We will be starting soon!

Thanks for joining us

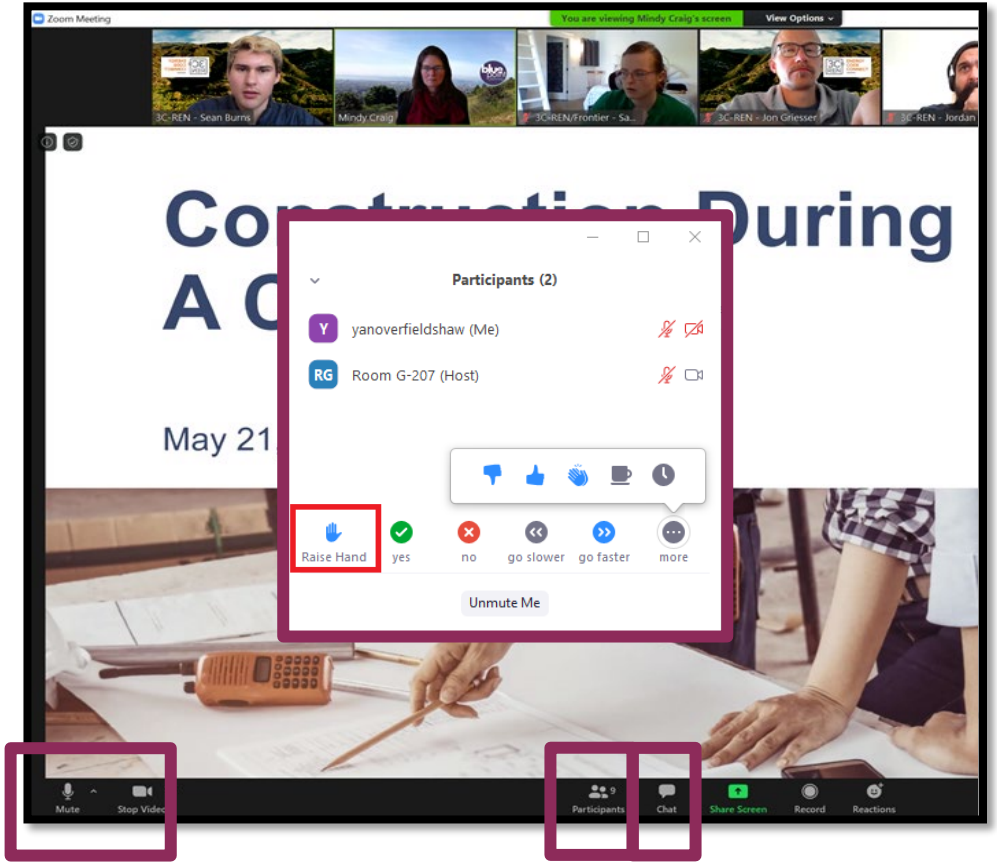
Introduction to Passive House

Steve Mann, The Passive House Network and Home Energy Services

May 1, 2023

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
805.220.9991

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

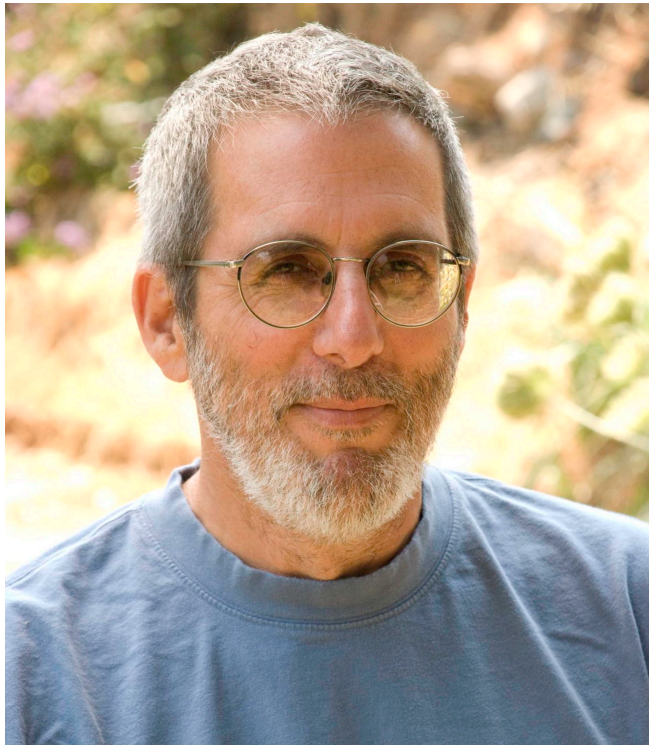
3C-REN
Staff Online

Introduction to the Passive House Standard

The Passive House Network

Presented By

The Passive House Network



Steve Mann

Home Energy Services
Berkeley, CA

Steve Mann, is a California HERS Rater and Certified Energy Analyst (CEA), LEED AP+ Homes and Green Rater, and is a certified Passive House Designer, Tradesperson, Trainer, and building Certifier with the Passive House Institute.

PASSIVE HOUSE CERTIFIER
Passive House Institute accredited

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER

CERTIFIED PASSIVE HOUSE TRADESPERSON
TRADESPERSON

The Network

The Passive House Network

Passive House Empire State
The Passive House Network

Passive House Pennsylvania
The Passive House Network

New Jersey Passive House
The Passive House Network

Passive House Washington DC
The Passive House Network

Passive House Minnesota
The Passive House Network

Passive House Rocky Mountains
The Passive House Network

Passive House America
The Passive House Network

Passive House Institute

International PASSIVE HOUSE Association iPHA

North American Certifiers Circle — Passive House Certifier — Passive House Institute accredited

Global Knowledge. Regional Context. Local Applications

BECOME A MEMBER!

AIA Course Description

The Passive House Network

North American Passive House Network

AIA CEU Provider #502111363

Introduction to Passive House Standard

Presentation #1day_Intro_PH

Passive House goals and methodology change how architects and builders think and work, making the architectural design a driver of climate, health, and social solutions. This is a 4-hour course that dives into the basic principles, history, certification, and the new frontiers of Passive House design as it continues to challenge and change industry expectations. All theory is then illustrated through 3 case studies outlining specific Passive House principles.

Learning Objectives

The Passive House Network

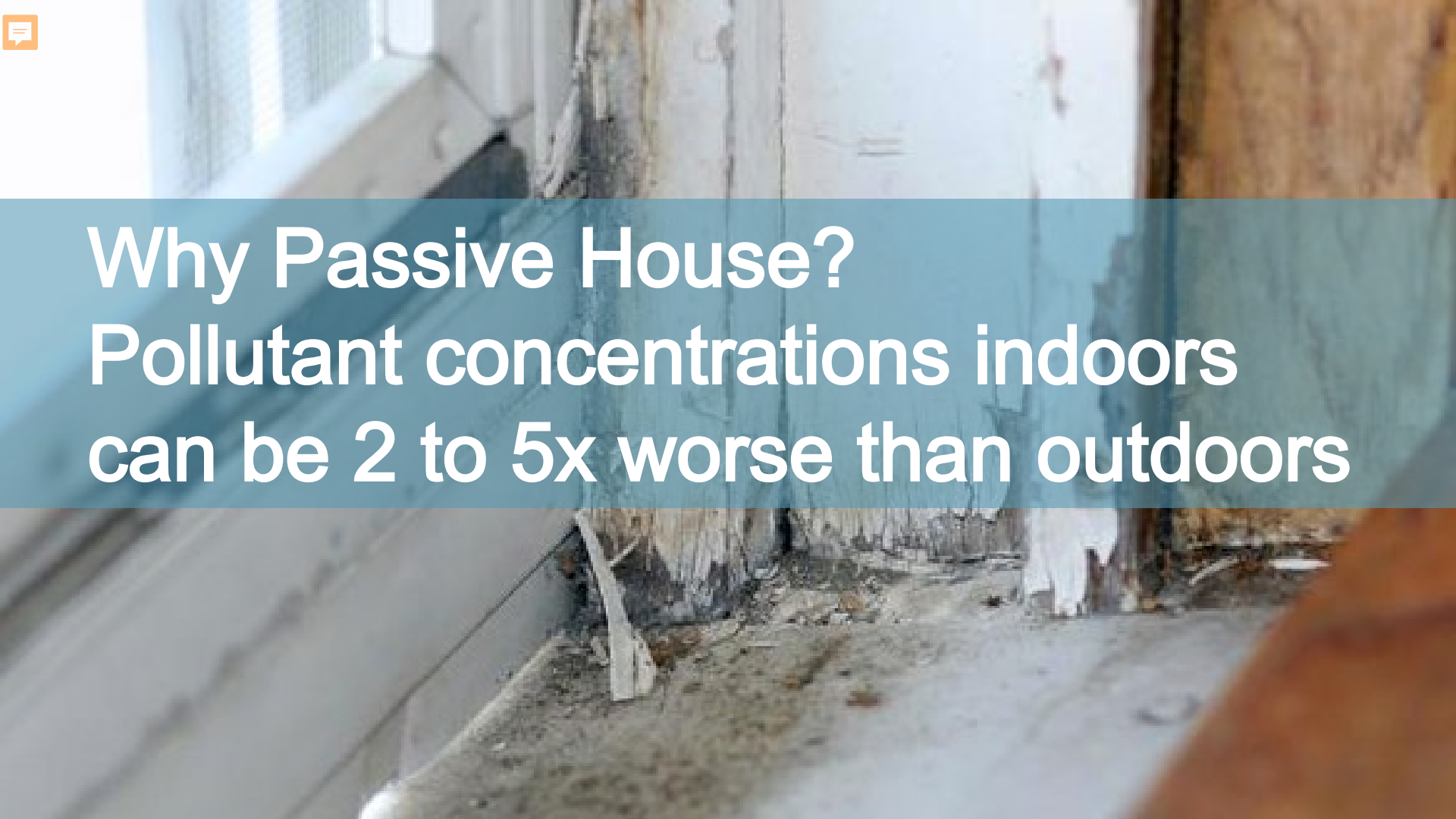
- **Learning Objective 1:**
  Outline the 5 basic principles of Passive House design and how each principle contributes to the health, safety and welfare of occupants.
- **Learning Objective 2:**
  Describe why and how hygienic ventilation is an essential defining component of Passive House design and operation. And outline how the Passive House design focuses on very good energy efficiency which results in side-benefits like great occupant thermal and acoustic comfort, improved occupant health outcomes, and economic affordability.
- **Learning Objective 3:**
  Outline the major Passive House tools: PHPP, DesignPH and Therm, and provide an overview of the tools in correlation with data-driven design.
- **Learning Objective 4:**
  To understand how to get from where the participant is now to building a building adhering to the international passive house standard through applicable case studies. And illustrate the data-driven' design process used to help projects meet their comfort, durability and climate goals.

Part 1: The Passive House Idea

- Why Passive House?
- Passive House and our Climate Goals
- Passive House and ‘Net Zero’ Goals
- Passive House and Occupant Satisfaction
- How do you Make a Passive House?
  - Continuous Insulation
  - Airtightness
  - Thermal Bridge Free
  - Windows and Doors
  - Ventilation with Heat Recovery

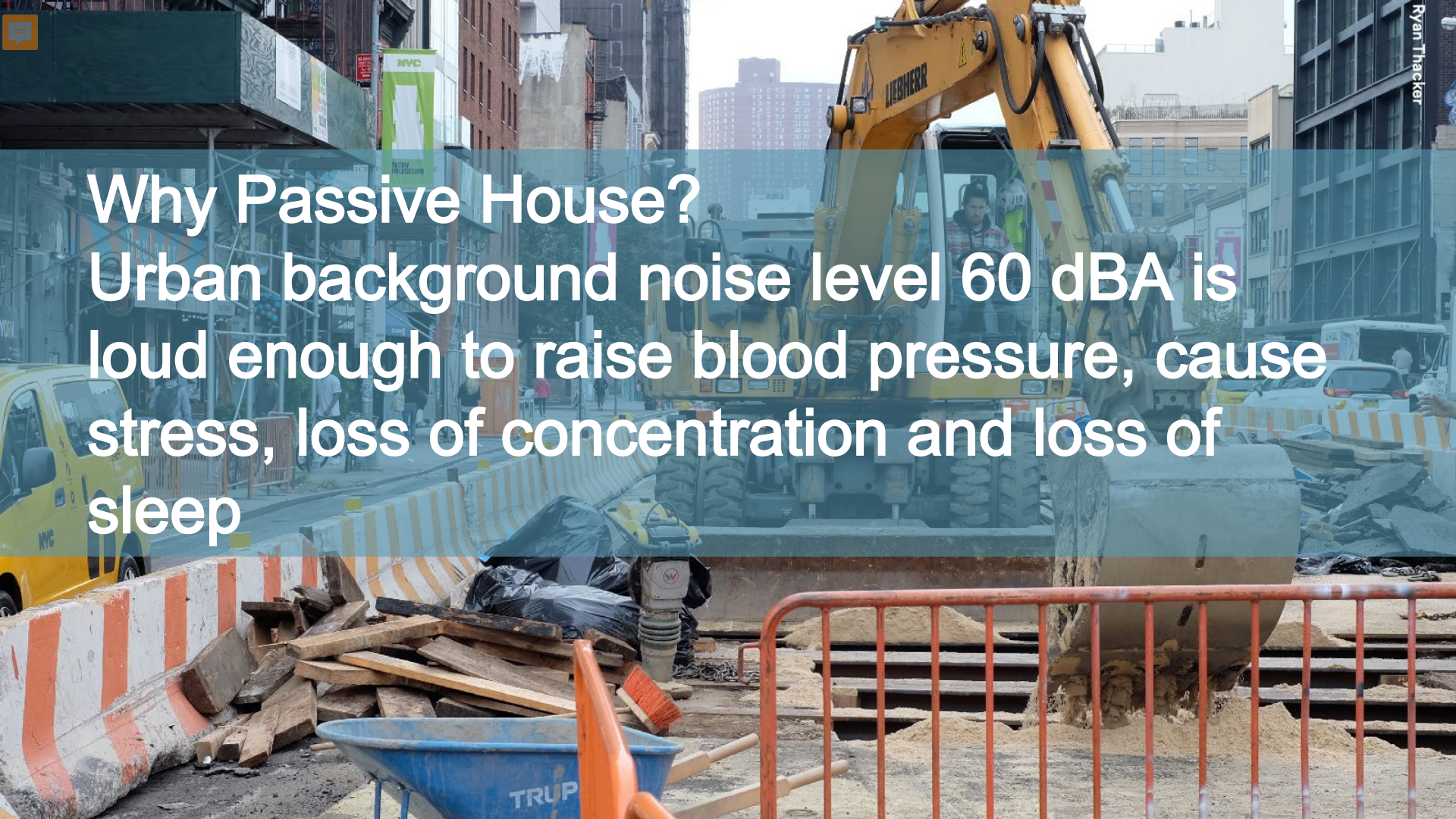
Why Passive House?


Why Passive House?
In North America most of us will spend close to 90% of our time indoors
STOP
STOP
NYUPublicSafety


Why Passive House?
Pollutant concentrations indoors
can be 2 to 5x worse than outdoors

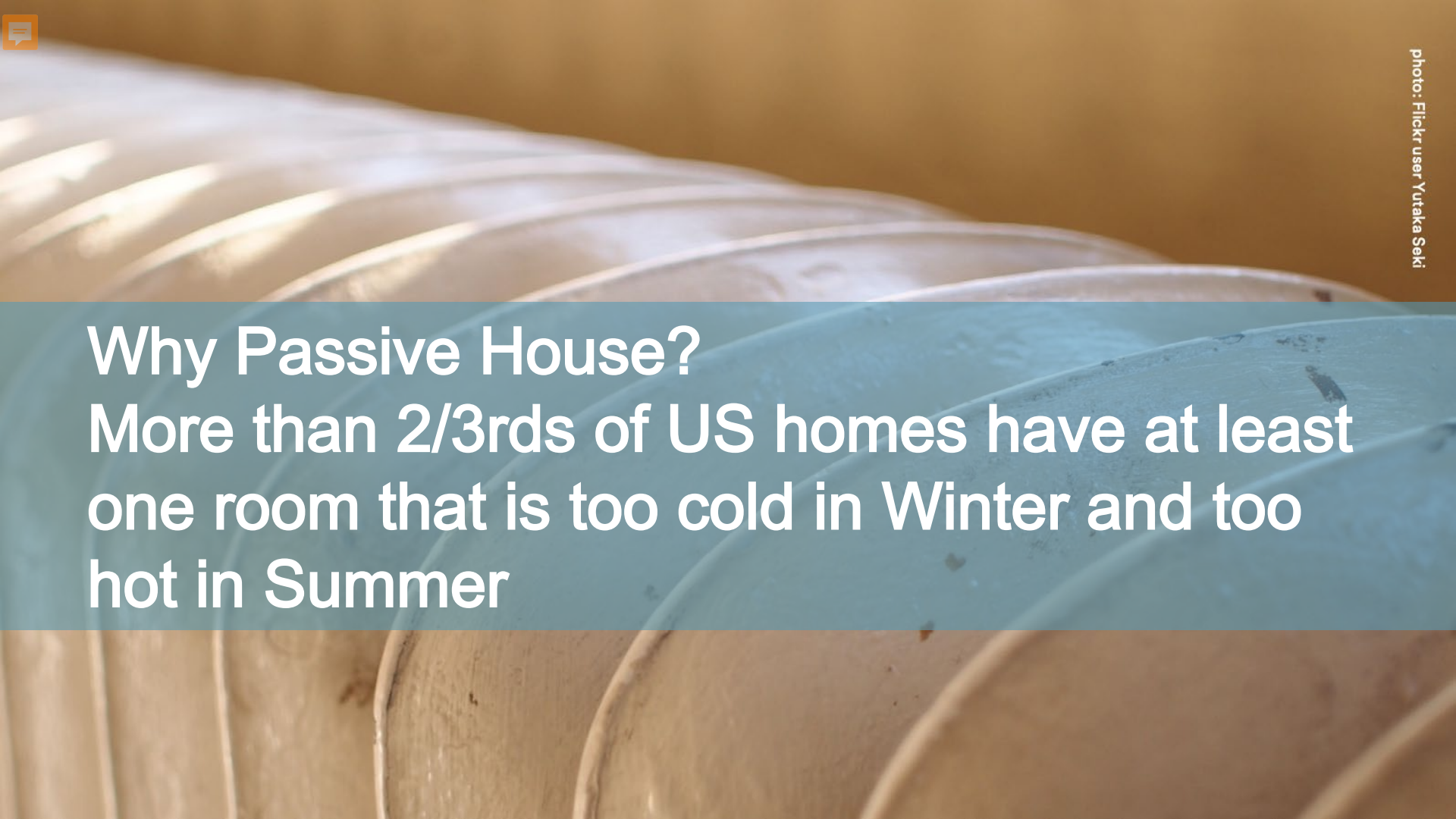

Why Passive House?
1/3 of all buildings in US have mold
& mildew growth

Why Passive House? Because even the outdoor air isn't always 'fresh'



Why Passive House?

Urban background noise level 60 dBA is loud enough to raise blood pressure, cause stress, loss of concentration and loss of sleep

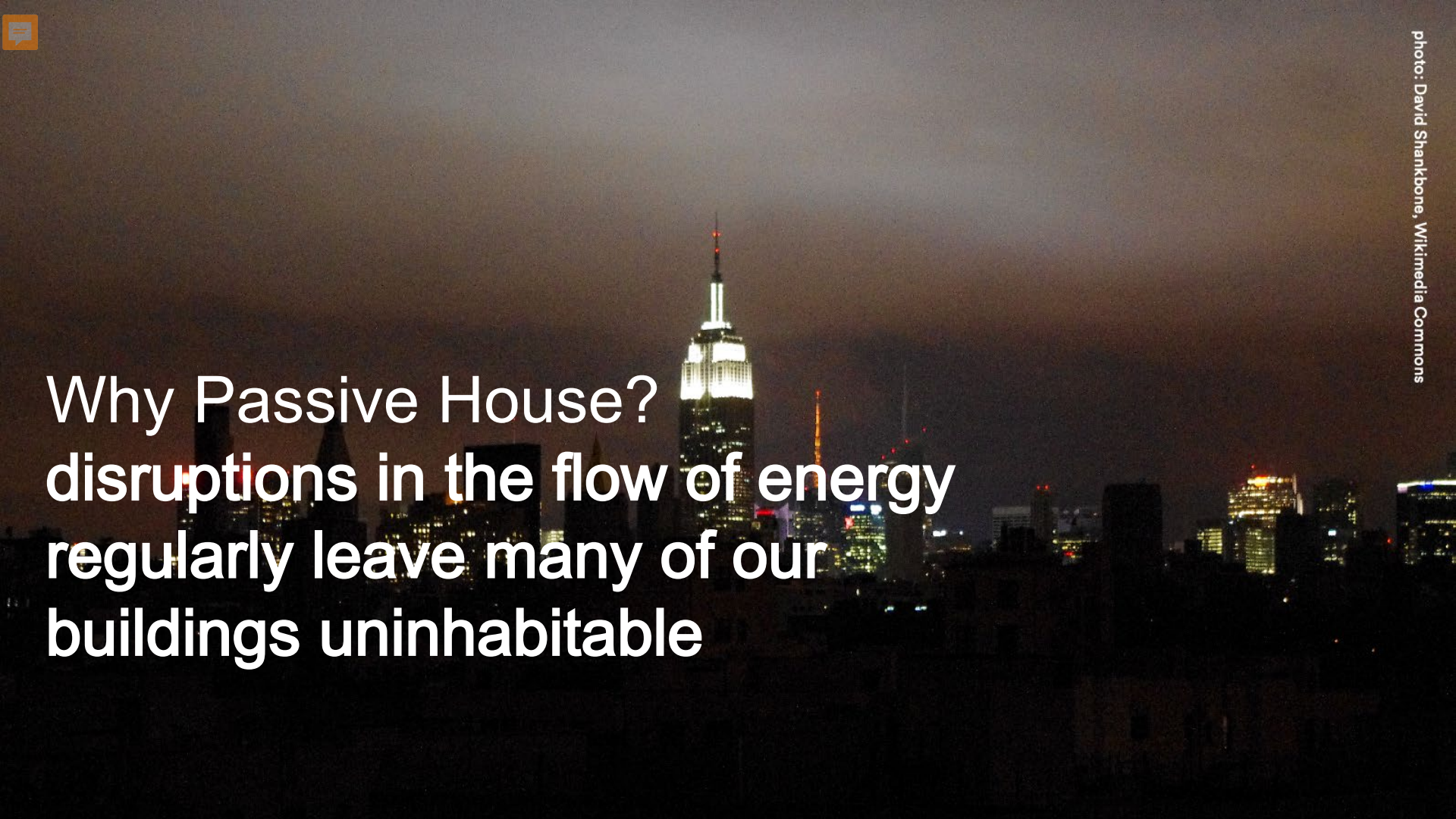


Why Passive House?

More than 2/3rds of US homes have at least one room that is too cold in Winter and too hot in Summer

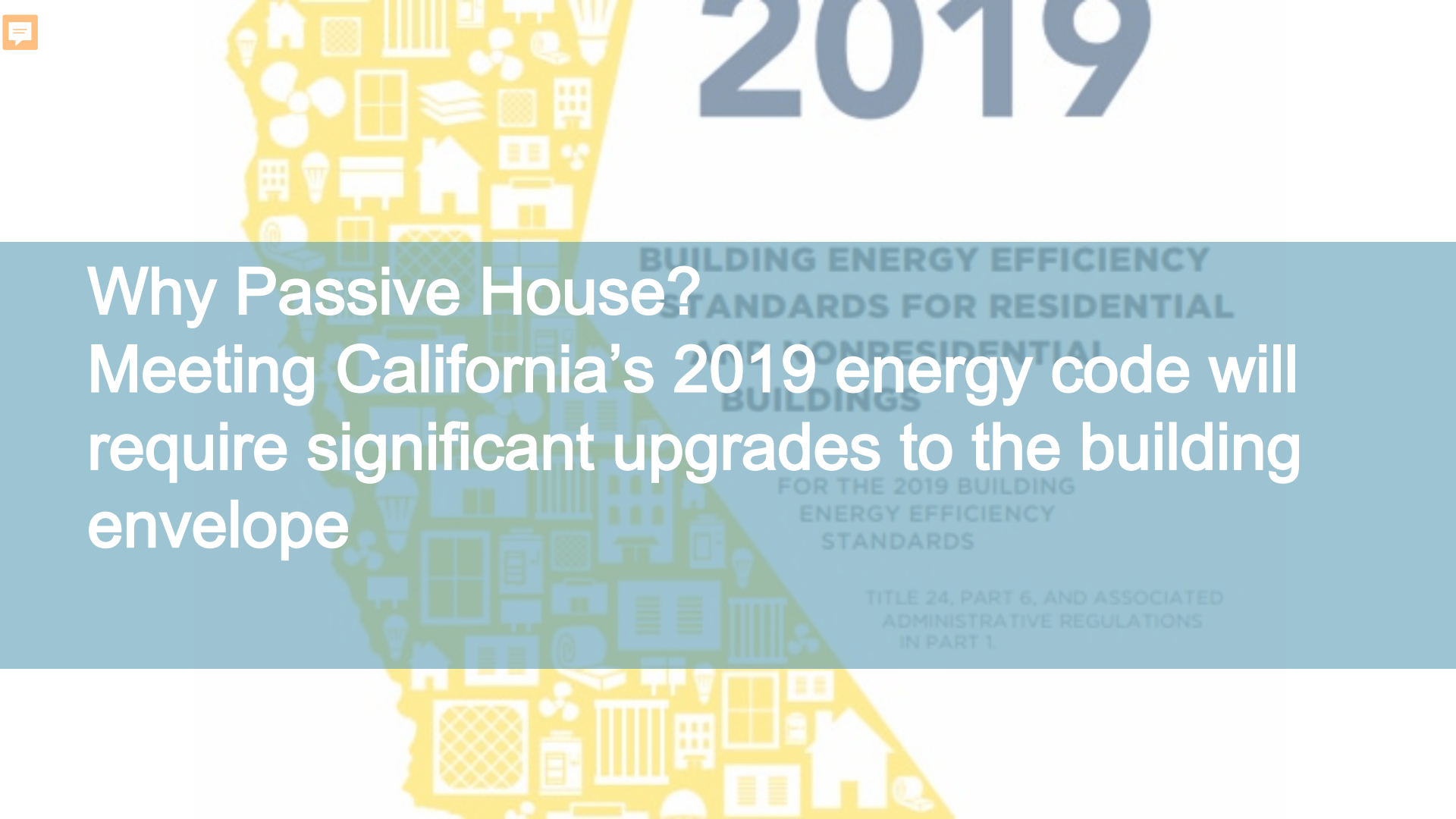
Why Passive House?
Buildings are currently responsible for 31% of all greenhouse gas submissions in the US

photo: Flickr user Jason Eppink



Why Passive House?

disruptions in the flow of energy regularly leave many of our buildings uninhabitable



Why Passive House?
Meeting California's 2019 energy code will require significant upgrades to the building envelope

Why Passive House
for health,
for comfort,
for durability,
for resiliency,
for predictability,

and do all that with 75% less energy

photo: Field Condition & Pavel Bendov (Test House at Cornell Tech)

