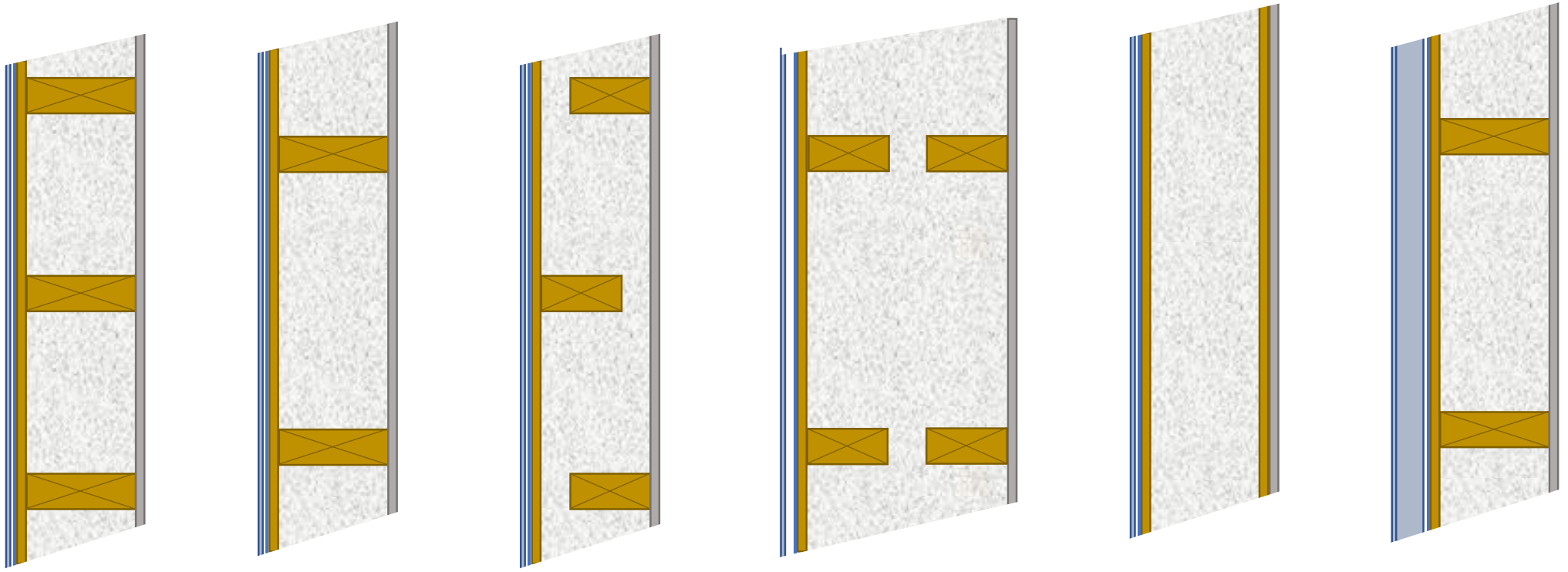


Thermal Control: Thermal Bridging Problem

Thermal Control: Thermal Bridging Problem



Thermal Control: Thermal Bridging Options



Conventional Framing
25-30% F.F.

Advanced Framing
19% F.F.

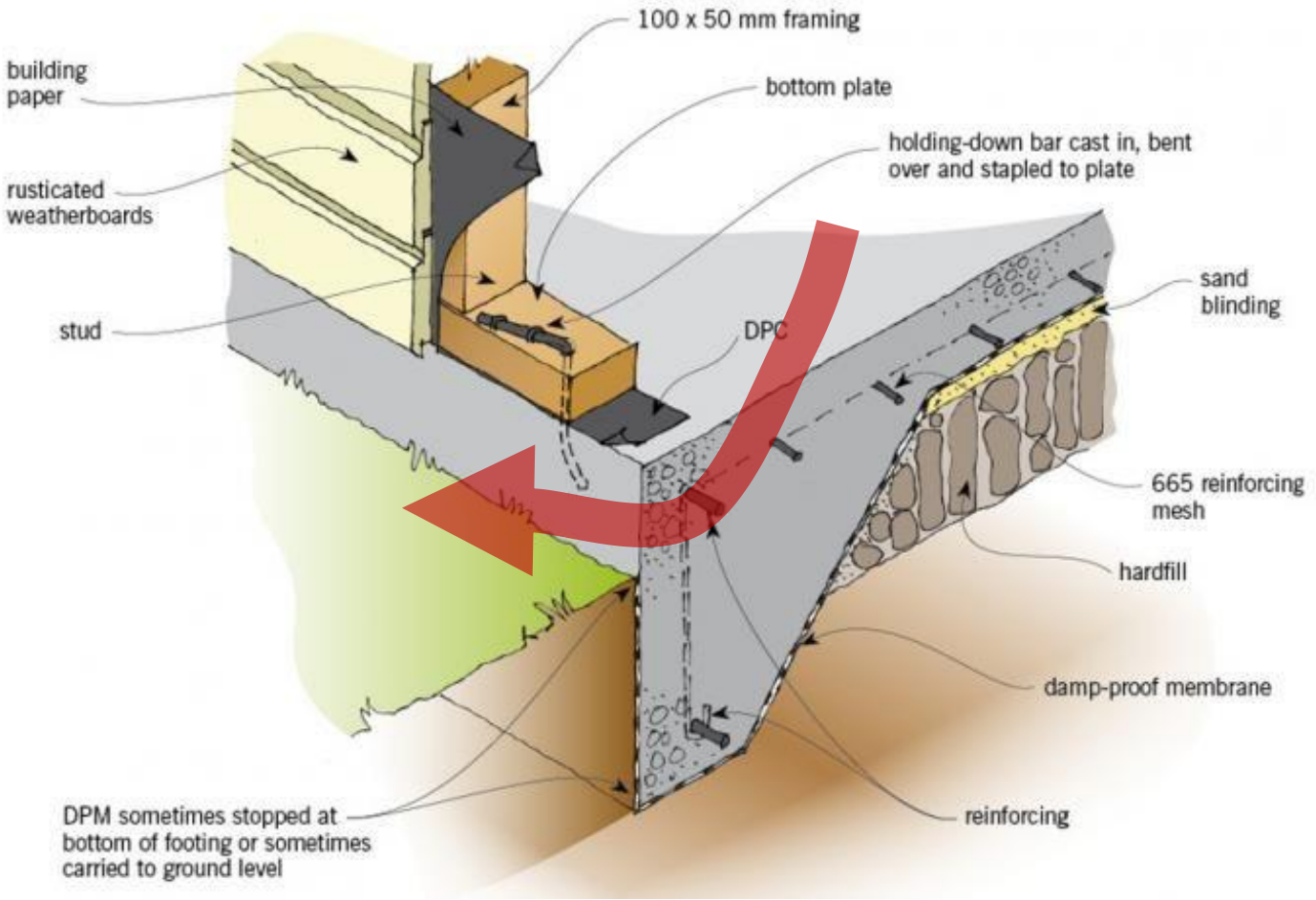
Staggered Stud Framing
12% F.F.

Double-Wall Framing
10% F.F.

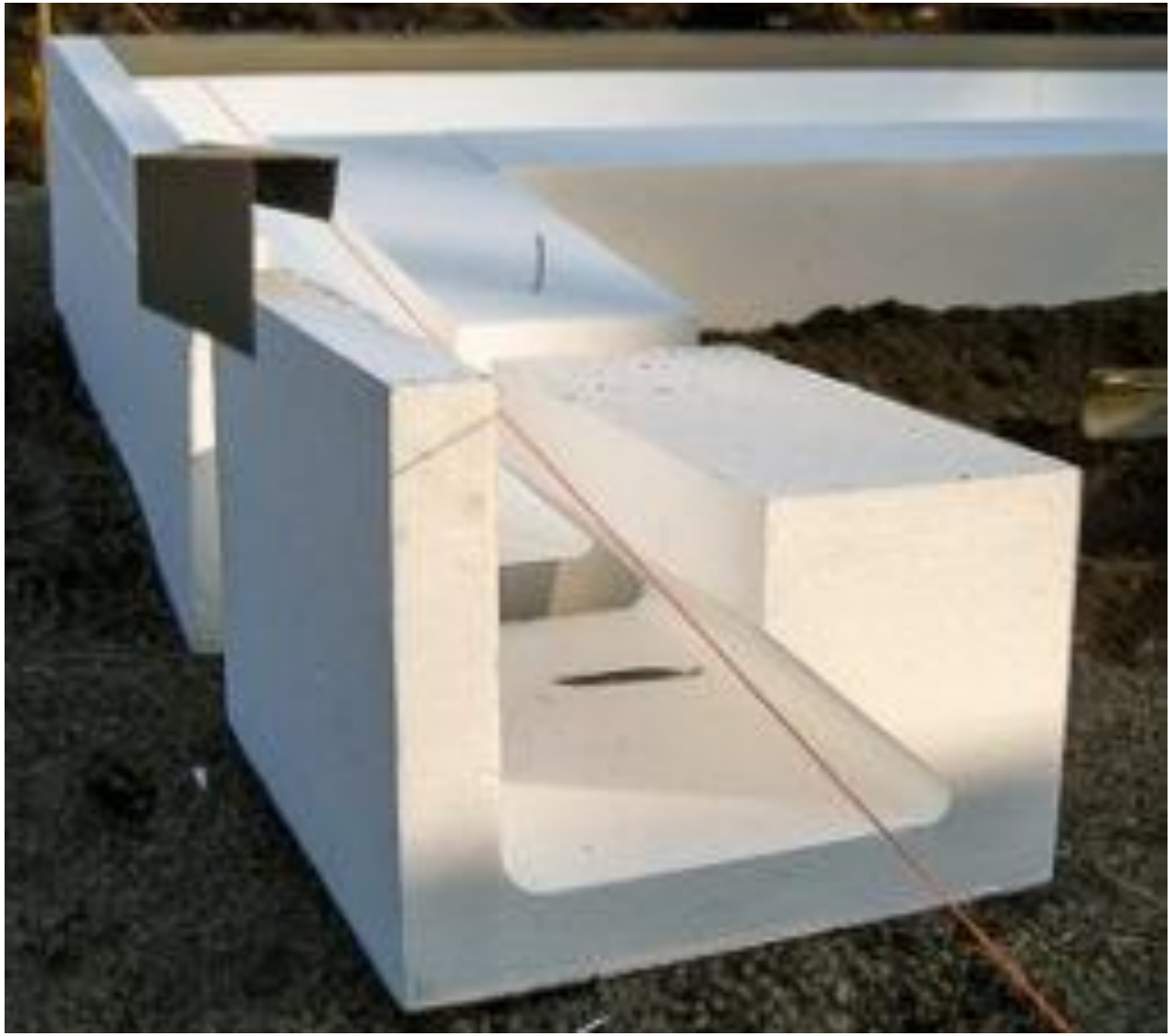
Structural Insulated Panels
5% F.F.

Rigid Insul. Sheathing
2% F.F.

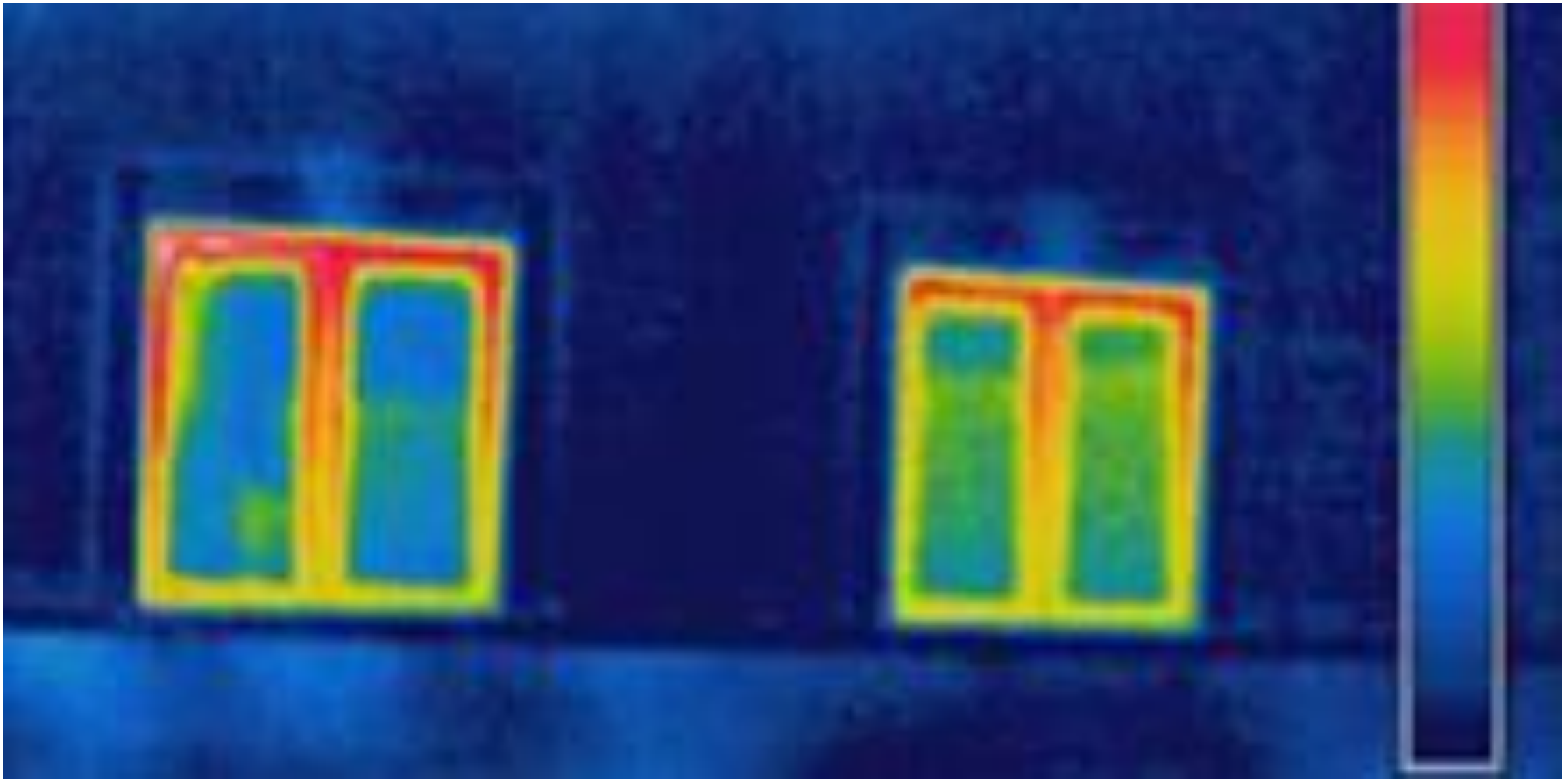
Thermal Control: Thermal Bridging Problem



