Passive House EnerPHit: Take Your Building Deeper

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PHA Passive House Academy

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Session Description:

- **Passive House EnerPHit: Take Your Building Deeper**
- Passivhaus has been the standard for cutting edge Energy Efficiency since the 1990s.
- PHI has recently come out with the new EnerPHit Standard for Deep Energy retrofits because typical existing conditions make the Passivhaus Standard practically impossible to achieve.
- With Passivhaus methodology and components the implemented retrofit should result in the maximum improvement with respect to thermal comfort, structural protection, cost-effectiveness and energy efficiency.
- Tomas O'Leary and Ken Levenson will go into the details and implications of this new Passivhaus standard for Deep Energy Retrofits

Learning Objectives:

1. Outline three paths to EnerPHit Certification
2. Describe EnerPHit in relation to Passive House
3. List several key ways EnerPHit is different from typical Deep Energy Retrofits
4. Describe typical challenges and startegies in completing EnerPHit projects

Recent Passive House Developments

Upgrades to Passive House Planning Package

designPH

the 3D interface for PHPP

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User login

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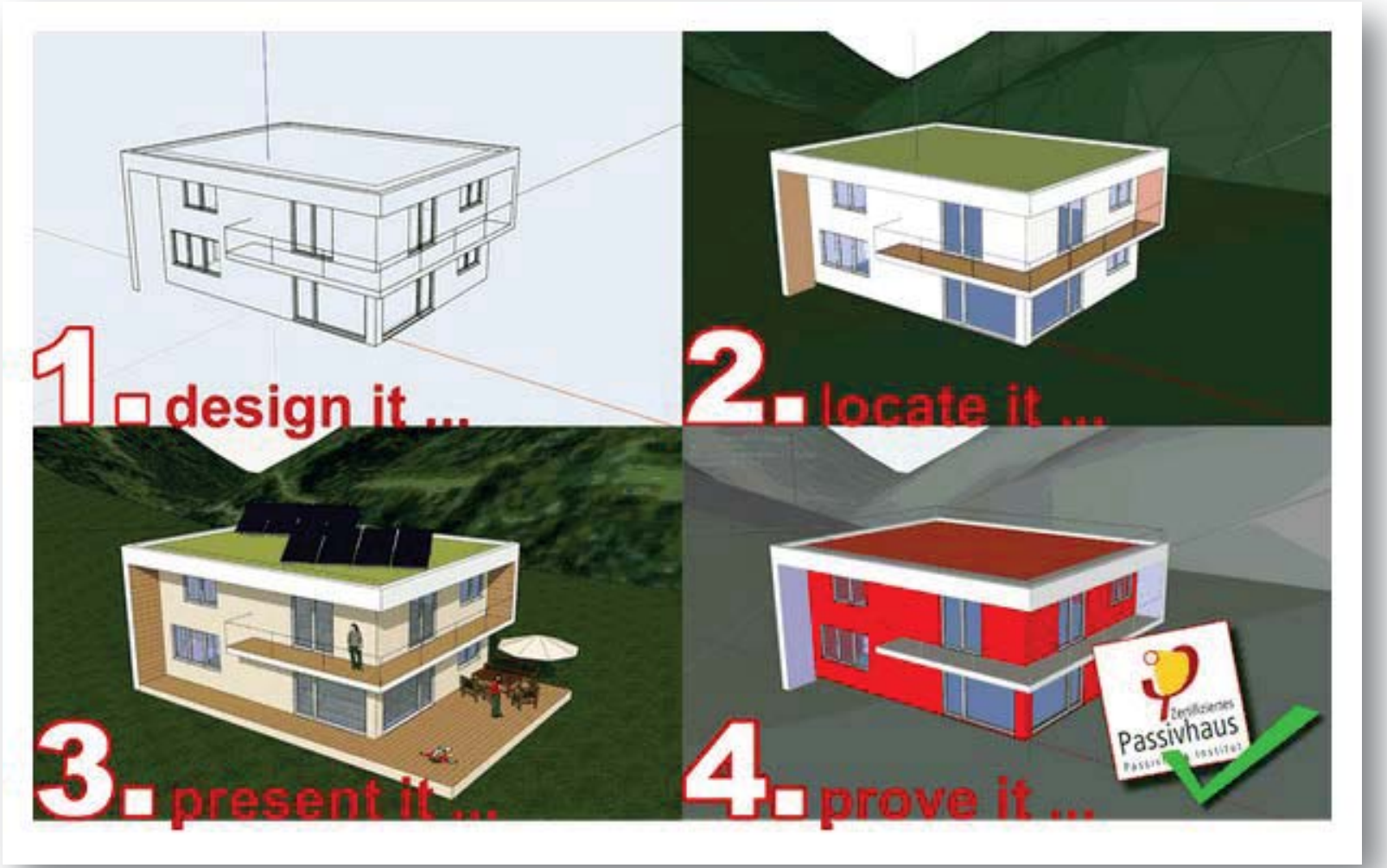
Log in

designPH is set to revolutionise the way we use PHPP

first public release of *design*PH Version 1.0 is out now!

Super easy and Super quick...



A Global Standard

5 Classification of regions with equivalent requirements (glazing and transparent components)

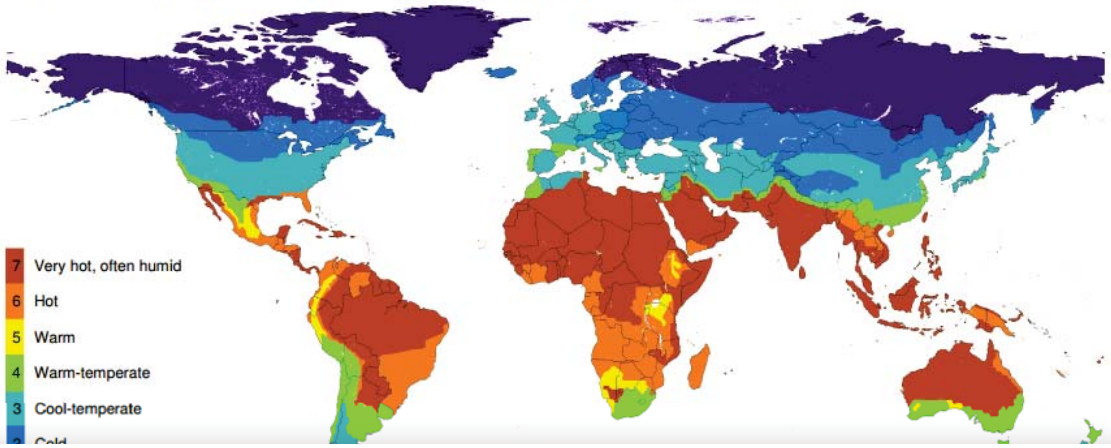


Table 2: Boundary conditions, acceptable certification criteria and efficiency classes for glazing

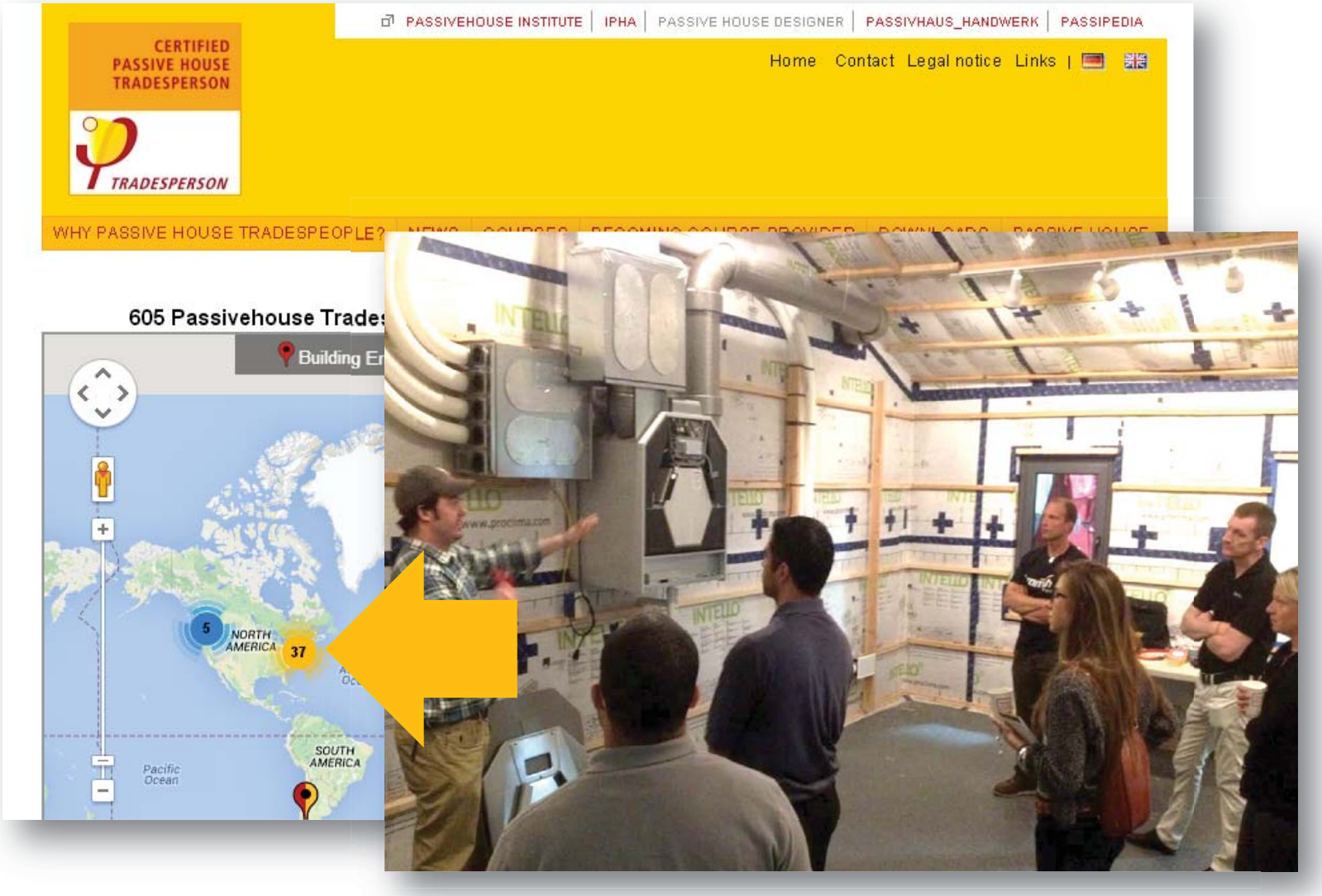
Region No.	Name	Boundary condition for hygiene criterion θ_a	rHl	Hygiene criterion $\theta_{SI,min}$	f_{Rsi}	Ambient temperature for comfort criterion [°C]	Maximum heat transmission coefficient Orientierung	[°]	$U_{W,installed}$	U_W	U_g	Solar-factor	Glazing efficiency classes For each class, Ueq must be less than A	B	C
1	Arctic	-34	0.40	9	0.80	-50	vertical	90	0.45	0.40	0.35	0.70	-0.10	-0.05	0.00
							inclined	45	0.50	0.50	0.50				
							horizontal	0	0.60	0.60	0.60				
2	Cold	-16	0.45	11	0.75	-28	vertical	90	0.65	0.60	0.55	1.00	-0.15	-0.07	0.00
							inclined	45	0.70	0.70	0.70				
							horizontal	0	0.80	0.80	0.80				
3	Cool-temperate	-5	0.50	13	0.70	-16	vertical	90	0.85	0.80	0.75	1.60	-0.35	-0.20	0.00
							inclined	45	1.00	1.00	1.00				
							horizontal	0	1.10	1.10	1.10				
4	Warm-temperate	5	0.55	14	0.60	-3	vertical	90	1.30	1.25	1.20	3.20	-1.20	-0.90	-0.60
							inclined	45	1.50	1.50	1.50				
							horizontal	0	1.70	1.70	1.70				
5	Warm	10	0.70	16	0.55	11	vertical	90	2.90	2.85	2.80	6.40	-3.00	-2.50	-2.00
							inclined	45	3.30	3.30	3.30				
							horizontal	0	3.80	3.80	3.80				
6	Hot	not relevant		not defined		not relevant			1.60	1.55	1.50	not defined			
7	Extremly hot, often humid	not relevant		not defined		not relevant			1.30	1.25	1.20	not defined			

Ever Expanding Database of Certified PH Components

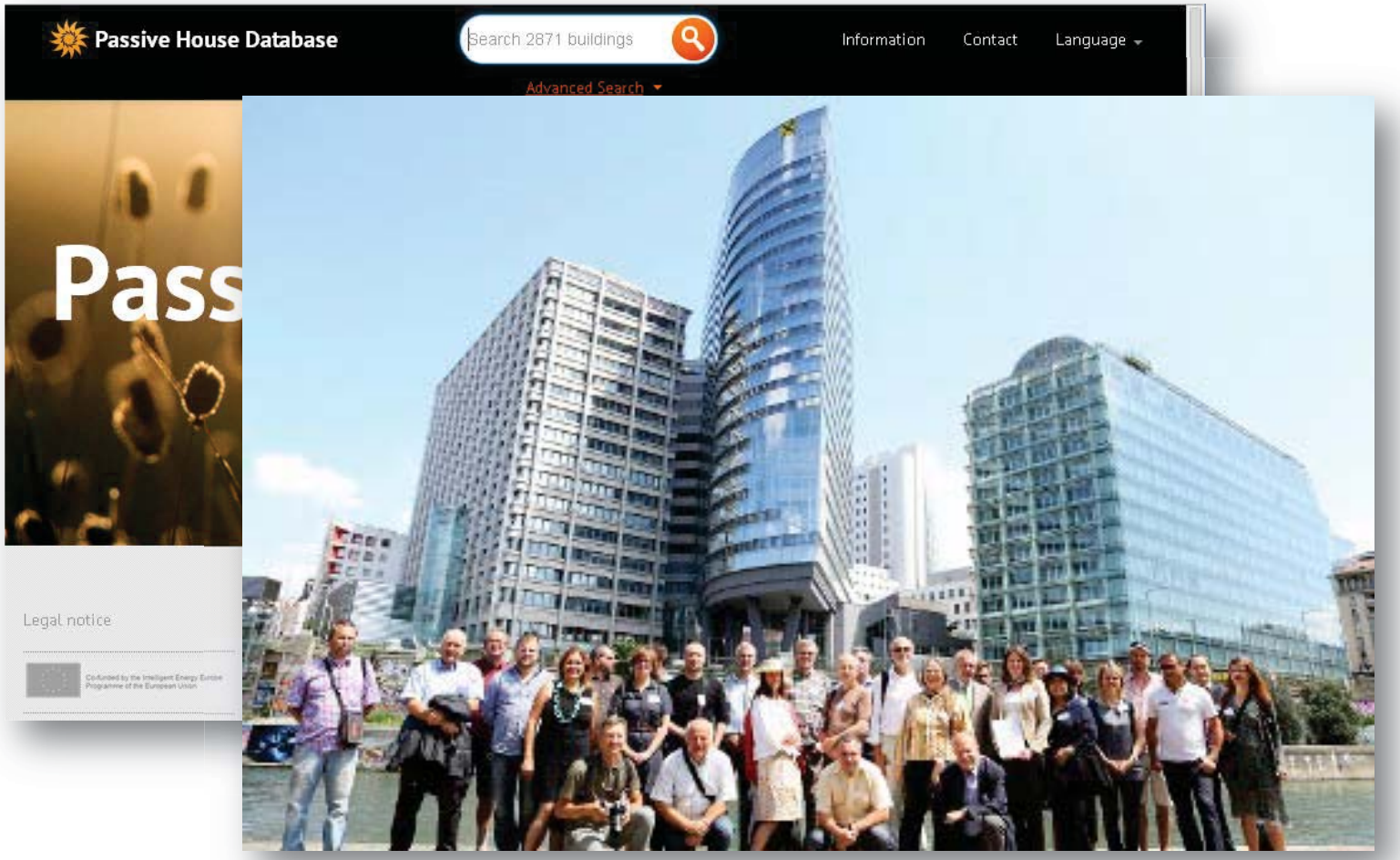
Database of Certified Passive House Components

Opaque building envelope (Construction & insulation systems, connections)	Transparent building envelope (Doors, glazing, windows, etc.)	Building Services
		
Wall and construction systems	Window frames	Ventilation systems (Capacity < 600m³/h)
EnerPHit insulation systems	Frames for fixed glazing	Ventilation systems (Capacity > 600m³/h)
Floor slab insulation systems	Sliding doors	Compact heat pump units
Flue systems	Curtain wall systems	
ICF for roof parapets	Inclined curtain wall systems	
Balcony connections	Roof windows	
Facade anchors	Skylights	
	Glazing	

