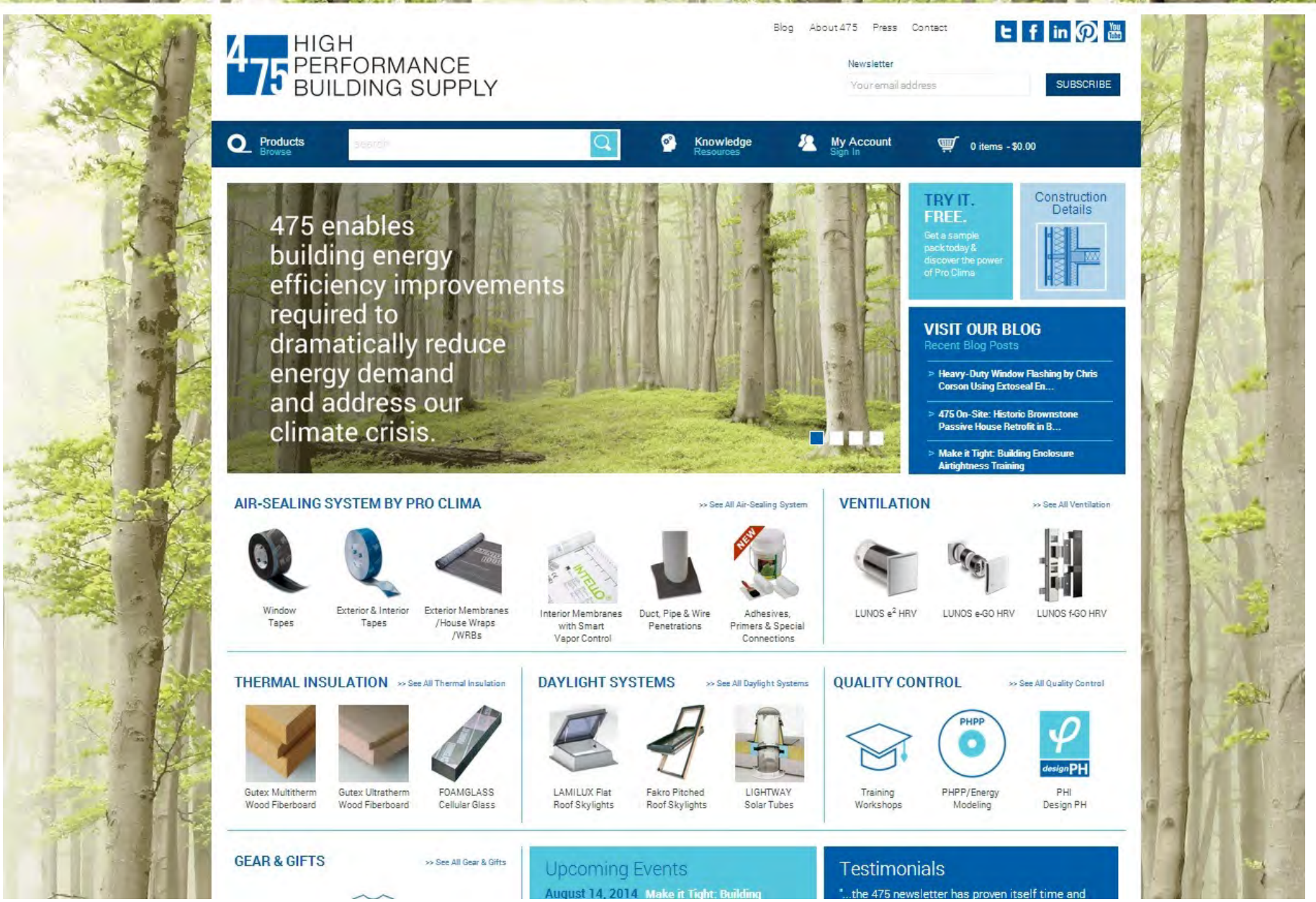
High Performance Building Materials for Passive House Construction


475 HIGH PERFORMANCE BUILDING SUPPLY
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475 enables building energy efficiency improvements required to dramatically reduce energy demand and address our climate crisis.
TRY IT. FREE.
Get a sample pack today & discover the power of Pro Clima
Construction Details
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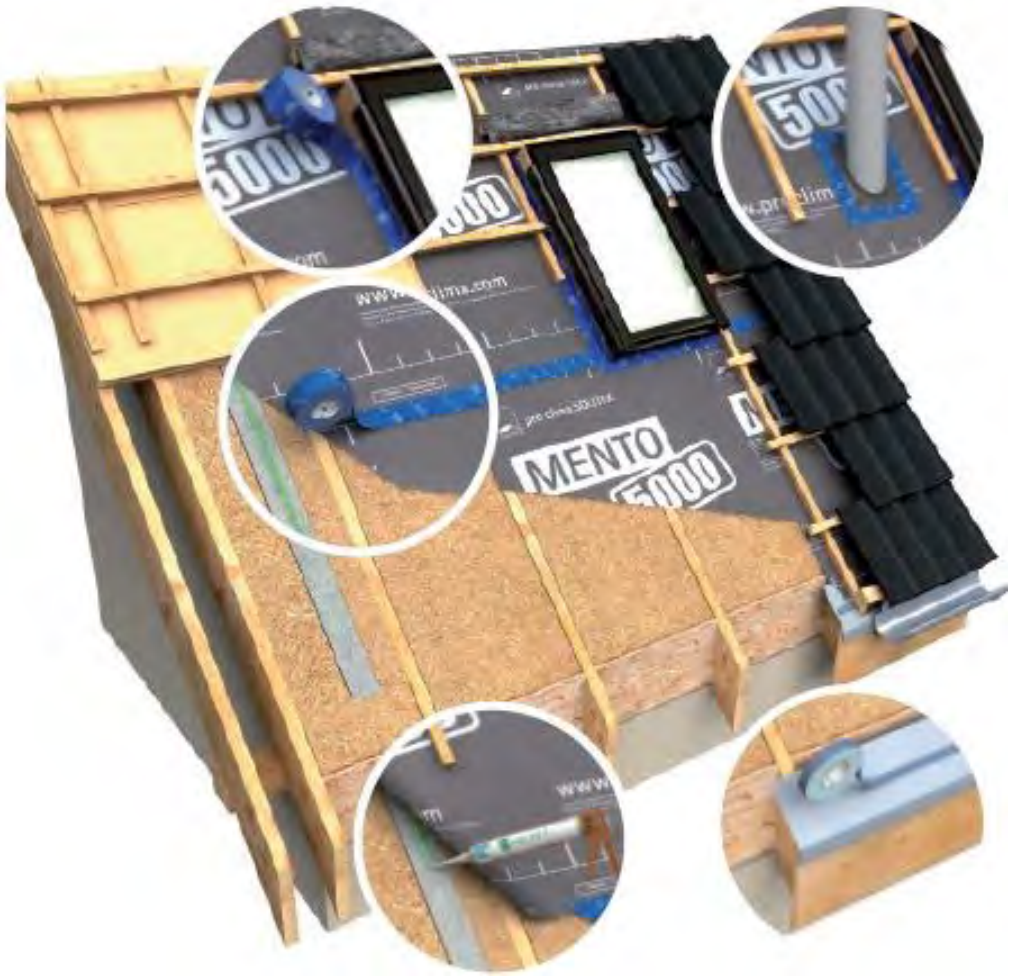
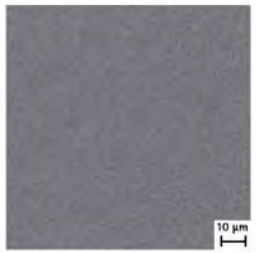
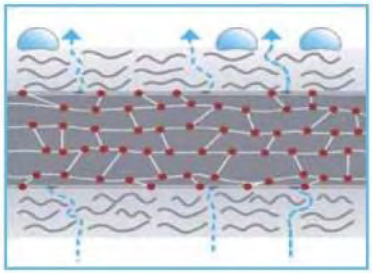
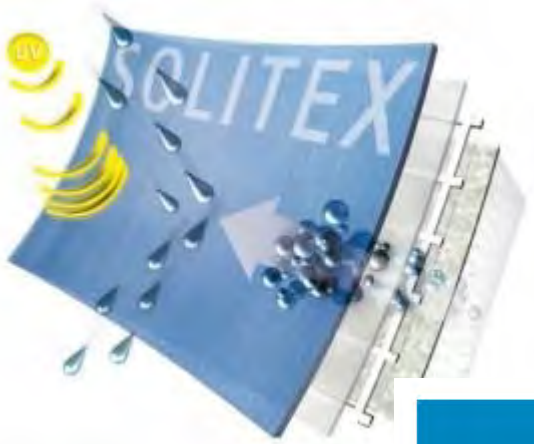
Heavy-Duty Window Flashing by Chris Corson Using Extoseal En...
475 On-Site: Historic Brownstone Passive House Retrofit in B...
Make it Tight: Building Enclosure Airtightness Training
AIR-SEALING SYSTEM BY PRO CLIMA
>> See All Air-Sealing System
Window Tapes
Exterior & Interior Tapes
Exterior Membranes /House Wraps /WRBs
Interior Membranes with Smart Vapor Control
Duct, Pipe & Wire Penetrations
Adhesives, Primers & Special Connections
VENTILATION
>> See All Ventilation
LUNOS e² HRV
LUNOS e-GO HRV
LUNOS f-GO HRV
THERMAL INSULATION
>> See All Thermal Insulation
Gutex Multitherm Wood Fiberboard
Gutex Ultratherm Wood Fiberboard
FOAMGLASS Cellular Glass
DAYLIGHT SYSTEMS
>> See All Daylight Systems
LAMILUX Flat Roof Skylights
Fakro Pitched Roof Skylights
LIGHTWAY Solar Tubes
QUALITY CONTROL
>> See All Quality Control
Training Workshops
PHPP/Energy Modeling
PHI Design PH
GEAR & GIFTS
>> See All Gear & Gifts
Upcoming Events
August 14, 2014 Make it Tight: Building
Testimonials
"...the 475 newsletter has proven itself time and

Exterior **air sealing** & **vapor control**









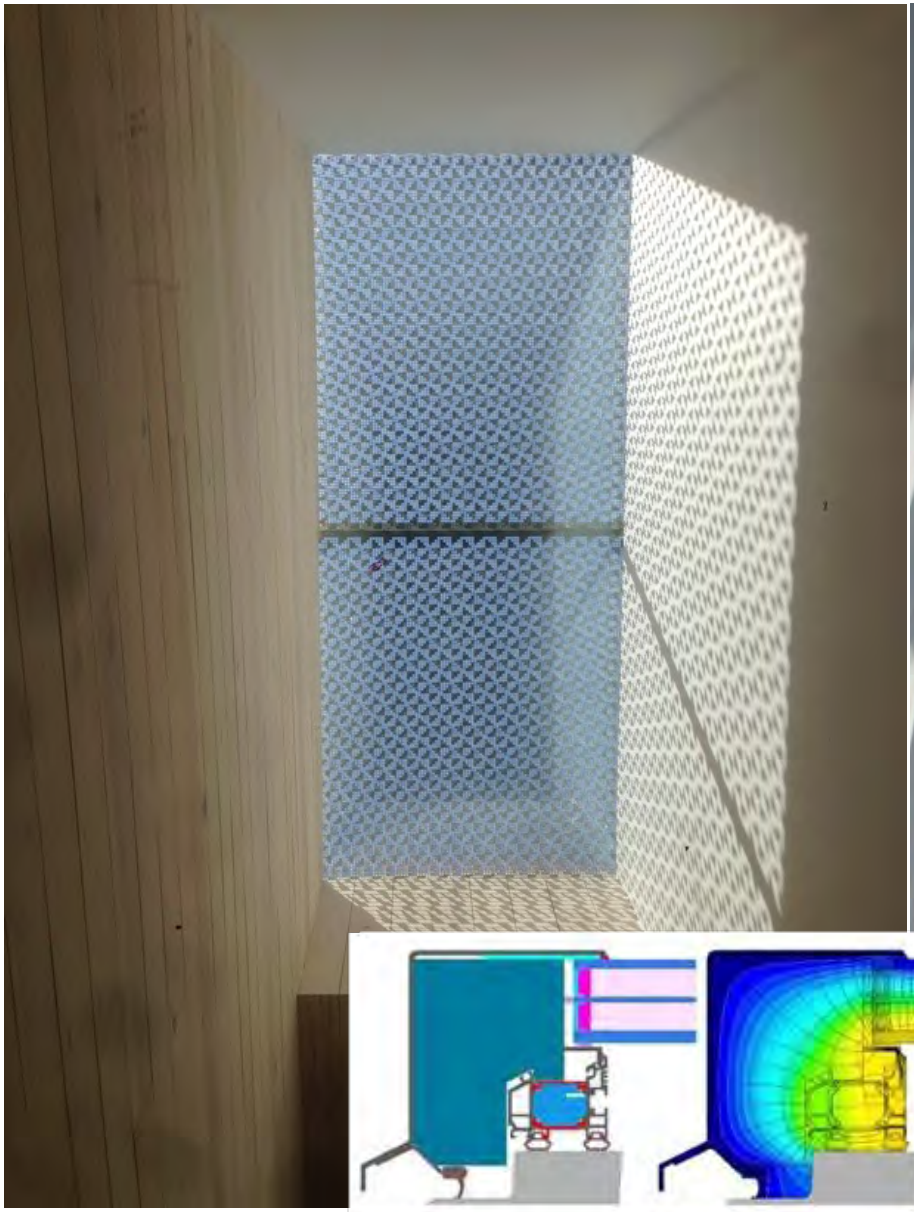
pro clima®

Interior **air sealing** & **vapor control**

pro clima®

Wood fiber insulation boards/WRB

GUTEX®



LAMILUX

Heat Recovery Ventilation

LUNOS
energy-efficient

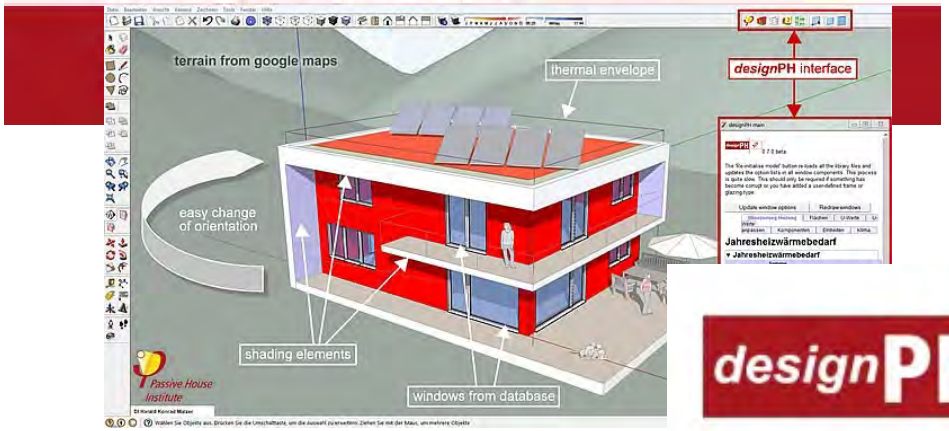
e2

PLUS X AWARD®
honored as:
BEST PRODUCT OF THE YEAR 2012

PLUS X AWARD®
achieved for:
Functionality
Ecology

- >90% efficient
- Very quiet
- Through wall/Ductless HRV

Quality Control: PHI Software & Retrotec Testing



designPH

High Performance Building Materials for Passive House Construction

@foursevenfive | www.foursevenfive.com | 800-995-6329

Credit: Kavanagh Tuite Architects
Project: Roebuck Student Housing, University College Dublin

Learning Objectives:

1. Outline meaning and characteristics of high performance materials.
2. Describe the principles of Passive House, and its impacts on construction.
3. Describe strategies for utilizing high performance materials to achieve Passive House goals.
4. Outline steps for how material utilization strategies can be optimized for affordability, comfort and durability.

What makes Passive House different?

Integrated Goals & Methodology:

1. Focus on Passive Elements:

- **Orientation**
- **Massing**
- **Insulation**
- **Airtightness**
- **Windows**
- **Doors**
- **Passive Heat Gains**

2. Fixed Performance Goals:

- **Heating**: 4.75Kbtu/sf2*yr demand or 3.17 btu/hr*sf **peak load**
- **Cooling & Dehumidification:** 4.75Kbtu/sf2*yr + climate specific dehumidification
- **Primary Energy:** ~38Kbtu/ft2*yr
- **Airtightness:** Tested limit 0.6 ACH50

3. Calculated Energy Balance:

- **Passive House Planning Package** (PHPP)

"Peak Load Equivalent"
For 1,000 sq ft house

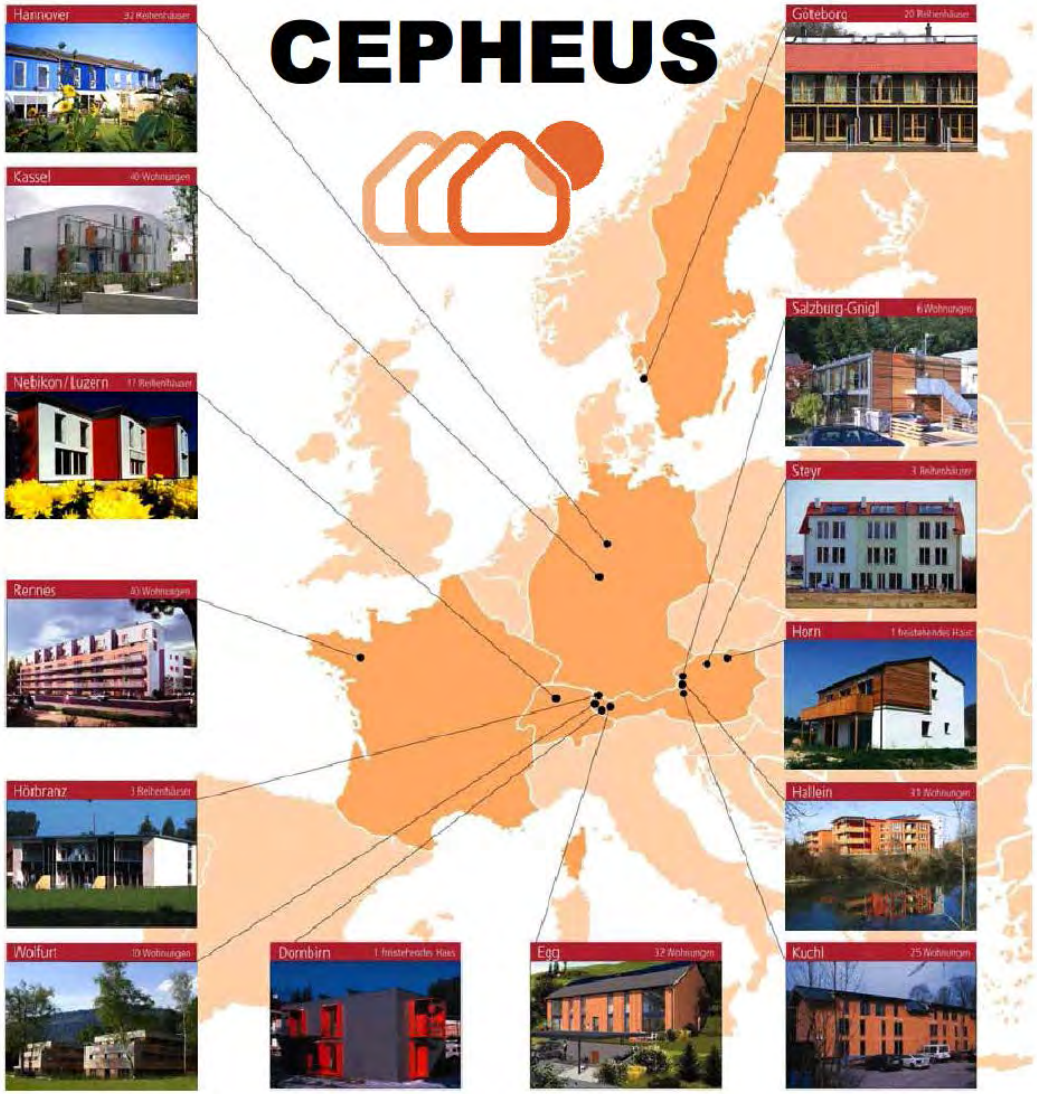
Peak load is the original "Source EUI" metric. The calculation now is for Primary Energy Renewable (PER) and is no longer directly comparable to EUI but still roughly corresponds to this original number for Passive House Classic certification.

