We will be starting soon!

Thanks for joining us

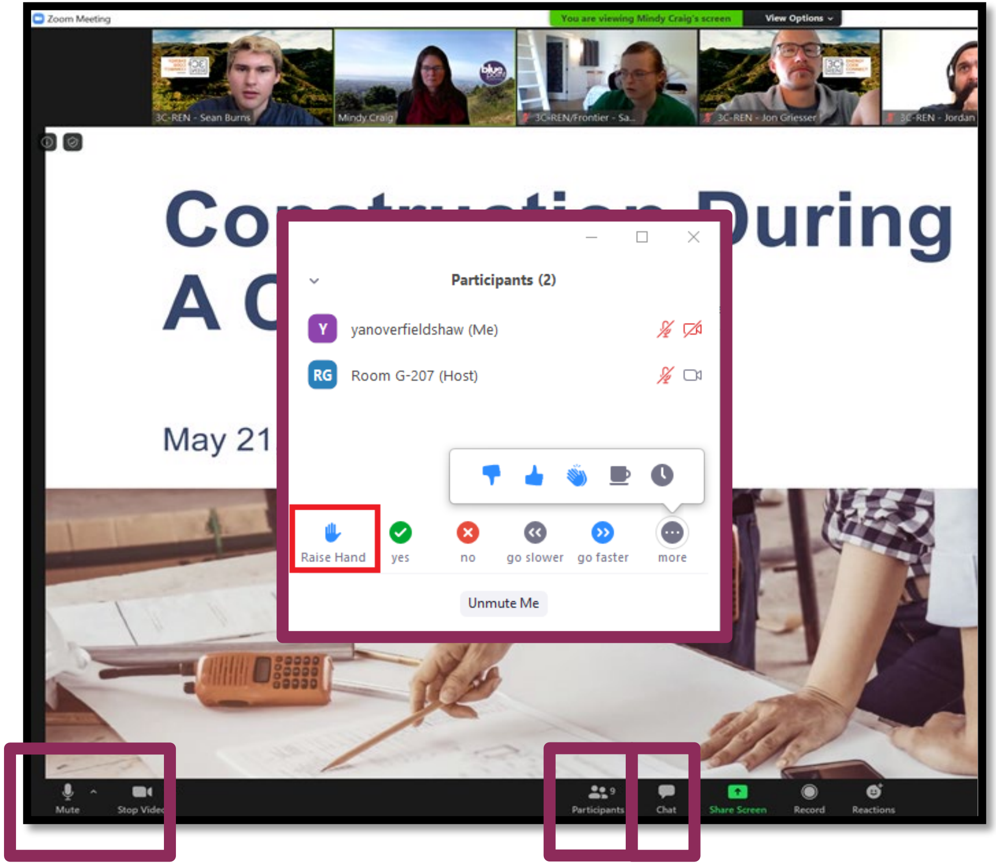
Introduction to Passive House Retrofits

Steve Mann – The Passive House Network and Home Energy Services

July 24th, 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

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

Questions about Title 24?

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

3C-REN

in BALANCE™
Green Consulting

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.

CEUs and Upcoming Events

- Continuing Education Units Available
  - Contact shuskey@co.slo.ca.us for 2.0 AIA LUs.
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - August 6th - Beyond Energy: Using Passive House Standards To Boost Resilience Of California's Built Environment
  - August 8th - Heat Pumps for Heating and Cooling – Part 2: All-Electric Design and Construction Series
  - August 27th - Introduction to Passive House Trades
  - September 5th - Passive Design/Build™ Boot Camp – Free info session
  - September 24th - Building Electrification, Passive House PER & California
  - September 30th – October 4th – Passive Design/ Build Boot Camp – **In Person in San Luis Obispo**
- Visit www.3c-ren.org/events for our full catalog of trainings.

Passive House Retrofits

The EnerPHit Standard

The
Passive House
Network

The Network

Global Knowledge. Regional Context. Local Applications

Passive House Rocky Mountains
The Passive House Network

Passive House Minnesota
The Passive House Network

New Jersey Passive House
The Passive House Network

Passive House Empire State
The Passive House Network

Passive House Pennsylvania
The Passive House Network

Passive House Washington DC
The Passive House Network

NORTH AMERICAN CERTIFIERS CIRCLE
PASSIVE HOUSE CERTIFIER
Passive House Institute accredited

International
PASSIVE HOUSE
Association
iPHA

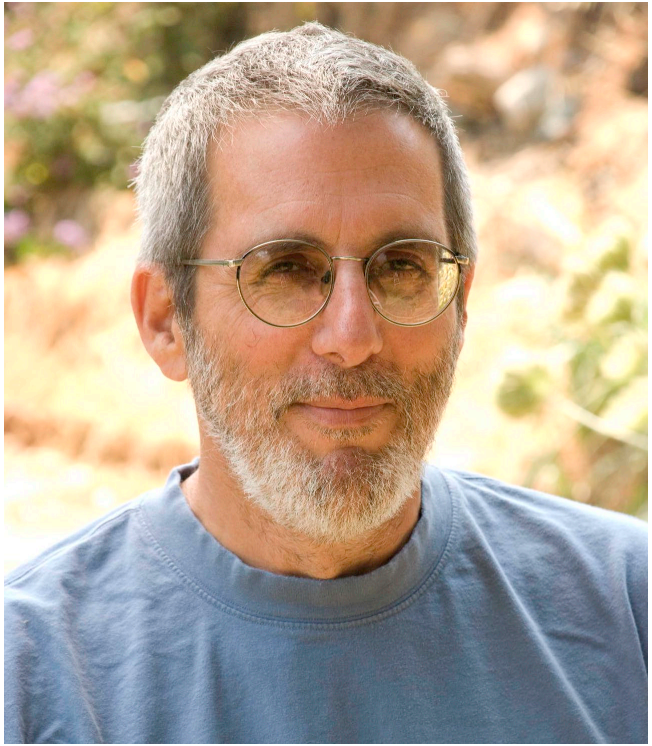
Passive House Institute

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER

CERTIFIED PASSIVE HOUSE TRADESPERSON
TRADESPERSON

Certified Passive House
Passive House Institute

Your Instructor



Steve Mann

Home Energy Services
Berkeley, CA

Steve Mann, is a California HERS ,LEED AP+ Homes and Green Rater, and a certified Passive House Consultant, 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

Course Description

Description:

The Passive House Institute developed EnerPHit certification standards to accommodate the realities of existing old buildings, where foundations, party lines, historic preservation, cost, and other factors make a typical Passive House certification impractical. This course takes a detailed look at the criteria, the pathways and the potential exemptions, that drive EnerPHit performance to deliver the health, efficiency, and resilience results we expect from Passive House. Through case studies of successful retrofits, see how to upgrade a building with respect to airtightness, insulation, thermal bridge reductions, high-performance windows, and ventilation.

AIA Course #20240123-PHN, 2 LU|HSW Credits
PHI: 3 Credits

Learning Objectives:

1. Outline reasons why the EnerPHit standard was developed and implemented to ensure Passive House health, efficiency and resilience outcomes are achievable.
2. Describe the two EnerPHit certification methods, the criteria differences and similarities and how these both accommodate high -performance outcomes.
3. Outline the roles of comfort criteria, ventilation requirements in driving design optimization.
4. Describe exemptions that may be utilized in when issues of existing/historic building don’t allow standard resolution.
5. Outline the EnerPHit Retrofit Plan program and approach for long -term step -by-step Passive House renovation approach
6. Describe EnerPHit pilot programs OutPHit and apartment renovation certifications.
7. Outline real -world EnerPHit solutions from case studies of masonry and wood frame buildings.

Agenda

Part 1: The EnerPHit Standard

1. Orientation
2. Passive House and EnerPHit
3. Two EnerPHit Methods
4. Window Comfort Criteria
5. Ventilation
6. Exemptions
7. Stepwise EnerPHit Retrofit Plan
8. Pilot Programs:
    a. OutPHit scales EnerPHit
    b. Apartment Certification

Part 2: EnerPHit Case Studies

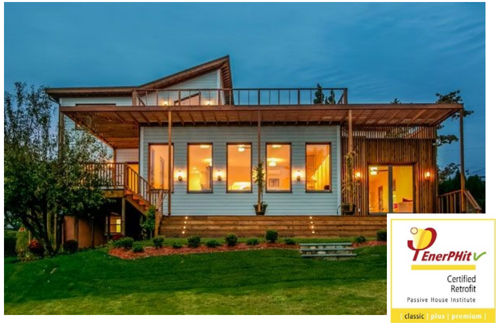
1. Historic Masonry
2. Wood Frame
3. Multifamily

Part 3: Resources

The EnerPHit Standard

Passive House Certified Retrofits: EnerPHit

The basic principle which should be applied for each structural intervention in an existing building is 'if it has to be done, it should be done properly.'

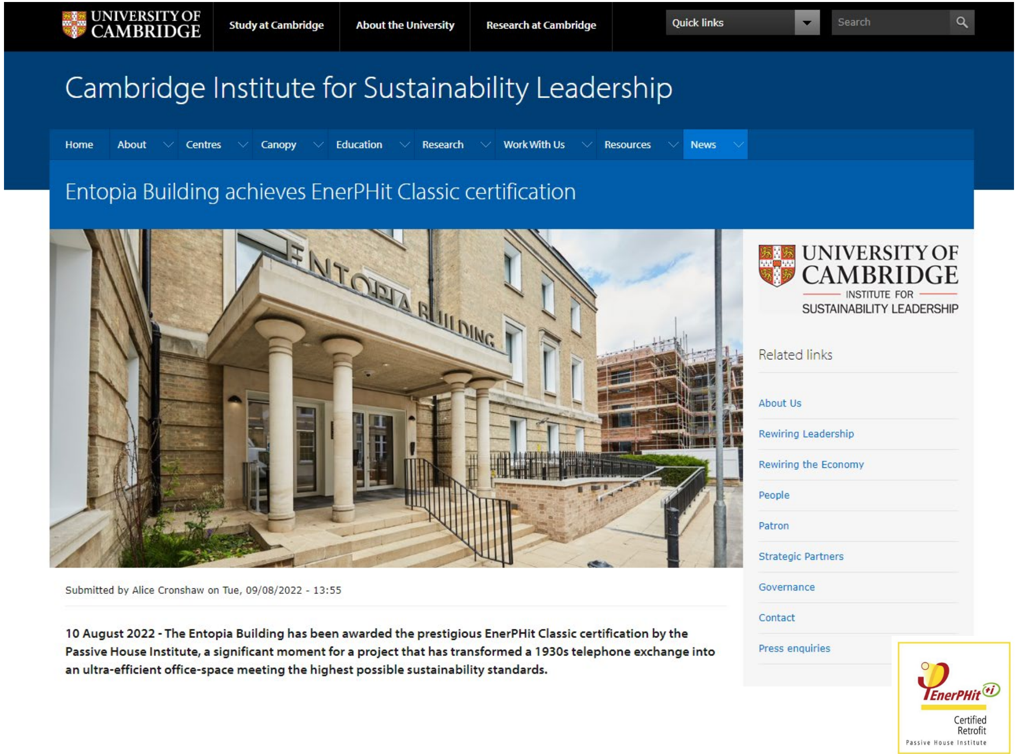


EnerPHit ✓
Certified Retrofit
Passive House Institute
| classic | plus | premium |

EnerPHit +i
Certified Retrofit
Passive House Institute

EnerPHit
Retrofit Plan
Pre-certified
Passive House Institute

Grocery Store Chain, Garment factory, Academic Building



Cambridge Institute for Sustainability Leadership

Entopia Building achieves EnerPHit Classic certification

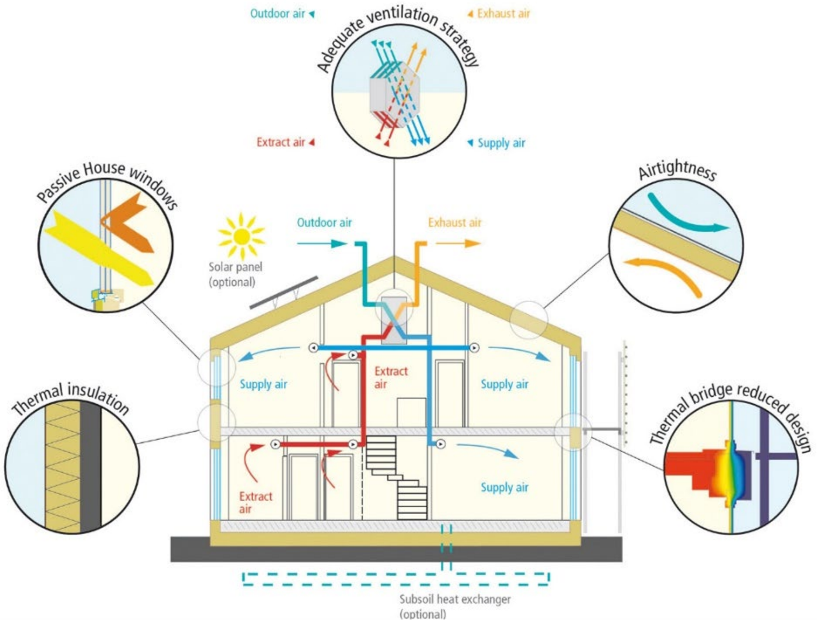
Submitted by Alice Cronshaw on Tue, 09/08/2022 - 13:55

10 August 2022 - The Entopia Building has been awarded the prestigious EnerPHit Classic certification by the Passive House Institute, a significant moment for a project that has transformed a 1930s telephone exchange into an ultra-efficient office-space meeting the highest possible sustainability standards.