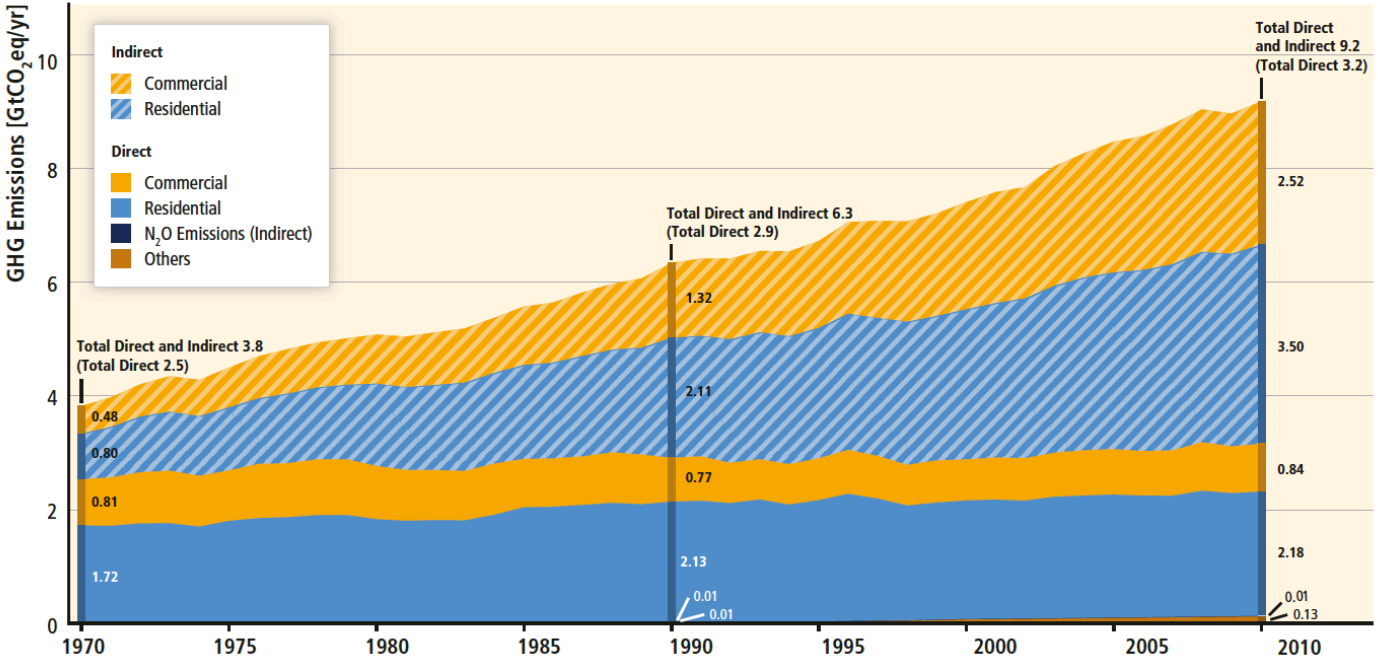
The Passive House Standard

The Passive House Network

Buildings + Greenhouse + Gas Emissions

The Passive House Network

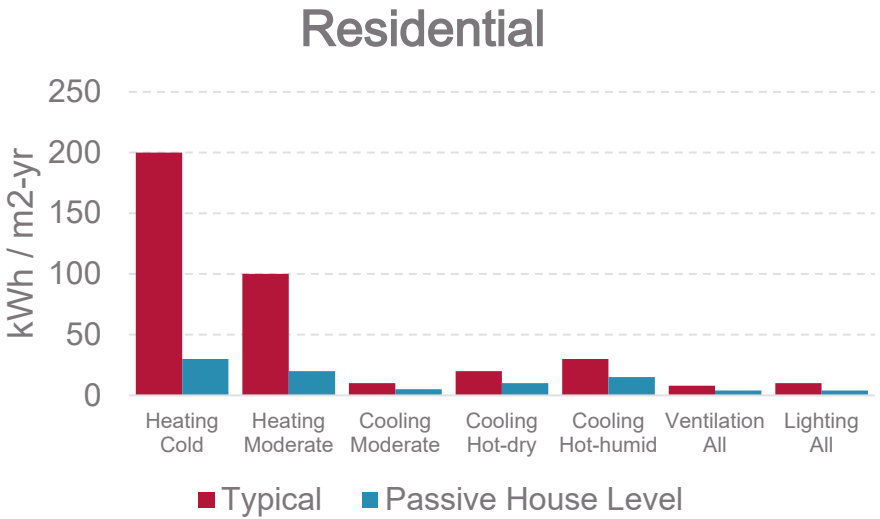
Worldwide, GHG Emissions from Buildings have more than doubled since 1970 alone

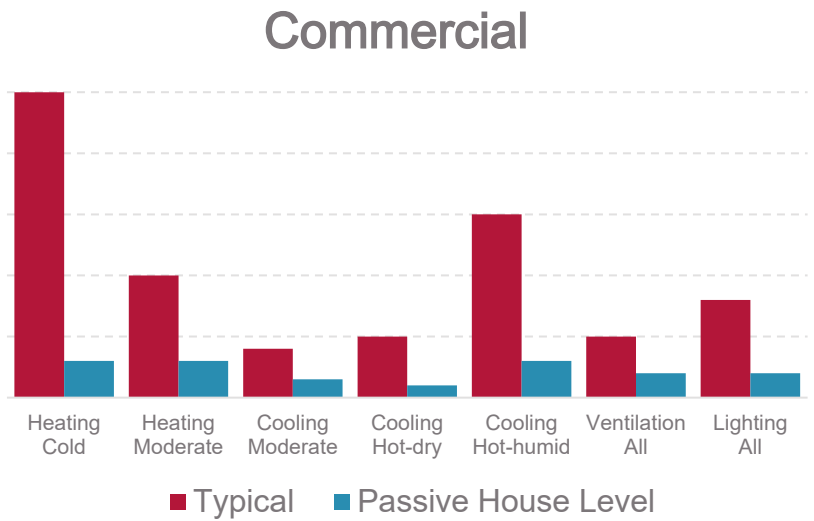


Buildings + Energy Consumption

The Passive House Network

From IPCC AR5: “A number of voluntary standards for heating energy use have been developed in various countries for residential buildings. The most stringent of standards with regard to heating requirements is the Passive House standard …. As seen from Table 9.3 [below], this standard represents a factor of 6 – 12 reduction in heating load in mild climates (such as Southern Europe) and up to a factor of 30 reduction in cold climate regions where existing buildings have little to no insulation.”



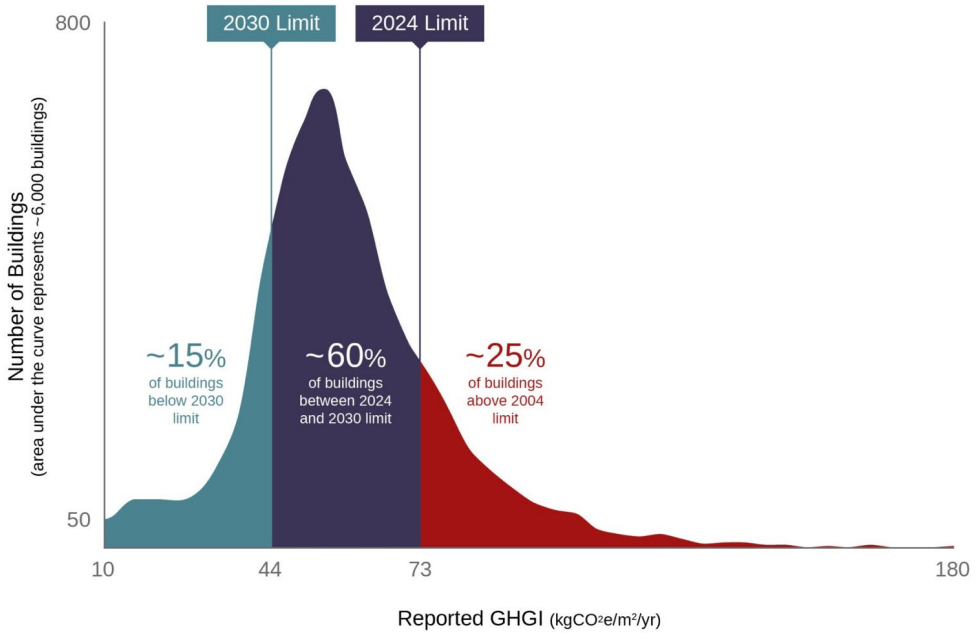


NYC Climate Mobilization Act

The Passive House Network

Distribution of Reported Greenhouse Gas Intensities in Existing NYC Multi-family Residential Buildings (2016 Data)

RESHAPE STRATEGIES



GREEN DEAL WITH IT

NYC Council passes sweeping building emission legislation

By JONATHAN HILBURG (@JHILBURG) • April 19, 2019

The Climate Mobilization Act, which Mayor de Blasio is expected to sign, would set increasingly harsh limits on carbon emissions for buildings over 25,000 square feet beginning in 2024. According to the Urban Green Council, New York City produces 50 million tons of carbon dioxide a year, and buildings account for approximately 67 percent of that–meaning buildings over 25,000 square feet produce 35 percent, or about 13 million tons of carbon dioxide, a year.

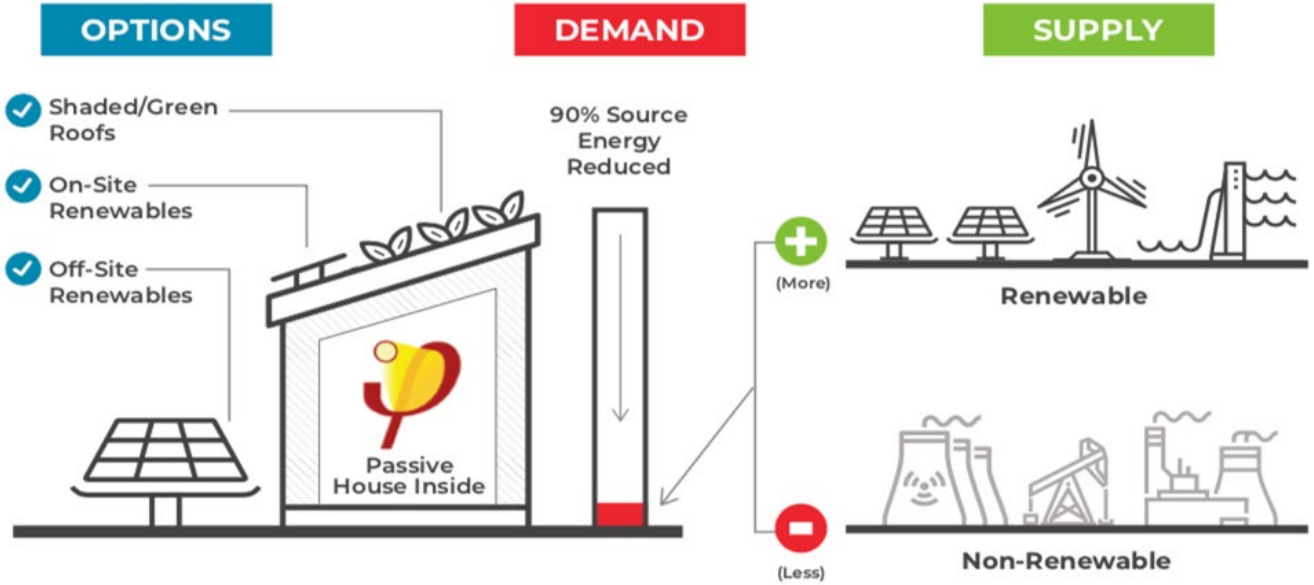
The legislation covering the affected 50,000 buildings will roll out in phases. This year, an Office of Building Energy and Emissions Performance and an advisory board will be created at the Department of Buildings to both regulate and enforce the new standards. When the law fully takes effect in 2024, emissions from qualifying buildings will need to be reduced 40 percent from 2005 levels by 2030. The Climate Mobilization Act then takes things one step further and requires that these same buildings slash their emissions by 80 percent by 2050.

California Zero Net Energy Goals

The Passive House Network

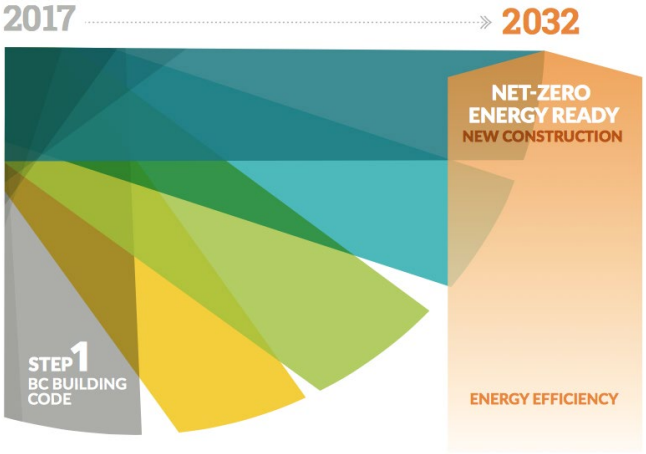
California Energy Efficiency Strategic Plan Goals:

- New codes will focus on reducing Carbon Emissions in addition to reductions in energy usage
- Future codes will likely require significant efficiency + onsite renewables



BC Energy Step Code

The Passive House Network



PHPP

British Columbia Energy Step Code:

- "The Province has committed to taking incremental steps to increase energy-efficiency requirements in the BC Building Code to make buildings net-zero energy ready by 2032. The BC Energy Step Code--a part of the BC Building Code--supports that effort."
- "Buildings designed and constructed … to the Passive House Planning Package (PHPP)…are deemed to comply…"

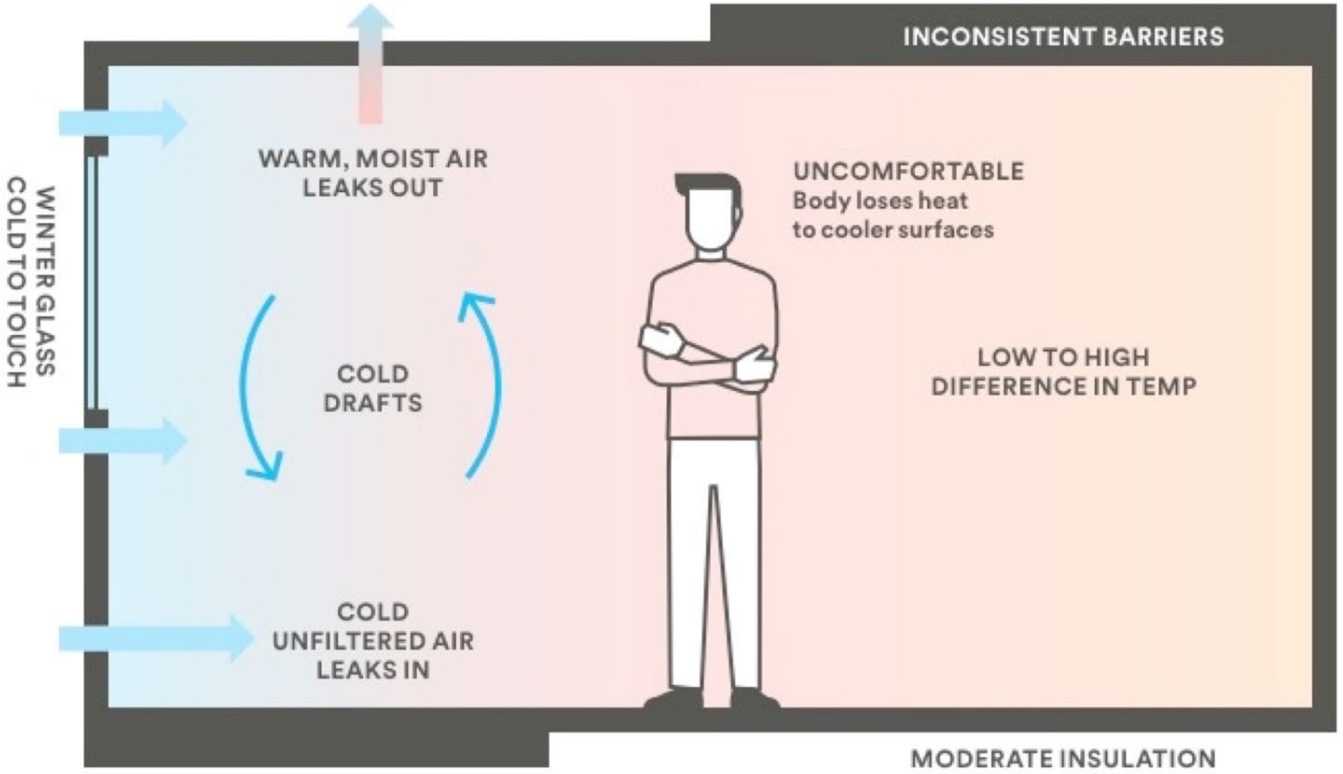
The 5 Basic Principles of Passive House

The Passive House Network

1. Continuous Insulation
2. Airtight Construction
3. Thermal Bridge Free
4. High Quality Windows and Doors
5. Fresh-Air Ventilation with Heat Recovery

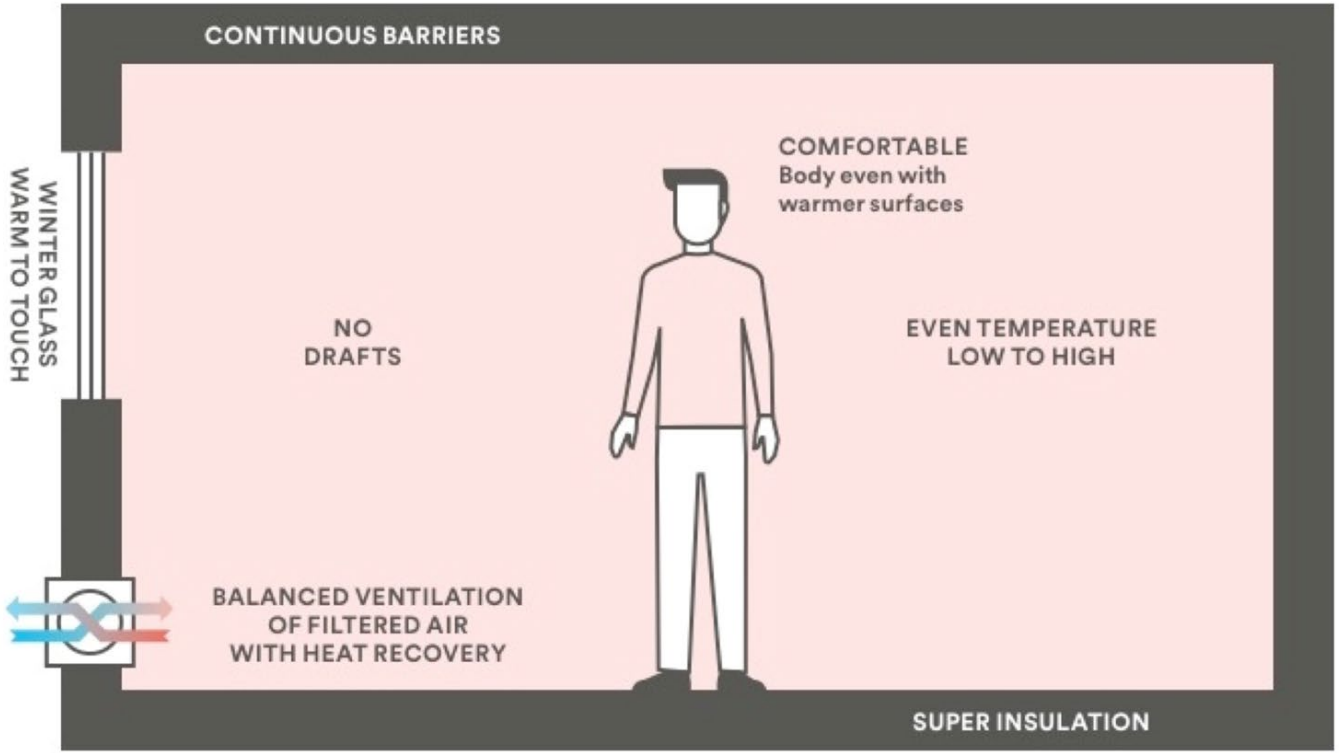
Design Outward From Occupant

The Passive House Network



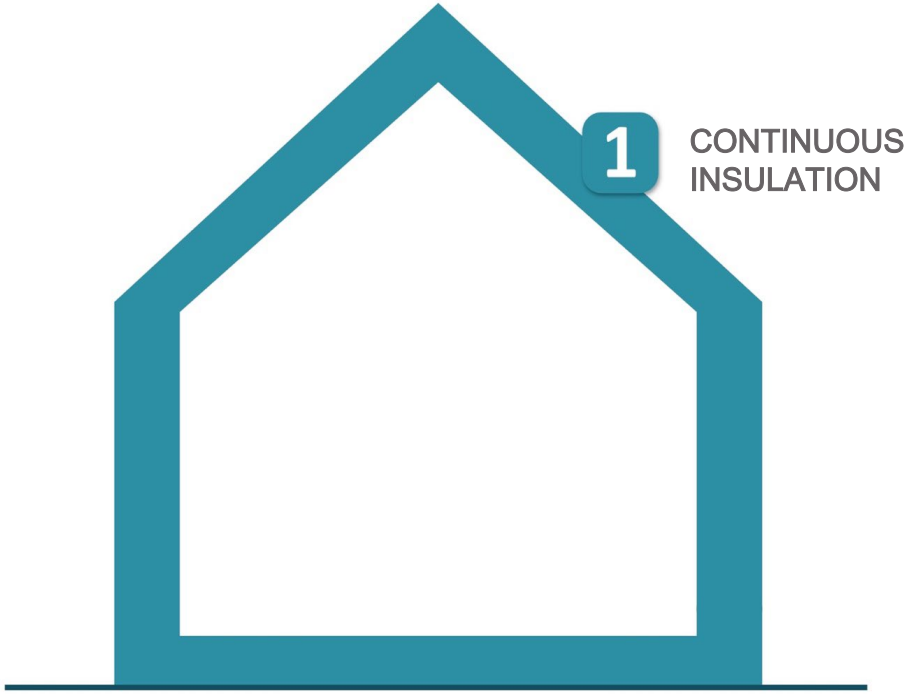
Design Outward From Occupant

The Passive House Network



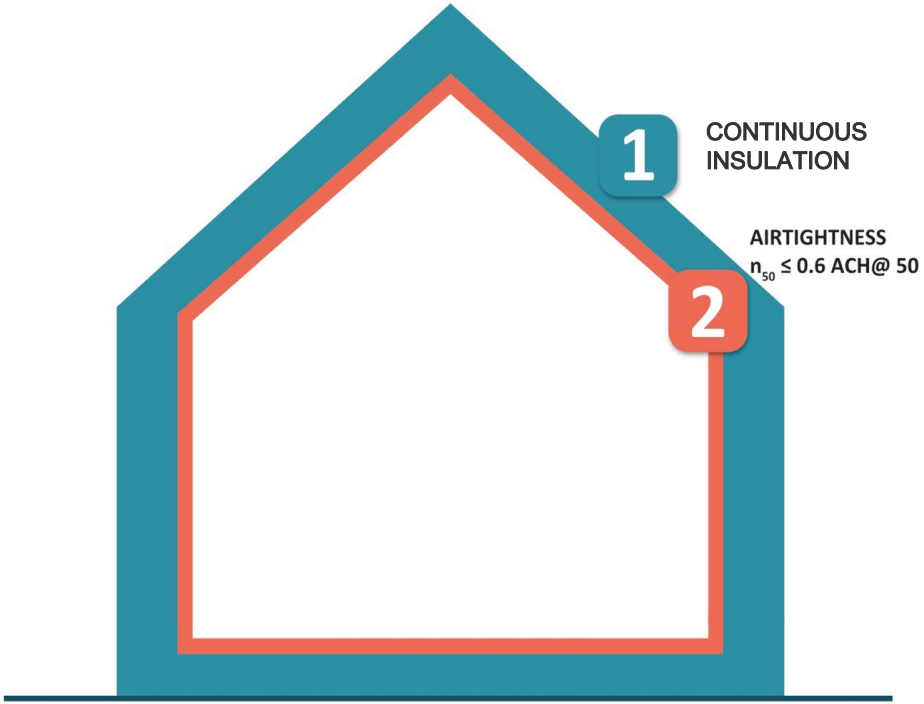
#1: Continuous Insulation Layer

The Passive House Network



- Reduce heat loss (winter)
- Reduce heat gain (summer)
- Comfortable interior surface temps

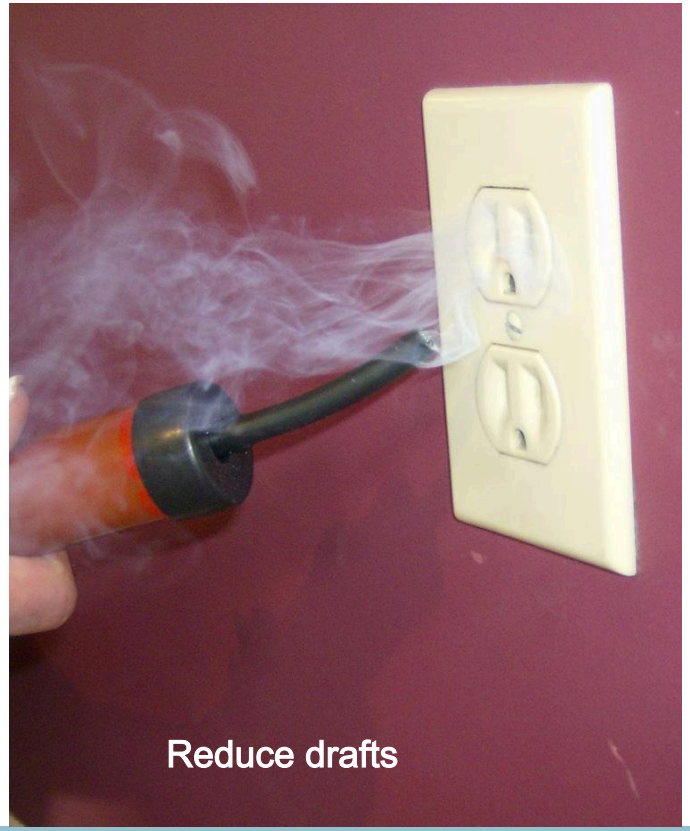
#2: Continuous Air -Tight Construction



- Reduce drafts
- Reduce possibility of moisture damage to envelope due to air transported moisture
- Reduce heat loss (winter)
- Reduce humidity (summer)

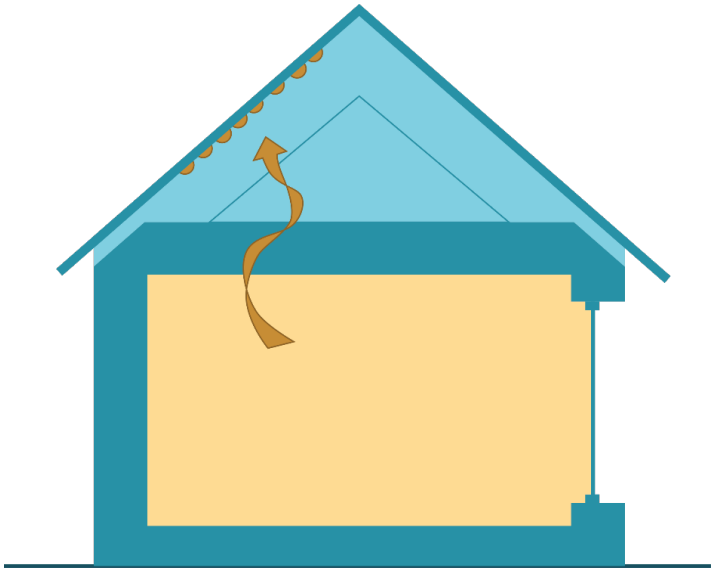
Comfort & Health

The Passive House Network



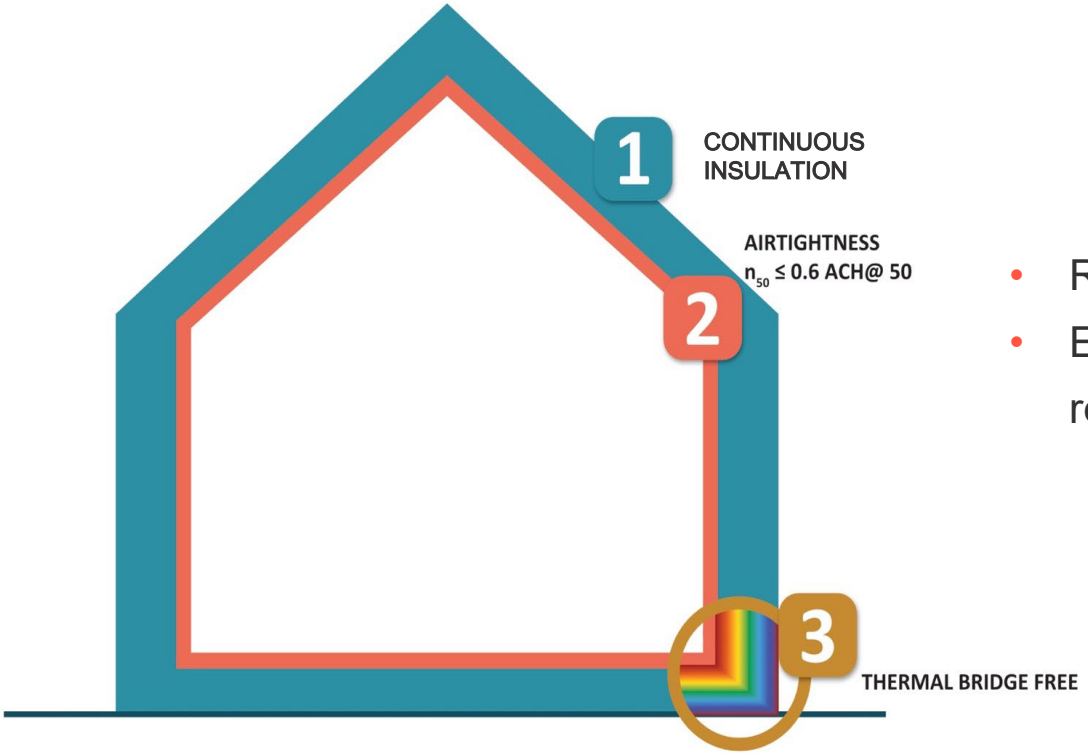
Durability

Attic sheathing with mold
from condensation



#3: Eliminate “Thermal Bridges”

The Passive House Network



- Reduce heat loss
- Eliminating cold surfaces means reduced risk of mold growth

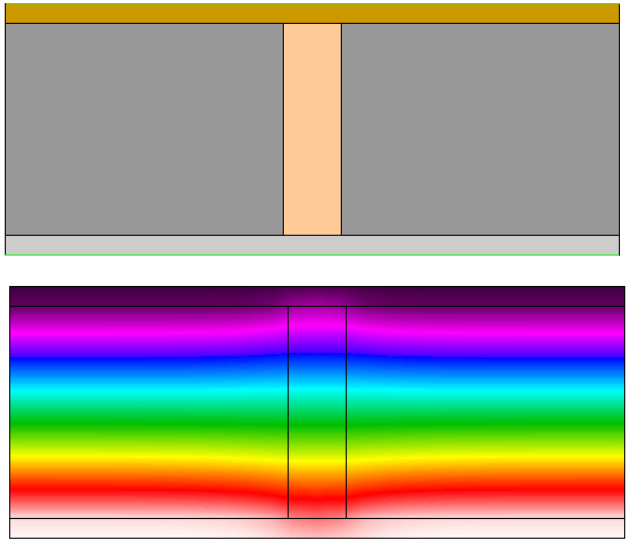
Thermal Bridge?

