Additional Resources

- Criteria for Buildings: Passive House - EnerPHit - PHI Low Energy Building – March 2023
- Criteria: 2.1 Passive House Standard

We will be starting soon!

Thanks for joining us

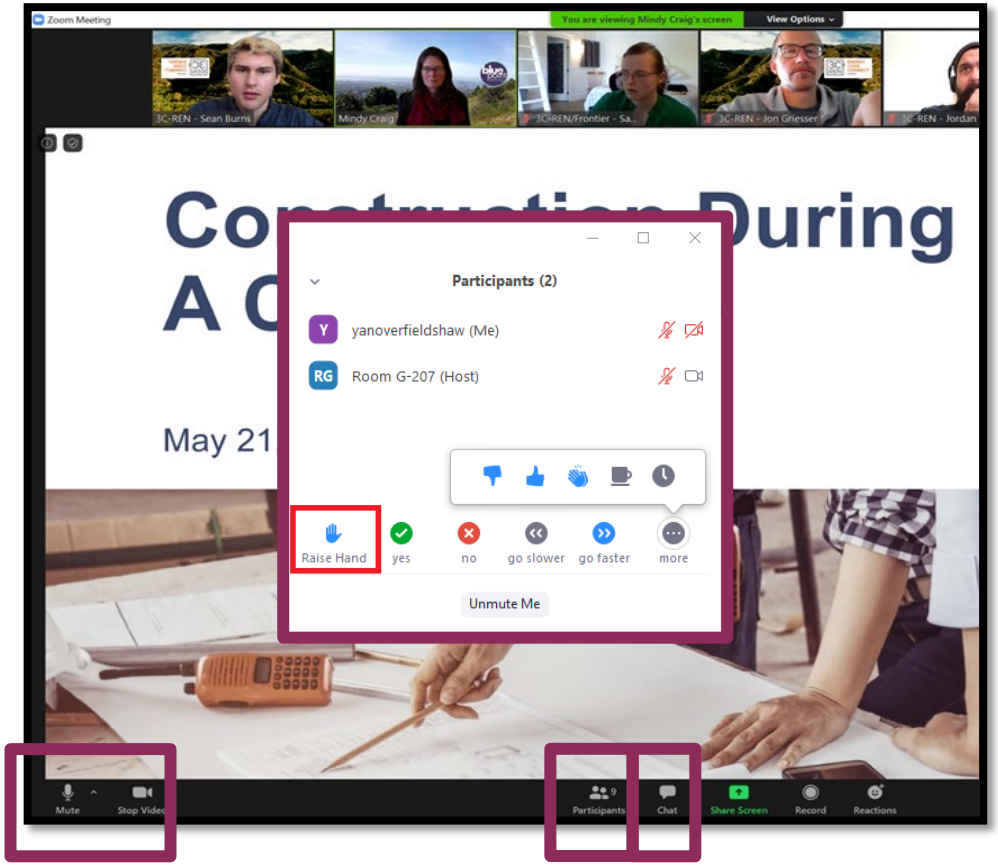
Introduction to Passive House Standard

Steve Mann – The Passive House Network and Home Energy Services

April 2, 2024

Zoom Orientation

- Please be sure your full name is displayed
- Please mute upon joining
- Use "Chat“ box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be recorded and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
  - **Building Professionals:** industry events, training, and energy code compliance support
  - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region

3C REN ENERGY CODE CONNECT

3C REN BUILDING PERFORMANCE TRAINING

3C REN HOME ENERGY SAVINGS

3C REN ENERGY CODE CONNECT

- Serves all building professionals
- Three services –
  - **Energy Code Coach**
  - **Training and Support**
  - **Regional Forums**
- Makes the Energy Code easy to follow

Energy Code Coach:
3c-ren.org/codes
805.781.1201

Event Registration:
3c-ren.org/events

3C REN

BUILDING PERFORMANCE TRAINING

- Serves current and prospective building professionals
- Expert instruction:
  - **Technical skills**
  - **Soft skills**
- Helps workers to thrive in an evolving industry

Event Registration:
3c-ren.org/events

3C REN HOME ENERGY SAVINGS

Multifamily (5+ units)

- No cost technical assistance
- Rebates up to $750/apartment plus additional rebates for specialty measures like heat pumps

Single Family (up to 4 units)

- Sign up to participate!
- Get paid for the metered energy savings of your customers

Enrollment:
3C-REN.org/contractor-participation

An introduction to Passive House

College of the Atlantic, Maine | OPAL Architecture

The Passive House Network

The Network

Global Knowledge. Regional Context. Local Applications

The Passive House Network

Passive House Seattle
The Passive House Network

Passive House Rocky Mountains
The Passive House Network

Passive House Minnesota
The Passive House Network

Passive House Pennsylvania
The Passive House Network

Passive House Washington DC
The Passive House Network

New Jersey Passive House
The Passive House Network

Passive House Empire State
The Passive House Network

Passive House Northeast
The Passive House Network

PHCA Passive House California

North American Certifiers Circle – Passive House Certifier

International Passive House Association iPHA

Passive House Institute

Designer – Certified Passive House Designer

Certified Passive House Tradesperson – Tradesperson

Certified Passive House – Passive House Institute

Agenda

The Passive House Network

1. Why Passive House?
2. What's the logic?
3. The methodology
4. The Tools
5. More Examples

Waring School, Massachusetts, Opal Architecture

Why Passive House?

“Building is not a neutral act.”

The Passive House Network

90% time indoors
40% global emissions
>Unreliable
>Expensive
>Unhealthy
>Exacerbate inequality

With growing extremes, it starts with occupants

The Passive House Network

We have two kinds of buildings:
Those that are prepared for climate change, and those that are not.

Build your future.

Realization: efficiency underlies what we value most.

The Passive House Network

- Comfort
- Zero Emissions
- Healthy
- Cost Effective
- Resilience
- Safety
- Sustainable
- Lower Risk
- Beauty

- Passive House

Vermont Artists Lodging, Ryall Sheridan Architects

Universal wants…Fundamental performance

Empower architecture to drive performance

The Passive House Network

It's the enclosure

It's *not* the systems

Re-engage fundamentals

Empower building elements

Empower details

Empower architects/team

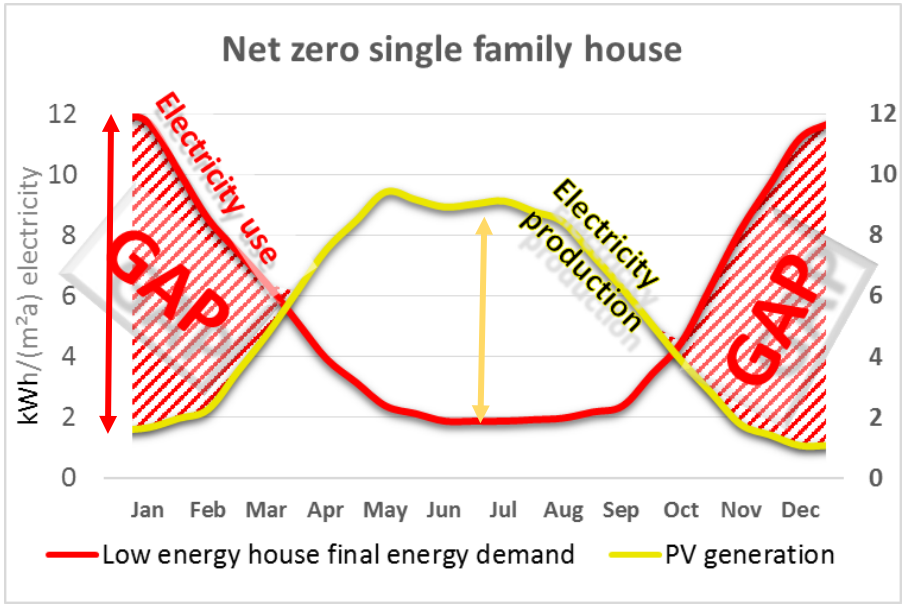
Empower builders

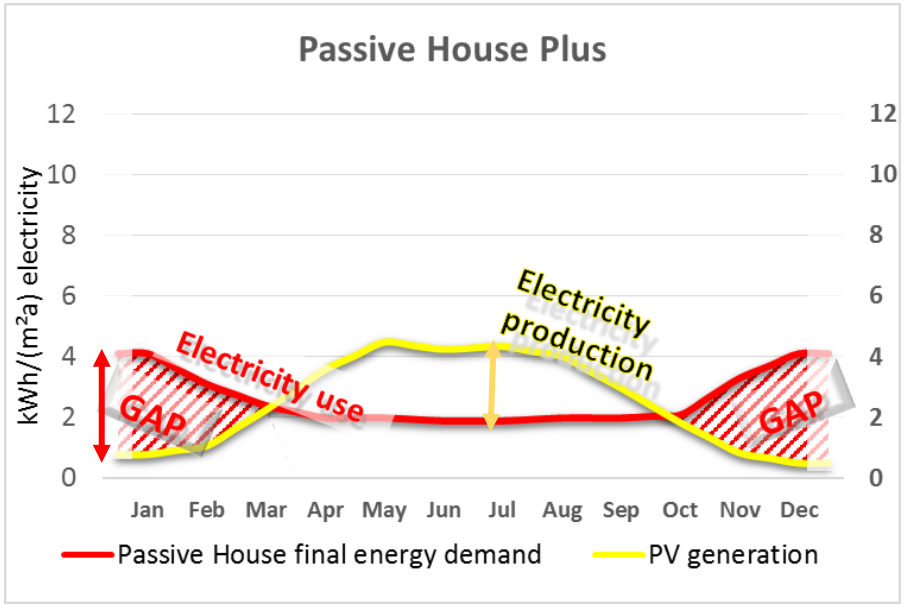
Home, Minneapolis

Garment Factory, Sri Lanka

Empower electrification: “crush the heating demand”