Training The Trades



Expanding Database of Projects Globally

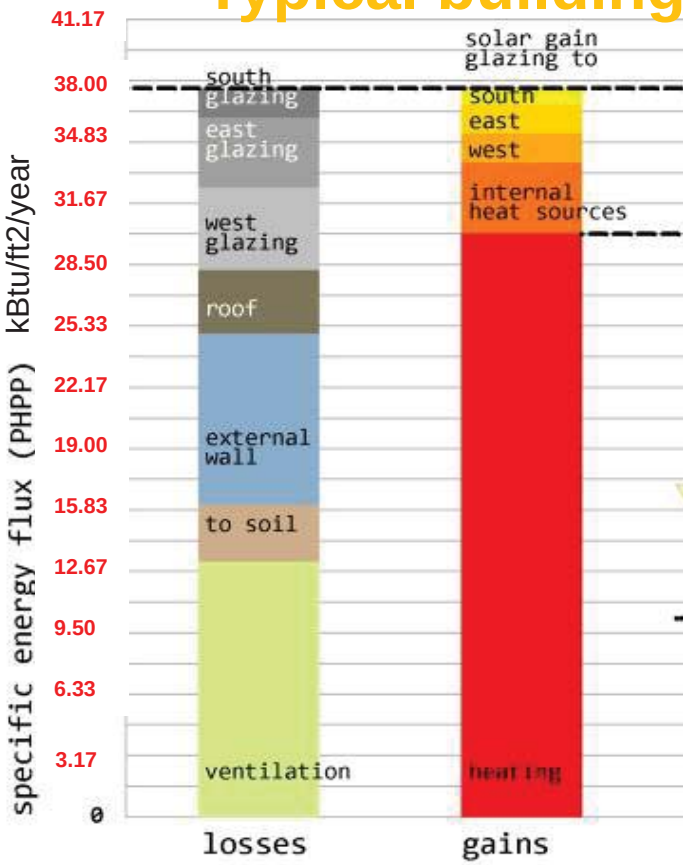


20 Storey Certified PH in Vienna Image by Advantage Austria

Defining the EnerPHit Standard

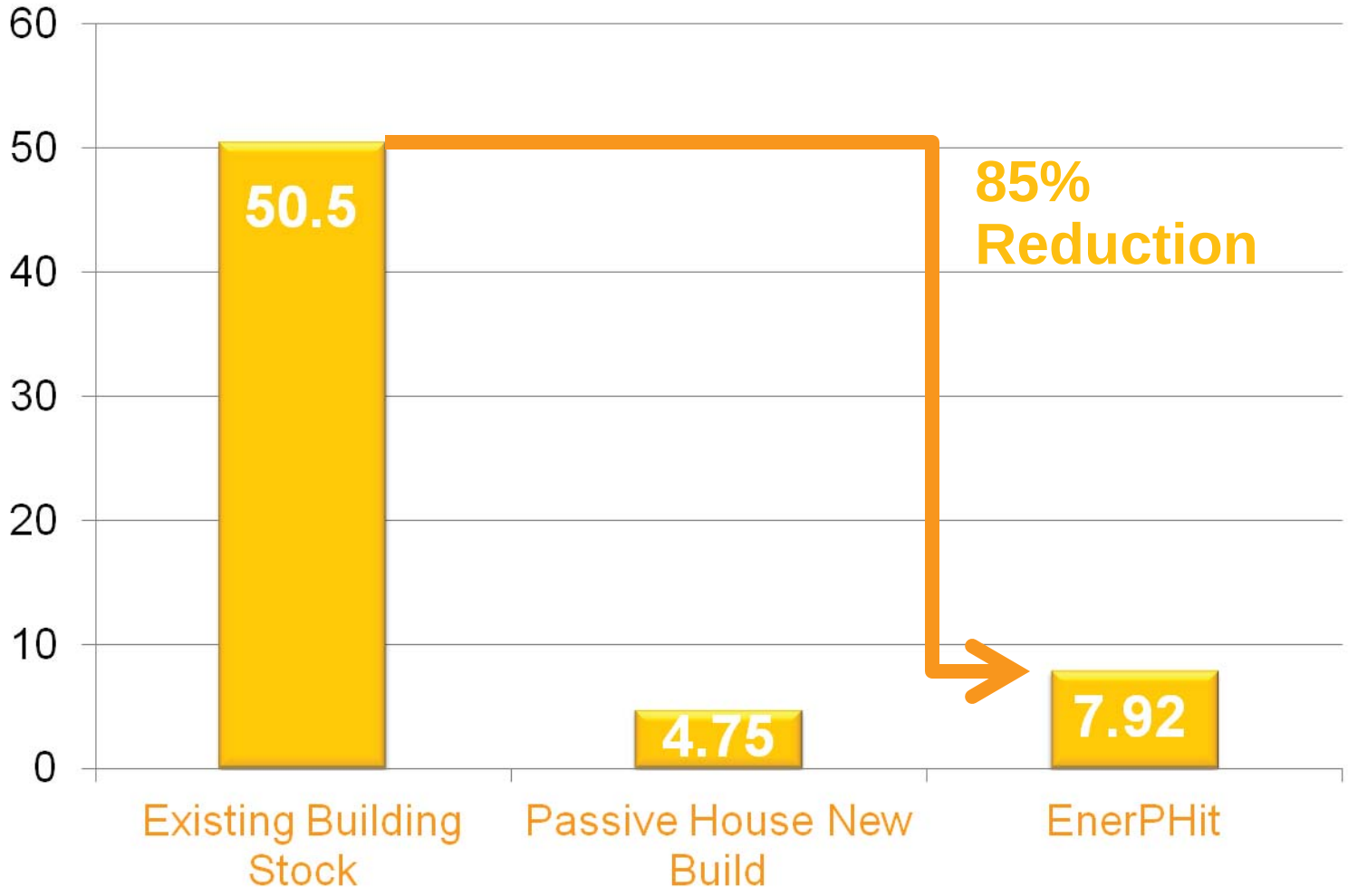
HOW does a Passive House work?

Typical building



If you minimise heat losses and maximise solar gains, you can reduce heating demand very significantly

Annual Space Heating Demand (kBtu/ft^2.year)



Source Energy (incl. plug loads)

- **Approx 10% higher than new build PH standard, or 42** kBtu/(ft^2.year)

Exeloncorp.com

Configuration and Location

Buildings must have at least **one exterior wall, one roof surface and a floor slab or basement ceiling**

Climate Zones 4 &5

Wikimedia.org

EnerPHit Certification

Three Alternative Tracks:

1. **Retrofit to the 'new-build' standard (preferable) - max space heating demand of 4.75 kBtu/(ft^2.year)**

2. **EnerPHit - 7.92 kBtu/(ft^2.year)**

3. **EnerPHit $^{+i}$ – 'component certification' for key elements of the building**

EnerPHit $^{+i}$

Outsulation: R $\geq$ **38 hr.ft^2.°F / Btu**

Insulation: R $\geq$ **16 hr.ft^2.°F / Btu**

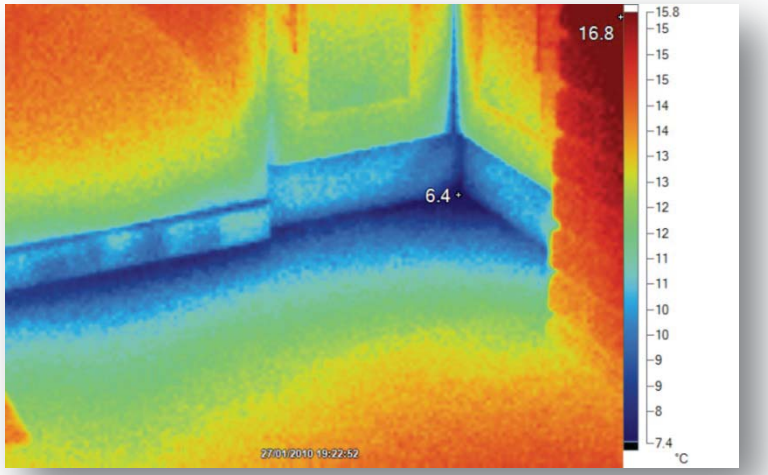
Minimum comfort requirements:

Exterior wall: $R \geq 7\ hr.ft^2.°F / Btu$

Roof: $R \geq 16$

Floor: Surface temperature ≥63 °F

Windows: $R_{W/D,\ installed} \geq 7\ hr.ft^2.°F / Btu$



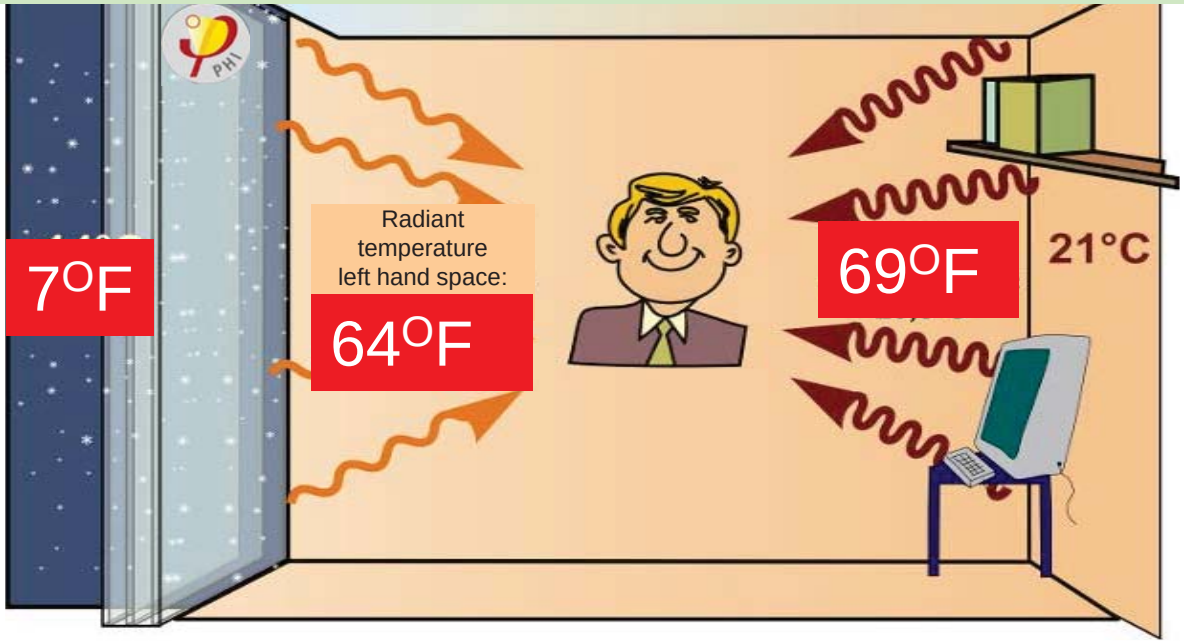
www.thermoman.co.uk

Knittybutton.com

Interior surface temperature of windows

R=7.1 (hr.ft².°F)/BTU

Certified Passive House window, U_w= 0.14 Btu/hr.ft².F

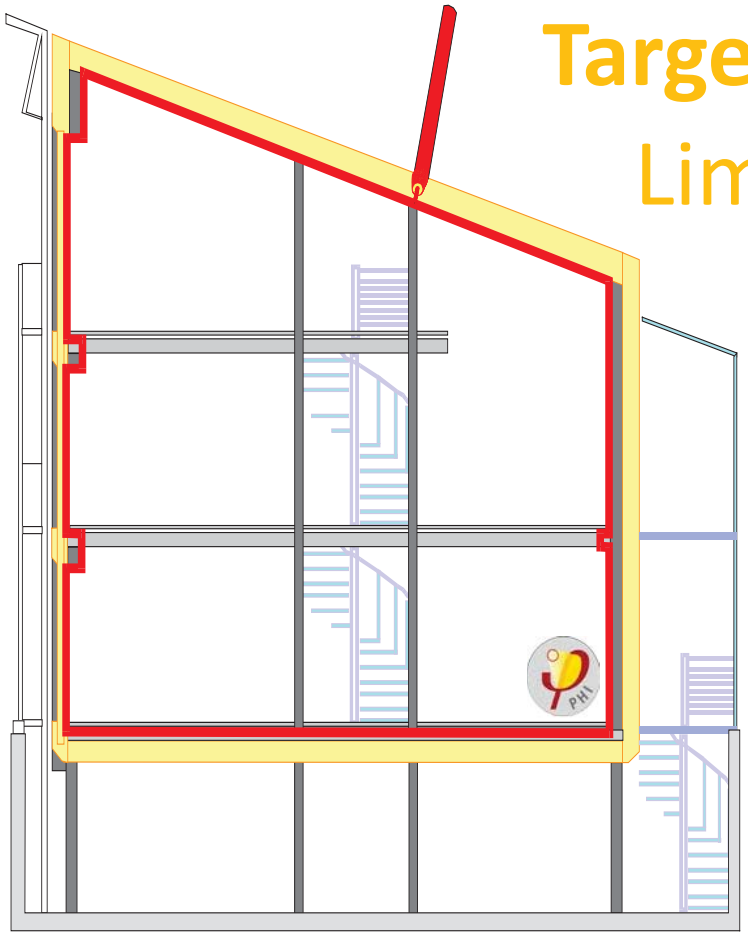


Radiant temperature asymmetry of just 4˚F

Radiator no longer required under the window

Source: PHI / Sariri, Author: PHI/F. Freundorfer

Airtightness is a planning task



Target $n_{50} \leq 0.6$ ACH

Limit $n_{50} = 1.0$ ACH

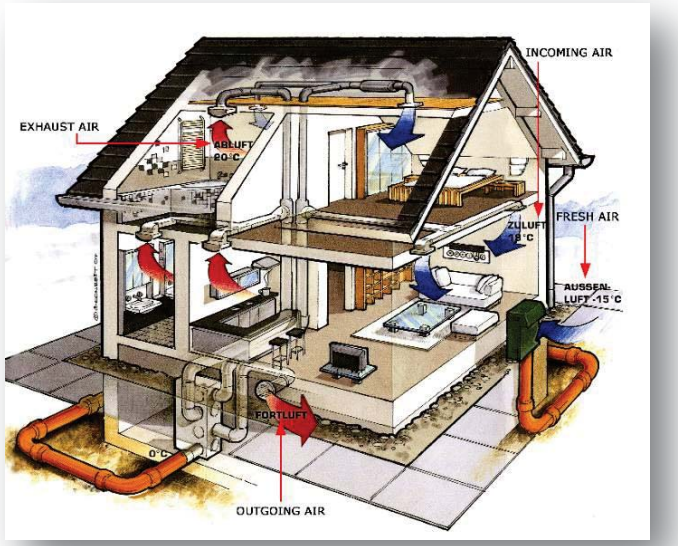
If n_{50} 0.6 h^{-1} is exceeded, leak detection must be carried out and confirmed in writing

Source: Passivhaus Institut/ Sarir i Author: SP


AIR TIGHT BUILDING
This is an airtight building, all penetrations to the external envelope must be identified and reported to Bill and Julie.
El edificio esta cellado hermeticamente con una membrana
Favor de tener cuidado de no penetrar la membrana
Todas penetraciones deben ser reportado a Bill o Julie

Mechanical Fresh Air Ventilation

Same as new-build PH standard



All conditioned spaces must be connected to a supply or extract air system with **heat recovery**

Efficiency of heat recovery
$\eta_{HR,eff} \geq 75\ \%$

Maximum **electricity** consumption ≤ 0.77 Wh/CFM

Exemptions for Insulation Levels:

- Landmark restrictions
- Cost ineffective
- Legally prohibited
- Unacceptable restriction of use
- Special requirements (fire)
- Components unavailable
- Other ...

www.bu.edu

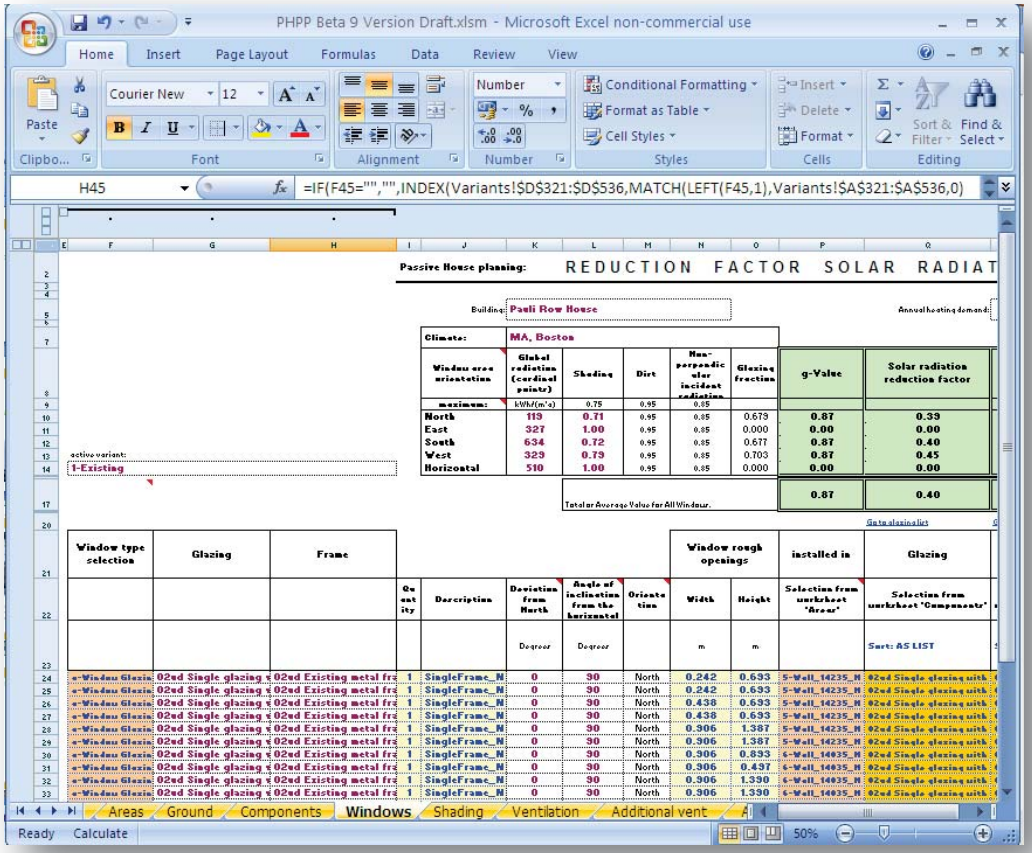
But - requirements for moisture protection and for thermal Comfort must be complied with in each case.

Proof of Moisture Protection Required

- Ensure no excessive moisture in the construction
- Prevent indoor air currents behind the insulation
- Use suitable insulation materials
- Hygrothermal simulation normally required

Rule-of-Thumb Work not Allowed

Energy balance of retrofit must be verified with the Passive House Planning Package (PHPP).



Summary of Key EnerPHit Criteria

Ventilation with ≥ 75 % heat recovery
Electricity demand max. 0.77 Wh/CFM

Heat protection:

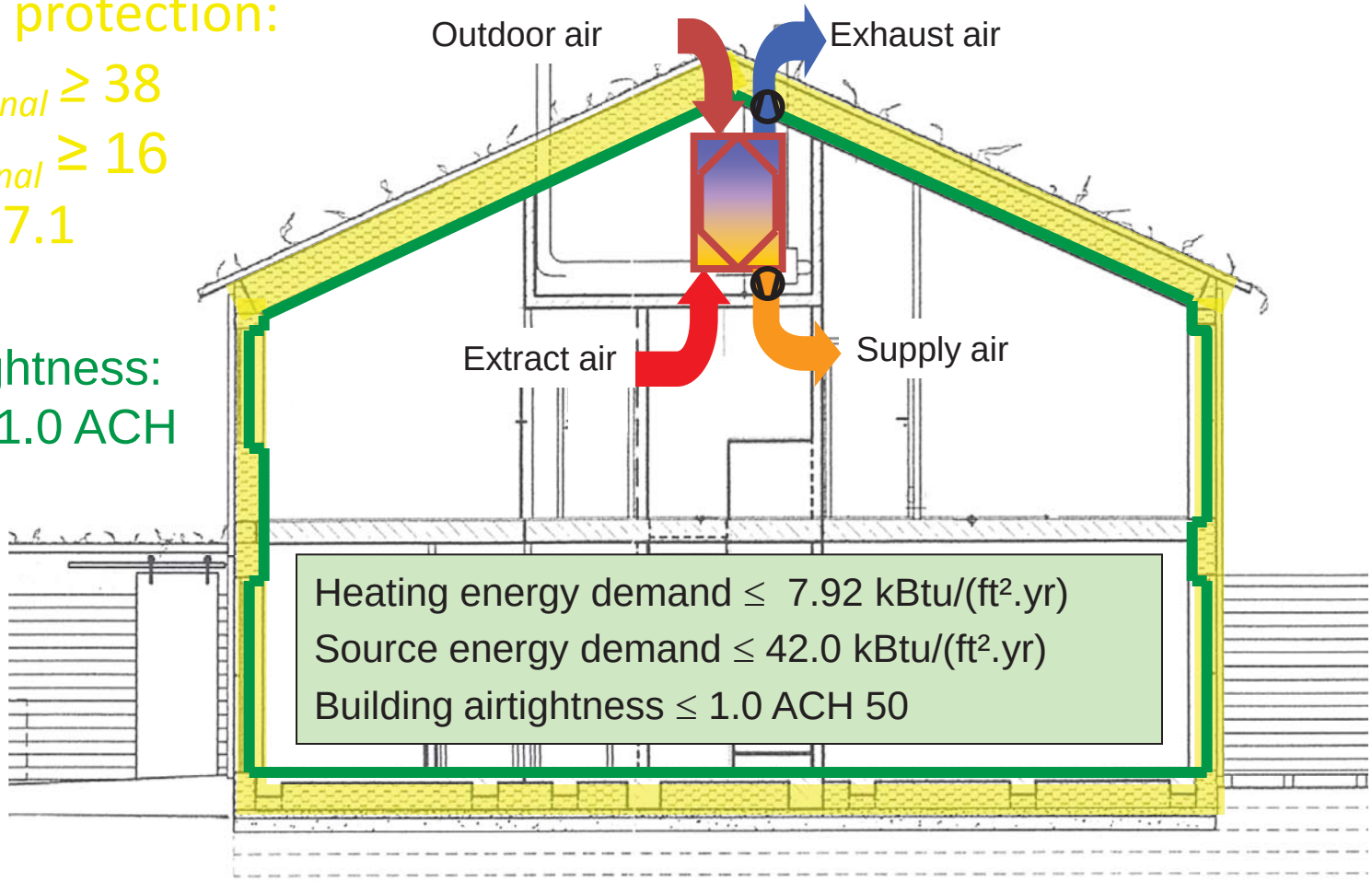
$R_{external} \geq 38$

$R_{internal} \geq 16$

$R_w \geq 7.1$

Airtightness:

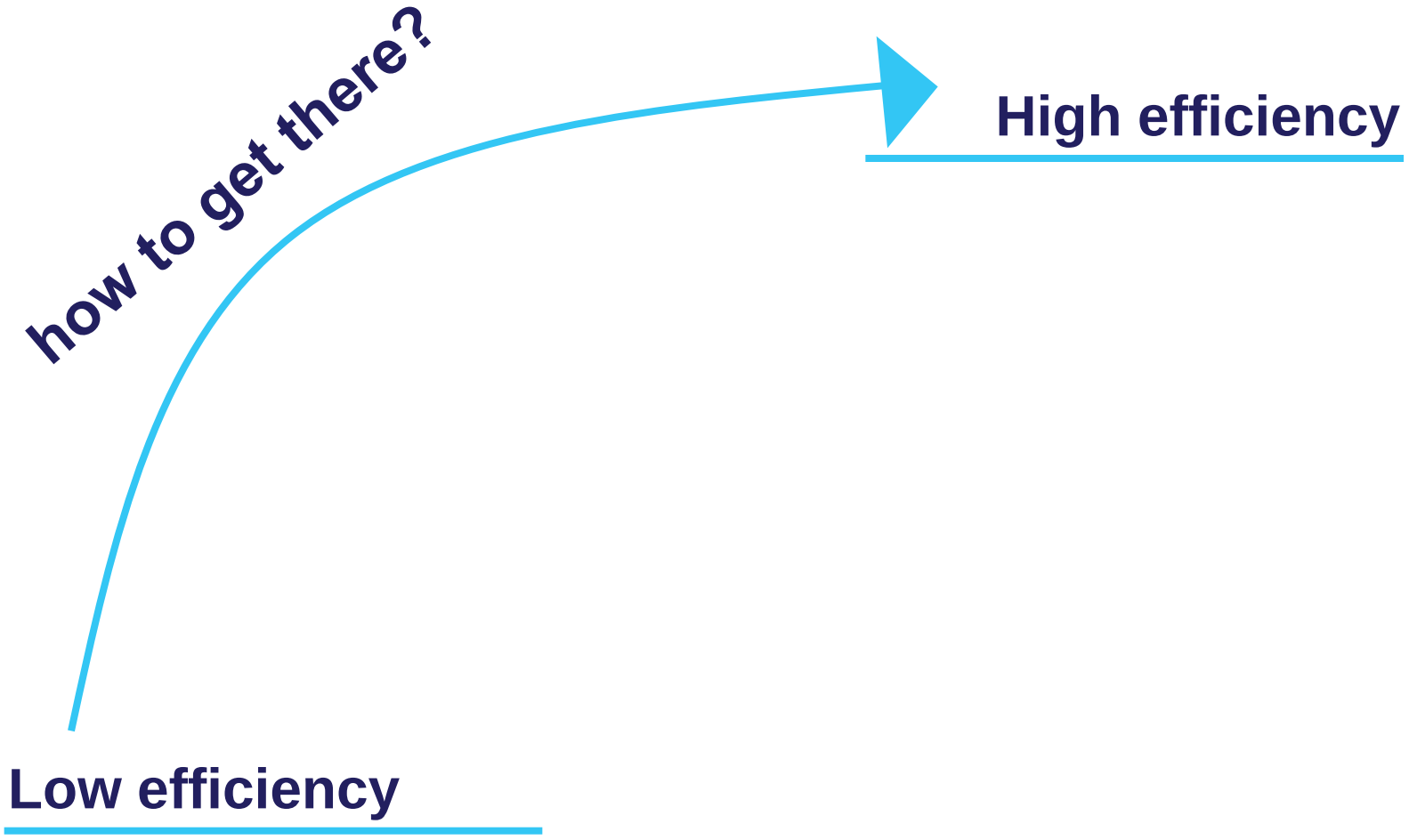
$n_{50} \leq 1.0$ ACH



Source: PHI/ [Cepheus 18 und 22]

Author: PHD

EuroPHit Research Project


how to get there?
High efficiency
Low efficiency

Where to start?

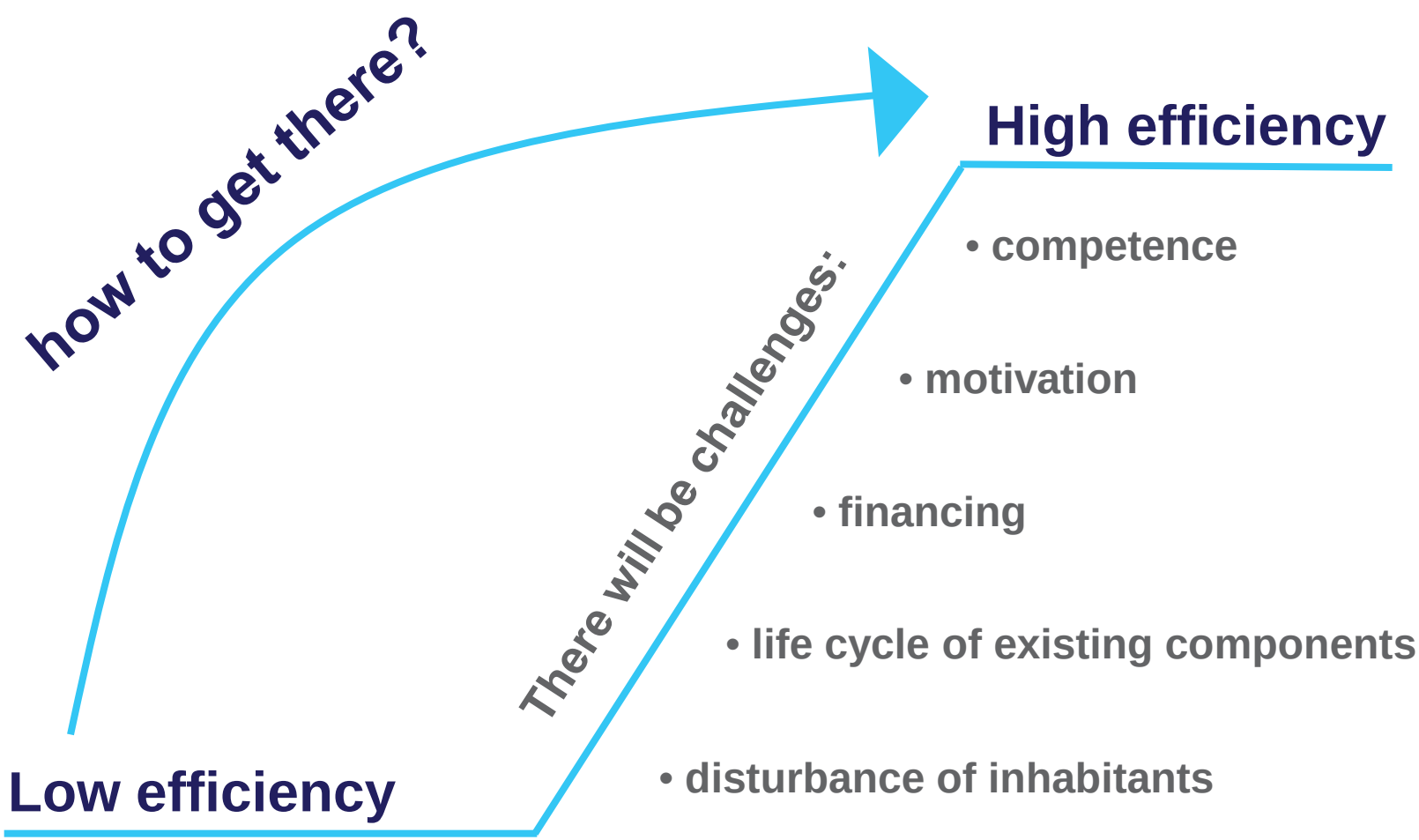
Windows?

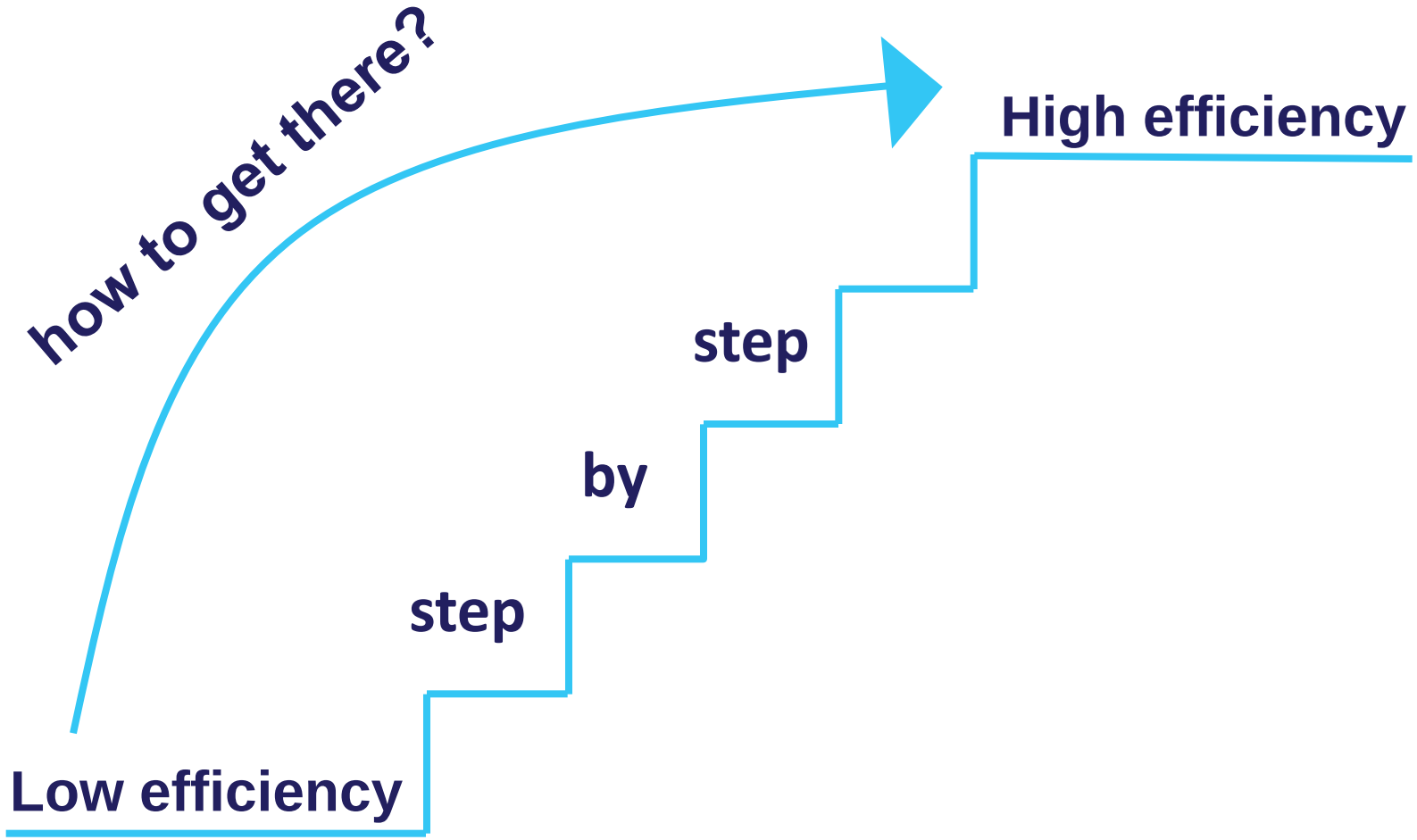
Air-tightness?

Insulation?

Image: tabstaba.blogspot.com/

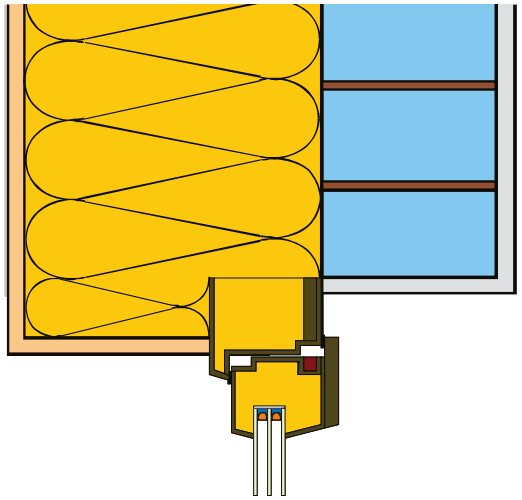
Whatever you Do – Do it right!


how to get there?
High efficiency
There will be challenges:
• competence
• motivation
• financing
• life cycle of existing components
• disturbance of inhabitants
Low efficiency


how to get there?
High efficiency
step
by
step
Low efficiency

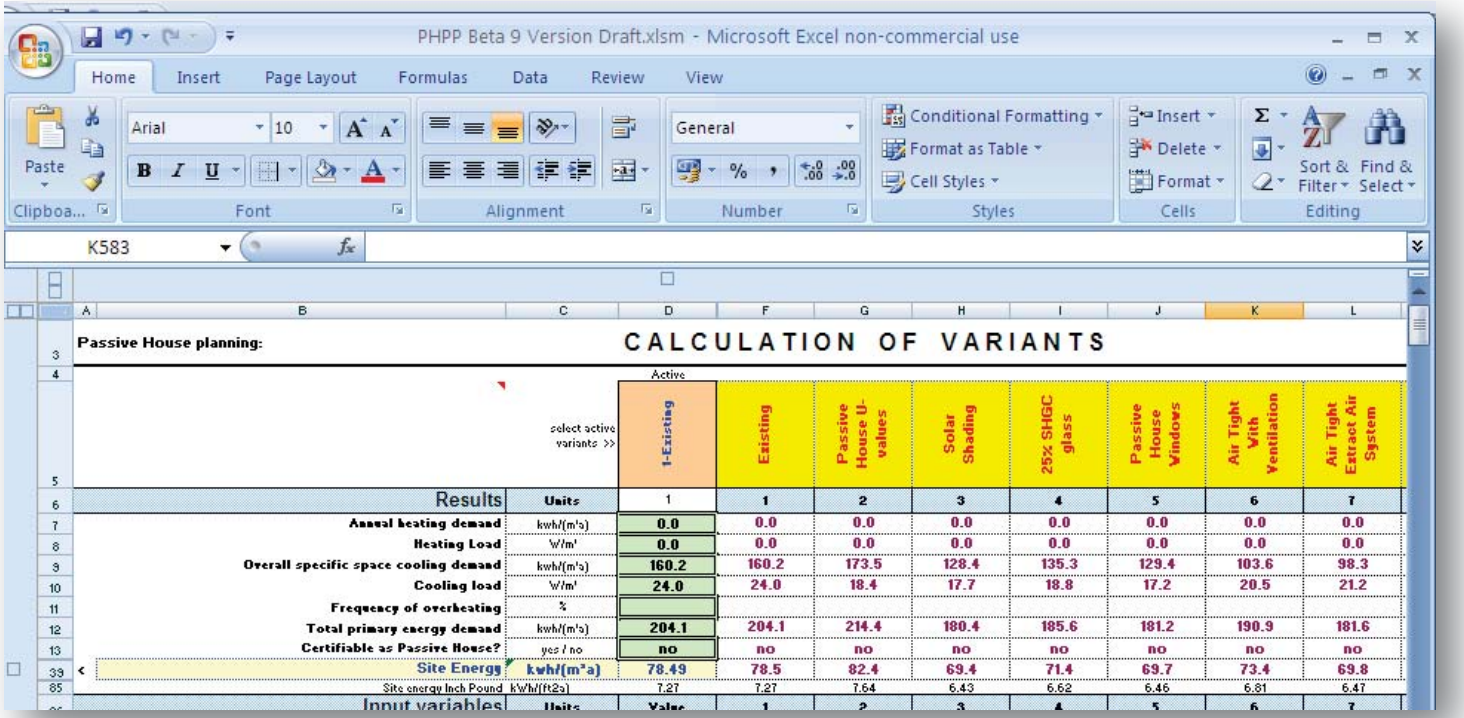
Step by Step Retrofit

Replacement Passive House Windows:



Placed in the (future) external insulation layer

PHPP Version 9 (Beta):Step by Step Retrofitting



Energy impact of individual measures

Documents for Certification

Supporting documents and datasheets

Airtightness Testing Report

Confirmation of detection and sealing of leaks

HRV / ERV Commissioning Report

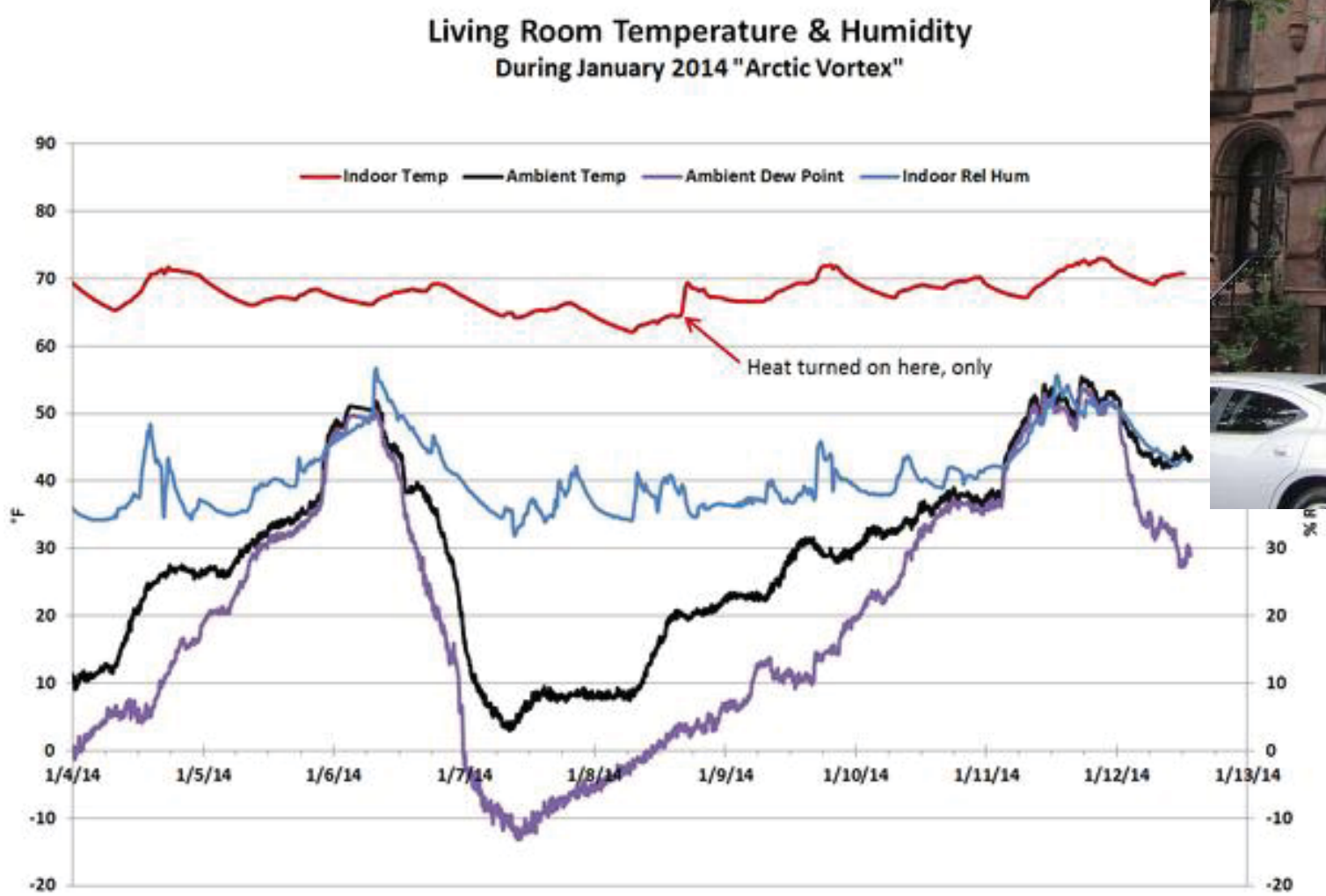
Construction Manager’s Declaration

Photographs of key construction details

Why EnerPHit?