The Passive House Network

Wood stud wall, insulated cavity:

Nominal R-value (through cavity): 22.3

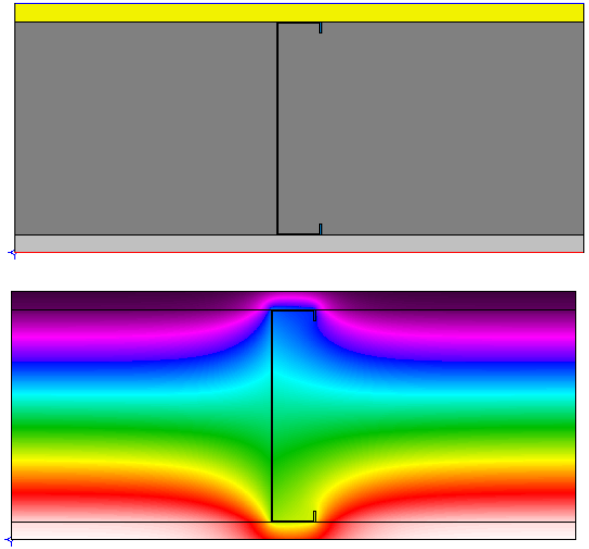
Actual R-value (incl. framing): 19.0



Steel stud wall, insulated cavity:

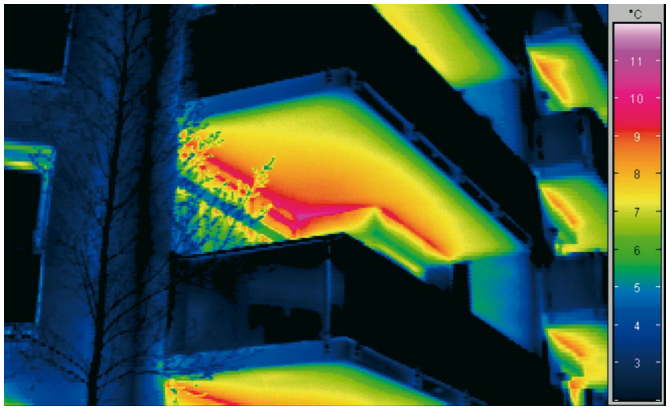
Nominal R-value (through cavity): 22.3

Actual R-value (incl. framing): 11.6

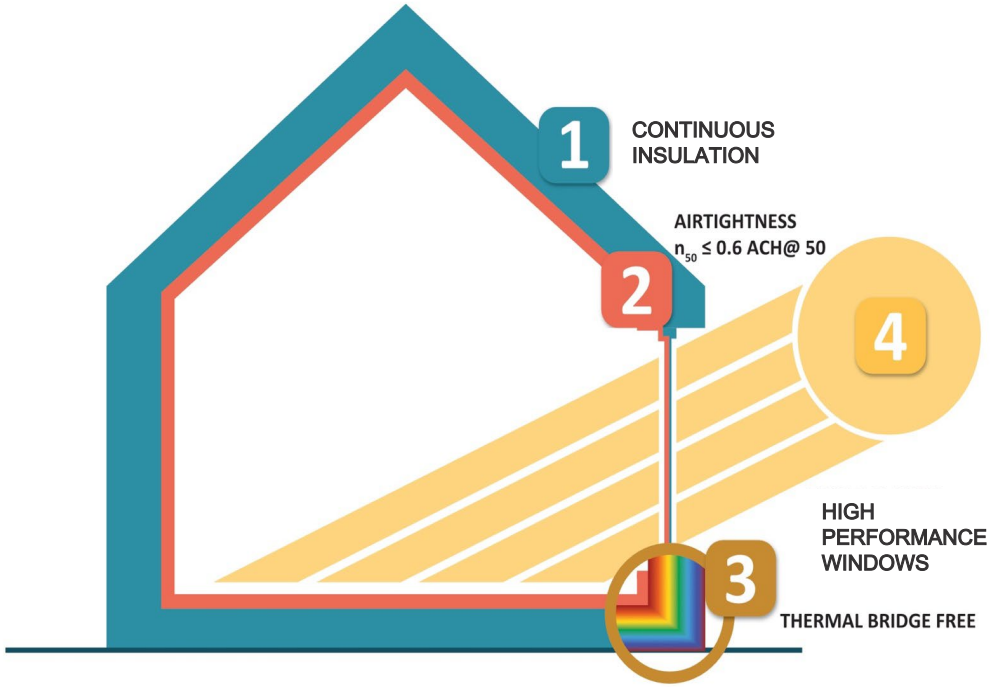


Cold Surfaces, Mold, Condensation

The Passive House Network



#4: High Performance Glazing



- Glass's high int. surface temps lead to increased occupant comfort
- No need for expensive perimeter heating to combat cold surfaces

Passive House Windows

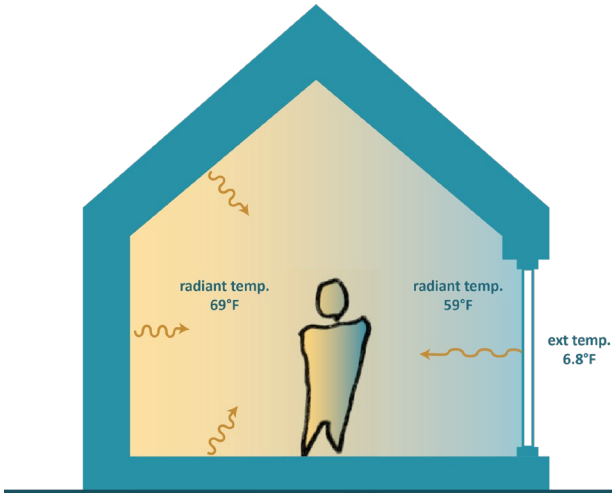
The Passive House Network

Occupant Comfort

The Passive House Network

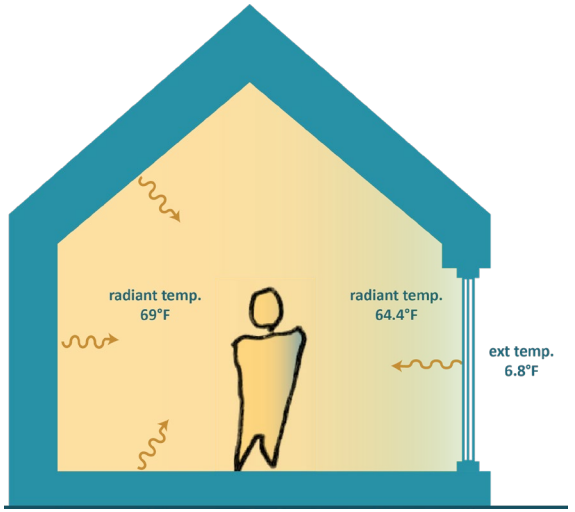
Standard window, R -3 (hr.ft².°F)/Btu

Radiant temperature difference: **10°F**



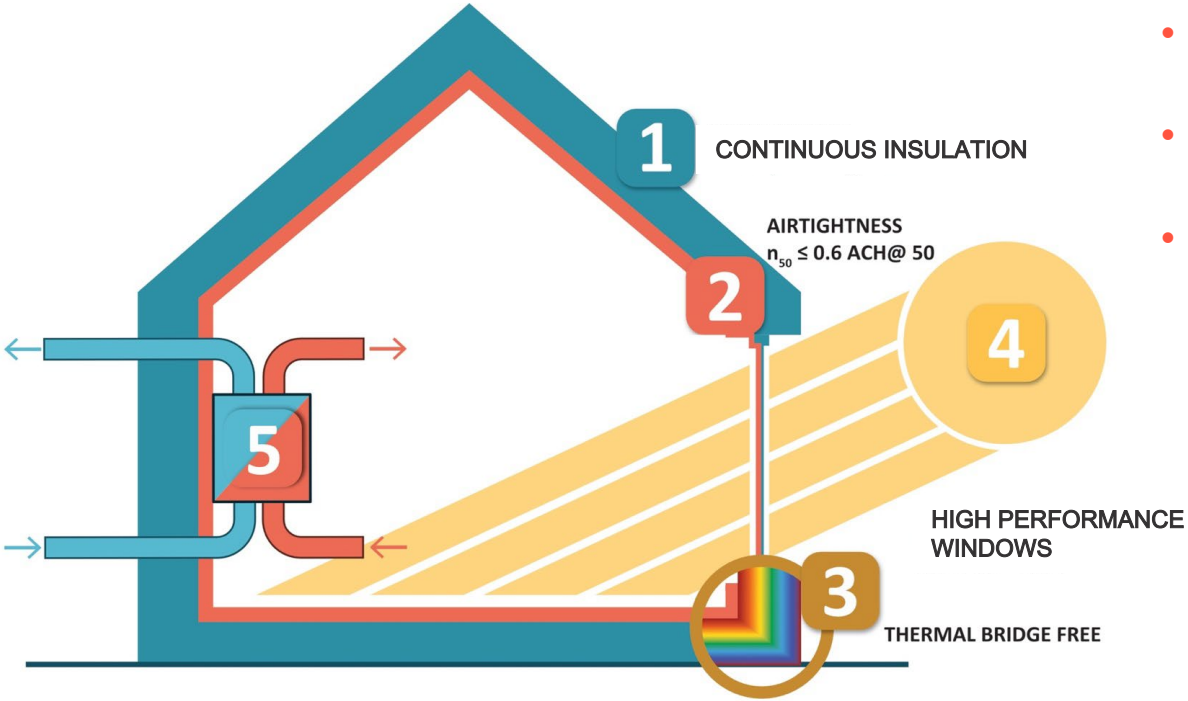
Passive House window R-7 (hr.ft².°F)/Btu

Radiant temperature difference: **< 6°F**



The radiant temperature asymmetry of 10 ºF is far too high (should be less than 7.2 ºF).
A compensating heating surface near the window is required.

#5: Fresh -Air Ventilation + Heat Recovery



- Clean, filtered fresh air all year round
- Reduced heat loss in winter
- Eliminate stale air

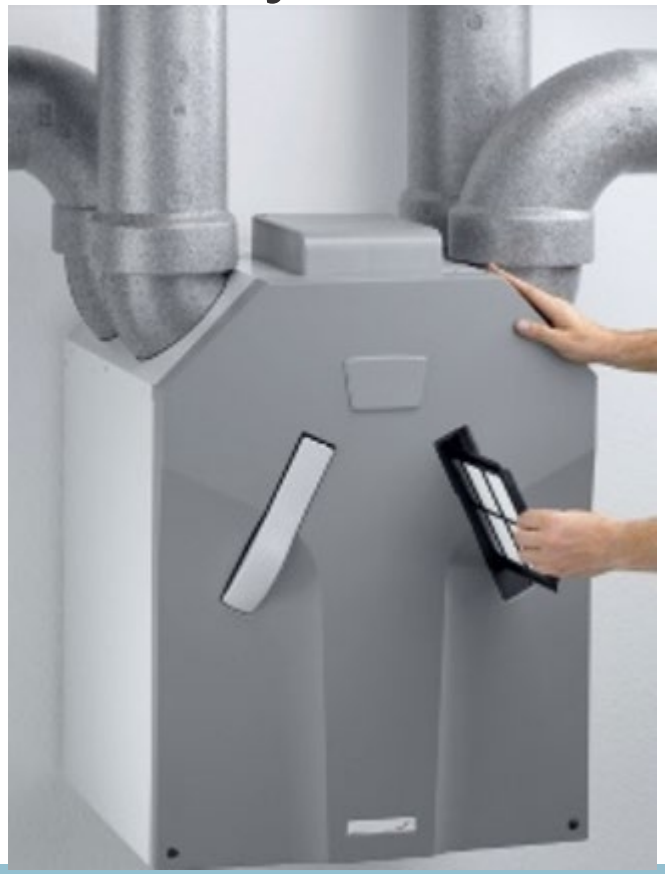
Balance Ventilation w/Heat Recovery

The Passive House Network

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

H/ERV's must be:

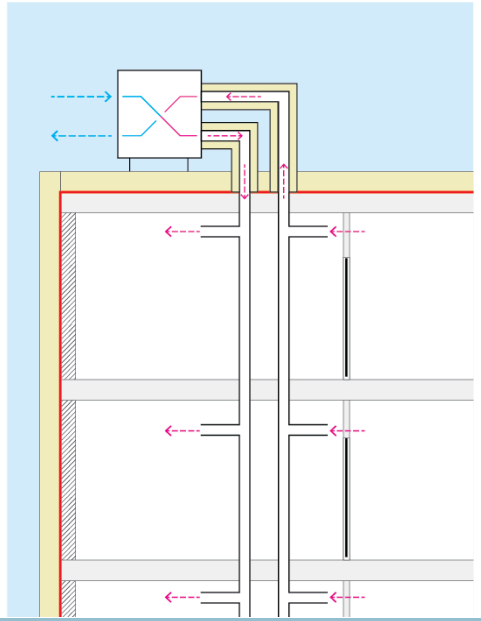
- Super-insulated
- Airtight
- Thermal bridge free
- Quiet
- Energy efficient
- Suitably located



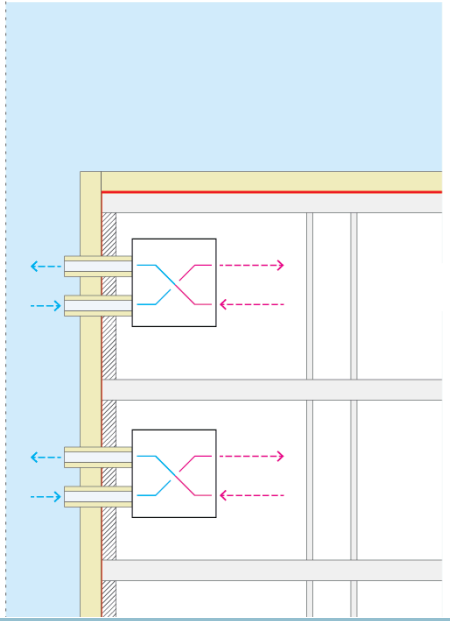
System Configuration

The Passive House Network

Centralized:
One main ventilator unit for the entire building

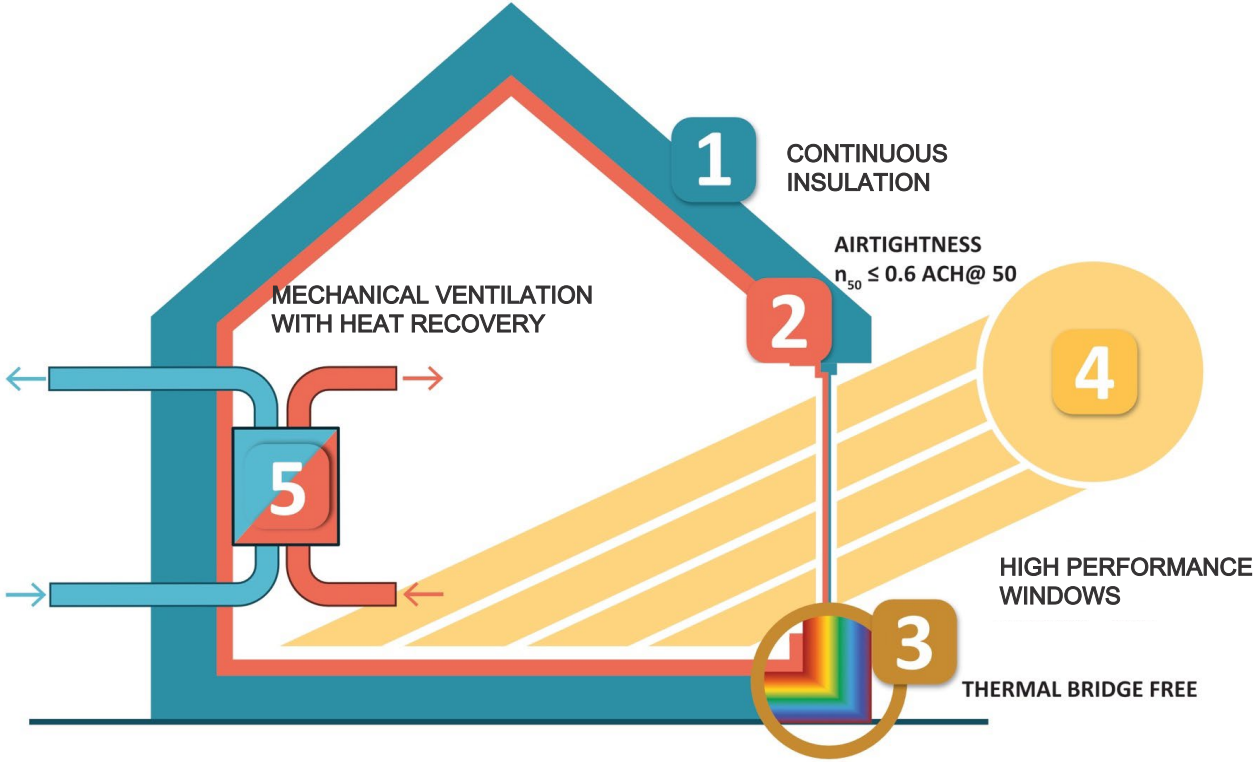


Decentralized:
Multiple ventilators distributed throughout the building



5 Steps to a Passive House

The Passive House Network



Part 2: The Passive House Idea

- What Certifications are Available?
- Why Certify?
- The Passive House Certifiers, Consultants and Tradespeople
- The Certification Sequence
- Certifying a Passive House
  - New Construction, Retrofits, Mixed-Use, Non-Residential
  - Certification Verification Requirements
- Certified Passive House Products

What Can Be Passive House “Certified”

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Performance Versus Prescriptive

The Passive House Network

Passive House is a **performance based** building standard:

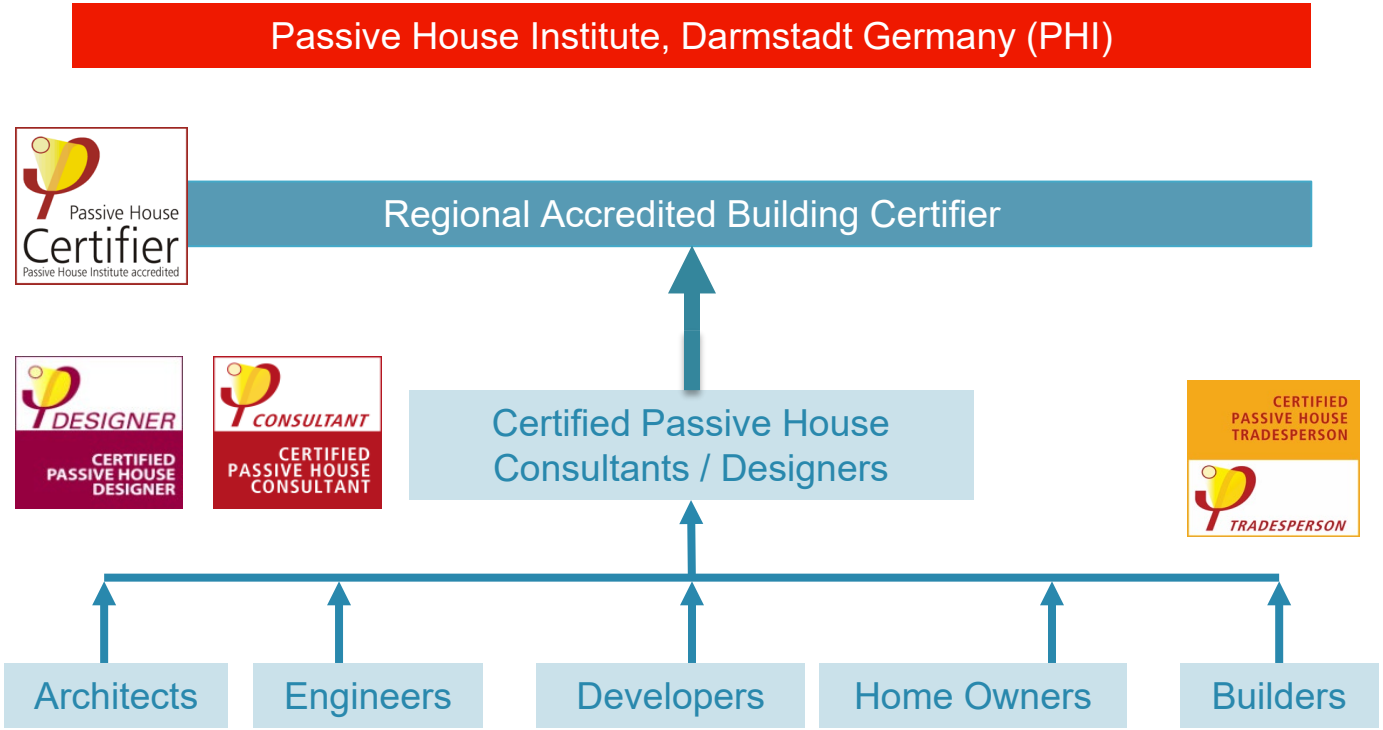
- Scientifically validated energy model (PHPP);
- Strict standards testing protocols for key elements such as windows and ventilation;
- Verified construction details (example, thermal bridging);
- Photo-catalogue of all details and assemblies required for certification;
- Blower door testing according to strict protocols;
- Ventilation system commissioning and sign-off;

Building Code, ASHRAE, LEED tend to be prescriptive in approach

Passive House does exactly what it says on the label.

People: Certifiers, Designers, Tradespeople

The Passive House Network



People: Building Certifiers

The Passive House Network

CertiPHIers™

People: Designers & Tradespeople

The Passive House Network

- Accreditation awarded by Passive House Institute
- Two paths to gaining the awards: (1) passing the PHI exam (vast majority), (2) submitting mini -thesis on personally executed certified project
- New in 2019: 'Expert' Badges for Simulation Modelers and On -Site Inspectors

PHPP Expert

Construction Verifier
energy efficiency

- Two accreditation types: (1) Building Envelope, (2) Mechanical Services
- Accreditation awarded by passing PHI test
- Mostly taken by tradespersons but also popular with building designers

People: VeriPHiers

The Passive House Network

VeriPHy

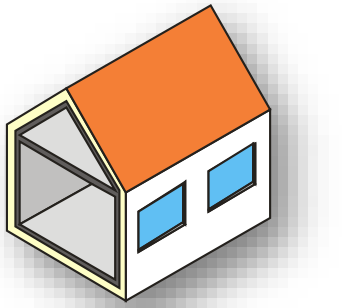
Passive House On-Site Verification

Third-party, on-site verification of key
Passive House quality assurance indicators during construction

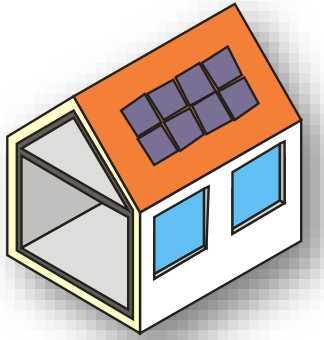
Optional service elected by building owner, typically in response to incentives

Buildings: New Construction

The Passive House Network



Certified
Passive House
Passive House Institute
| **classic** | plus | premium |



Certified
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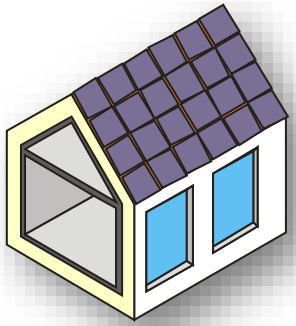
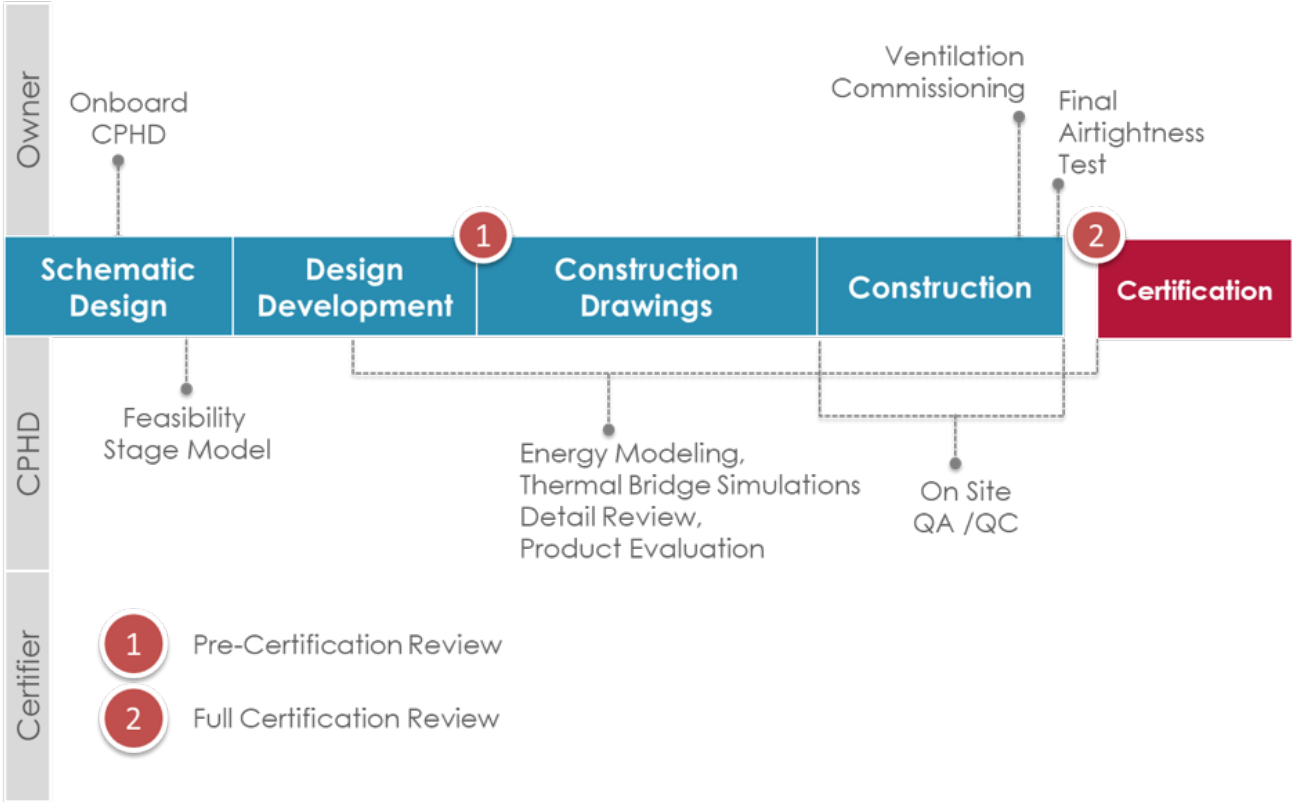


Certified
Passive House
Passive House Institute
| classic | plus | **premium** |

+ renewable energy generation on site or nearby and/or higher energy efficiency

Buildings: A Roadmap To Certification

The Passive House Network



Buildings: Airtightness Testing

The Passive House Network

Negative Pressure Test

Positive Pressure Test

Buildings: Photographic Evidence

The Passive House Network

Buildings: Ventilation System Balancing

The Passive House Network

Buildings: Retrofit Classes

- EnerPHit standard first introduced by PHI in 2010
- Can be reached in one step, or several steps (phased)
- If phased:
  - Must develop an EnerPHit Retrofit Plan (ERP)
  - When total building energy use has been reduced by 20%, first ‘pre-certification’ can be issued by the certifier

Buildings: Non Residential

The Passive House Network

Why Certify Your Building?