PHIUS+ Separate set of targets and uses WUFI Passive

Verification of the Methodology

2000:

250 dwelling units in 14 different building projects as Passive House Buildings



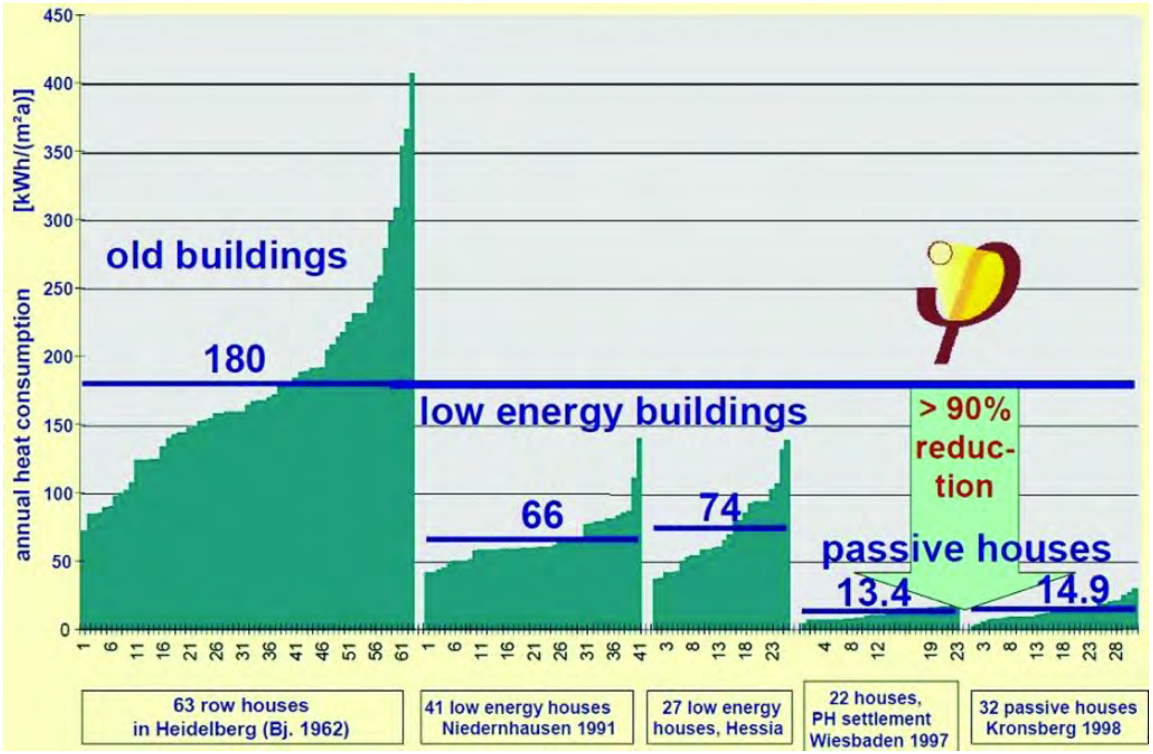
Delivers comfort with dramatic energy savings:

Approx **90%**

reduction in heating & cooling

Up to **75%**

reduction in total energy usage.



Supports renewables transition:

- **Path to Net-Zero Buildings & more.**
- Allows switching to all electric buildings.
- More even utility demand profile.
- Primary Energy Renewable (PER) Calculation optimizes building energy use for 100% renewable grid.

Bold Implementation

BRUSSELS, 2015: All buildings, private, public, new and retrofitted **mandated** Passive House performance.

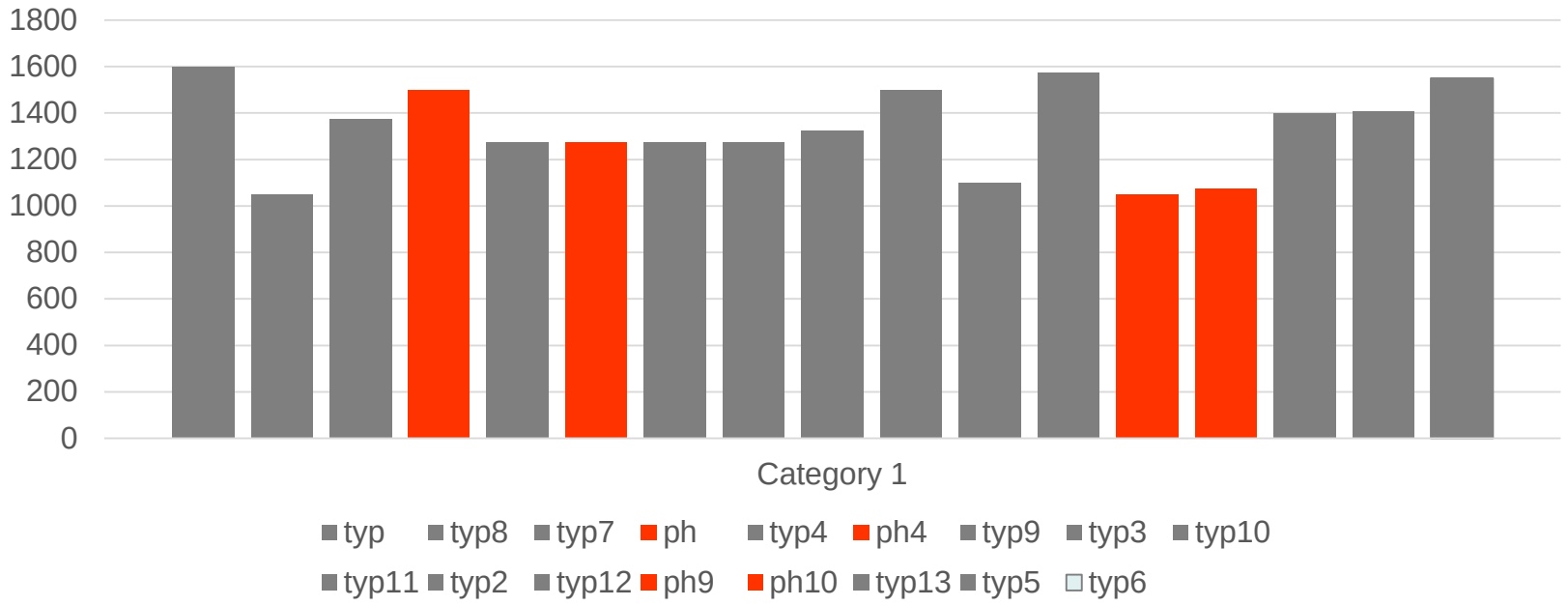
EUROPE, 2020:

Nearly zero-energy buildings.

NYC (& Vancouver…)

Not Typical “Cost-Plus” Paradigm

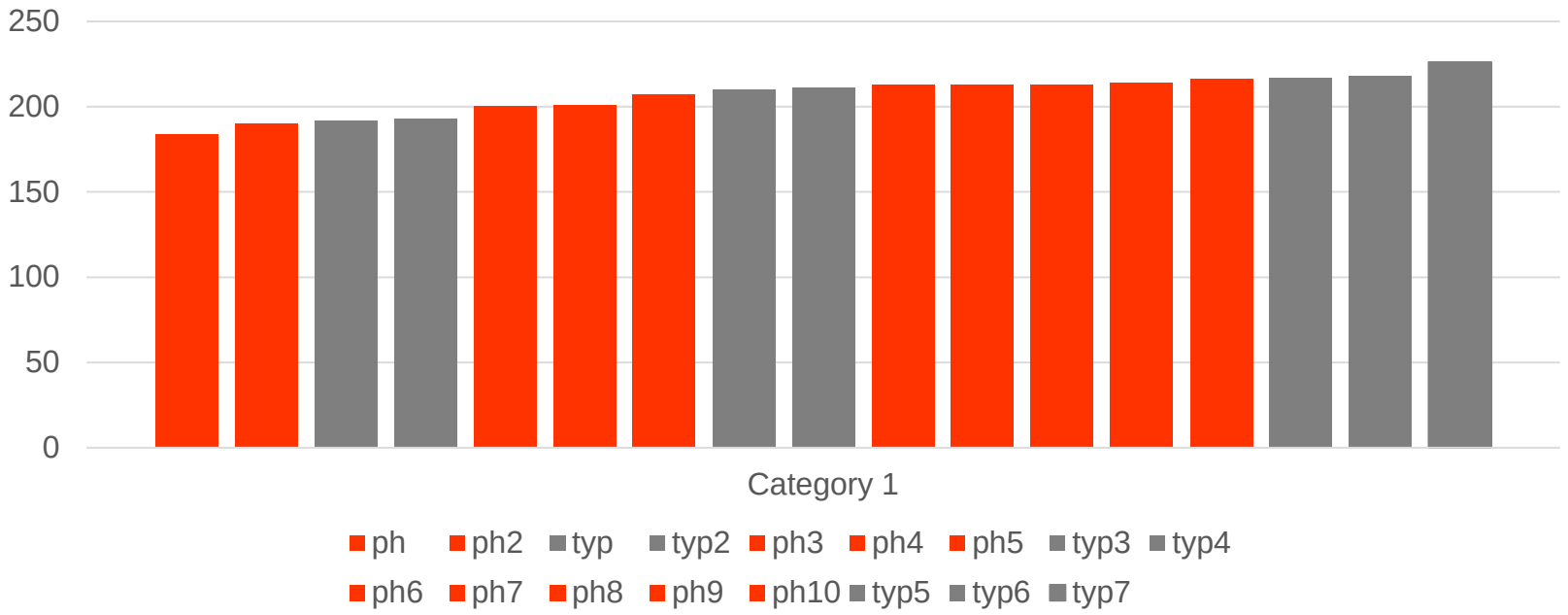
Brussels: City Block Multi-Use Complex – Competitive Design-Build Bids



eu 1,225/m2 vs. eu 1,362/m2 average

Not Typical “Cost-Plus” Paradigm

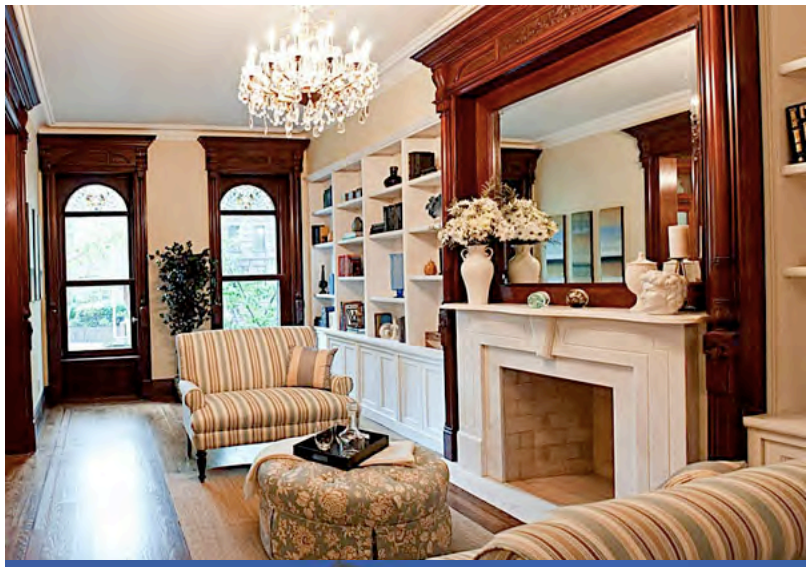
PHFA Multifamily Housing Around Philadelphia Region = 17 Buildings



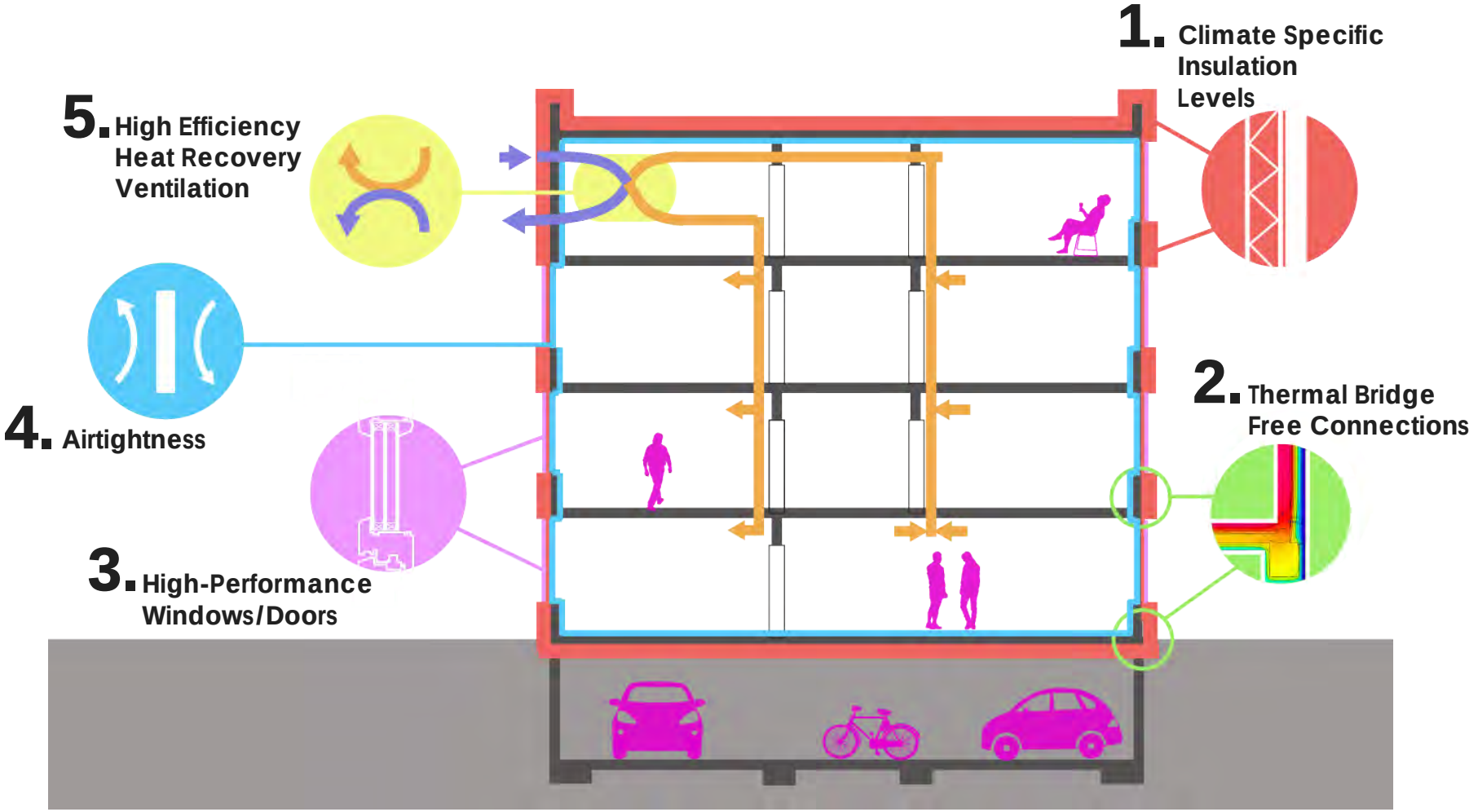
$206/sf vs. $208/sf average

Complex Buildings in Varied Climates

Retrofit of Existing Buildings

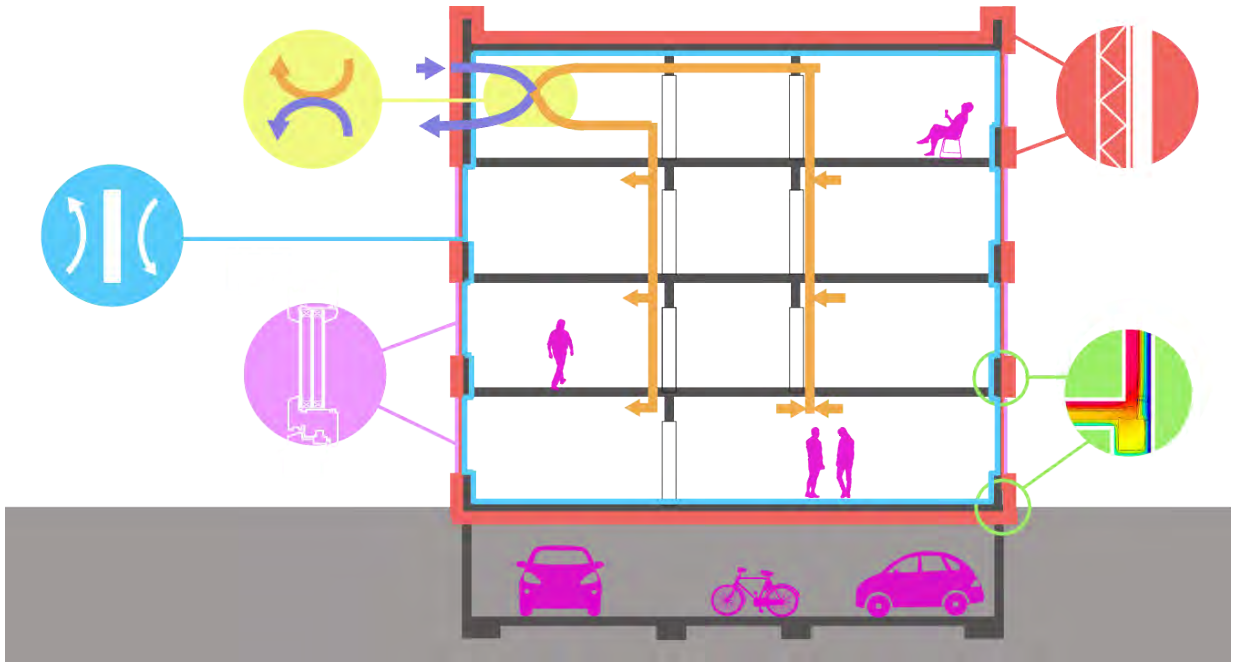


Five key principles:



Win-win

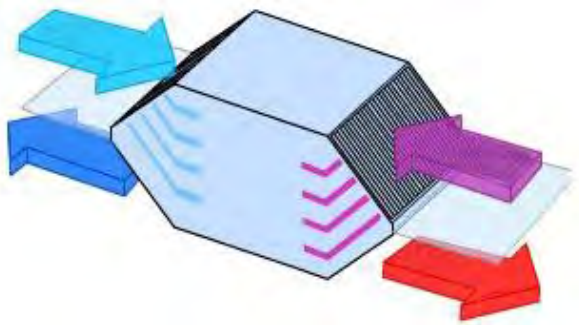
A **very low energy building** via **optimized methods** produces:

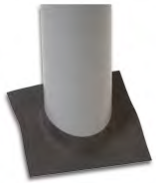


1. Comfort
2. Health
3. Affordability
4. Efficiency
5. Predictability
6. Security
7. Resiliency
8. Climate Mitigation
9. Renewables Transition