Passive House & EnerPHit

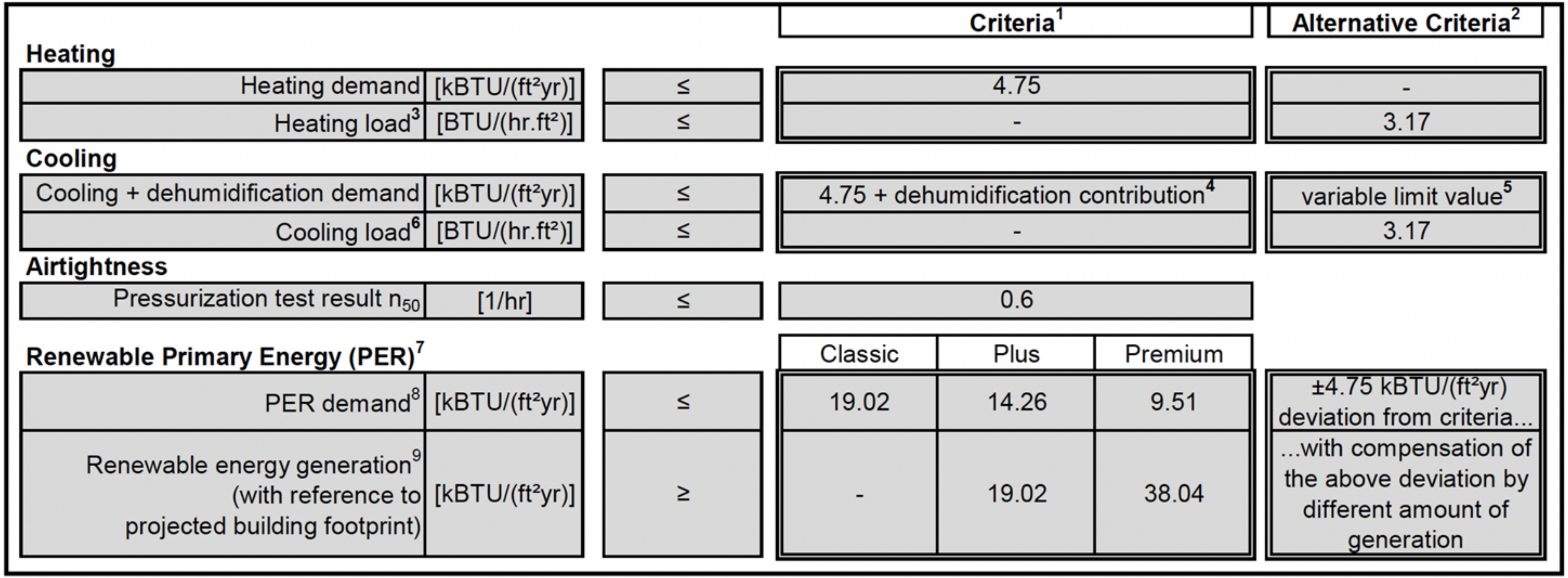
Passive House

- Low Operational Energy
- Excellent Occupant Comfort
- Good Indoor Air Quality
- Durable (Low Moisture Risk)
- Resilience



"I am thinking of having the stove removed altogether; it is only in the way."
Fridtjof Nansen, 1897 regarding the Research Ship *Fram*

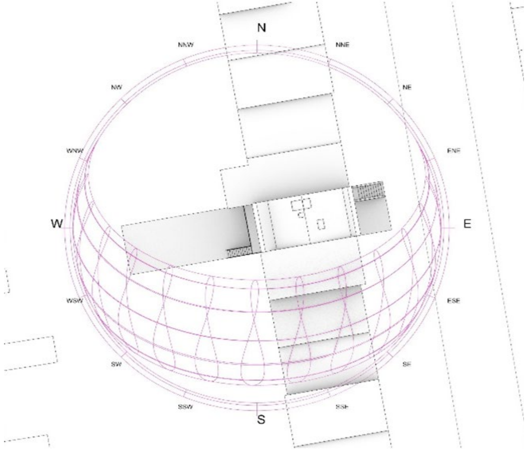
Passive House Certification Criteria



			Criteria[1]			Alternative Criteria[2]
Heating						
Heating demand	[kBTU/(ft^{2}yr)]	≤	4.75			-
Heating load[3]	[BTU/(hr.ft^2)]	≤	-			3.17
Cooling						
Cooling + dehumidification demand	[kBTU/(ft^{2}yr)]	≤	4.75 + dehumidification contribution[4]			variable limit value[5]
Cooling load[6]	[BTU/(hr.ft^2)]	≤	-			3.17
Airtightness						
Pressurization test result n_{50}	[1/hr]	≤	0.6			
Renewable Primary Energy (PER)[7]			Classic	Plus	Premium	
PER demand[8]	[kBTU/(ft^{2}yr)]	≤	19.02	14.26	9.51	±4.75 kBTU/(ft^{2}yr) deviation from criteria...
Renewable energy generation[9] (with reference to projected building footprint)	[kBTU/(ft^{2}yr)]	≥	-	19.02	38.04	...with compensation of the above deviation by different amount of generation

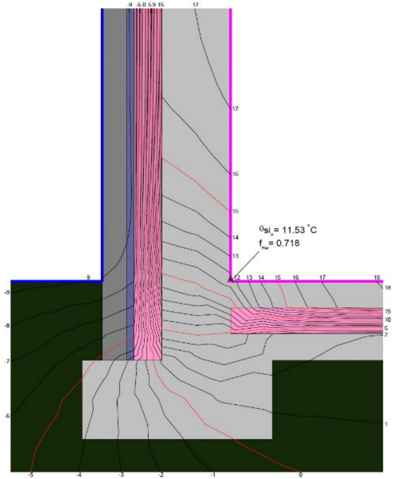
Why not just do Passive House?

It is not always possible to achieve the Passive House Standard (new constructions) for refurbishments of existing buildings, even with adequate funds. For this reason, the PHI has developed the "EnerPHit – Quality-Approved Energy Retrofit with Passive House Components" Certificate.



Orientation/Siting

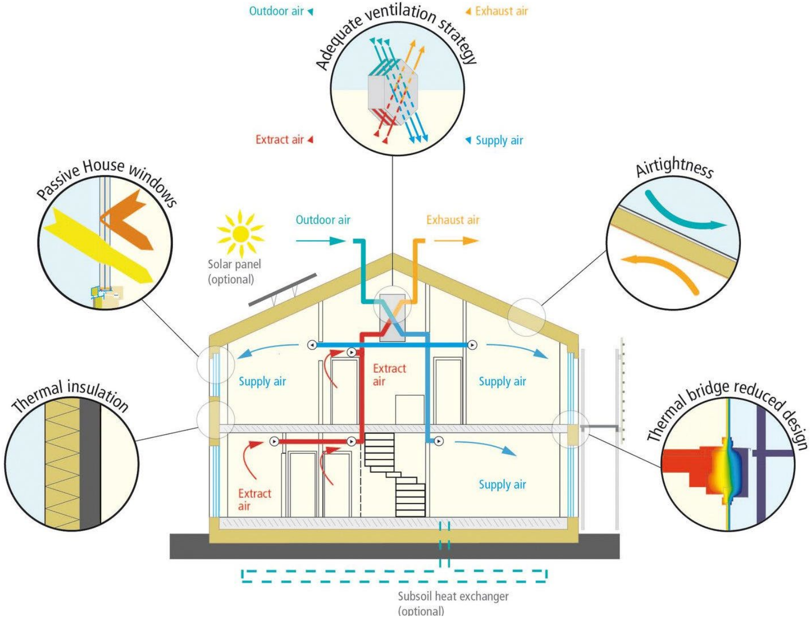
Air Sealing



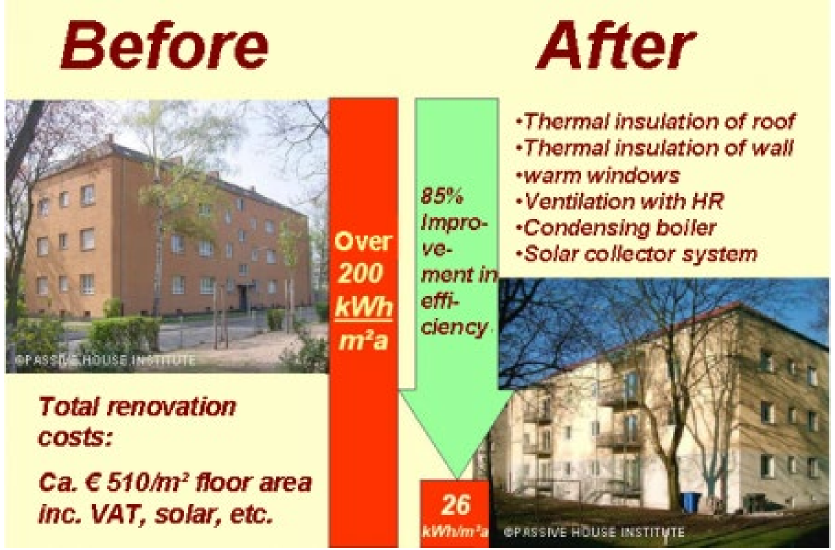
Thermal Bridging

Why not just do Passive House?

- Continuous Insulation
- Airtight
- Thermal Bridge Free
- High -Performance Windows
- Mechanical Ventilation with HR



2010 First EnerPHit Pilot Projects



Before

After

- Thermal insulation of roof
- Thermal insulation of wall
- warm windows
- Ventilation with HR
- Condensing boiler
- Solar collector system

Over 200 kWh m²a

85% Improvement in efficiency

26 kWh/m²a

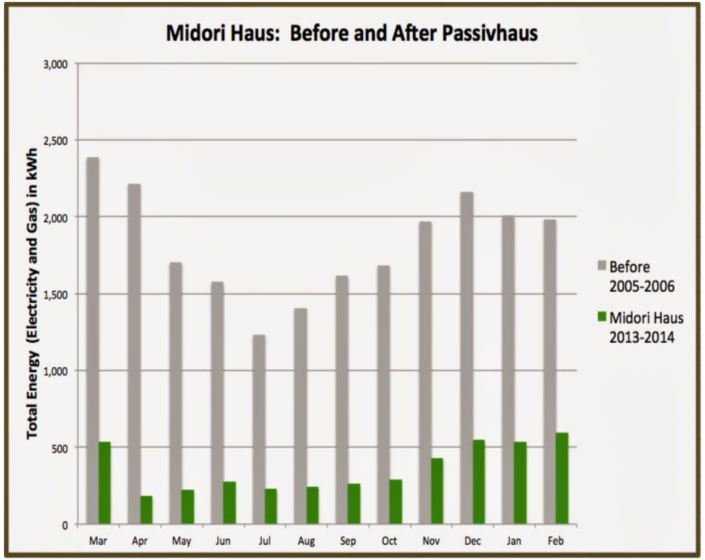
Total renovation costs:

Ca. € 510/m² floor area inc. VAT, solar, etc.

©PASSIVE HOUSE INSTITUTE

©PASSIVE HOUSE INSTITUTE

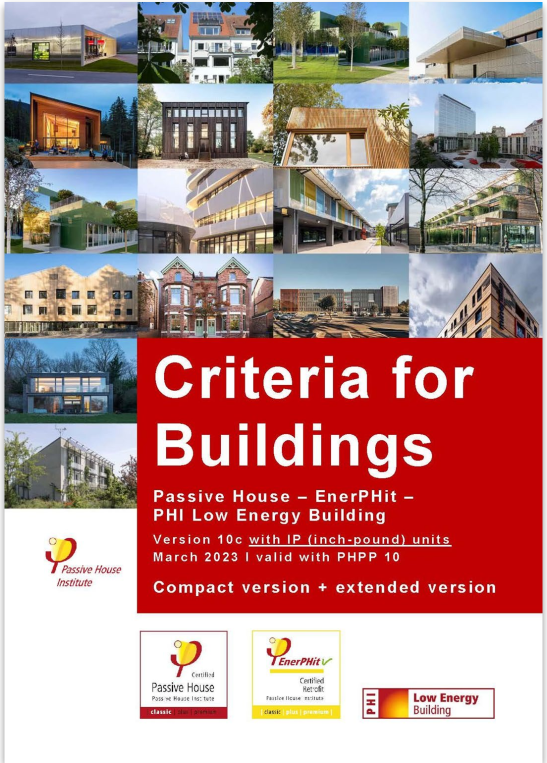
Certified Passive House



http://midorihaus.com/tag/energy-data/

MidoriHaus, Santa Cruz
Essential Habitat

Consult the Criteria



Criteria for Buildings

Passive House – EnerPHit –
PHI Low Energy Building

Version 10c with IP (inch-pound) units
March 2023 I valid with PHPP 10

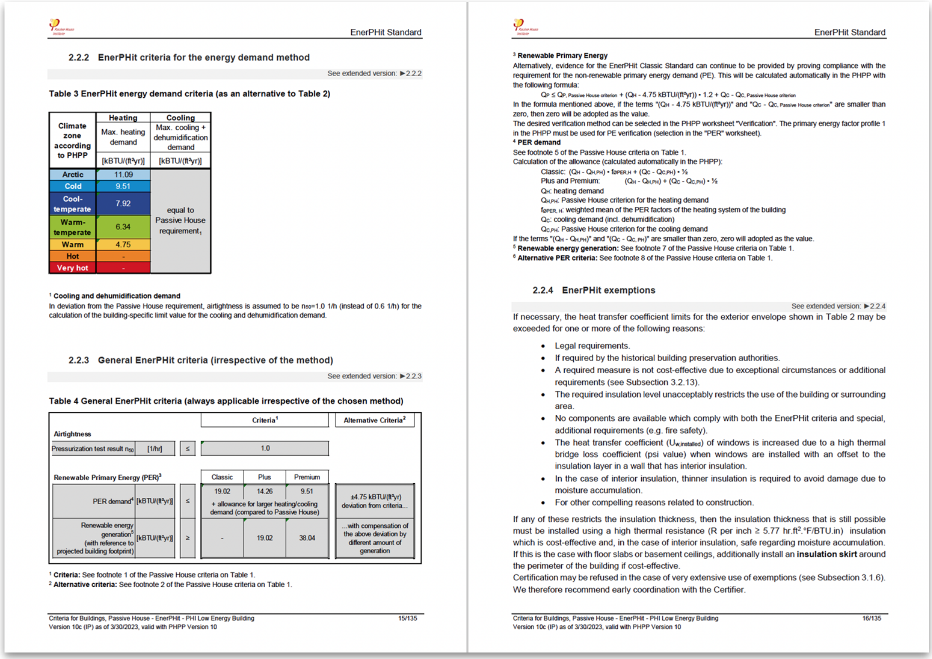
Compact version + extended version

Passive House Institute

Certified Passive House
Passive House Institute
classic | plus | premium

EnerPHit
Certified Retrofit
Passive House Institute
classic | plus | premium

PHI Low Energy Building



EnerPHit Standard

2.2.2 EnerPHit criteria for the energy demand method

See extended version: ►2.2.2

Table 3 EnerPHit energy demand criteria (as an alternative to Table 2)

Climate zone according to PHPP	Heating	Cooling
	Max. heating demand	Max. cooling + dehumidification demand
	[kBTU/(ft^{2}yr)]	[kBTU/(ft^{2}yr)]
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	-	

[1] **Cooling and dehumidification demand**
In deviation from the Passive House requirement, airtightness is assumed to be n_{50}=1.0 1/h (instead of 0.6 1/h) for the calculation of the building-specific limit value for the cooling and dehumidification demand.

2.2.3 General EnerPHit criteria (irrespective of the method)

See extended version: ►2.2.3

Table 4 General EnerPHit criteria (always applicable irrespective of the chosen method)

			Criteria[1]			Alternative Criteria[2]
Airtightness						
Pressurization test result n_{50}	[1/hr]	≤	1.0			
Renewable Primary Energy (PER)[3]			Classic	Plus	Premium	
PER demand[4]	[kBTU/(ft^{2}yr)]	≤	19.02	14.26	9.51	±4.75 kBTU/(ft^{2}yr) deviation from criteria...
			+ allowance for larger heating/cooling demand (compared to Passive House)			
Renewable energy generation[5] (with reference to projected building footprint)	[kBTU/(ft^{2}yr)]	≥	-	19.02	38.04	...with compensation of the above deviation by different amount of generation

[1] **Criteria:** See footnote 1 of the Passive House criteria on Table 1.
[2] **Alternative criteria:** See footnote 2 of the Passive House criteria on Table 1.

Criteria for Buildings, Passive House - EnerPHit - PHI Low Energy Building 15/135
Version 10c (IP) as of 3/30/2023, valid with PHPP Version 10

EnerPHit Standard

[3] **Renewable Primary Energy**
Alternatively, evidence for the EnerPHit Classic Standard can continue to be provided by proving compliance with the requirement for the non-renewable primary energy demand (PE). This will be calculated automatically in the PHPP with the following formula:

$$Q_P \le Q_{P,\text{ Passive House criterion}} + (Q_H - 4.75\text{ kBTU/(ft}^2\text{yr))} \cdot 1.2 + Q_C - Q_{C,\text{ Passive House criterion}}$$

In the formula mentioned above, if the terms "$(Q_H - 4.75\text{ kBTU/(ft}^2\text{yr))}$" and "$Q_C - Q_{C,\text{ Passive House criterion}}$" are smaller than zero, then zero will be adopted as the value.
The desired verification method can be selected in the PHPP worksheet "Verification". The primary energy factor profile 1 in the PHPP must be used for PE verification (selection in the "PER" worksheet).