Thermal Control: Thermal Bridging Solutions

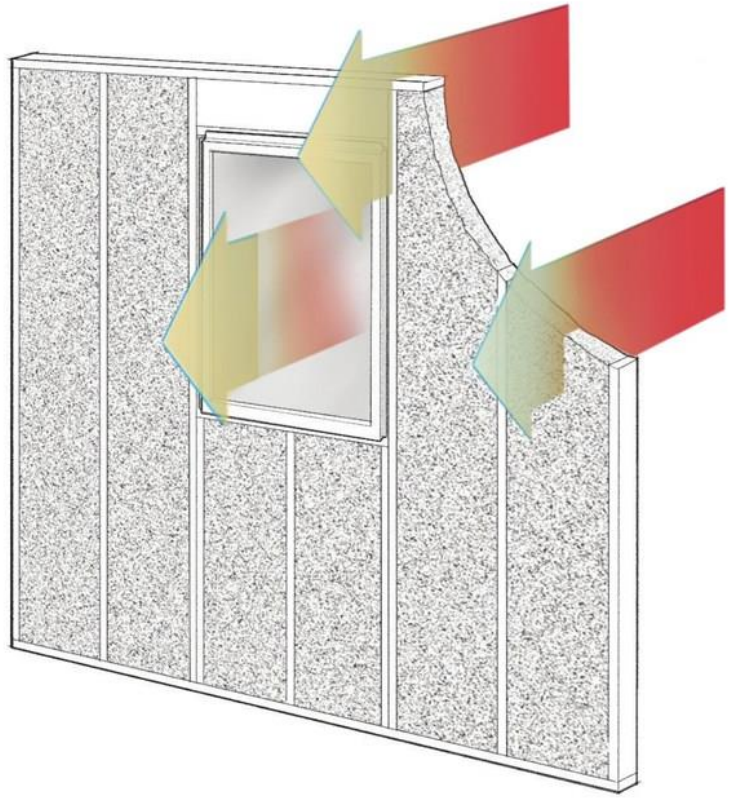


Thermal Control: Cold Climate Window Problem



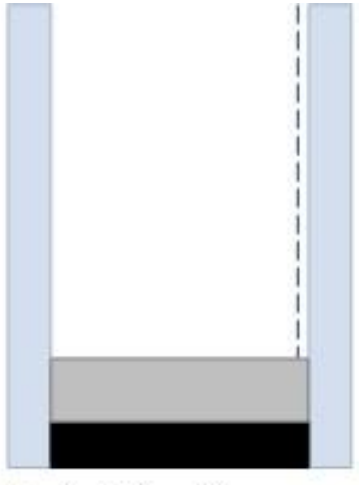
Thermal Control: Cold Climate Window Problem

Window 15% of Wall Area	Wall R-Value with Windows w/Varied Wall Insulation Levels for Cold Climate			
U-Value	**R-0**	**R-18**	**R-39**	**R-60**
0.30	R-5	R-11	R-15	R-17
0.20	R-5	R-13	R-19	R-23
0.15	R-5	R-14.5	R-23	R-28
0.10	R-5.5	R-16	R-27	R-34

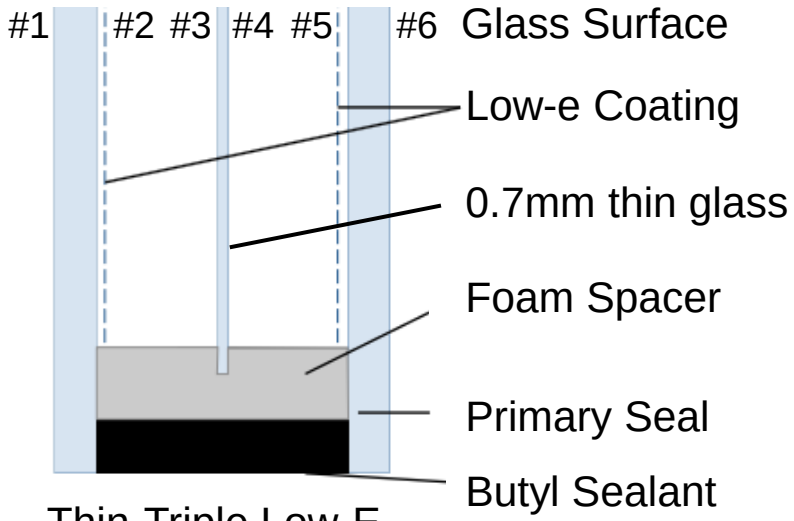


Sources: "*Holes in the Wall: To Improve the Energy Performance of Walls, Look at the Total R-Value*," Journal of Light Construction, February 2014; Multi-Assembly R-Value / U-Value Calculator – Cascadia Windows and Doors; Michael Blasnik Presentation, 2014 ACI Conference

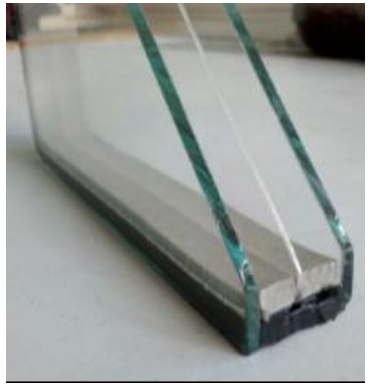
Advanced Thin-Triple Low-E Window



Typical Double Low-E



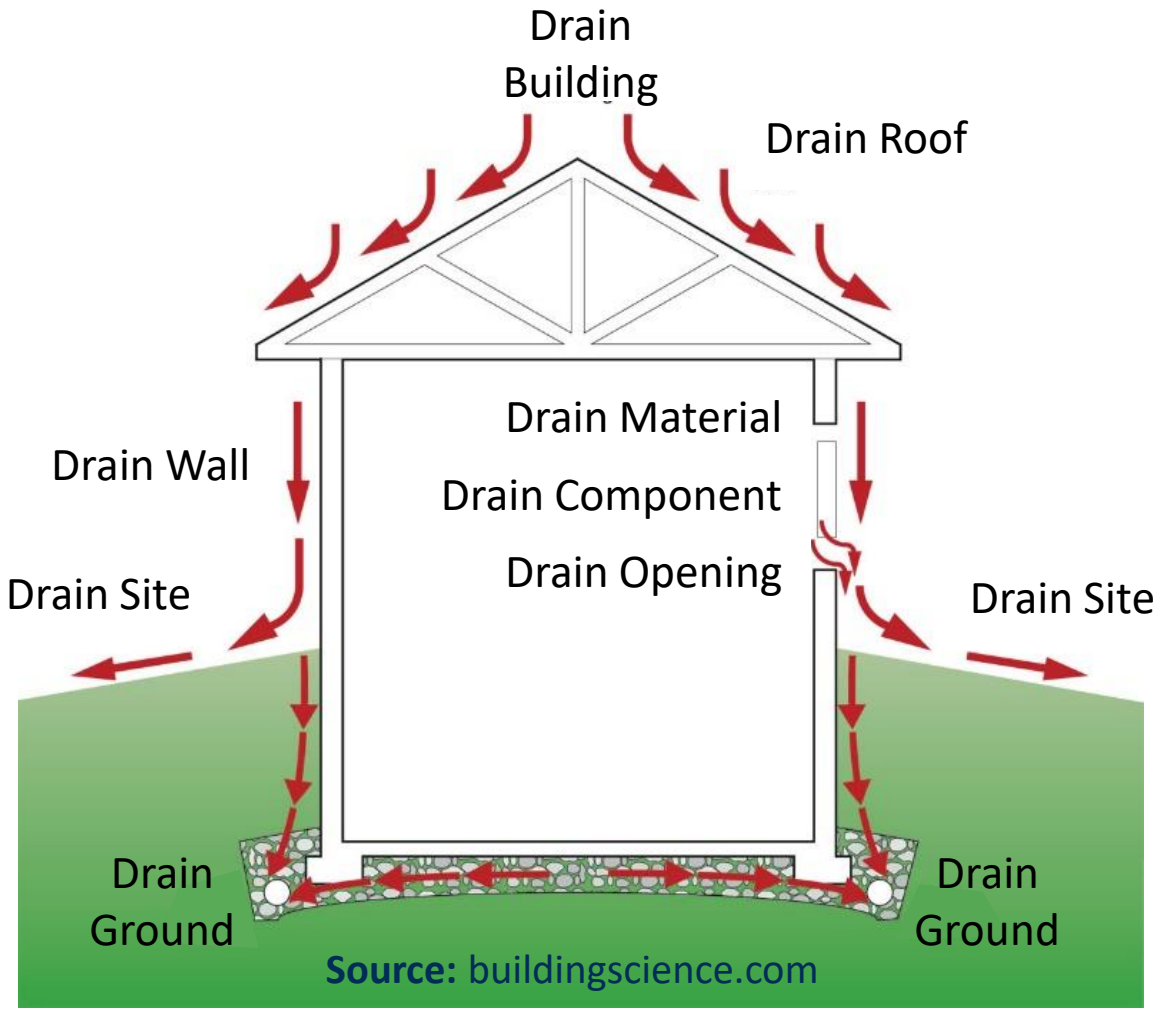
Thin-Triple Low-E



Benefits:

- Low-cost R-5 to R-10
- Thin float glass used in LED televisions widely available
- Krypton gas fill has dropped in cost
- Light-weight easy to install
- Manufacturer plants not required to fully retool

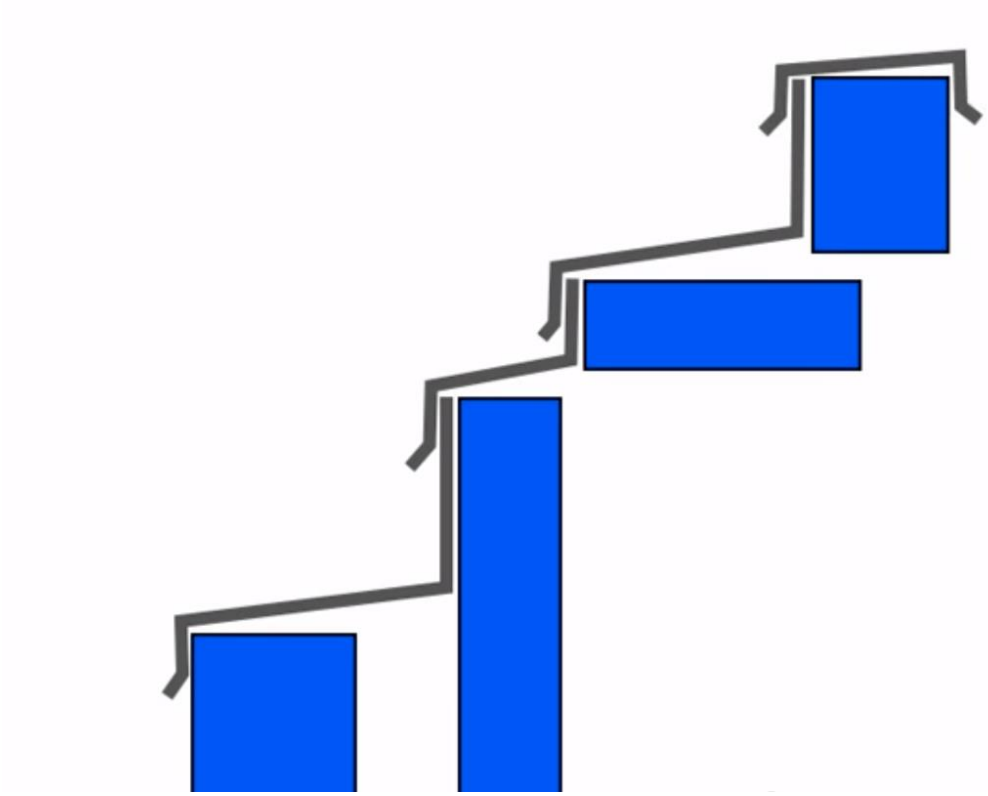
Bulk Moisture Control



Bulk Moisture Flow Control Best Practices

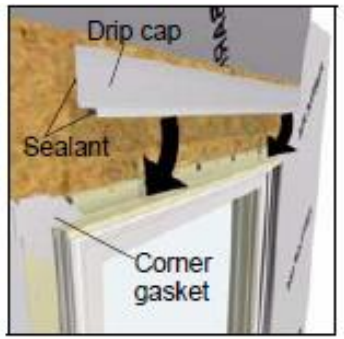
Best Practices		
Bulk Moisture Flow Control Layer	Roofs	Sealed Water Control Layer Flashing Heavy Membranes
	Walls, Openings, Penetrations	Sealed Water Control Layer Capillary Break Flashing
	Foundation	Water/Damp-Proofing Capillary Break Fabric Filter at Drain Tile
	Site	Slope Away from Home