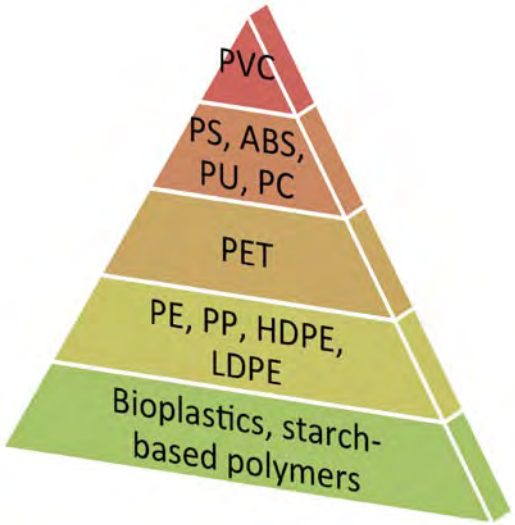
Universe of Critical Materials Support

(or don't support) Passive House Construction





High Performance General Criteria



Toxicity

Performance

Robustness

Airtightness Budget

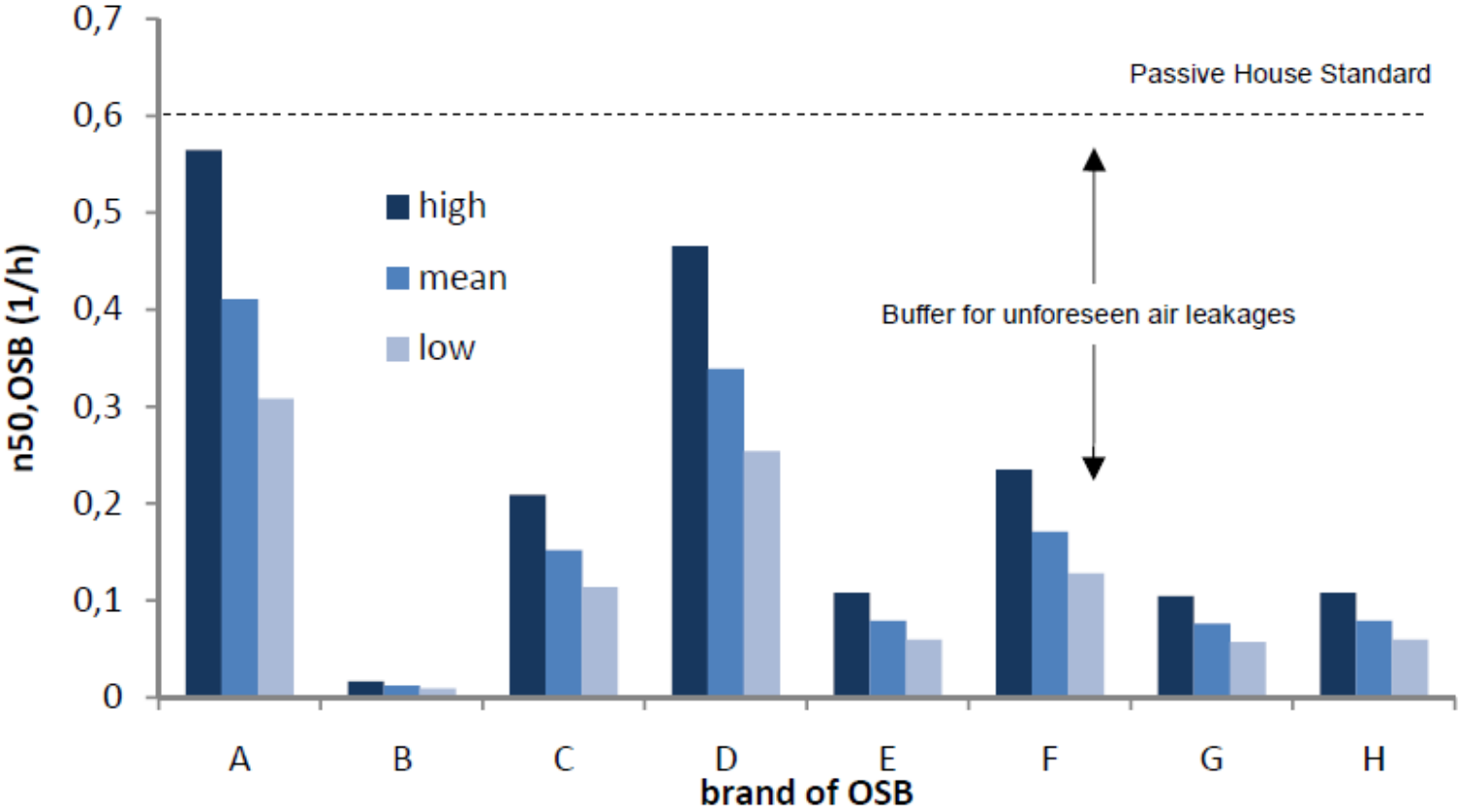


Figure 4: Theoretical contribution of air transport through OSB to global n_{50}-value

5th International Symposium on Building and Ductwork Air-tightness
October 21-22, 2010, Copenhagen/Lyngby, Denmark

e·u·[z·]
energie + umwelt zentrum

OSB leaky?

Photo: Ecological building systems

Does it leak?

Photo:Paul Jennings

Airtight per ASTM E2178

Material	Thickness (minimum)
Plywood	3/8 in.
Oriented strand board	3/8 in.
Extruded polystyrene insulation board	½ in.
Foil-faced urethane insulation board	½ in.
Exterior gypsum sheathing or interior gypsum board	½ in.
Cement board	½ in.
Built up roofing membrane	
Modified bituminous roof membrane	
Fully adhered single-ply roof membrane	
A Portland cement/sand parge, stucco, or gypsum plaster	½ in.
Cast-in-place and precast concrete	
Sheet metal	
Closed cell 2 lb/ft3 nominal density spray polyurethane foam	1 in.

US Dept of Energy:

Application

working in **cold** and **wet** conditions

Worse

- Spray Foam & Butyl Based adhesives:
  - 25 to 40 degree temp limit
  - Low moisture required
  - Clean surfaces

Better

Pressure Sensitive Acrylic (PSA) Adhesives

- Molecular bonding
- 1 hour setup

Caulking Adhesive

- 48 hour setup

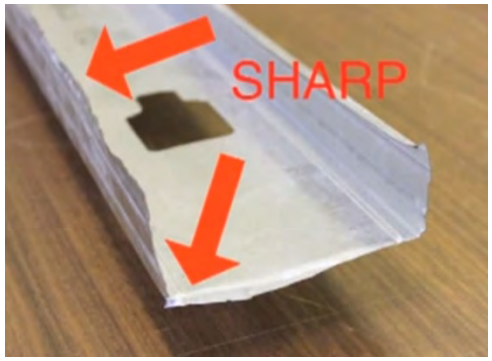
- **15 degree temp limit**
- **Moisture tolerant**

Credit: Journal of Light Construction, *Trouble Shooting Spray-Foam Insulation* by Mason Knowles, Sept 2010

Is it tough?

Is it meant to be a **sacrificial layer**?

Vs.

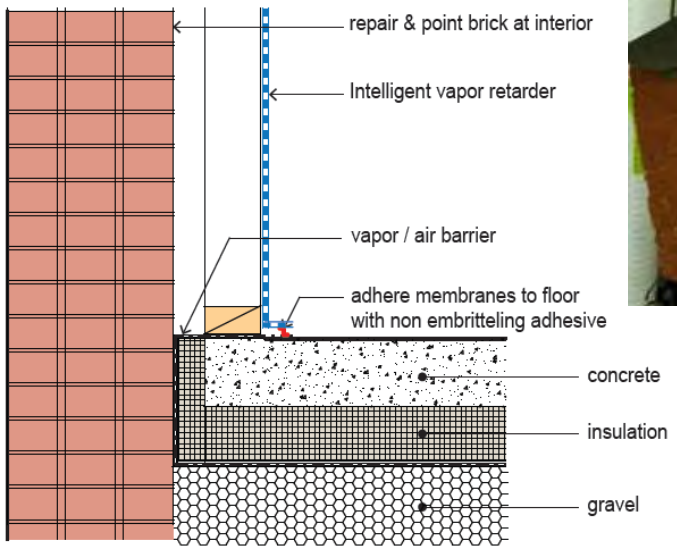


Vs.

Longevity

Flexibility – Materials can't embrittle over time.

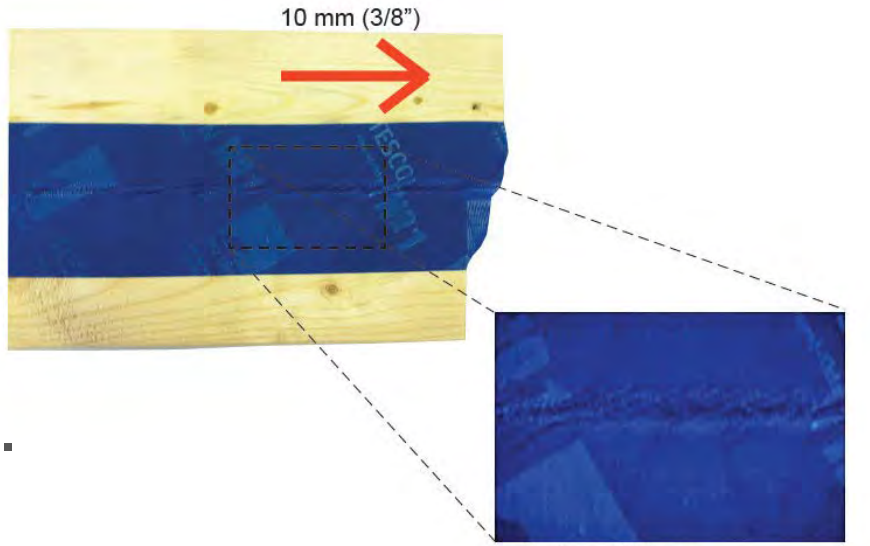
Vs.



Longevity

Flexibility – Materials can't delaminate or tear over time.

Vs.



Is it Green?

In **production**, **life** time usage & **disposal**

Can it Multitask?

- Water control?
  - WRBs
- Vapor control?
  - Vapor open vs. vapor closed/retarding/variable
- Thermal control?
  - Board insulations

Most Critical Components are Certified

Passive House Institute

Component Database

Explore the house and find the links or
let the hotspots show up

Opaque building envelope

- Wall and construction systems
- Façade anchors
- Floor slabs
- ICF for roof parapets
- Flue systems
- Balcony connections
- Attic staircases
- Airtightness systems

Building services

- Compact heat pump units
- Ventilation systems (capacity < 600 m^3/h)
- Ventilation systems (capacity > 600 m^3/h)
- Drain water heat recovery

Transparent building envelope

- Windows
- Roof windows
- Skylights
- Curtain wall systems
- Glass roofs
- Openable glass roof elements
- Shutters
- Entry doors
- Sliding doors
- Glazing
- Spacers

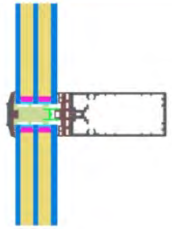
Component Database

English

Glass roof
LAMILUX CI-System Glasarchitektur PR60 energysave (Glasdach)

Info | *U* value calculation

Component id: 0159ic03
Manufacturer: LAMILUX Heinrich Strunz GmbH
Category: Glass Roof
Material: Aluminium
U_W: 0.81 W/(m² K)
Efficiency class: phA
Spacer: Super Spacer TriSeal / T-Spacer Premium
Climate zones: Cool, temperate



Download certificate (en , de)

Frame cut	Frame width b_f/mm	Frame *U* value U_f/(W/(m² K))	Glass edge Ψ value Ψ_g/(W/(m K))	Temperature factor f_{Rsi} = 0,25 m²K/W
Transom Fixed	60	0.79	0.034	0.79
Top Fixed	60	0.79	0.034	0.79
Bottom Fixed	60	0.79	0.034	0.79
Lateral Fixed	60	0.79	0.034	0.79
Mullion Fixed	60	0.79	0.034	0.79

Component Database

Ventilation system (capacity > 600 m³/h)
Adconair 76 03 01

Info

Component id: 0845vi03
Manufacturer: Menerga GmbH
Air flow range from... : 1000 m³/h
To... : 2000 m³/h
At external pressure: 265 Pa
Heat recovery rate: 88%
Humidity recovery: 0%
Available external pressure (with installed filters): 228 Pa
Sound level of unit: 57.0 dB(A)
Climate zones: Cool, temperate

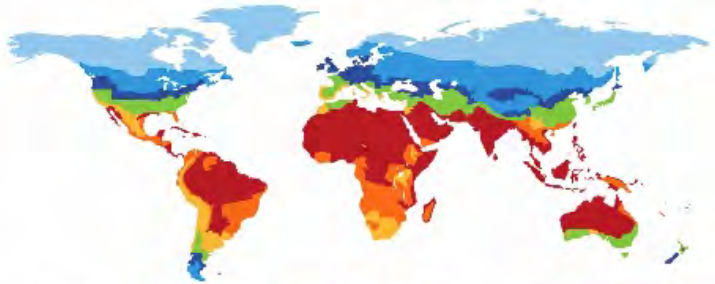
Acoustic duct
Outdoor air: 64.0 dB(A)
Supply air: 78.0 dB(A)
Extract air: 72.0 dB(A)
Exhaust air: 69.0 dB(A)

Download certificate (en , de)

CERTIFICATE

Certified Passive House Component
Component-ID 1106as03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: Airtightness Systems | **Surface Air Sealing**

Manufacturer: **pro clima**
Moll bauökologische Produkte GmbH
Rheintalstr. 35-43
68723 Schwetzingen, Germany

Product-System: pro clima **INTELLO**

Description: System for surface air sealing

System Components: Airtight membrane „INTELLO"
Self-adhesive Tape „TESCON VANA"
Self-adhesive Tape „CONTEGA SOLIDO SL"

permeability
0.01 m³/(hm²) (±0.002)

instructions for use
coherent ✓

recommended detailing
comprehensive ✓

This certificate was awarded based on the following criteria:

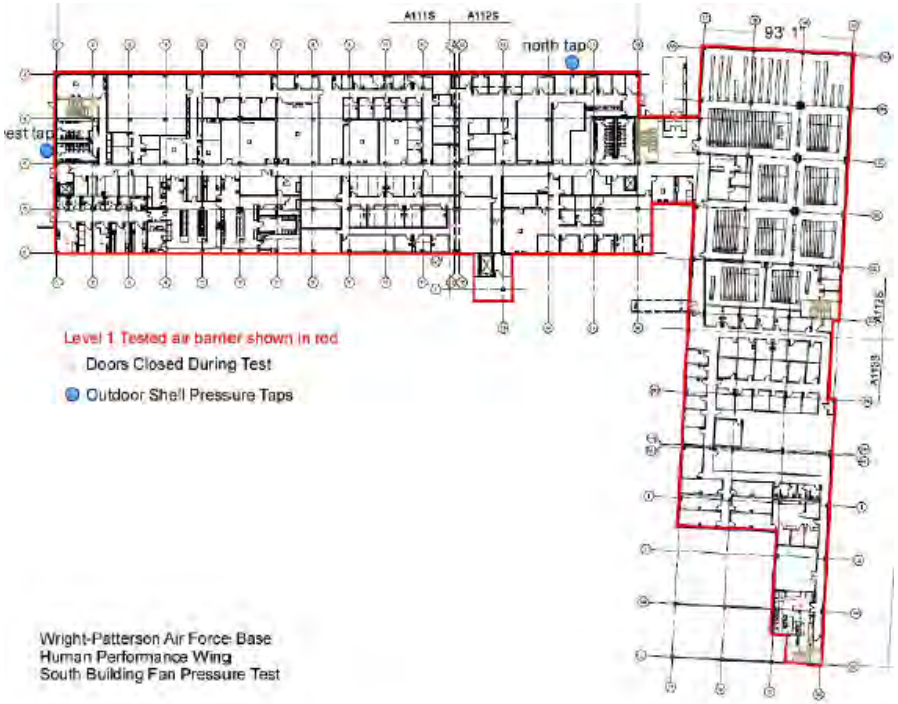
Tested under standard boundary conditions the system meets the listed requirements

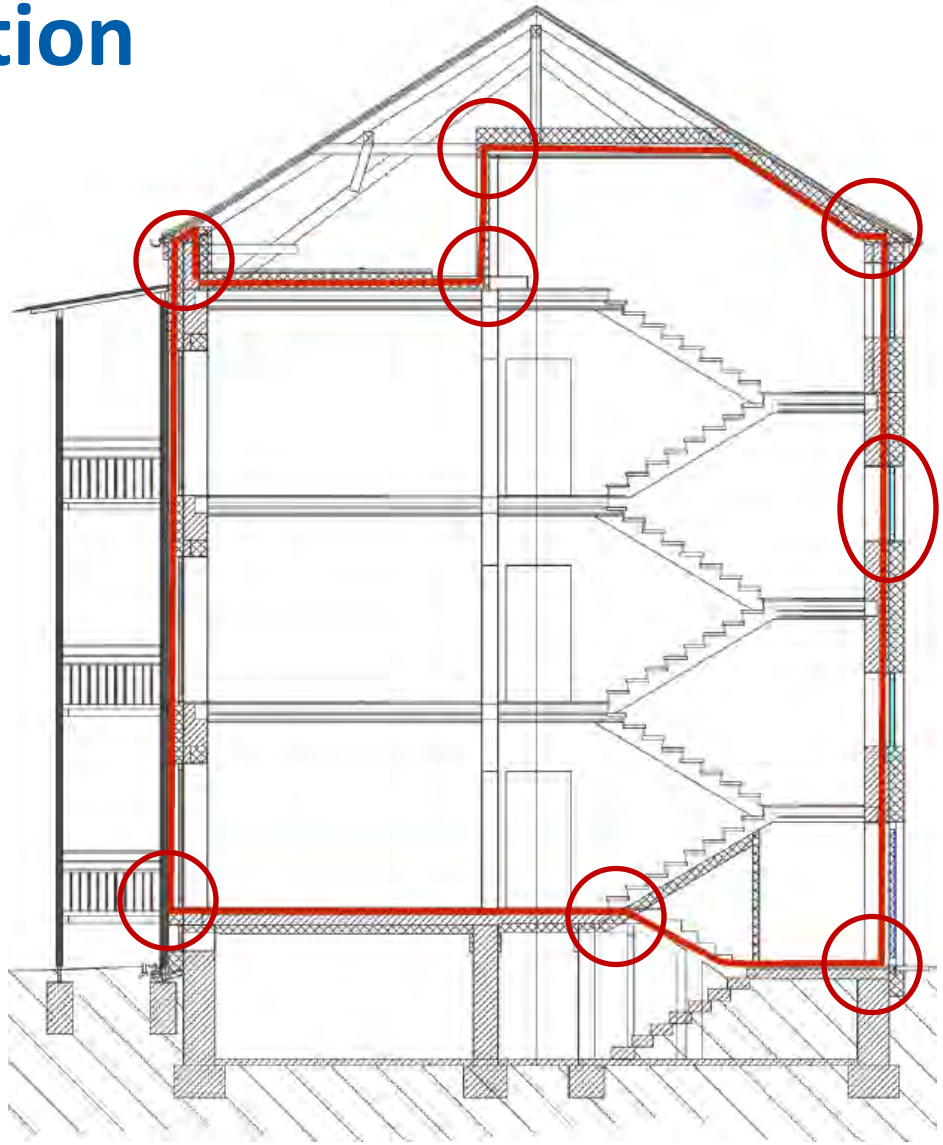
Class	permeability per unit area @ 50 Pa [m³/(hm²)]
phA	≤ 0.10
phB	≤ 0.16
phC	≤ 0.25

The manufacturer supplies coherent and comprehensive instructions for use and detailing recommendations for all system components.
Adhering to these recommendations the system can greatly simplify the execution of an airtight building fabric. The complete Certification Report may also be downloaded at www.passiv.de.