[4] **PER demand**
See footnote 5 of the Passive House criteria on Table 1.
Calculation of the allowance (calculated automatically in the PHPP):

Classic: $(Q_H - Q_{H,PH}) \cdot f_{øPER,H} + (Q_C - Q_{C,PH}) \cdot ½$
Plus and Premium: $(Q_H - Q_{H,PH}) + (Q_C - Q_{C,PH}) \cdot ½$
Q_H: heating demand
$Q_{H,PH}$: Passive House criterion for the heating demand
$f_{øPER,H}$: weighted mean of the PER factors of the heating system of the building
Q_C: cooling demand (incl. dehumidification)
$Q_{C,PH}$: Passive House criterion for the cooling demand

If the terms "$(Q_H - Q_{H,PH})$" and "$(Q_C - Q_{C,PH})$" are smaller than zero, zero will adopted as the value.

[5] **Renewable energy generation:** See footnote 7 of the Passive House criteria on Table 1.

[6] **Alternative PER criteria:** See footnote 8 of the Passive House criteria on Table 1.

2.2.4 EnerPHit exemptions

See extended version: ►2.2.4

If necessary, the heat transfer coefficient limits for the exterior envelope shown in Table 2 may be exceeded for one or more of the following reasons:

- Legal requirements.
- If required by the historical building preservation authorities.
- A required measure is not cost-effective due to exceptional circumstances or additional requirements (see Subsection 3.2.13).
- The required insulation level unacceptably restricts the use of the building or surrounding area.
- No components are available which comply with both the EnerPHit criteria and special, additional requirements (e.g. fire safety).
- The heat transfer coefficient ($U_{w,installed}$) of windows is increased due to a high thermal bridge loss coefficient (psi value) when windows are installed with an offset to the insulation layer in a wall that has interior insulation.
- In the case of interior insulation, thinner insulation is required to avoid damage due to moisture accumulation.
- For other compelling reasons related to construction.

If any of these restricts the insulation thickness, then the insulation thickness that is still possible must be installed using a high thermal resistance (R per inch ≥ 5.77 hr.ft^2.°F/BTU.in) insulation which is cost-effective and, in the case of interior insulation, safe regarding moisture accumulation. If this is the case with floor slabs or basement ceilings, additionally install an **insulation skirt** around the perimeter of the building if cost-effective.
Certification may be refused in the case of very extensive use of exemptions (see Subsection 3.1.6). We therefore recommend early coordination with the Certifier.

Criteria for Buildings, Passive House - EnerPHit - PHI Low Energy Building 16/135
Version 10c (IP) as of 3/30/2023, valid with PHPP Version 10

https://passivehouse.com/03_certification/02_certification_buildings/08_energy_standards/08_energy_standards.html

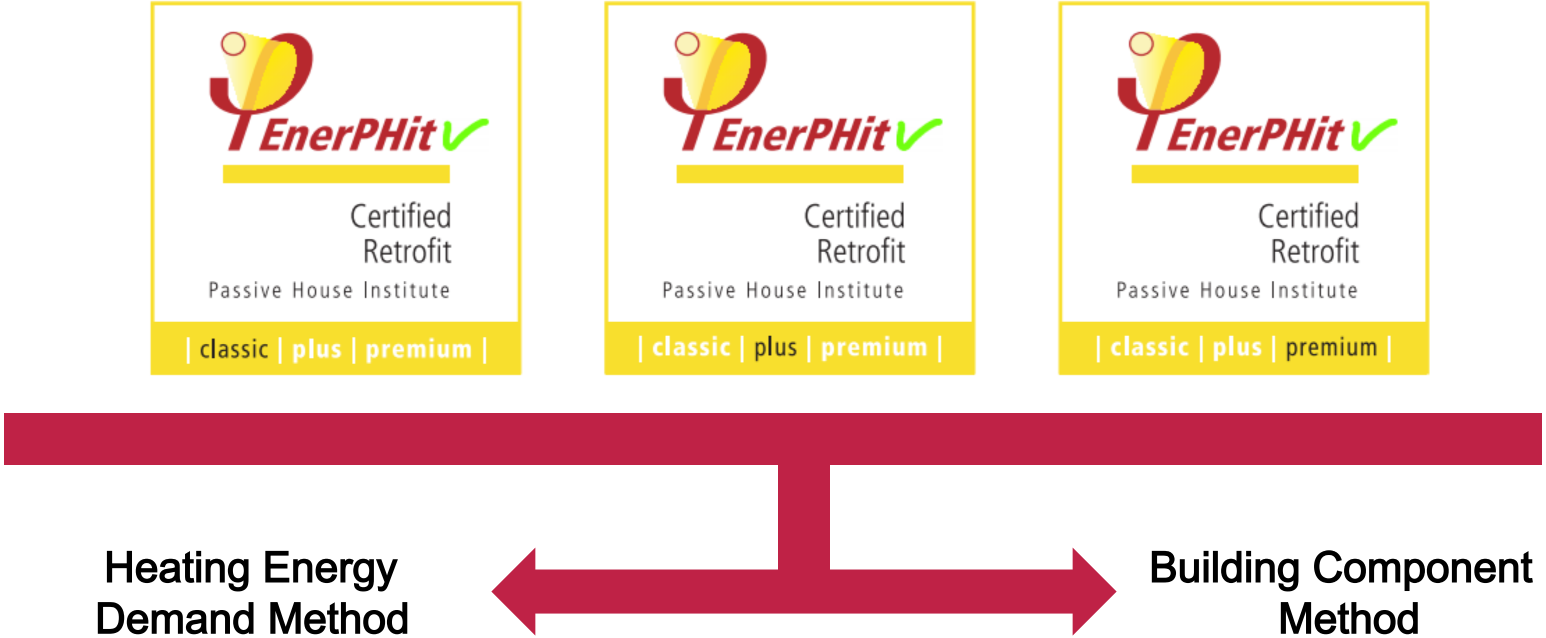
Advanced Classes Available

MORE EFFICIENT, MORE ONSITE RENEWABLES

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

Two EnerPHit Methods

Two Paths to EnerPHit Certification



Heating Energy Demand Method

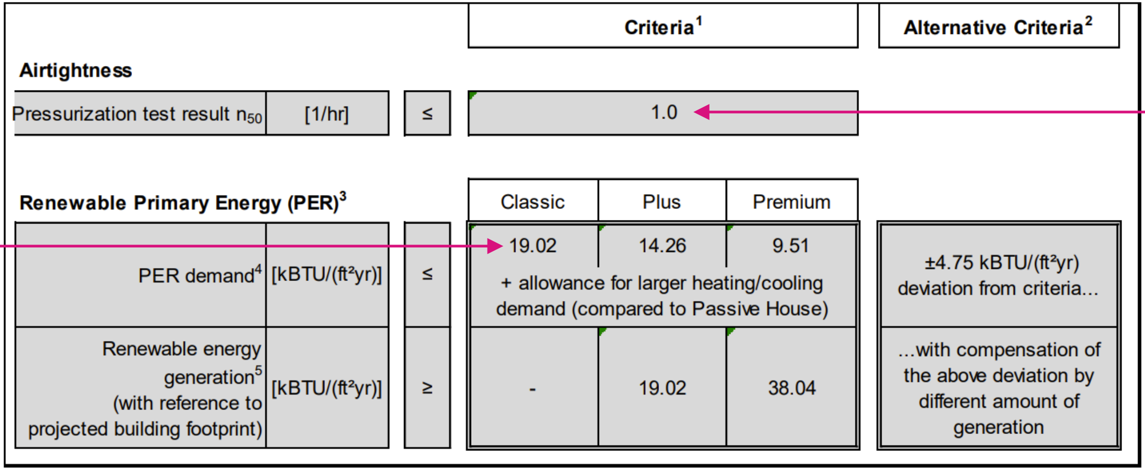
Building Component Method

General EnerPHit Criteria

Applicable irrespective of which certification method is used

Regardless of Method

- ➔ Primary (source) energy limits relaxed to accommodate additional heating/cooling demand
- ➔ Airtightness is (slightly) relaxed
- ➔ Moisture management is carefully assessed
- ➔ Window thermal comfort is enforced

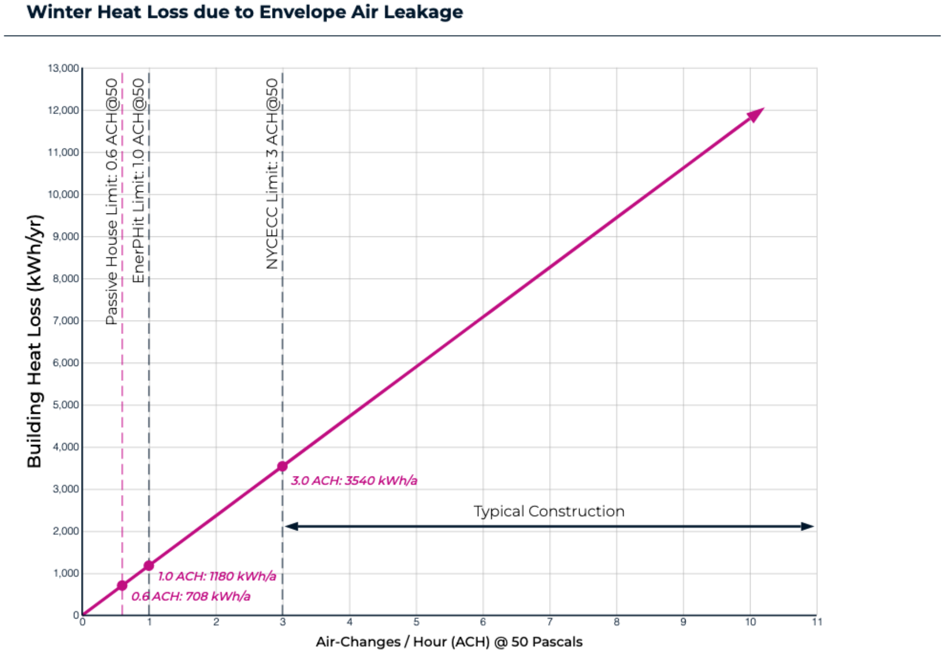


			Criteria[1]			Alternative Criteria[2]
Airtightness						
Pressurization test result n_{50}	[1/hr]	≤	1.0			
Renewable Primary Energy (PER)[3]			Classic	Plus	Premium	
PER demand[4]	[kBTU/(ft^{2}yr)]	≤	19.02	14.26	9.51	±4.75 kBTU/(ft^{2}yr) deviation from criteria...
			+ allowance for larger heating/cooling demand (compared to Passive House)			
Renewable energy generation[5] (with reference to projected building footprint)	[kBTU/(ft^{2}yr)]	≥	-	19.02	38.04	...with compensation of the above deviation by different amount of generation

Airtightness up from 0.6 to 1.0 ACH 50

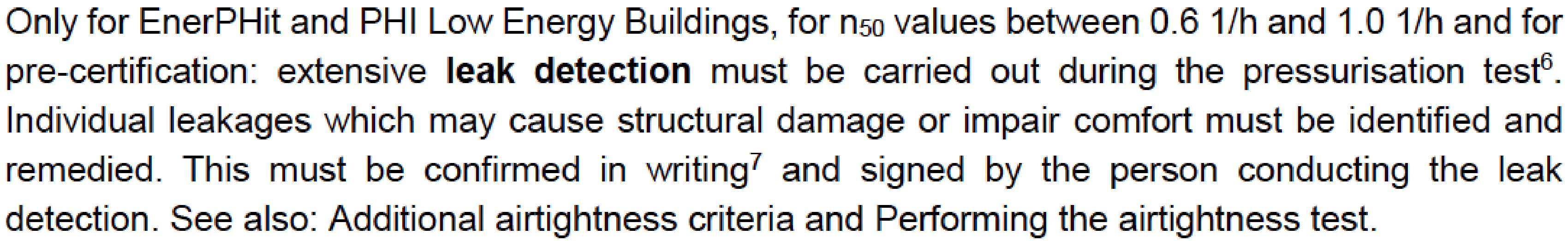
Primary (source) nergy adjusted slightly

Airtightness

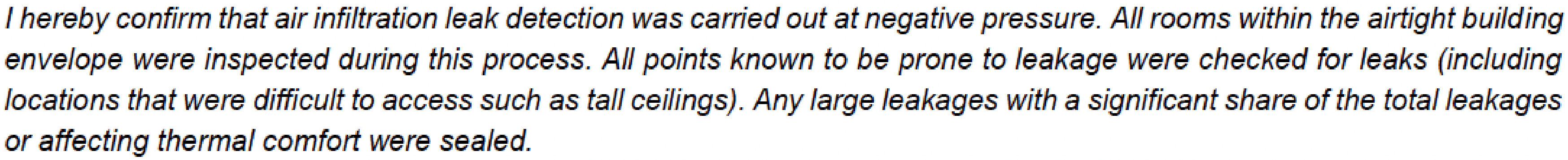


EnerPHit airtightness limit ≤ 1.0 ACH at 50Pa tested according to ISO 9972 (method 1) – multipoint test at both positive and negative pressures

Mandatory Leak Detection >0.6 ACH 50



Only for EnerPHit and PHI Low Energy Buildings, for n_{50} values between 0.6 1/h and 1.0 1/h and for pre-certification: extensive **leak detection** must be carried out during the pressurisation test[6]. Individual leakages which may cause structural damage or impair comfort must be identified and remedied. This must be confirmed in writing[7] and signed by the person conducting the leak detection. See also: Additional airtightness criteria and Performing the airtightness test.



I hereby confirm that air infiltration leak detection was carried out at negative pressure. All rooms within the airtight building envelope were inspected during this process. All points known to be prone to leakage were checked for leaks (including locations that were difficult to access such as tall ceilings). Any large leakages with a significant share of the total leakages or affecting thermal comfort were sealed.