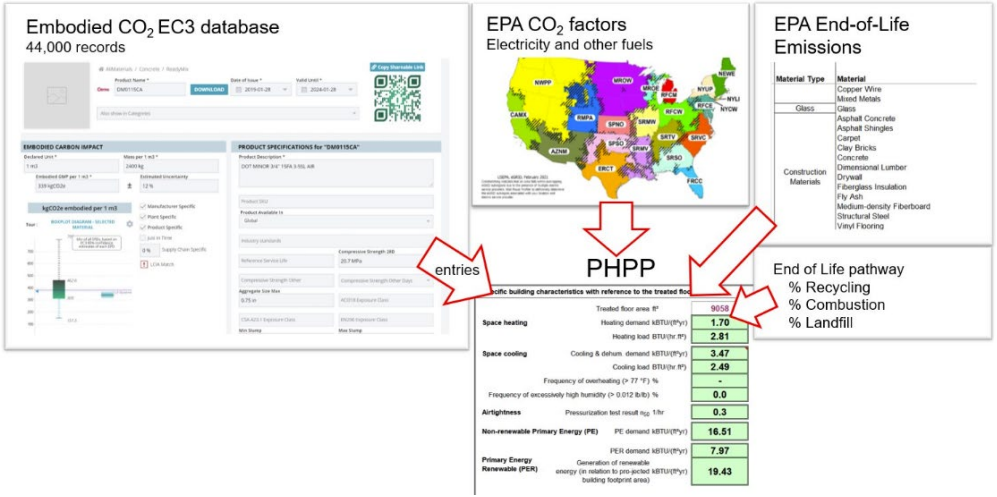
The Passive House Network

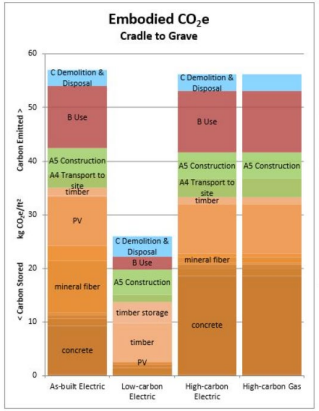


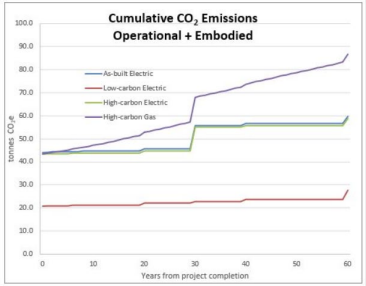


Empowers Embodied Carbon Reductions

The Passive House Network







If Operational varies then adjust these cells

Operational CO_2	Scen 1	Scen 2	Scen 3	Scen 4
Heating Demandl kBTU/(ft²yr)	3.7	3.7	3.7	3.7
Final Energy kBTU/(ft²yr) (excl PV)	16.4	16.4	16.4	16.4
metric tonnes CO_2e (incl PV if any)	0.6	0.6	0.6	28.5
US tons CO_2e (incl PV if any)	0.7	0.7	0.7	31.5
kgCO2e/ft² (incl PV if any)	0.6	0.6	0.6	27.5

Embodied CO_2	Scen 1	Scen 2	Scen 3	Scen 4
metric tonnes CO_2e	59.2	27.0	58.2	58.2
US tons CO_2e	65.2	29.8	64.2	64.2
kgCO2e/ft²	57.0	26.0	56.1	56.1

The PHN PHribbon: calculate total cradle -to-grave building carbon emissions,

Works with Codes & Other Standards

Winthrop Center, Boston

Certifications: Passive House, LEED Platinum, Well

What’s the logic?

Precursors of Passive House

The Passive House Network

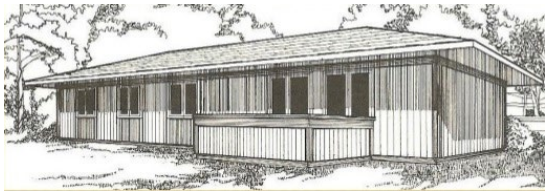
Vernacular, China

Fridtjof Nansen's polar ship, the “Fram”, 1893

DTH zero-energy house, Denmark, 1973

The Philips Experimental House, Germany, 1974

Illinois Lo-Cal House, Wayne Shick, US 1976



Saskatchewan Conservation House w/ Harold Orr, Canada 1977

First Passive House, 1990

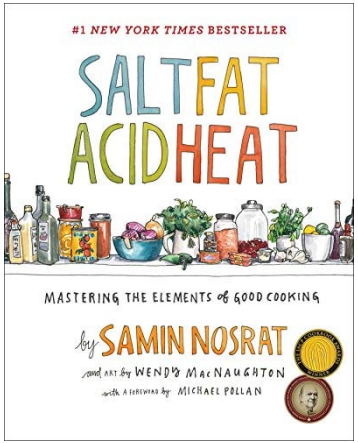
The Passive House Network

How we use fundamental elements matters

The Passive House Network

"I was working as a physicist. I read that the construction industry had experimented with adding insulation to new buildings and that energy consumption had failed to reduce. This offended me – it was counter to the basic laws of physics. I knew that they must be doing something wrong. So I made it my mission to find out what, and to establish what was needed to do it right."

- Wolfgang Feist

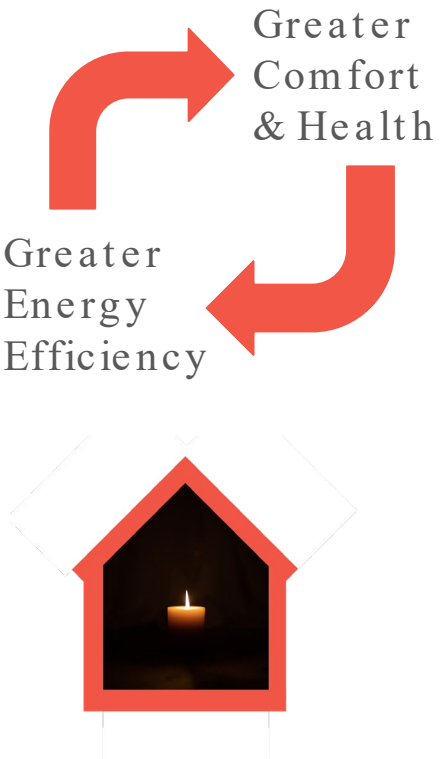


Passive House uniquely masters the elements of high -performance building.

Power of a simple idea

"A Passive House is a building, for ***which thermal comfort*** *(ISO 7730)* ***can be achieved*** *solely* ***by post-heating or post-cooling of the fresh air mass****, which is* ***required to achieve sufficient indoor air quality*** *conditions –* ***without the need for additional recirculation*** *of air."*

– Passive House Institute



What drives building performance

Enclosure
- Insulation
- Thermal Bridge Free
- Airtightness
- Windows/Doors
- Solar Control

Ventilation
- Hygienic
- Heat Recovery
- Continuous Supply
- Balanced Exhaust

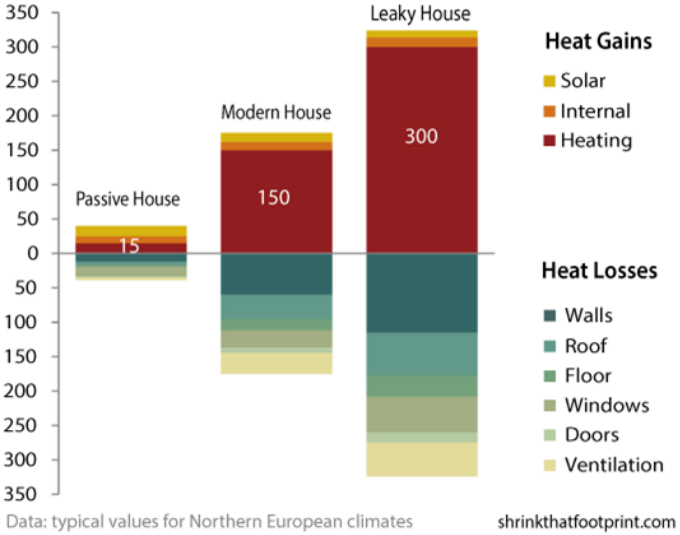
Occupants
- Comfort Criteria
- Activities

Energy Balance
- Min. Active Heating
- Min. Active Cooling
- Calculated in PHPP

Decouple power & performance with fixed target

The Passive House Network

Energy Balance

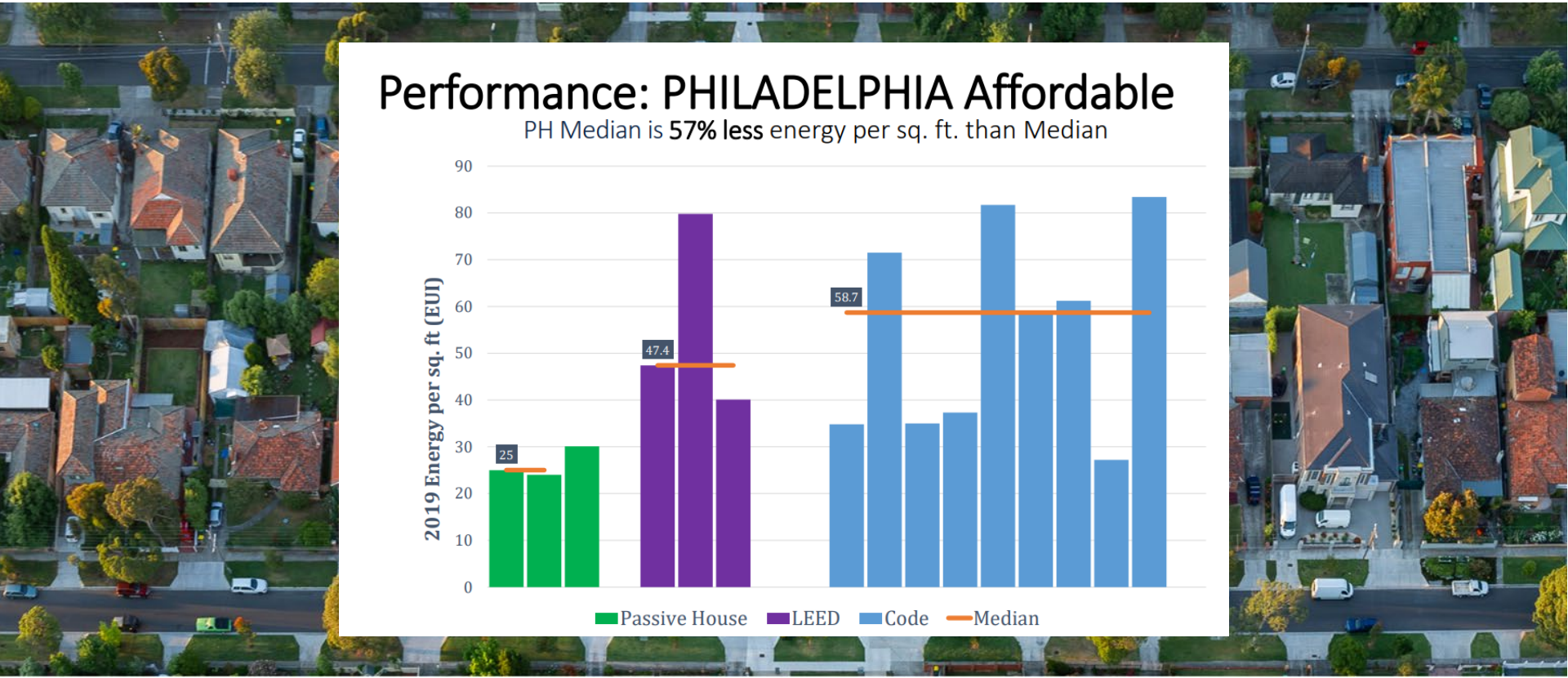


Certified Passive House
Passive House Institute

Not relative improvement to a baseline.

Predictable Performance is THE thing.