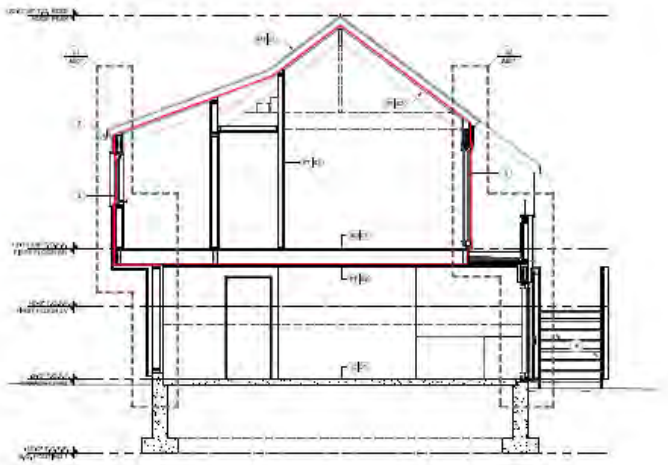
phA
CERTIFIED COMPONENT
Passive House Institute

Examine in Plan & Section

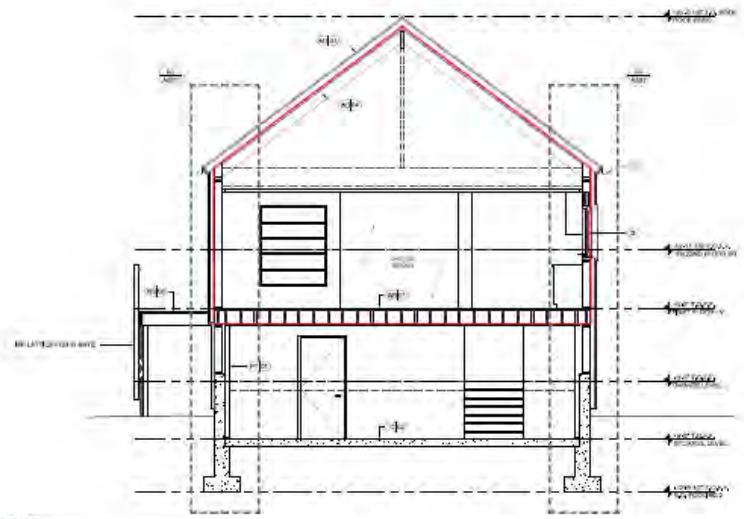




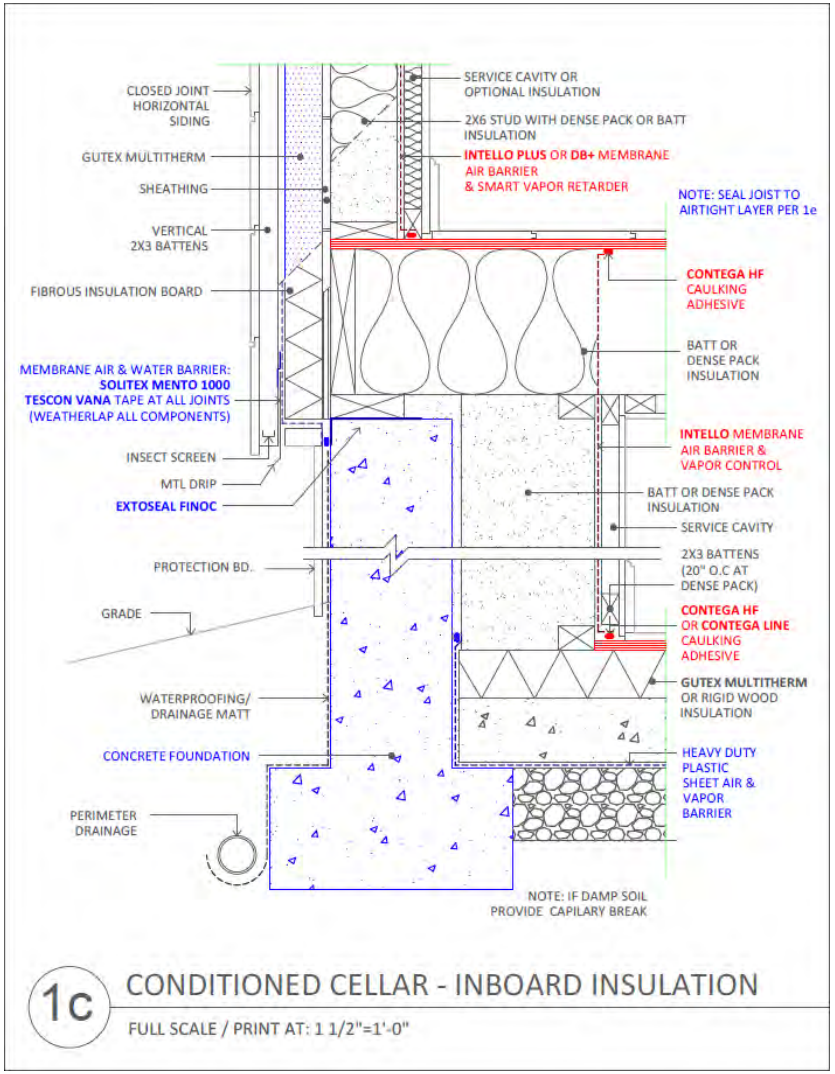
Specialized Drawings



01 SECTION: EAST



02 SECTION: WEST



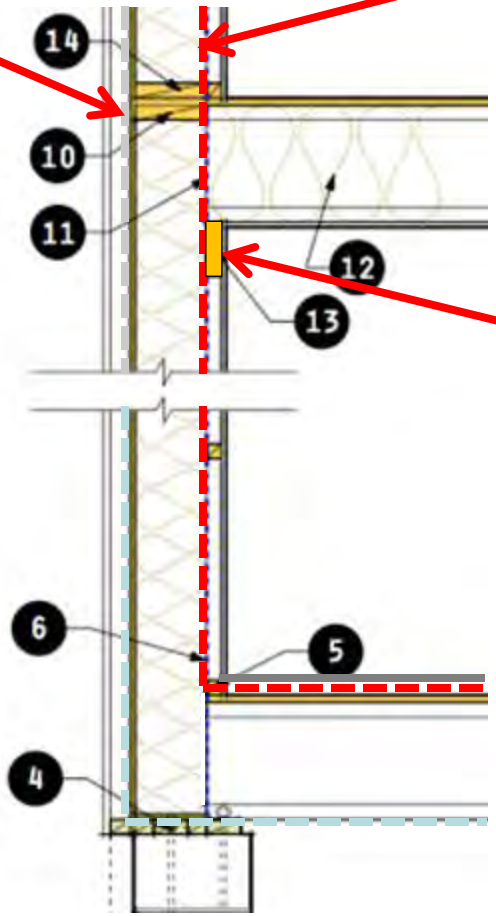
1c CONDITIONED CELLAR - INBOARD INSULATION

FULL SCALE / PRINT AT: 1 1/2"=1'-0"

Simplify Wherever Possible

Continuous wind-tight weather barrier

Continuous air barrier with vapor control



Ledger supporting 2nd floor framing

Exterior

Interior

Credit: Gregory La Vardera, Lamidesign.com

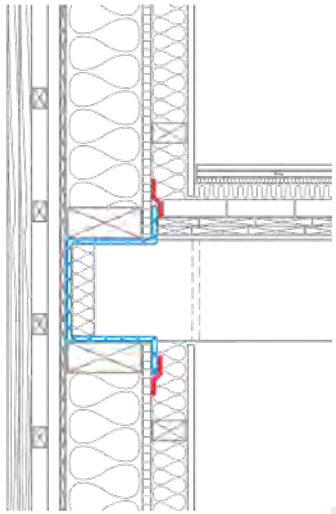
Sequence for continuity

Step One

Step Two

Credit: Ed May, http://bldgtypblog.blogspot.com/

Sequence



Minimize Penetrations

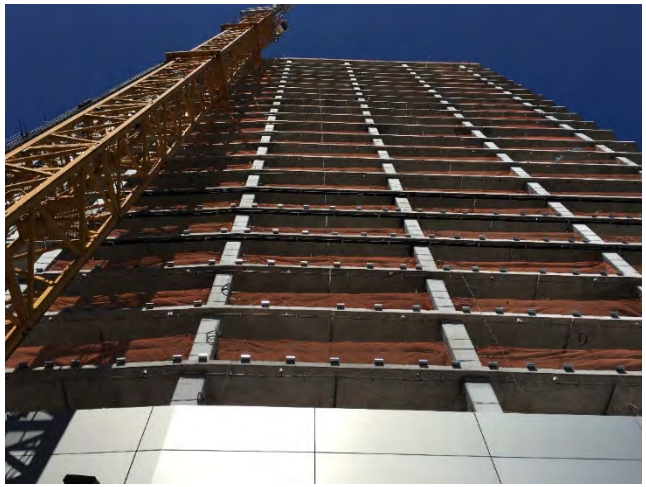
Wire and pipe penetration sealing

Allow for **room** to gasket properly

Credit: Ed May, BldgTYp

Credit: Roger Lin, Southern Exposure Homes

Clip/Post/Joist penetration sealing



Construction Planning

- Team meeting
  - Supervisors/foremen must buy in and take responsibility (all trades)
  - Identify few personnel to execute bulk of airsealing
- Training
  - Passive House Tradesperson Training for key personnel
- Sequencing
  - Do not impede or cover the air barrier
- 1st Blowerdoor test
  - As early in process as possible.

Commission & test critical components

- **Airtightness**
- **Doors & Windows**
- **Ventilation flow rates**
- **Heating & Cooling systems**

Measure and collect data…

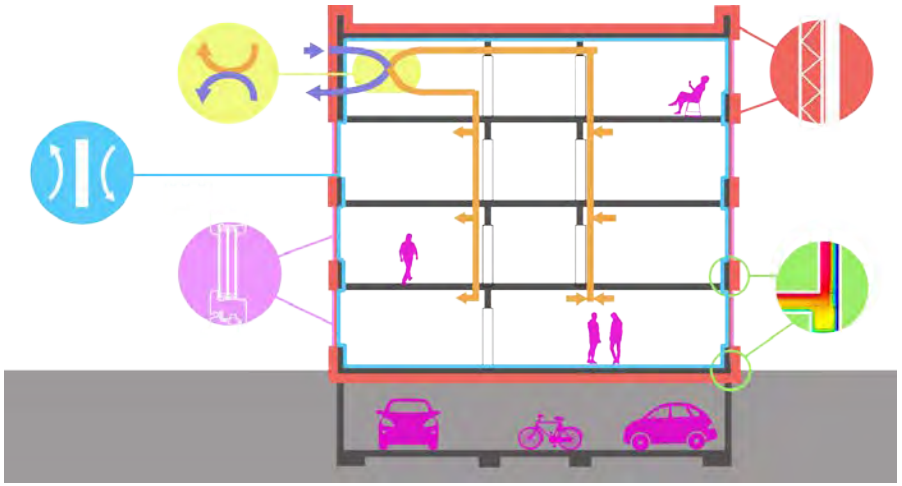
Make sure everything is running smooth…

Protect critical components

Service Cavity & Vented Rain Screen

Critical Aspects/Principles

- Airtightness
- Vapor Control
- Well Insulated
- High-performance windows
- Fresh air ventilation

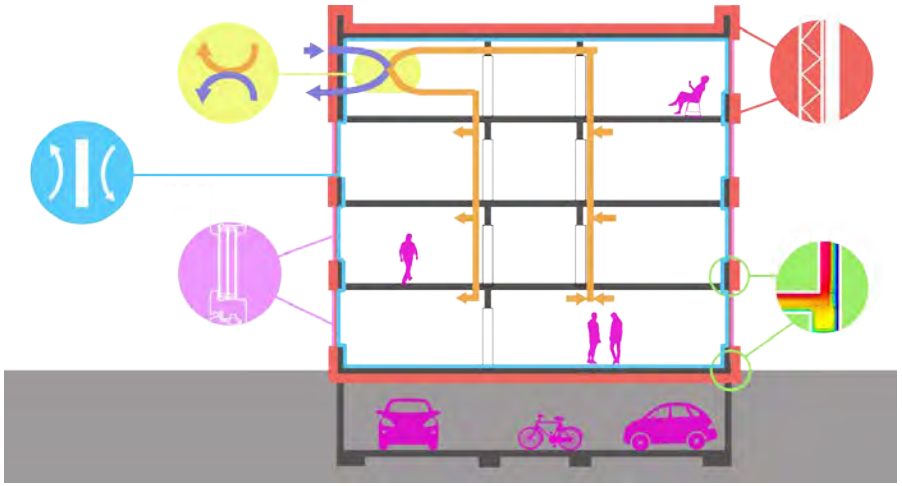


….and Key Themes

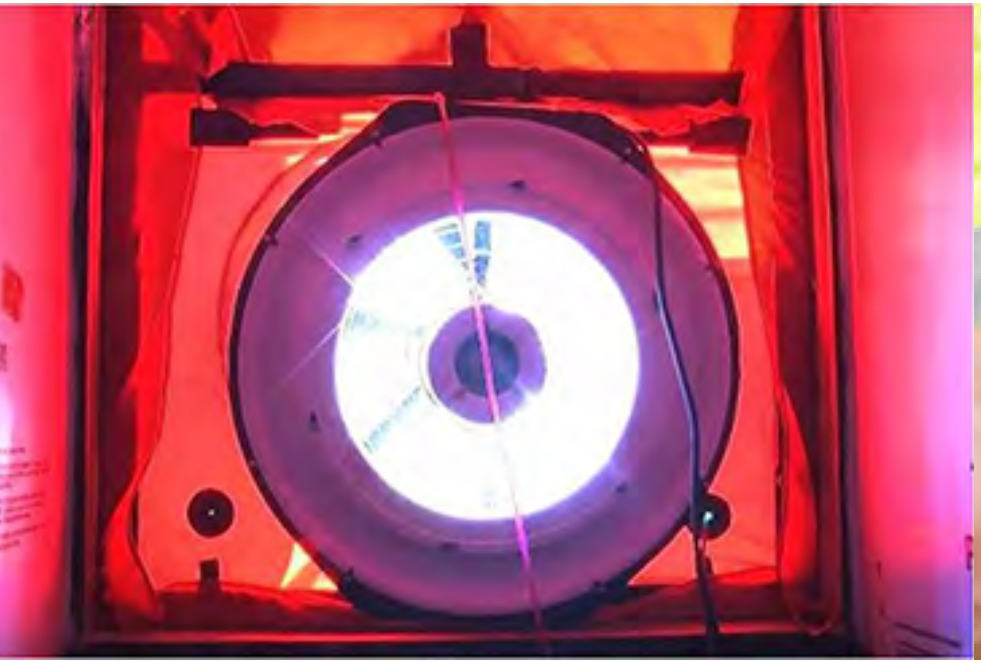
- Continuity
- Integration
- Lower toxicity (not PH specific)
- Inspection & Testing
- Commissioning
- Training
- Teamwork
- Affordability via Optimization

Critical Aspects/Principles

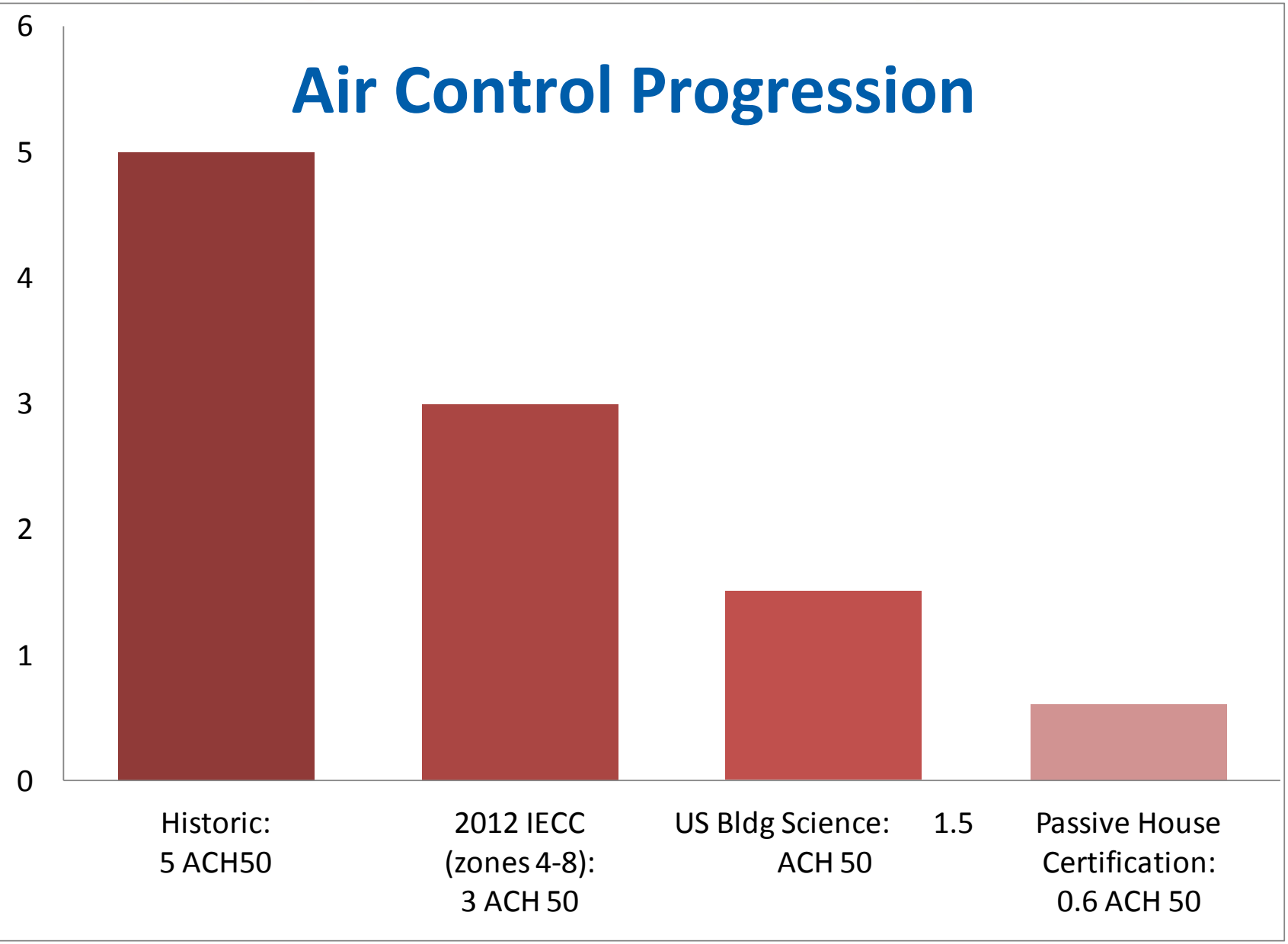
- **Airtightness**
- Vapor Control
- Well Insulated
- High-performance windows
- Fresh air ventilation