Source: Criteria for Buildings, Passive House - EnerPHit - PHI Low Energy Building Version 10c

Moisture Resistance

"…all standard cross sections and connection details must also be planned and executed so that excessive moisture build-up in the building component can be ruled out with the intended building use."

$$f_{Rsi} = \frac{\theta_{si} - \theta_a}{\theta_i - \theta_a}$$

θ_{si}: minimum interior surface temperature as per multi-dimensional heat flow calculation [°C]

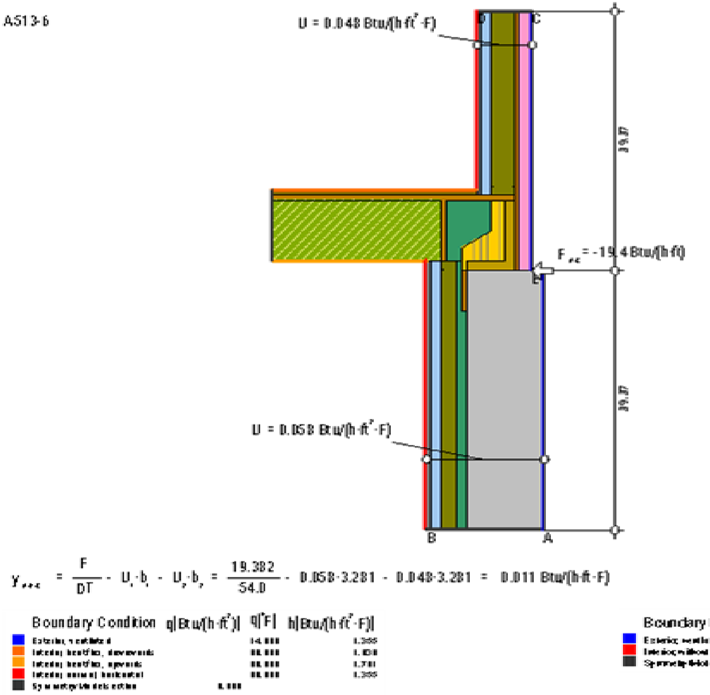
θ_a: outside temperature as per multi-dimensional heat flow calculation [°C]

θ_i: inside temperature as per multi-dimensional heat flow calculation [°C]

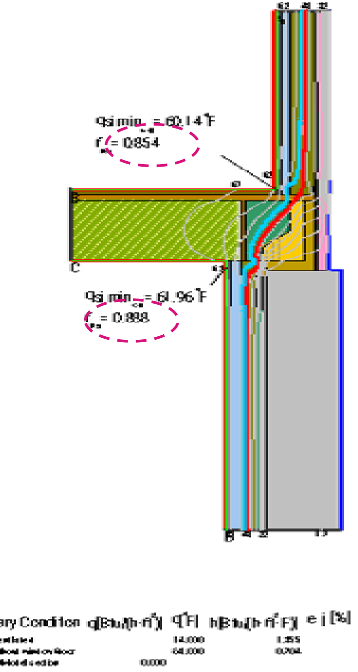
Climate zone	**Min. temperature factor**
	$f_{Rsi=1.42\ hr.ft^2.°F/BTU}$
	[]
Arctic	0.80
Cold	0.75
Cool-temperate	0.70
Warm-temperate	0.65
Warm	0.55
Hot	-
Very hot	-

Moisture Resistance

Psi values according to EN ISO 10077



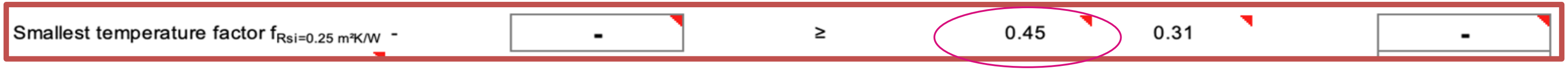
fRsi values according to EN ISO 13788



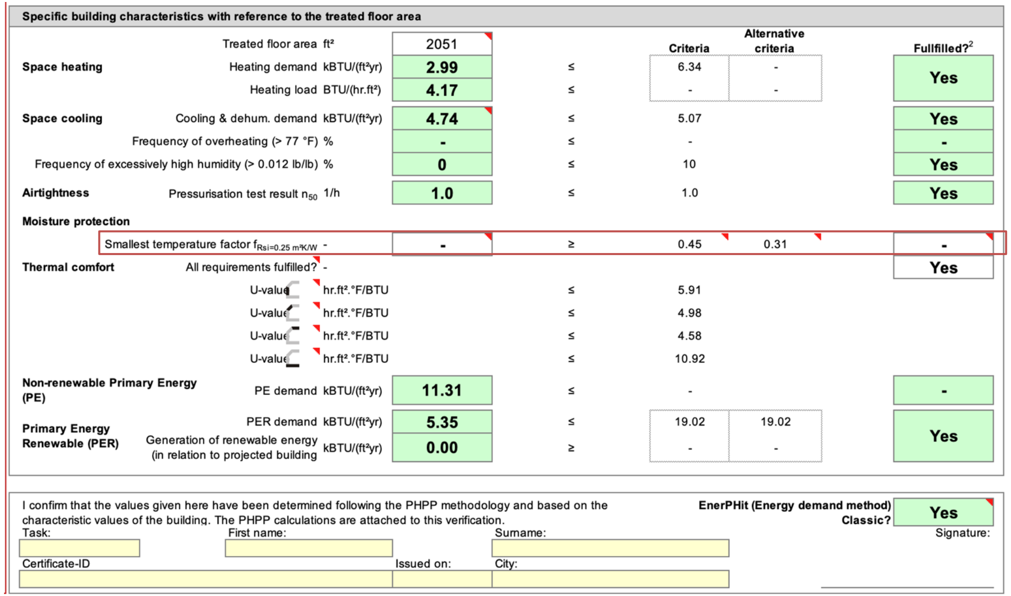
Climate zone	Min. temperature factor
	fRsi=1.42 hr.ft².°F/BTU
	[]
Arctic	0.80
Cold	0.75
Cool-temperate	0.70
Warm-temperate	0.65
Warm	0.55
Hot	-
Very hot	-

Moisture Resistance

project -specific min fRsi



Smallest temperature factor $f_{Rsi=0.25\ m^2K/W}$ -	-	≥	0.45	0.31	-



Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	ft²	2051				
Space heating	Heating demand	kBTU/(ft²yr)	**2.99**	≤	6.34	-	Yes
	Heating load	BTU/(hr.ft²)	**4.17**	≤	-	-	
Space cooling	Cooling & dehum. demand	kBTU/(ft²yr)	**4.74**	≤	5.07		Yes
	Frequency of overheating (> 77 °F)	%	-	≤	-		-
	Frequency of excessively high humidity (> 0.012 lb/lb)	%	0	≤	10		Yes
Airtightness	Pressurisation test result n_{50}	1/h	1.0	≤	1.0		Yes
Moisture protection							
	Smallest temperature factor $f_{Rsi=0.25\ m^2K/W}$	-	-	≥	0.45	0.31	-
Thermal comfort	All requirements fulfilled?	-					Yes
	U-value	hr.ft².°F/BTU		≤	5.91		
	U-value	hr.ft².°F/BTU		≤	4.98		
	U-value	hr.ft².°F/BTU		≤	4.58		
	U-value	hr.ft².°F/BTU		≤	10.92		
Non-renewable Primary Energy (PE)	PE demand	kBTU/(ft²yr)	**11.31**	≤	-		-
Primary Energy Renewable (PER)	PER demand	kBTU/(ft²yr)	**5.35**	≤	19.02	19.02	Yes
	Generation of renewable energy (in relation to projected building	kBTU/(ft²yr)	**0.00**	≥	-	-	

I confirm that the values given here have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

EnerPHit (Energy demand method) Classic? Yes

Task:

First name:

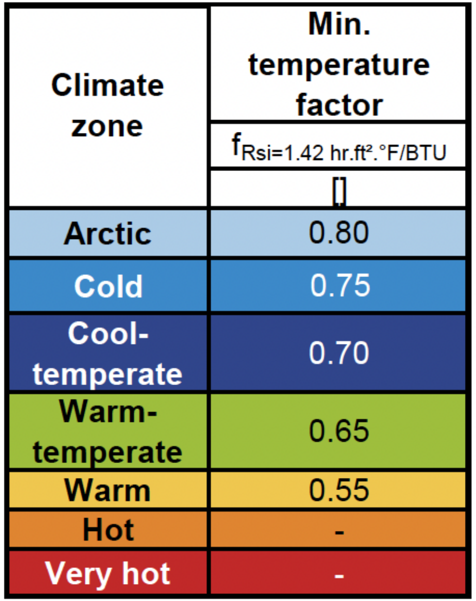
Surname:

Signature:

Certificate-ID

Issued on:

City:

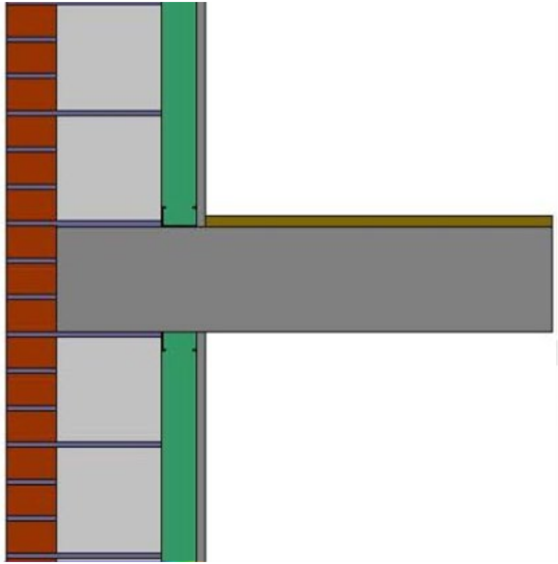


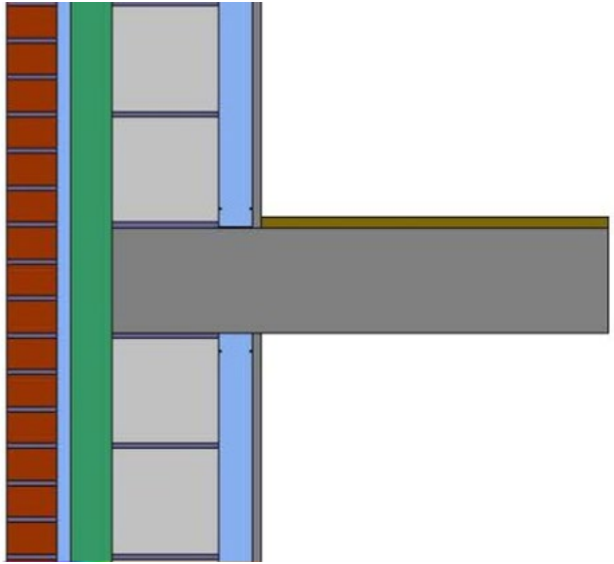
Climate zone	Min. temperature factor $f_{Rsi=1.42\ hr.ft^2.°F/BTU}$ []
Arctic	0.80
Cold	0.75
Cool-temperate	0.70
Warm-temperate	0.65
Warm	0.55
Hot	-
Very hot	-

fRsi: Interior vs Exterior Insulation

INTERIOR INSULATION

EXTERIOR INSULATION

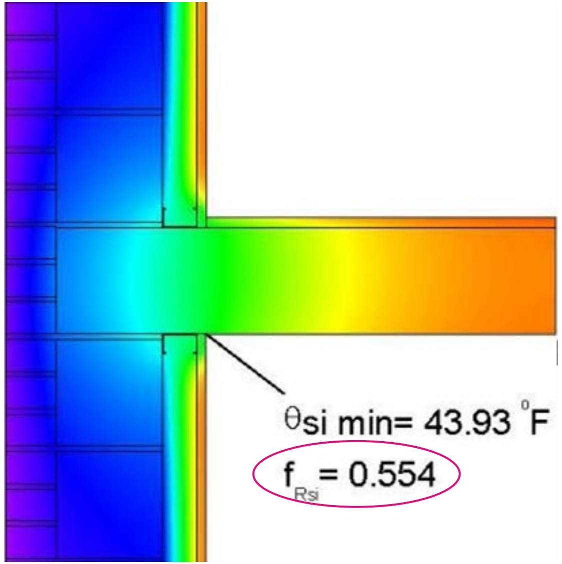




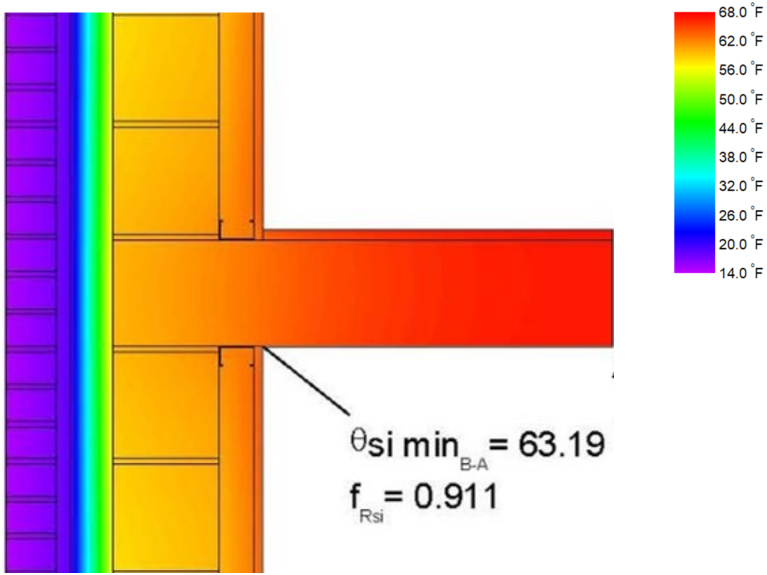
Source: BLDGtyp, llc

fRsi: Interior vs Exterior Insulation

INTERIOR INSULATION

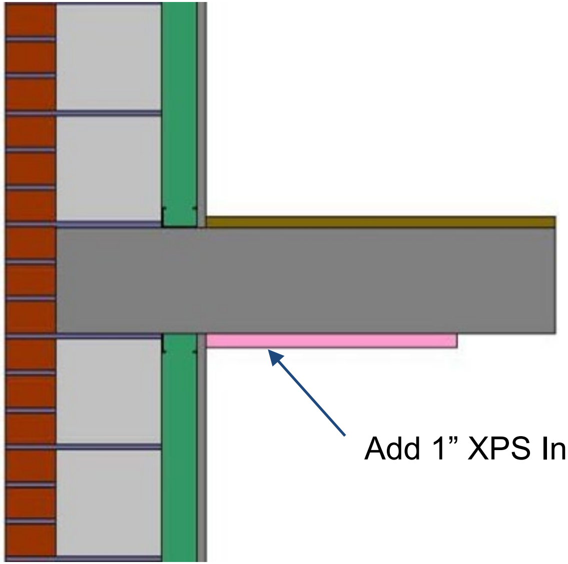


EXTERIOR INSULATION

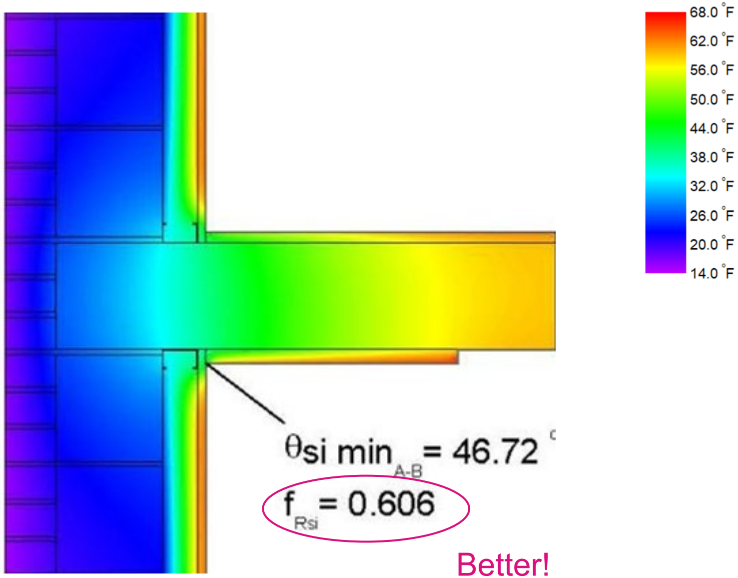


Source: BLDGtyp, llc

fRsi: Interior vs Exterior Insulation



Add 1” XPS Insulation

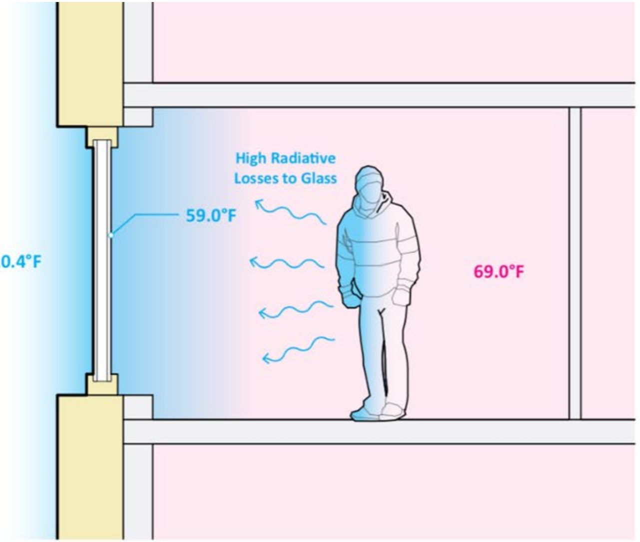


Better!