The Passive House Network



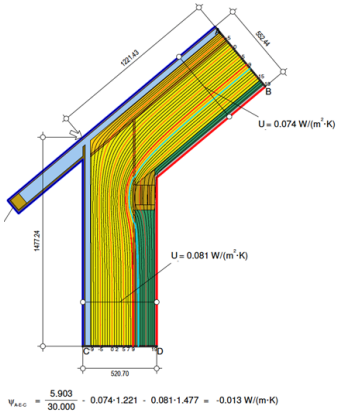
The Methodology

Element #1: Climate Specific Continuous Insulation

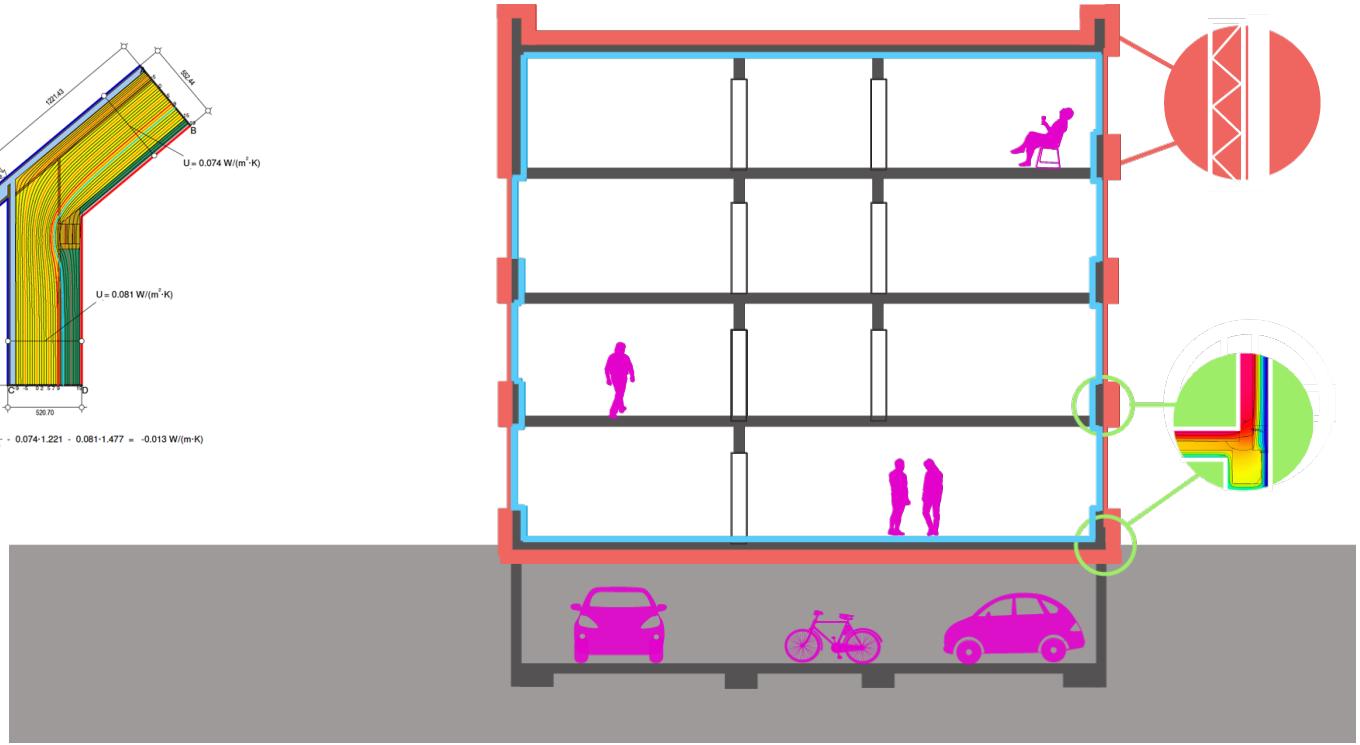
The Passive House Network

Insulation thickness is climate - specific, like a climate rated sleeping bag.

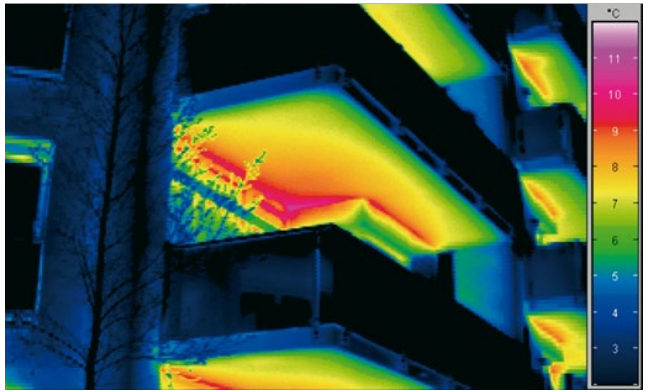
Element #2: Thermal Bridge Free Construction

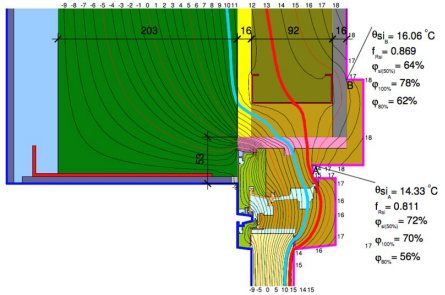


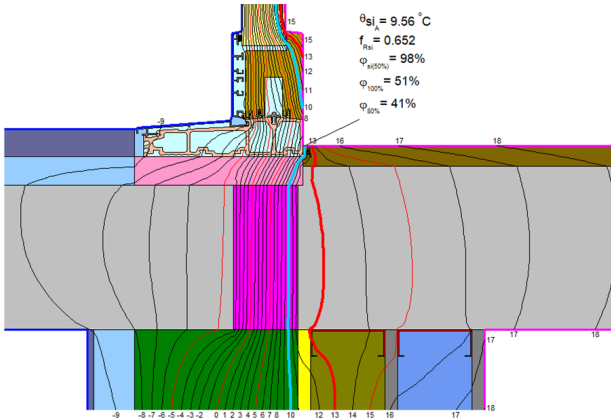
$$\Psi_{exc} = \frac{5.903}{30.000} - 0.074 \cdot 1.221 - 0.081 \cdot 1.477 = -0.013 \text{ W/(m·K)}$$



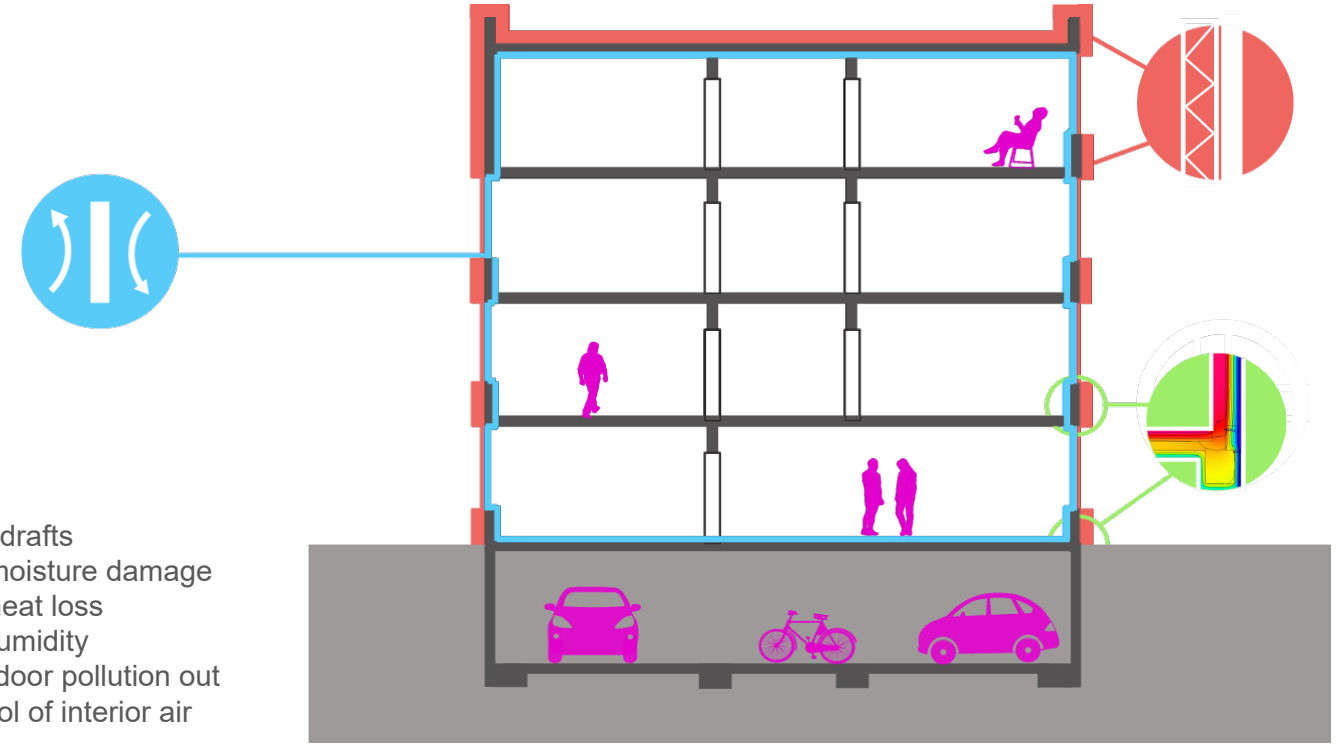
Element #2: Thermal Bridge Free Construction







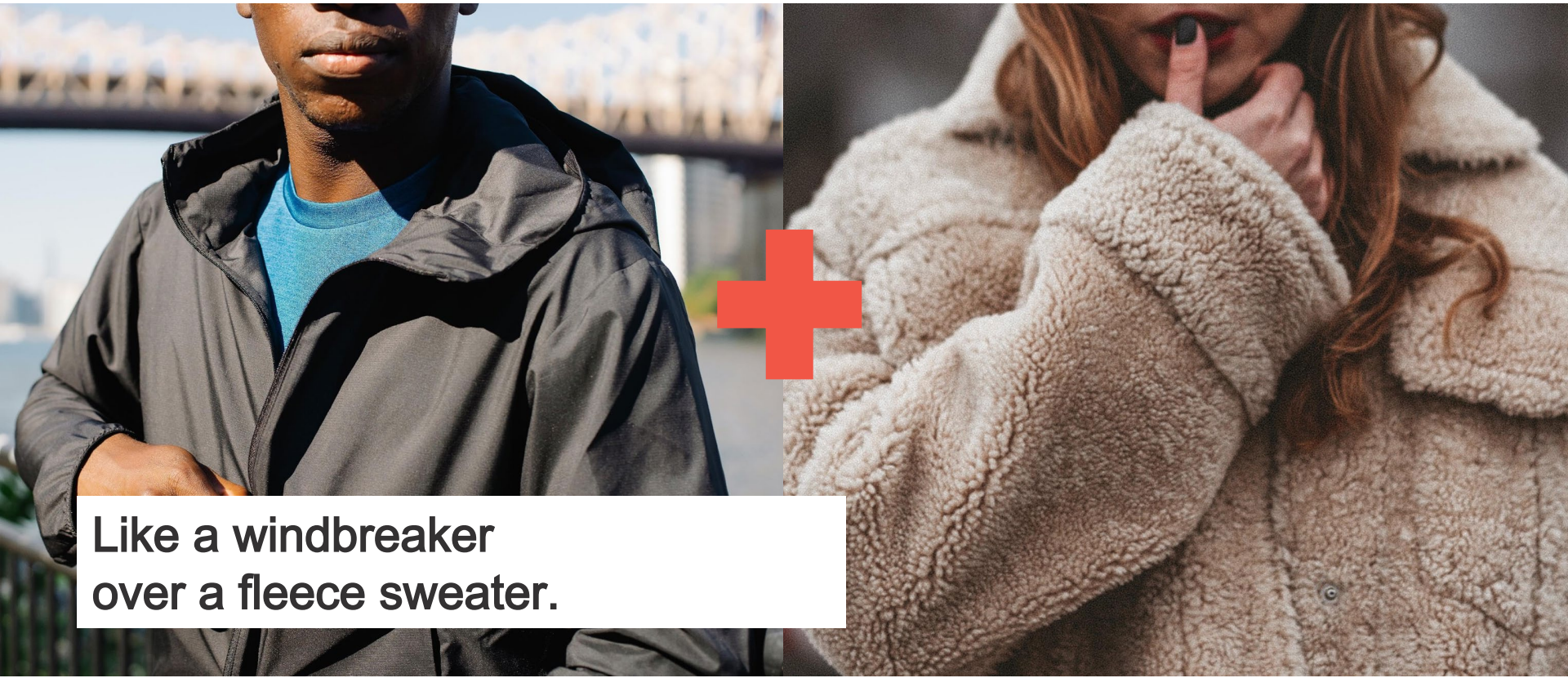
Element #3: Airtight/Smoke Tight Enclosure