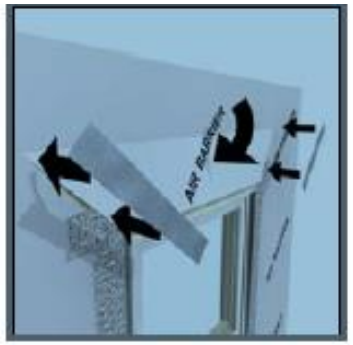
Bulk Moisture Flow Control: Flashing Concept

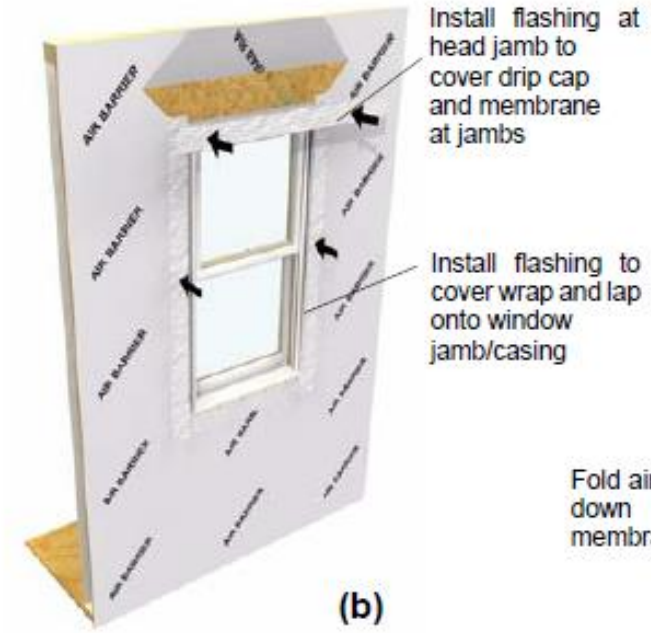


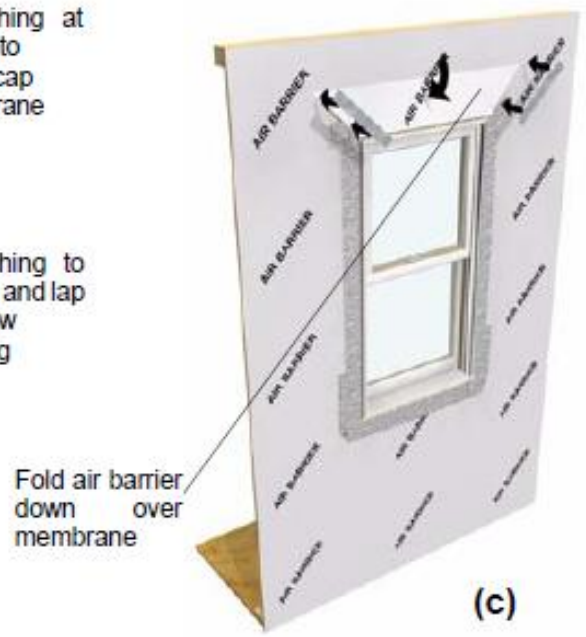
Sources: Journal of Light Construction Online, January 31, 2019

Bulk Moisture Flow Control: Flashing Applied









Bulk Moisture Flow Control: Flashing Applied

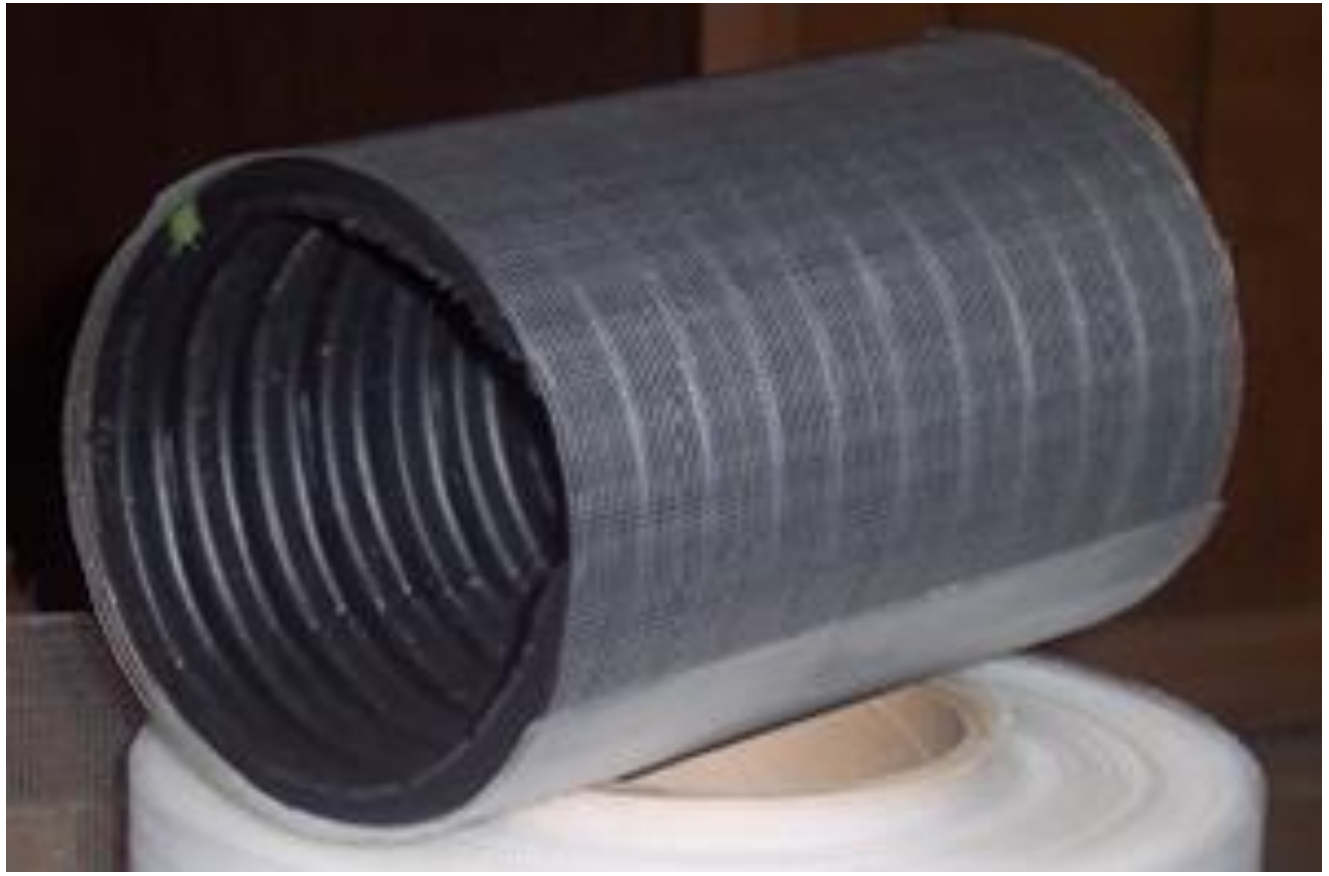
Without and With Step Flashing and Kick-out Flashing

Bulk Moisture Flow Control: Flashing Applied

Without and With Drip-Edge Flashing

Bulk Moisture Flow Control: Capillary Break

Bulk Moisture Flow Control: Fabric Filter Drain Tile

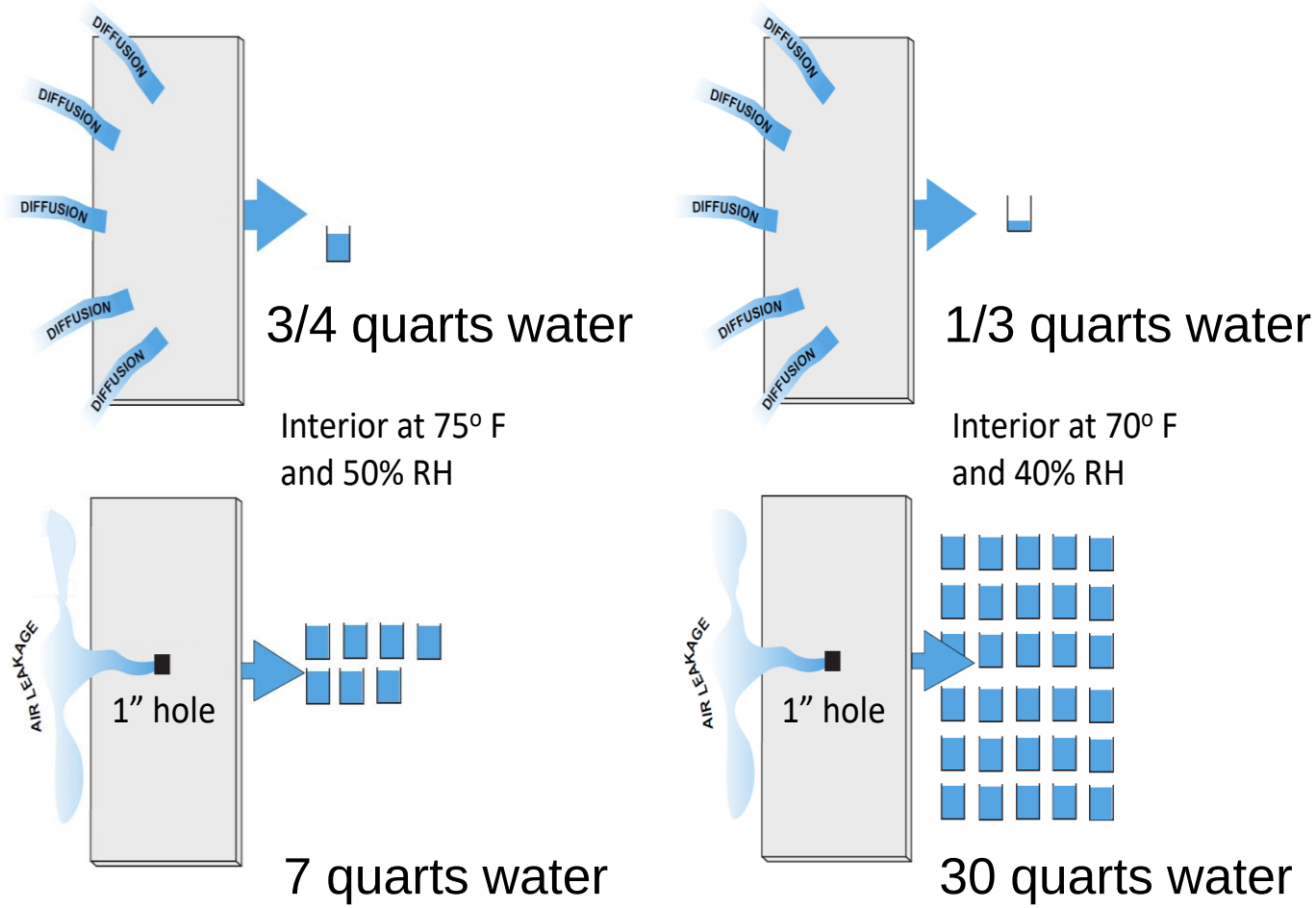


Without and With Drain Tile Fabric Filter

Moisture Vapor Flow Control Best Practices

Best Practices	
Moisture Vapor Flow Control Layer	Air Flow Control Best Practices
	Diffusion – Allow Assemblies to Dry
	Comfort System Moisture Control: • HVAC Quality Installation • Whole-House Dehumidification [HVAC Integrated or Dedicated]
	Indoor Air Quality Moisture Dilution: • Whole-House Ventilation • Spot Ventilation

Moisture Vapor Flow: Diffusion vs. Air Leakage



Hot-Humid Climate: Moisture vapor flow over Spring, Summer, and Fall from exterior to interior