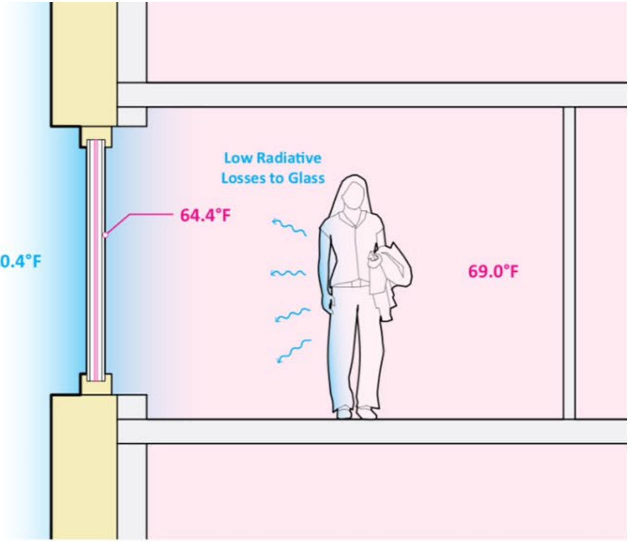
Source: BLDGtyp, llc

Window Comfort Criteria

Window Thermal 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.

PHI Certification Requirement

Minimum Thermal Protection:

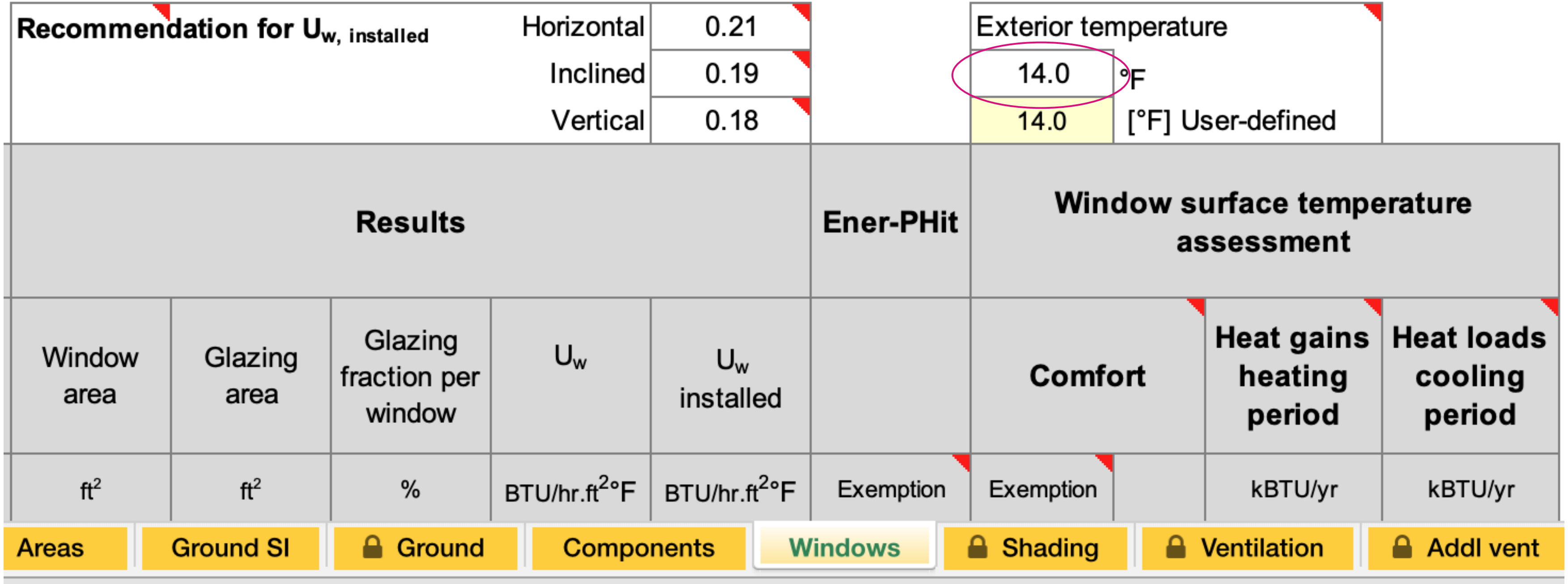
"For the arctic to warm-temperate climate zones interior surface temperatures of the standard cross-sections of walls and ceilings as well as the **average interior surface temperatures of windows may not be more than 7.6 F *[4.2 K]* below the operative indoor temperature 71.6 F *[22 C]*.**

The 'operative' temperature is a simplified combination temp that results from the air temp, mean radiant temp and air speed.

…The requirements will be checked in the PHPP with an indoor temperature of 71.6 F *[22 C]* and a **minimum outdoor temperature** taken from the climate data set for the building's location."

For PHI certification this is the mean temp over the coldest 12 hour period for the building's climate.

PHI Certification Requirement



Recommendation for $U_{w,\ installed}$		
	Horizontal	0.21
	Inclined	0.19
	Vertical	0.18

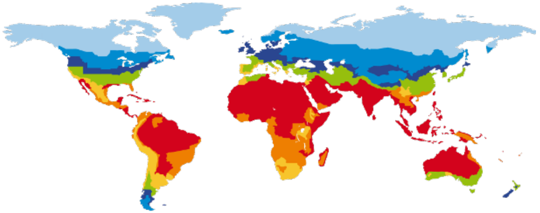
Exterior temperature	
14.0	°F
14.0	[°F] User-defined

Results					**Ener-PHit**	**Window surface temperature assessment**		
Window area	Glazing area	Glazing fraction per window	U_w	U_w installed		**Comfort**	**Heat gains heating period**	**Heat loads cooling period**
ft²	ft²	%	BTU/hr.ft²°F	BTU/hr.ft²°F	Exemption	Exemption	kBTU/yr	kBTU/yr

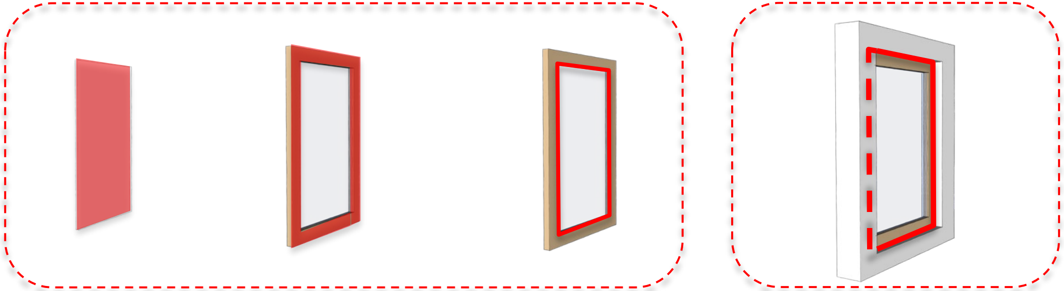
Areas | Ground SI | 🔒 Ground | Components | Windows | 🔒 Shading | 🔒 Ventilation | 🔒 Addl vent

For PHI certification this is the mean temp over the coldest 12 hour period for the building's climate.

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



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

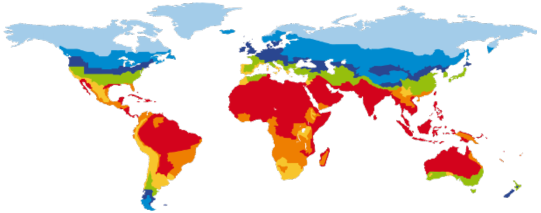


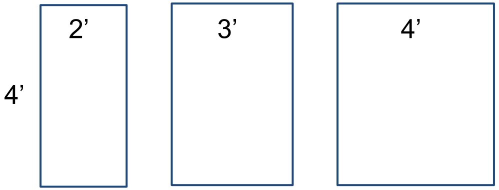
HIGH QUALITY COMPONENTS…

… INSTALLED WELL

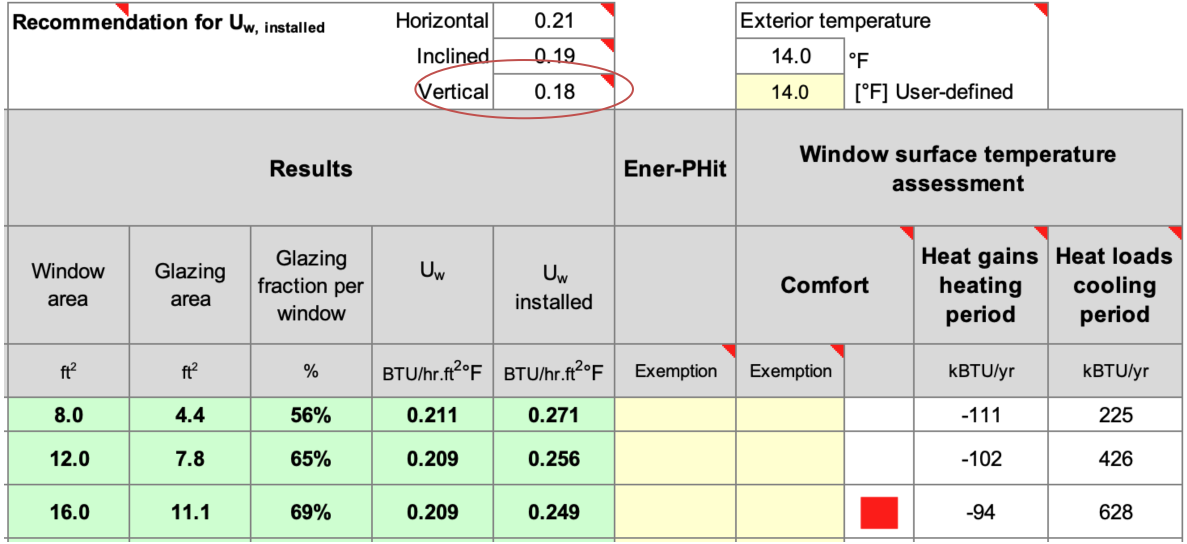
$$U_{w\text{-installed}} = \frac{(U_g \times A_{glass}) + (U_f \times A_{frame}) + (\Psi_{spacer} \times L_{spacer}) + (\Psi_{install} \times L_{install})}{A_{window}}$$

Maximum $U_{w\text{-installed}}$ by Climate Zone (and window size)





Climate Zone	U-value (installed) Btu/hr·ft^2·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



Recommendation for $U_{w,\ installed}$	Horizontal	0.21
	Inclined	0.19
	Vertical	0.18

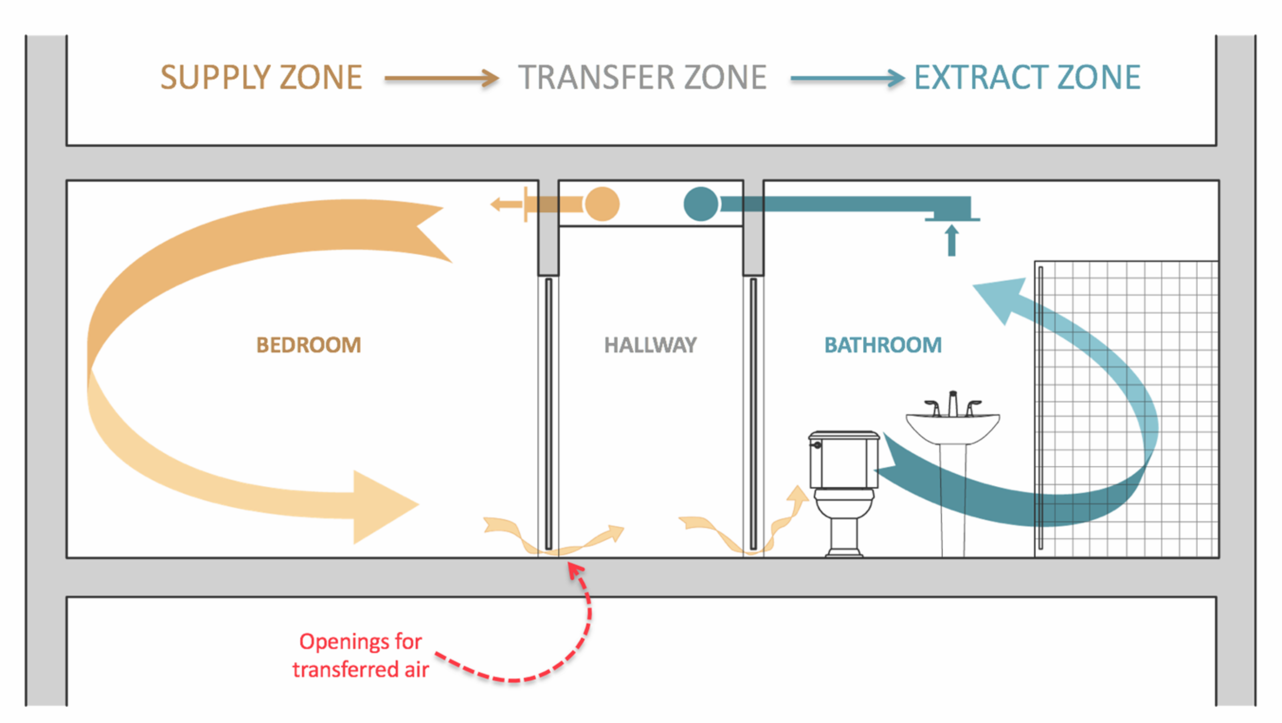
Exterior temperature	
14.0	°F
14.0	[°F] User-defined

Results					**Ener-PHit**	**Window surface temperature assessment**			
Window area	Glazing area	Glazing fraction per window	U_w	U_w installed		**Comfort**		**Heat gains heating period**	**Heat loads cooling period**
ft^2	ft^2	%	BTU/hr.ft^2°F	BTU/hr.ft^2°F	Exemption	Exemption		kBTU/yr	kBTU/yr
8.0	**4.4**	**56%**	**0.211**	**0.271**				-111	225
12.0	**7.8**	**65%**	**0.209**	**0.256**				-102	426
16.0	**11.1**	**69%**	**0.209**	**0.249**			🟥	-94	628