1.Reduces drafts
2.Reduce moisture damage
3.Reduce heat loss
4.Control humidity
5.Keep outdoor pollution out
6.Get control of interior air

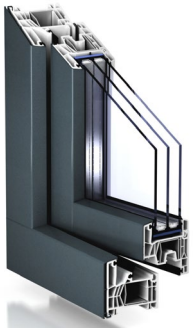
Element #3: Airtight Enclosure

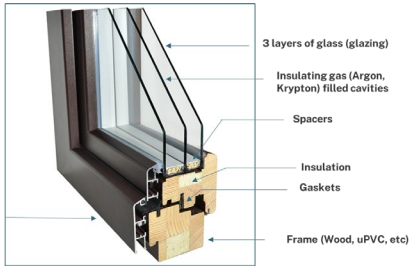
The Passive House Network

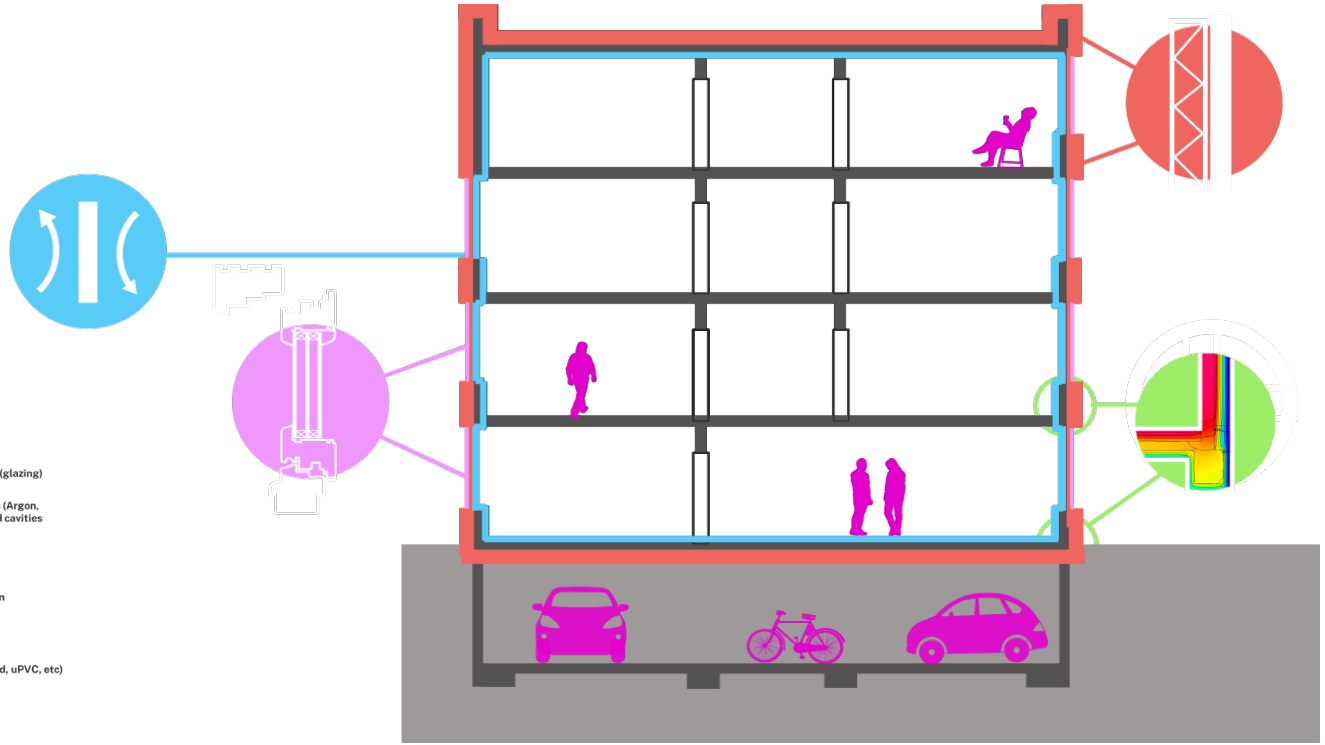


Like a windbreaker
over a fleece sweater.