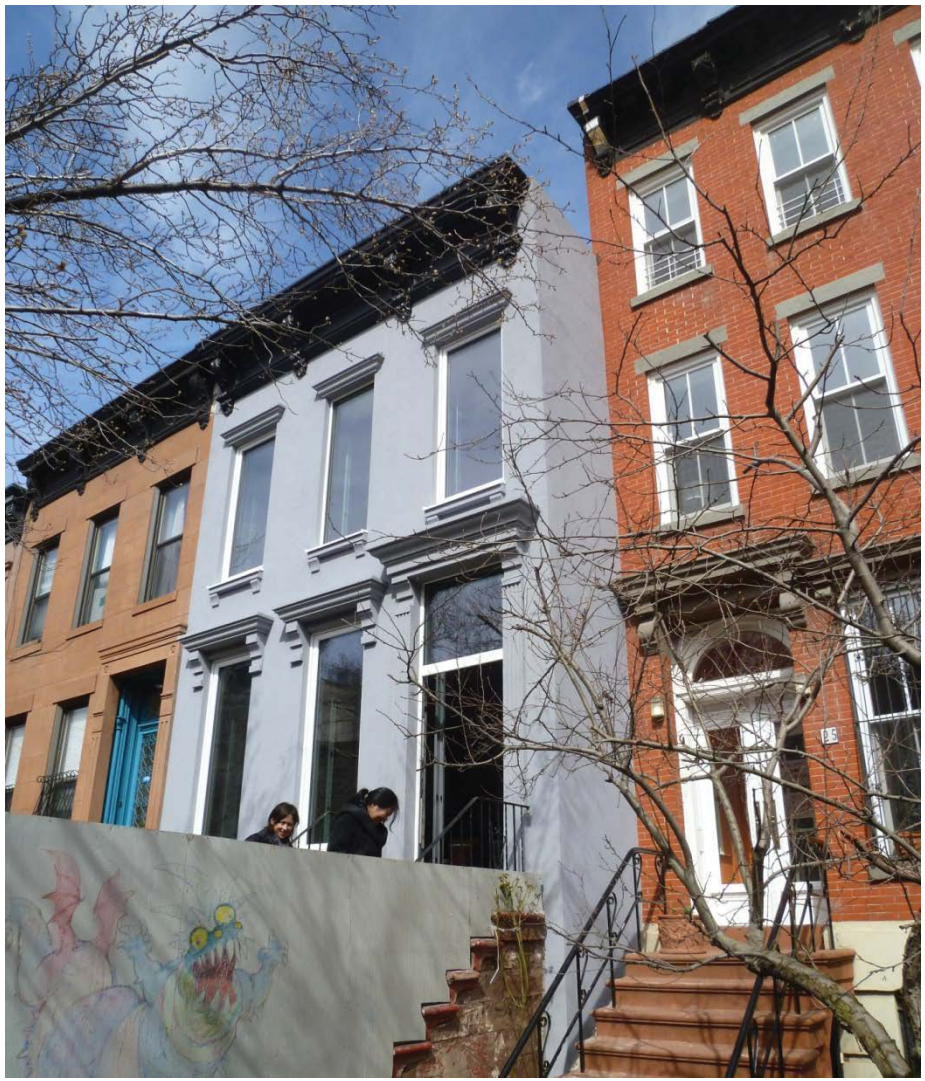
Quality Assurance

Featured in **JLC** Online article by Ted Cushman



Cramer Silkworth, Baukraft Engineering Brooklyn, NY

Westport, CT



Julie Moskovitz, Fabrica718

Brooklyn, NY

Greg Duncan Architect

Brooklyn, NY

Historic Masonry

Preserve, Protect and Perform

Protect:

Reduce wetting, Prevent Freeze Thaw, Prevent Mold, Preserve Historic Character, ensure it's robust for another 150 years.

Perform:

Comfort, Health, Efficiency, Resiliency, Affordability

Protect and Maximize Comfort:

1. Successfully **shed water**
2. Maximize **airtightness** and **vapor** control (The Drying Potential)
3. Maximize **safe insulation** levels
4. Minimize **thermal bridges**
5. Great **ventilation**
6. Great **windows**

Shed Water: cornices, sills, drains, roofs, walls, ground, porosity, mortar

DOE/BSC

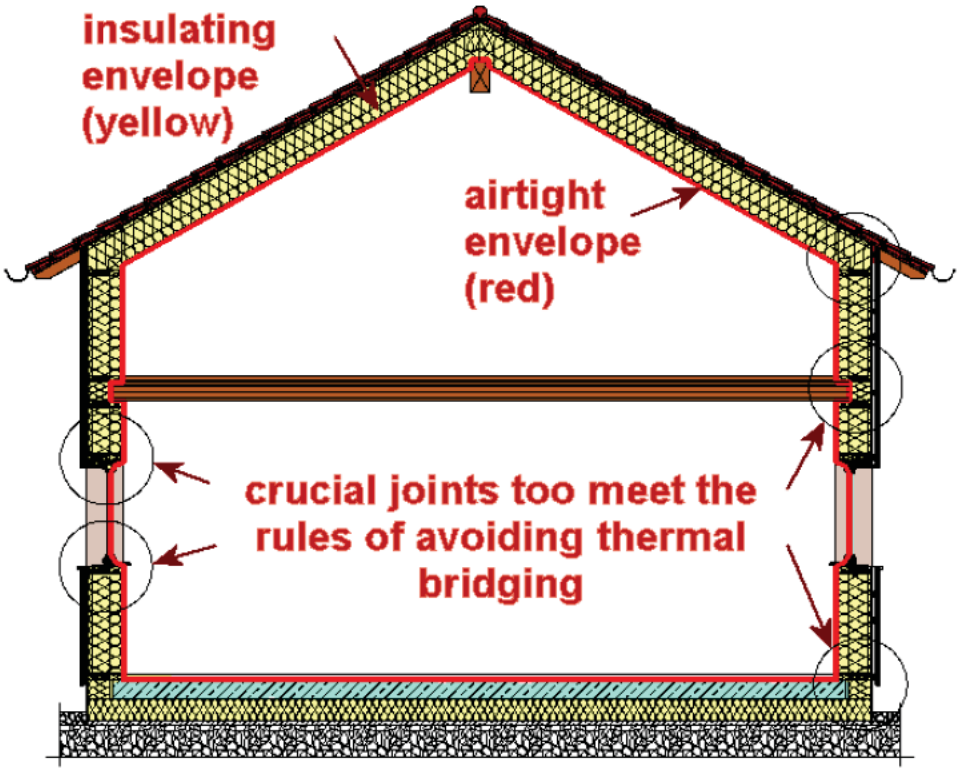
Freeze-Thaw is a whole systems failure

Expose the Problems & Repair

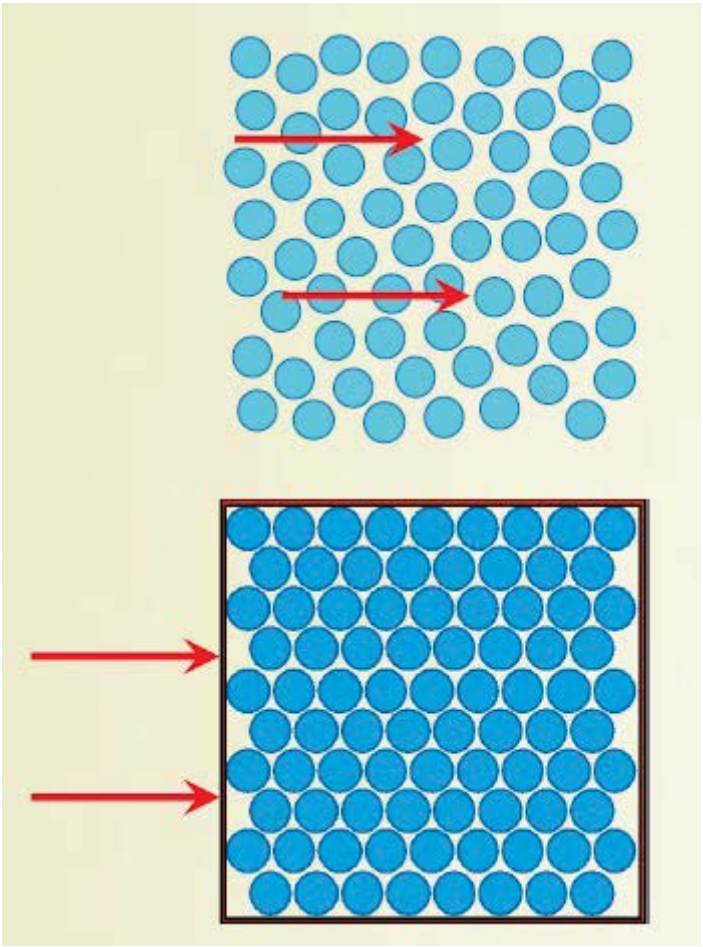
Pull everything away from brick
(with possible exception of plaster at party walls)

Surround with Airtightness.

Your Conditioned Spaces

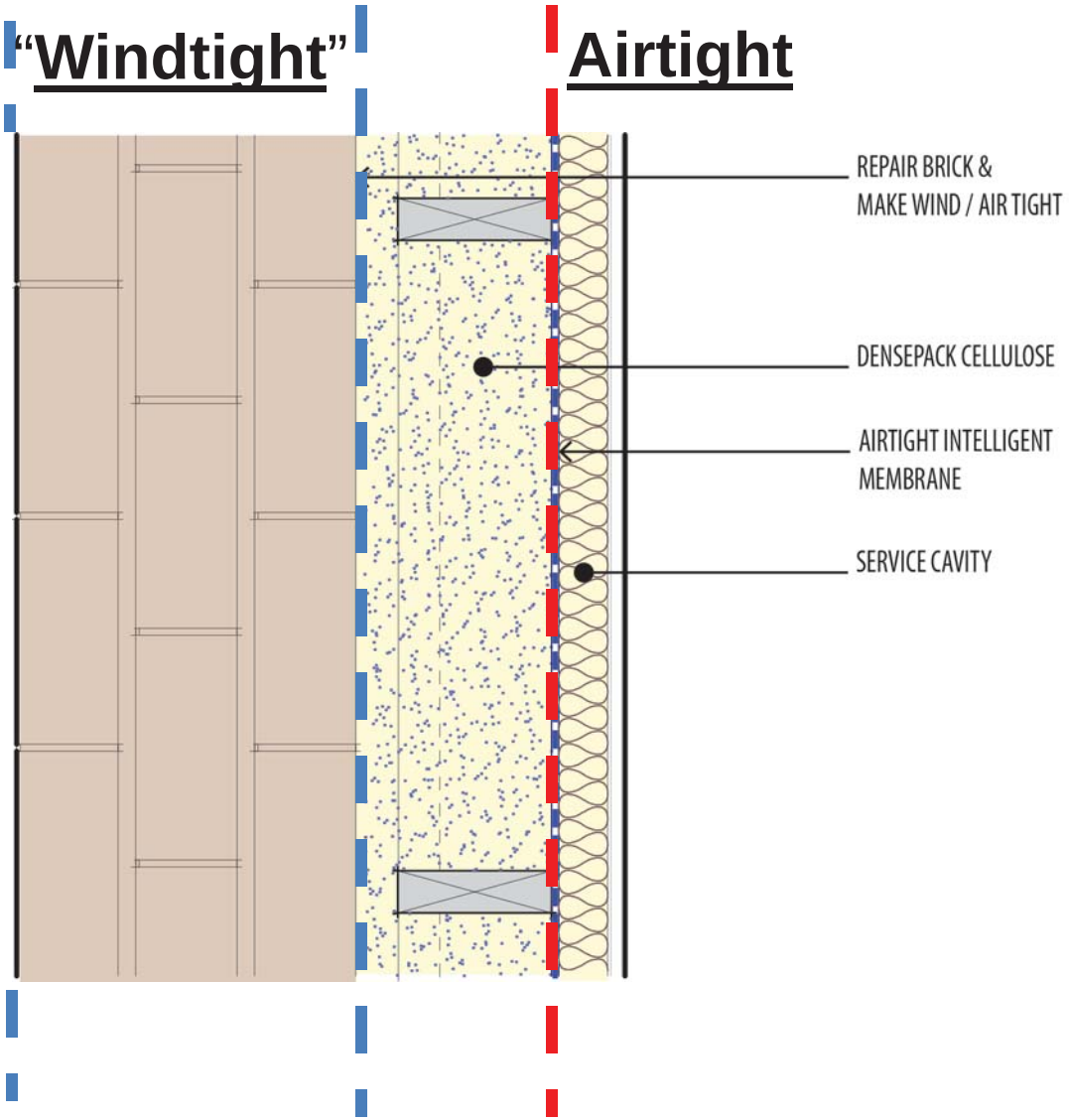


Ref http://passipedia.passiv.de/passipedia_en/



And Verify with Blower Door.

make airtight **inboard** & **outboard**.



Repoint Brick

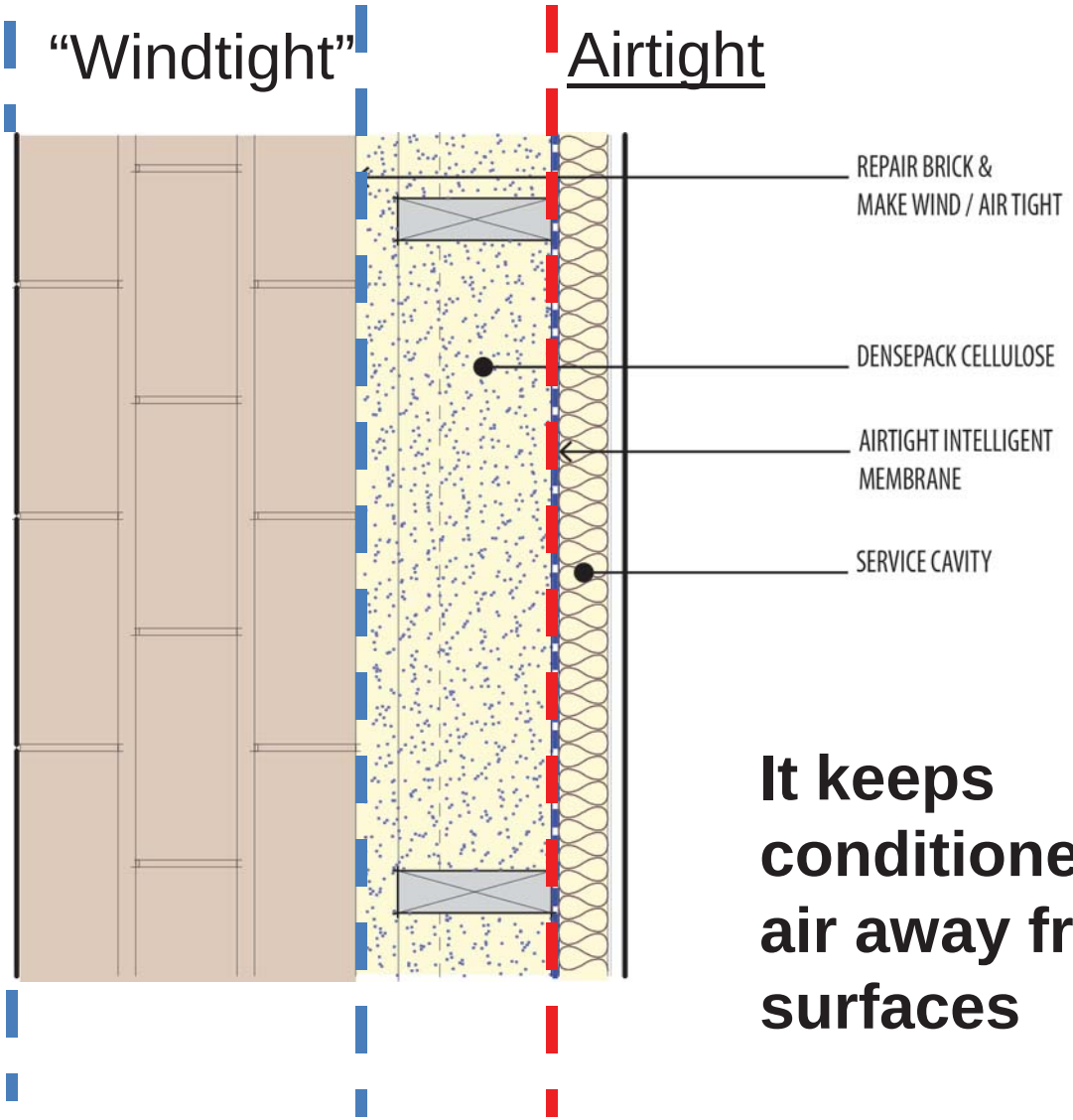
Making brick “windtight”/airtight.

Repointing is generally enough.