The Passive House Network

Independent Review

Certifiers' review services are separate and distinct from Passive House consulting and design services. This clear separation insures an independent and objective assessment. And additional **quality assurance** benefitting all parties involved, including not just owners and occupants, but also investors, governments, funders and other stakeholders.

Project Team Professional Development

The expert review of the energy calculations, design and construction documentation from a low-energy building science perspective furthers the education of the consultant, designer and builder.

Assurance For Project Team

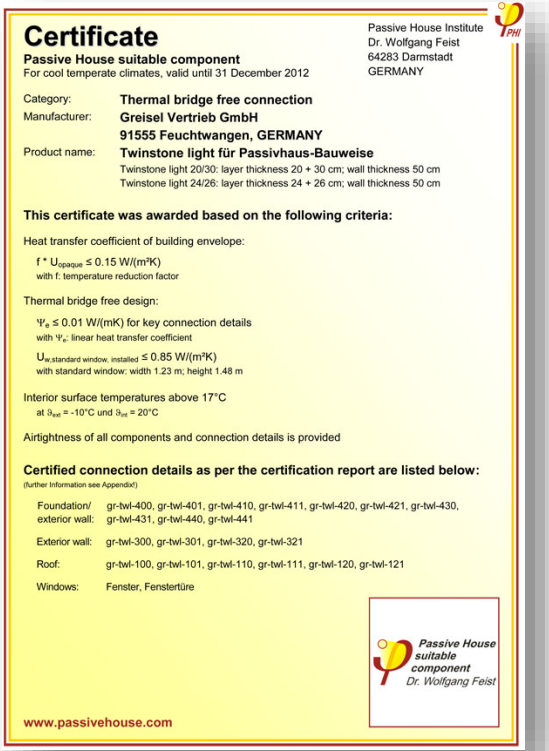
Expert review of the energy calculations, design, specifications and construction documentation is continuing education for the project team.

Assurance For Developers And Owners

The project team can breathe easier at all stages of the project, knowing their energy calculations and related details have been double-checked.

Products: Certified Components

The Passive House Network



Certificate

Passive House suitable component
For cool temperate climates, valid until 31 December 2012

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: **Thermal bridge free connection**
Manufacturer: **Greisel Vertrieb GmbH**
91555 Feuchtwangen, GERMANY
Product name: **Twinstone light für Passivhaus-Bauweise**
Twinstone light 20/30: layer thickness 20 + 30 cm; wall thickness 50 cm
Twinstone light 24/26: layer thickness 24 + 26 cm; wall thickness 50 cm

This certificate was awarded based on the following criteria:

Heat transfer coefficient of building envelope:

$f * U_{opaque} \leq 0.15$ W/(m²K)
with f: temperature reduction factor

Thermal bridge free design:

$\Psi_e \leq 0.01$ W/(mK) for key connection details
with Ψ_e: linear heat transfer coefficient

$U_{w,standard\ window,\ installed} \leq 0.85$ W/(m²K)
with standard window: width 1.23 m; height 1.48 m

Interior surface temperatures above 17°C
at ϑ_{ext} = -10°C und ϑ_{int} = 20°C

Airtightness of all components and connection details is provided

Certified connection details as per the certification report are listed below:
(further Information see Appendix!)

Foundation/ exterior wall: gr-twl-400, gr-twl-401, gr-twl-410, gr-twl-411, gr-twl-420, gr-twl-421, gr-twl-430, gr-twl-431, gr-twl-440, gr-twl-441

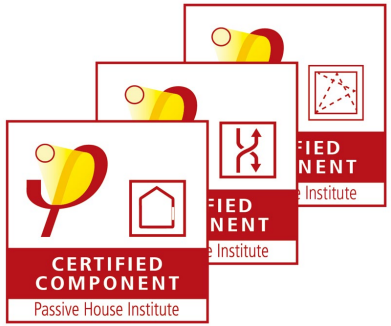
Exterior wall: gr-twl-300, gr-twl-301, gr-twl-320, gr-twl-321

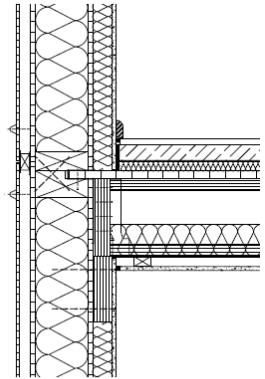
Roof: gr-twl-100, gr-twl-101, gr-twl-110, gr-twl-111, gr-twl-120, gr-twl-121

Windows: Fenster, Fenstertüre

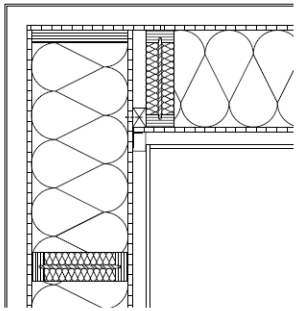
Passive House suitable component Dr. Wolfgang Feist

www.passivehouse.com





Deckenanschluss



Horizontalschnitt Außenwand

Products: Component Database

The Passive House Network

Part 3: The Passive House Tools

- The Passive House Planning Package (PHPP) and ‘Data Driven Design’
- The PHPP Model and Passive House Certification
- DesignPH, BIM2PHPP and PassivLink
- Building Codes and the PHPP
- Thermal Bridge Simulation Tools
- Airtightness Tools:
  - ‘Red Line’ Test
  - Detailing
  - Blower Door Testing

Th Passive House Energy Model

The Passive House Network

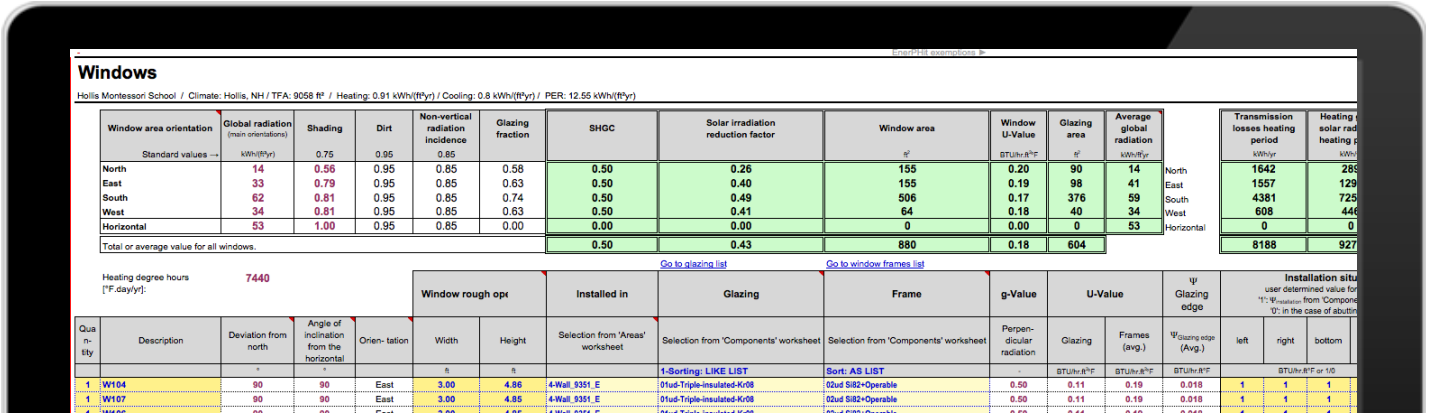
The Passive House Planning Package

The Passive House Network

What is PHPP?

- A numerical steady-state energy modeling spreadsheet
- Uses monthly climate data to quickly calculate detailed gains and losses for low-energy buildings

- Purpose built for low-energy buildings and Passive-House style buildings
- Excel spreadsheet based and low-cost



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	Window area	Window U-Value	Glazing area	Average global radiation		Transmission losses heating period	Heating / solar rad heating p
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	285
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

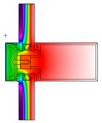
Qua n-tity	Description	Deviation from north	Angle of inclination from the horizontal	Orien- tation	Window rough ope Width	Height	Installed in Selection from 'Areas' worksheet	Glazing Selection from 'Components' worksheet	Frame Selection from 'Components' worksheet	g-Value Perpen- dicular radiation	U-Value Glazing	Frames (avg.)	Ψ Glazing edge ($\Psi_{Glazing\ edge}$) (Avg.)	Installation situ user determined value for 'I': $\Psi_{Installation}$ from 'Compone 'O': in the case of abutin left	right	bottom
		°	°		ft	ft		1-Sorting: LIKE LIST	Sort: AS LIST	-	BTU/hr·ft²°F	BTU/hr·ft²°F	BTU/hr·ft°F	BTU/hr·ft°F or 1/0		
1	W104	90	90	East	3.00	4.86	4-Wall_9351_E	01ud-Triple-insulated-Kr08	02ud Sl82+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 Sl82+Operable	0.50	0.11	0.19	0.018	1	1	1

Energy Modeling Options

The Passive House Network

Steady -State

- Internal Gains + Temp Set Point remain static throughout the entire simulation period.
- Climate / Weather files supply ALL of the inputs into the simulation
- **Fast** , Flexible, **Simple** to use
- May not be as accurate in very complex situations, ie: with **more than one thermal zone**, in shoulder seasons, etc..



PHPP + designPH

Dynamic

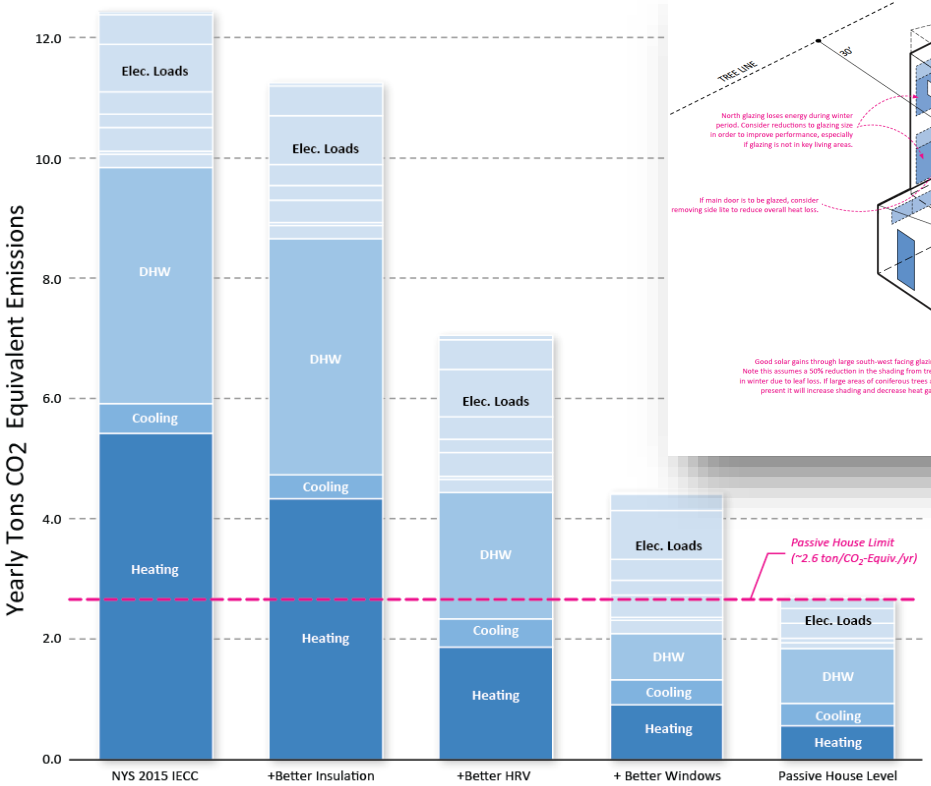
- Uses both the external boundary conditions from climate/weather file input, as well as data from previous simulation steps to create a more detailed (hourly, sub-hourly) model.
- Can include >1 thermal zone
- Can provide more accurate thermal-comfort modeling, as well as moisture movement
- Complex, slow

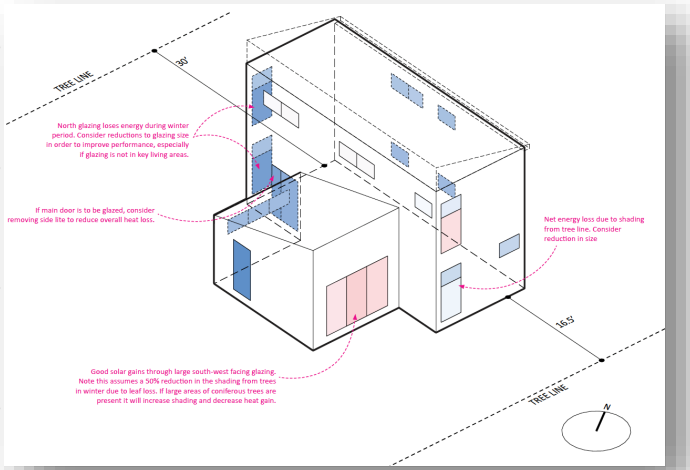
WUFI®

TRNSYS 17

Data Driven Design

The Passive House Network

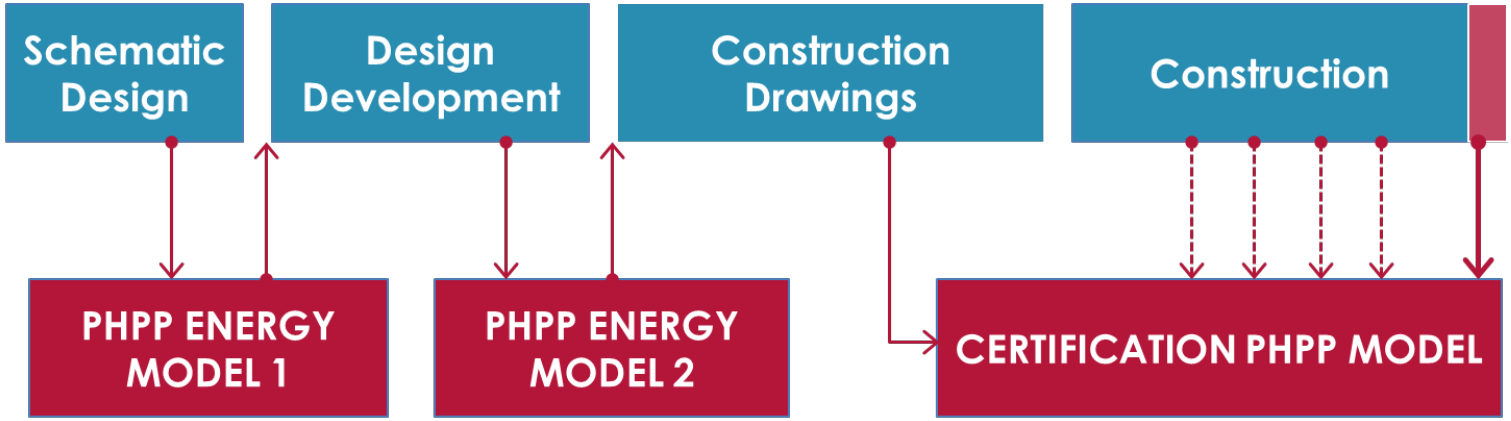




Source: bldgtyp , llc : SHCHT Cottages. 2016

PHPP and PHI Certification

The Passive House Network



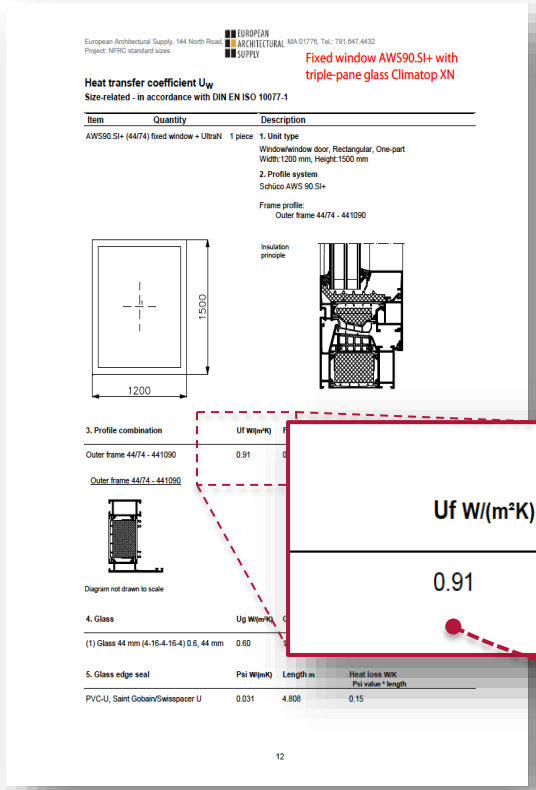
- massing & orientation
- window-to-wall %
- overheating risk, shading
- identify key challenges
- review potential assemblies, details, envelope systems

- develop key materials, assemblies and details
- first pass to resolve thermal bridging and identify challenges
- identify airtightness system and products
- develop mechanical system integration

- updates to model throughout CD and construction phases
- final as-built geometry / assemblies and thicknesses
- final as-built materials
- final as-built products
- resolve any last detail challenges
- update with final airtightness value
- update with final ventilation air flow rates

PHPP And PHI Certification

The Passive House Network



European Architectural Supply, 144 North Road, Project: NFRC standard sizes

EUROPEAN ARCHITECTURAL SUPPLY MA 01776, Tel.: 781.647.4432

Fixed window AWS90.SI+ with triple-pane glass Climatop XN

Heat transfer coefficient U_W

Size-related - in accordance with DIN EN ISO 10077-1

Item	Quantity	Description
AWS90.SI+ (44/74) fixed window + UltraN	1 piece	1. Unit type Window/window door, Rectangular, One-part Width:1200 mm, Height:1500 mm 2. Profile system Schüco AWS 90.SI+ Frame profile: Outer frame 44/74 - 441090

1500

1200

Insulation principle

3. Profile combination	Uf W/(m²K)	Fra
Outer frame 44/74 - 441090	0.91	0

Outer frame 44/74 - 441090

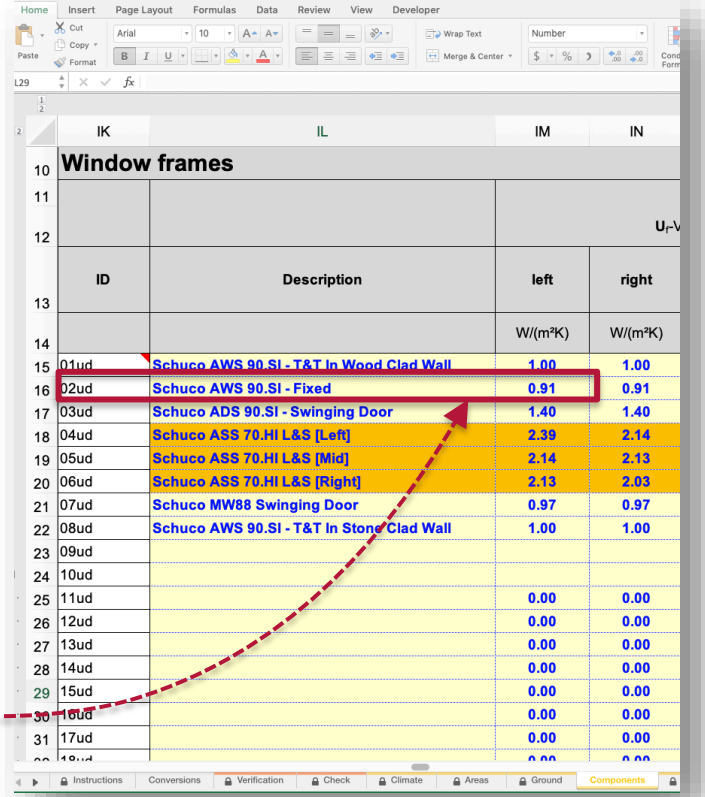
Diagram not drawn to scale

4. Glass	Ug W/(m²K)	G
(1) Glass 44 mm (4-16-4-16-4) 0.6, 44 mm	0.60	

5. Glass edge seal	Psi W/(mK)	Length m	Heat loss W/K Psi value * length
PVC-U, Saint Gobain/Swisspacer U	0.031	4.808	0.15

12

Uf W/(m²K)	Fra
0.91	0.37



Home Insert Page Layout Formulas Data Review View Developer

Paste Cut Copy Format Arial 10 Wrap Text Merge & Center Number

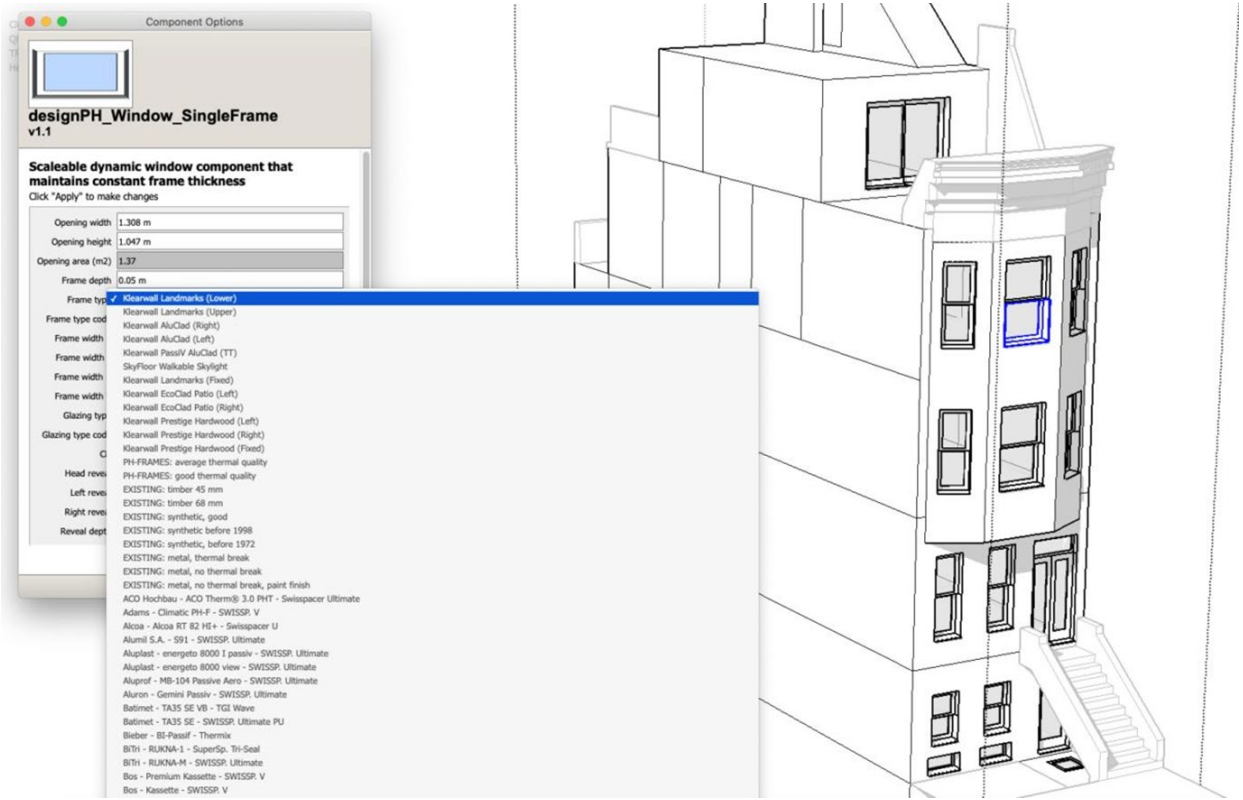
L29

	IK	IL	IM	IN
10	**Window frames**			
11				
12				U_f-V
13	**ID**	**Description**	**left**	**right**
14			W/(m²K)	W/(m²K)
15	01ud	Schuco AWS 90.SI - T&T In Wood Clad Wall	1.00	1.00
16	02ud	Schuco AWS 90.SI - Fixed	0.91	0.91
17	03ud	Schuco ADS 90.SI - Swinging Door	1.40	1.40
18	04ud	Schuco ASS 70.HI L&S [Left]	2.39	2.14
19	05ud	Schuco ASS 70.HI L&S [Mid]	2.14	2.13
20	06ud	Schuco ASS 70.HI L&S [Right]	2.13	2.03
21	07ud	Schuco MW88 Swinging Door	0.97	0.97
22	08ud	Schuco AWS 90.SI - T&T In Stone Clad Wall	1.00	1.00
23	09ud			
24	10ud			
25	11ud		0.00	0.00
26	12ud		0.00	0.00
27	13ud		0.00	0.00
28	14ud		0.00	0.00
29	15ud		0.00	0.00
30	16ud		0.00	0.00
31	17ud		0.00	0.00

Instructions Conversions Verification Check Climate Areas Ground Components

‘DesignPH 3D” Modeling Interface

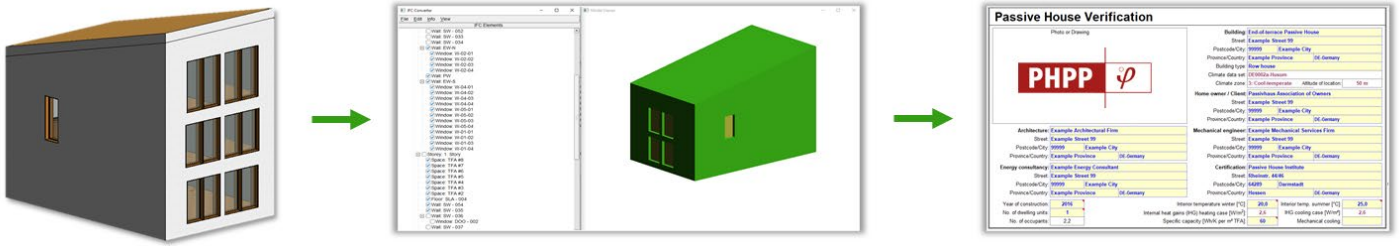
The Passive House Network



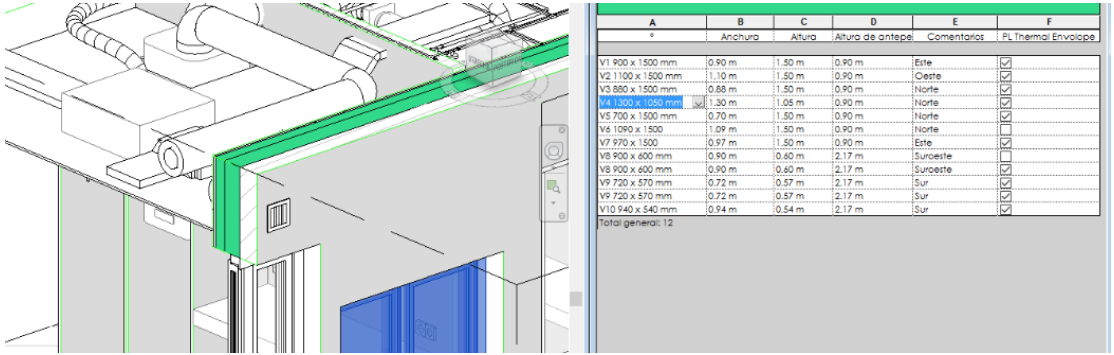
New BIM Tools

The Passive House Network

‘BIM2PH’ IFC Converter:

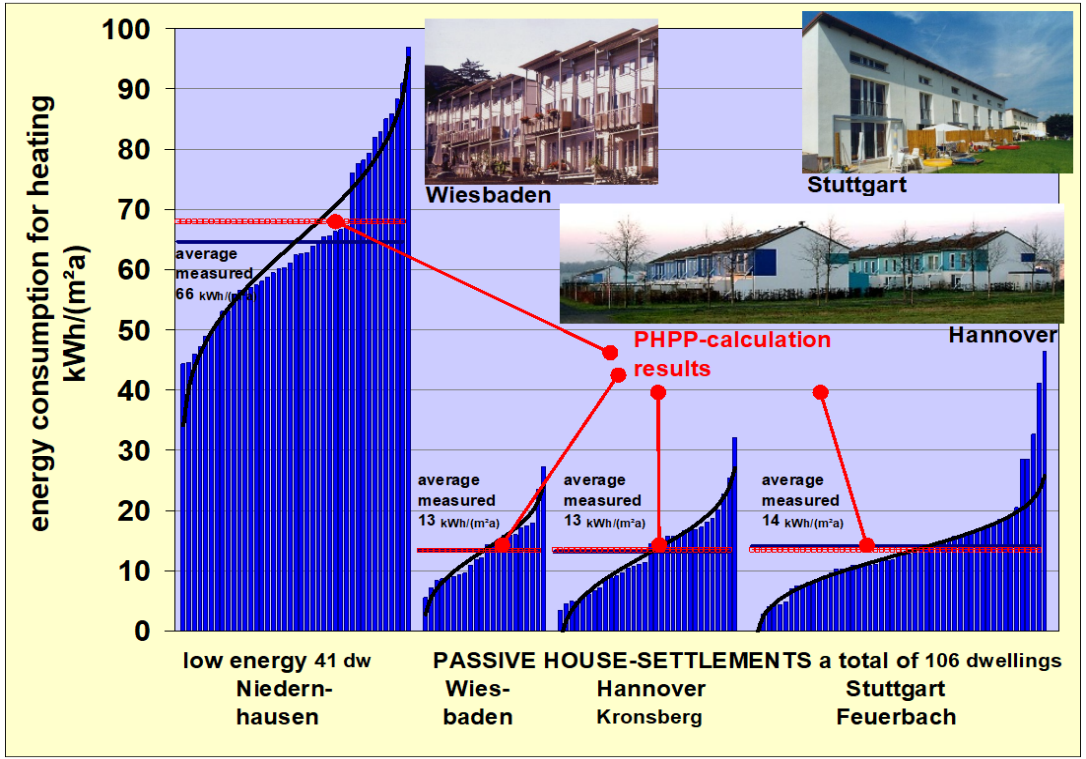


‘PassivLink ’ Plugin for Revit:



	A	B	C	D	E	F
	◦	Anchura	Altura	Altura de antepe	Comentarios	PL Thermal Envolope
V1	900 x 1500 mm	0.90 m	1.50 m	0.90 m	Este	☑
V2	1100 x 1500 mm	1.10 m	1.50 m	0.90 m	Oeste	☑
V3	880 x 1500 mm	0.88 m	1.50 m	0.90 m	Norte	☑
V4	1300 x 1050 mm	1.30 m	1.05 m	0.90 m	Norte	☑
V5	700 x 1500 mm	0.70 m	1.50 m	0.90 m	Norte	☑
V6	1090 x 1500	1.09 m	1.50 m	0.90 m	Norte	☐
V7	970 x 1500	0.97 m	1.50 m	0.90 m	Este	☑
V8	900 x 600 mm	0.90 m	0.60 m	2.17 m	Suroeste	☐
V8	900 x 600 mm	0.90 m	0.60 m	2.17 m	Suroeste	☑
V9	720 x 570 mm	0.72 m	0.57 m	2.17 m	Sur	☑
V9	720 x 570 mm	0.72 m	0.57 m	2.17 m	Sur	☑
V10	940 x 540 mm	0.94 m	0.54 m	2.17 m	Sur	☑
Total general: 12						

PHPP Testing: International



PHPP Testing: ANSI/ASHRAE 140 -2017

The Passive House Network

- PHPP software evaluation completed in 2019
- Full testing report available online

nypassivehouse.org/wp-content/uploads/2019/06/PHPP-ASHRAE-140-Validation-Report-Jan-23-2019.pdf

PHPP and Energy Codes

The Passive House Network

New York State Stretch Energy Code 2020

3.16 Addition of New Section R408
Passive House

Section R408
Passive House

R408.1 General. *Buildings* shall comply with either Section R408.1.1 or R408.1.2 and shall comply with Section R408.2.

R408.1.1. Passive House Institute US (PHIUS) Approved Software. PHIUS+. Passive Building Standard - North America, where Specific Space Heat Demand and (sensible only) Cooling Demand, as modeled and field-verified by a Certified Passive House Consultant, is less than or equal to 9kBTU/ft2/year. The *dwelling unit* shall also be tested with a blower door and found to exhibit no more than 0.05 CFM50/ft² or 0.08 CFM75/ft² of air leakage.

R408.1.2 Passive House Institute (PHI) Approved Software. Passive House Institute: Low Energy Building Standard, where Specific Space Heating and (sensible only) Cooling Demand is less than or equal to 9.5 kBTU/ft²/year, as modeled and field-verified by a Certified Passive House Consultant. The *dwelling unit* shall also be tested with a blower door and found to exhibit an *infiltration* rate of no more than 1.0 air changes per hour under a pressure of 50 Pascals.

PHPP and Energy Codes

The Passive House Network

Ontario Building Code SB-12 (Part 9)

a) energy performance shall be calculated in conformance with Article 9.36.6.4., and

b) airtightness shall be tested in accordance with Article 9.36.6.5.

(See Note A-9.36.6.3.(2).)

3) *Buildings* designed and constructed to conform to Step 5 of any of Tables 9.36.6.3.A to 9.36.6.3.C and to the Passive House Planning Package, version 9 or newer, are deemed to comply with this Subsection if the energy model according to which the *building* is designed and constructed is prepared by a Certified Passive House Designer, or Certified Passive House Consultant, who is approved by the Passive House Institute.

9.36.6.4. Energy Modelling

1) Energy modelling shall be performed using a computer program that employs calculation methods that have been tested in accordance with ANSI/ASHRAE 140, "Evaluation of Building Energy Analysis Computer Programs" with variations in the computer program from the range recommended therein reported in accordance with Division C.

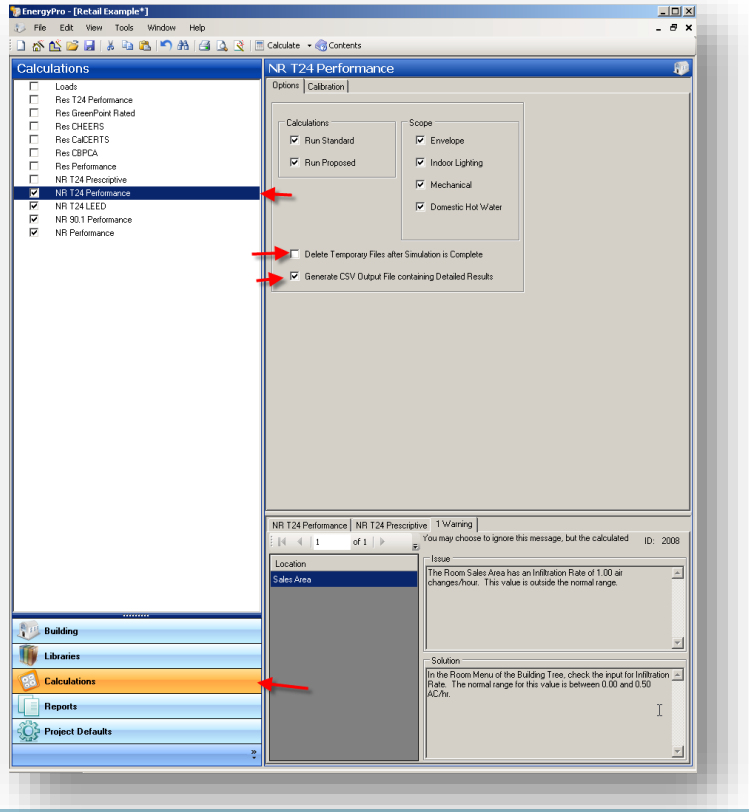
PHPP and Energy Codes

The Passive House Network

And in California? Not yet…

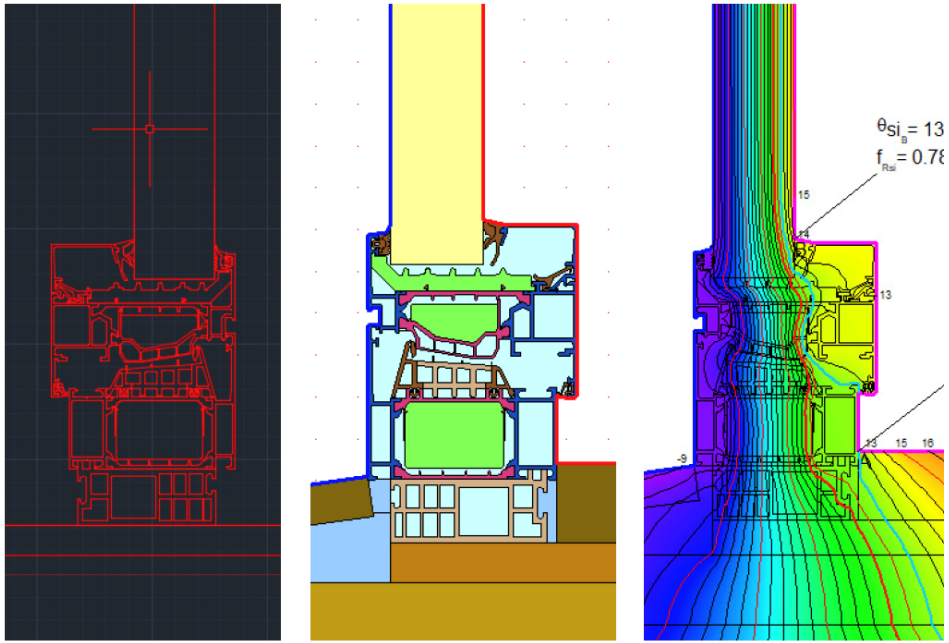
Residential:
- CBECC-Res
- EnergyPro
- Right-Energy Title 24

Commercial:
- CBECC-Com
- IES Virtual Environment
- EnergyPro



Thermal Bridge Simulations

The Passive House Network



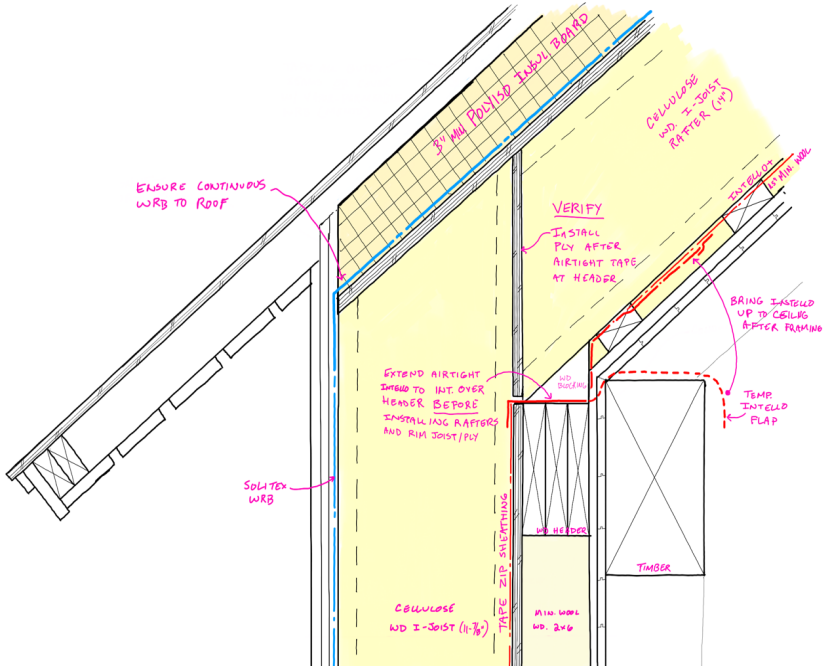
1) A flat 2-D CAD 'Base-File' is created for each assembly and detail required. This CAD is drawn full scale and all hatches, notes and dimensions removed.

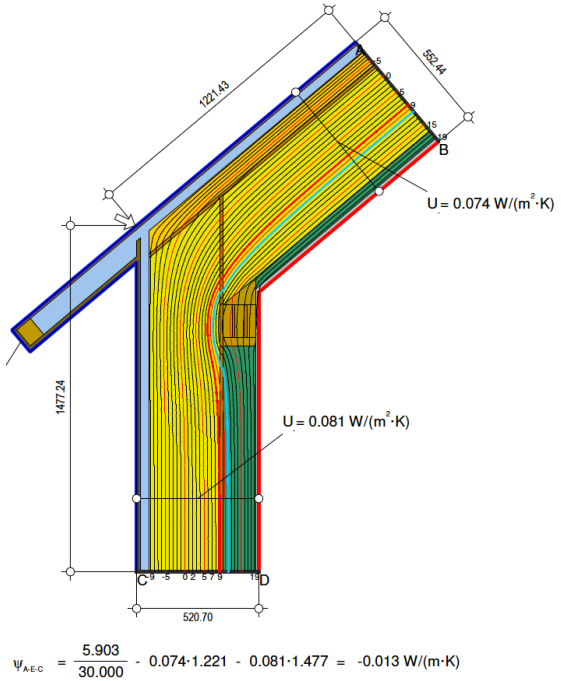
2) In the simulation environment, closed polygons for all elements are created, and material informations (conductivity, emissivity) is applied to each element. Boundary conditions are applied to the interior and exterior.

3) Simulations are executed for the detail and relevant values (R-Values, surface temperatures) are assessed and output for use in the whole-building model or for certification verification.

Thermal Bridge Free Detailing

The Passive House Network



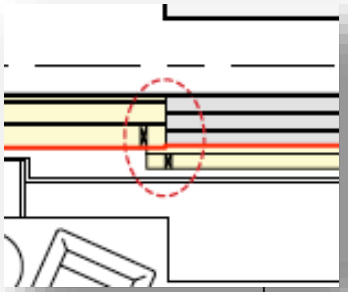


$$\Psi_{A\text{-}C} = \frac{5.903}{30.000} - 0.074 \cdot 1.221 - 0.081 \cdot 1.477 = -0.013 \text{ W/(m·K)}$$

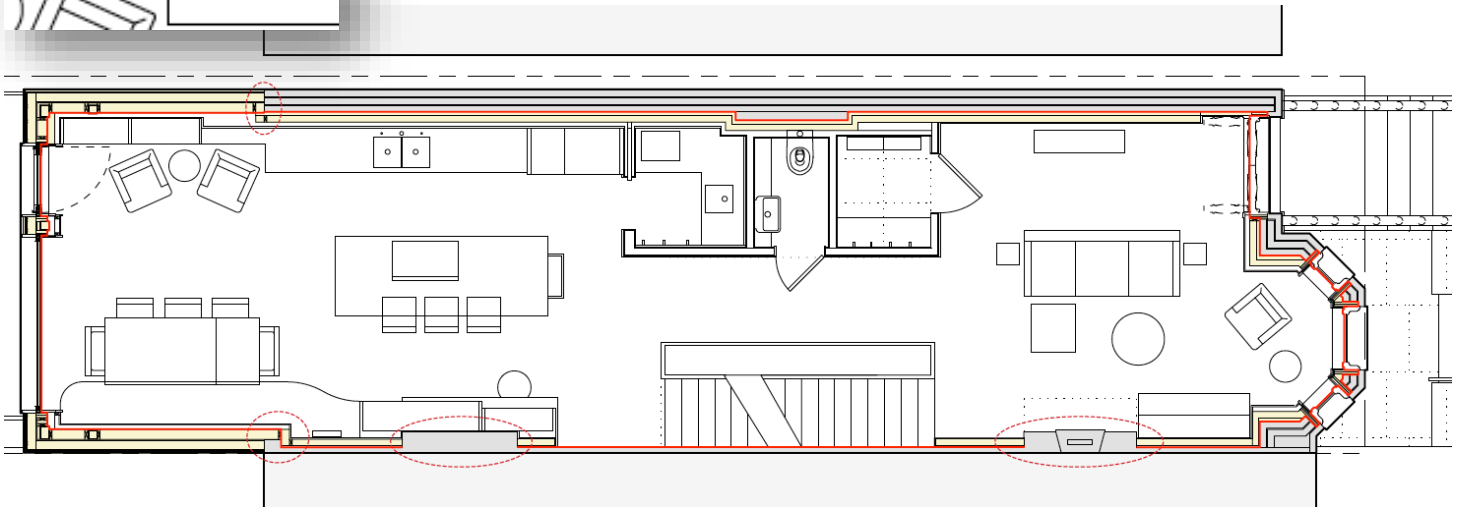
Source: bldgtyp , llc : Chatham, NY PHI 'Low Energy Building'. 2019

Airtightness Tools: ‘Red Line Test’

The Passive House Network

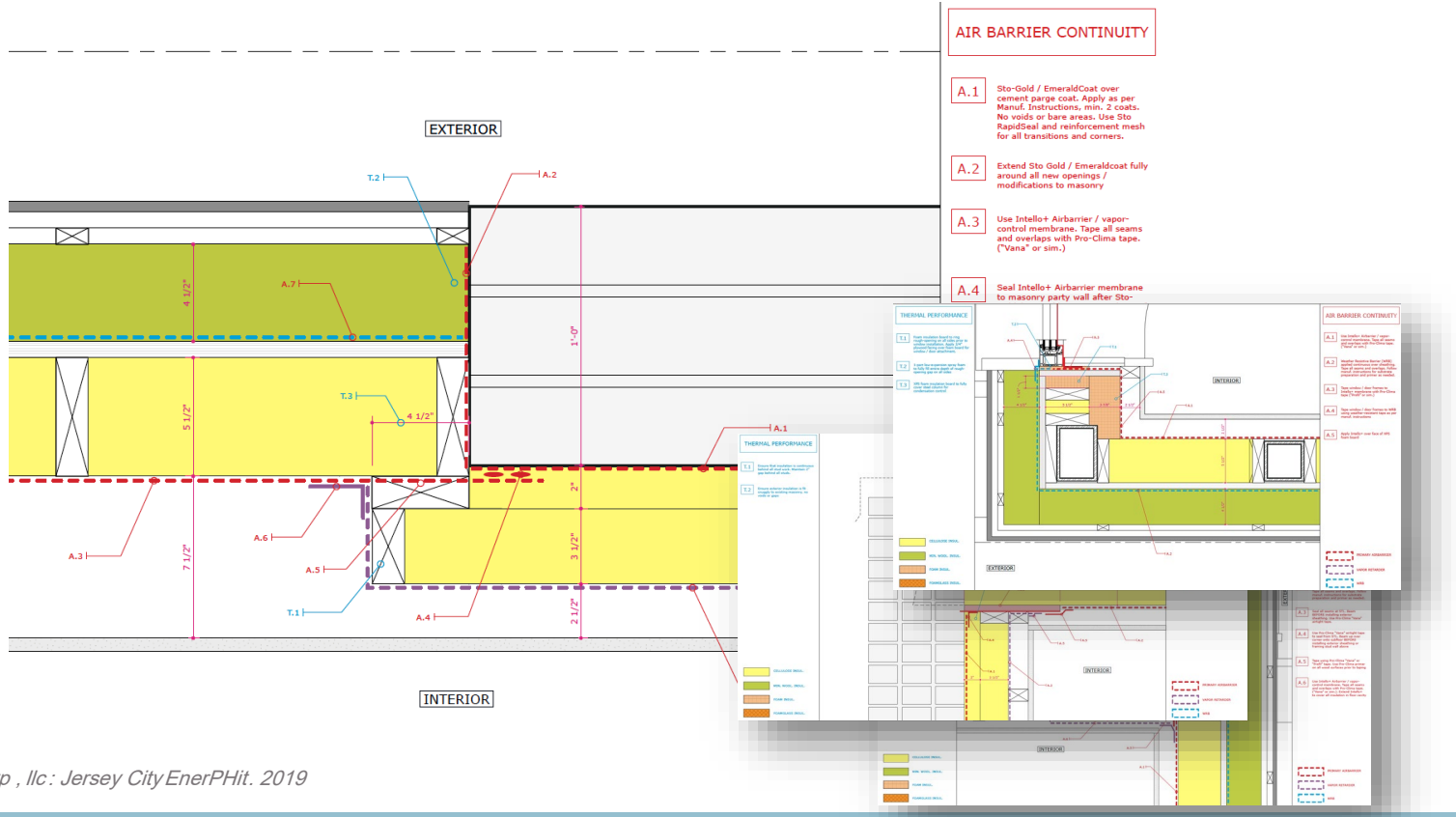


- Draw one single airtight layer around the entire plan or section drawing.
- Anyplace there is confusion or ambiguity about the airtightness connection, mark that clearly for further development



Airtightness Tools: Detailing

The Passive House Network



Source: bldgtyp , llc: Jersey City EnerPHit. 2019

Airtightness Tools: Blower Door Testing

The Passive House Network

Let’s take a break.

CASE STUDY #1

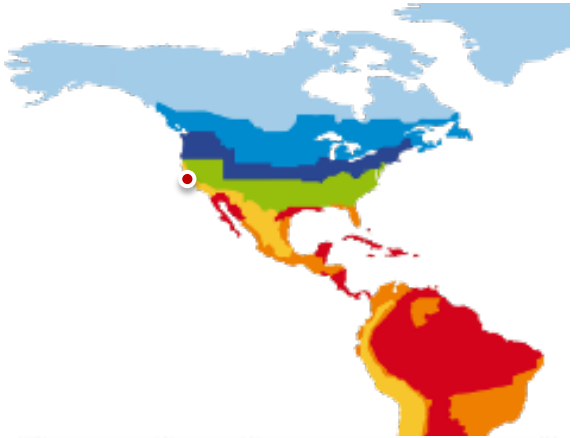
Retrofit | Sunnyvale, CA
Single Family Home

FOCUS:
Fresh-Air Ventilation + Systems

The Passive House Network

Sunnyvale, CA

The Passive House Network



Climate	No	Region
Heating climate	1	Arctic
	2	Cold
	3	Cool-temperate
	4	Warm-temperate
	5	Warm
Cooling climate	6	Hot
	7	Very hot

TEAM:

Architect: Passive House BB

Passive House Consultants /Builder: One Sky Homes

Sunnyvale House

The Passive House Network

Location & Orientation

- 1 story SFR 1,408 ft^2 + attached garage, 3 BR, 2 BA
- Heat pump heating/cooling, induction cooking, CO2 HPWH
- Video tour: https://www.youtube.com/watch?v=HwZu_EoDBag

Modeled Peak Loads

- Heating load:
  - 9.0 kBtu/h (CA Code/ASHRAE)
  - 4.7 kBtu/h (PHPP)
- Cooling load:
  - 9.8 kBtu/h (CA Code/ASHRAE)
  - 2.6 kBtu/h (PHPP)

CA Energy Code Margins

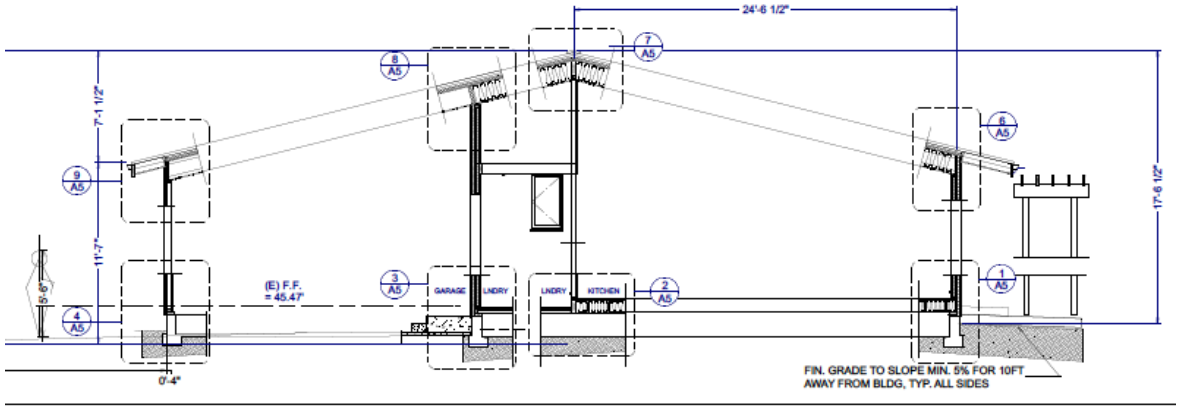
- 2013: 55% (permitted code)
- 2016: 56%
- 2019: 100% (including solar)

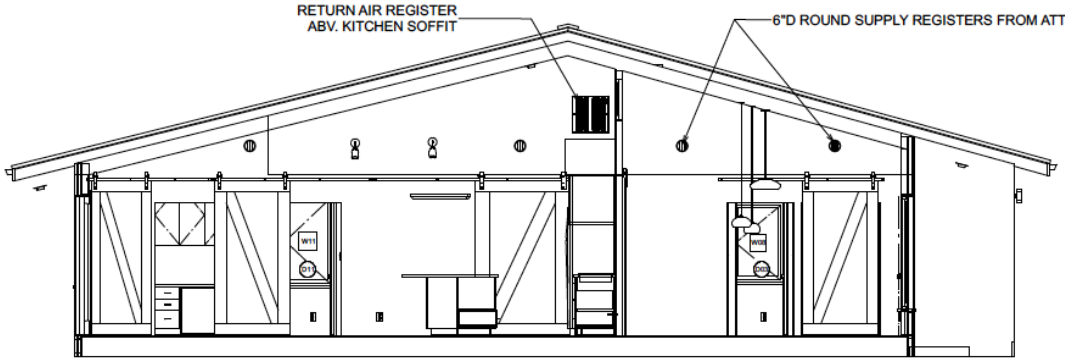
Sunnyvale House

The Passive House Network

Step 1: Make Room for Mechanicals

The Passive House Network



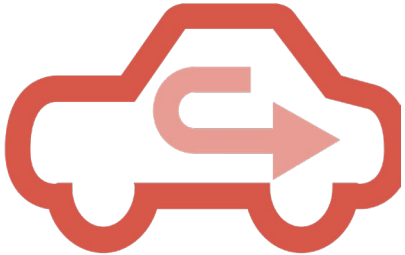


Source: Bronwyn Barry, PassiveHouseBB

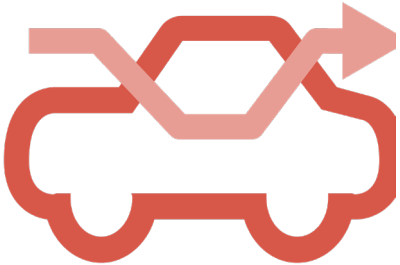
HVAC?