Ventilation

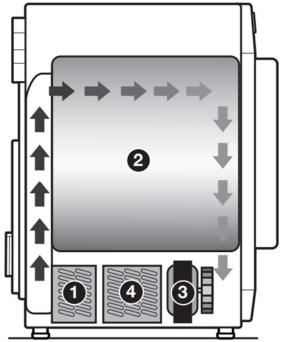
Ventilation System

Cascade Ventilation



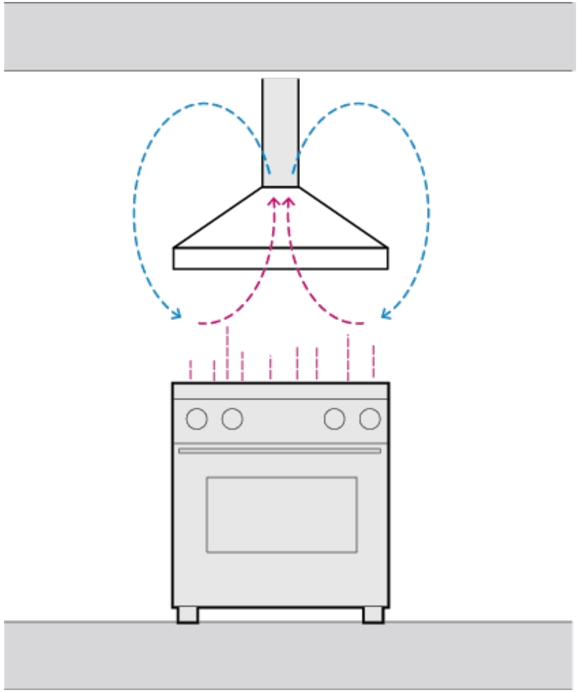
Ventilation System

Ventless Appliances



Source: Whirlpool

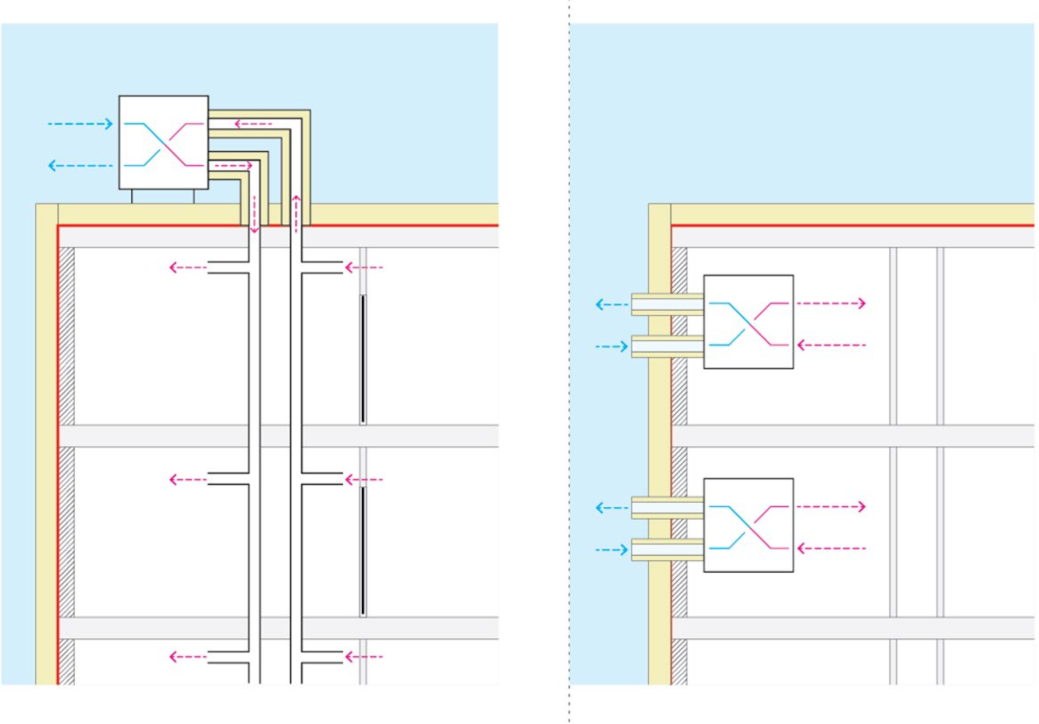
Filtered Recirculation



Ventilation System

Retrofit Considerations

- ➔ Centralized vs decentralized (per unit/floor) system
- ➔ Units located inside vs outside
- ➔ Ductwork run inside vs outside



Two EnerPHit Methods

Two Paths to EnerPHit Certification

EnerPHit
Certified
Retrofit
Passive House Institute
| classic | plus | premium |

EnerPHit
Certified
Retrofit
Passive House Institute
| classic | plus | premium |

EnerPHit
Certified
Retrofit
Passive House Institute
| classic | plus | premium |

Heating Energy Demand Method

Building Component Method

General EnerPHit Criteria
Applicable irrespective of which certification method is used

Two EnerPHit Methods

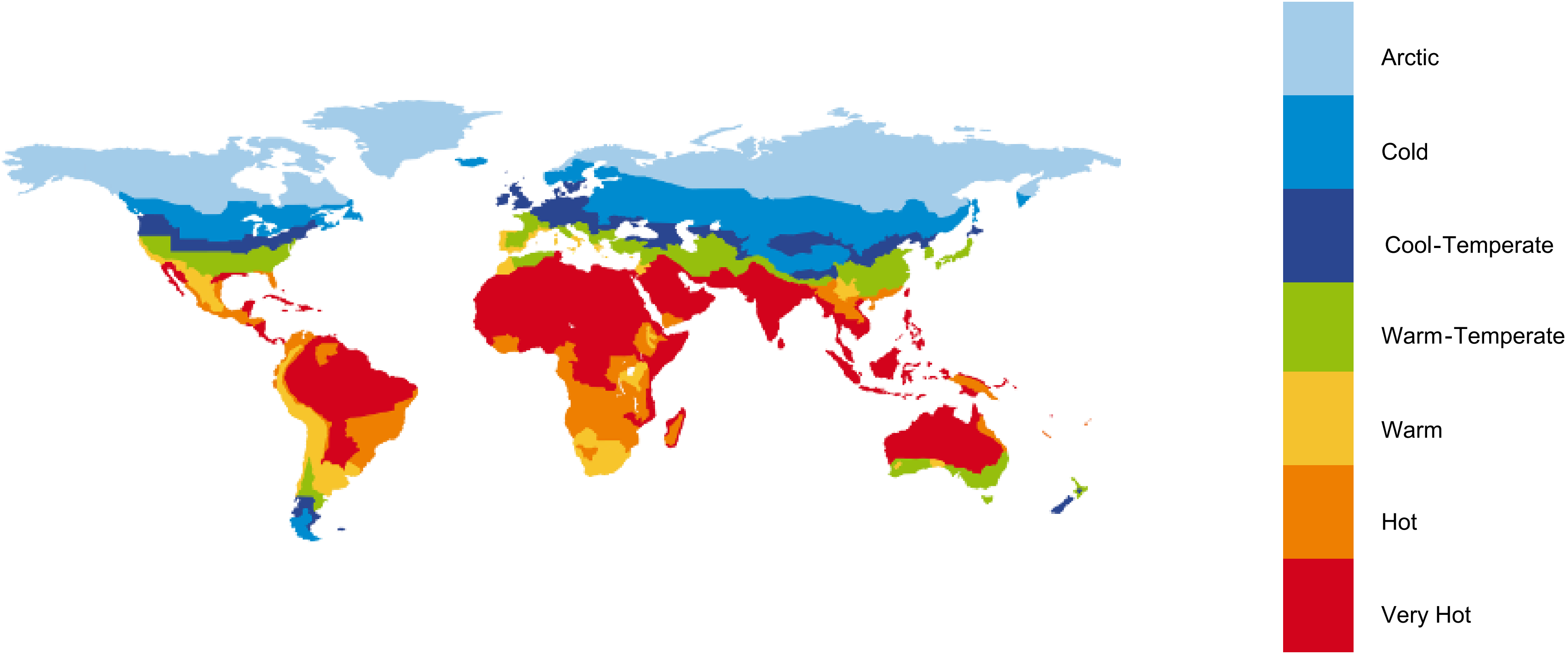
EnerPHit by (Heating) Energy Demand

- Performance-based - modeled energy demand in PHPP
- Very similar to Passive House certification method
- Climate zone-specific annual heating demand target

EnerPHit by Building Component

- Prescriptive
- Based on location-specific minimum assembly R-value and component U-value requirements
- Whole-building ventilation system efficiency (≥75%) enforced

Passive House Climate Zones



Passive House Climate Zones

Anchorage, AK	🟦	Arctic
Duluth, MN; Kalispell, MT; Calgary, Alberta	🟦	Cold
Chicago, IL; Olympia, WA; Cleveland, OH; Boston, MA	🟦	Cool-Temperate
Portland, OR; Salt Lake City, UT; Kansas City, MO; Nashville, TN; New York, NY	🟩	Warm-Temperate
Oakland, CA; Dallas, TX; Memphis, TN; Atlanta, GA; Jacksonville, FL;	🟨	Warm
Tucson, AZ; San Antonio, TX; Miami, FL	🟧	Hot
Acapulco, Mexico; Palm Springs, CA; Phoenix, AZ	🟥	Very Hot

Two Methods

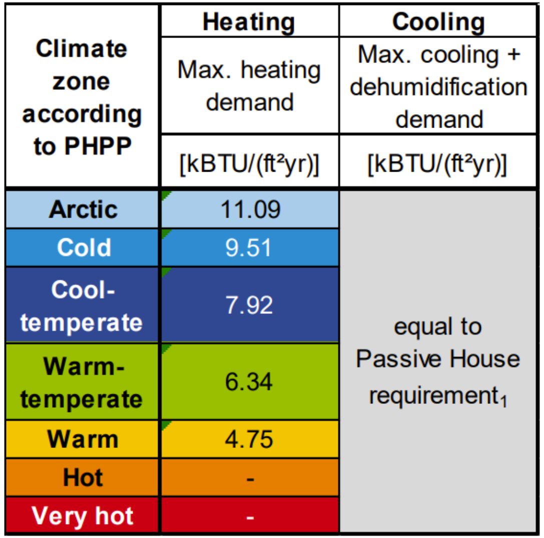
Energy Demand Method

Climate zone according to PHPP	Heating	Cooling
	Max. heating demand	Max. cooling + dehumidification demand
	[kBTU/(ft^{2}yr)]	[kBTU/(ft^{2}yr)]
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 Method

Climate zone according to PHPP	Opaque envelope[1] against...				Windows (including exterior doors)					Ventilation	
	...ground	...ambient air			Overall[4]			Glazing[5]	Solar load[6]		
	Insulation	Exterior insulation	Interior insulation[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 recovery rate[7]	Min. humidity recovery rate[8]
	Min. thermal resistance (R-value)			Cool colours							
	[hr.ft^2.°F/BTU]			-	[BTU/hr.ft^2.°F]			-	[kBTU/(ft^{2}yr)]	%	
Arctic	Determined 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 Demand Method

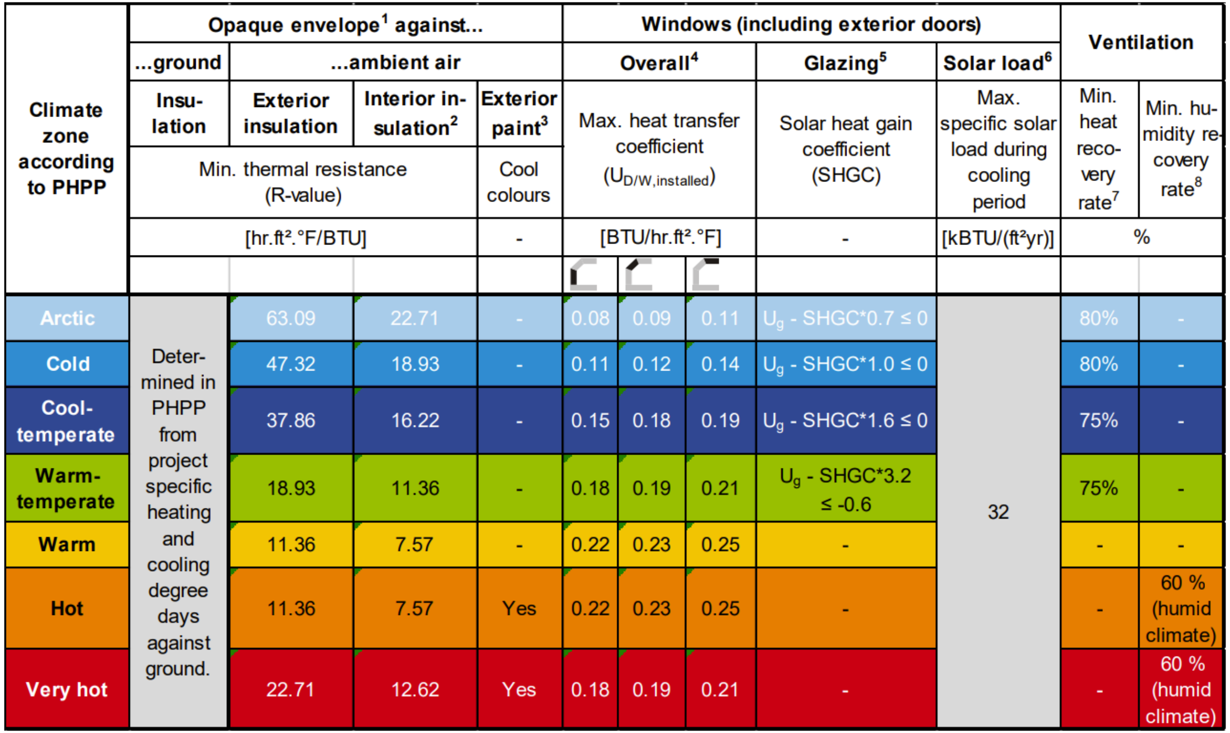


Climate zone according to PHPP	Heating	Cooling
	Max. heating demand	Max. cooling + dehumidification demand
	[kBTU/(ft²yr)]	[kBTU/(ft²yr)]
Arctic	11.09	equal to Passive House requirement[1]
Cold	9.51	
Cool-temperate	7.92	
Warm-temperate	6.34	
Warm	4.75	
Hot	-	
Very hot	-	

- ➔ Performance-based - modeled energy demand in PHPP
- ➔ Very similar to Passive House certification method
- ➔ Climate zone-specific annual heating demand target

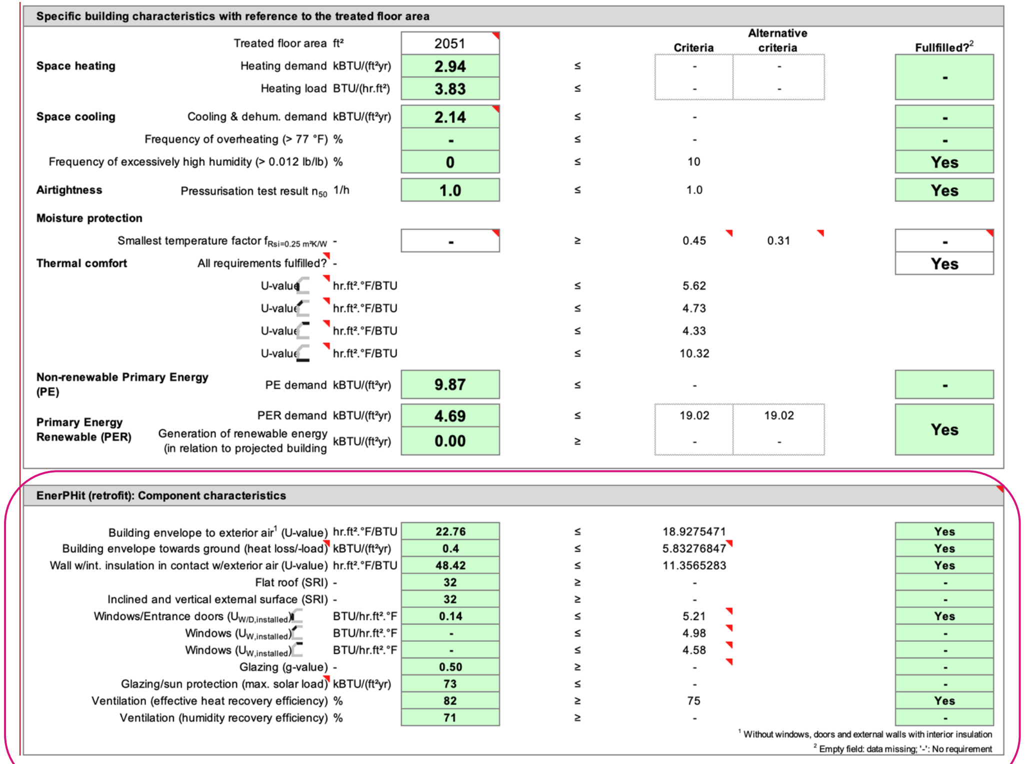
Component Method

- ➔ Prescriptive
- ➔ Based on location-specific minimum assembly R-value and component U-value requirements
- ➔ Whole-building ventilation system efficiency (≥75%) enforced



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 insulation[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 recovery rate[7]	Min. humidity recovery rate[8]
	Min. thermal resistance (R-value)			Cool colours							
	[hr.ft².°F/BTU]			-	[BTU/hr.ft².°F]			-	[kBTU/(ft²yr)]	%	
Arctic	Determined 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)