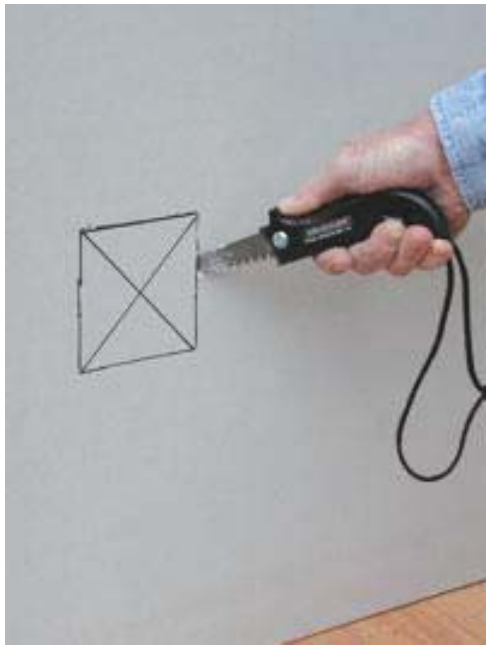
Plaster

Sto Emerald Coat

Optimal Airtightness Inboard of Insulation



It keeps conditioned/humid air away from cold surfaces



Drywall is a sacrificial layer.

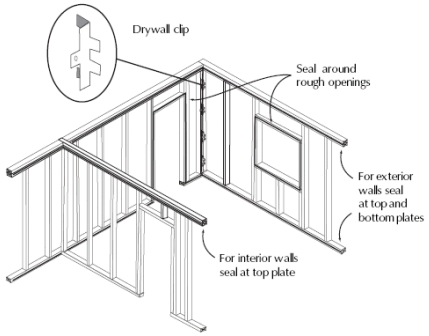
Drywall?

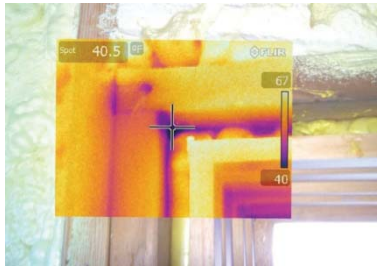
exposed to the occupants

isn’t continuous with the insulation (floors, room partitions)

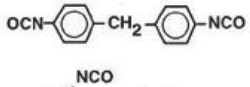
too many junctions at floors and walls

many holes (outlets, plumbing, windows)





Spray Foam?



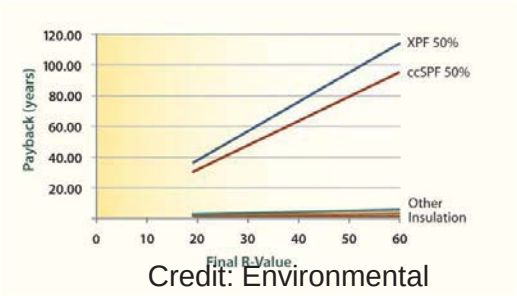
Pure MDI's

Dangerous **Toxic** ingredients
Unacceptable **fire accelerant**
Global warming potential
Installation **problems**
Unreliable performance

(See ***Foam Fails*** series on our **blog**.)

Not optimal

Woods Hole, MA 2011



Credit: Environmental Building News

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

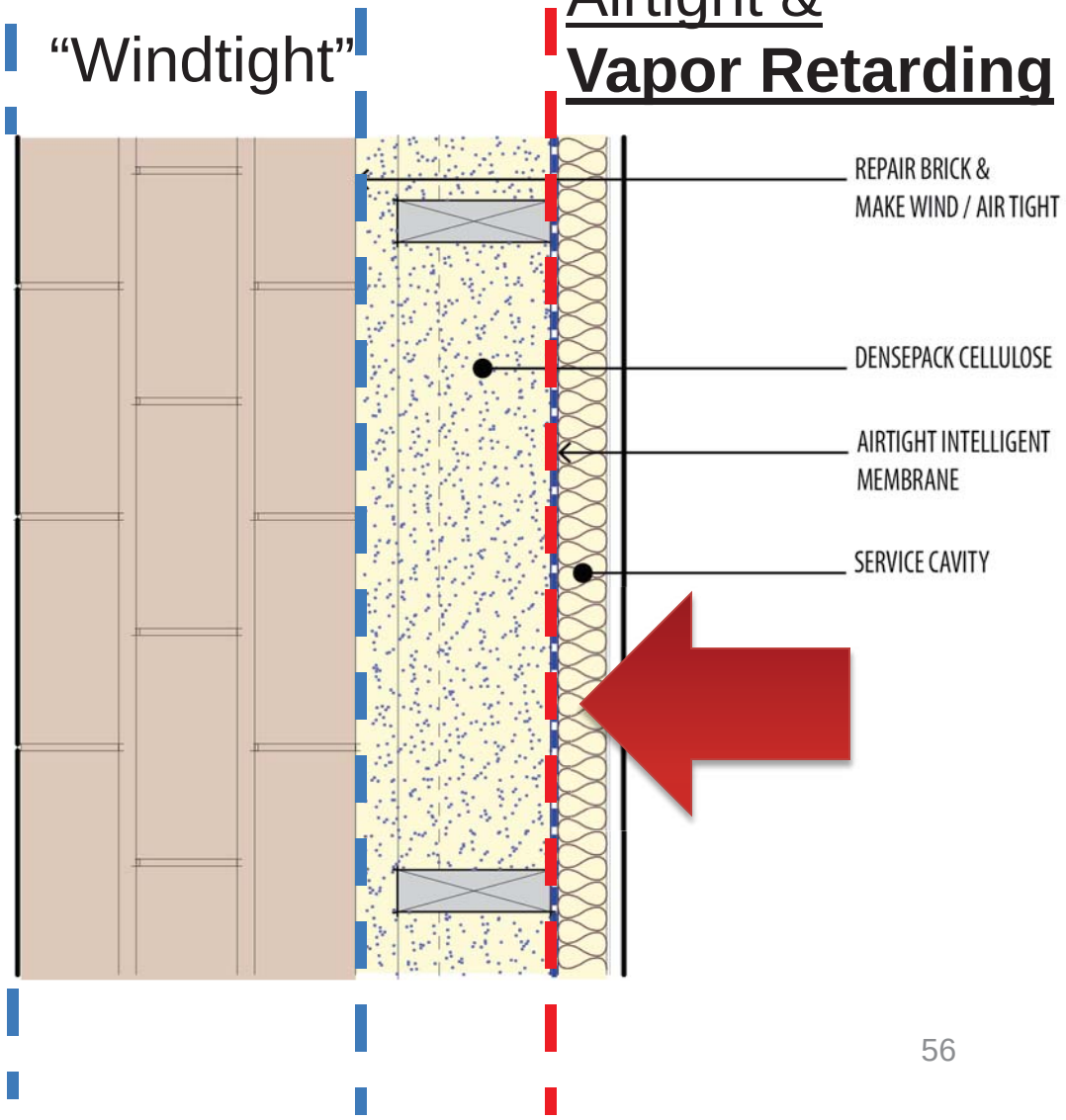
Airtight Membranes

Prevent Condensation from Vapor Diffusion

Interior Vapor Retarders

- Smart membranes
- **No Poly**

Alex Wilson



Maximize the Drying: Material Selection

Vapor Open

Brick
Cellulose
Mineral Wool
Fiberglass
Gyp Board
Latex Paint

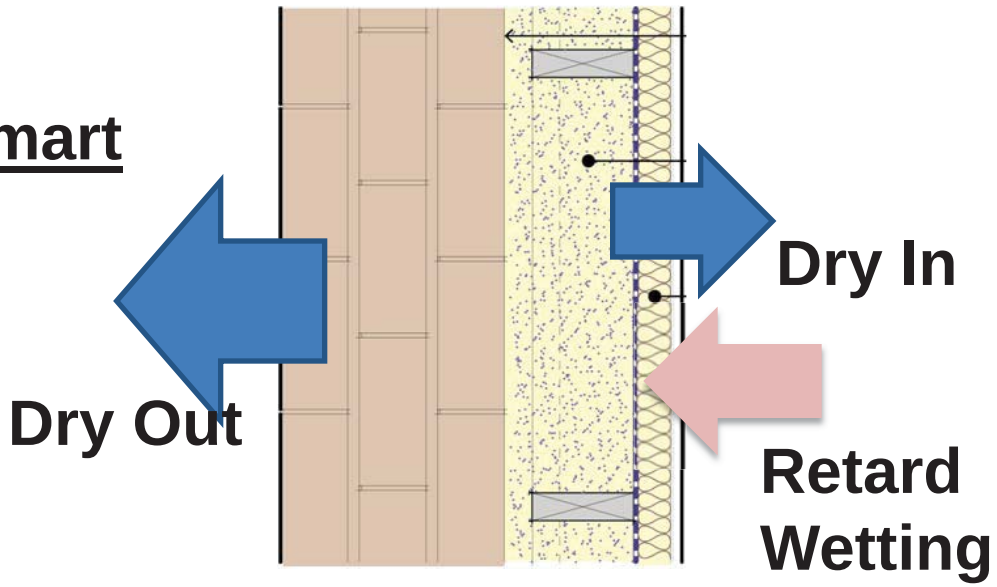
Vapor Variable – Smart

Membranes

Vapor Retarding

Foam - >1.5” CC
OSB
Plywood
Poly – vapor closed

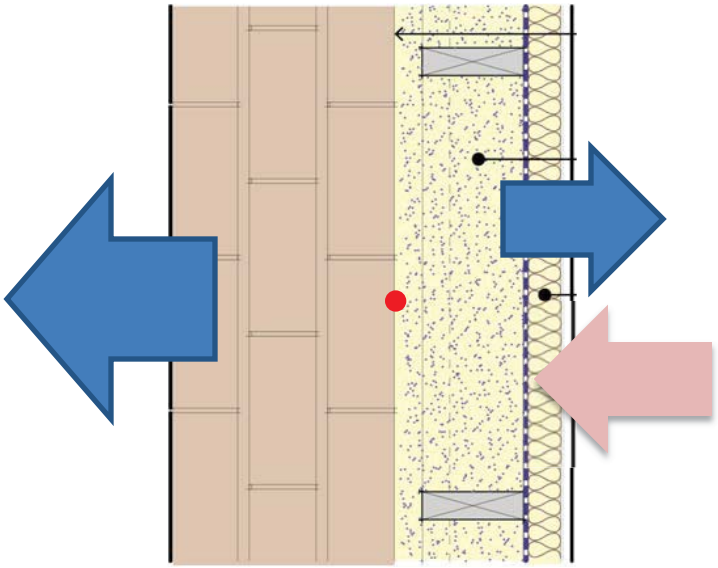
1. **Vapor Open Construction to Exterior**
2. **Smart Vapor Retarding at Interior**



Let's look at some assemblies

Insulation:
Dense-Pack Cellulose
Fiberglass

Outboard:
Shed water
Windtight
Vapor open

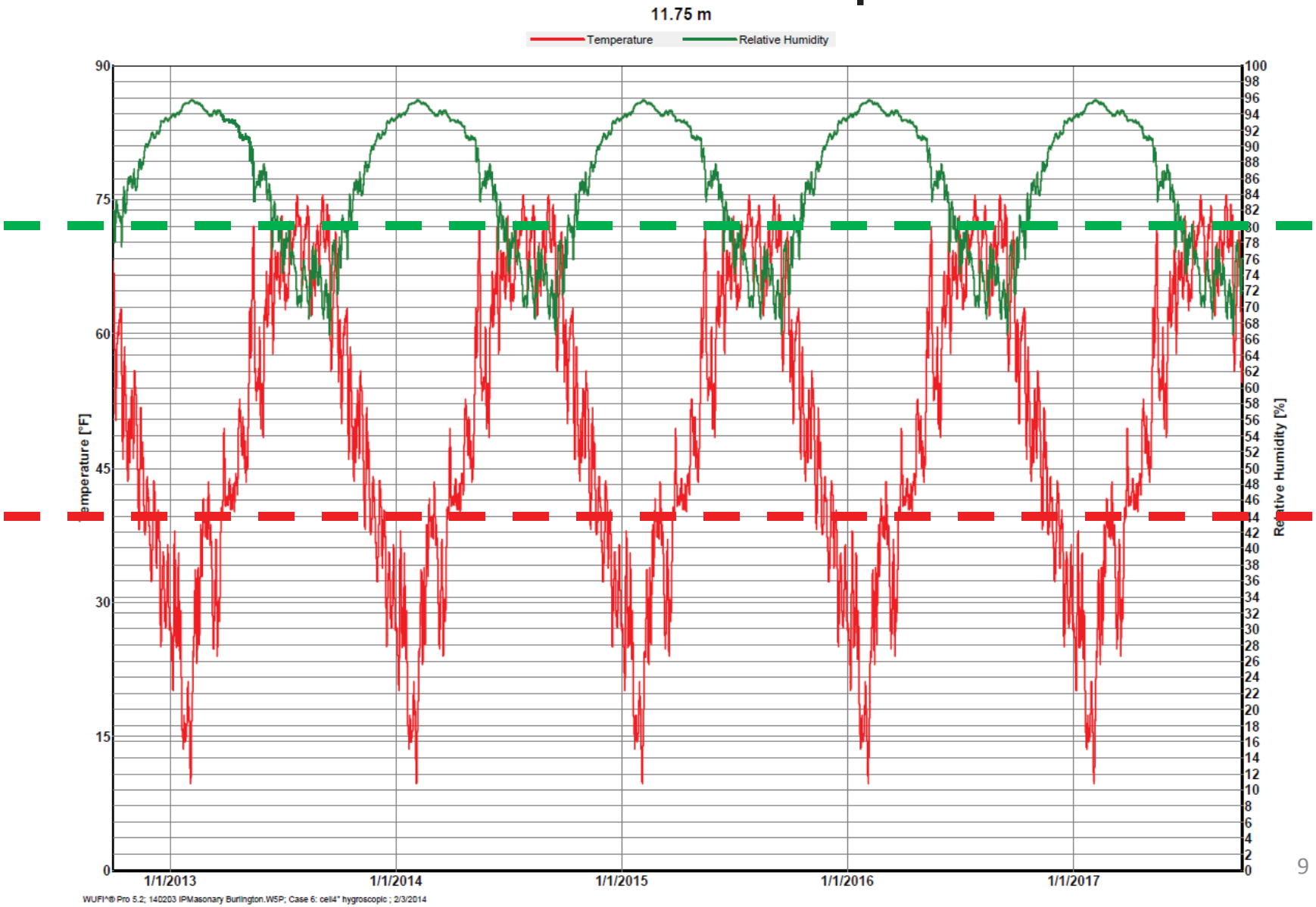


Inboard
Airtight
Vapor Retarding

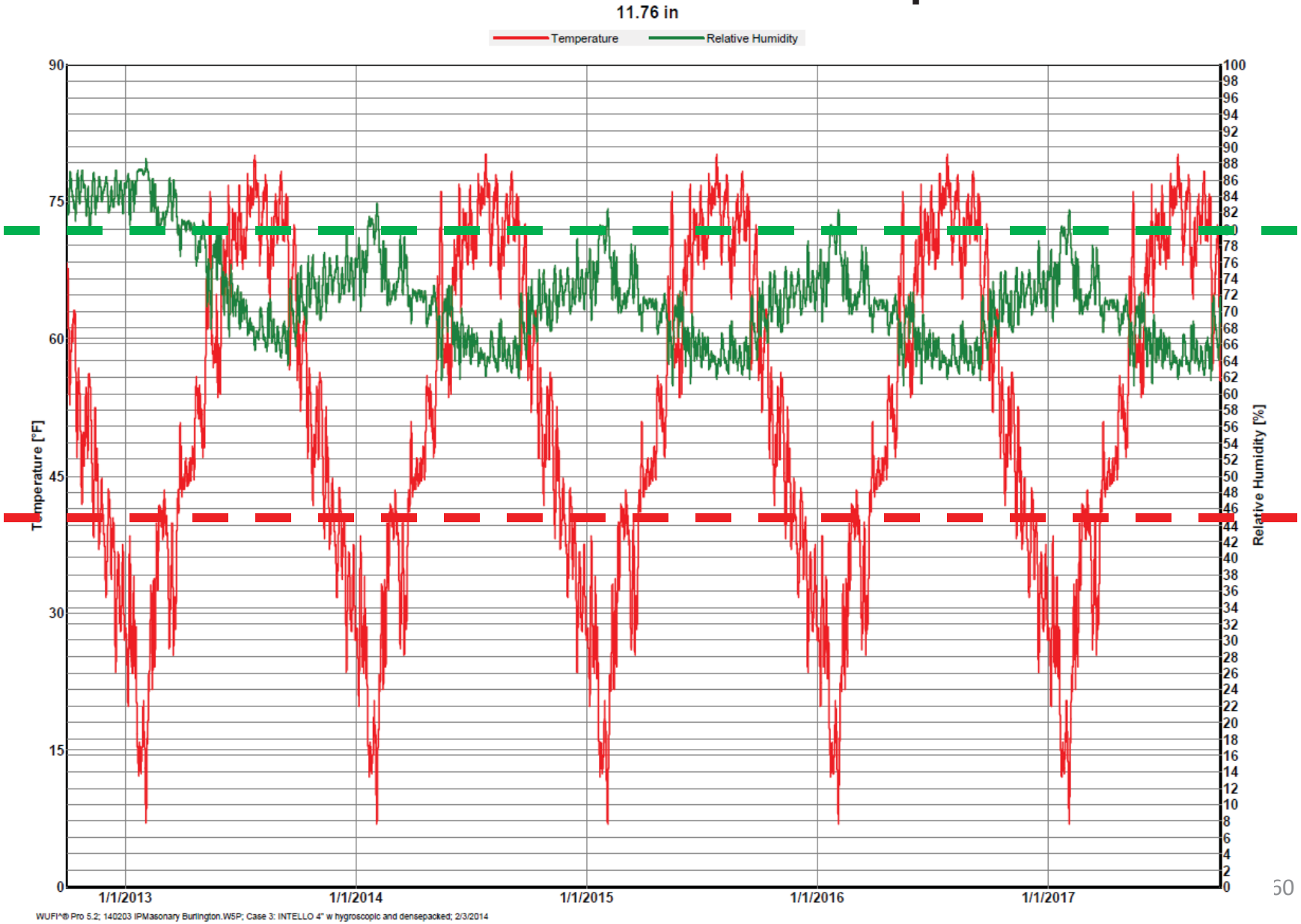
At Red Dot
- Moisture load?
- Mold potential?
- Helping or hurting freeze-thaw potential?