The Passive House Network

Heating, Air -Conditioning

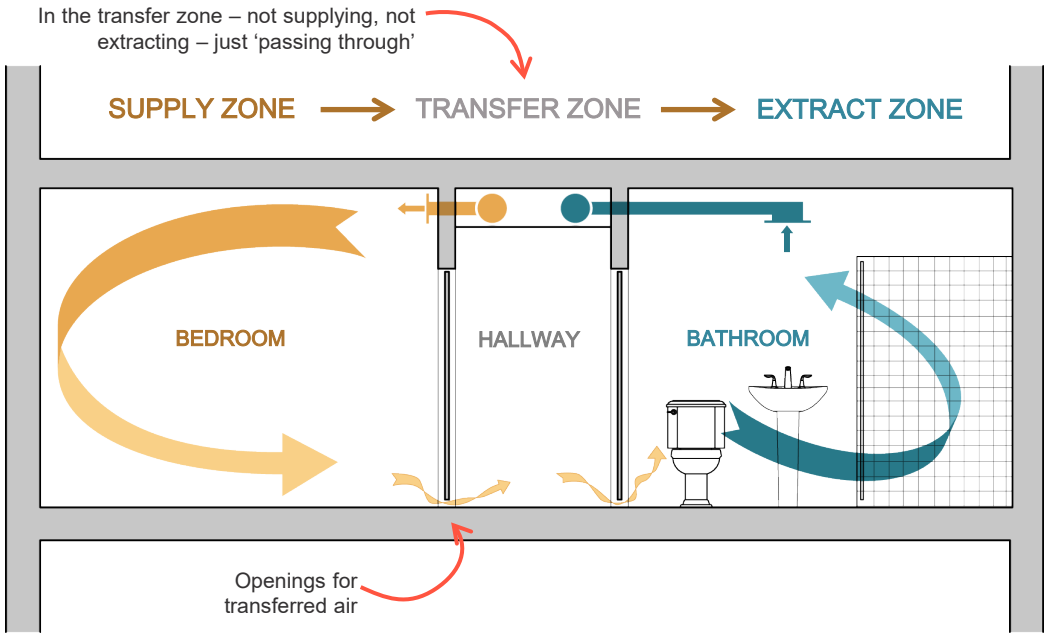


Fresh-Air Ventilation



‘Cascade’ Ventilation

The distribution of ventilation (fresh air supply and stale air extraction) should use as little ductwork as possible but still provide airflow throughout the entire building:

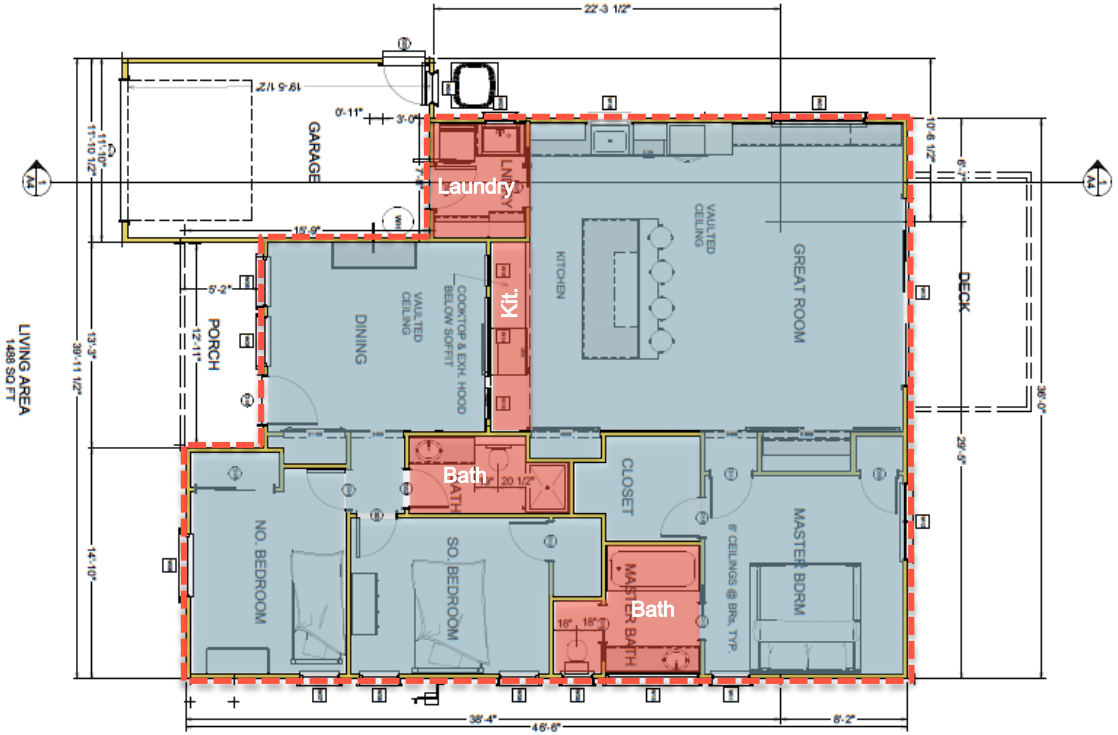


Dedicated Fresh -Air Ventilation Layout

The Passive House Network

EXTRACT

SUPPLY



Source: Bronwyn Barry, PassiveHouseBB

Fresh-Air: Energy Recovery Ventilator (ERV)

MERV 13 Filter

>75% Heat Recovery

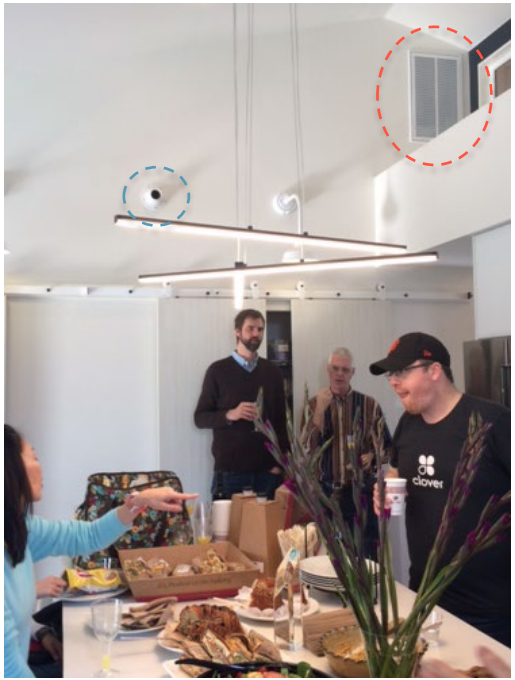
Zehnder ComfoAir 350

- 24/7 Balanced, Filtered Fresh Air
- Heat and Moisture Recovery
- Quiet
- Low-Energy

The Passive House Network

Electric induction cooktop with dedicated exhaust hood

Continuous (24/7) balanced extract (high) and filtered fresh-air supply (low)



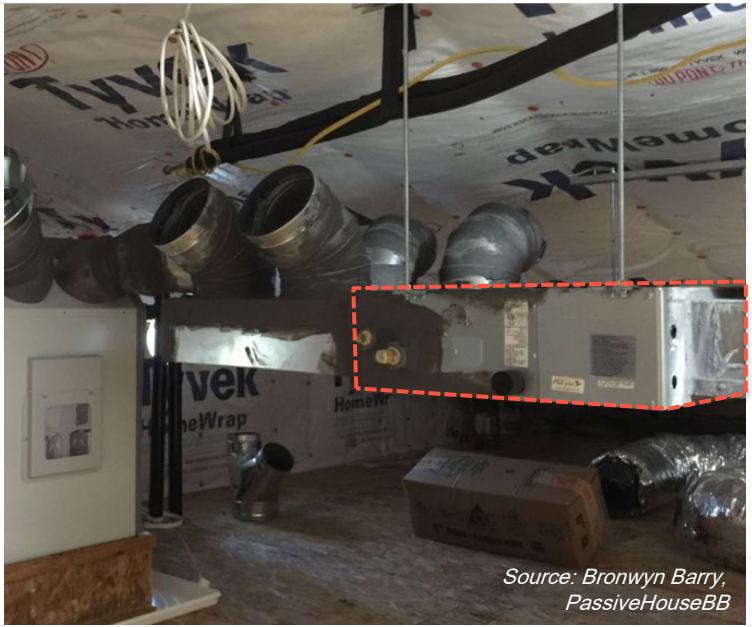
Source: Bronwyn Barry, PassiveHouseBB

Heating, Cooling, and Dehumidification

The Passive House Network

- Electric Heat Pump ‘outdoor’ unit
- Chlorine-free non-ozone depleting refrigerant

- Electric Heat Pump ‘indoor’ unit
- Peak Heat Load: 4.2 kBtu/h
- Peak Cooling Load: 2.7 kBtu/h



Source: Bronwyn Barry, PassiveHouseBB

DHW

Electric Heat Pump
Stiebel Eltron
Accelera 300
80gallon HPWH

- Programmable
- Fits in the garage
- (Needs room to ‘breathe’)

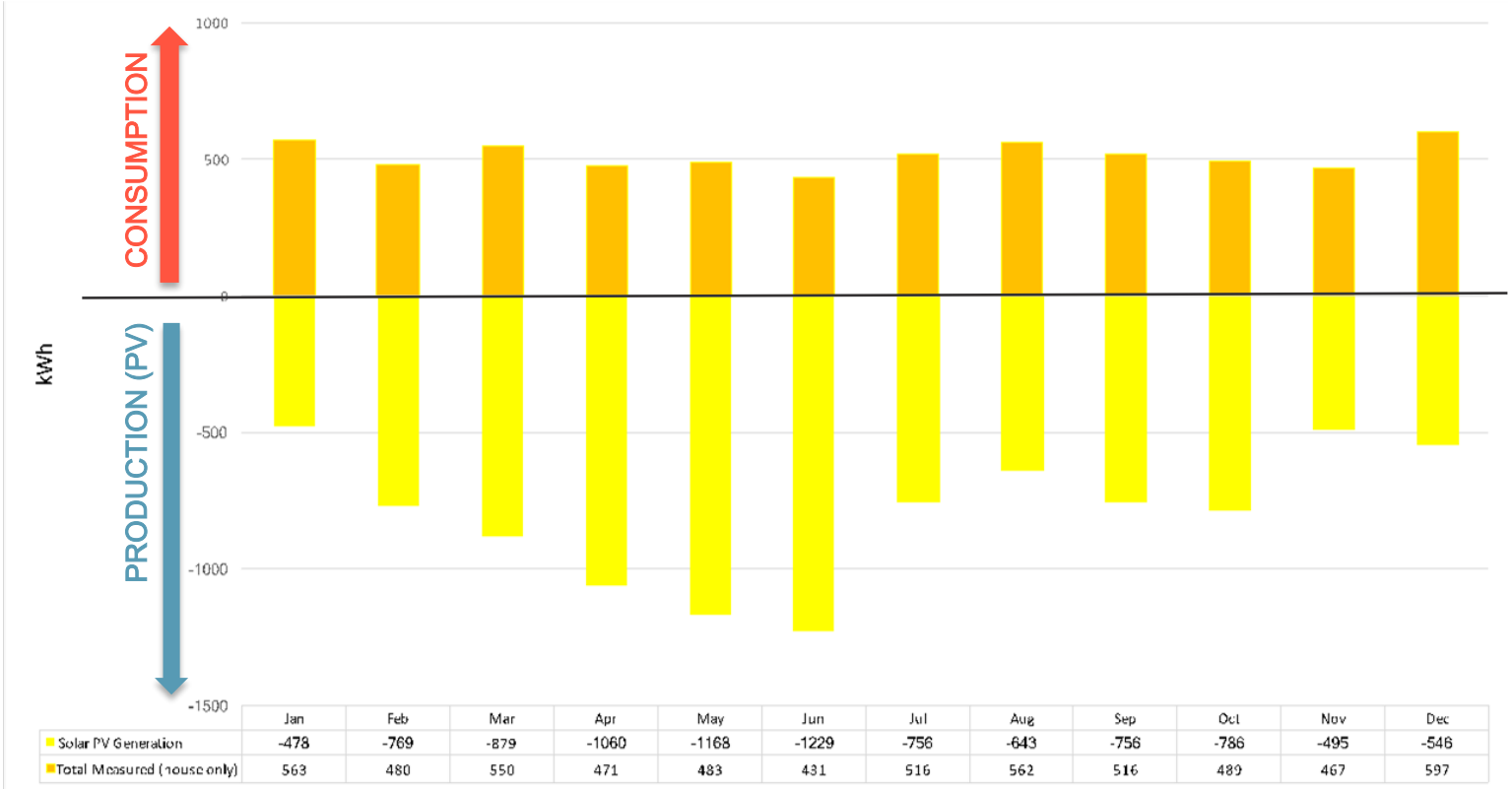
Source: Bronwyn Barry, PassiveHouseBB

The Passive House Network

7.7 kW Sunpower PV Array

Measured Data: 2017 -2018

The Passive House Network

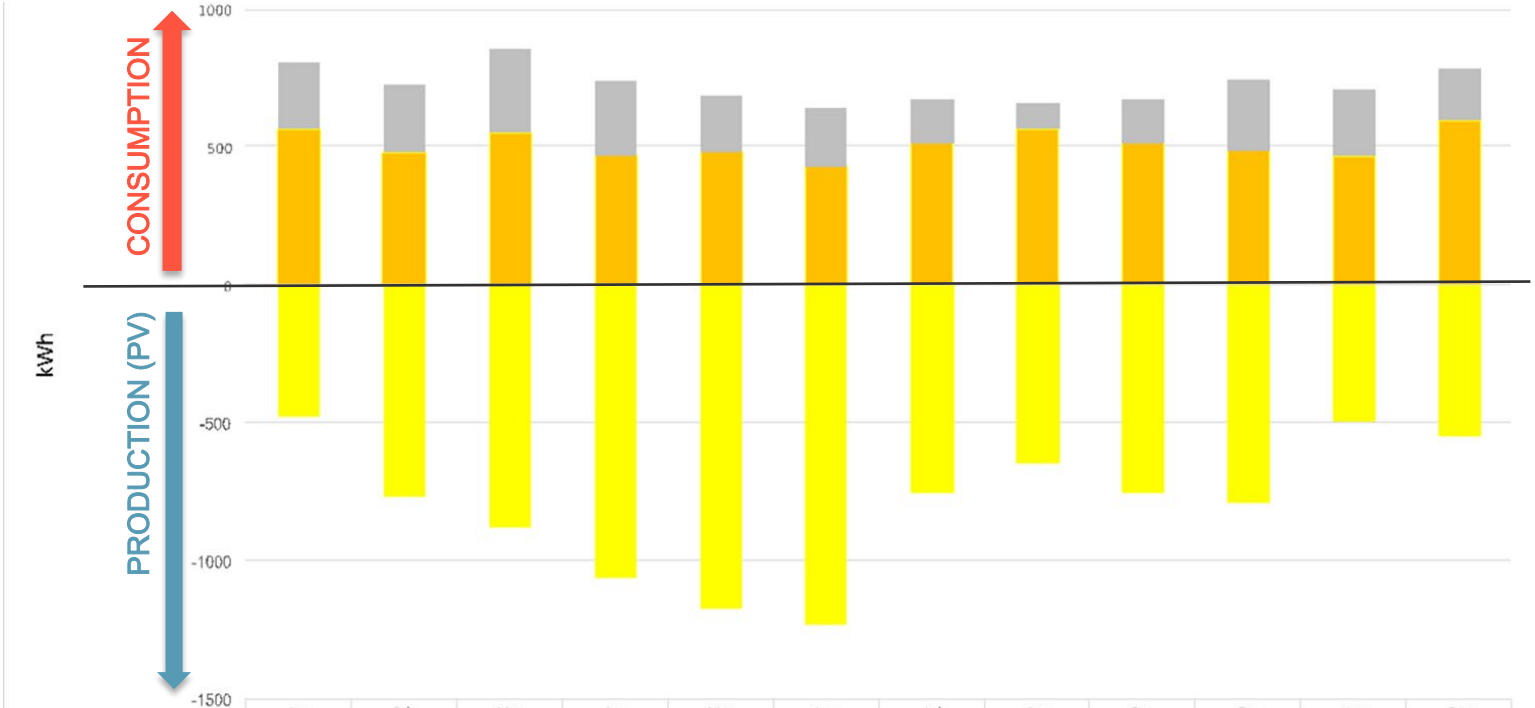


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar PV Generation	-478	-769	-879	-1060	-1168	-1229	-756	-643	-756	-786	-495	-546
Total Measured (house only)	563	480	550	471	483	431	516	562	516	489	467	597

Source: Bronwyn Barry, PassiveHouseBB

And Add an Electric Car?

The Passive House Network

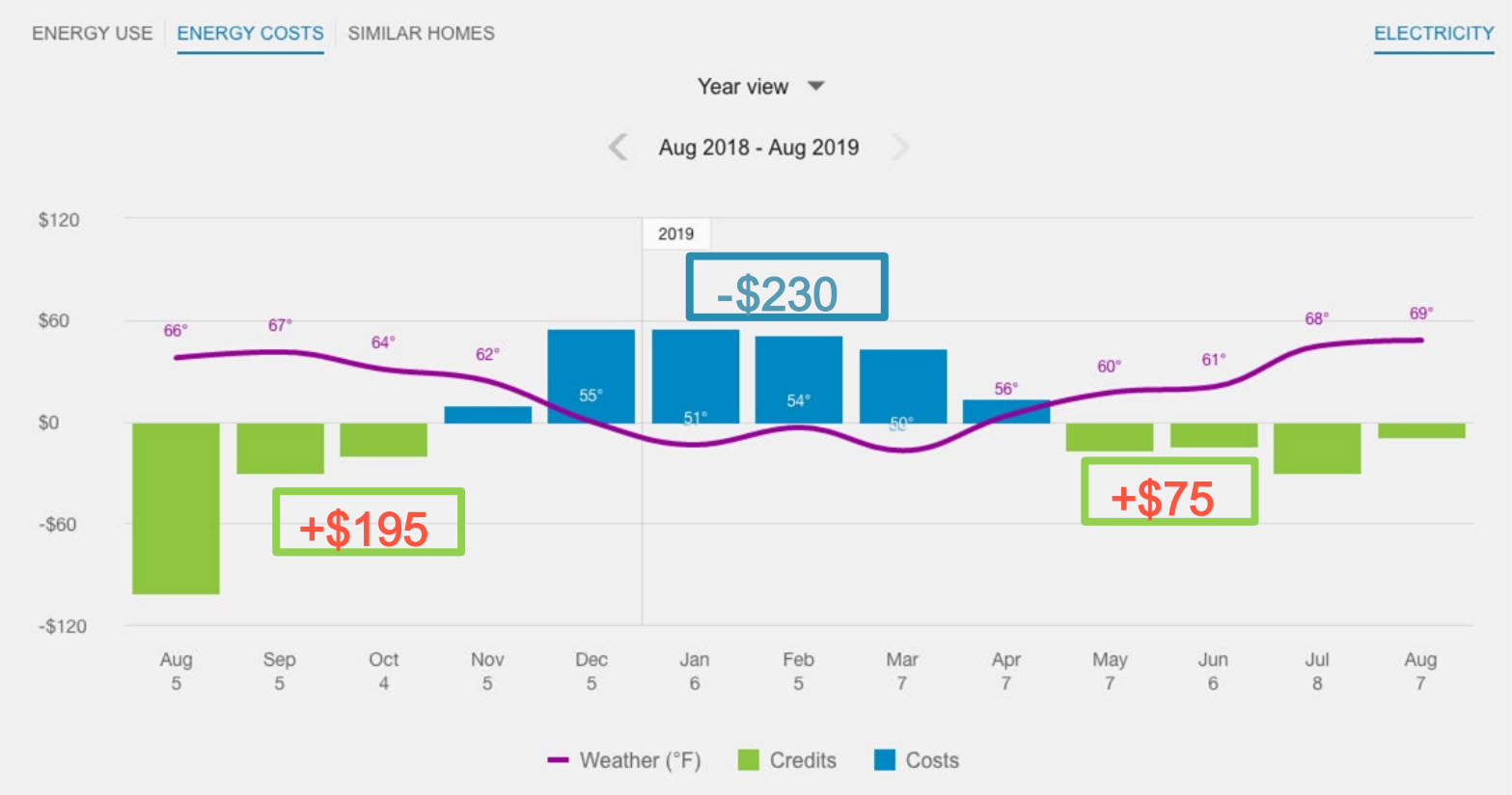


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar PV Generation	-478	-769	-879	-1060	-1168	-1229	-756	-643	-756	-786	-495	-546
Electric Vehicle Charging	244	250	306	272	204	212	159	101	159	257	240	187
Total Measured (house only)	563	480	550	471	483	431	516	562	516	489	467	597

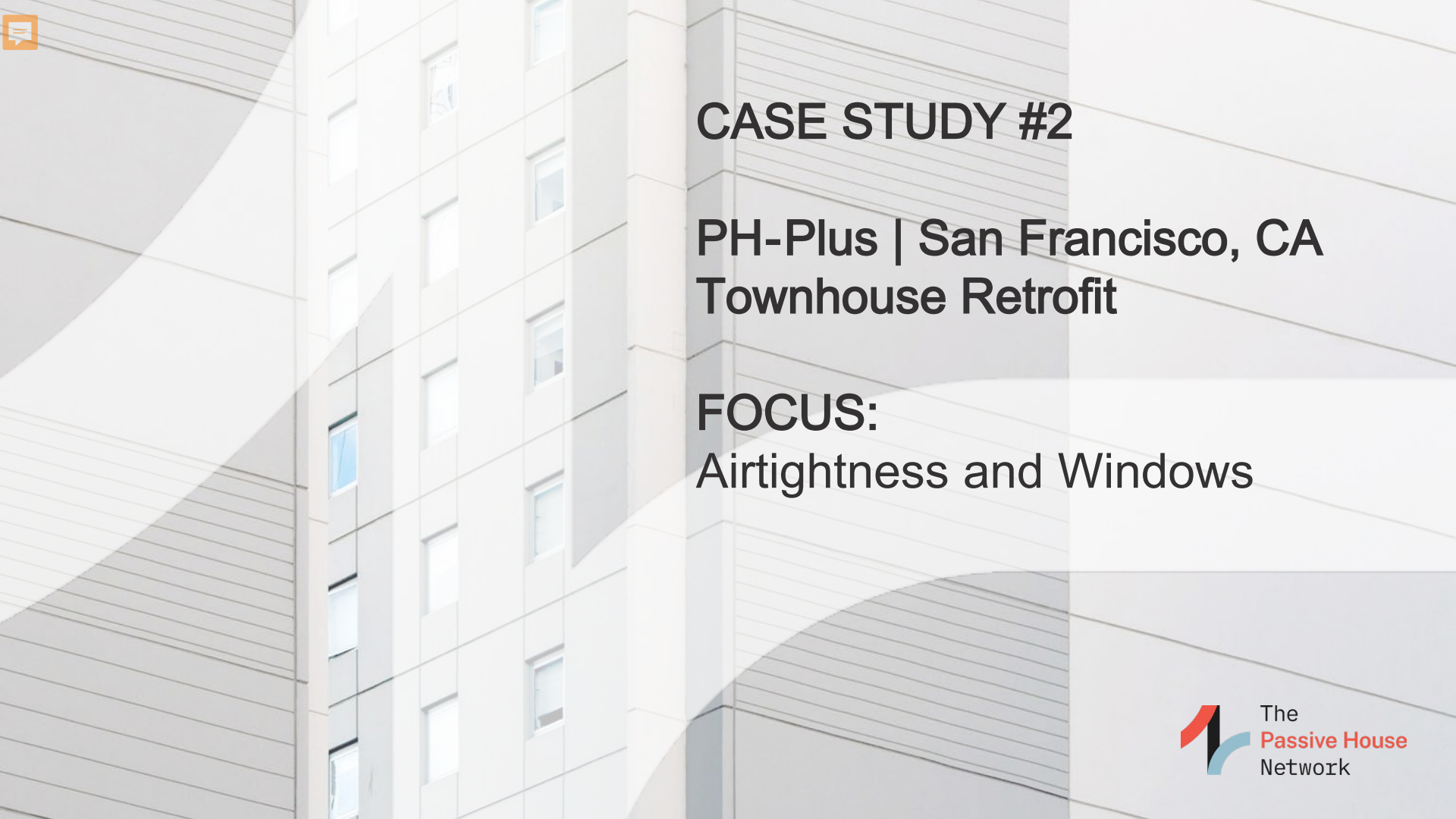
Source: Bronwyn Barry, PassiveHouseBB

Measured Data: 2018 -2019

The Passive House Network



Source: Bronwyn Barry, PassiveHouseBB



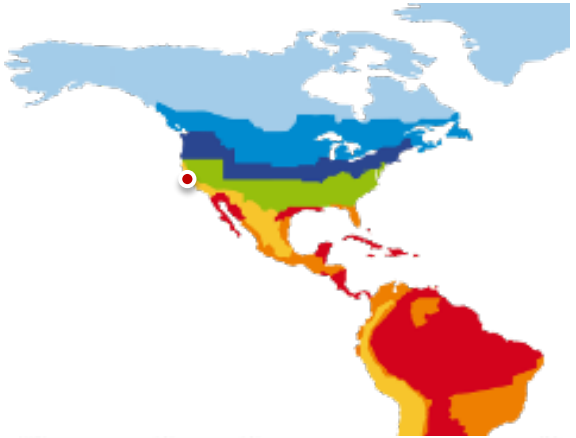
CASE STUDY #2

PH-Plus | San Francisco, CA
Townhouse Retrofit

FOCUS:
Airtightness and Windows

The Passive House Network

San Francisco, CA



Climate	No	Region
Heating climate	1	Arctic
	2	Cold
	3	Cool-temperate
	4	Warm-temperate
	5	Warm
Cooling climate	6	Hot
	7	Very hot

TEAM:
Architect: 450 Architects, Inc.
Builder: Rinaldi Construction Co.
Passive House Consultants: PH Academy

Location & Orientation

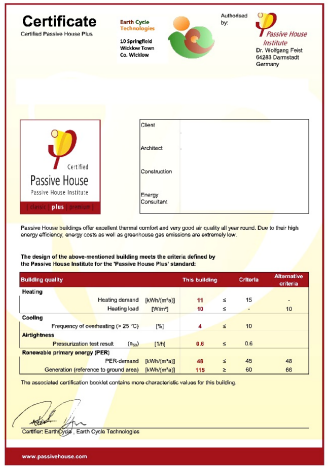
- 4 story SFR w/au pair apartment, 3,012 SF, 4 BR, 3 BA
- Electric resistance heating
- Gas cooking
- CO2 Electric Heat Pump Hot Water
- Zero lot lines east and west
- LEED Platinum

Modeled Peak Loads

- Heating load:
  - 13.1 kBtu/h (CA Code/ASHRAE)
  - 7.4 kBtu/h (PHPP)
- Cooling load:
  - 37.0 kBtu/h (CA Code/ASHRAE)
  - 3.9 kBtu/h (PHPP)

CA Energy Code Margins

- 2013: 41% (permitted code)
- 2016: 68% better + ZNE
- 2019: 85% better + ZNE


Certificate

Certified Passive House Plus

Earth Cycle Technologies

Authorised by: Passive House Institute

10 Springfield
Wicklow Town
Co. Wicklow

Dr. Wolfgang Feist
64283 Darmstadt
Germany

Certified Passive House
Passive House Institute
classic plus premium

Client
Architect
Construction
Energy Consultant

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the "Passive House Plus" standard.

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	11	≤	15	-
Heating load	[W/m²]	10	≤	-	10
Cooling					
Frequency of overheating (> 25 °C)	[%]	4	≤	10	
Airtightness					
Pressurization test result	(n_{50})	[1/h]	0.6	≤	0.6
Renewable primary energy (PER)					
PER demand	[kWh/(m²a)]	48	≤	45	48
Generation (reference to ground area)	[kWh/(m²a)]	119	≥	60	66

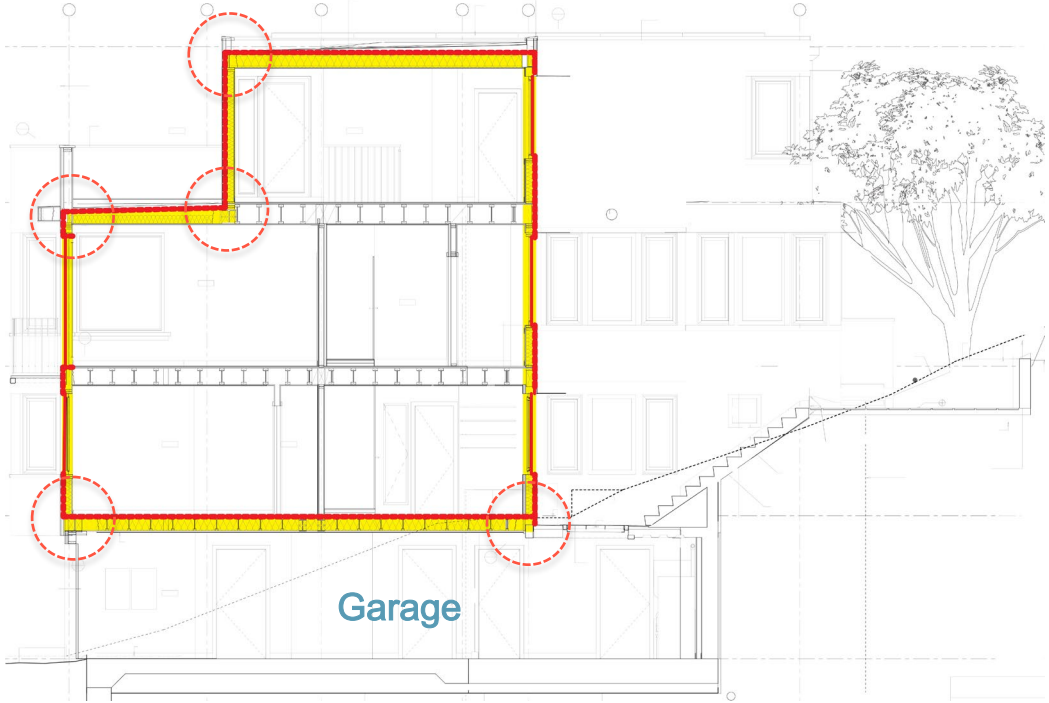
The associated certification booklet contains more characteristic values for this building.