Measure Airtightness

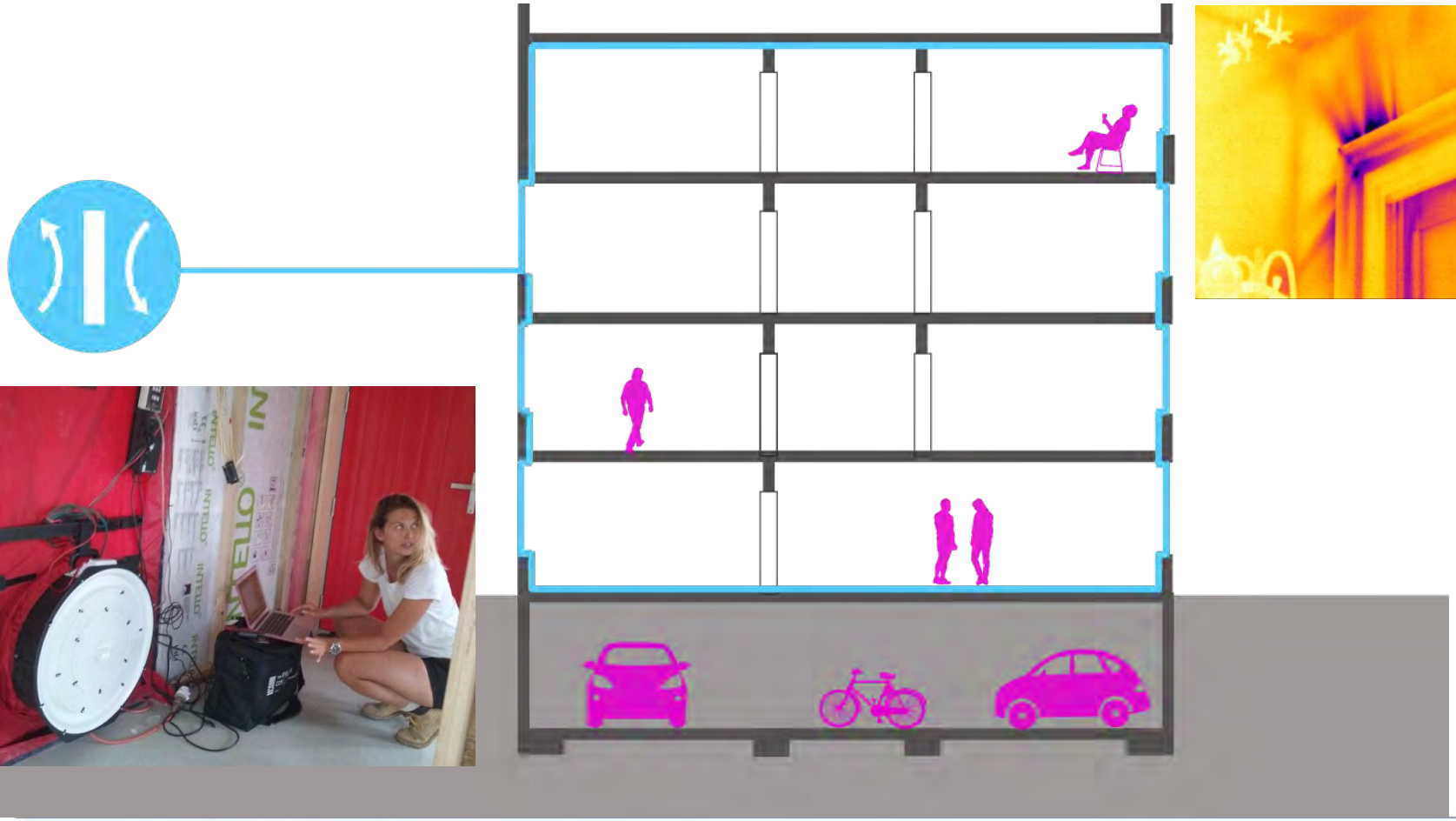


Air Control Progression



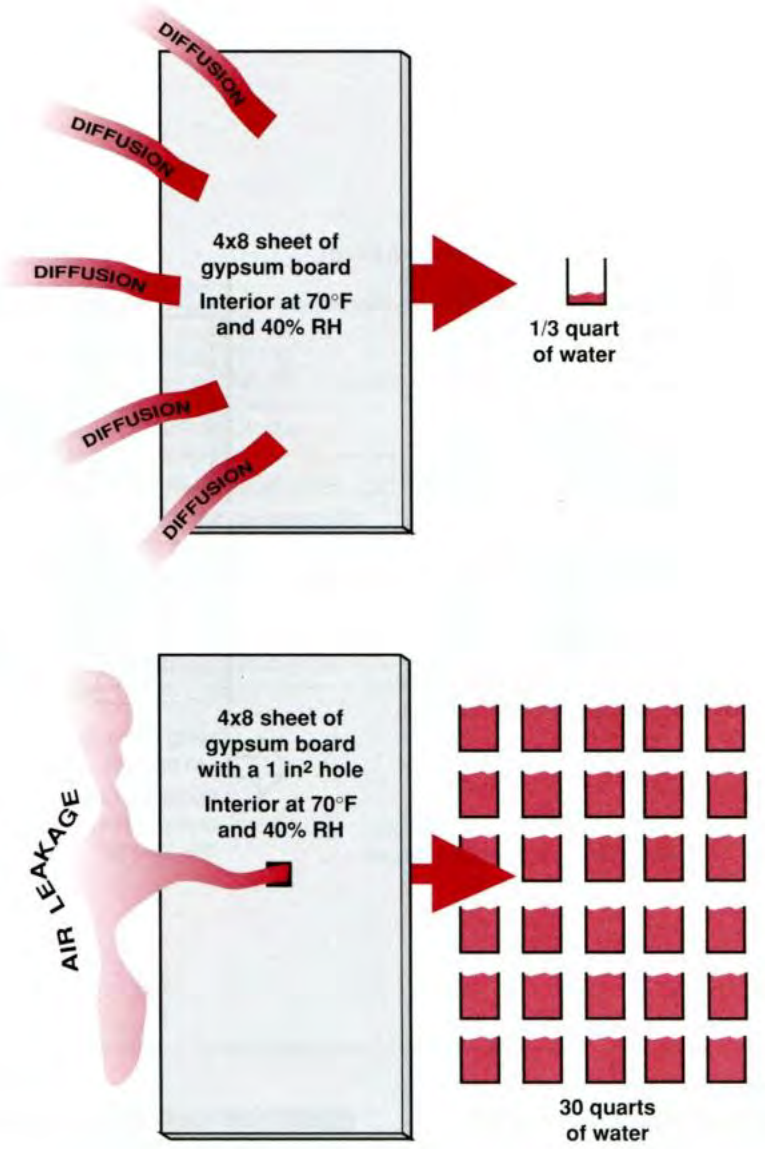
Airtightness

Driving Force for **Performance**



Air Control

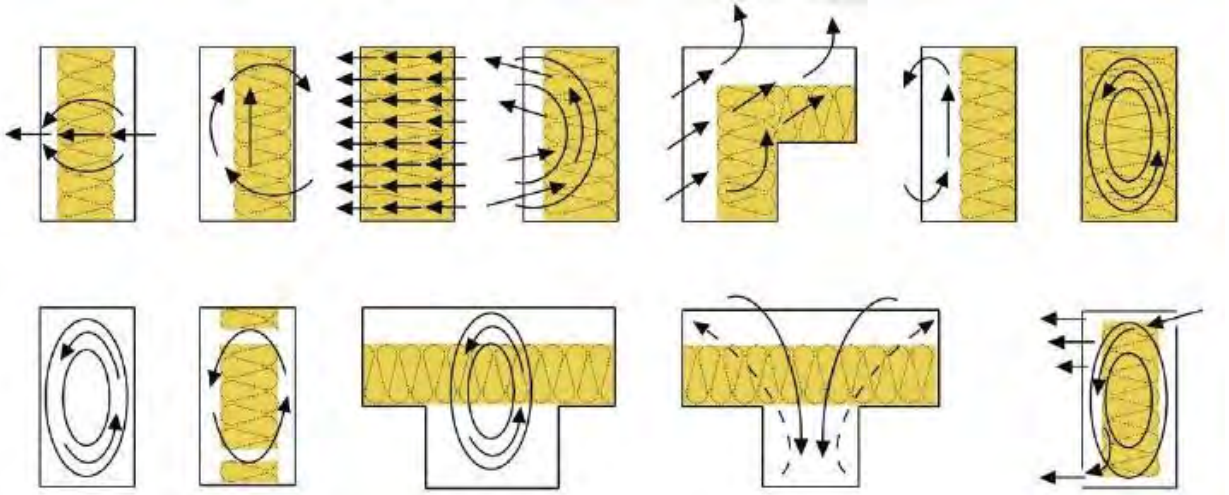
- Second only to water control.
- **Disproportionately effects**:
  - **Indoor air quality**: control the air to control the quality
  - **Comfort**: drafts are uncomfortable
  - **Air transported wetting**: a bigger liability than diffusion wetting
  - **Heat loss/thermal bypass**



Credit: Building Science Corporation

Thermal Bypass Diagrams

Thermal bypass describes heat loss that gets around intended thermal insulation, including: **windwashing**, **air infiltration**, and **convective loops**.



Credit: Mark Siddall, Building Green Magazine

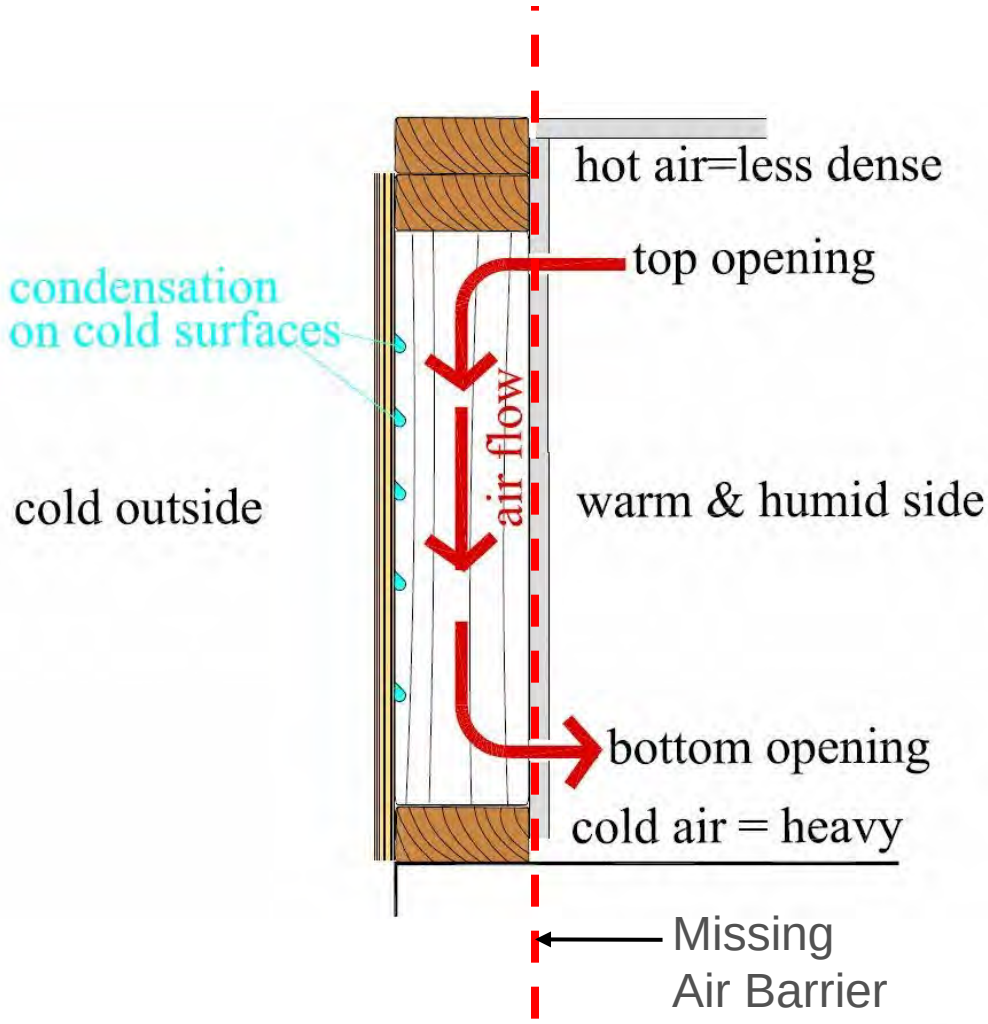
Thermal Performance of **Leaky** vs. **Airtight** enclosures:

Factor of **4.8** or a **79% reduction in performance**

Fraunhofer Institute, Stuttgart Germany

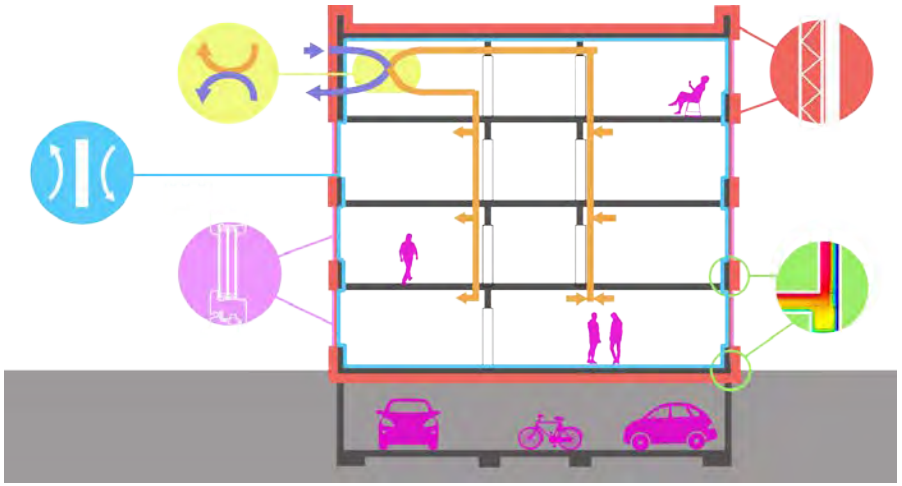
Why Inboard Airtightness is Better

1. Keeps conditioned air within the conditioned space.
2. Better protection against condensation risk.
3. Places the components of this most important control layer in a climate controlled location.
4. Leaks can often be more readily found and easier to repair.
5. **The air control layer can/should double as a vapor control layer**.



Critical Aspects/Principles

- Airtightness
- **Vapor Control**
- Well Insulated
- High-performance windows
- Fresh air ventilation

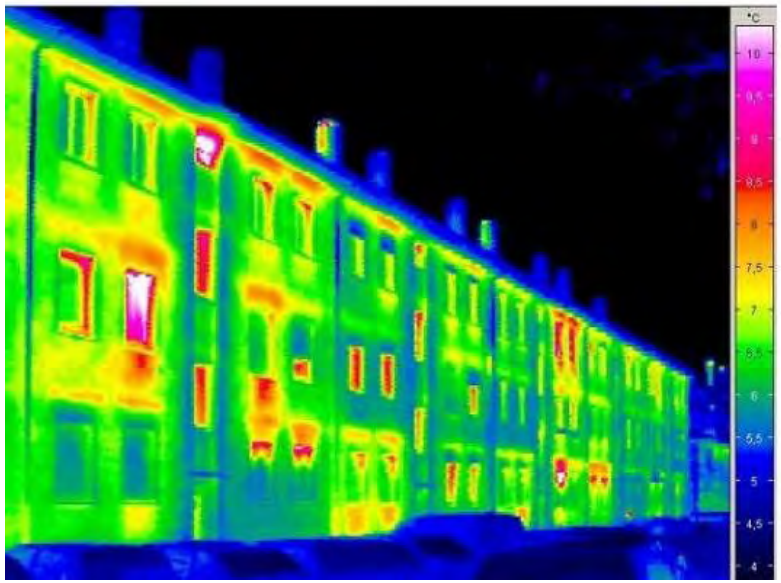


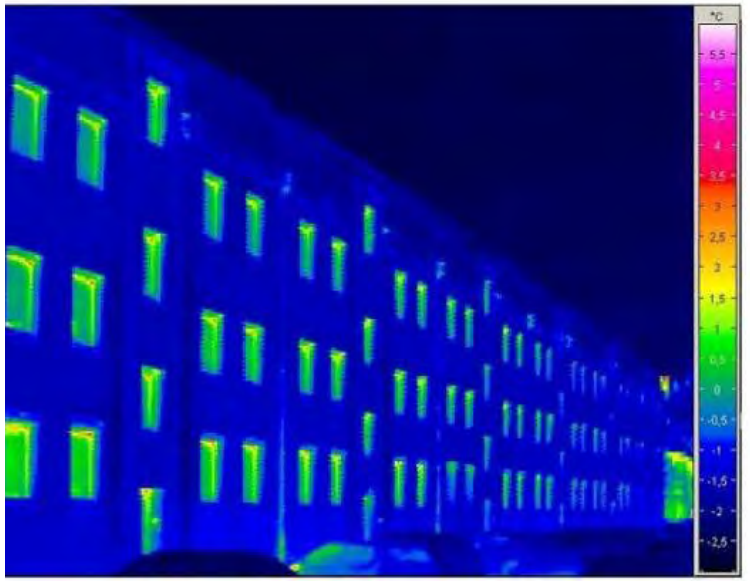
Vapor Control

- Airtightness
- Vapor Control
- Warm surface temperatures
- High-performance windows
- Fresh air ventilation

Avoid Sweating

Poorly insulated walls are often heated dry





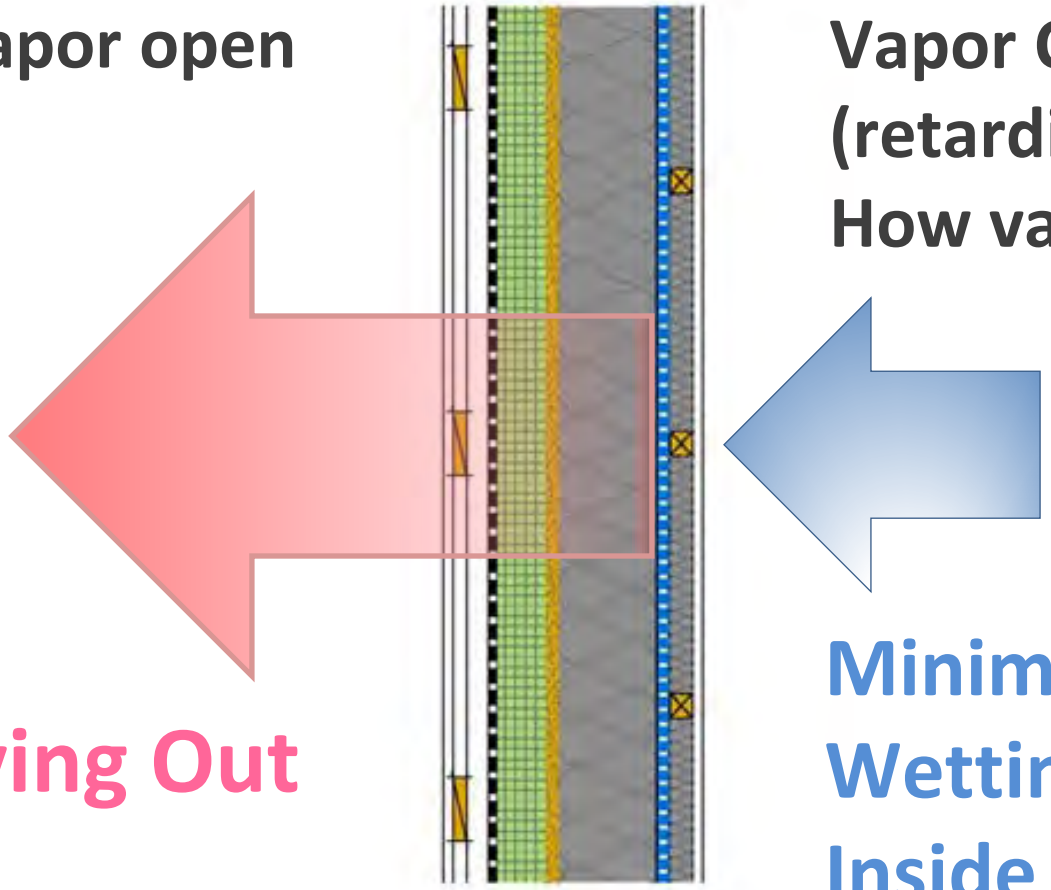
Well built assemblies **dry through vapor diffusion**.
(or they don't dry)

Drying Outward in Winter

Outside Winter Inside

Vapor open

Vapor Closed (retarding/variable) How variable?



Drying Out

Minimize potential Wetting from Inside

Drying Inward in Summer

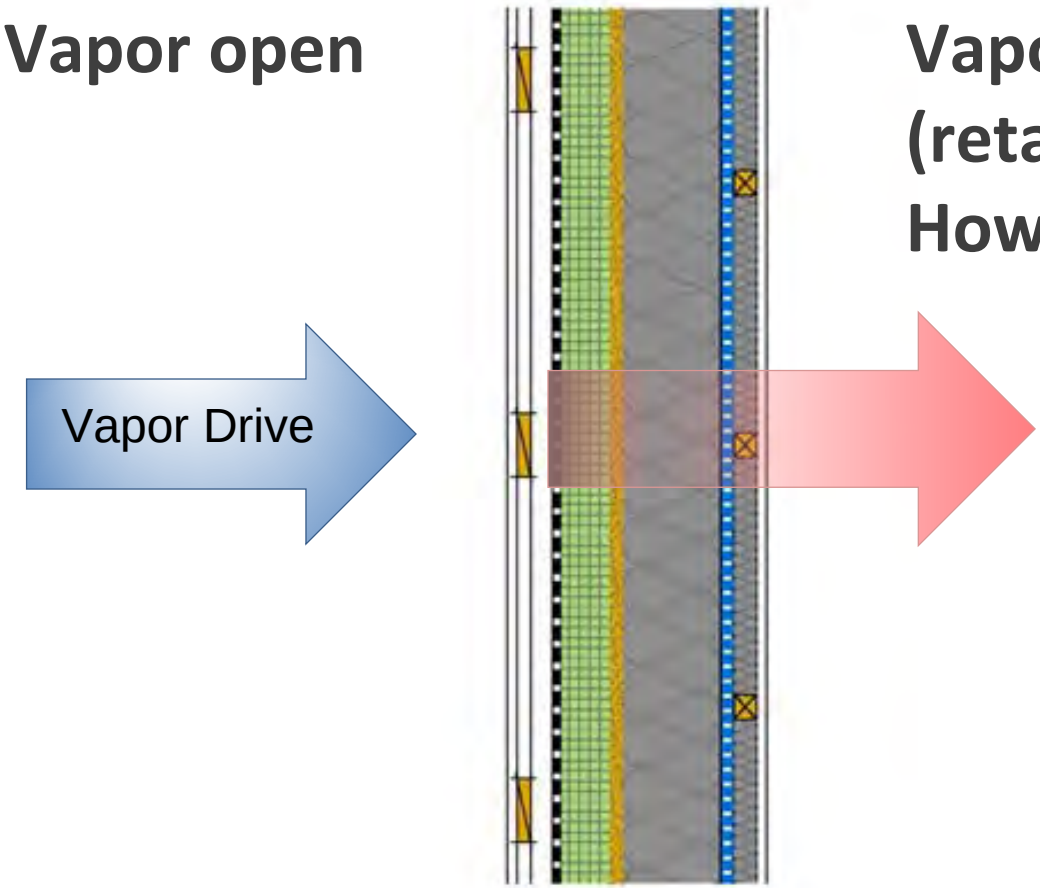
Summer

Outside

Vapor open

Inside

Vapor Open
(retarding/variable)
How variable?