In Burlington Vermont

4” Cellulose without vapor control



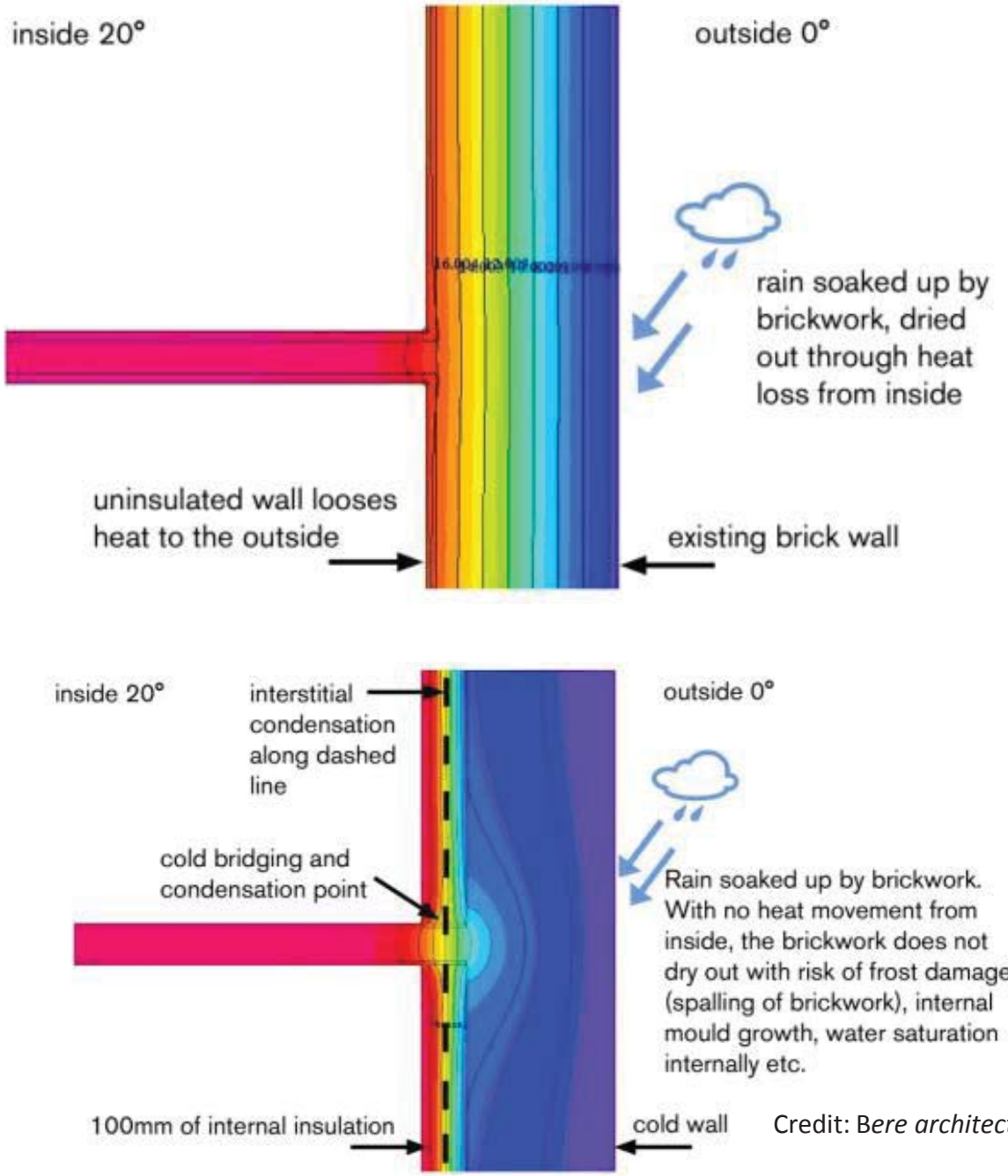
4” Cellulose with smart vapor control



Wood 3x as conductive along grain then perpendicular to it.

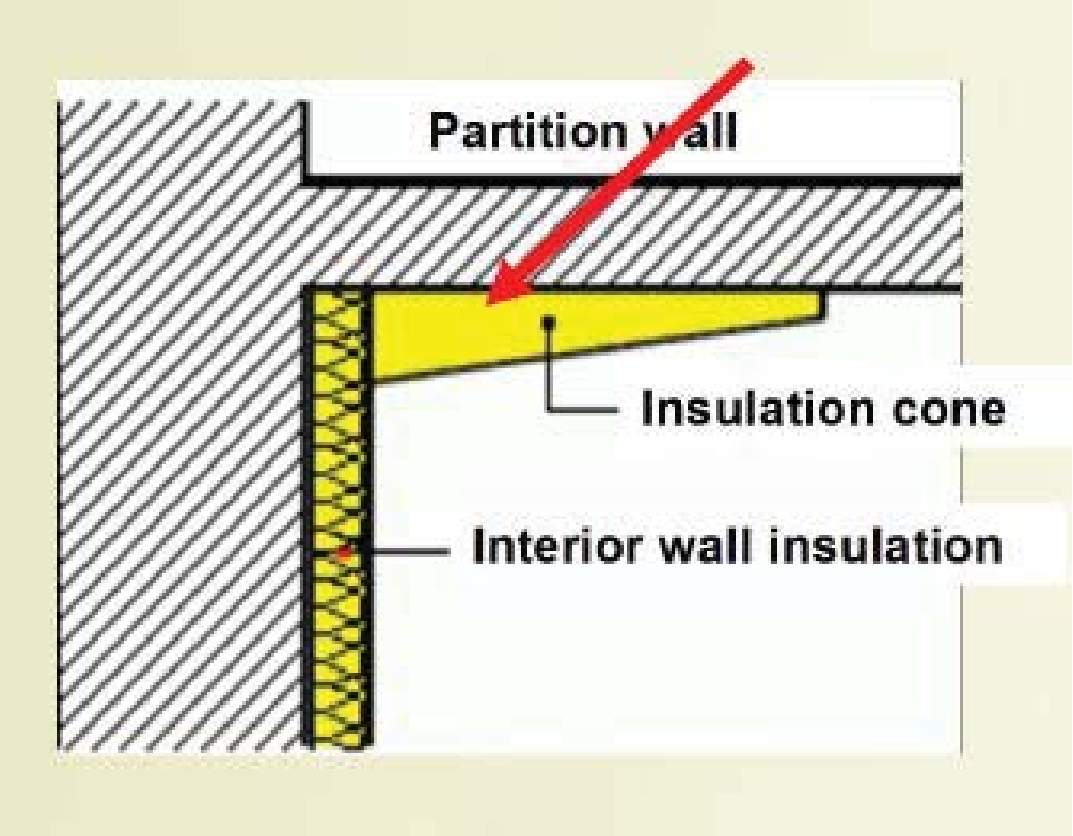
Keep wall dry.

Airseal joist/beam if it cannot be supported internally/on ledge.



Credit: B*ere architects UK*

Thermal bridge free: Party Walls



Floors?

Thermal bridges: can moderate insulation levels

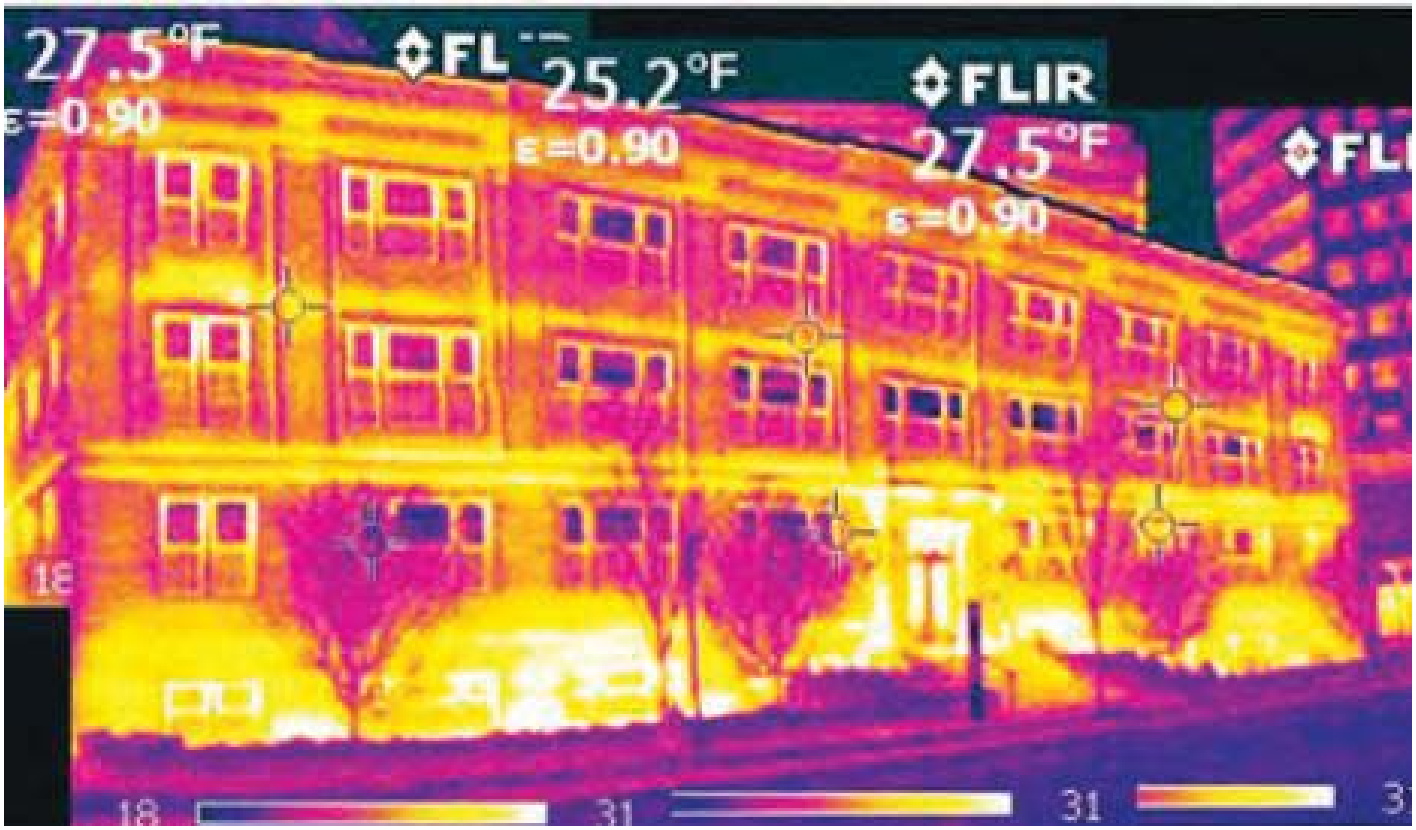
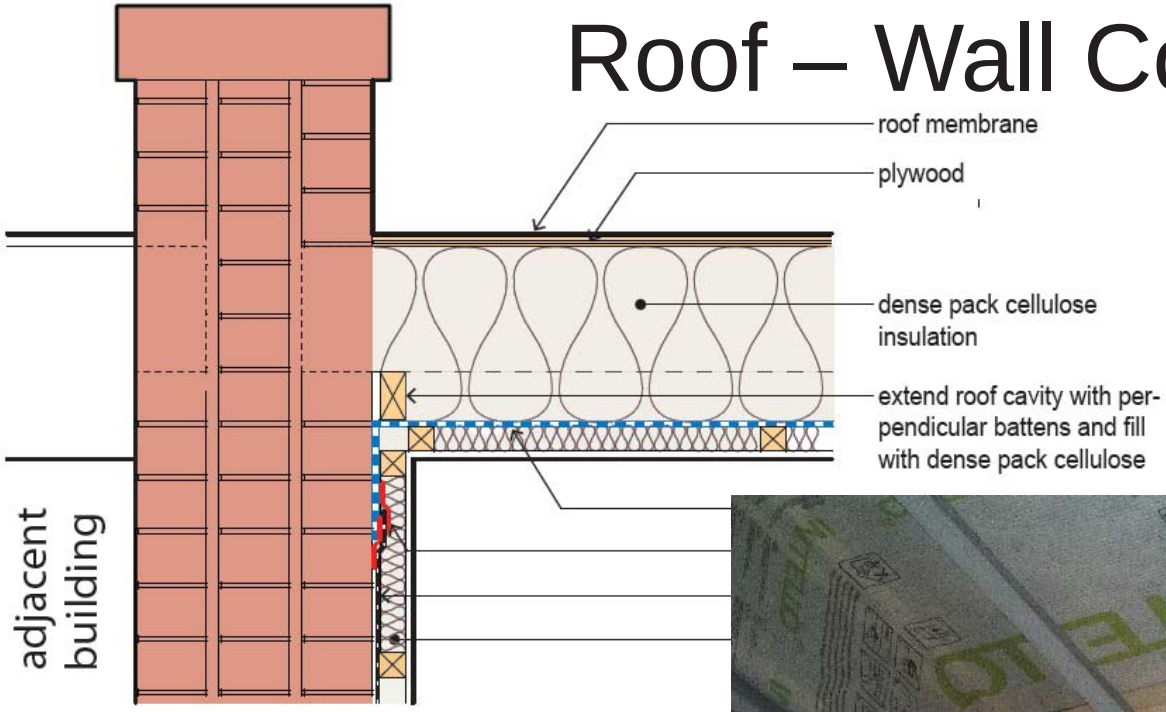


Photo Credit: Building Science Corporation

Roof – Wall Connection



Prospect Avenue, Brooklyn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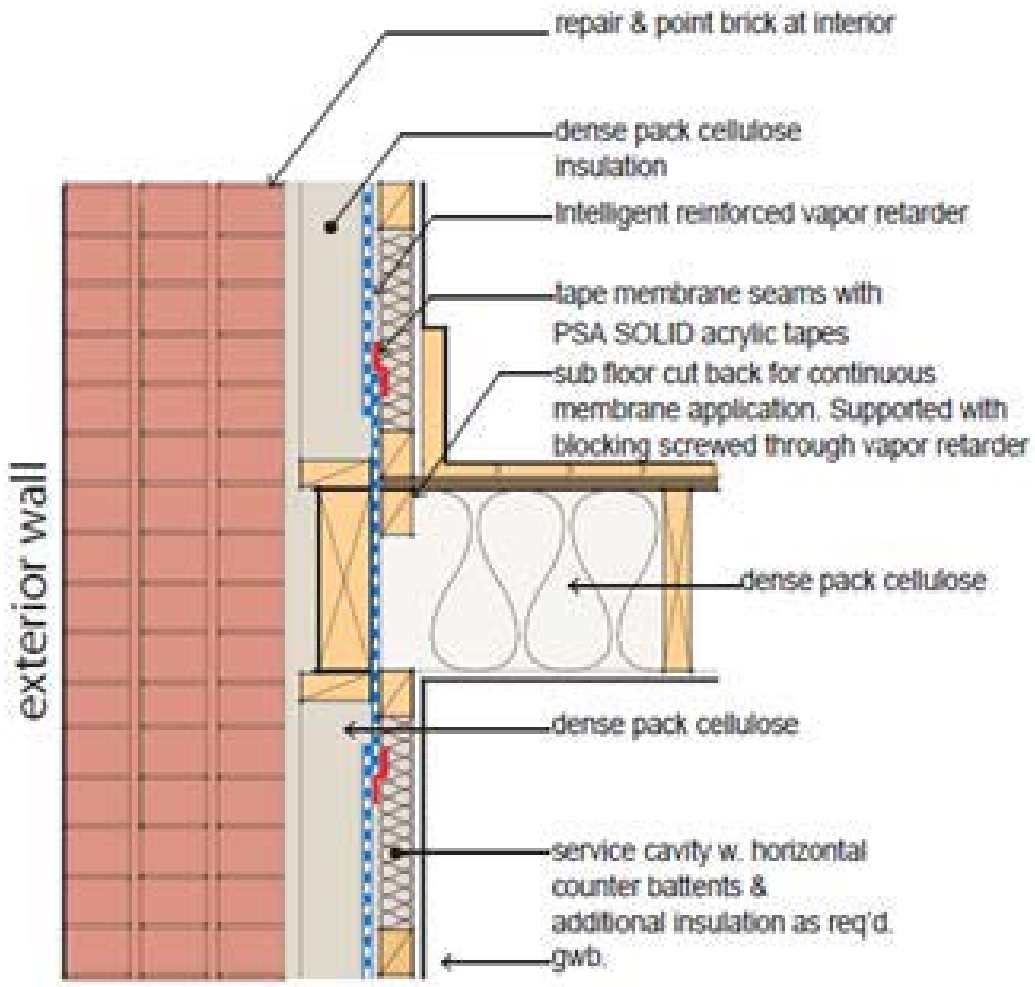
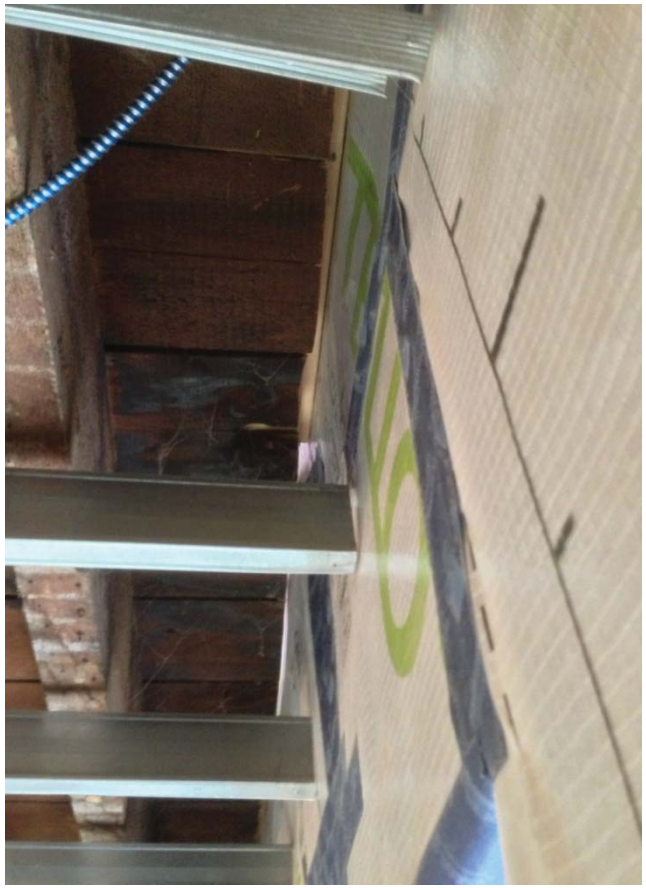
Floor – Wall Connection





Beam penetrations

you need room to airseal – cut back the floor

Prospect Avenue, Brooklyn

Prospect Avenue, Brooklyn

Slab on Grade

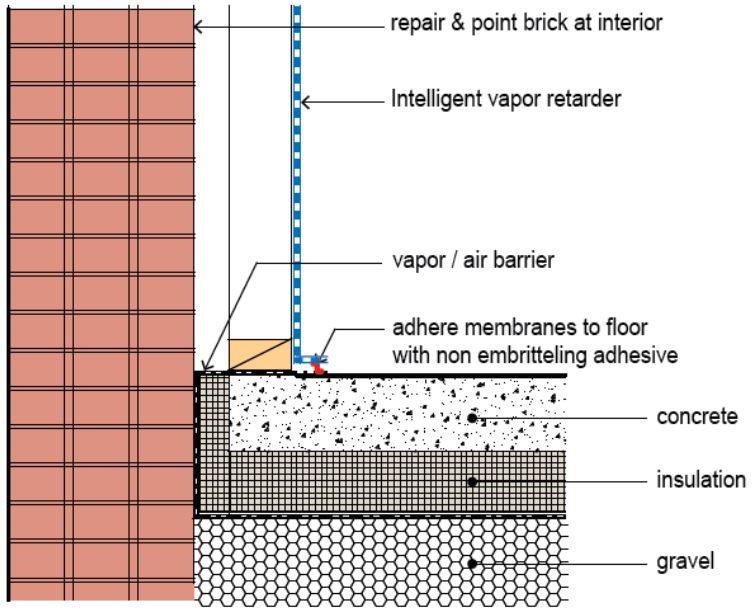
Brooklyn Heights

Wall – Slab Connections

- Felt tape to masonry walls – plastered in

Wall – Slab Connections

- Acrylic adhesive for uneven and porous materials
  - Doesn't embrittle/dry out, remains flexible