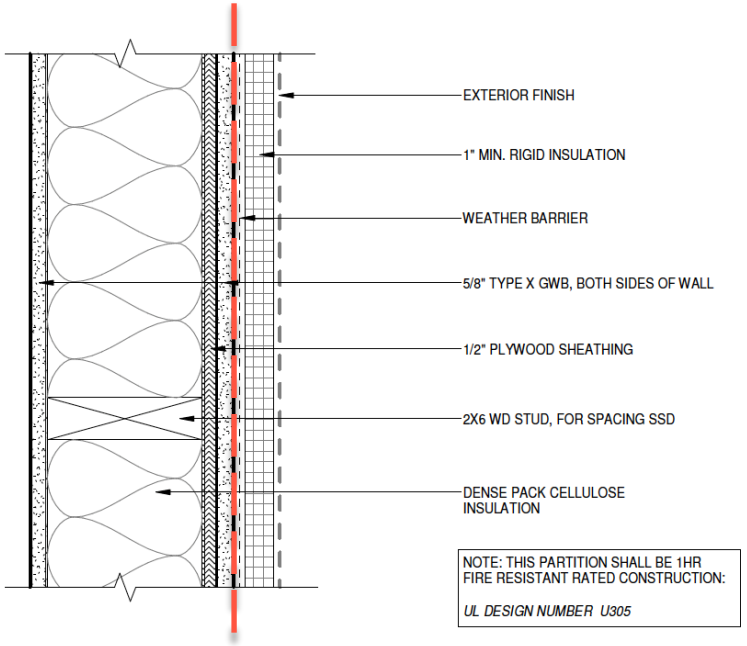
Certifier Earth Cycle Technologies

www.passivehouse.com

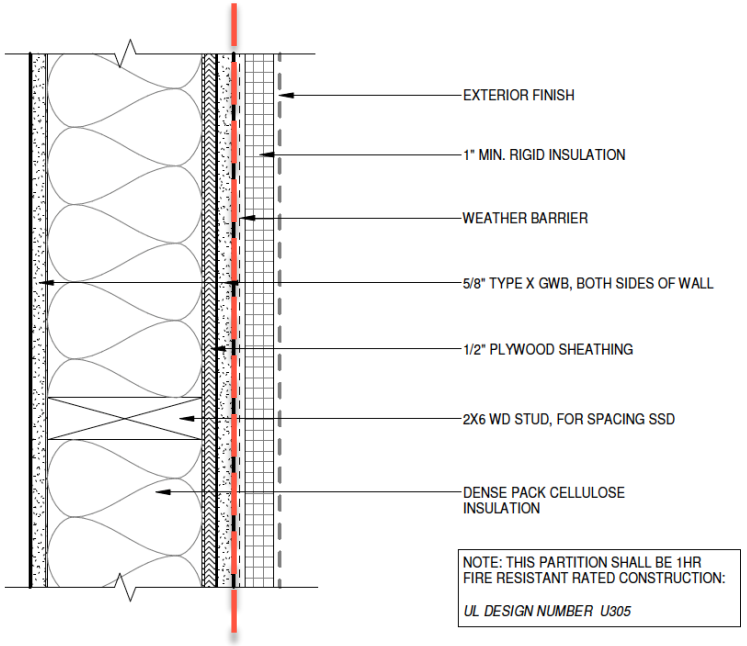
Air Barrier + Insulation Layer

The Passive House Network





1 / A8.0 TYP. WALL ASSEMBLY - 1 HR. RATED
3" = 1'-0"



1
A8.0

TYP. WALL ASSEMBLY - 1 HR. RATED
3" = 1'-0"


Blueskin VP100


Blueskin VP100


Henry
Air Tight

BUILDING LEAKAGE TEST

Fax:

Date of Test: 7/7/2018
Test File: 4021 19th Blower Door Testing

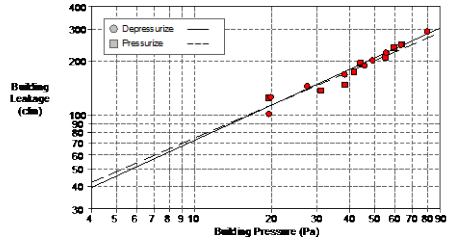
Customer: Ben & Madhulika Chambers
2507 15th Street
San Francisco, CA 94114
Phone: 415.609.6174
Fax:

Test Results at 50 Pascals:	Depressurization	Pressurization	Average
V50: cfm Airflow	208 (+/- 5.4 %)	200 (+/- 8.9 %)	204
n50: 1/h (Air Change Rate)	0.59	0.56	0.57
w50: cfm/ft² (Floor Area)	0.0691	0.0666	0.0678
q50:			

Leakage Areas:			
Canadian EqLA @ 10 Pa (in²)	21.2 (+/- 15.1 %)	21.8 (+/- 31.9 %)	21.5
LBL ELA @ 4 Pa (in²)	11.2 (+/- 24.2 %)	12.0 (+/- 51.4 %)	11.6

Building Leakage Curve:		
[illegible]	16.0 (+/- 38.3 %)	18.0 (+/- 81.2 %)
[illegible]	15.9 (+/- 38.3 %)	18.0 (+/- 81.2 %)
Exponent (n)	0.657 (+/- 0.103)	0.617 (+/- 0.217)
Correlation Coefficient	0.98491	0.94322

Test Standard: EN 13829
Test Mode: Depressurization and Pressurization
Type of Test Method:
Regulation complied with:

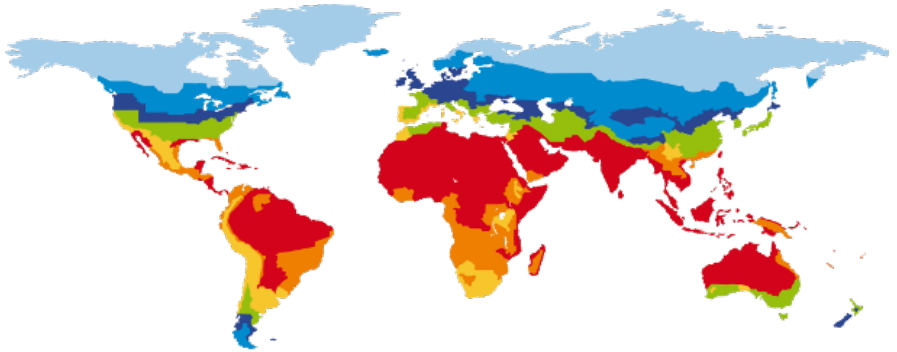


0.57 ACH@50Pa

Maximum $U_{w\text{-}installed}$ by Climate Zone

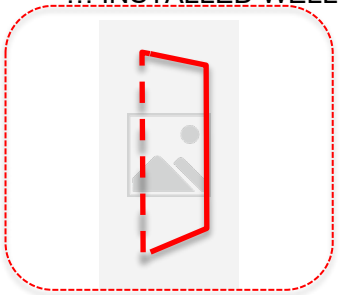
The Passive House Network

Climate Zone	U-value (installed) Btu/hr·ft² F
1. Arctic	0.08
2. Cold	0.11
3. Cool Temperate	0.15
4. Warm Temperate	0.18
5. Warm	0.22
6. Hot	0.22
7. Very Hot	0.18



HIGH QUALITY COMPONENTS…

… INSTALLED WELL



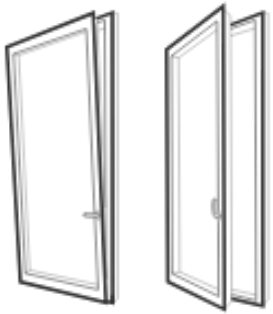
$$U_{w\text{-installed}} = \frac{(U_g \times A_{glass}) + (U_f \times A_{frame}) + (\Psi_{spacer} \times L_{spacer}) + (\Psi_{install} \times L_{install})}{A_{window}}$$

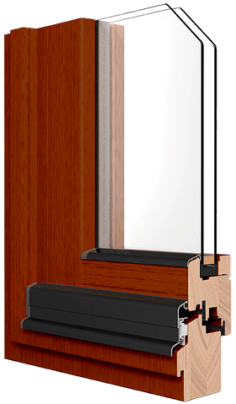
High -Performance Windows

The Passive House Network

Zola Classic Wood Frame:
Tilt-Turn Operation
U-0.245 Btu/hr-ft^2-F

Glass:
U-0.176 Btu/hr-ft^2-F
SHGC ~0.6
Double-Pane

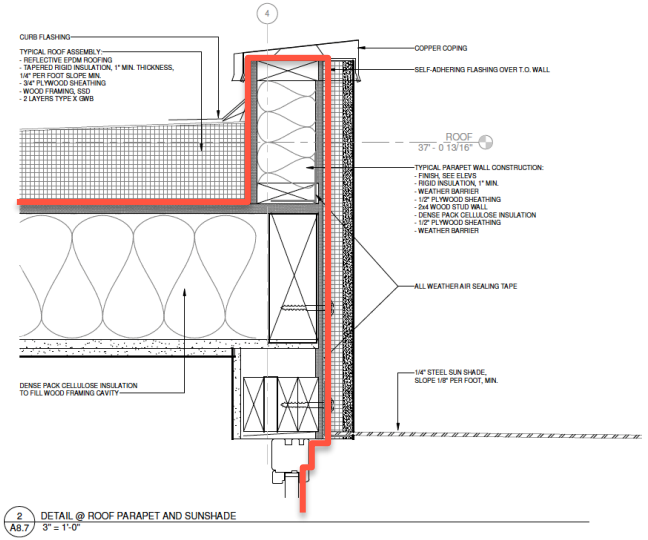




Airtightness Gasketing

The Passive House Network

Window Installation Details



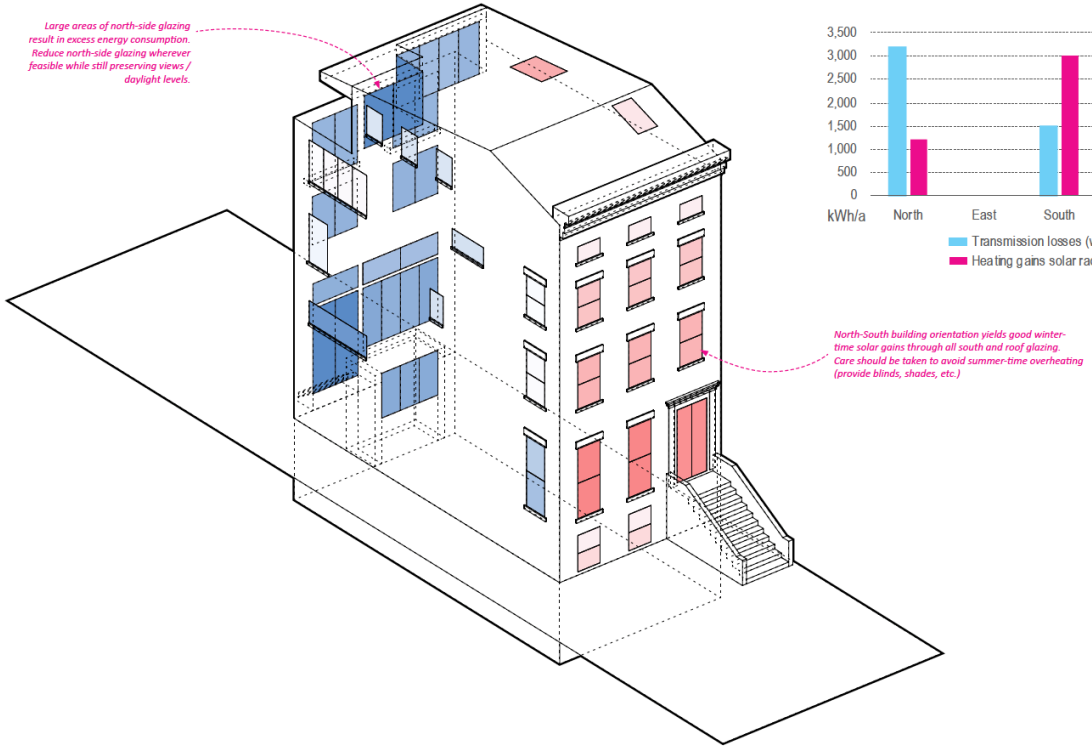
Window Inputs in the PHPP

The Passive House Network

Quantity	Description	Glazing	Frames (avg.)	PSI Glazing edge (Avg.)	PSI Installation (Avg.)	Window Area	Glazing area	U_w installed	Glazed fraction per window	Comfort	Energy balance
		BTU/hr-sf-F	BTU/hr-sf-F	BTU/hr-ft-F	BTU/hr-ft-F	m^2	m^2	BTU/hr-sf-F	%	Exemption	kWh/a
1	N0.1	0.06	0.19	0.023	0.023	1.6	1.05	0.16	65%		-88
1	N0.2	0.06	0.19	0.023	0.028	1.6	1.05	0.16	65%		-84
1	N0.3	0.06	0.19	0.023	0.023	1.6	1.05	0.16	65%		-88
1	N1.1	0.06	0.19	0.023	0.023	2.0	1.31	0.16	67%		-79
1	N1.2	0.06	0.19	0.023	0.028	2.0	1.31	0.15	67%		-75
1	N1.3	0.06	0.19	0.023	0.028	2.0	1.31	0.15	67%		-75
1	N1.4	0.06	0.19	0.023	0.023	2.0	1.31	0.16	67%		-79
1	N1.5	0.06	0.19	0.023	0.023	3.4	2.06	0.16	60%		-147
1	N1.6	0.06	0.19	0.023	0.023	3.4	2.06	0.16	60%		-147
1	N2.1	0.06	0.19	0.023	0.023	1.8	1.21	0.16	67%		-67
1	N2.2	0.06	0.19	0.023	0.023	1.8	1.21	0.16	67%		-67
1	N2.3	0.06	0.19	0.023	0.023	1.8	1.21	0.16	67%		-67
1	N3.1	0.06	0.19	0.023	0.028	1.7	1.11	0.16	66%		-59
1	N3.2	0.06	0.19	0.023	0.028	1.7	1.11	0.16	66%		-59
1	N3.3	0.06	0.19	0.023	0.028	1.7	1.11	0.16	66%		-59

$$U_{w\text{-installed}} = \frac{(U_g \times A_{glass}) + (U_f \times A_{frame}) + (\Psi_{spacer} \times L_{spacer}) + (\Psi_{install} \times L_{install})}{A_{window}}$$

Individual Window Energy Balance



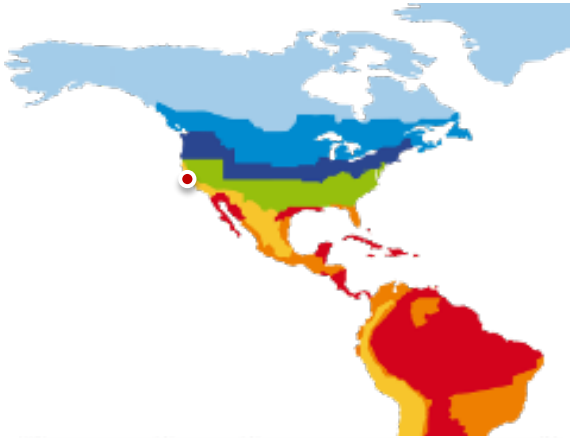
CASE STUDY #3

’PHI Classic’| Berkeley, CA
Single-Family Detached

FOCUS:
Insulation + Thermal Bridging

The Passive House Network

Berkeley, CA

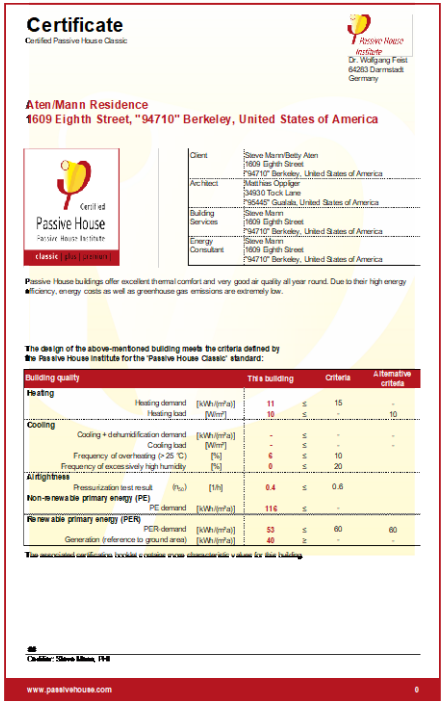


Climate	No	Region
Heating climate	1	Arctic
	2	Cold
	3	Cool-temperate
	4	Warm-temperate
	5	Warm
Cooling climate	6	Hot
	7	Very hot

TEAM:
Architect: Matthias Oppliger
Builder: Master Builders
Passive House Consultants: Home Energy Services

Berkeley House

The Passive House Network



Certificate

Certified Passive House Classic

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Aten/Mann Residence
1609 Eighth Street, "94710" Berkeley, United States of America

certified Passive House
Passive House Institute
classic | plus | premium

Client	Steve Mann/Betty Aten 1609 Eighth Street "94710" Berkeley, United States of America
Architect	Matthias Oppliger 34630 Tock Lane "95445" Gualala, United States of America
Building Services	Steve Mann 1609 Eighth Street "94710" Berkeley, United States of America
Energy Consultant	Steve Mann 1609 Eighth Street "94710" Berkeley, United States of America

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the "Passive House Classic" standard:

Building quality			TNI building		Criteria	Alternative criteria
Heating						
Heating demand	[kWh/(m²a)]		11	≤	15	-
Heating load	[W/m²]		10	≤	-	10
Cooling						
Cooling + dehumidification demand	[kWh/(m²a)]		-	≤	-	-
Cooling load	[W/m²]		-	≤	-	-
Frequency of overheating (> 25 °C)	[%]		6	≤	10	
Frequency of excessively high humidity	[%]		0	≤	20	
Airtightness						
Pressurization test result	(n_{50})	[1/h]	0.4	≤	0.6	
Non-renewable primary energy (PE)						
PE demand	[kWh/(m²a)]		116	≤	-	
Renewable primary energy (PER)						
PER demand	[kWh/(m²a)]		53	≤	60	60
Generation (reference to ground area)	[kWh/(m²a)]		40	≥	-	-

The associated certification booklet contains more characteristic values for this building.

Certifier: Steve Mann, PHI

www.passivehouse.com 0

Location & Orientation

- 1 story SFR 1,035 ft2 + attached garage, 2 BR, 2 BA
- Electric resistance heating
- Induction cooking
- CO2 Electric Heat Pump Hot Water
- LEED Platinum
- Video tour: https://vimeo.com/470048016

Modeled Peak Loads

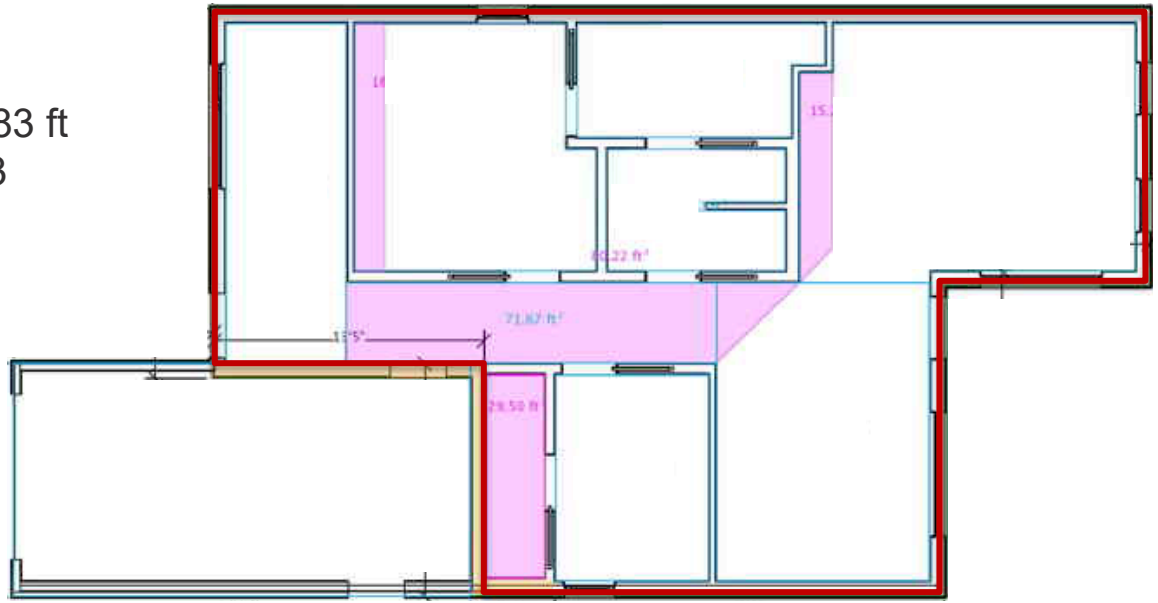
- Heating load:
  - 8.2 kBtuh (CA Code/ASHRAE)
  - 2.8 kBtuh (PHPP)
- Cooling load:
  - 10.6 kBtuh (CA Code/ASHRAE)
  - 0.4 (PHPP)

CA Energy Code Margins

- 2016: 68% + ZNE (permitted code)
- 2019: 54%, not quite ZNE

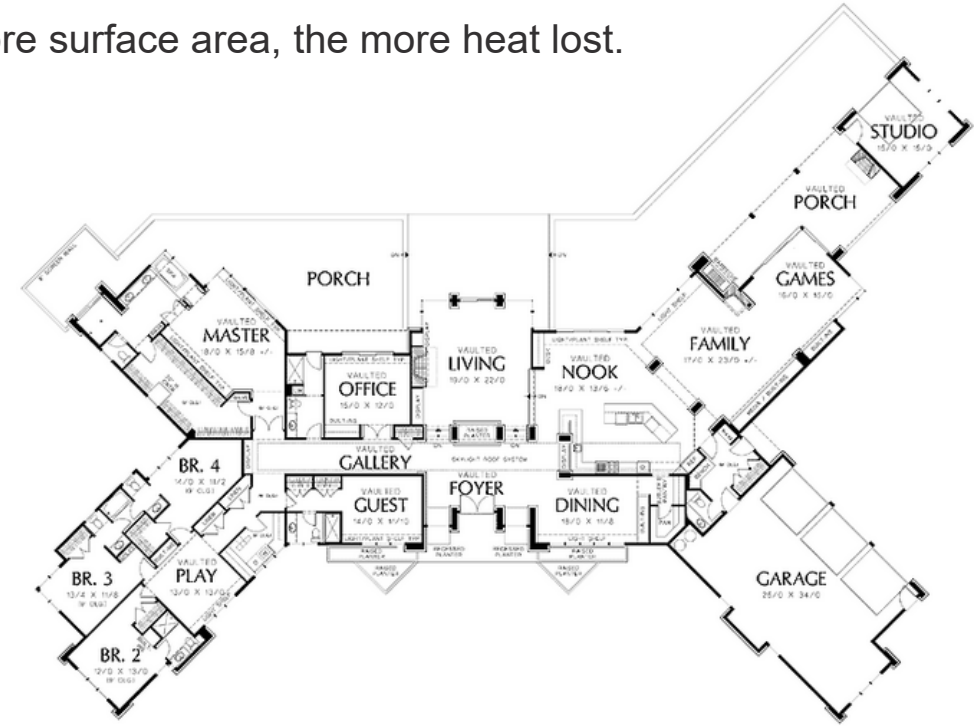
The Passive House Network

TFA: 874 ft2
Ceiling Heights: 9.83 ft
Gross Vol: 8556 ft3
Net Vol: 8294 ft3



Passive House and Building Form

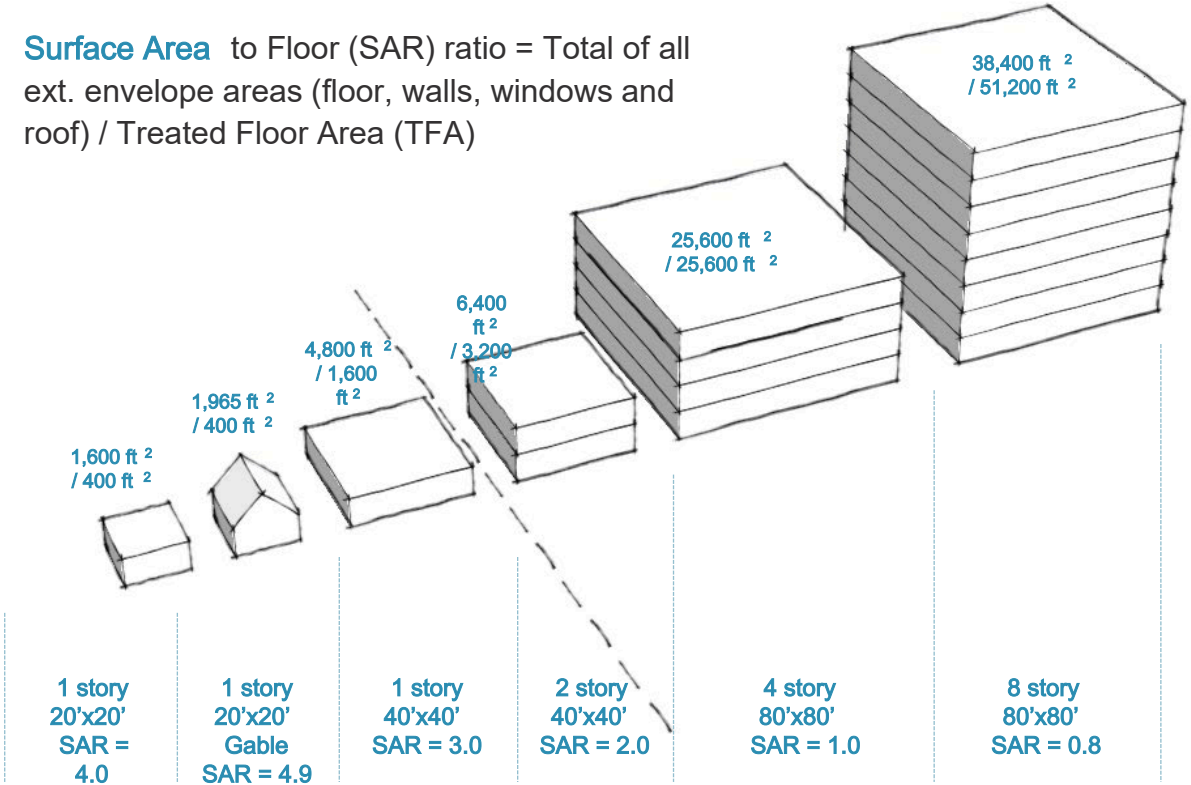
The more surface area, the more heat lost.