Element #4: High -Performance Windows w/ Solar Protection

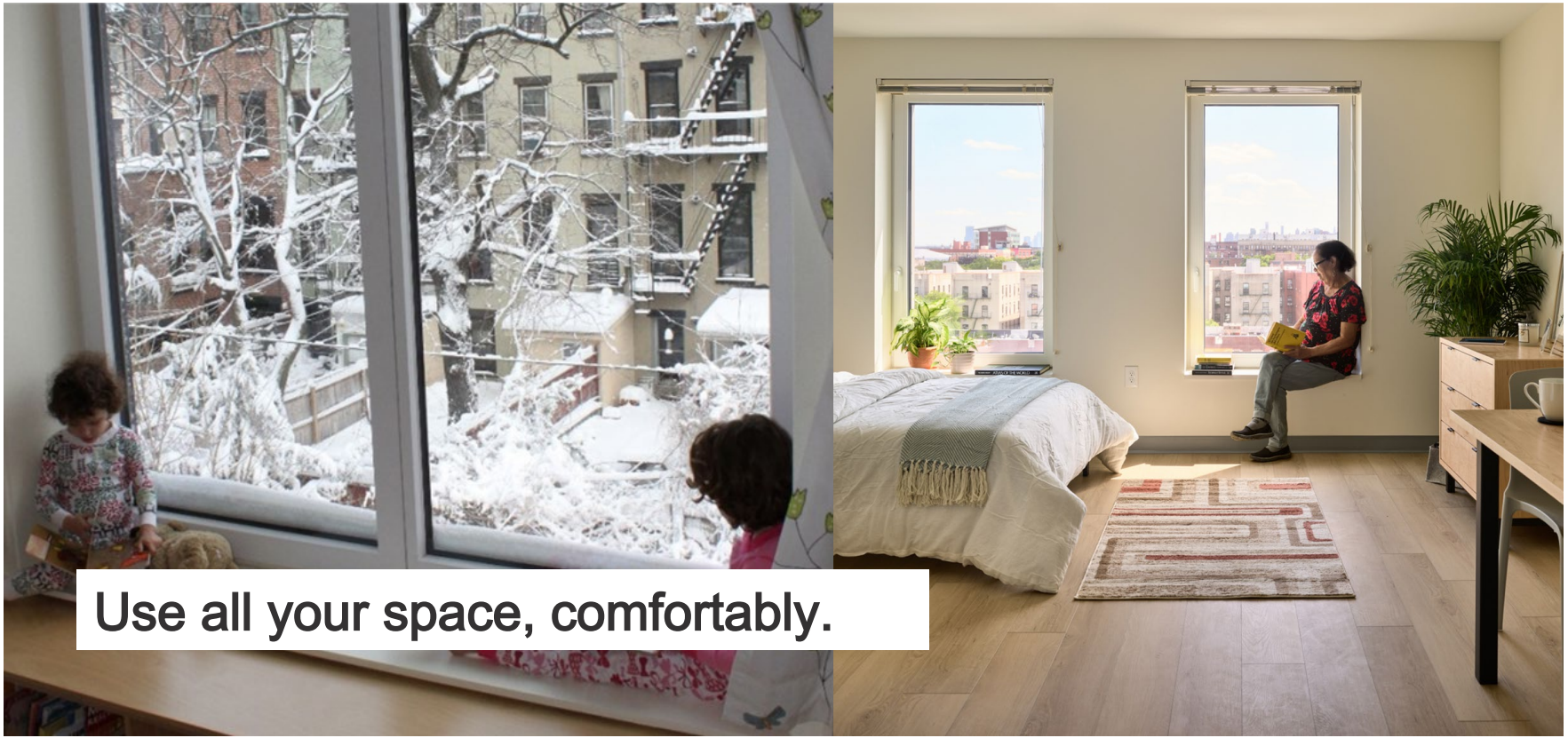




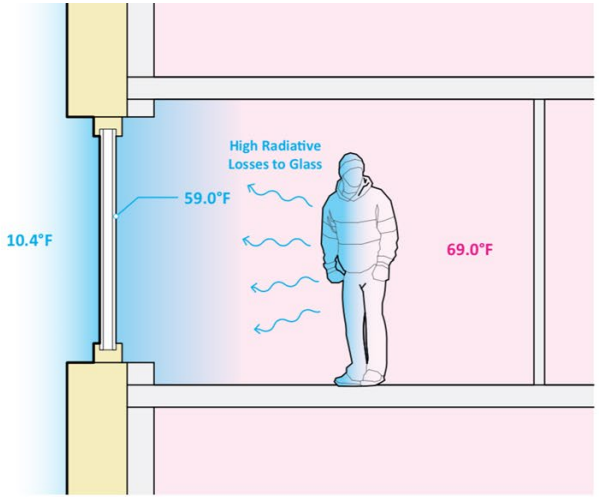


Element #4: High -Performance Windows w/ Solar Protection

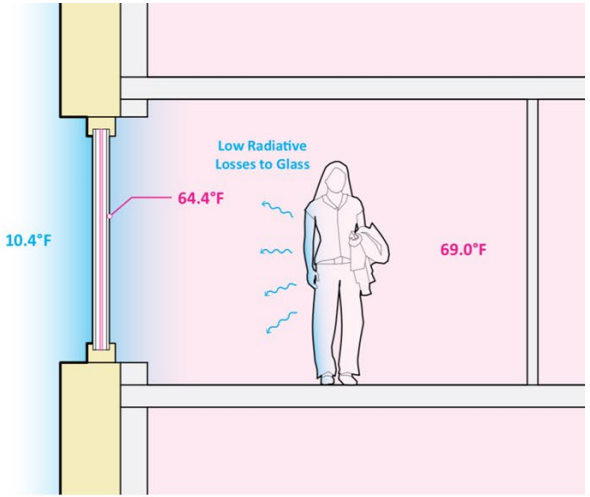
The Passive House Network



Occupant Comfort



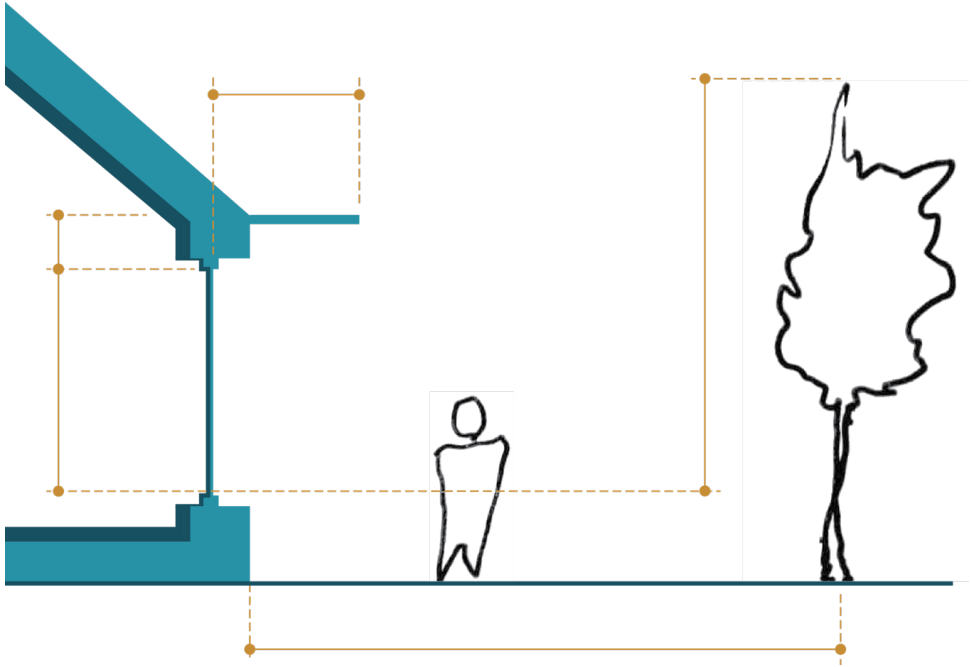
DOUBLE GLAZING = 10°F ASYMMETRY



TRIPLE GLAZING = < 5°F ASYMMETRY

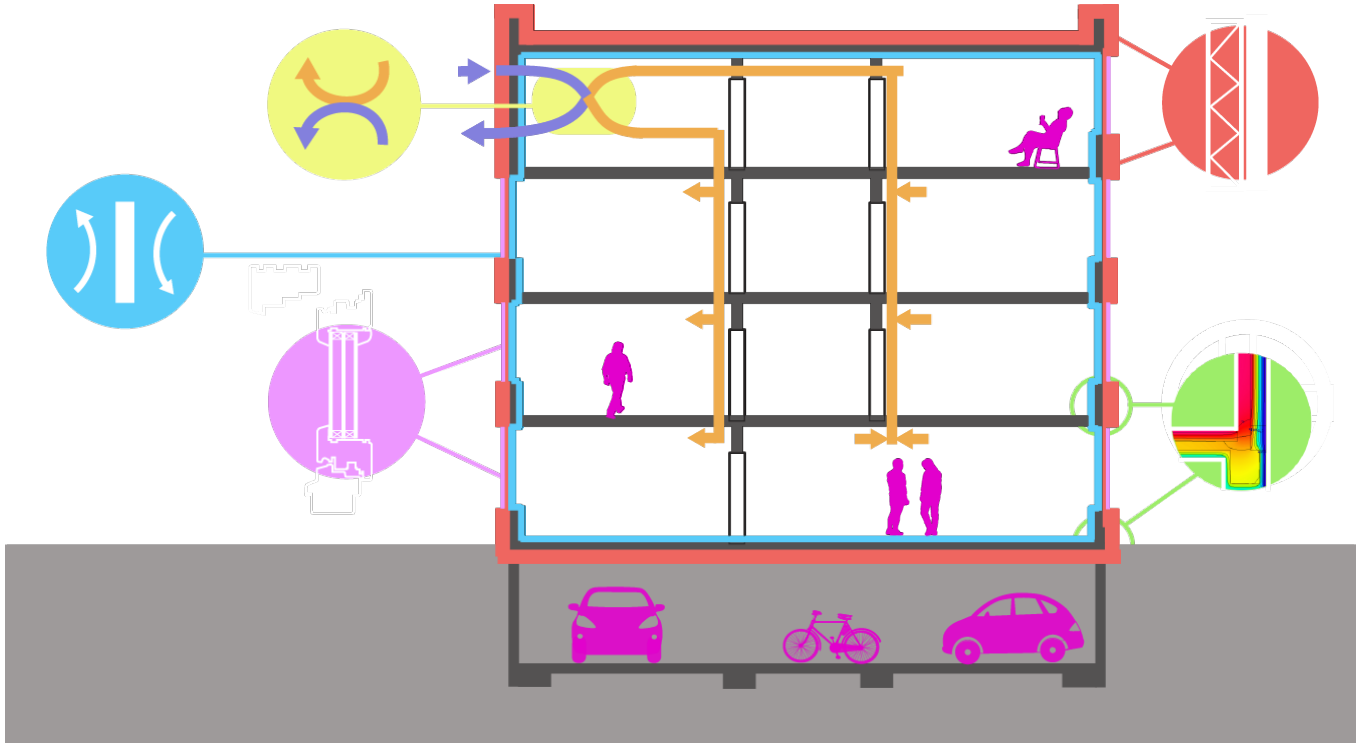
- PHI threshold values much more conservative than DIN 1946, ISO 7730 and others.
- Acts as a proxy for many thermal comfort factors (radiant temperature asymmetry, air stratification, air movement from convective looping, etc.)

Shading is considered and integrated



Element #5: Hygienic Ventilation w/ Heat Recovery

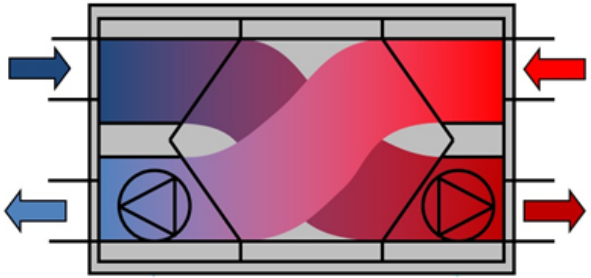
The Passive House Network



Element #5: Hygienic Ventilation w/ Heat Recovery

Comfortable Healthy Air No Matter the Weather

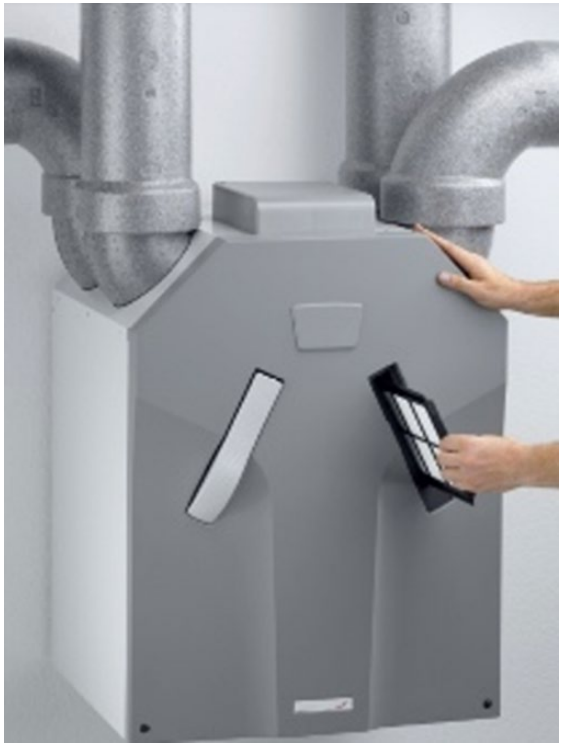
The H/ERV (heat/energy recovery ventilator) is the lungs of the building.



H/ERV's must be:

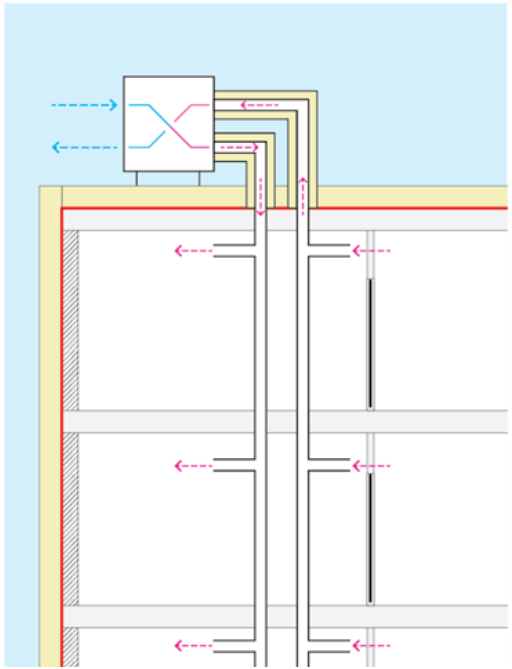
- Super-insulated
- Airtight
- Thermal bridge free
- Quiet
- Energy efficient
- Suitably located