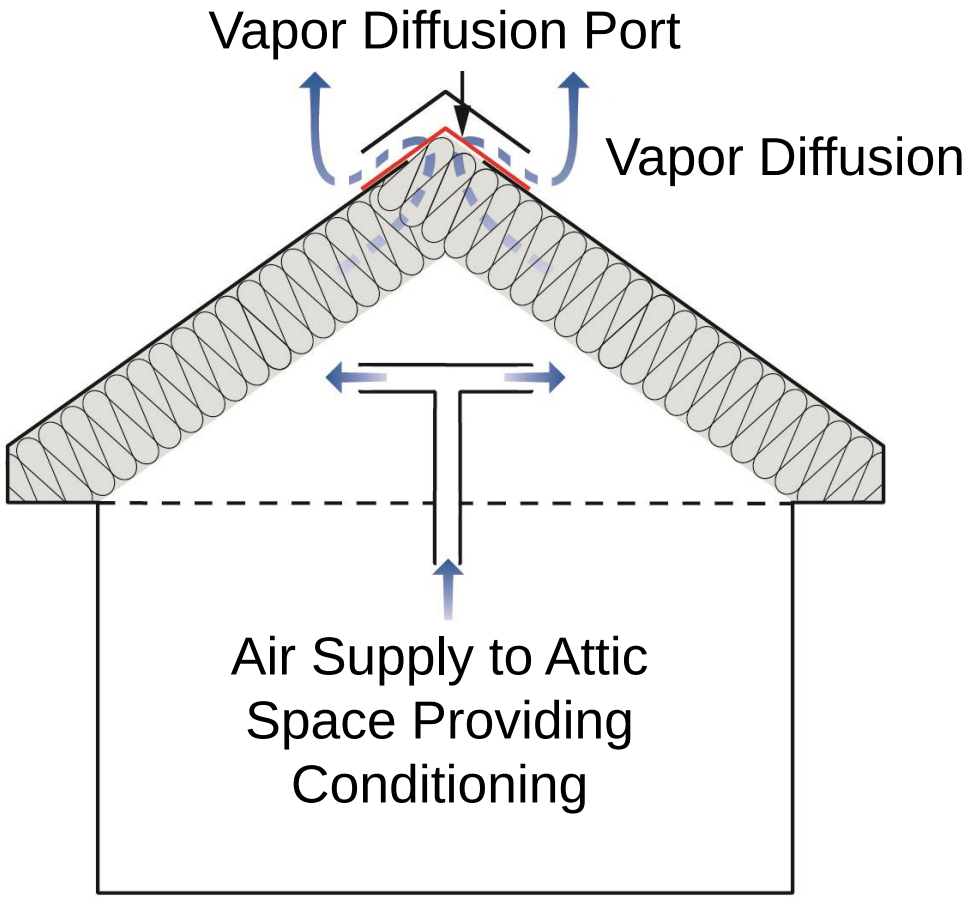
Cold Climate: Moisture vapor flow over winter from the interior to exterior

Moisture flow due to air leakage vs. diffusion with 5 Pascal pressure difference:

~10X Greater
in Hot-Humid Climate

~100X Greater
in Cold Climate

Moisture Vapor Flow: Unvented Attic Vapor Diffusion



Home with Conditioned Unvented Attic

Source: buildingscience.com

Managing Energy-Efficient Buildings Ripple Effect:

Comfort

Comfort Factors

• Mean Radiant Temperature	Enclosure Natural Comfort Radiant Heating
• Air Temperature • Relative Humidity	HVAC System Dehumidification
• Air Speed	Ceiling Fans
• Clothing • Activity	Occupant Behavior

Comfort System: Quality Installation Problem

Fault Type	Testing High	Testing Low
Equipment Sizing	31 – 93%	0 – 9%
Air Flow	8 – 29%	50 – 93%
Refrigerant Charge	4 – 50%	29 – 78%
Duct Leakage	67 – 100%	N.A.

U.S. DOE study found that 30 to 100% of field measured HVAC systems evidenced significant faults

Comfort System: Quality Installation

HVAC Design:

1. Calculate Heating/Cooling Loads
2. Select Equipment that Meets Loads
3. Design Compact Duct System that Gets Air from Equipment to Rooms and Back
4. Humid Climates: High Latent Capacity or Whole-House Dehumidification

HVAC Commissioning:

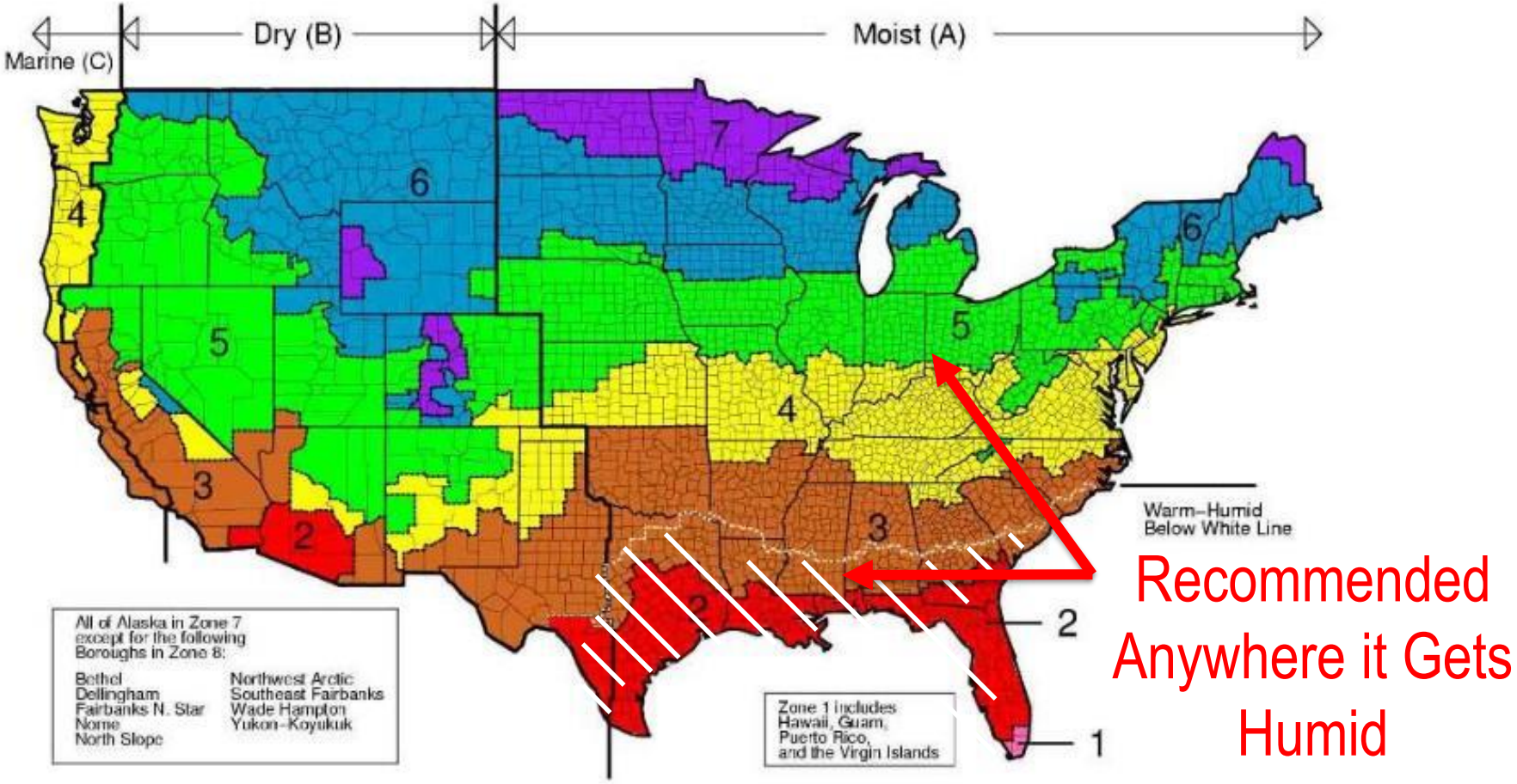
A. Check Airflow at Air Handler
B. Check Refrigerant Charge
C. Measure Airflow at Registers/Exhaust

Comfort System: Quality Installation, Right-Size

Non-Compact Duct Layout

Compact Duct Layout

Comfort System: Dehumidification



Comfort System: Dehumidification Options

Strategies:

- Stand-alone Dehumidifier
- Ducted Dehumidifier
- Variable Speed A/C System w/Dehumidification Mode/Controls

Energy Consumption (HERS 50 Home):

60% RH Setpoint: About 170 kWh/yr

50% RH Setpoint: ~800 kWh/yr – **about 5X**

Source: Supplemental Dehumidification for Humid Climates. Presented by Armin Rudd, Building Science Corp, at ACI National Conference May 2013. Supported in part by DOE Building America

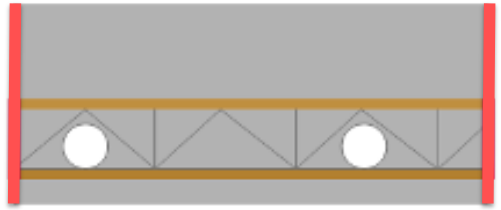
Comfort System: Attic Duct Location Problem

10-45% Added Thermal losses

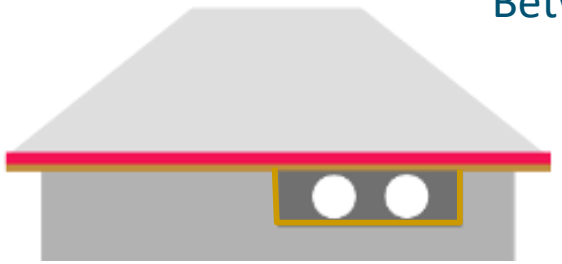
Dust and Moisture Contaminants

Comfort System: Duct Location Solution

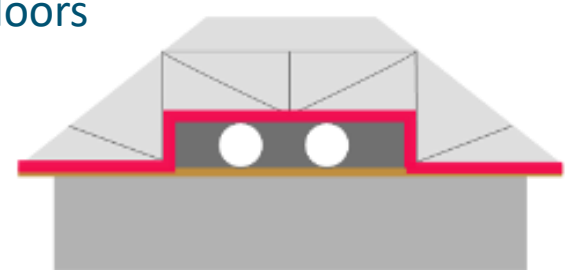
Ducts in Conditioned Space



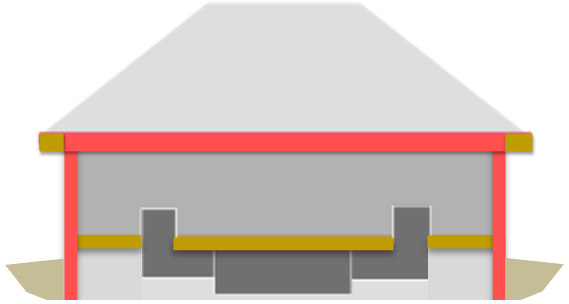
Between Floors



Dropped Ceiling



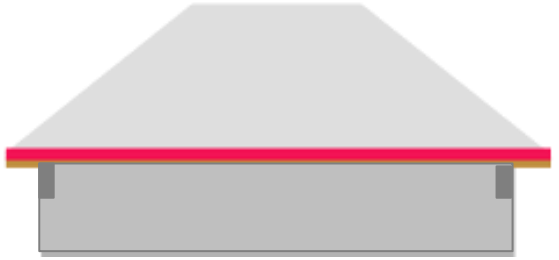
Modified Attic Truss



Unvented Crawl Space/Basement

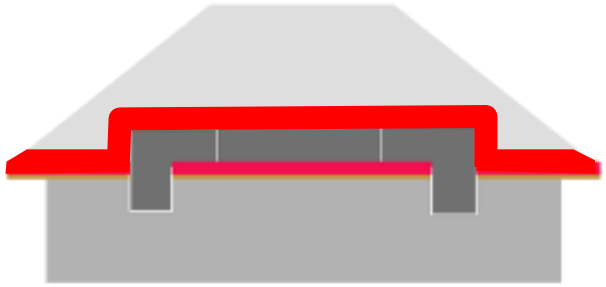
Unvented Attic

Ductless Systems



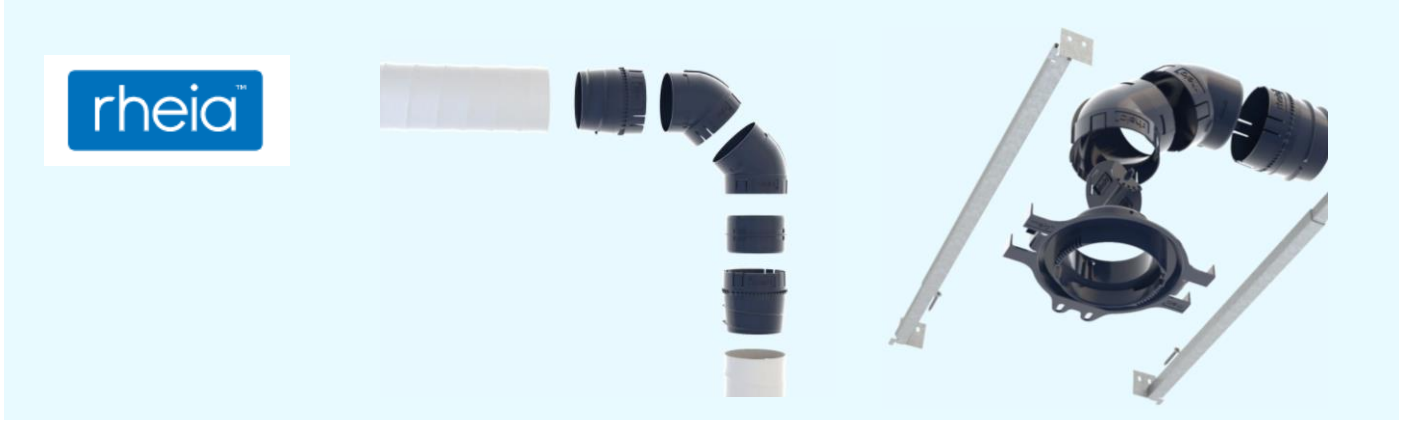
Mini-Split

Buried Ducts



Ducts in *Vented* Attic

Comfort System: Plug-and-Play Ducts



Benefits:

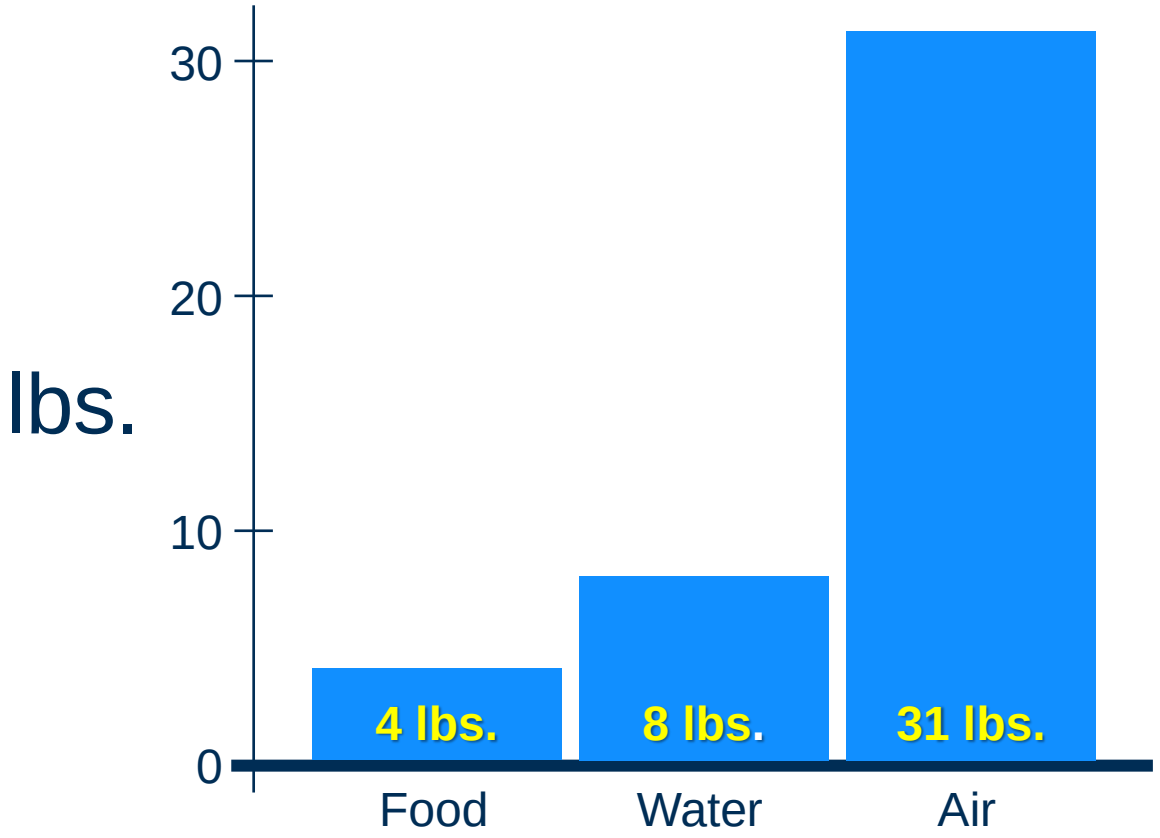
- Energy Savings
  - Ducts in Conditioned Space
  - Smaller System Size
- Lower Cycle Time
  - Integrated Duct Sealing
  - One-Size Duct Runs
  - Snap-fit Connection System
  - App-Based Balancing
  - 25-50% Less Rough-in Time
- More Comfort
  - Predictive Airflow Design
  - More Diffusers/Mixing

Comfort System: Plug-and-Play Duct System

Managing Energy-Efficient Buildings Ripple Effect:

Indoor Air Quality

Why Indoor Air Quality



Potential Contaminant Exposure:

- Mold Spores
- Dust Mites
- Dust
- Formaldehyde
- VOCs
- Combustion Gases
- Soil Gases

Why Indoor Air Quality: Air Quality Risk

Indoor vs. outdoor contaminants on average

2-5 times greater

While Americans Spend

70% of inside their homes

Source: EPA

Why Indoor Air Quality: Health Epidemic

"If your child doesn't use an inhaler,
consider yourself a lucky parent because,

1 in 10 children in the U.S. suffers from asthma."

Source: Remarks for Administrator McCarthy, Announcement of Clean Power Plan, Washington, DC, June 2, 2014

Why Indoor Air Quality: Willingness to Pay

At least 80%

of home buyers and homeowners of all age groups report they would pay more for a healthier home.

Source: "Green and Healthier Homes: Encouraging Consumers of all Ages in Sustainable Living," Dodge Data & Analytics, 2015

Best Practices: Indoor Air Quality

Strategy	Best Practices	
Indoor Air Quality	Source Control	Building Science Control Layers
		Screens
		Low- and No-Chemical Materials
		Whole-House Dehumidification
	Fresh Air	Whole-House Ventilation
		Spot Ventilation (Kitchen/Baths)
	High-Capture Filtration	Whole-House Air Filters
		Central Vacuum Cleaners

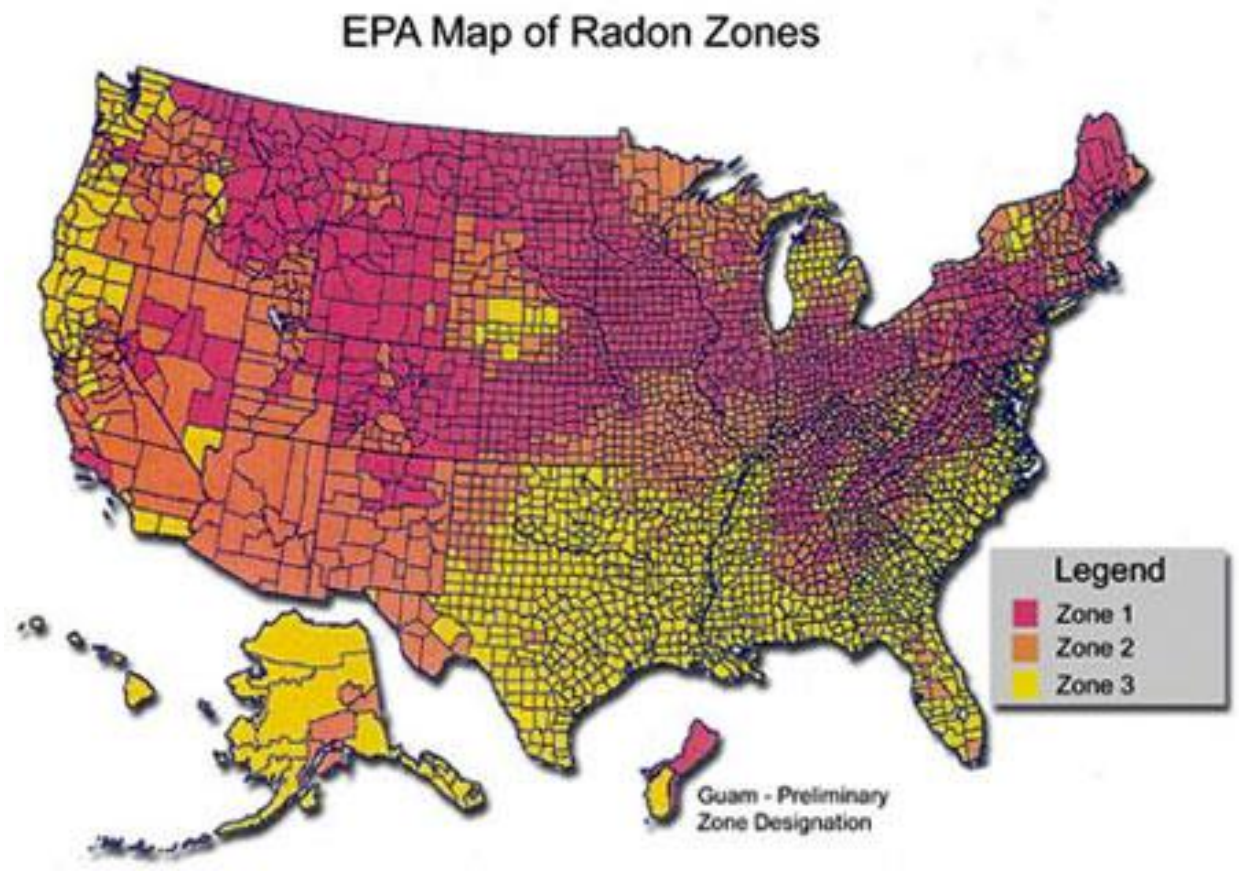
Source Control: Key Contaminants & Strategies

Contaminant	Control Strategy
Chemicals [Voc's/Formaldehyde]	• Low/No Contaminant Products [paints, carpets, sheathing, cabinets, adhesives]
Moisture [mold, mustiness]	• Building Science Control Layers • HVAC QI/Dehumidification
Biological/Particulates [dust mites, pests, pollen, dust]	• Air Sealing • Pest Screens at Vents (except clothes dryer) • HVAC QI/Dehumidification
Combustion Gases [gravity exhaust equip., gas cooktops, gas ovens, fireplaces, candles]	• Direct- and Power-vent Equipment • Electric Cooking Appliances • Air-Tight/Outdoor Combustion Air Fireplaces
Radon [radioactive gases in granitic soil]	• Radon Resistant Construction

Source Control: Low Chemical Materials

- Low Formaldehyde Pressed Wood
- Low Formaldehyde Cabinets
- Low VOC Paints
- Low VOC Carpet, Padding, Adhesives

Source Control: Radon



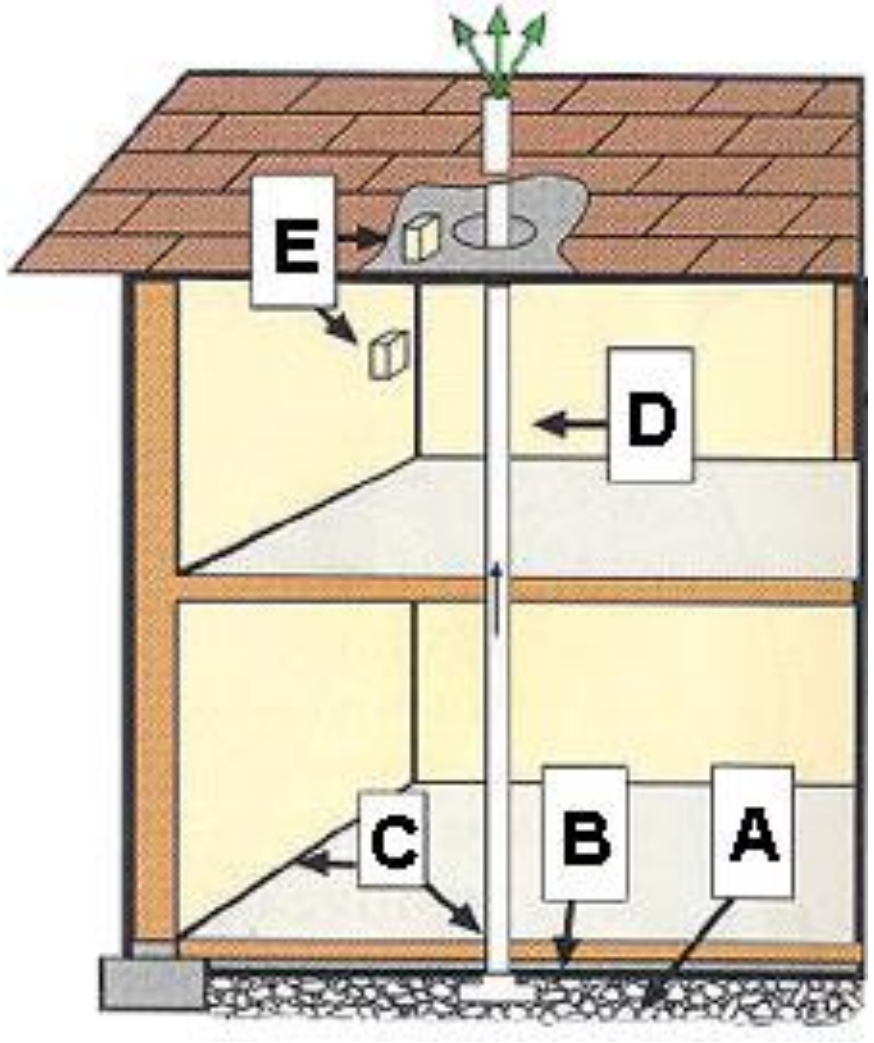
Surgeon General's Warning: Radon Causes Lung Cancer

Note: these maps indicate average risk by county. However, **High levels of Radon can be found in any home**.