Thermally Broken Beam Connection

Prospect Avenue,
Brooklyn

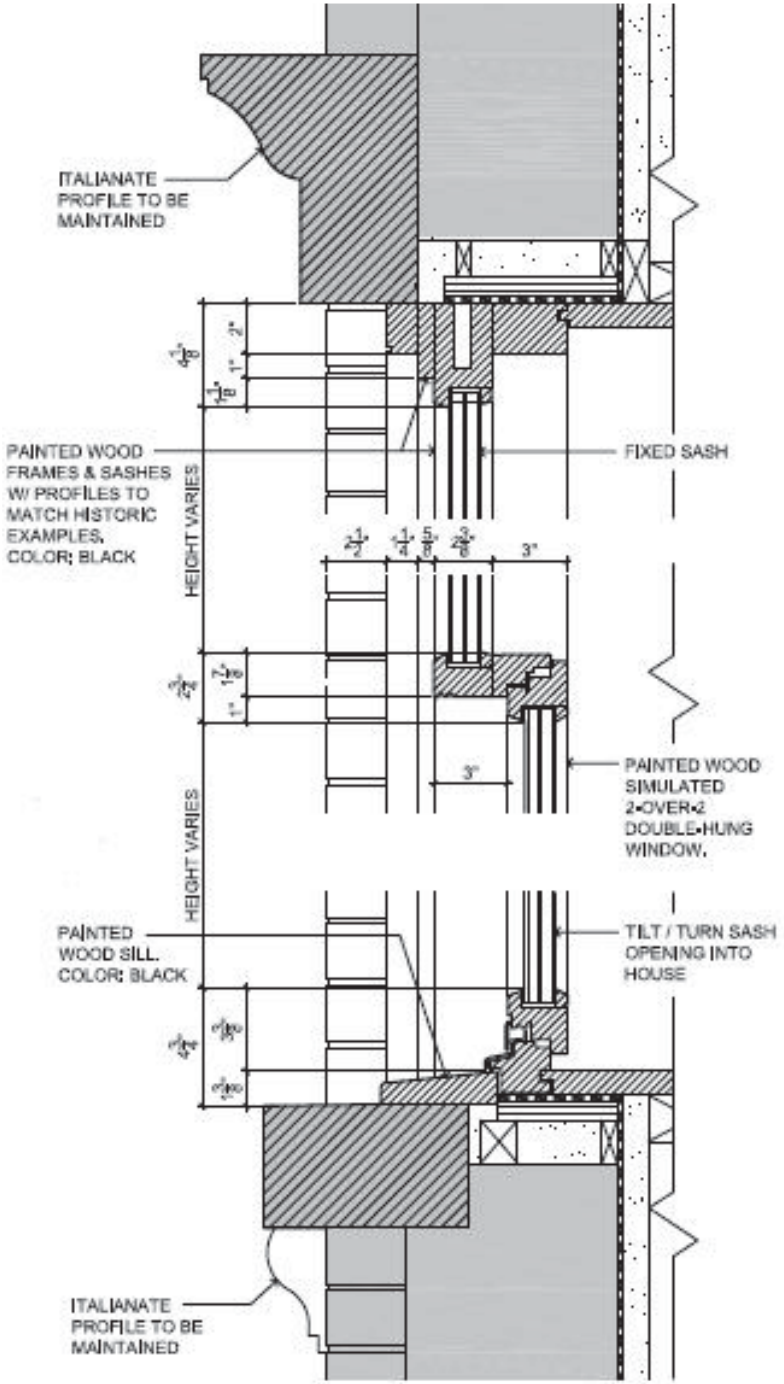
Move beams inboard?

DOE/BSC

…or build a building in a building?

Great Windows

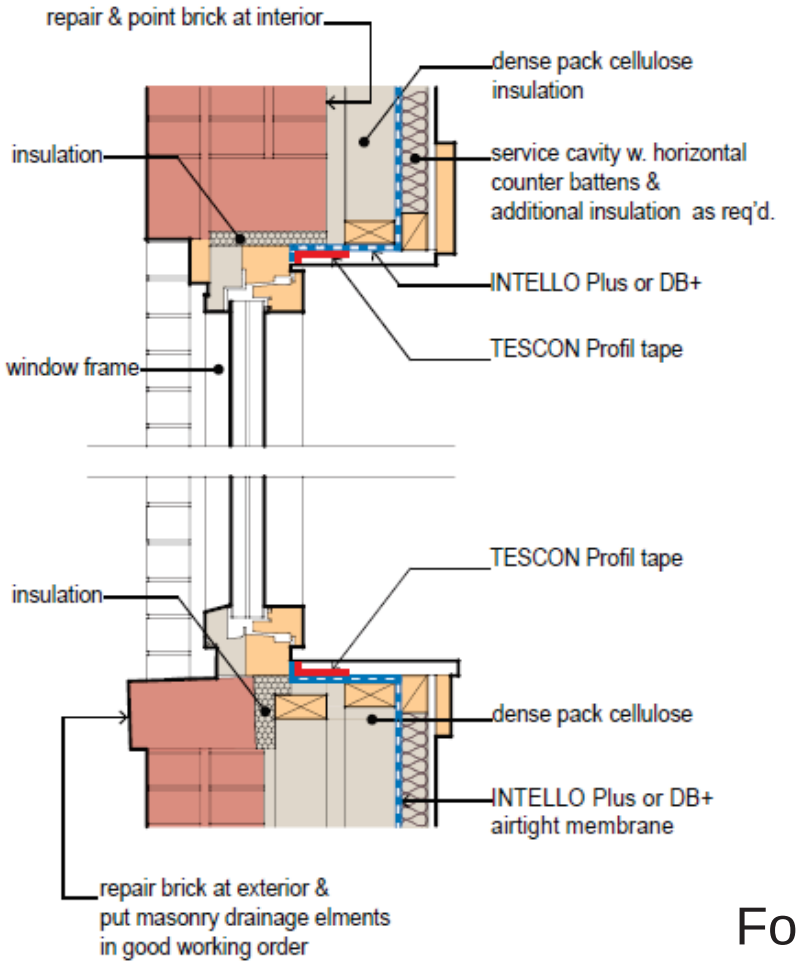
Park Slope, Brooklyn

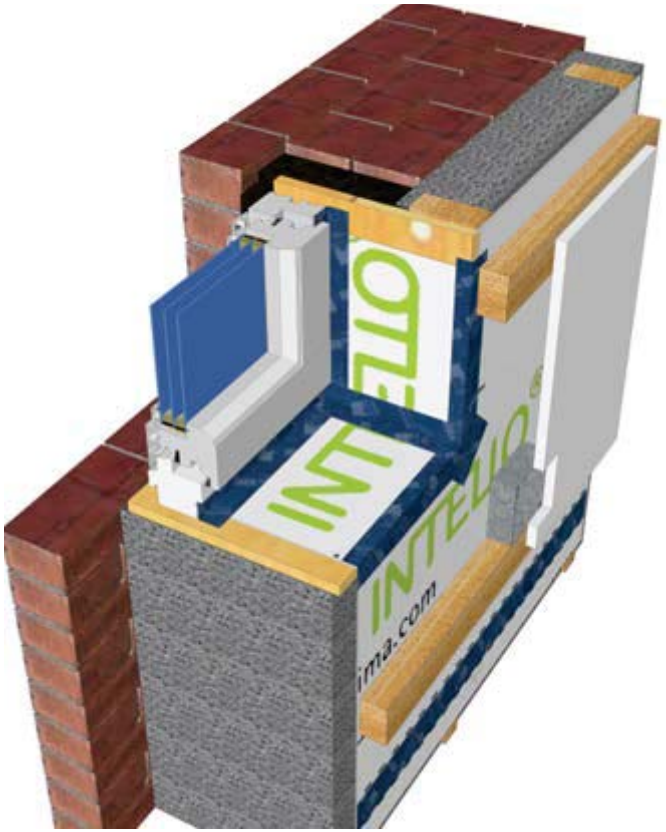


Simulated Historic Double-Hung Windows

Brooklyn Heights Prospect Heights

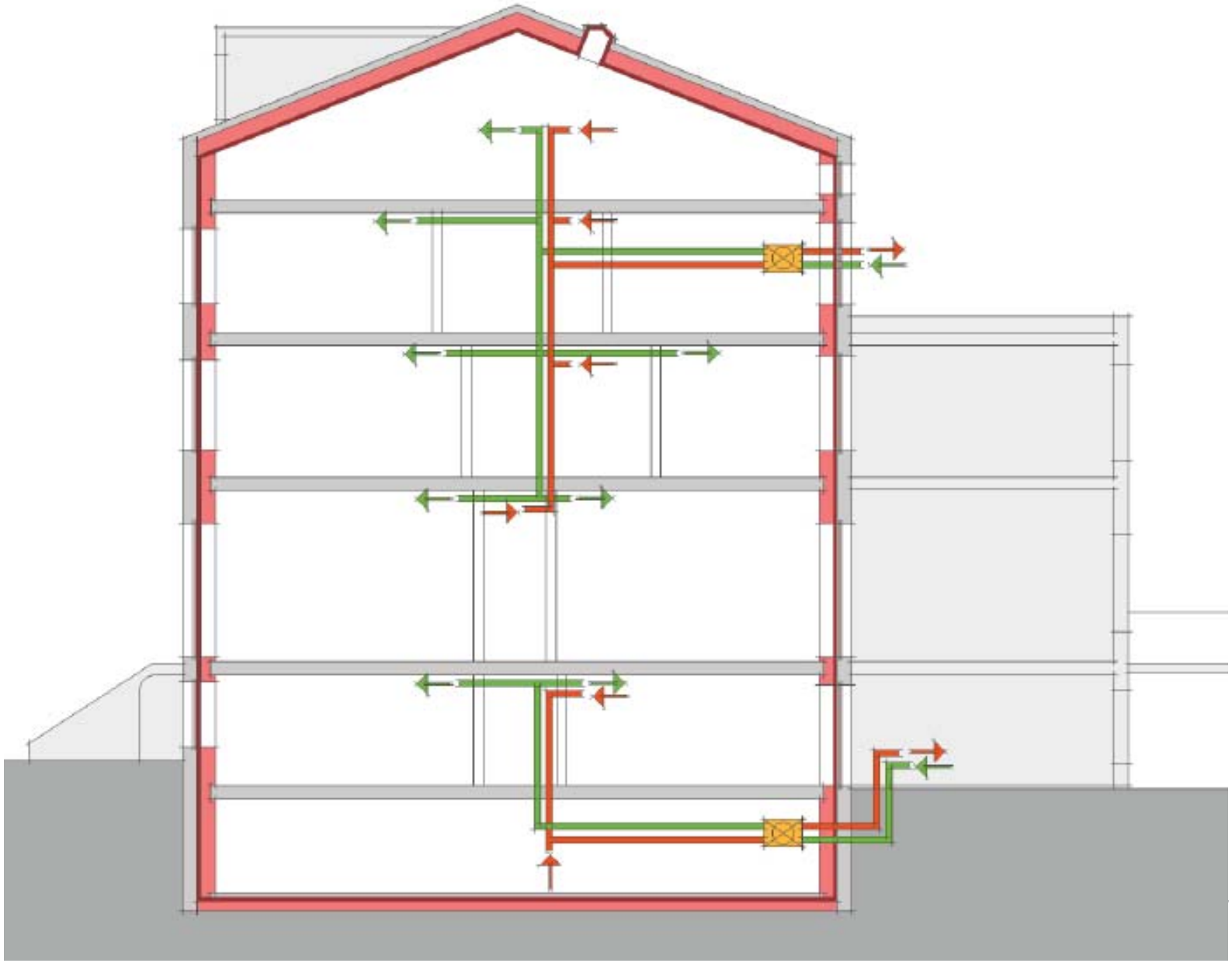
Window integration





Fold membrane into the window opening

Ventilation integration

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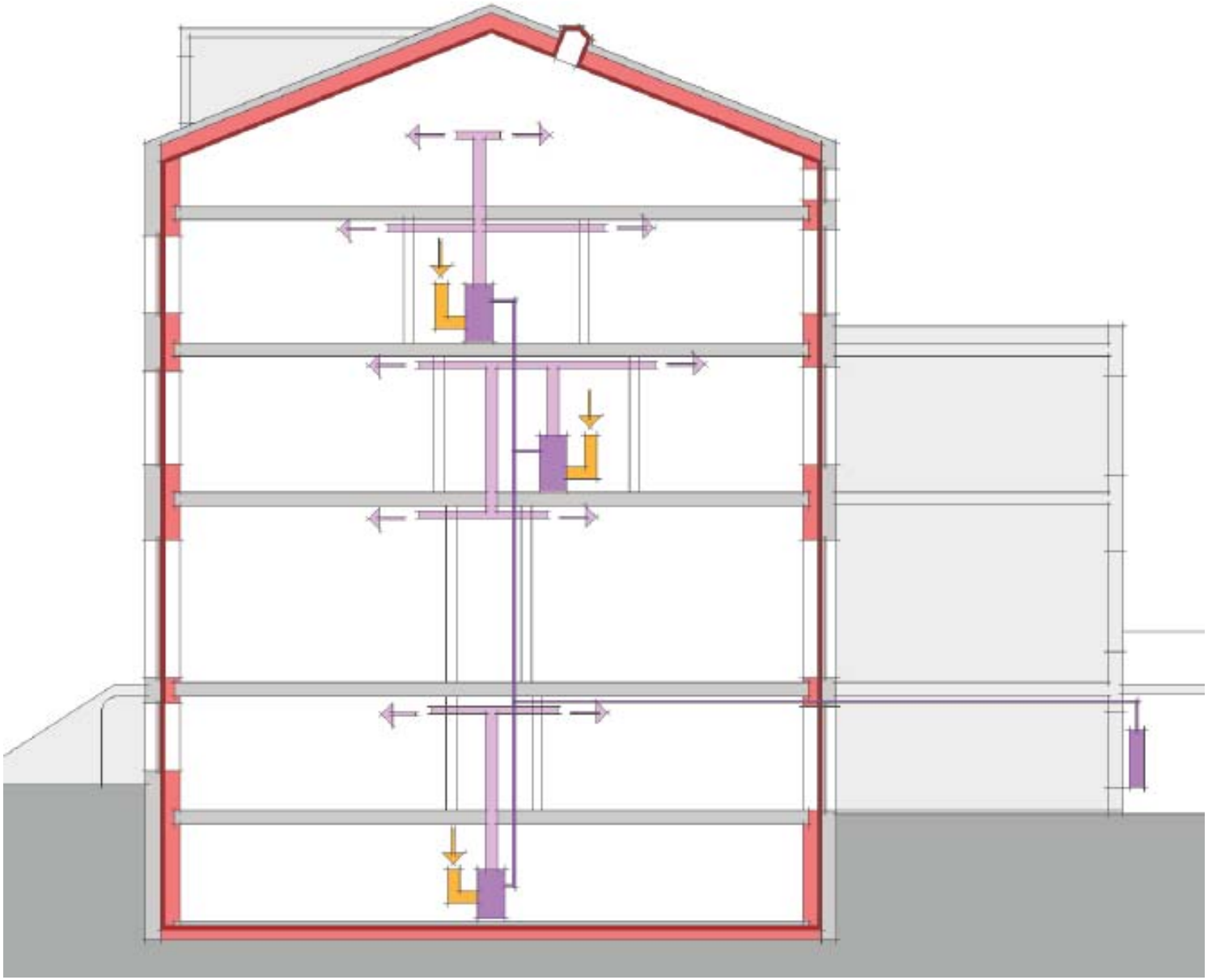
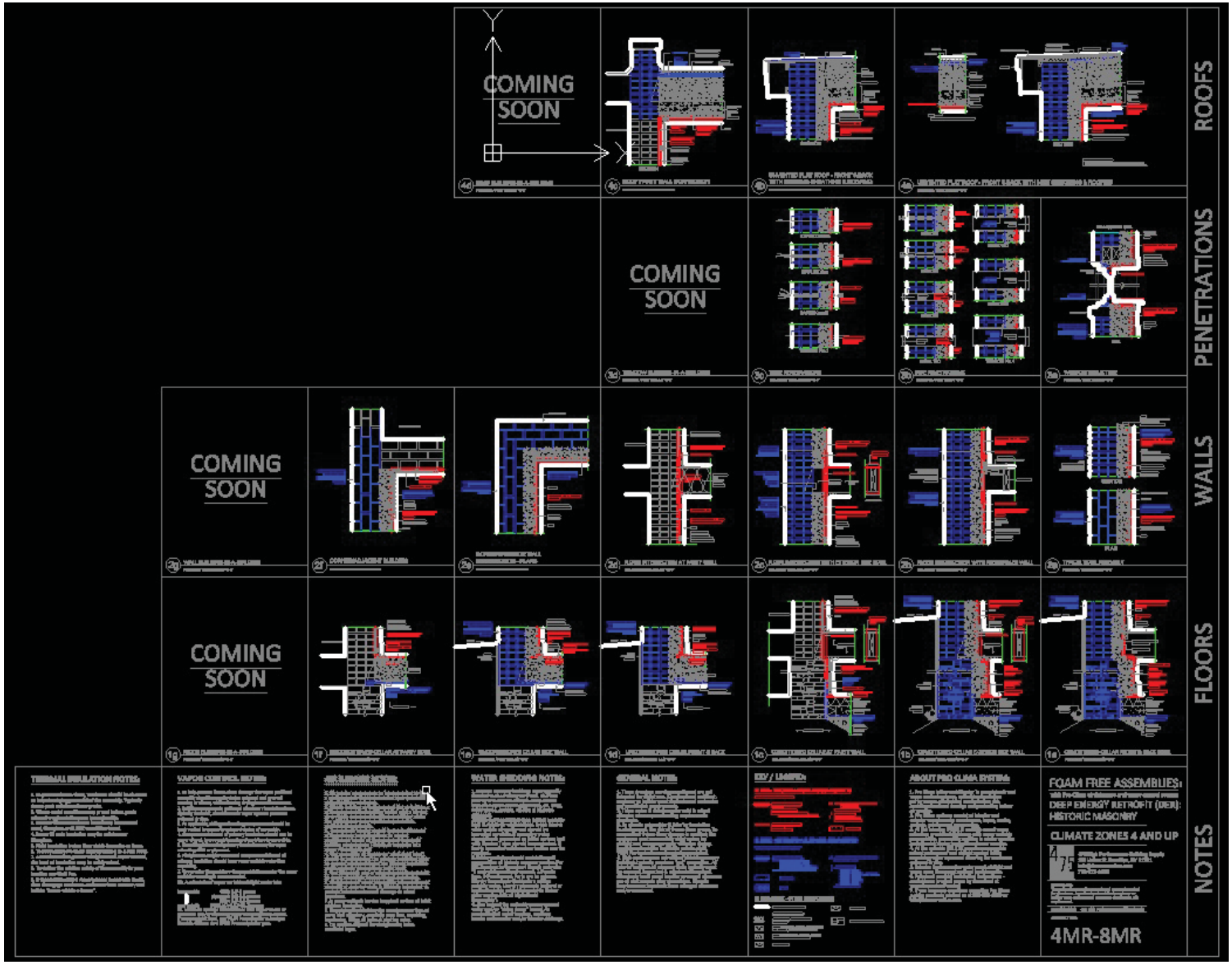
Heating & Cooling integration