Passive Heat/Energy Exchange Cores

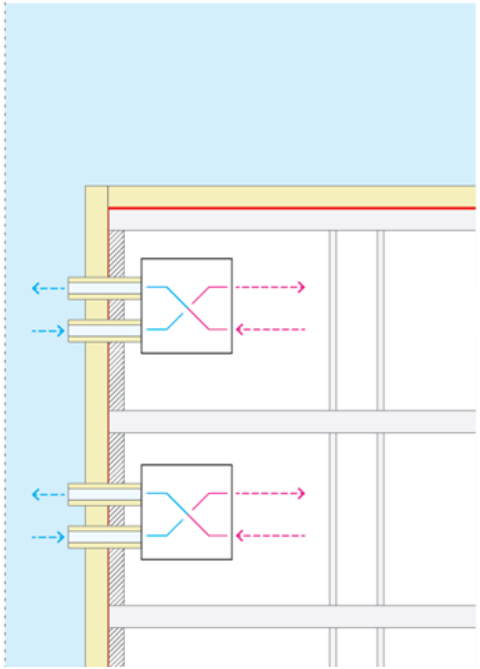


Ventilation System Configuration

Centralized:
One main ventilator unit for the entire building



Decentralized:
Multiple ventilators distributed throughout the building



Establish Fundamental Performance

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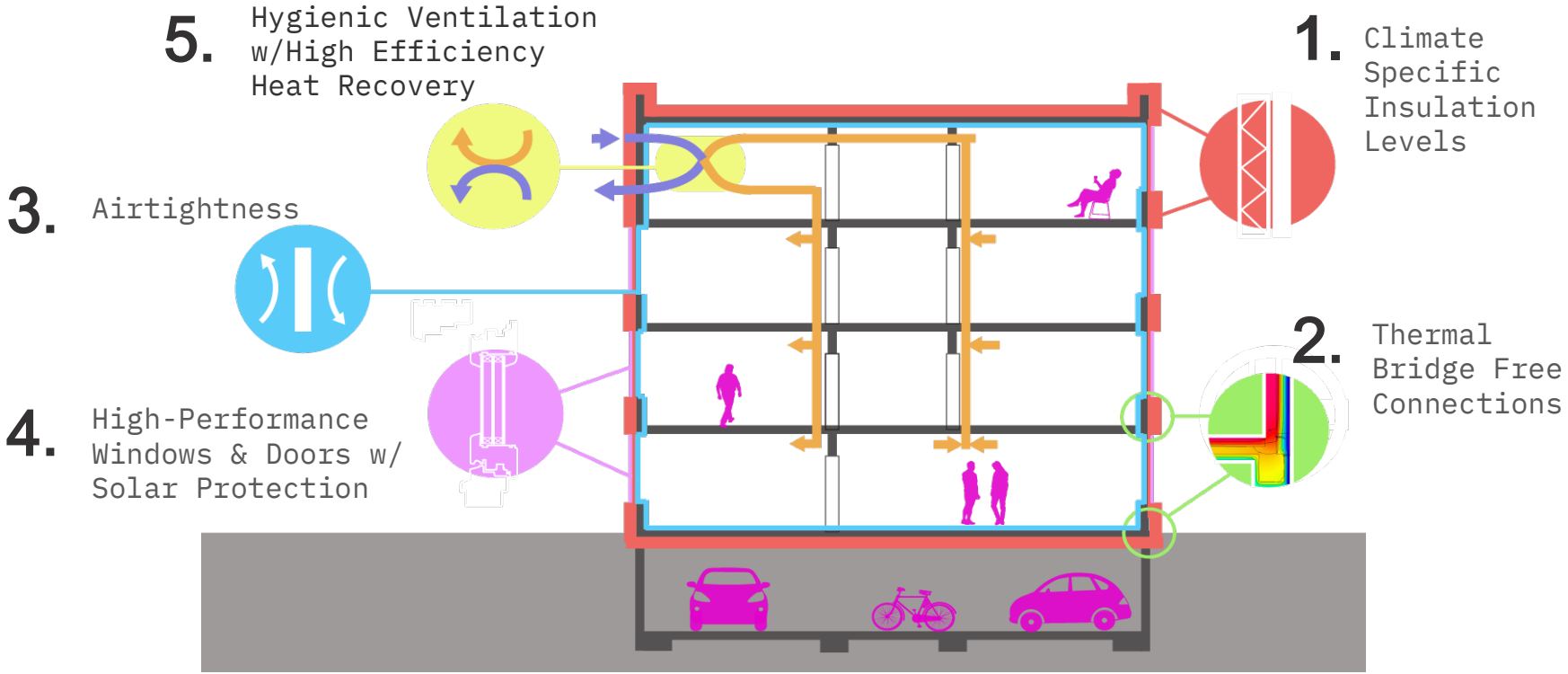
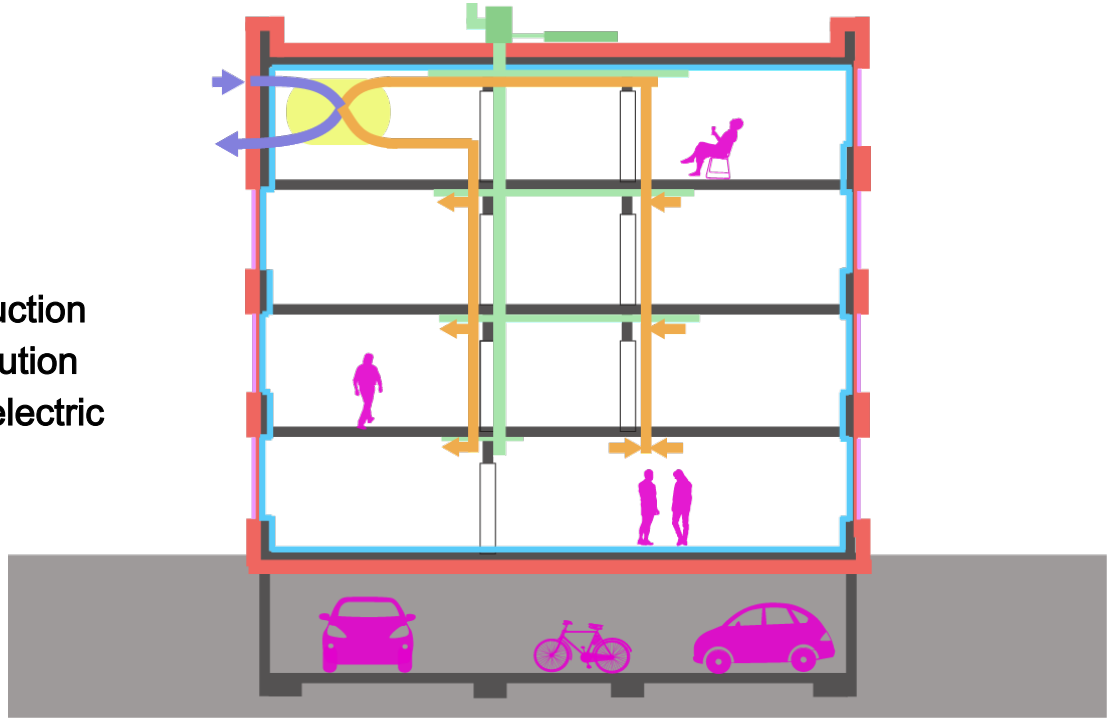


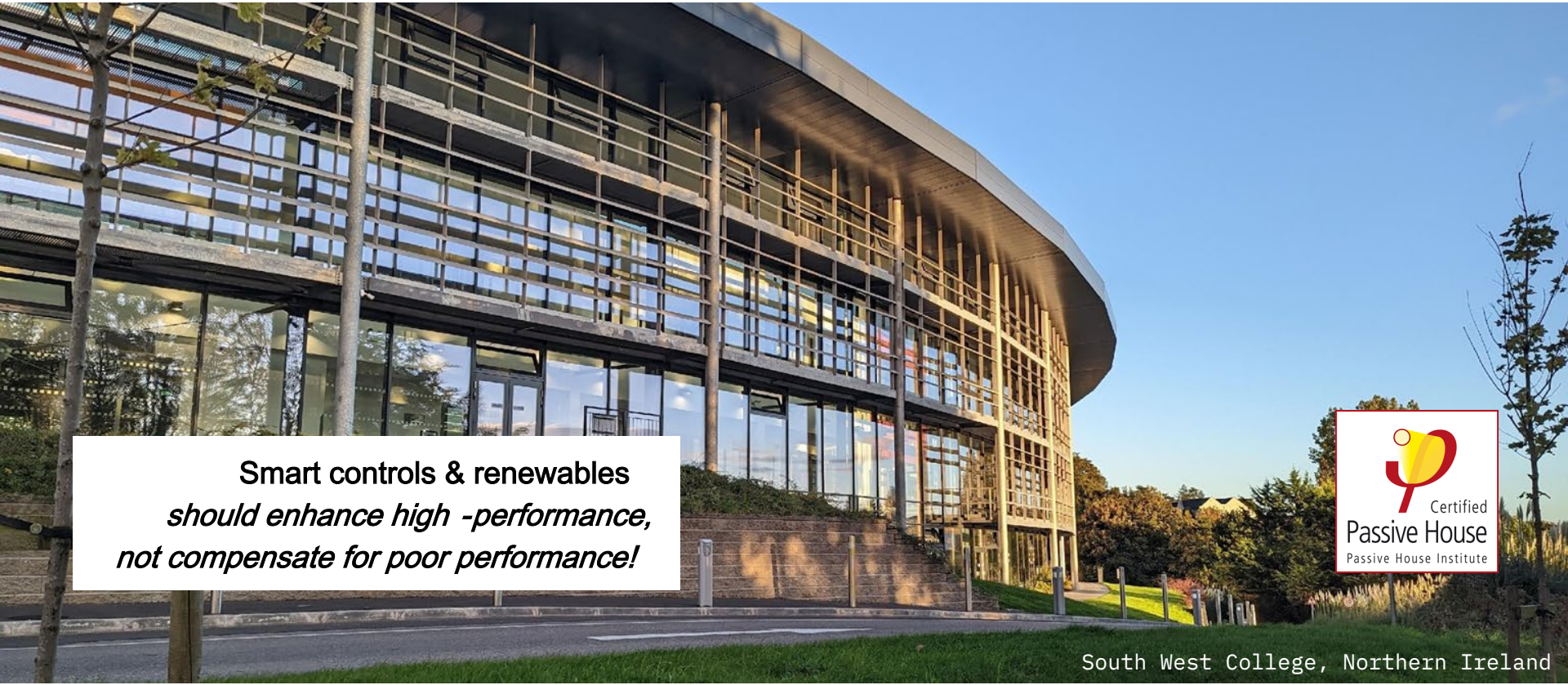
THEN: Right size Heating & Cooling Systems

75% equip sizing reduction
Efficient distribution
Often all -electric



THEN: Renewables & Smart Systems

The Passive House Network



Calculated Predictability = Optimized Design

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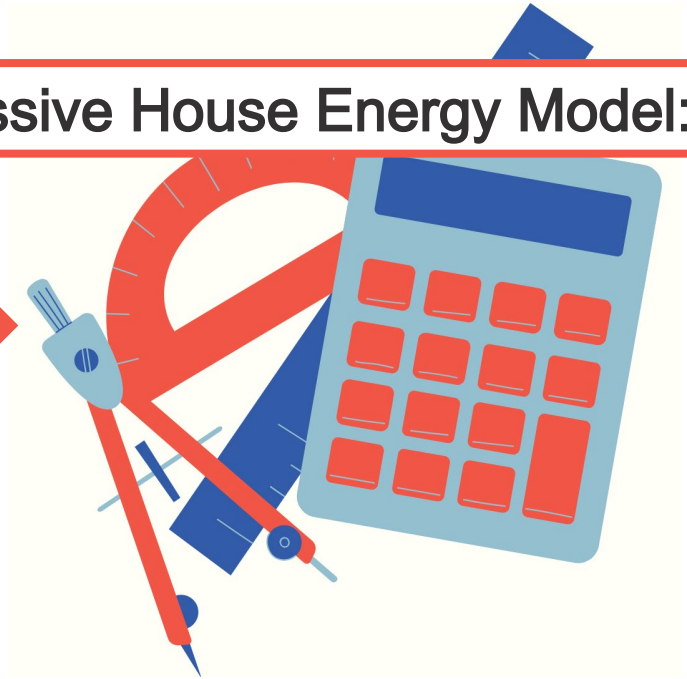
Passive House Energy Model: PHPP