1 in 15
homes in the U.S. have excessive levels of radon

21,000
lung cancer deaths each year including 3,000 people who never smoked

Source Control: Radon Resistant Construction



Moisture Control:

A. Gas Permeable Layer (min. 4” clean gravel)

B. Plastic Sheeting (under slab)

C. Sealing and Caulking (all openings in slab)

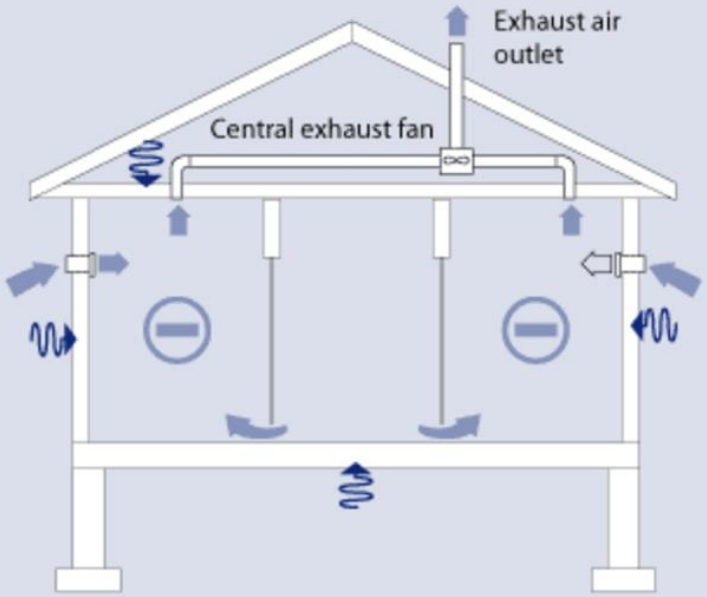
Additional Measures:

D. Vent Pipe (3 or 4 inch PVC pipe)

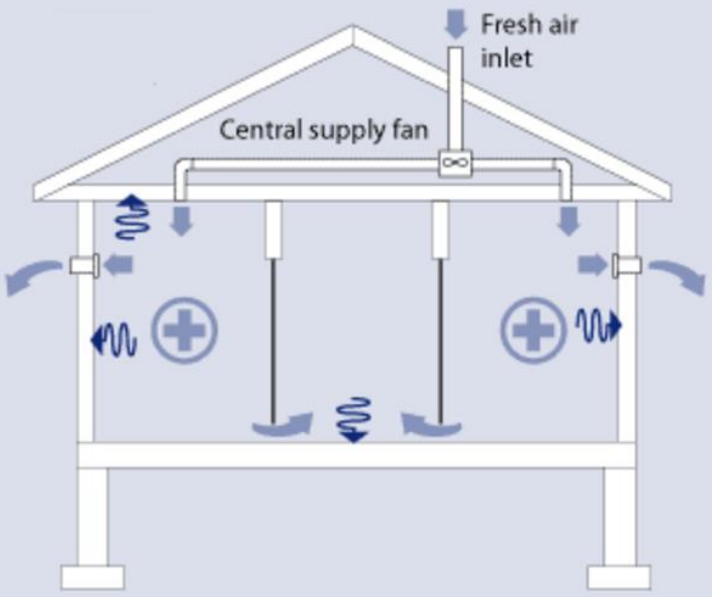
E. Junction Box (if fan needed later)

Fresh Air: Whole-House Ventilation Types

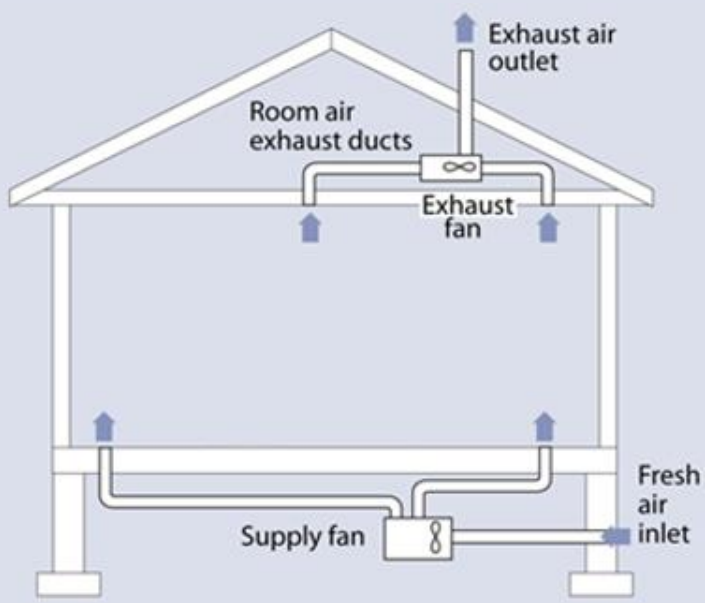
Exhaust-Only



Supply-Only

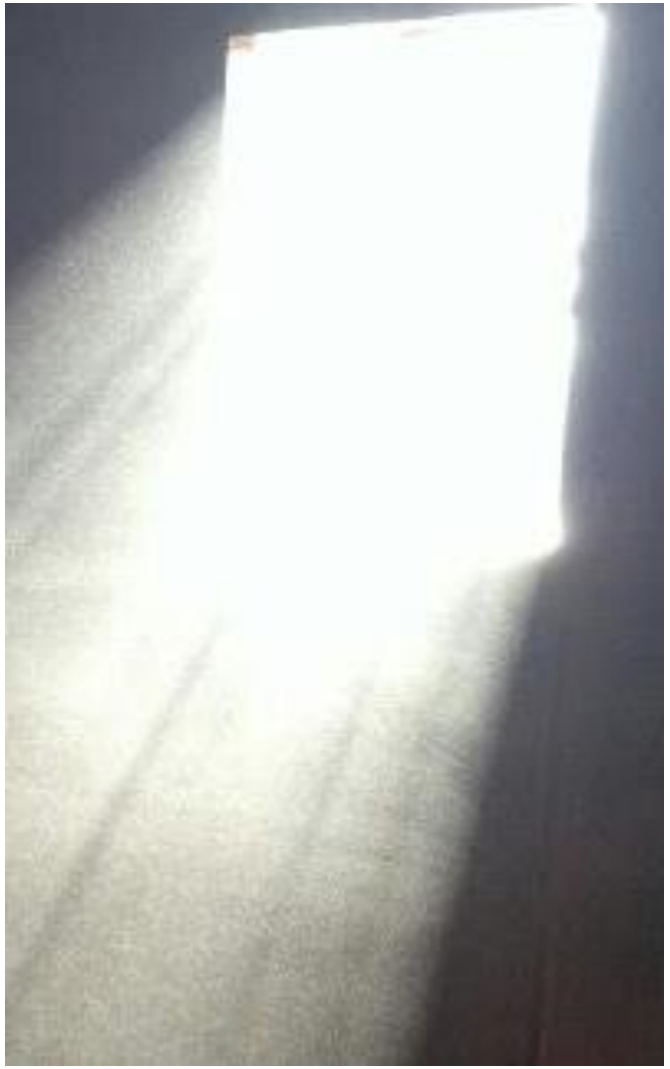


Balanced-Only



Why High-Capture Filtration

Performance | Bldg. Science | Efficient Smart | **IAQ** | Water Efficient | Resilience



40 Pounds

Average amount of dust collected in a six-room home in a single year

45 Toxic Chemicals

can be laced in dust

Sources:

"Asthma for Dummies," Wiley Publishing Inc., Hoboken, NJ, 2004

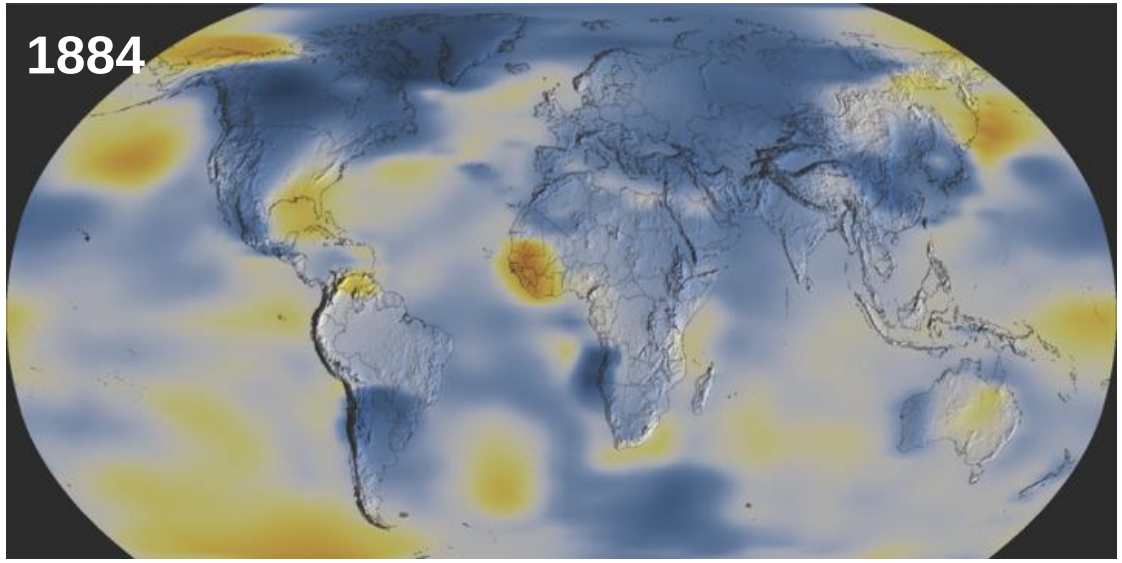
"Consumer Product Chemicals in Indoor Dust: A Quantitative Meta-Analysis of U.S. Studies," Environmental Science & Technology, September 14, 2016

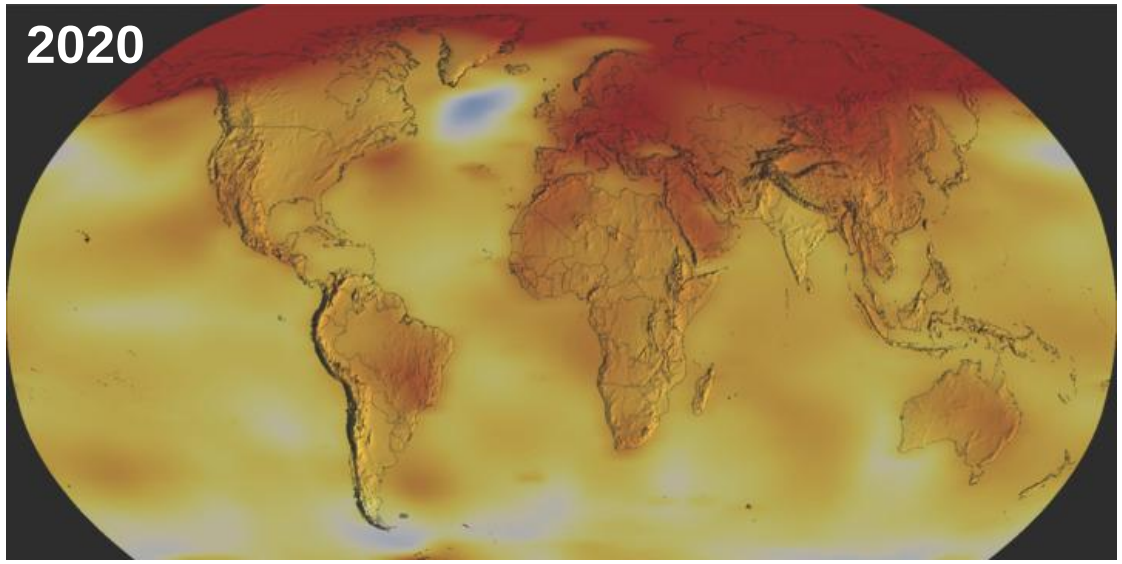
High-Capture Filtration: MERV 11 HEPA Filter