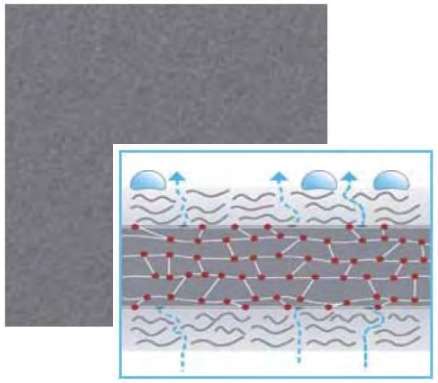


Vapor open sheathing at **Exterior**

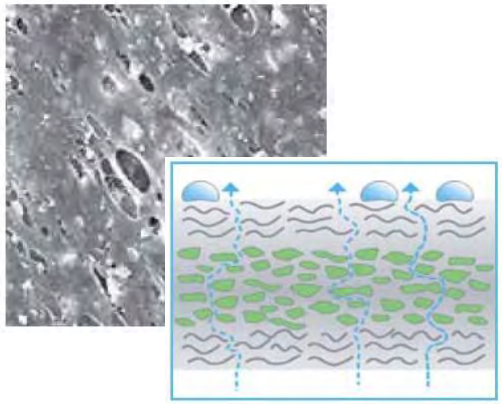
Membranes: Mechanically Fastened

Exterior and Interior

Exterior Airtight Membranes
Pro Clima: SOLITEX, FRONTA QUATTRO, FRONTA HUMIDA & INTESANA, etc
Siga: Majcoat (no reinforced option, less water proof)



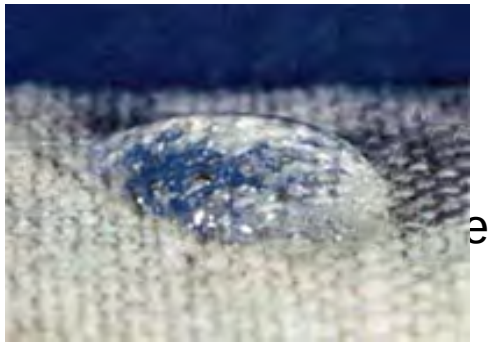
Not
~~Siga Majvest~~
~~Tyvek~~
~~Greenguard~~
~~Hydrogap~~
~~Delta Foxx~~
~~Typar etc~~



Interior Airtight Membranes
Pro Clima: DB+, DA, INTELLO Plus
Certainteed: Membrain (no reinforced option)
Siga: Majpell (no reinforced option, not vapor variable)
Polyethelene (vapor closed)

Water penetration due to reduced surface tension

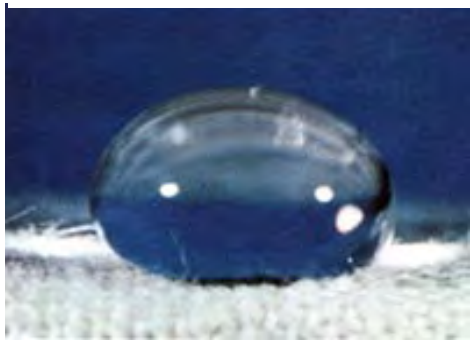
Conventional technology: PE /PP membrane: (micro)porous



Water can penetrate the structure due to the reduced water tension caused by:

- Wood preservatives (salts and detergents)
- Chainsaw oil
- Materials contained in the wood (resins, oils or terpentines)
- Not completely airtight (porous)

New technology : TEEE membrane: nonporous and monolithic



Nonporous structures are always watertight and are not affected by:

- Wood preservatives (salts and detergents)
- Chainsaw oil
- Materials contained in the wood (resins, oils or terpentines)
- Completely airtight

High quality exterior membranes

Functions:

Top Layer:

Protection of the membrane from the outside at installation process (during the installation of the battens and subsequent roofing).

Membrane:

WRB: Waterproof against driving rain, Monolithic Actively vapor open (temp roof, roof underlayment and WRB)

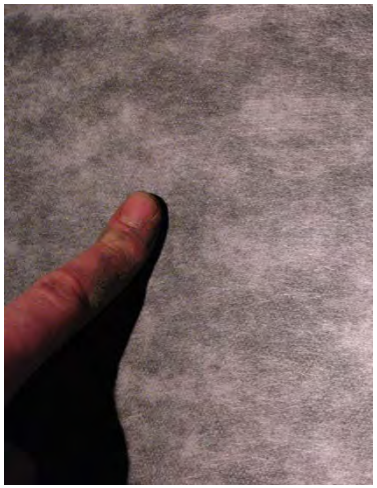
Bottom layer:

Protection of the membrane against irregularities in the substrate (rafters or timber shuttering)

Active vapor open TEEE

Condensation on PE / PP micro-porous membrane

- Pores filled = vapor closed



Dry surface on TEEE nonporous monolithic membrane

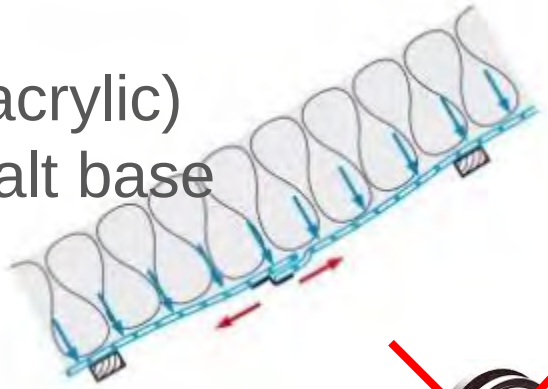
– remains vapor open, protects building

Tapes

Acrylic, butyl…..

Acrylic Options:
Pro Clima: TESCON Vana, Profil, CONTEGA and more
3M, Siga, ZIP

Bitumen/Butyl Options:
Pro Clima, EXTOSEAL ENCORS (butyl/acrylic)
WR Grace, Vycor (primer required) asphalt base



Primers must **match** profile of adhesive

Note: Expanding/Impregnated Foam cannot be practically installed airtight in our experience

Tapes

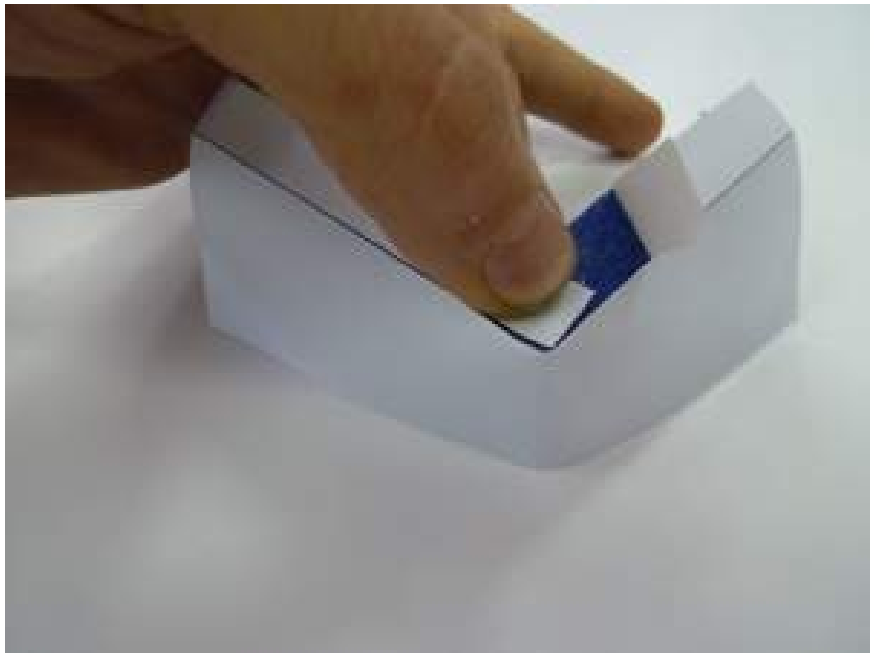
Adhesion must hold
Slippage doesn't
provide confidence or durability

Peter Yost

Pro Clima primer on masonry tile with Contego Exo
- forced to failure: internal delamination of tape

Tapes

Address Penetrations



Tapes

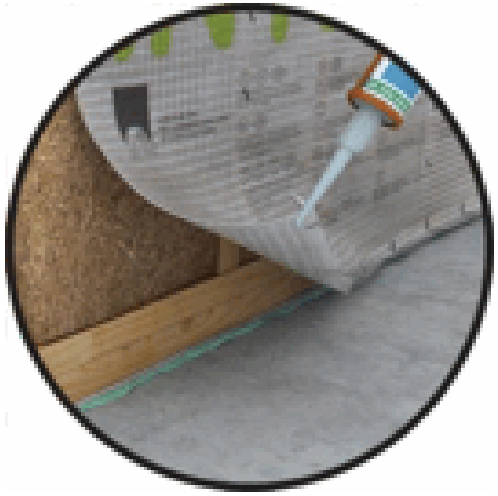
Address Penetrations
(blind taping for concealed hinges)

Caulking Sealant

Acrylic, can be tricky

Pro Clima: CONTEGA HF

Contega Classic

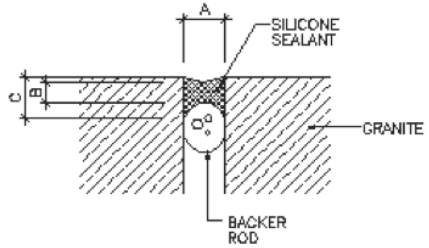


Siga primur

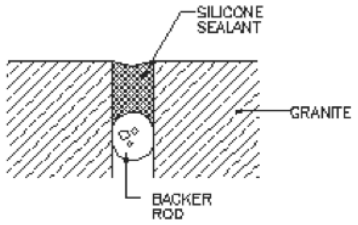
Tremco acoustical

CONVENTIONAL MOVING WEATHERSEAL

GOOD JOINT DESIGN

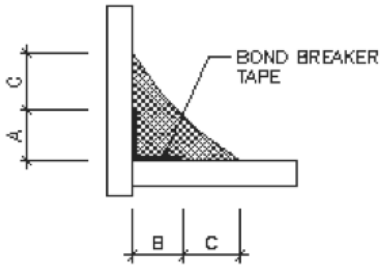


POOR JOINT DESIGN

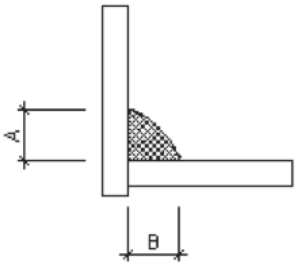


MOVING CORNER JOINT

GOOD JOINT DESIGN



POOR JOINT DESIGN

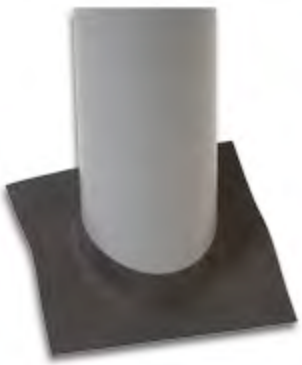


Gaskets

<u>EPDM Rubber for wires, pipes and ducts</u>

Pro Clima KAFLEX

Pro Clima ROFLEX



<u>Plastic Electric Boxes</u>

Pro Clima INSTAA Boxes

LESSCO

<u>Liquid pipe sealing</u>

Pro Clima WYFLEXA or CONTEGA HF

Zip Liquid Flash

Prosoco Fast Flash

Insulations

Mineral wool:

Roxul

Urea-extended phenol formaldehyde binder - very low ppm (Greenguard)

No flame retardants

Fiberglass:

Typically with phenol formaldehyde binder

Dense pack: Jet Stream Ultra binder free by Knauf

Below: JM Spider with hydrolyzed polyester binder

Alex Wilson, BuildingGreen

Insulations

Cellulose:

Check for Aluminum Sulfates

15% Borates for fire, pest and mold prevention.

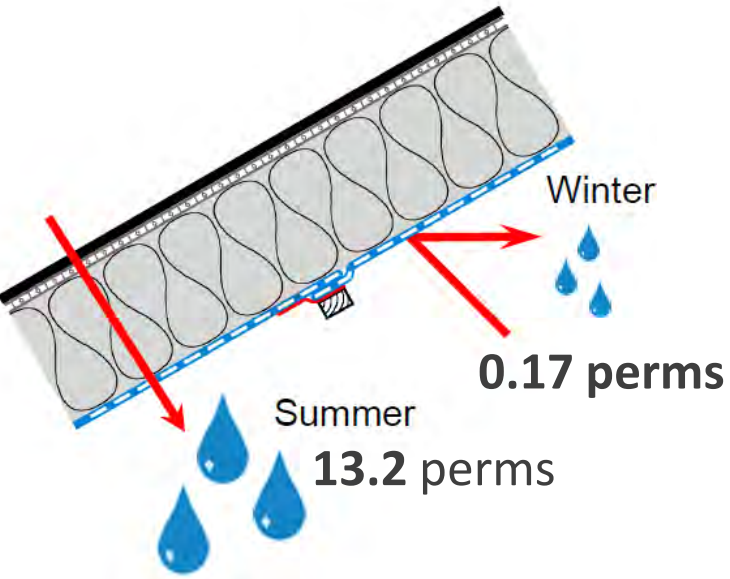
Woodfiber Board:

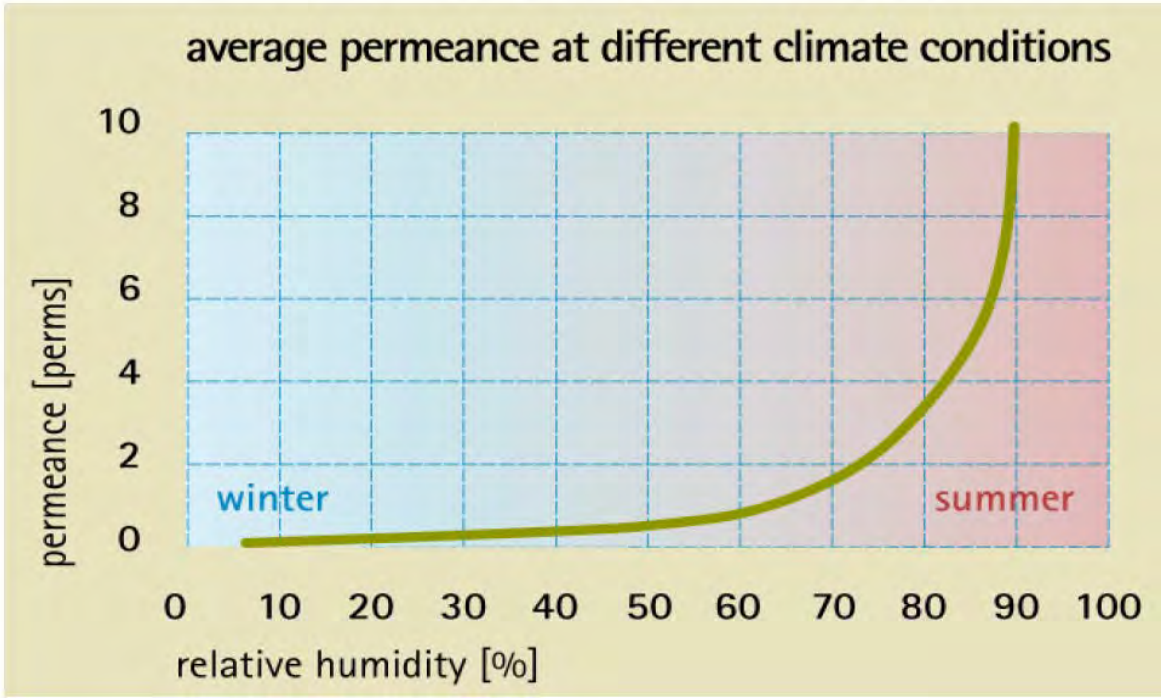
Gutex & Agepan

High recycled content, check % of PU binder

As risks increase: Intelligent Vapor Retarders….

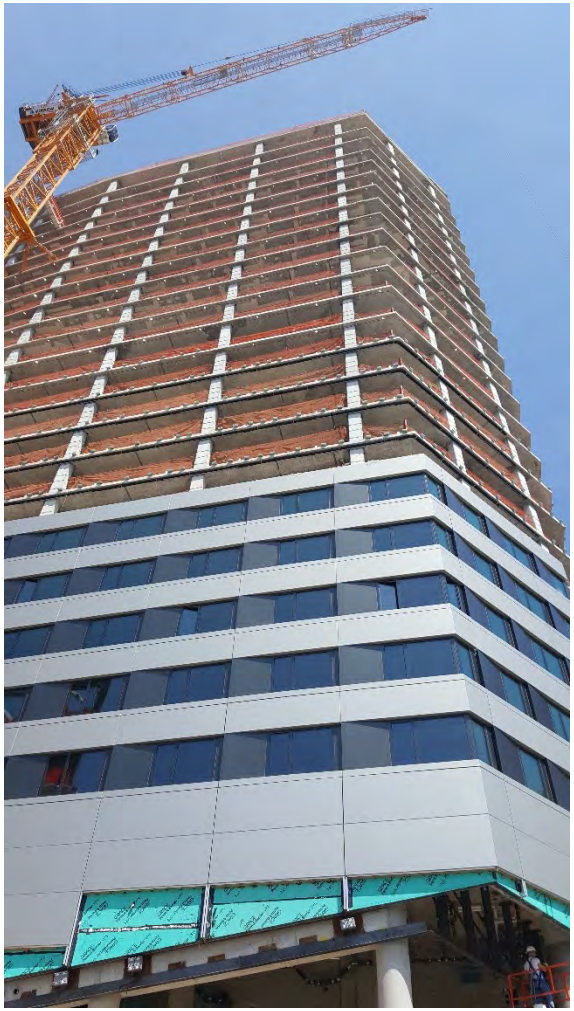
prevent wetting and **promote drying**
building drying reserves, for maximum protection