Surface Area to Floor Area Ratio (SAR)

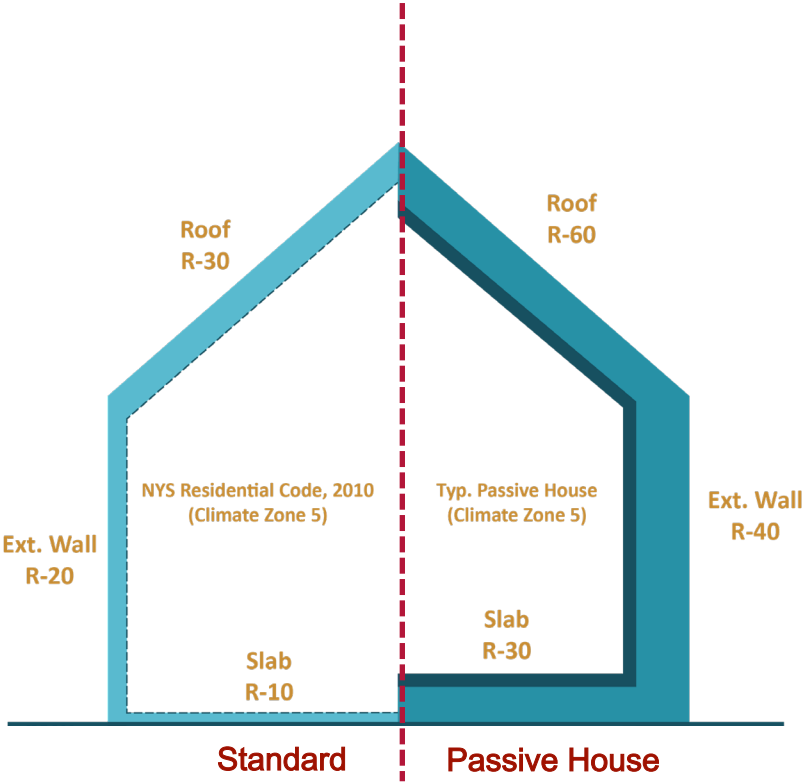
The Passive House Network

Surface Area to Floor (SAR) ratio = Total of all ext. envelope areas (floor, walls, windows and roof) / Treated Floor Area (TFA)



Climate Specific, Continuous Insulation

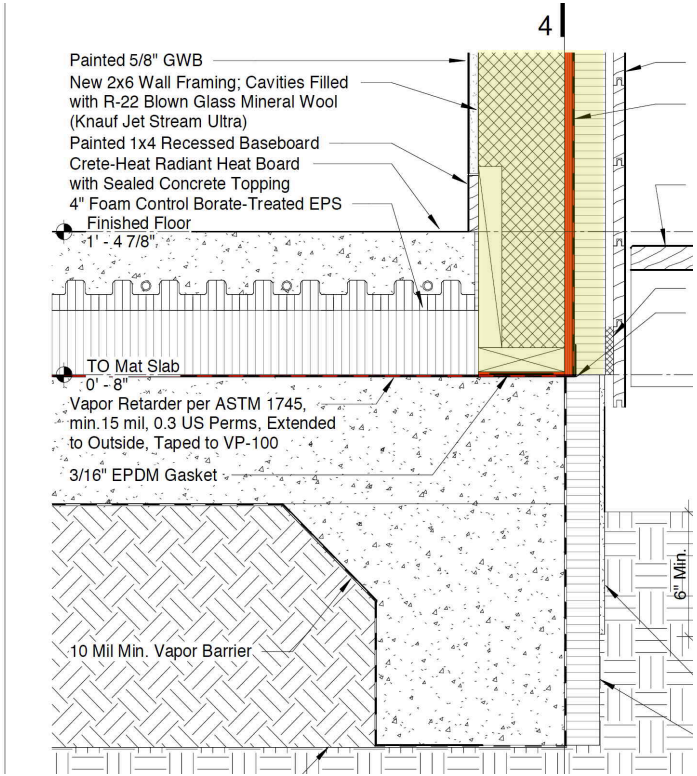
The Passive House Network

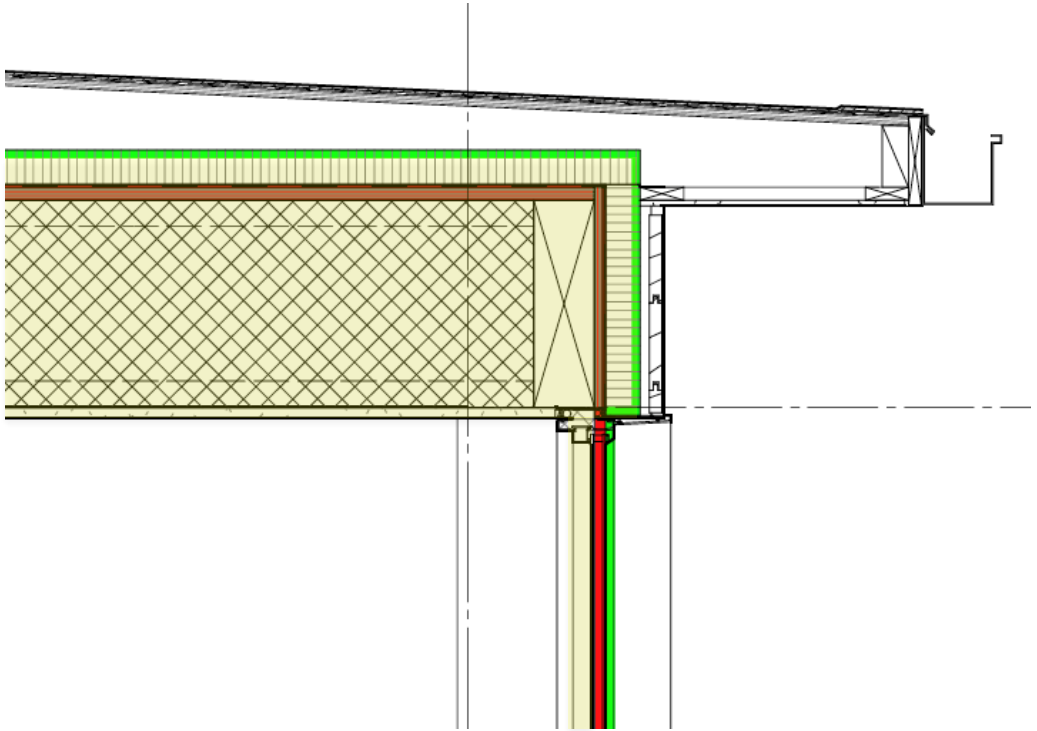


Note! Insulation levels required will be climate specific.
Harsh climates require higher R - values – just like sleeping bags.

Source: mountainwarehouse

The Passive House Network


4
Painted 5/8" GWB
New 2x6 Wall Framing; Cavities Filled with R-22 Blown Glass Mineral Wool (Knauf Jet Stream Ultra)
Painted 1x4 Recessed Baseboard
Crete-Heat Radiant Heat Board with Sealed Concrete Topping
4" Foam Control Borate-Treated EPS
Finished Floor
1' - 4 7/8"
TO Mat Slab
0' - 8"
Vapor Retarder per ASTM 1745, min.15 mil, 0.3 US Perms, Extended to Outside, Taped to VP-100
3/16" EPDM Gasket
10 Mil Min. Vapor Barrier
6" Min.



Reducing Thermal Bridges

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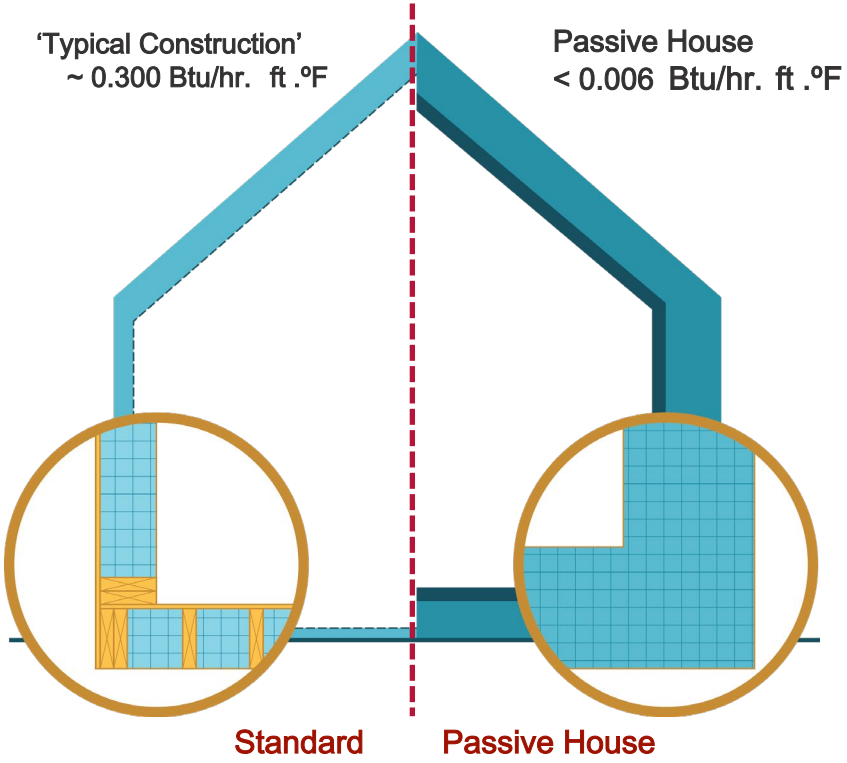
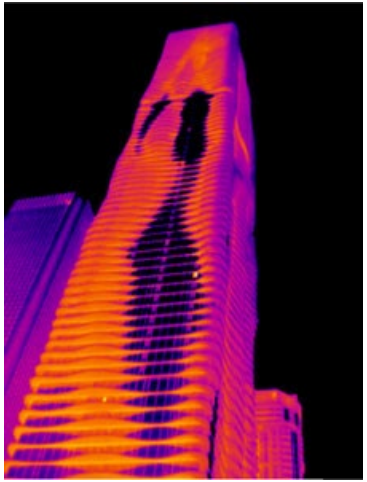


Thermal Bridges: Condensation, Mold

The Passive House Network

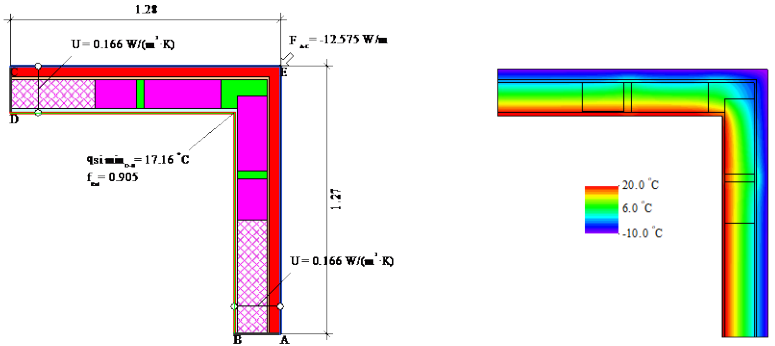
Thermal Bridges: Heat Loss



"We have R-11 radiant barrier paint on the projecting slabs…"

-BSI-062: Thermal Bridges Redux

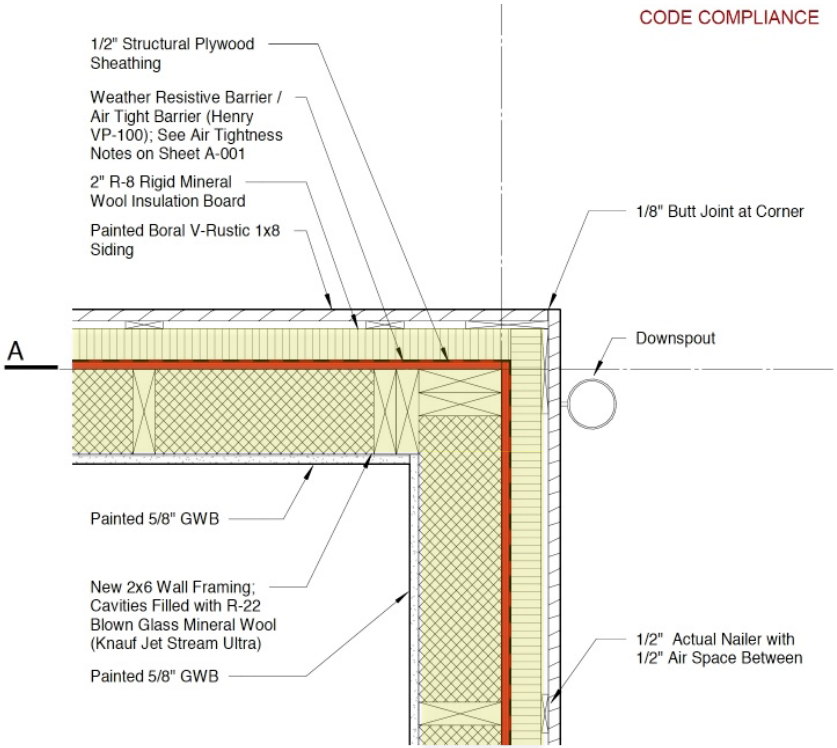
Typical Outside Corner



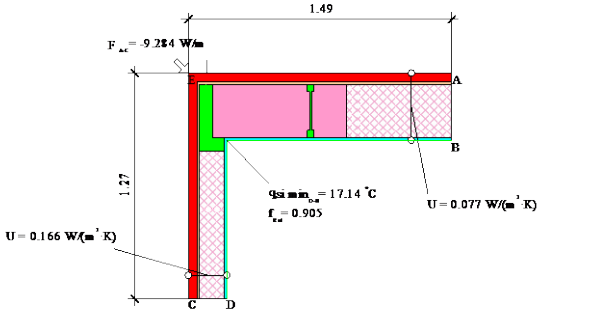
$$y_{exc} = \frac{F}{DT} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{12.575}{30.000} - 0.166 \cdot 1.269 - 0.166 \cdot 1.283 = -0.005 \text{ W/(m·K)}$$

Material	l [W/(m·K)]
2x6 JetStream Ultra	0.034
Drywall	0.209
Framing Lumber	0.130
JetStream Ultra	0.034
OSB	0.130
Roxul Rockboard 60	0.034

Boundary Condition	q [C]	R [(m²·K)/W]
Exterior, ventilated	-10.000	0.130
Interior, normal, horizontal	20.000	0.130
Symmetry/Model section		



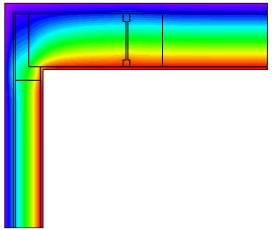
Roof Eave



$$\psi_{exc} = \frac{F}{DT} - U_1 b_1 - U_2 b_2 = \frac{9.284}{30.000} - 0.077 \cdot 1.485 - 0.166 \cdot 1.269 = -0.016 \text{ W/(m·K)}$$

Boundary Condition	q[°C]	R[(m²·K)/W]
Exterior, ventilated	-10.000	0.130
Interior, heat flux, downwards	20.000	0.170
Interior, normal, horizontal	20.000	0.130
Symmetry/Model section		

Material	l [W/(m·K)]	e
2x12 JetStream Ultra	0.027	0.900
2x6 JetStream Ultra	0.034	0.900
Dryvit	0.209	0.900
Framing Lumber	0.130	0.900
JetStream Ultra	0.034	0.900
OSB	0.130	0.900
Roxul Rockboard 60	0.034	0.900



Window Details are Critical

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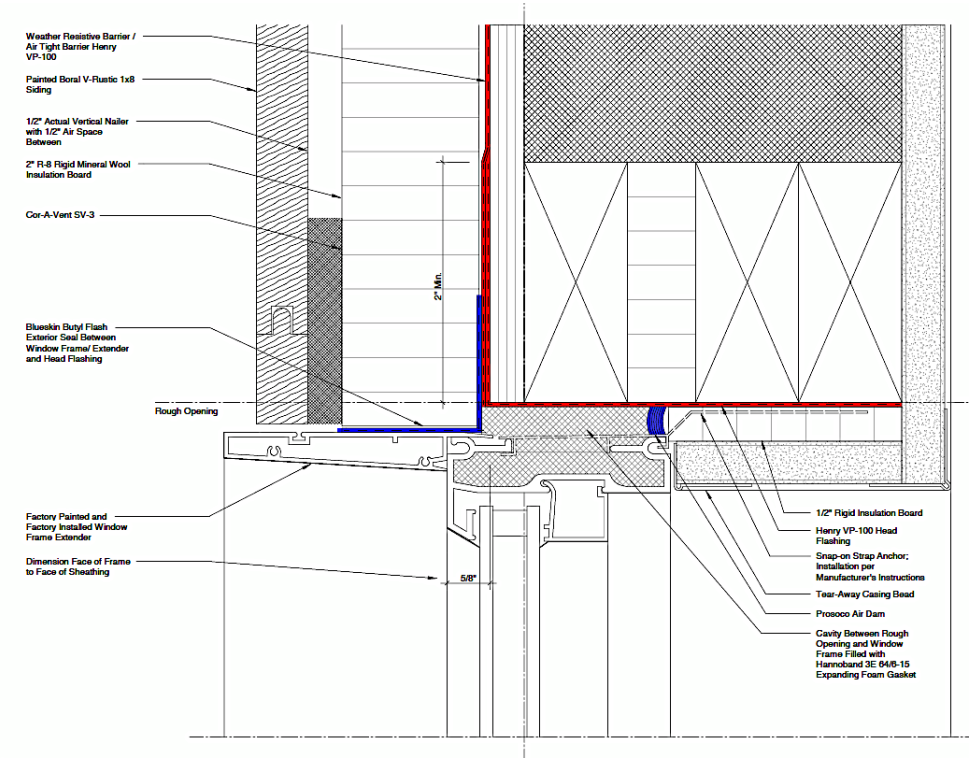
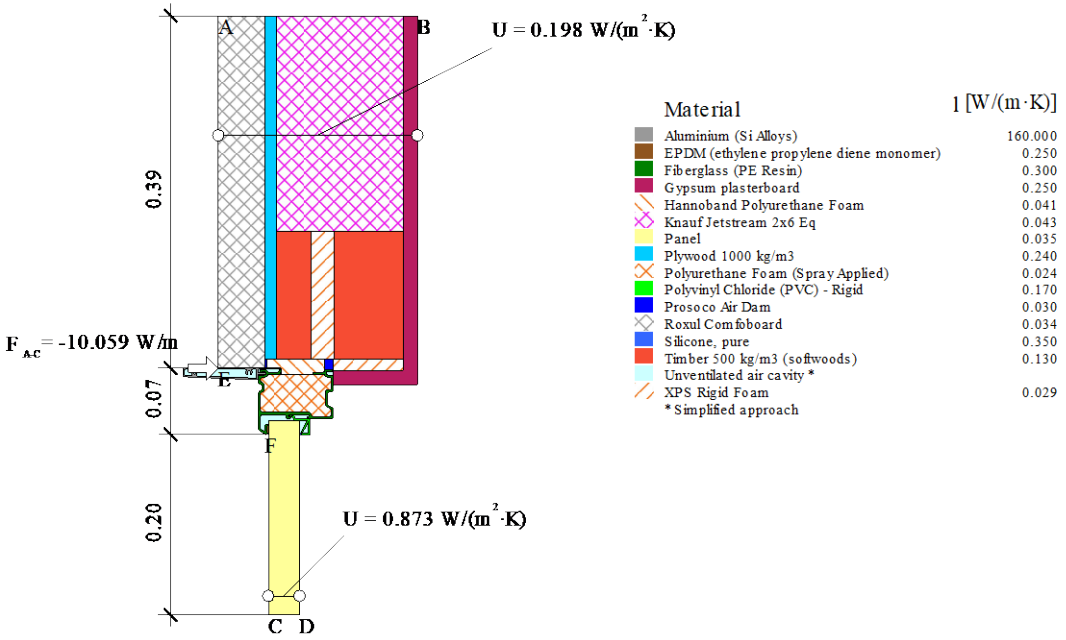




$$y_{AEC,*} = \frac{F}{DT} - U_1 \cdot b_1 - U_2 \cdot b_2 - U_3 \cdot b_3 = \frac{10.059}{30.000} - 0.198 \cdot 0.386 - 0.873 \cdot 0.073 - 0.873 \cdot 0.198 = 0.022 \text{ W/(m·K)}$$

PASSIVE HOUSE RESULTS

COMFORTABLE

PASSIVE HOUSE RESULTS

HEALTHY

PASSIVE HOUSE RESULTS

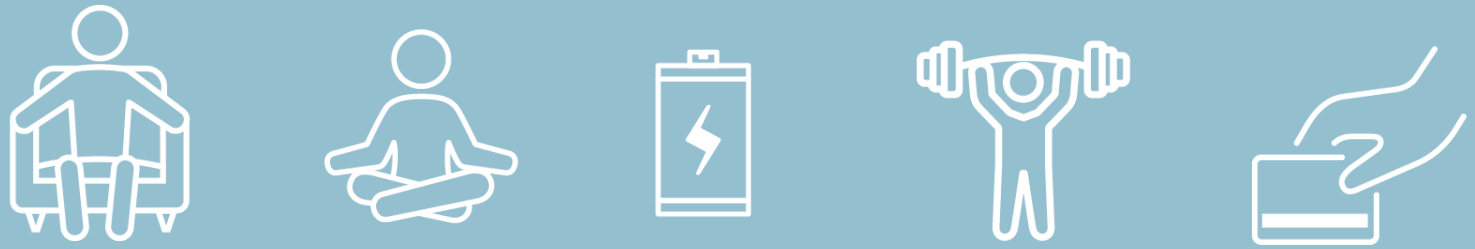
ULTRA-LOW ENERGY USE

PASSIVE HOUSE RESULTS

PREDICTABLE & RESILIENT

PASSIVE HOUSE RESULTS

COST EFFECTIVE



Published Resources

The Passive House Network

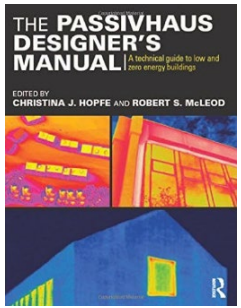
The Passive House Designer's Manual
Christina J. Hopfe and Robert S. McLeod

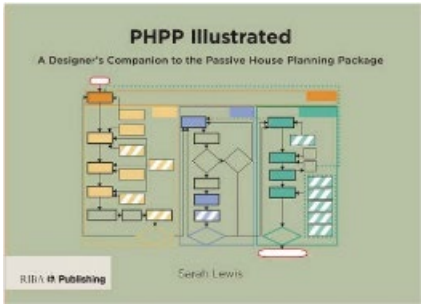
The Passivhaus Handbook
Janet Cotterell and Adam Dadeby

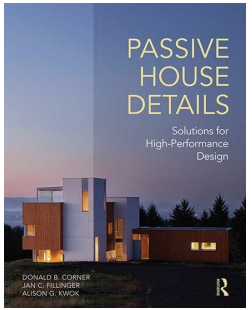
Passive House Design
Gonzalo Roberto and Rainer Vallentin

PHPP Illustrated
Sarah Lewis

Passive House Details: Solutions for High -Performance Design
Donald Corner, Jan Fillinger, and Alison Kwok







Passive House International

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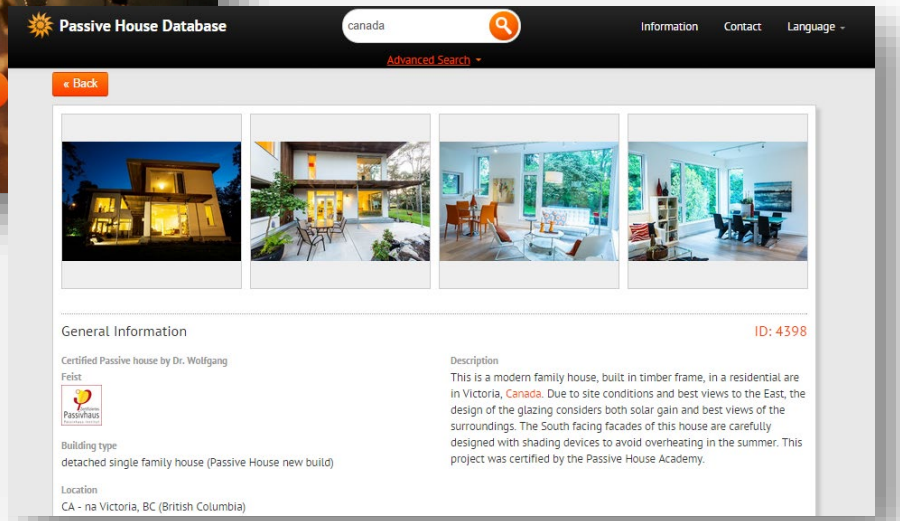
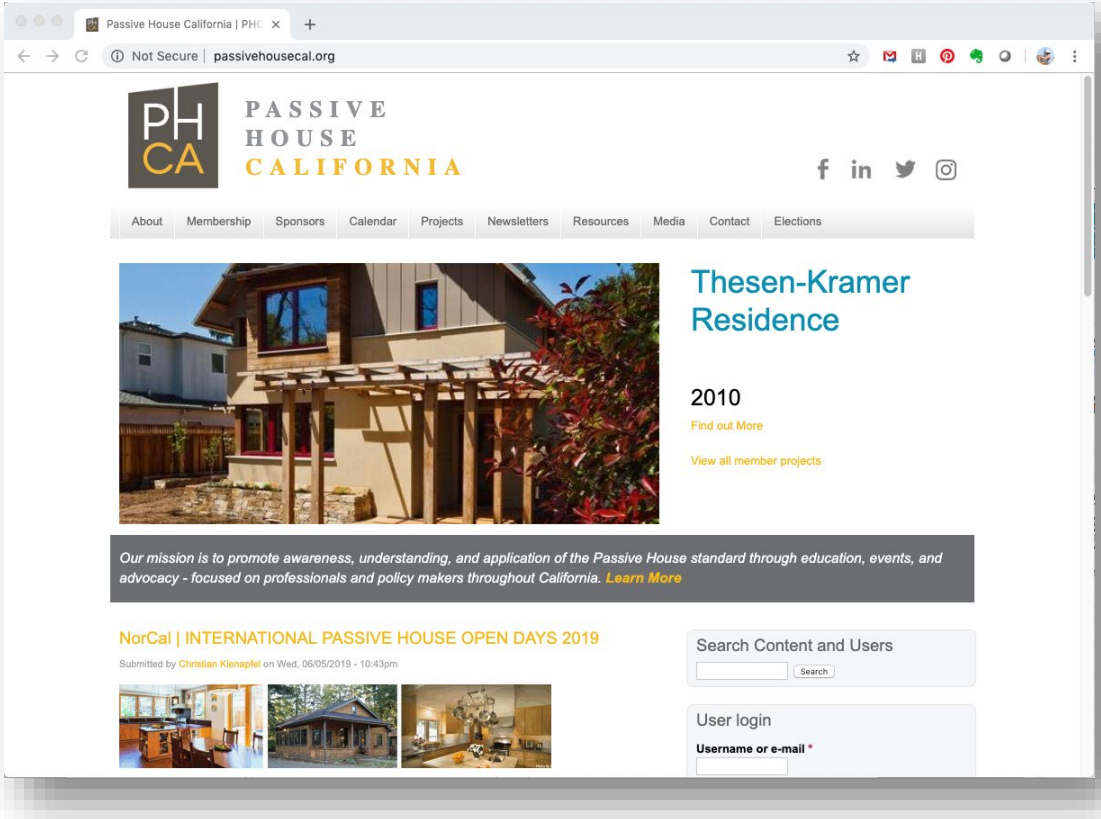


passivehouse.com
passivehouse-database.org

Passive House California

The Passive House Network



PassiveHouseCAL.org

Education Is the Key

The Passive House Network

Get Trained Online

Architects, Engineers, Consultants, Owners, Contractors, Real Estate Brokers, Policymakers & More

Introductory

Learn the basic principles of Passive House design and construction. An ideal entry point for anyone interested in the high-performance building standard, these courses range from 30 minutes to one day in length and are available live and on-demand.

Core Certified Courses

These courses provide professional certification for those working on Passive House buildings who want a recognized credential. This includes the CPHD course for architects, consultants & engineers, and the CPHT course for builders.

Specialized Courses

These courses provide expert training as particular roles may require. This includes the design and energy modeling software like PHPP, Therm, and Design PH, and includes deeper dives into retrofits, windows, and more.

PHN Certified Passive House Training

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www.naphnetwork.org

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Passive House Institute

International PASSIVE HOUSE Association iPHA

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Seize the power of Passive House.

Closing

- Continuing Education Units Available
  - Contact shuskey@co.slo.ca.us for AIA LU/ HSW
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - May 4 – 2022 CALGreen Codes for Residential and Non-Residential
  - May 18 – Water Heating Distribution Best Practices – Class 4: High Performance Fundamentals Series
  - May 23 – Targeting Zero Net Carbon Design – Class 1: ZNCD Series
  - June 1 - Heat Pump Fundamentals: Space Conditioning and Water Heating – Class 5: HPF Series
  - June 15 - Home Assessments for Decarbonization – Class 6: High Performance Fundamentals Series
  - June 20 - Energy Performance for ZNC Operations – Class 2: Zero Net Carbon Design Series
  - **June 26 - June 30 – Passive House Designer/ Consultant Certification – Submit an Interest Form!**

Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

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