Component Method in PHPP



Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	ft²	2051				
Space heating	Heating demand	kBTU/(ft²yr)	2.94	≤	-	-	-
	Heating load	BTU/(hr.ft²)	3.83	≤	-	-	
Space cooling	Cooling & dehum. demand	kBTU/(ft²yr)	2.14	≤	-		-
	Frequency of overheating (> 77 °F)	%	-	≤	-		-
	Frequency of excessively high humidity (> 0.012 lb/lb)	%	0	≤	10		Yes
Airtightness	Pressurisation test result n_{50}	1/h	1.0	≤	1.0		Yes
Moisture protection							
	Smallest temperature factor $f_{Rsi=0.25\ m^2K/W}$	-	-	≥	0.45	0.31	-
Thermal comfort	All requirements fulfilled?	-					Yes
	U-value	hr.ft².°F/BTU		≤	5.62		
	U-value	hr.ft².°F/BTU		≤	4.73		
	U-value	hr.ft².°F/BTU		≤	4.33		
	U-value	hr.ft².°F/BTU		≤	10.32		
Non-renewable Primary Energy (PE)	PE demand	kBTU/(ft²yr)	9.87	≤	-		-
Primary Energy Renewable (PER)	PER demand	kBTU/(ft²yr)	4.69	≤	19.02	19.02	Yes
	Generation of renewable energy (in relation to projected building	kBTU/(ft²yr)	0.00	≥	-	-	

EnerPHit (retrofit): Component characteristics

Building envelope to exterior air[1] (U-value)	hr.ft².°F/BTU	22.76	≤	18.9275471	Yes
Building envelope towards ground (heat loss/-load)	kBTU/(ft²yr)	0.4	≤	5.83276847	Yes
Wall w/int. insulation in contact w/exterior air (U-value)	hr.ft².°F/BTU	48.42	≤	11.3565283	Yes
Flat roof (SRI)	-	32	≥	-	-
Inclined and vertical external surface (SRI)	-	32	≥	-	-
Windows/Entrance doors ($U_{W/D,installed}$)	BTU/hr.ft².°F	0.14	≤	5.21	Yes
Windows ($U_{W,installed}$)	BTU/hr.ft².°F	-	≤	4.98	-
Windows ($U_{W,installed}$)	BTU/hr.ft².°F	-	≤	4.58	-
Glazing (g-value)	-	0.50	≥	-	-
Glazing/sun protection (max. solar load)	kBTU/(ft²yr)	73	≤	-	-
Ventilation (effective heat recovery efficiency)	%	82	≥	75	Yes
Ventilation (humidity recovery efficiency)	%	71	≥	-	-

[1] Without windows, doors and external walls with interior insulation

[2] Empty field: data missing; '-': No requirement

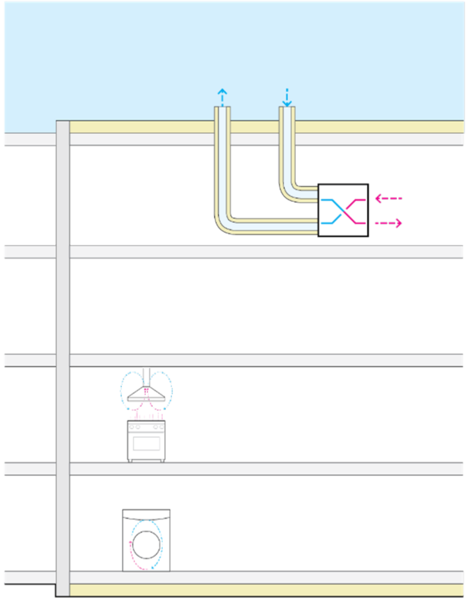
no heating/cooling demand criteria

new section with prescriptive criteria

Ventilation System Efficiency

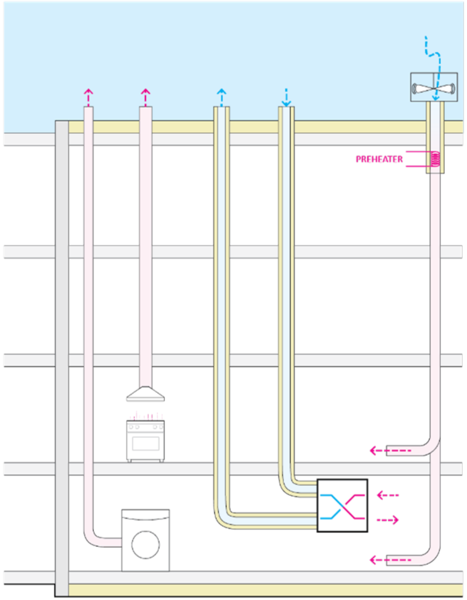
System Must be ⩾ 75% Efficient

- ➔ Includes H/ERV efficiency
- ➔ Includes H/ERV duct losses
- ➔ Includes exhaust-only ventilation (dryers, range hoods, etc.)



- ➔ 84% Efficient ERV located in attic (10’ of ductwork)
- ➔ Ventless electric heat pump condensing dryer
- ➔ Recirculating range hood
- ➔ Total System Efficiency = 78%

Eligible for EnerPHit by Component Certification



- ➔ 84% Efficient ERV located in cellar(35’ of ductwork)
- ➔ Vented dryer
- ➔ Exhausting range hood
- ➔ Total System Efficiency = 71%

NOT eligible for EnerPHit by Component Certification

Exemptions

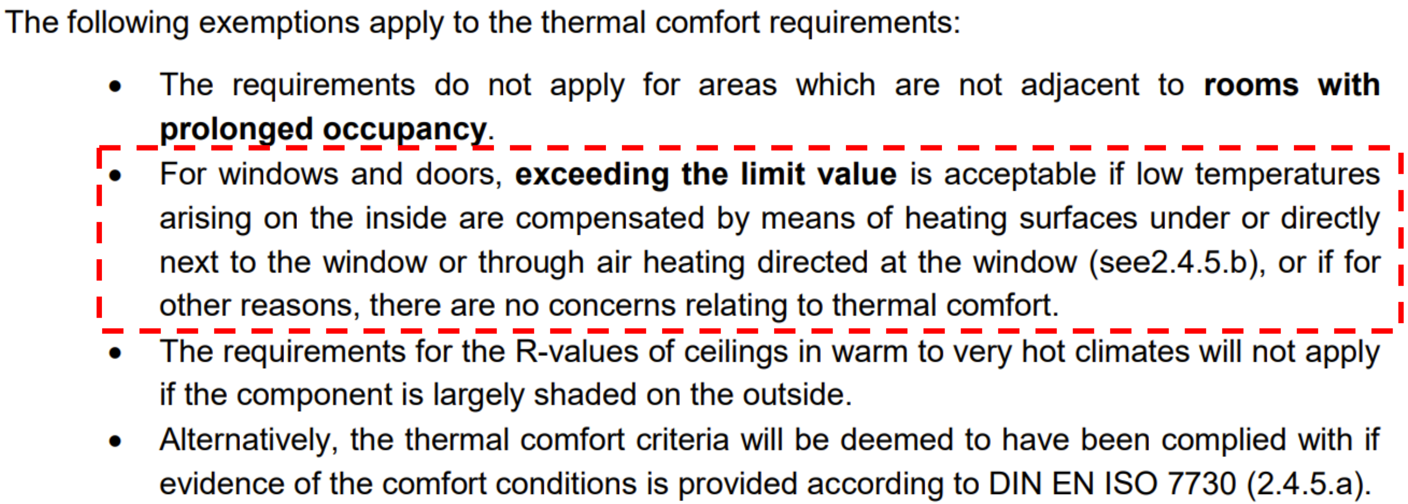
Allowable Exemptions

If necessary, the heat transfer coefficient limits for the exterior envelope shown in Table 2 may be exceeded for one or more of the following reasons:

- Legal requirements.
- If required by the historical building preservation authorities.
- A required measure is not cost-effective due to exceptional circumstances or additional requirements (see Subsection 3.2.13).
- The required insulation level unacceptably restricts the use of the building or surrounding area.
- No components are available which comply with both the EnerPHit criteria and special, additional requirements (e.g. fire safety).
- The heat transfer coefficient ($U_{w,installed}$) of windows is increased due to a high thermal bridge loss coefficient (psi value) when windows are installed with an offset to the insulation layer in a wall that has interior insulation.
- In the case of interior insulation, thinner insulation is required to avoid damage due to moisture accumulation.
- For other compelling reasons related to construction.

If any of these restricts the insulation thickness, then the insulation thickness that is still possible must be installed using a high thermal resistance (R per inch ≥ 5.77 hr.ft^2.°F/BTU.in) insulation which is cost-effective and, in the case of interior insulation, safe regarding moisture accumulation. If this is the case with floor slabs or basement ceilings, additionally install an **insulation skirt** around the perimeter of the building if cost-effective.
Certification may be refused in the case of very extensive use of exemptions (see Subsection 3.1.6). We therefore recommend early coordination with the Certifier.

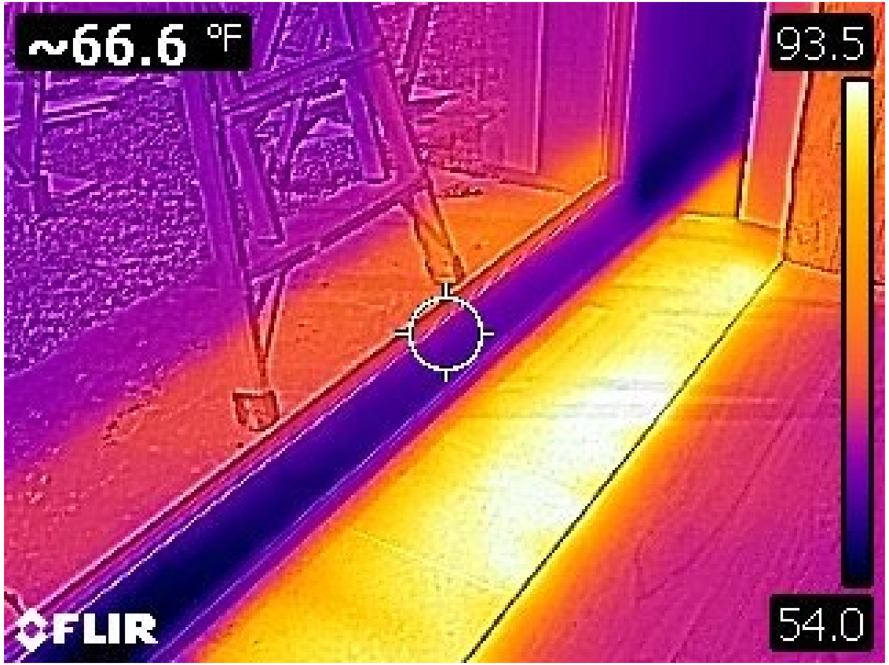
And if the window just can’t get there?



The following exemptions apply to the thermal comfort requirements:

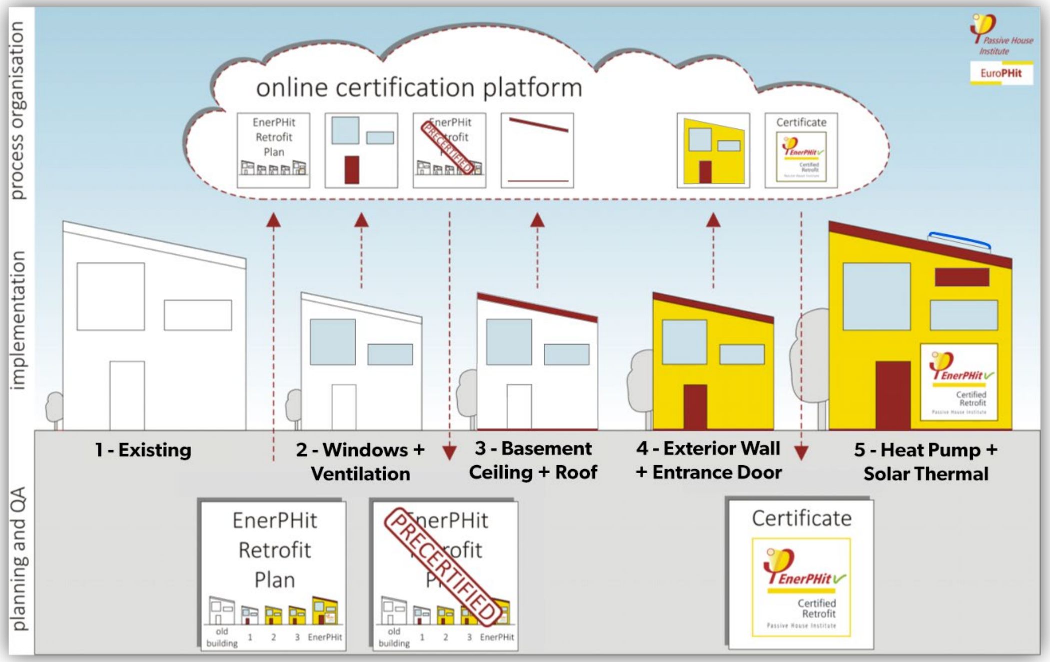
- The requirements do not apply for areas which are not adjacent to **rooms with prolonged occupancy**.
- For windows and doors, **exceeding the limit value** is acceptable if low temperatures arising on the inside are compensated by means of heating surfaces under or directly next to the window or through air heating directed at the window (see2.4.5.b), or if for other reasons, there are no concerns relating to thermal comfort.
- The requirements for the R-values of ceilings in warm to very hot climates will not apply if the component is largely shaded on the outside.
- Alternatively, the thermal comfort criteria will be deemed to have been complied with if evidence of the comfort conditions is provided according to DIN EN ISO 7730 (2.4.5.a).

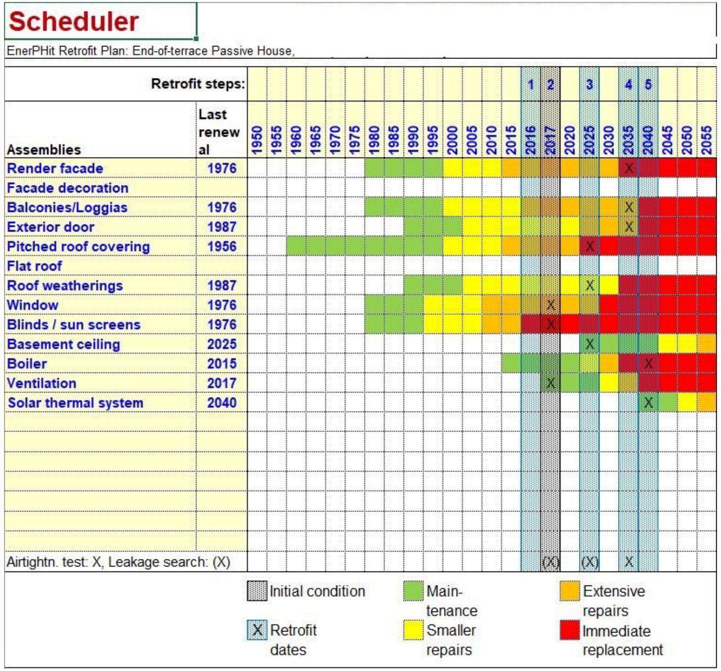
And If We Just Can't Get There?



EnerPHit Retrofit Plan

Step by Step!