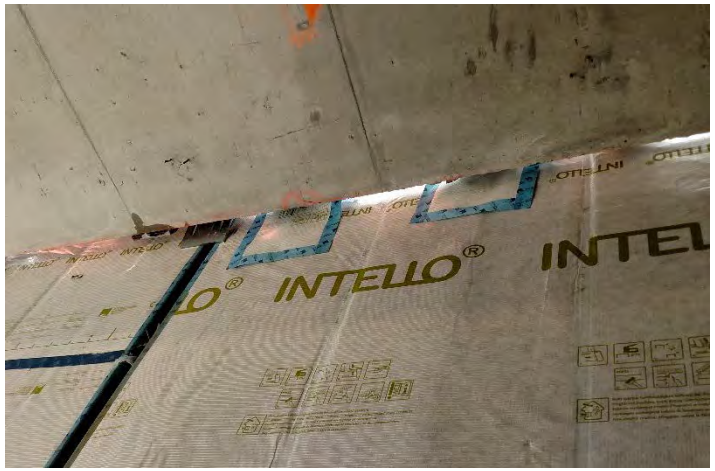




Cornell Tech

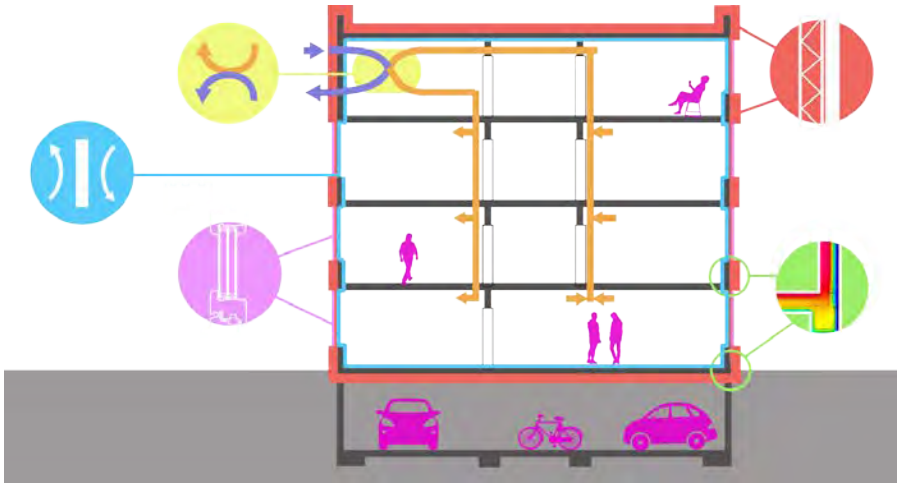
Panelized System Continuous Envelope



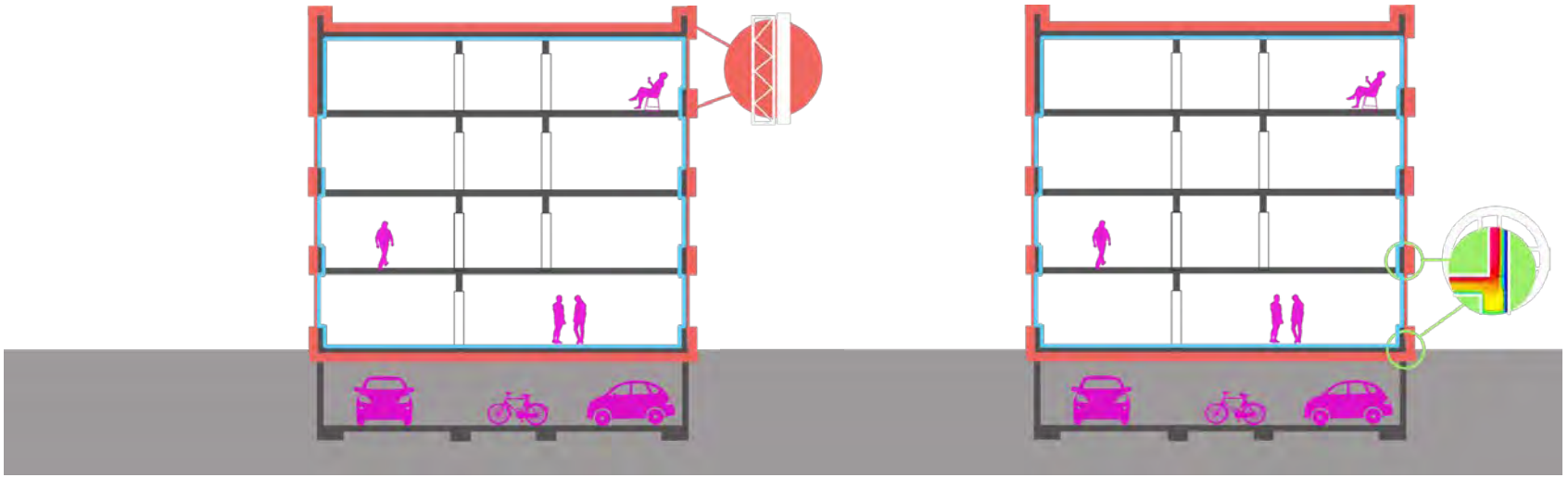


Critical Aspects/Principles

- Airtightness
- Vapor Control
- **Well Insulated**
- High-performance windows
- Fresh air ventilation



Warm Surface Temperatures

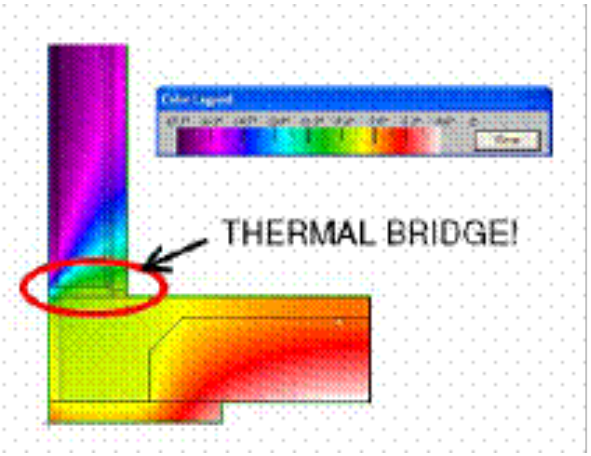


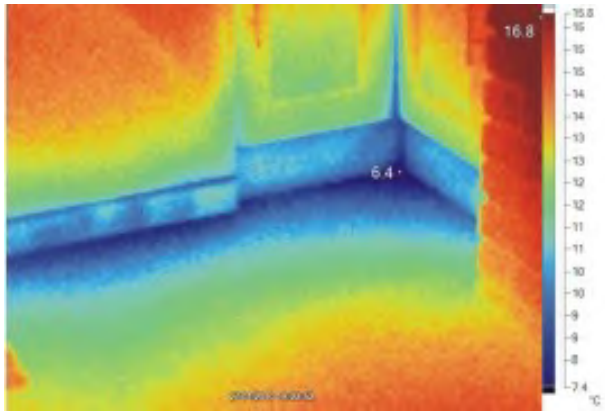
Continuation insulation

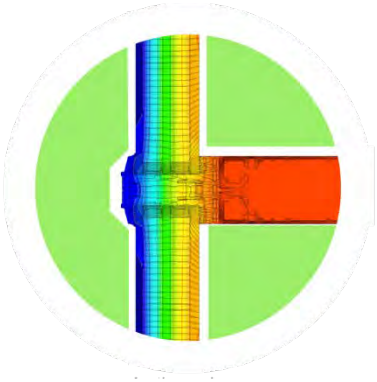
Thermal Bridge Free

Insulation levels are climate specific, like sleeping bags

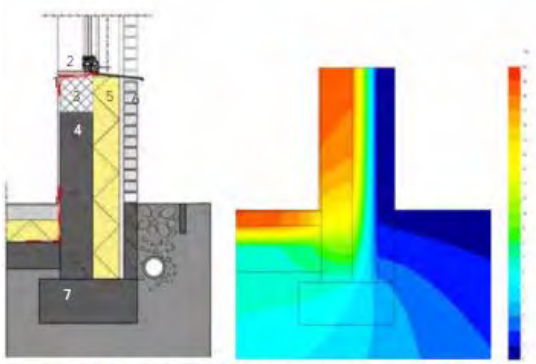
Comfort Criteria and Safety from Condensation



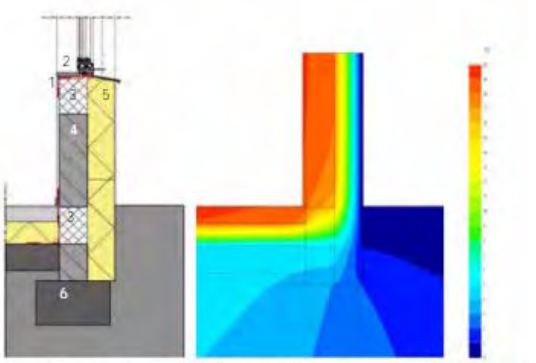




Thermal Breaks at the **Foundation**

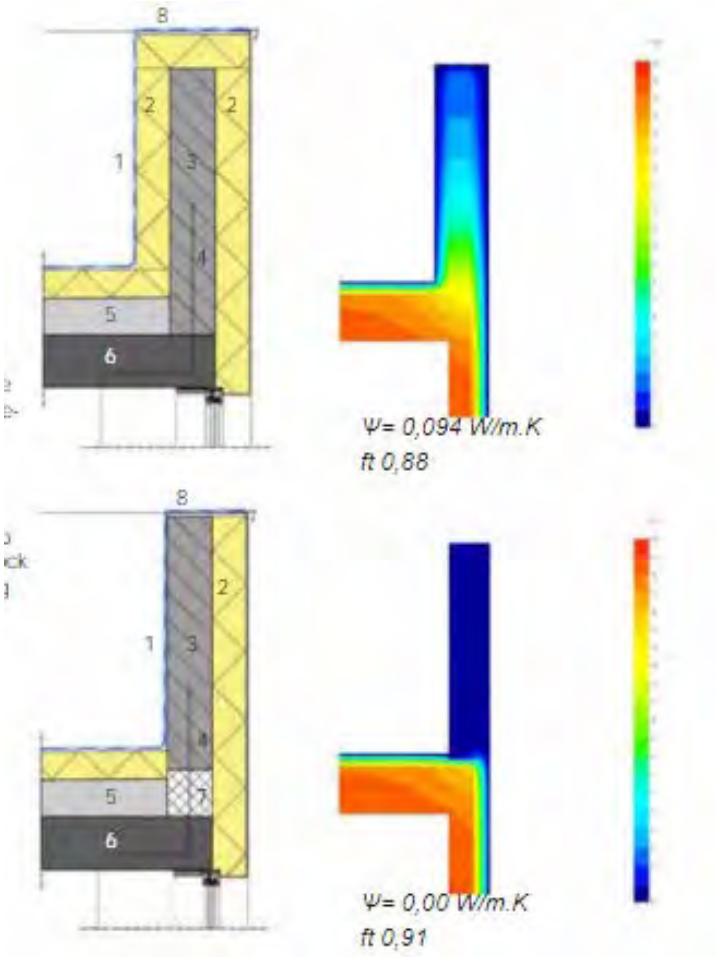


Junction with no insulation block in the brickwork: Ψ=0,27 W/m.K



Junction including an insulation block in the brickwork: Ψ= - 0,02 W/m.

Parapet Walls



A2M passive+architecture

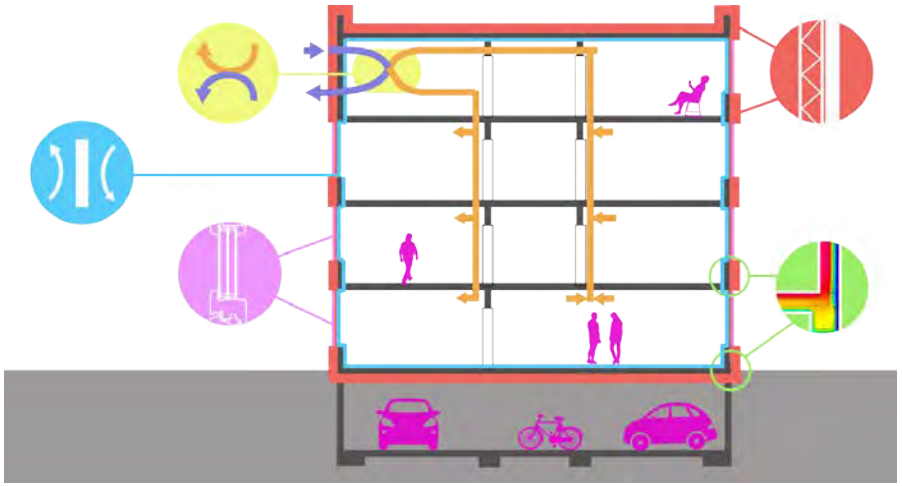
Thermal Break at the Rain Screen

Thermal Break at Balcony

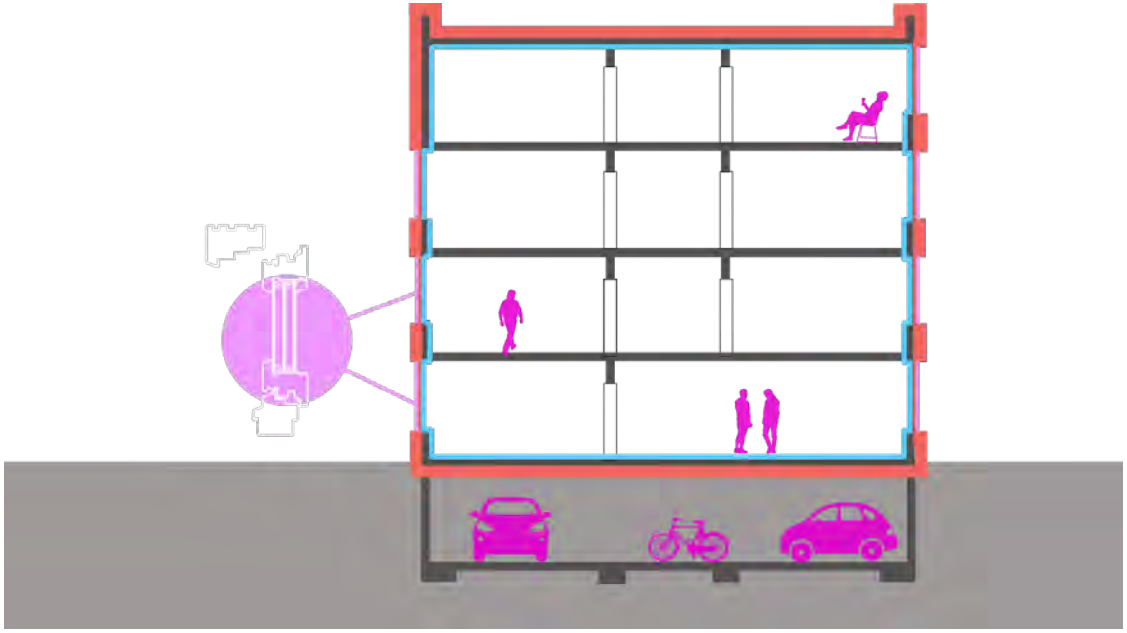
Schöck

Critical Aspects/Principles

- Airtightness
- Vapor Control
- Well Insulated
- **High-performance windows**
- Fresh air ventilation