Download DWG details



Wood Frame

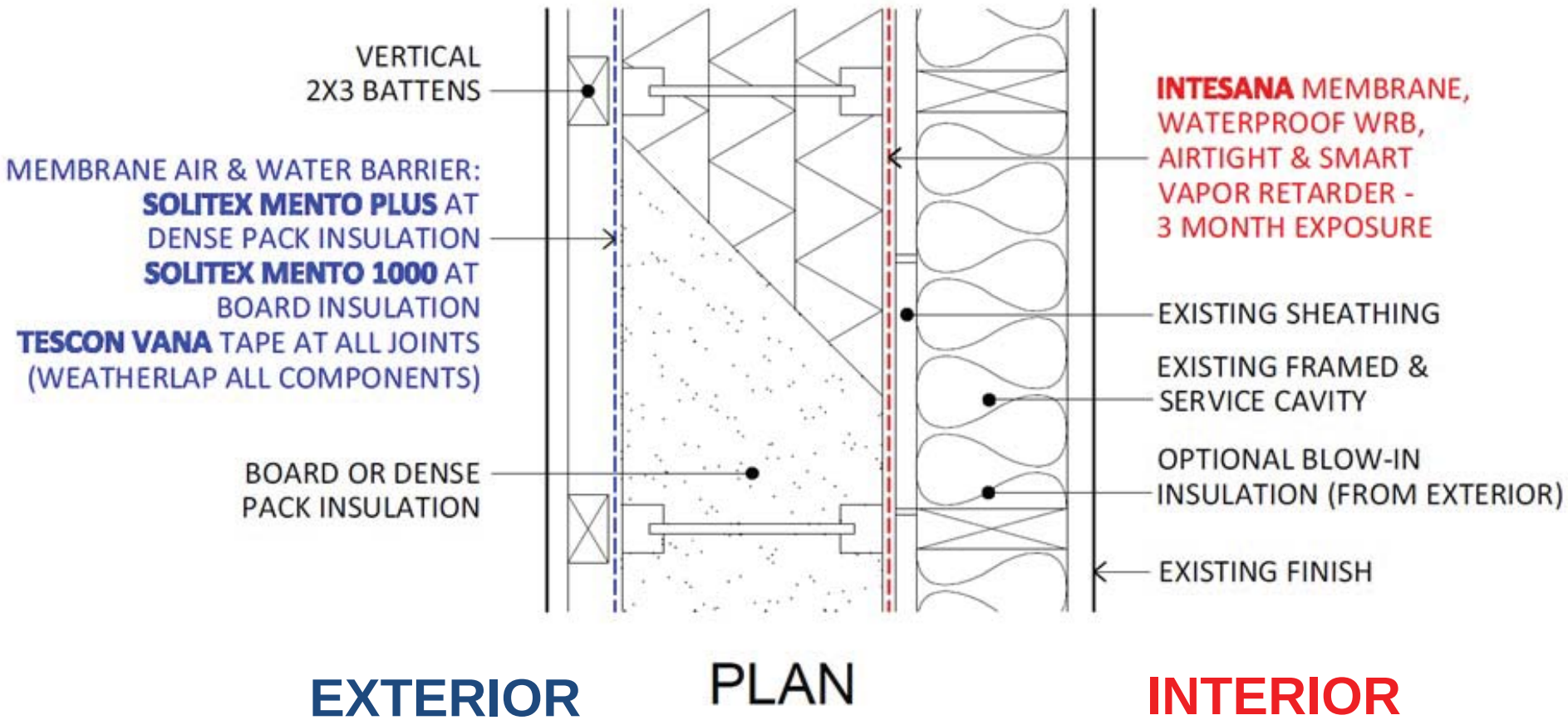

VERTICAL
2X3 BATTENS
MEMBRANE AIR & WATER BARRIER:
SOLITEX MENTO PLUS AT
DENSE PACK INSULATION
SOLITEX MENTO 1000 AT
BOARD INSULATION
TESCON VANA TAPE AT ALL JOINTS
(WEATHERLAP ALL COMPONENTS)
BOARD OR DENSE
PACK INSULATION
INTESANA MEMBRANE,
WATERPROOF WRB,
AIRTIGHT & SMART
VAPOR RETARDER -
3 MONTH EXPOSURE
EXISTING SHEATHING
EXISTING FRAMED &
SERVICE CAVITY
OPTIONAL BLOW-IN
INSULATION (FROM EXTERIOR)
EXISTING FINISH
EXTERIOR
PLAN
INTERIOR

Photo Credit: Ted Cushman

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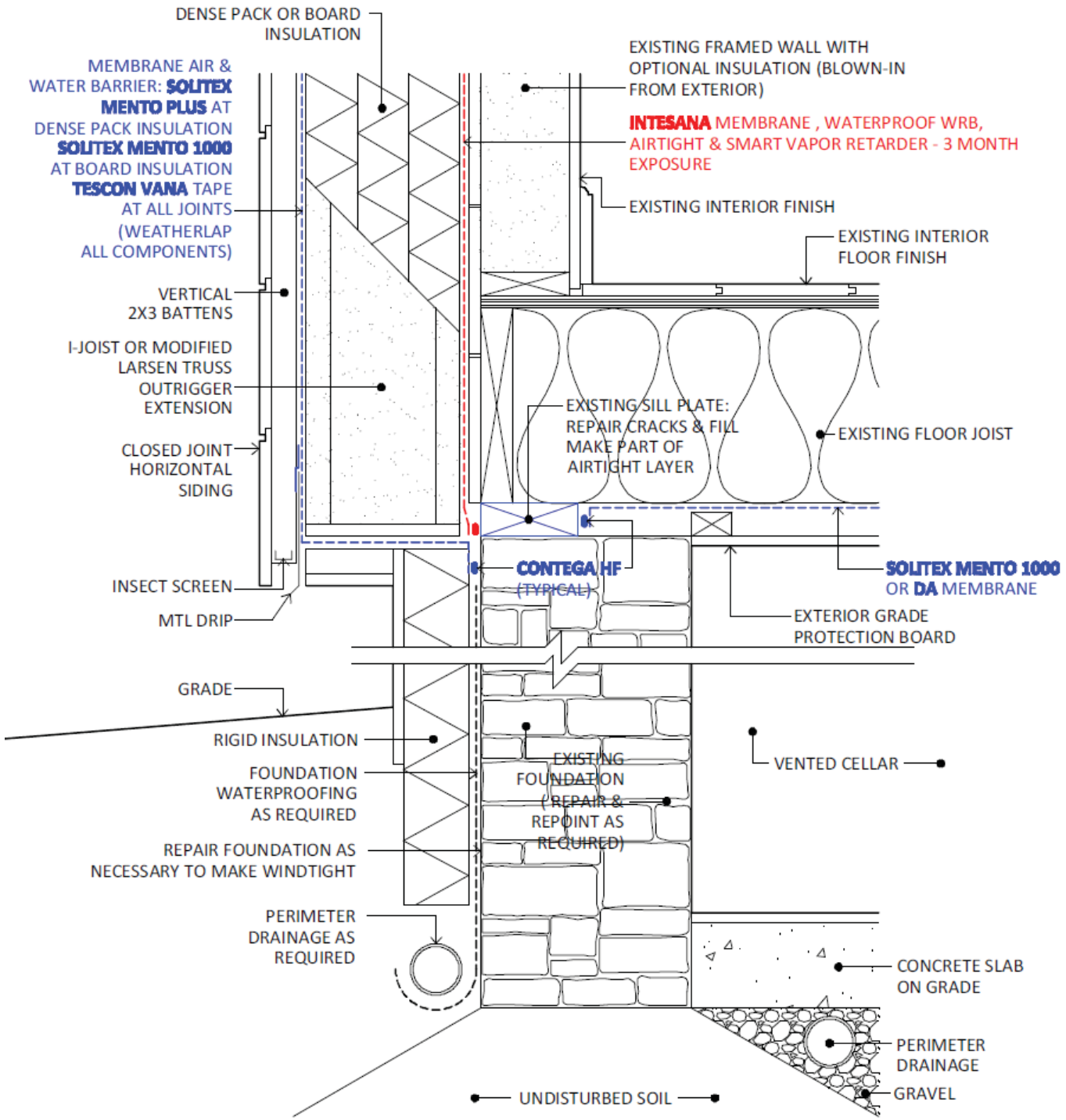
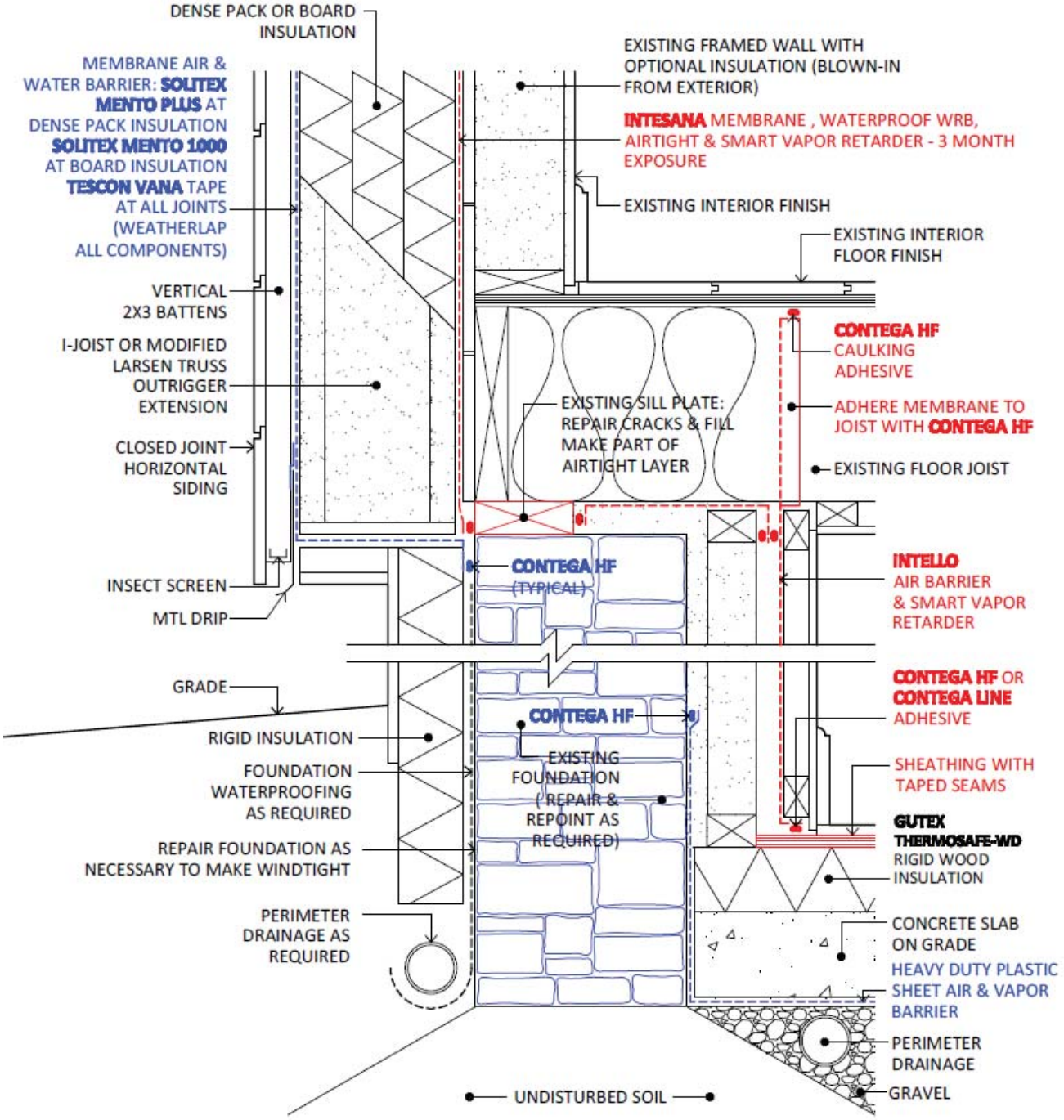
MENTO

Photo Credit: Alex Wilson

Photo Credit: Alex Wilson


DENSE PACK OR BOARD INSULATION
MEMBRANE AIR & WATER BARRIER: SOLITEX MENTO PLUS AT DENSE PACK INSULATION SOLITEX MENTO 1000 AT BOARD INSULATION TESCON VANA TAPE AT ALL JOINTS (WEATHERLAP ALL COMPONENTS)
VERTICAL 2X3 BATTENS
I-JOIST OR MODIFIED LARSEN TRUSS OUTRIGGER EXTENSION
CLOSED JOINT HORIZONTAL SIDING
INSECT SCREEN
MTL DRIP
GRADE
RIGID INSULATION
FOUNDATION WATERPROOFING AS REQUIRED
REPAIR FOUNDATION AS NECESSARY TO MAKE WINDTIGHT
PERIMETER DRAINAGE AS REQUIRED
EXISTING FRAMED WALL WITH OPTIONAL INSULATION (BLOWN-IN FROM EXTERIOR)
INTESANA MEMBRANE , WATERPROOF WRB, AIRTIGHT & SMART VAPOR RETARDER - 3 MONTH EXPOSURE
EXISTING INTERIOR FINISH
EXISTING INTERIOR FLOOR FINISH
EXISTING SILL PLATE: REPAIR CRACKS & FILL MAKE PART OF AIRTIGHT LAYER
EXISTING FLOOR JOIST
CONTEGA HF (TYPICAL)
SOLITEX MENTO 1000 OR DA MEMBRANE
EXTERIOR GRADE PROTECTION BOARD
VENTED CELLAR
EXISTING FOUNDATION (REPAIR & REPOINT AS REQUIRED)
CONCRETE SLAB ON GRADE
PERIMETER DRAINAGE
GRAVEL
UNDISTURBED SOIL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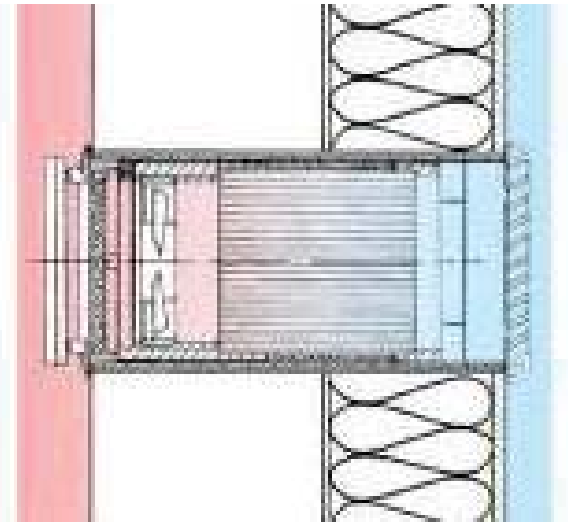
EXISTING FLOOR JOIST
CONTEGA HF (TYPICAL)
INTELLO AIR BARRIER & SMART VAPOR RETARDER
CONTEGA HF OR CONTEGA LINE ADHESIVE
CONTEGA HF
EXISTING FOUNDATION (REPAIR & REPOINT AS REQUIRED)
SHEATHING WITH TAPED SEAMS
GUTEX THERMOSAFE-WD RIGID WOOD INSULATION
CONCRETE SLAB ON GRADE
HEAVY DUTY PLASTIC SHEET AIR & VAPOR BARRIER
PERIMETER DRAINAGE
GRAVEL
UNDISTURBED SOIL



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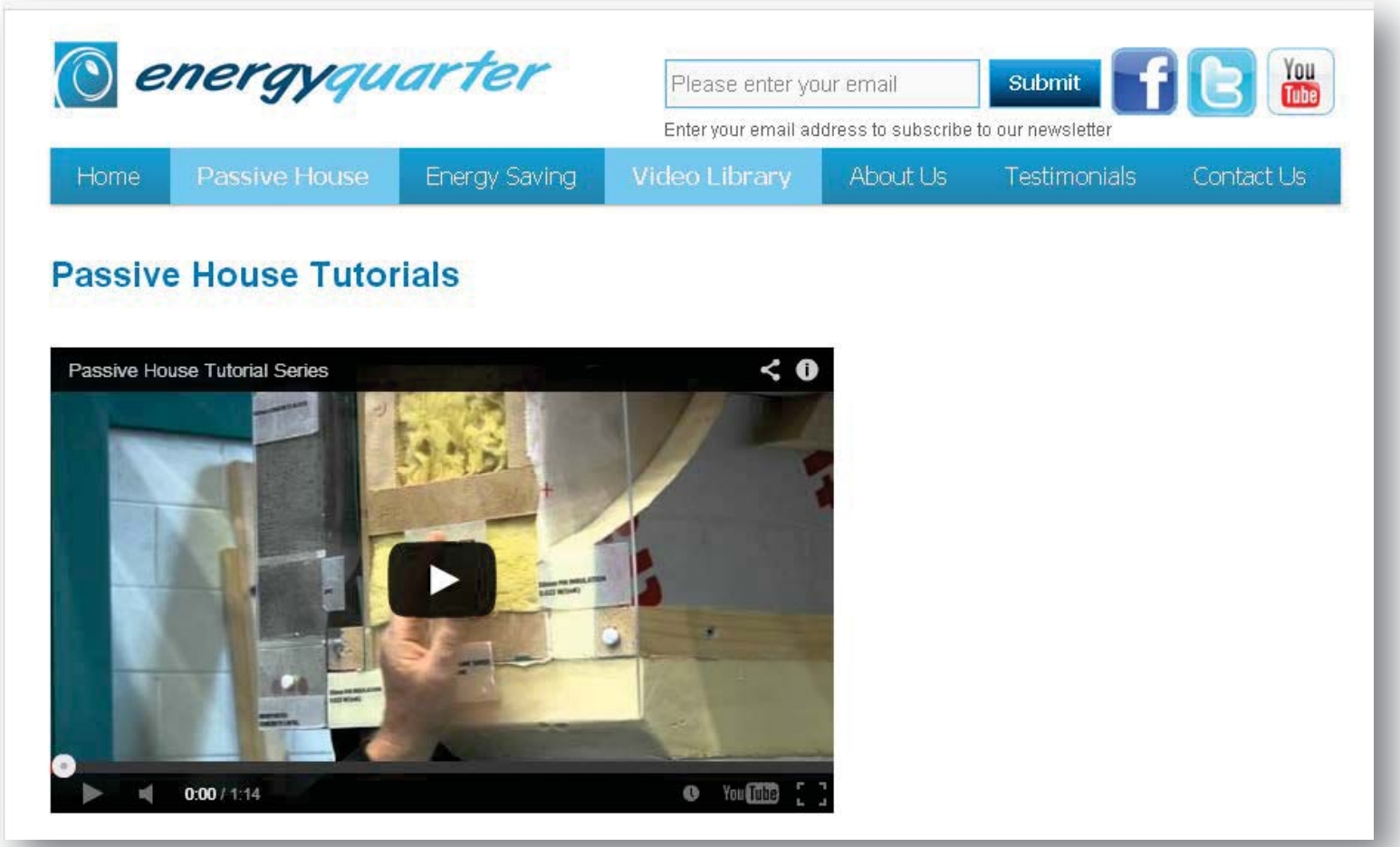

Questions?

This concludes the American Institute of Architects
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ken@foursevenfive.com

Thank You!