5

Principles



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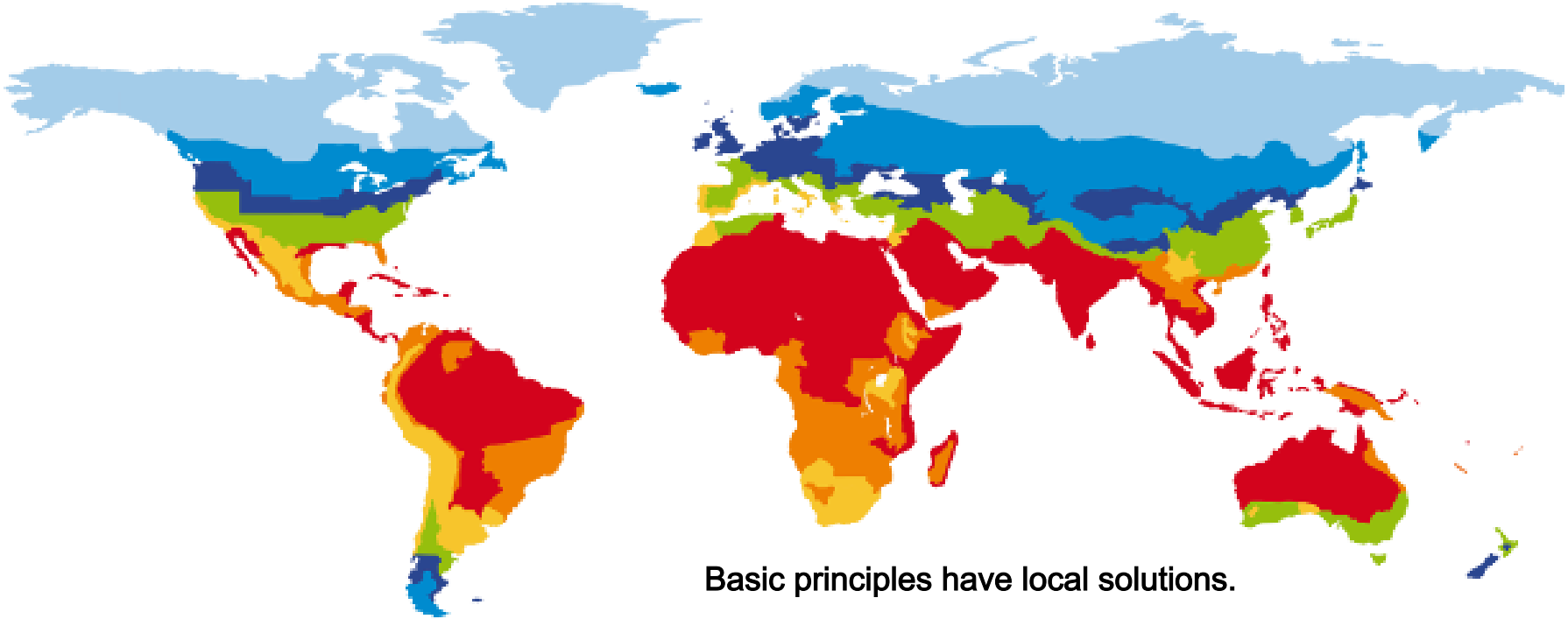
90%

Reduction in heat demand

Certified Passive House
Passive House Institute

Global Application

The Passive House Network



Basic principles have local solutions.

The Tools

Certified Professionals

The Passive House Network

CERTIFIED PASSIVE HOUSE DESIGNER

The on-demand and hybrid formats allow students to leverage the benefits of on-demand & live online training to best meet their learning preferences.
35 AIA LU/HSW credits

CERTIFIED PASSIVE HOUSE TRADESPERSON

Atlantic Cohort Schedule

Winter 2024 - On-Demand / Live Online CPHD/C Training

January 18th start

Depending on your learning preferences, **you can tackle this course in three ways:**

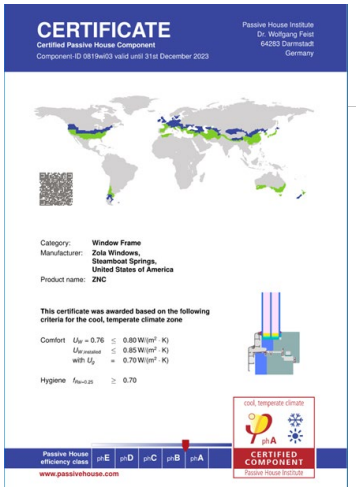
1. Focus on the on-demand content and view recordings of live-online content. **(Most flexible)**
2. Stick to the cohort schedule of live online-sessions. **(Best for clear pacing and making connections and community)**
3. Do a mix! Start before or after the cohort registration deadline, focus on the on-demand format at your pace, and also attend the live-online sessions as makes sense for you. **(Most popular)**

On-Demand Activities		Live Online Activities		
Week Starts	**Content**	**Activity Date/Time**	**Activity**	**Led by**
1/15/24	Module 1: **Introduction** Module 2: **Insulation**	1/18/24 | 12-1 PM ET	Kick-Off	PHN
1/29/24	Module 3: **Airtightness** Module 4: **Thermal Bridging** Module 5: **Windows**	2/1/24 | 12-1 PM ET	Q&A Session 1	CPHD Practitioner
2/5/24	Module 6: **Ventilation** Webinar 1: **Building Services & Economics**	2/8/24 | 12-3 PM ET	Webinar 1: Building Envelope	PHN Trainer
2/12/25	Module 7: **Heating & DWH** Module 8: **Cooling** Module 9: **Certification**	2/15/24 | 12-1 PM ET	Q&A Session 2	CPHD Practitioner
2/19/24	Module 10: **Economics** Module 11: **QA/QC** Module 12: **Bidding**	2/22/14 | 12-1 PM ET	Q&A Session 3	CPHD Practitioner
2/26/24	Module 13: **designPH** Webinar 2: **Building Services & Economics**	2/29/24 | 12-3 PM ET	Webinar 2: Building Services & Economics	PHN Trainer
3/4/24	Module 14: **PHPP**	-	-	-
3/11/24	Module 15: **Exam Prep Course & Wrap-up**	-	-	-
3/18/24	Access Exam Prep Modules	-	-	-
3/25/24	Review Exam Prep Modules	3/28/24 | 12-2 PM ET	**Exam Review**	PHN Trainer
4/1/24	Review Exam Prep Modules	4/3/24 | 10-11 AM ET	**Tech Setup (Required)**	PHN with PHA
4/8/24	Review Exam Prep Modules	4/10/24 | 10-1 PM ET	**PHI CPHD/C Exam**	PHN with PHA

All online sessions - excluding the Tech Setup & Exam - will be recorded and made available for all cohort students for reference.

Certified Passive House Components

The Passive House Network



Climate icon legend

- Arctic
- Cold
- Cool, temperate
- Warm, temperate
- Warm
- Hot
- Very hot

Opaque building envelope

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

Transparent building envelope

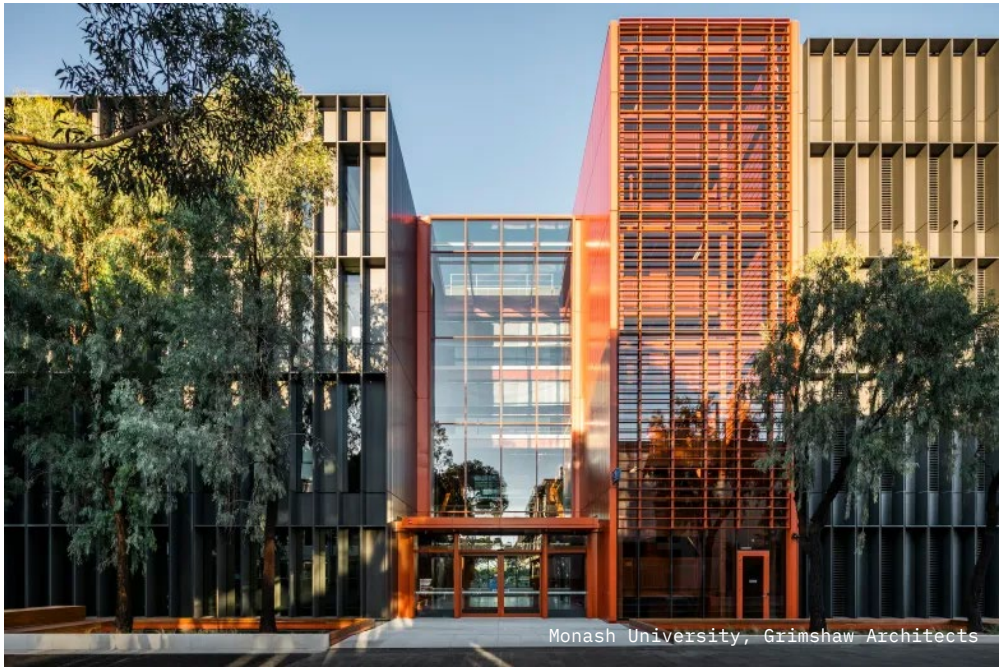
- Windows
- Roof windows
- Skylights
- Curtain wall systems
- Glass roofs
- Openable elements in glass roof
- Shutters
- Entry doors
- Sliding doors
- Glazing
- Glazing edge bonds
- Fall protections

Building services

- Heat pumps
- Ventilation systems (capacity < 600 m^3/h)
- Decentralised ventilation system (single room only / with second room connection)
- Decentralised ventilation system (school room)
- Ventilation systems (capacity > 600 m^3/h)
- Drain water heat recovery
- Exhaust air wall system

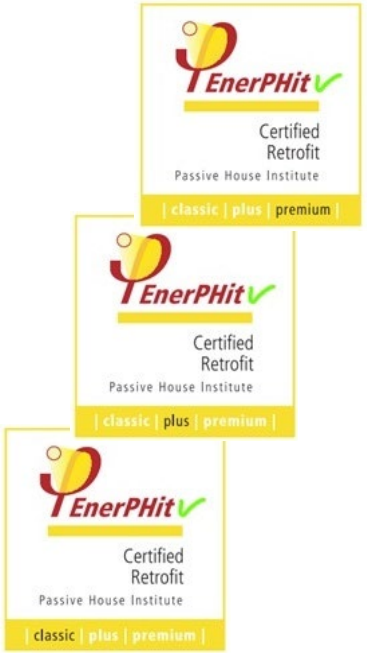
CERTIFIED COMPONENT
Passive House Institute

Building Certification


Monash University, Grimshaw Architects

Certified Retrofits: EnerPHit

Becker & Becker Architects



Two EnerPHit methods

The Passive House Network

Performance Method

Climate zone according to PHPP	Heating	Cooling
	Max. heating demand	Max. cooling + dehumidification demand
	[kBTU/(ft²yr)]	[kBTU/(ft²yr)]
Arctic	11.09	equal to Passive House requirement[1]
Cold	9.51	
Cool-temperate	7.92	
Warm-temperate	6.34	
Warm	4.75	
Hot	-	
Very hot	-	

Component Based Prescriptive Method

Table 2: EnerPHit component criteria

Climate zone according to PHPP	Opaque envelope[1] against...				Windows (including exterior doors)					Ventilation	
	...ground	...ambient air			Overall[4]			Glazing[5]	Solar load[6]		
	Insu-lation	Exterior insulation	Interior in-sulation[2]	Exterior paint[3]	Max. heat transfer coefficient ($U_{D/W,installed}$)			Solar heat gain coefficient (SHGC)	Max. specific solar load during cooling period	Min. heat reco-very rate[7]	Min. hu-midity re-covery rate[8]
	Min. thermal resistance (R-value)			Cool colours							
	[hr.ft².°F/BTU]			-	[BTU/hr.ft².°F]			-	[kBTU/(ft²yr)]	%	
					C	C	C				
Arctic	Deter-mined in PHPP from project specific heating and cooling degree days against ground.	63.09	22.71	-	0.08	0.09	0.11	U_g - SHGC*0.7 ≤ 0	32	80%	-
Cold		47.32	18.93	-	0.11	0.12	0.14	U_g - SHGC*1.0 ≤ 0		80%	-
Cool-temperate		37.86	16.22	-	0.15	0.18	0.19	U_g - SHGC*1.6 ≤ 0		75%	-
Warm-temperate		18.93	11.36	-	0.18	0.19	0.21	U_g - SHGC*3.2 ≤ -0.6		75%	-
Warm		11.36	7.57	-	0.22	0.23	0.25	-		-	-
Hot		11.36	7.57	Yes	0.22	0.23	0.25	-		-	60 % (humid climate)
Very hot		22.71	12.62	Yes	0.18	0.19	0.21	-		-	60 % (humid climate)

Energy Modeling: bim2PH + designPH + PHPP +...

designPH 2.0

bim2PH

Passive House Institute

Windows

Hollis Montessori School / Climate: Hollis, NH / TFA: 9058 ft² / Heating: 0.91 kWh/(ft²yr) / Cooling: 0.8 kWh/(ft²yr) / PER: 12.55 kWh/(ft²yr)