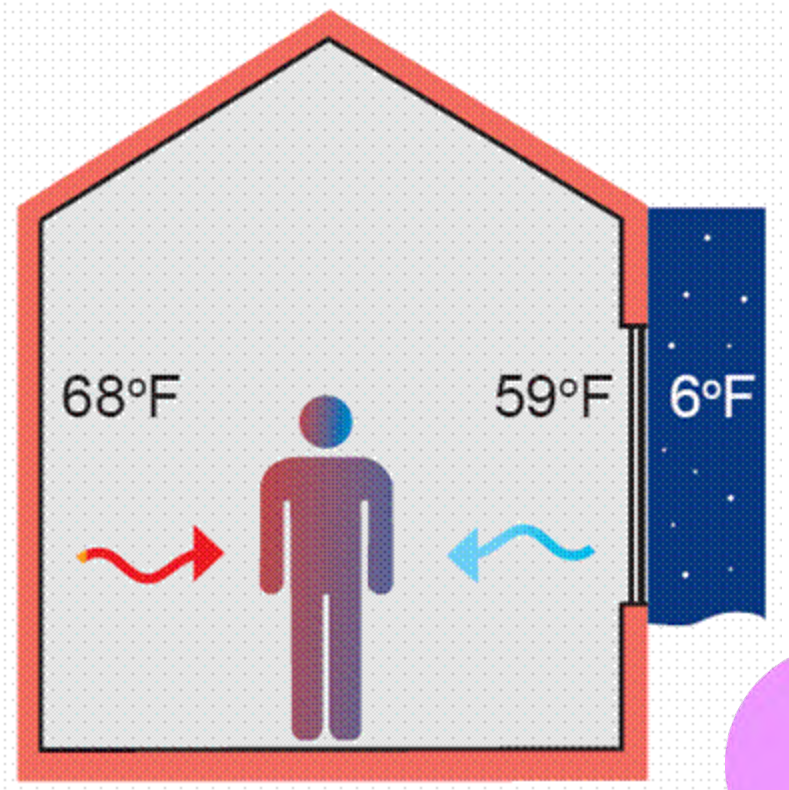
High-Performance Windows



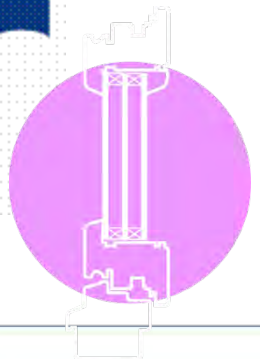
Comfort drives performance

Comfort drives performance

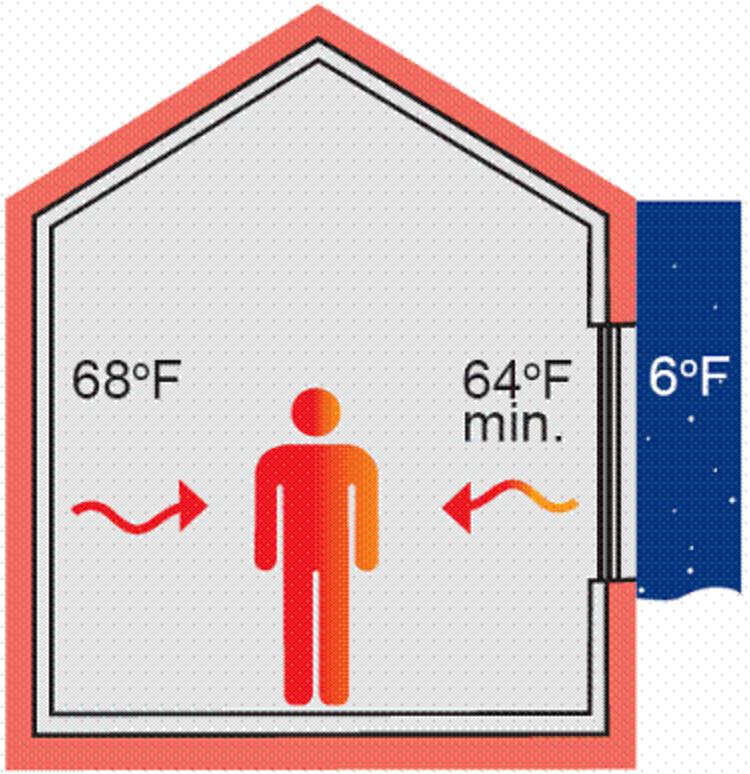
Typical **Double** Glazing



discomfort

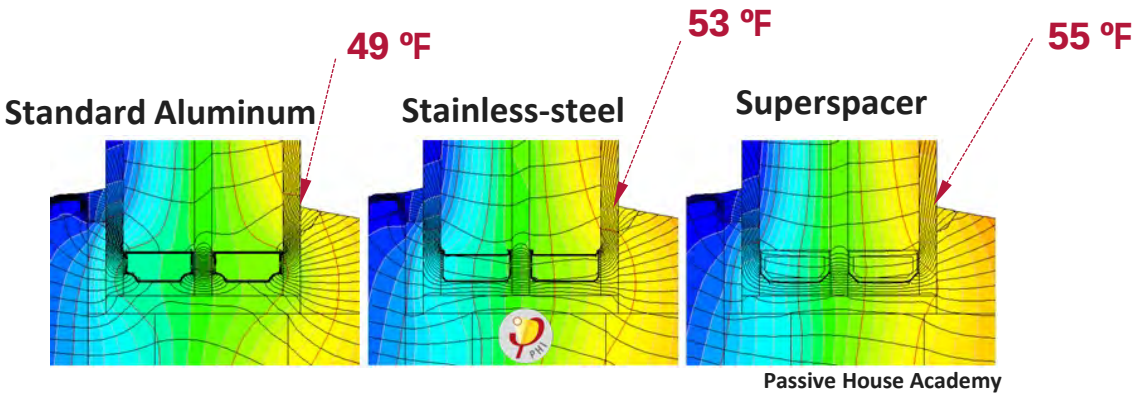


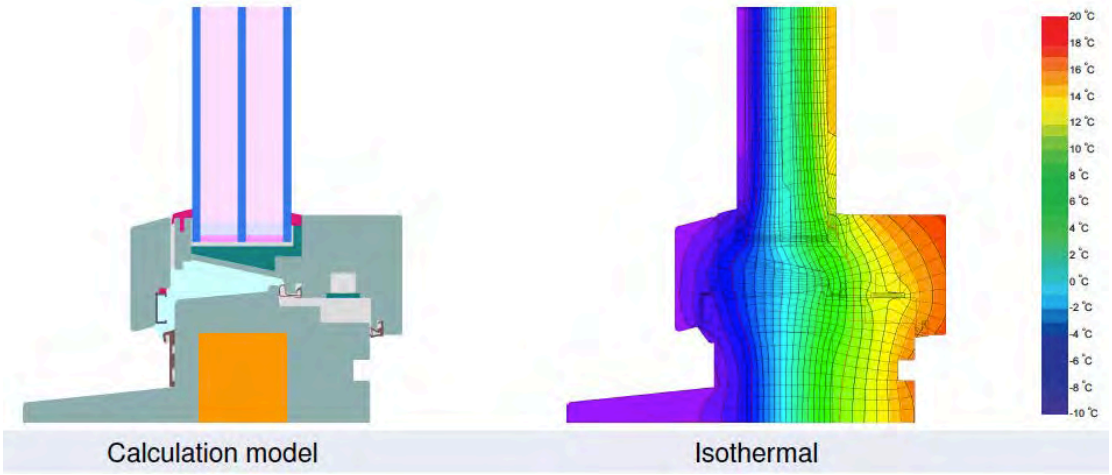
PH Windows



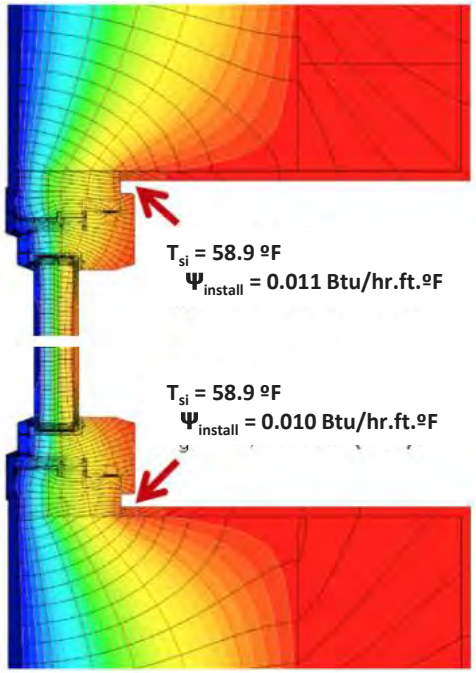
comfort

Spacers Matter, Frames Matter

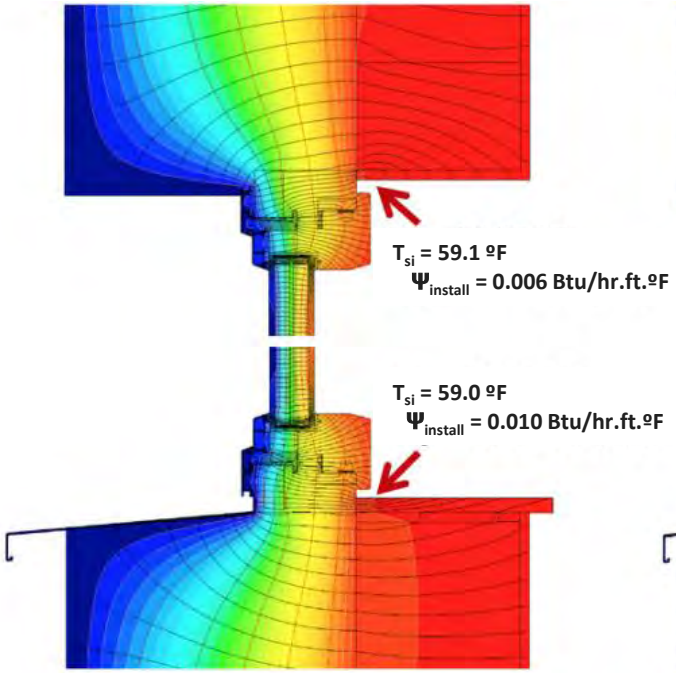




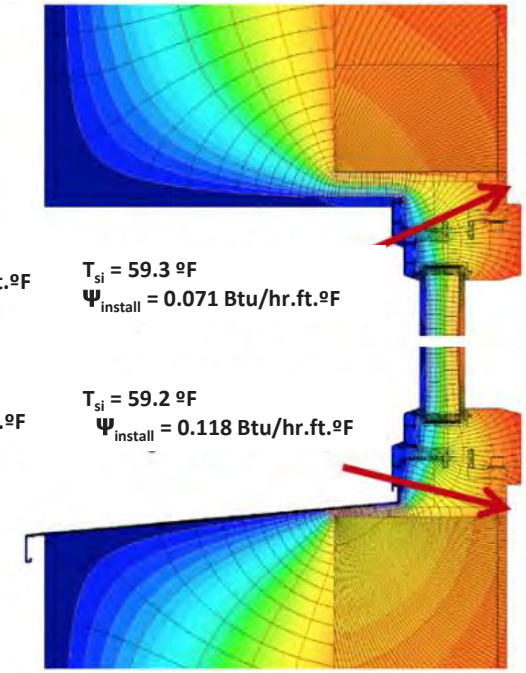
Window Placement Matters



$U_{w\text{-}installed}$ = 0.151 Btu/hr.ft².ºF
($R_{w\text{-}installed}$ = 6.62 hr.ft².ºF/Btu)



$U_{w\text{-}installed}$ = 0.148 Btu/hr.ft².ºF
($R_{w\text{-}installed}$ = 6.76 hr.ft².ºF/Btu)

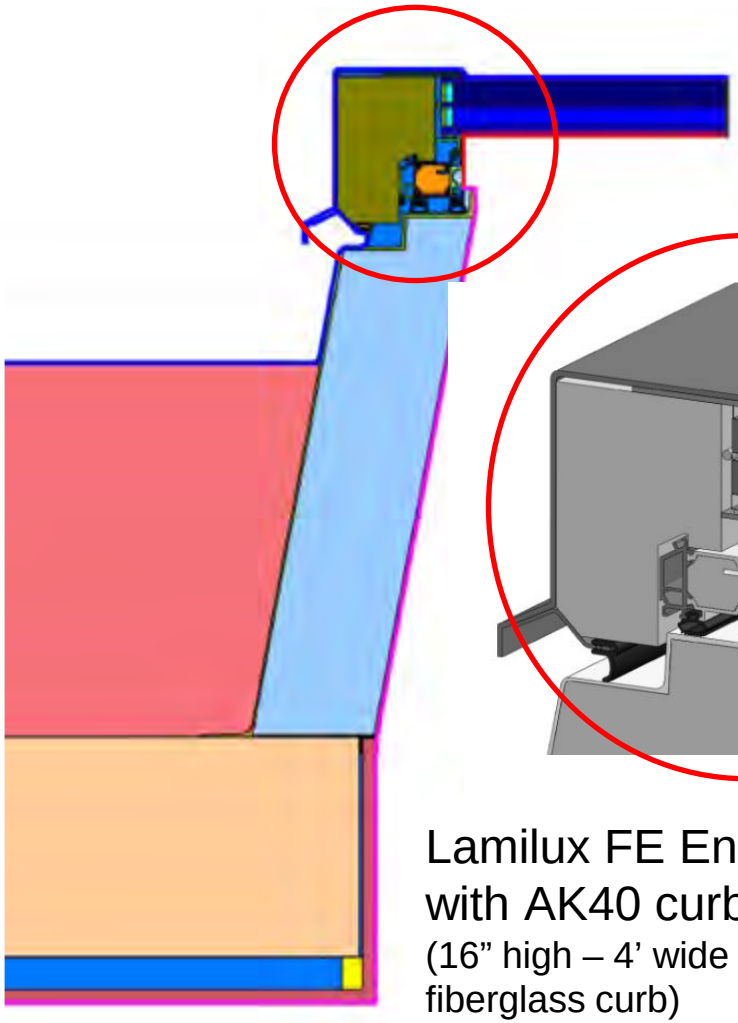


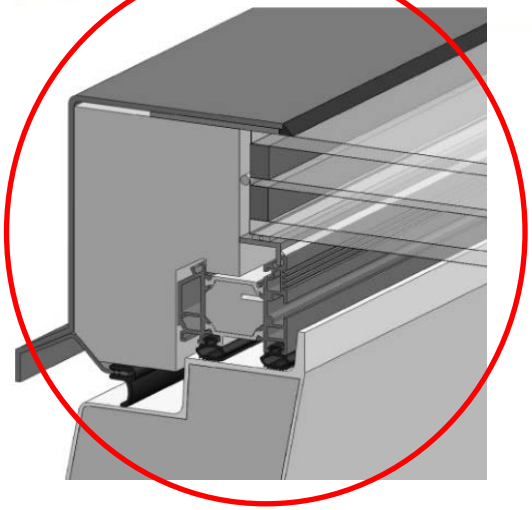
$U_{w\text{-}installed}$ = 0.215 Btu/hr.ft².ºF
($R_{w\text{-}installed}$ = 4.65 hr.ft².ºF/Btu)

Passive House Academy

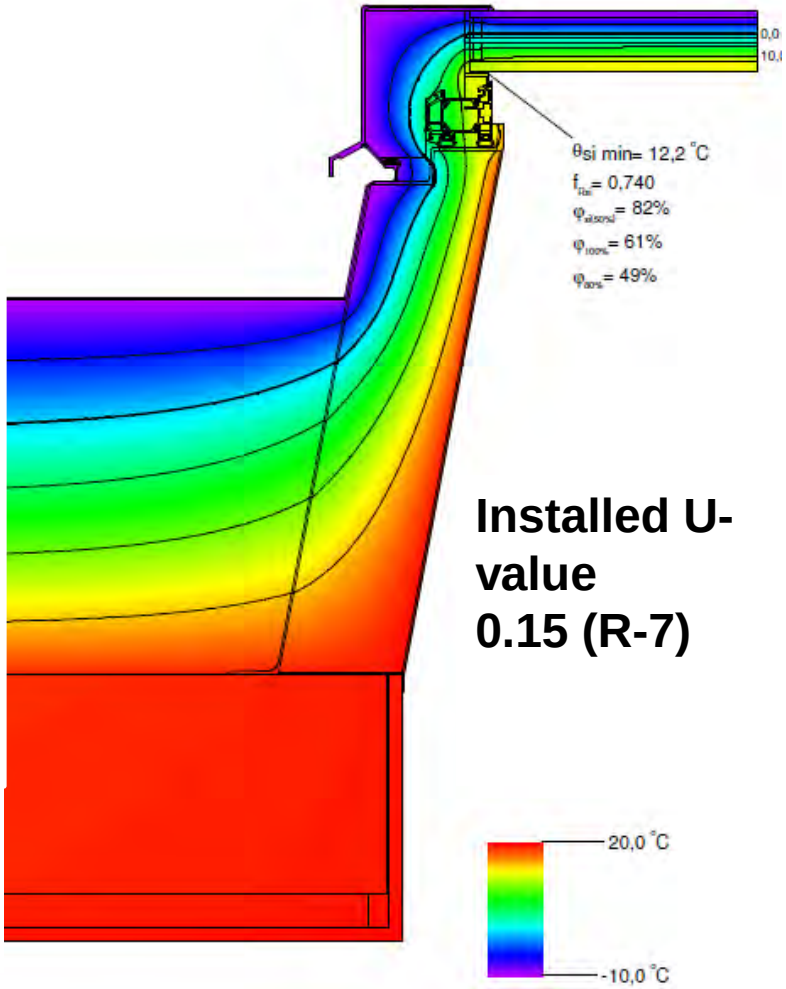
Passive House Institute

Skylight Integration….





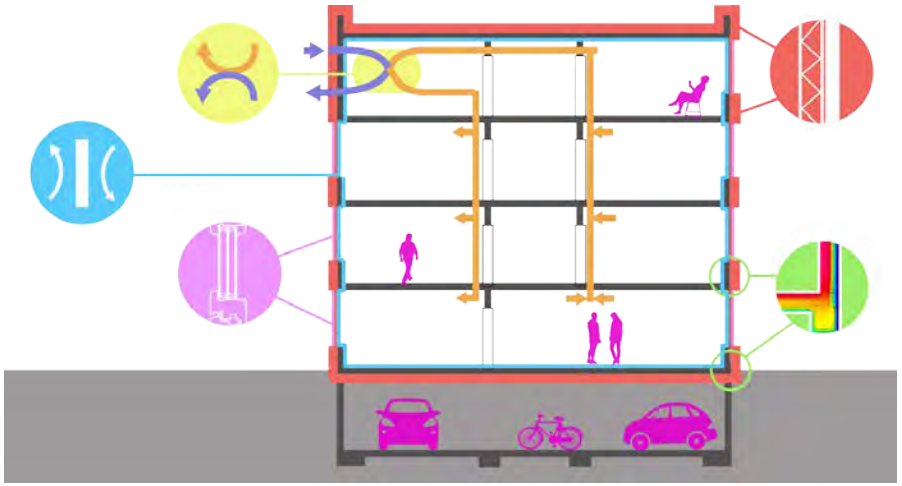
Lamilux FE Energysave with AK40 curb
(16” high – 4’ wide insulated fiberglass curb)



Installed U-value 0.15 (R-7)

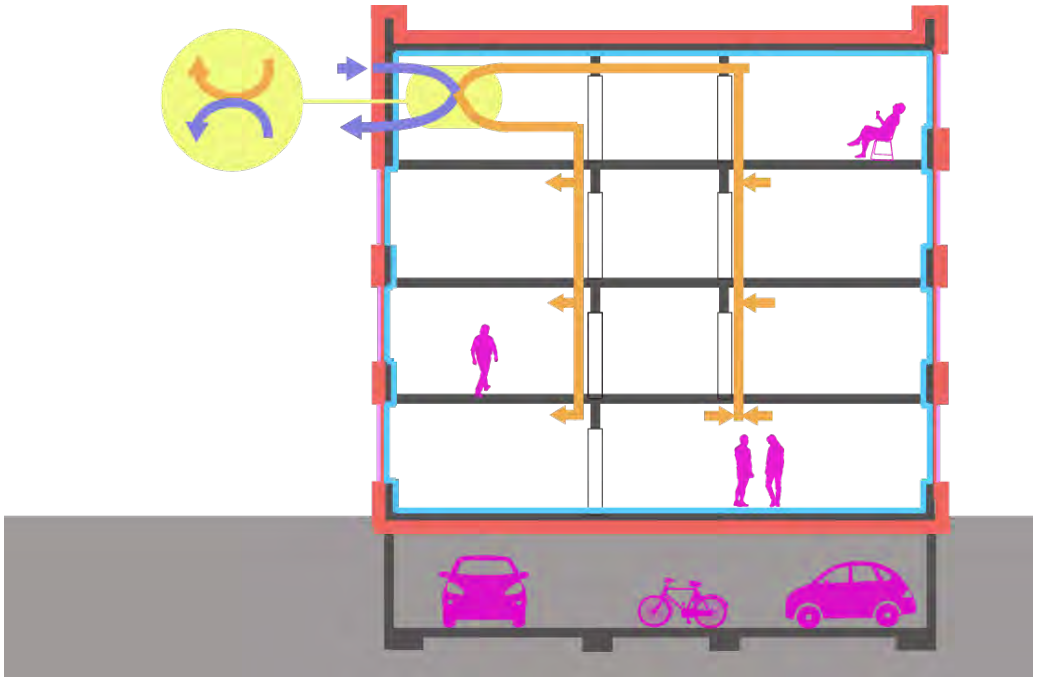
Critical Aspects/Principles

- Airtightness
- Vapor Control
- Well Insulated
- High-performance windows
- **Fresh air ventilation**



Fresh Air Ventilation

- Supply to every served space: living rooms, bedrooms, etc...
- Exhaust from every service space: bathrooms, kitchens, etc...
- Individual unit control
- Humidity control



Centralized vs. Decentralized

- Central Units: at top/bottom/middle of building with risers
- Semi-Central Units: at each floor
- Semi-Decentralized Units: at each apartment
- Decentralized Units: at each room

Central & Semi-Central
(Ventacity, Swegon)

Semi-Decentralized
(Zehnder)

Decentralized
(Lunos)

Humidity and HRV vs. ERV (for Multifamily)

- **HRV** only recovers heat energy – **good for lowering humidity in winter**
- **ERV** recovers humidity/latent energy – maintaining indoor humidity levels & **good for preventing moisture loading in summer**.

Suggested Solution:

- Address summer humidity with active cooling.
- Address winter humidity with HRV system.

Lower Toxicity

Consider Chemical Risks

- Occupational Health
- Occupant Health
- Biosphere Health
  - Chemical sensitization
  - Respiratory ailments
  - Neurological ailments
  - Cancer

Work to Lower Toxicity

- No/low VOCs
- In manufacture, application, life and disposal
- Toward natural building.
- “Less is Best”

- International Living Future Institute: Red List
- USGBC LEED
- BuildingGreen: Greenspec
- Healthy Building Network: Pharos Project
- Declaration EPD: ISO 14025
- California EPA Air Resources Board
- Perkins & Will’s Precautionary List

Training, Documentation, Verification & Orientation

Predictability Relies on Process….

Trained Professionals: Architects, Engineers, Builders Consultants (PH certified)

Integrated Design

Onsite Verification

Occupant Orientation

Third Party **VeriPHy**

Airtightness Testing Plan

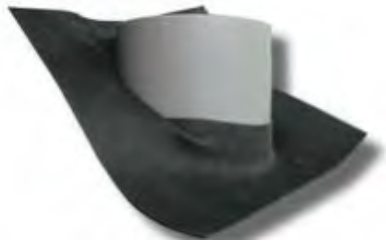
MEP **Commissioned** accordingly

Certification:

Signage more numerous than “No Smoking”

Verify materials for continuity

- Manufacturers
- Airsealing system /Performance requirements
  - Airtight materials (membranes, sheathing)
  - Air-sealing tapes
  - Adhesives
- Accessories
  - Tape primers
  - Gaskets for pipes, cables and ducts
  - Outlet airtight enclosures



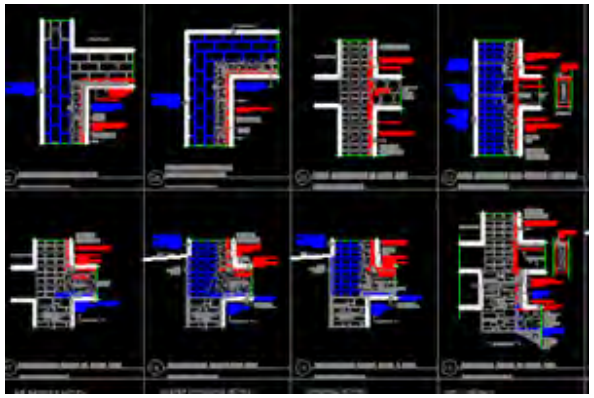
Summary

1. Robust (next generation) materials & components
2. Less toxic materials too
3. Fully integrated
4. Forming continuous control layers (predictability)
5. With simplified detailing
6. Sequenced
7. Protected
8. Tested & Commissioned
9. With trained workforce
10. Providing optimized function and affordability

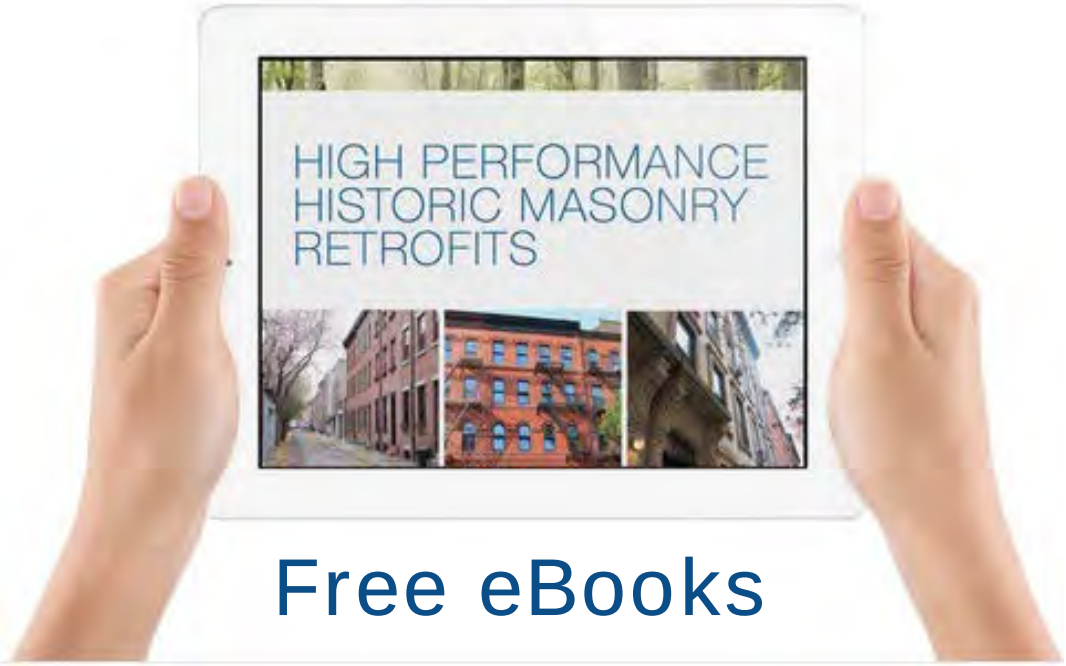
475 Can Help!

info@foursevenfive.com

475 CAD Details



Knowledge and Resources



Free eBooks

Thank You!