Managing Energy-Efficient Buildings Ripple Effect

Resilience

Why Resilience: Huge Risk Based on Science

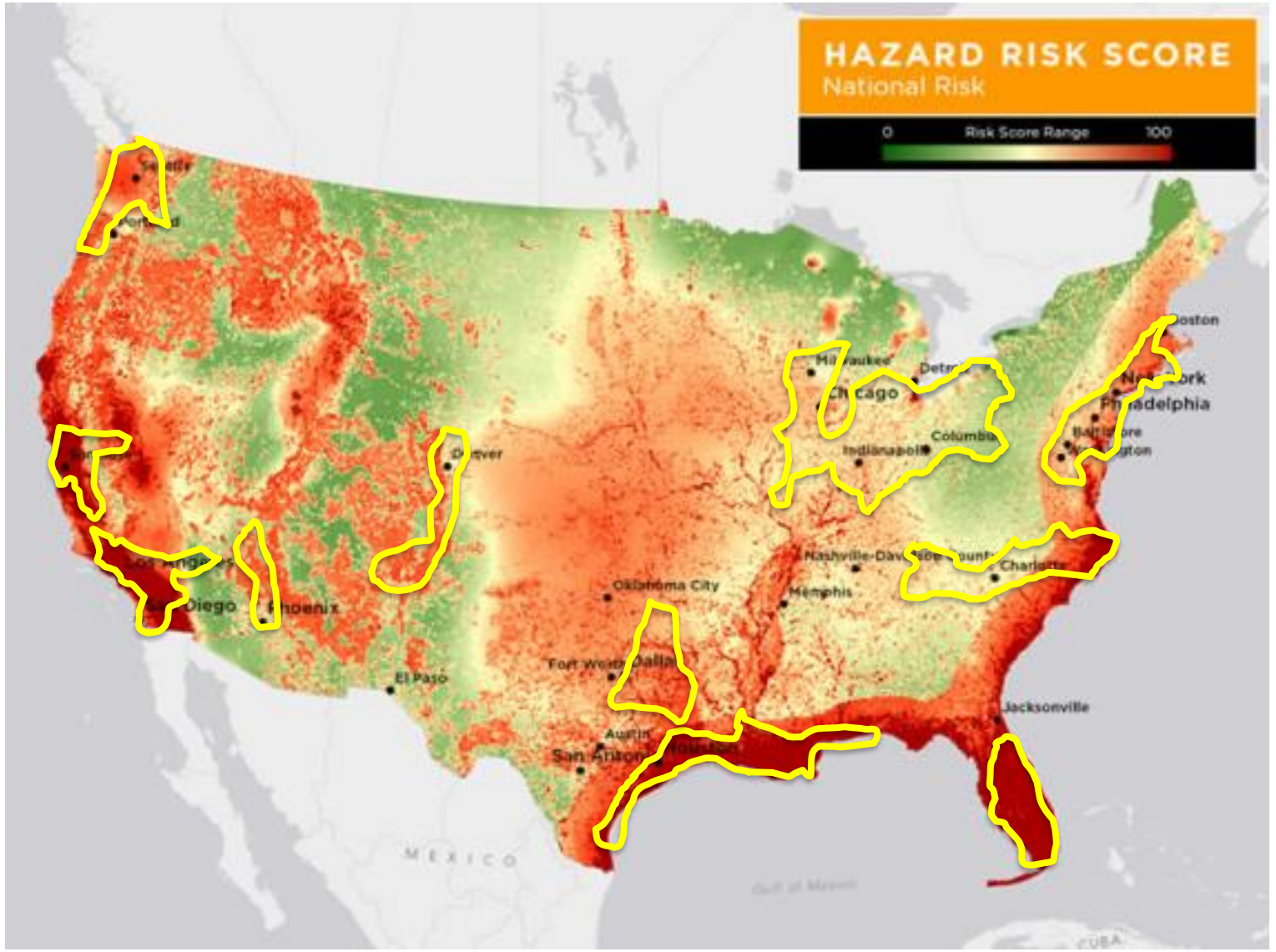




- **>90%** of warming on earth past 50 years occurred in the ocean
- **Doubling** of warming with water vapor than CO^2 alone.
- **21%** increased extreme storms for every 1º C increase in sea surface temperature
- **60%** increase in extreme storms by 2100 forecast based on current climate model projections

Source: NASA

Why Resilience: Huge Risk Based on Exposure



43% of U.S. homes with an estimated market value of

$6.6 Trillion

in counties with high natural disaster risk.

Source: Realty Trac

Why Resilience: Huge Risk Based on Data

$350+ Billion:

estimated property losses
due to catastrophes in the U.S.
from 2010 to 2019

Source: Tabulated data from Insurance Information Institute, https://www.iii.org/fact-statistic/facts-statistics-us-catastrophes#:~:text=Insured%20losses%20due%20to%20natural,%2452%20billion%20total%20for%202018.

Why Resilience: Insurance Savings

Insurance Cost Relative to Base Flood Elevation (BFE)

Premium at 4 Ft. Below BFE	Premium at BFE	Premium at 3 Ft. Above BFE
$9,500/year **$95,000/ 10 Years**	$1,410/year **$14,100/ 10 Years**	$427/year **$4,270/ 10 Years**

Source: American Planning Association, https://www.planning.org/research/postdisaster/briefingpapers/floodinsurance.htm

Why Resilience: Insurance Availability and Cost

CNBC

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NATURAL DISASTERS

Insurers take a hard look at California and see growing wildfire risk

Insurers refused to renew thousands of polices in fire areas after a wildfire disaster

The New York Times

Extreme Weather › | Updates | Tropical Depression Nicholas | Map: Wildfires in the West | Evacuating the Disabled

With Extreme Weather, Home Insurance Will Cost More. If You Can Get It.

Homes in Queens were flooded by the remnants of Hurricane Ida last week. As extreme weather becomes more common, insurance companies are rethinking which homes to cover and at what price. Benjamin Norman for The New York Times

By Paul Sullivan

Sept. 10, 2021

Why Resilience: Real Estate Value

Builder

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Land

HOME > LAND > WHAT MOTHER NATURE HAS TO SAY ABOUT PROPERTY VALUES

Posted on: August 30, 2018 1 Like

BUILDER

WHAT MOTHER NATURE HAS TO SAY ABOUT PROPERTY VALUES

Land valuation calculations get more complex as the pace and severity of natural disasters intensify.

By John McManus

If land acquisition and real estate investment strategists didn't already have enough on their plates, what with polar opposite mixed-signals on the economic horizon line, now there's this.

What to make of the location of building lots and their relative susceptibility to weather and disaster events, and the fact that the frequency of these events seems to be accelerating?

One study uses evidence that disaster risk has begun to determine winners and losers in real estate value.

One study uses evidence that disaster risk has begun to determine winners and losers in real estate value.

Why Resilience: Real Estate Value

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TRENDS

THE WALL STREET JOURNAL.

Flooding Risk Knocks $7 Billion Off Home Values, Study Finds

By Laura Kusisto | Aug 27, 2018

Flooding has erased nearly $7 billion in value for homeowners in New York, New Jersey and Connecticut since 2005, a new study finds.

Best Practices: Resilience

Best Practices		
Resilience	Disaster Resistance	Wildfire Resistance
		Flood Resistance
		Wind/Impact Resistance
		Earthquake Resistance
		Severe Winter Weather Resistance
	Post-Disaster Occupancy	High-Performance Home
		Natural Comfort
		Solar Electric
		Solar Hot Water
		Battery Storage

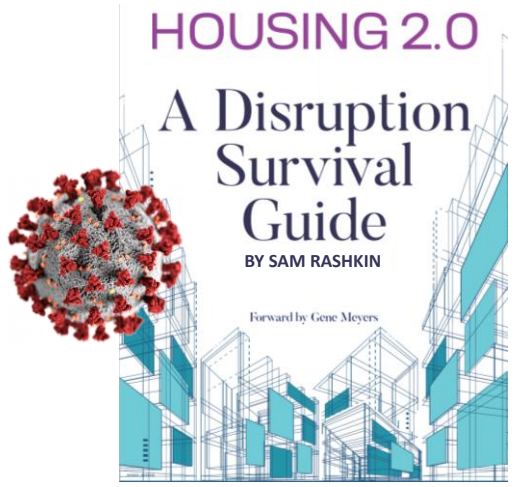
Energy Efficiency and Resilience Ripple Effect

Resiliency Risk	Complement	Conflict
Wildfires	Unvented Attics	Vented Attics
	Unvented Crawl Space	Vented Crawl Space
	Noncombustible Materials	Flammable Insulation
High Winds/Impact (hurricanes, tornadoes)	Unvented Attics	Vented Attics
	Concrete/SIPs	Wood Frame Walls
	Operable Shutters	Large Overhangs
Earthquakes	Wood Frame Walls	Masonry Walls
Floods	Raised Homes	Unvented Crawl Space
	Concrete/Masonry Walls	Insulated Slab
Severe Winter Weather	Vented Attics	Unvented Attics

Managing Energy-Efficient Buildings Ripple Effect

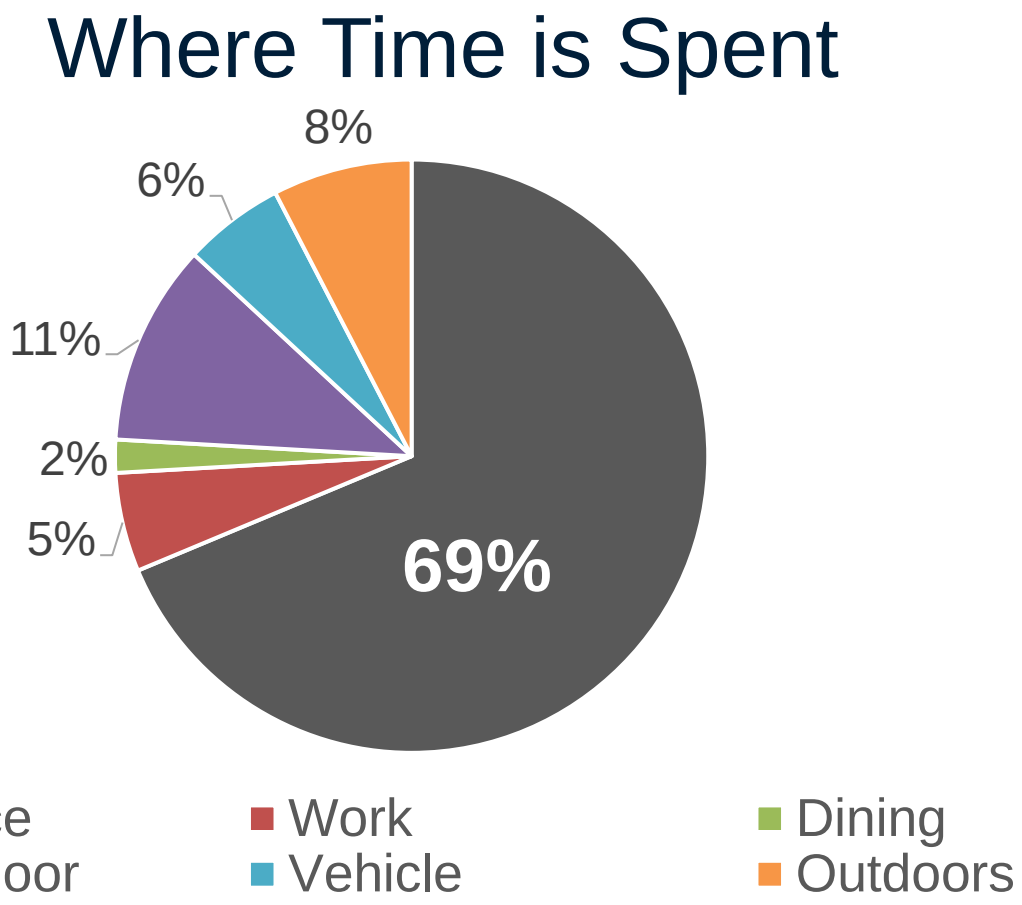
User Experience (UX)

User Experience Ripple-Effect Personal Journey



1996 2012 2014 2020 2021

Why Housing User Experience?



Source: National Human Activity Pattern Survey, LBNL, 2001

Home is where life happens™

Why Housing User Experience?

Homes where life happens better

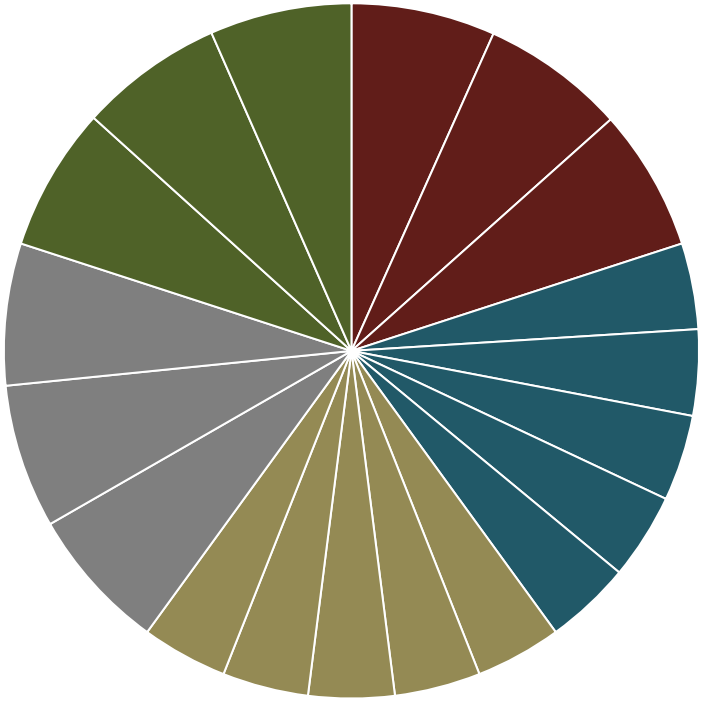
What Housing User Experiences?

Framework for Optimizing Housing User X

What Housing User Experiences?

Sales:
3 Strategies
21 Best Practices

Community:
3 Strategies
21 Best Practices



Quality:
3 Strategies
19 Best Practices

Design:
5 Strategies
50 Best Practices

Performance:
5 Strategies
42 Best Practices

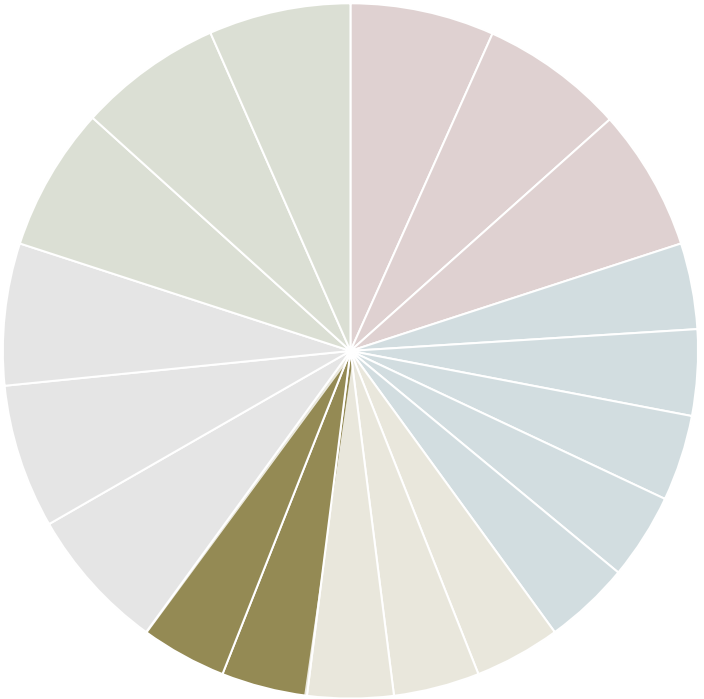
UX Optimization Framework:

- 5 User Experiences
- 19 Strategies
- 150+ Best Practices

What Housing User Experiences?