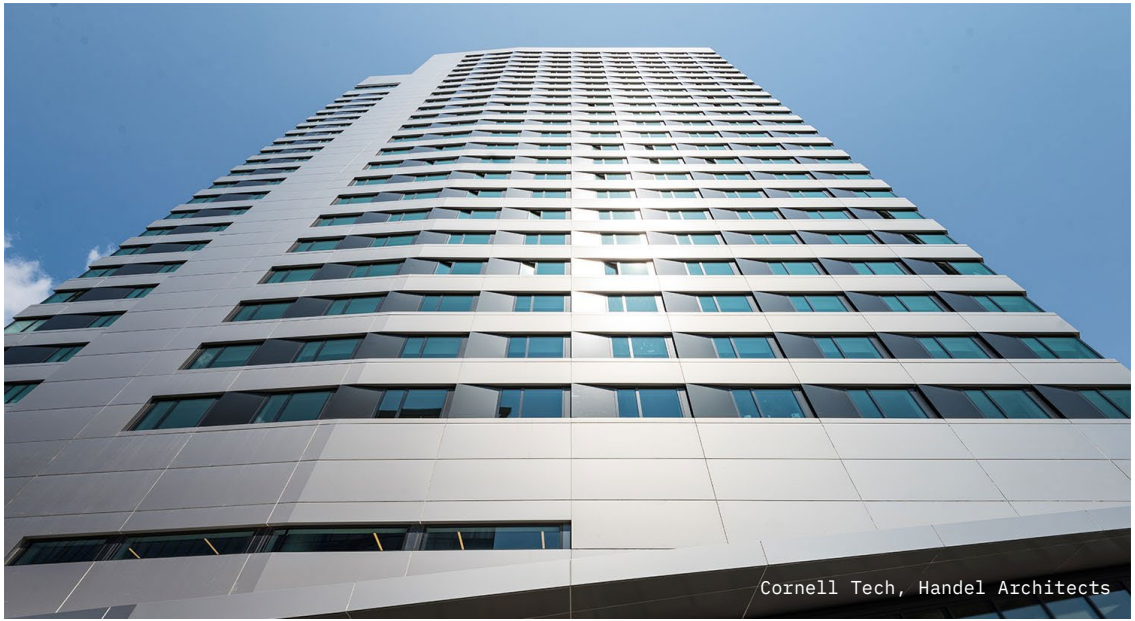
Window area orientation	Global radiation (main orientations)	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	SHGC	Solar irradiation reduction factor						
Standard values →	kWh/(ft²yr)	0.75	0.95	0.85				ft²	BTU/hr.ft².°F	ft²	kWh/ft²yr		kWh/yr	kWh/
North	14	0.56	0.95	0.85	0.58	0.50	0.26	155	0.20	90	14	North	1642	289
East	33	0.79	0.95	0.85	0.63	0.50	0.40	155	0.19	98	41	East	1557	129
South	62	0.81	0.95	0.85	0.74	0.50	0.49	506	0.17	376	59	South	4381	725
West	34	0.81	0.95	0.85	0.63	0.50	0.41	64	0.18	40	34	West	608	446
Horizontal	53	1.00	0.95	0.85	0.00	0.00	0.00	0	0.00	0	53	Horizontal	0	0
Total or average value for all windows.						0.50	0.43	880	0.18	604			8188	927

Heating degree hours [°F.day/yr]: 7440

Go to glazing list | Go to window frames list

Qua n-tity	Description	Deviation from north	Angle of inclination from the horizontal	Orien- tation	Window rough ope Width	Height	Installed in Selection from 'Areas' worksheet	Glazing Selection from 'Components' worksheet	Frame Selection from 'Components' worksheet	g-Value Perpen-dicular radiation	U-Value Glazing	Frames (avg.)	Ψ Glazing edge ($\Psi_{Glazing\ edge}$ (Avg.)	Installation situ user determined value fo '1': $\Psi_{installation}$ from 'Compone '0': in the case of abuttin left	right	bottom
		°	°		ft	ft		1-Sorting: LIKE LIST	Sort: AS LIST	-	BTU/hr.ft².°F	BTU/hr.ft².°F	BTU/hr.ft².°F	BTU/hr.ft².°F or 1/0		
1	W104	90	90	East	3.00	4.86	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Si82+Operable	0.50	0.11	0.19	0.018	1	1	1
1	W107	90	90	East	3.00	4.85	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Si82+Operable	0.50	0.11	0.19	0.018	1	1	1

Blower Door: Pressurize & Depressurize



Roadmap to Building Certification: Quality Assured

Benefits of Certification

The North American Certifiers Circle (NACC) certification provides many benefits to the developer, designer, consultant, builder, owner, and others.

Independent Review
Review services provided by a certifier are separate and distinct from those of a Passive House consultant or designer. This ensures an independent and objective assessment as well as additional quality assurance that benefits all parties involved.

Avoid False Starts
By working with a certifier from the start of the project the project can benefit from the experience and institutional knowledge of the certifier, avoiding rookie mistakes that need to be later undone.

Professional Development for Project Teams
The review of energy calculations and design and construction documentation through the lens of experts in high-performance building allows other members of the project team to gain a new perspective.

Assurance for the Project Team
Consultants, designers, and builders alike can breathe easier knowing their energy calculations and related details have been double-checked before construction begins.

Cost Control
We have established that the biggest driver of additional costs for Passive House is the experience or inexperience of the project team. No one has more experience than the building certifiers. Consequently the four reasons above work together to help you contain costs and meet your budget.

An initiative of Passive House Canada, The Passive House Network and the NACC members.

PASSIVEHOUSE CANADA

The Passive House Network

NACC MEMBERS

Find a NACC member for your next building project:

US Based Members

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www.certiphiers.com

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Mizu Passive House Consulting
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Peel Passive House Consulting
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RDH Building Science Inc.
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Passive House Academy
www.passivehouseacademy.com

Passive House Institute
passivehouse.com

Praxis
praxis-rb.com

Zephir Passivhaus Italia
passivhausitalia.com

March 2024

Building Certifier Scope of Services

A North American Certifiers Circle Guidance

The Passive House Network

More Examples, so far…

Highrises

Vancouver

Chelsea, NYC

Boston skyscraper named world's biggest 'Passive House' office

The building, which will use far less energy than a conventional design, is the latest example of the efficiency standard's growing popularity.

11 October 2023

Winthrop Center in downtown Boston is now the largest Passive House office space in the world. (Millennium Partners)

Affordable Housing

The Passive House Network


Brownsville, Brooklyn


Sendero Verde, East Harlem

UK RIBA Sterling Prize Winner

The Passive House Network

Goldsmith Street, Norwich, UK, Mikhail Riches

Museums

Vancouver Museum of Art, Herzog & de Meuron

Ravensburg, Austria

Government buildings

Belgian Embassy, Kinshasa Congo, A2M

Brussels Environment, architectenbureau cepezed

Archive

Universities

College of the Atlantic, Maine

Universities


Cambridge, UK


East Anglia, UK

Recreation Centers

Townhouse Retrofits

The Passive House Network

Homes…

The Passive House Network

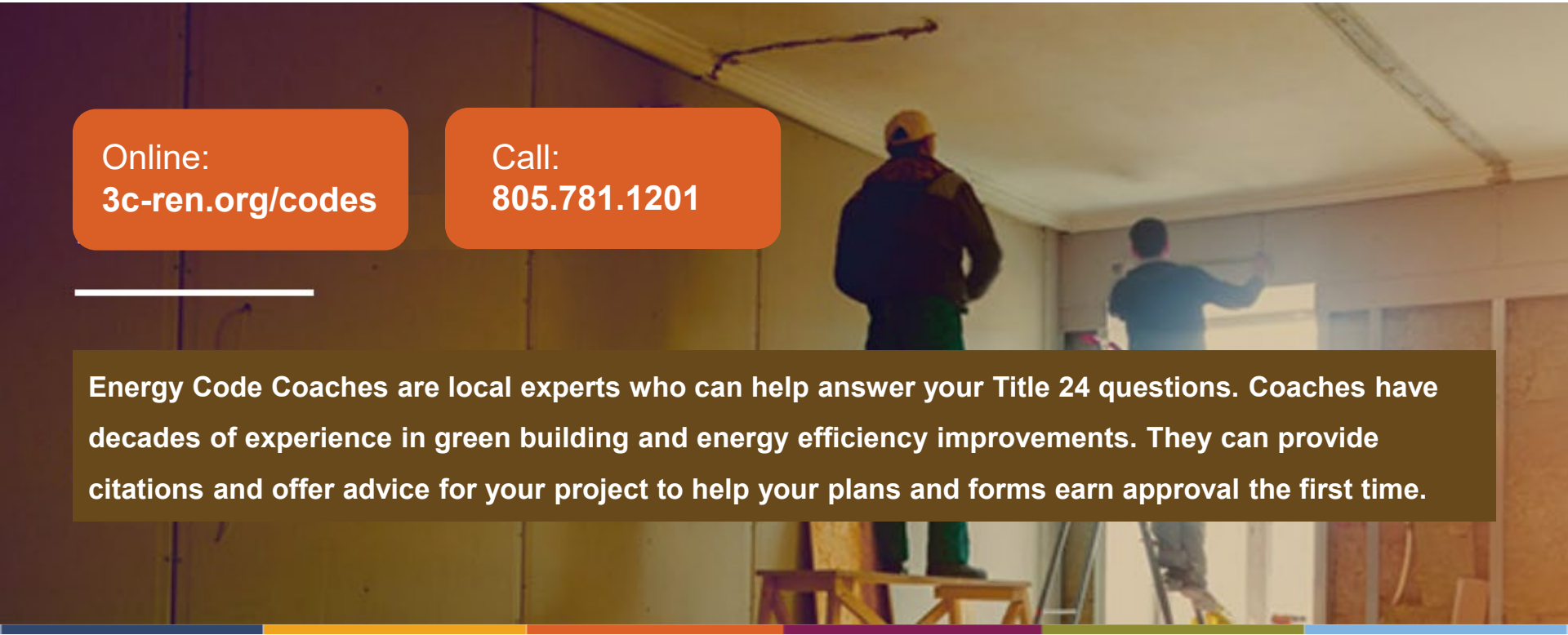
Build your future.

Get Passive House trained.

www.passivehousenetwork.org

Questions about Title 24?

3C-REN offers a *free* Code Coach Service



Online:
3c-ren.org/codes

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 questions. Coaches have decades of experience in green building and energy efficiency improvements. They can provide citations and offer advice for your project to help your plans and forms earn approval the first time.

Closing

- Continuing Education Units Available
  - Contact shuskey@co.slo.ca.us for AIA LUs
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - April 4th - Why Energy Consultants Should Learn to do Residential HVAC Design
  - April 9th - Blower Door Basics and Beyond
  - April 11th - Is a Heat Pump Water Heater Right for Me?
  - April 16th - Overcoming Installation Challenges with Heat Pumps
  - April 18th - Certified Passive House Designer/Consultant (CPHD/C) Pacific Spring Hybrid Cohort
- Visit www.3c-ren.org/events for our full catalog of trainings.

Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

3C REN

TRI-COUNTY REGIONAL ENERGY NETWORK

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