Sales:
3 Strategies
21 Best Practices

Community:
3 Strategies
21 Best Practices



Quality:
3 Strategies
19 Best Practices

Design:
5 Strategies
50 Best Practices

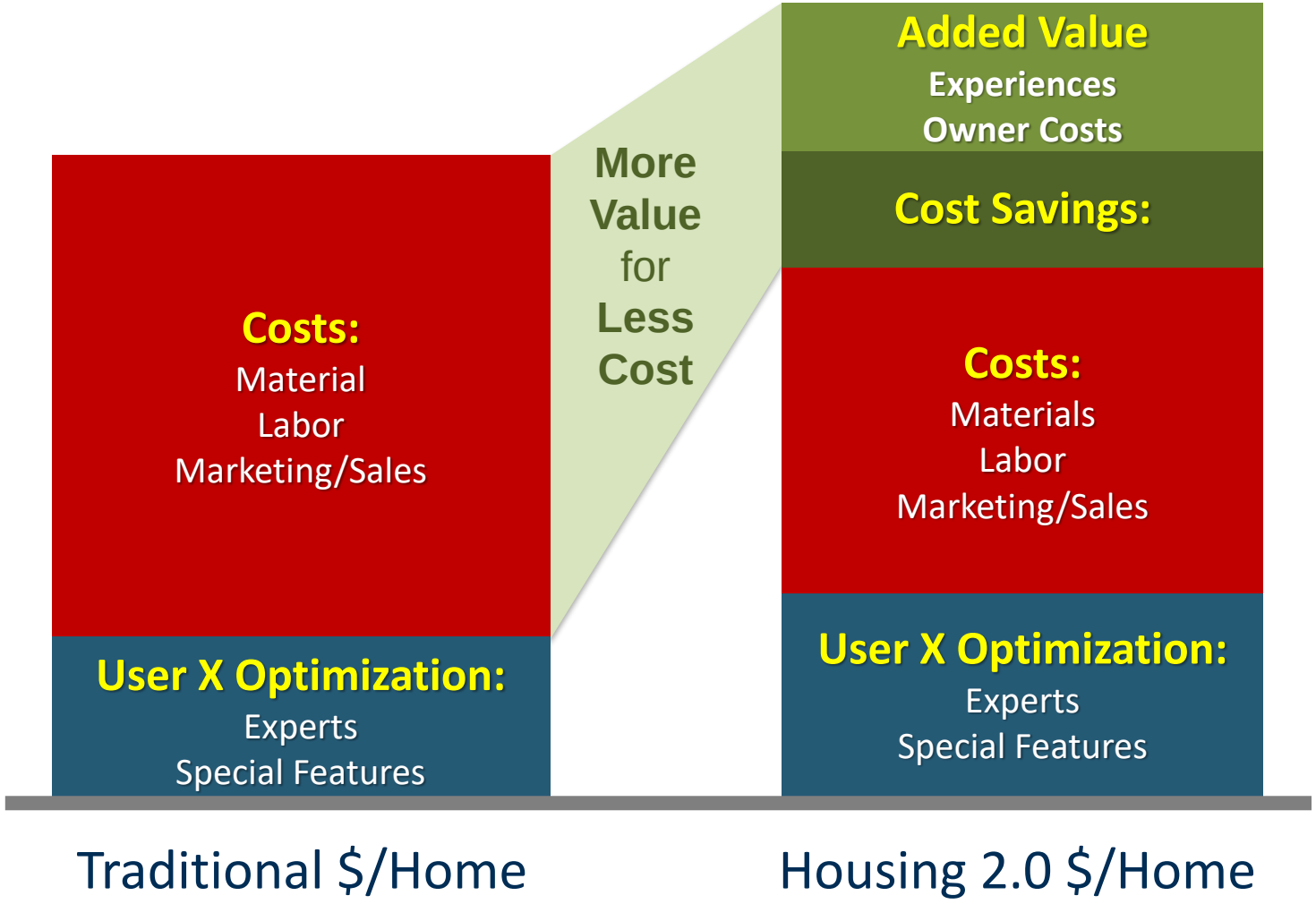
Performance:
5 Strategies
42 Best Practices

UX Optimization Framework:

- 5 User Experiences
- 19 Strategies
- 150+ Best Practices

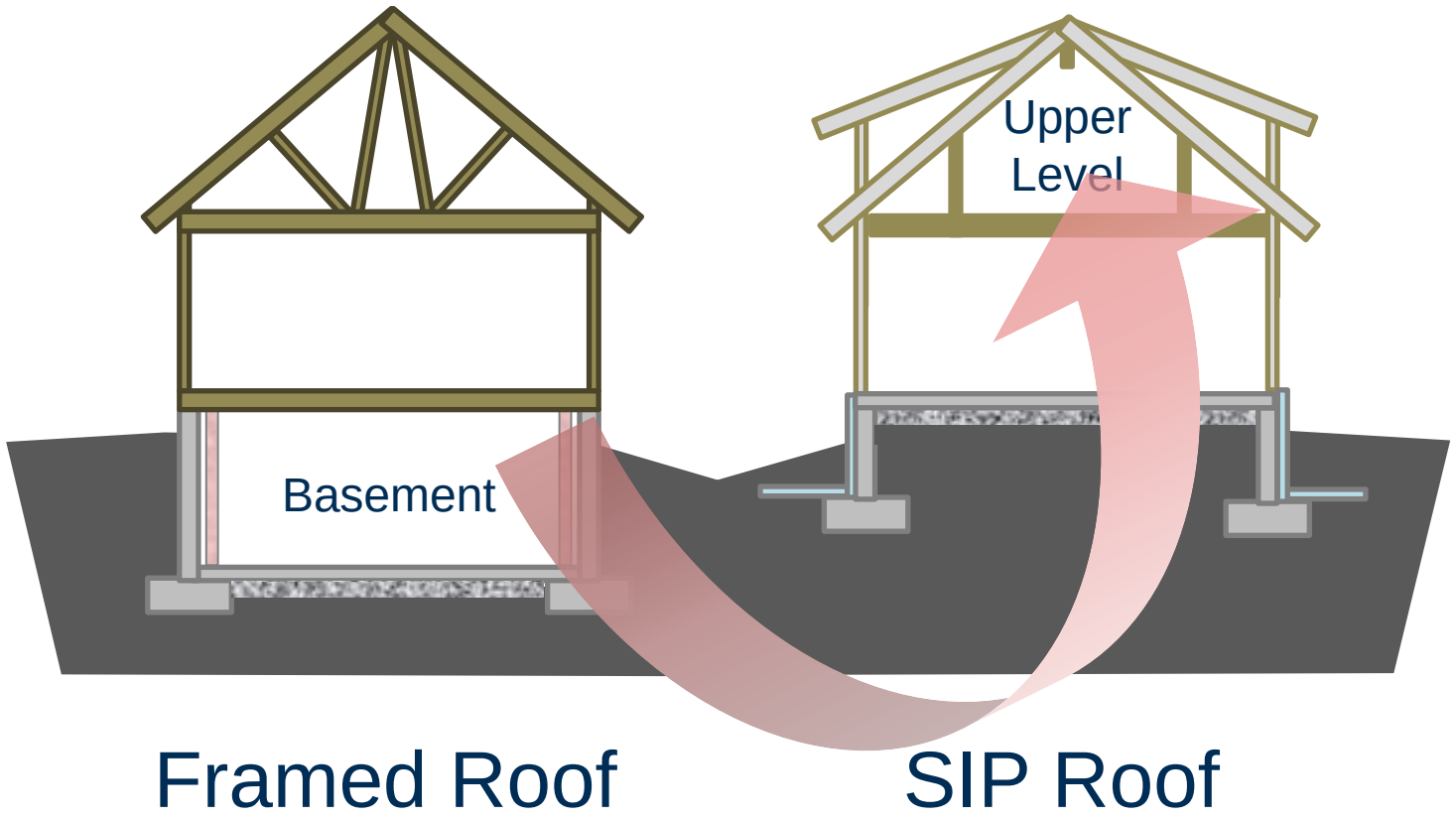
Energy-efficient buildings are a small part of the solution.

How Apply Housing User Experience Framework?



Invest in UX While Optimizing Cost/Value

UX Ripple-Effect Example: Enclosure & Design



Cost Savings	
Foundation[1]	up to **$6K**
Wall Framing	**$1K - $2K**
Egress Windows	**$1K - $2K**
Air Seal/Barriers	**$1K - $2K**
Attic Venting	**$1K - $1.5K**
Crane for Roofing	**$1K - $1.5K**
Reduced Waste	**$1K - $2K**
Time (3 days)	**$1.5K - $2.5K**
Added Value	
2nd Fl. vs. B'ment	**$40K - $60K**

[1] "Frost-Protected Shallow Foundations, NAHB Research Center, 4/30/04

Housing 2.0: A Disruption Survival Guide

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Sam Contact Info:
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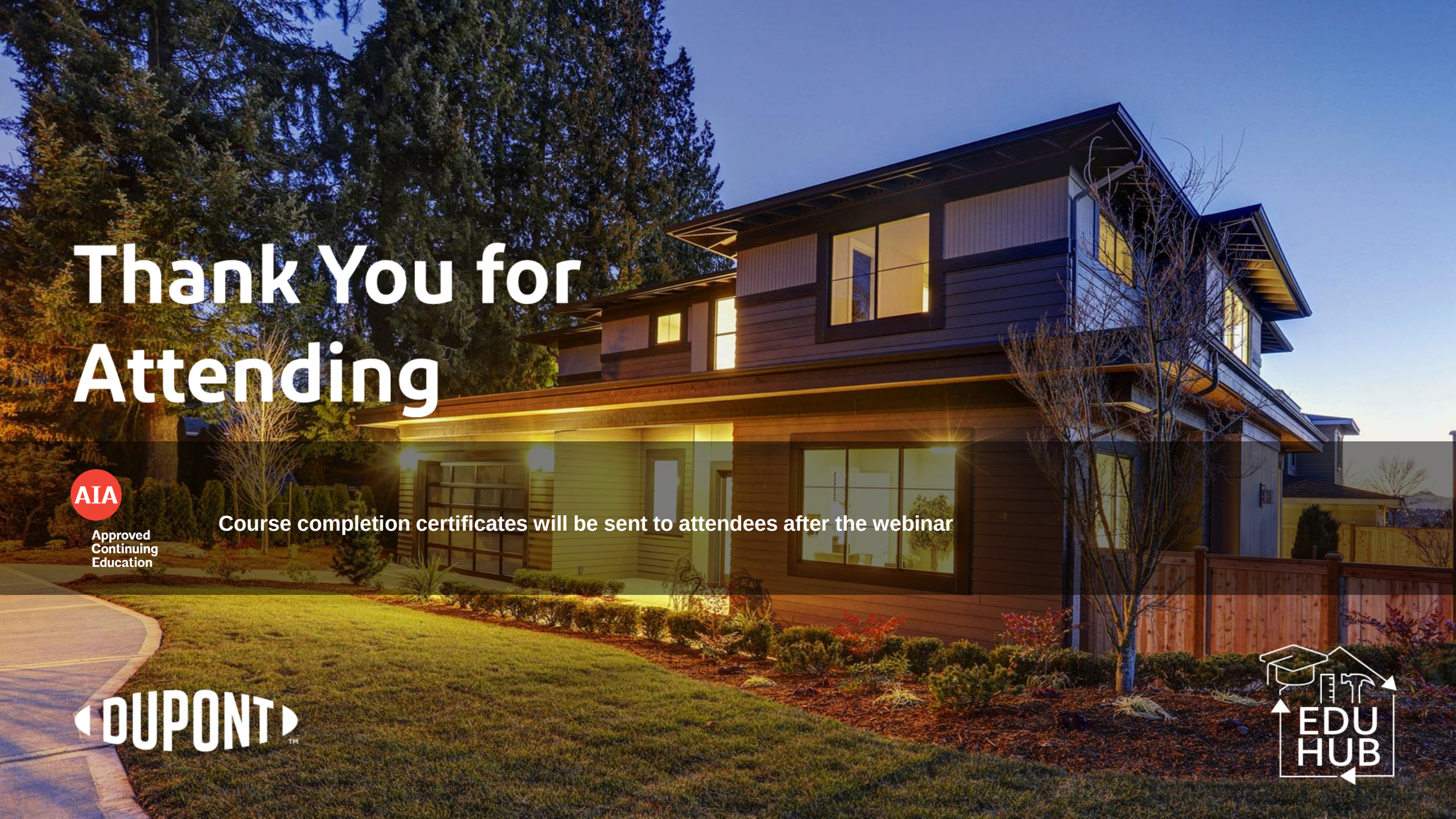
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