Scheduler

EnerPHit Retrofit Plan: End-of-terrace Passive House,

	Retrofit steps:														1	2		3		4	5			
Assemblies	Last renewal	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2016	2017	2020	2025	2030	2035	2040	2045	2050	2055
Render facade	1976							🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟧	🟧	🟥 X	🟥	🟥	🟥	🟥
Facade decoration																									
Balconies/Loggias	1976							🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟧	🟧 X	🟥	🟥	🟥	🟥
Exterior door	1987									🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧 X	🟥	🟥	🟥	🟥
Pitched roof covering	1956			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟥 X	🟥	🟥	🟥	🟥	🟥	🟥
Flat roof																									
Roof weatherings	1987									🟩	🟩	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨 X	🟨	🟥	🟥	🟥	🟥	🟥
Window	1976							🟩	🟩	🟩	🟨	🟨	🟨	🟧	🟧	🟧	🟧 X	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟥
Blinds / sun screens	1976							🟩	🟩	🟩	🟨	🟨	🟨	🟧	🟧	🟥	🟥 X	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
Basement ceiling	2025																		🟩 X	🟩	🟩	🟩	🟨	🟨	🟧
Boiler	2015														🟩	🟩	🟩	🟩	🟨	🟧	🟥	🟥 X	🟥	🟥	🟥
Ventilation	2017																🟩 X	🟩	🟩	🟨	🟧	🟥	🟥	🟥	🟥
Solar thermal system	2040																					🟩 X	🟩	🟨	🟧
Airtightn. test: X, Leakage search: (X)																	(X)		(X)		X				

▨ Initial condition
🟩 Main-tenance
🟧 Extensive repairs
☒ Retrofit dates
🟨 Smaller repairs
🟥 Immediate replacement

2013: 20 pilots looking at step-by-step retrofits

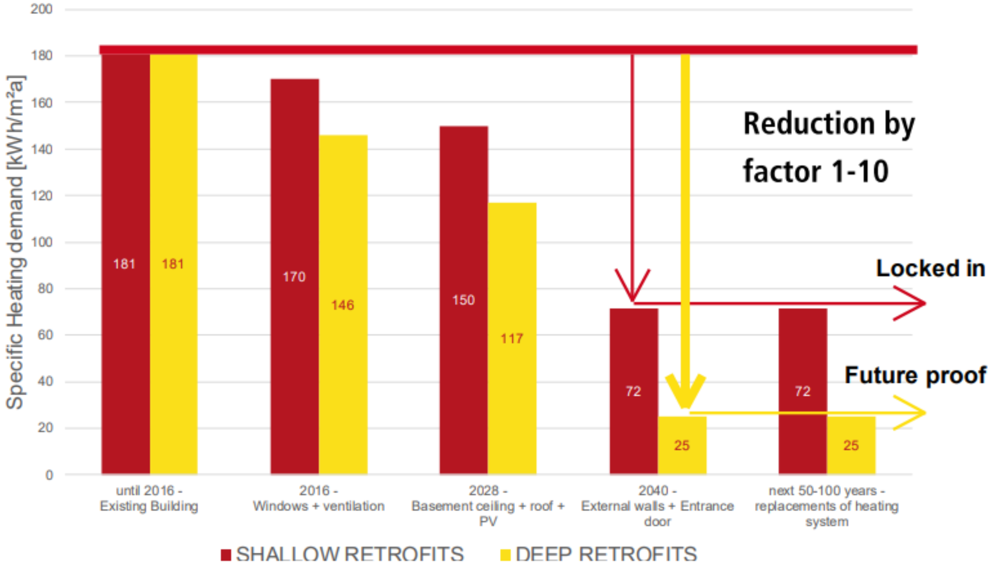
EuroPHit

Avoid Lock-In of insufficient measures

Step by Step **retrofits** with Passive House **components**

www.europhit.eu

Passive House Institute

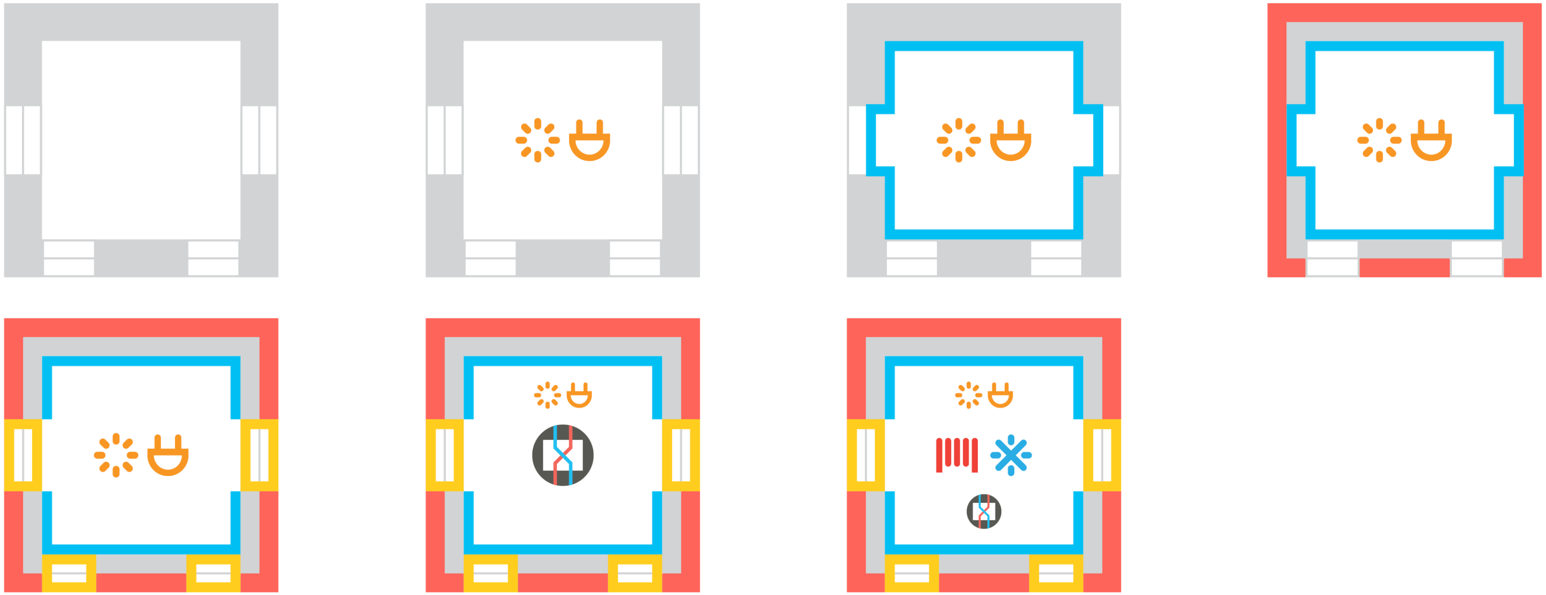


Reduction by factor 1-10

Locked in

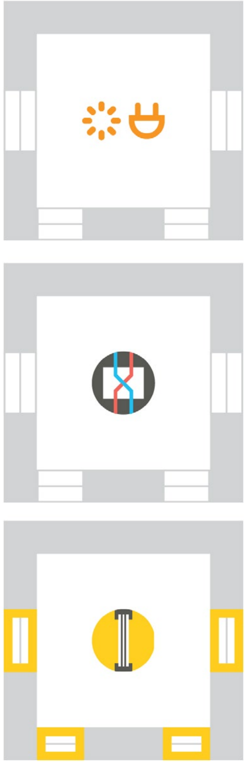
Future proof

Retrofit Staging/Phasing



Source: BEEx, Deep Energy Retrofit Training, 2019

Phasing



Plug Loads

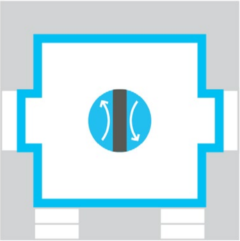
Ventilation System

Windows

Source: BEEx, Deep Energy Retrofit Training, 2019

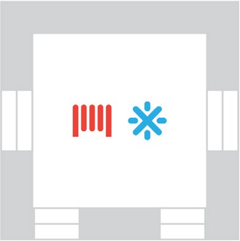
Phasing

Airtightness



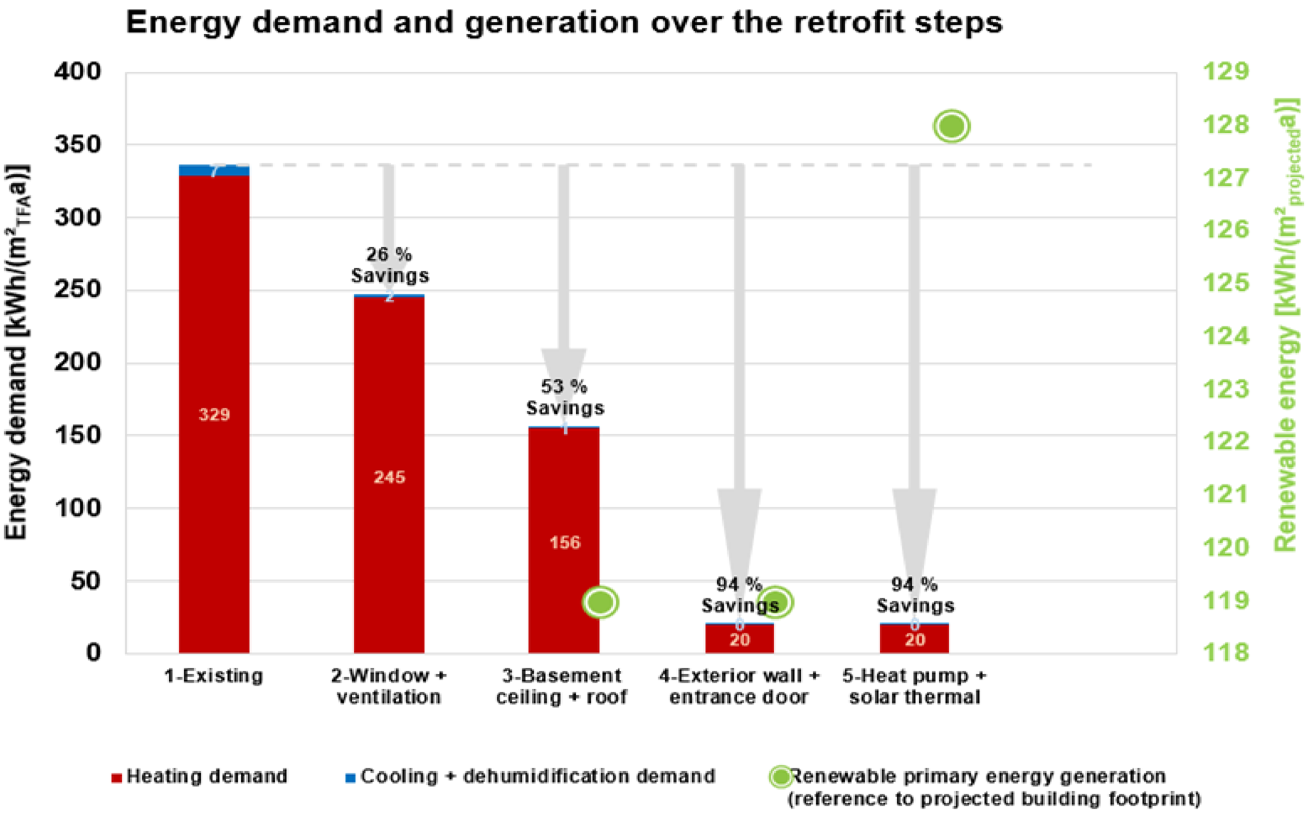
Insulation

Heating + Cooling

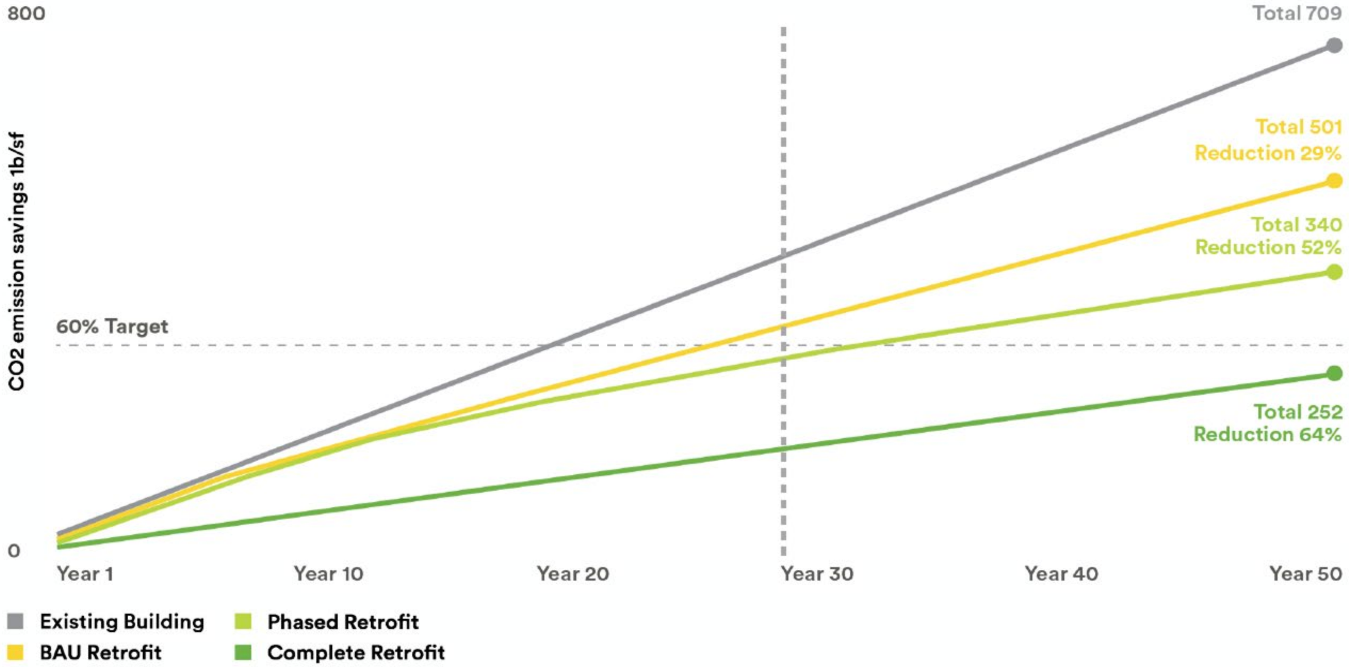


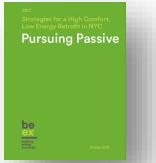
Source: BEEx, Deep Energy Retrofit Training, 2019

Phasing Retrofits & Energy Savings



“Pursuing Passive” Scenario Comparisons





Strategies for a High Comfort, Low Energy Retrofit in NYC

Pursuing Passive

be-exchange.org

EnerPHit Pilot Programs

Whole Building Renovation System Certification

outPHit

Logirep/ Colbert 70 appartments in Colombes, France. This building is an EnerPHit Retrofit with prefab modules retrofitted in 2020.

outPHit wants to…

…lower the barriers to the uptake of high quality deep retrofits by pairing ***prefabrication*** *and* ***streamlined processes*** *with the rigour of the* ***EnerPHit Standard*** *for renovations according to Passive House principles.*

Required

Obligatory additional descriptions / information

Thermal Bridges | Dummy project | Airtightness | Embodied Energy | User Manual

Nutzerhandbuch für den Geschoßwohnungsbau in Passivhaus-Standard

Teil A: Nutzerhandbuch

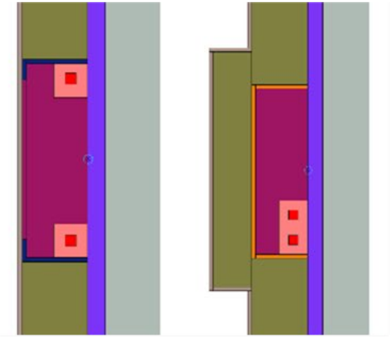
outPHit

2) Obligatory descriptions / information

- Thermal bridge free connection details
- Dummy building test calculation
- Airtightness concept description
- Embodied energy information of components
- User manual and inhabitant introduction
- External shading concept description + TBs

Implementation Concepts of Mechanical Ventilation

- Heat loss co-efficients of facade implemented installations
- Ventilation rates for smaller and bigger appartments from 60m³/h – 240m³/h
- Evaluates the system efficiency based on maximum distrubution lengths



Optional

Optional system features / options

SBS concepts RES systems Maintenance Efficiency design QA services

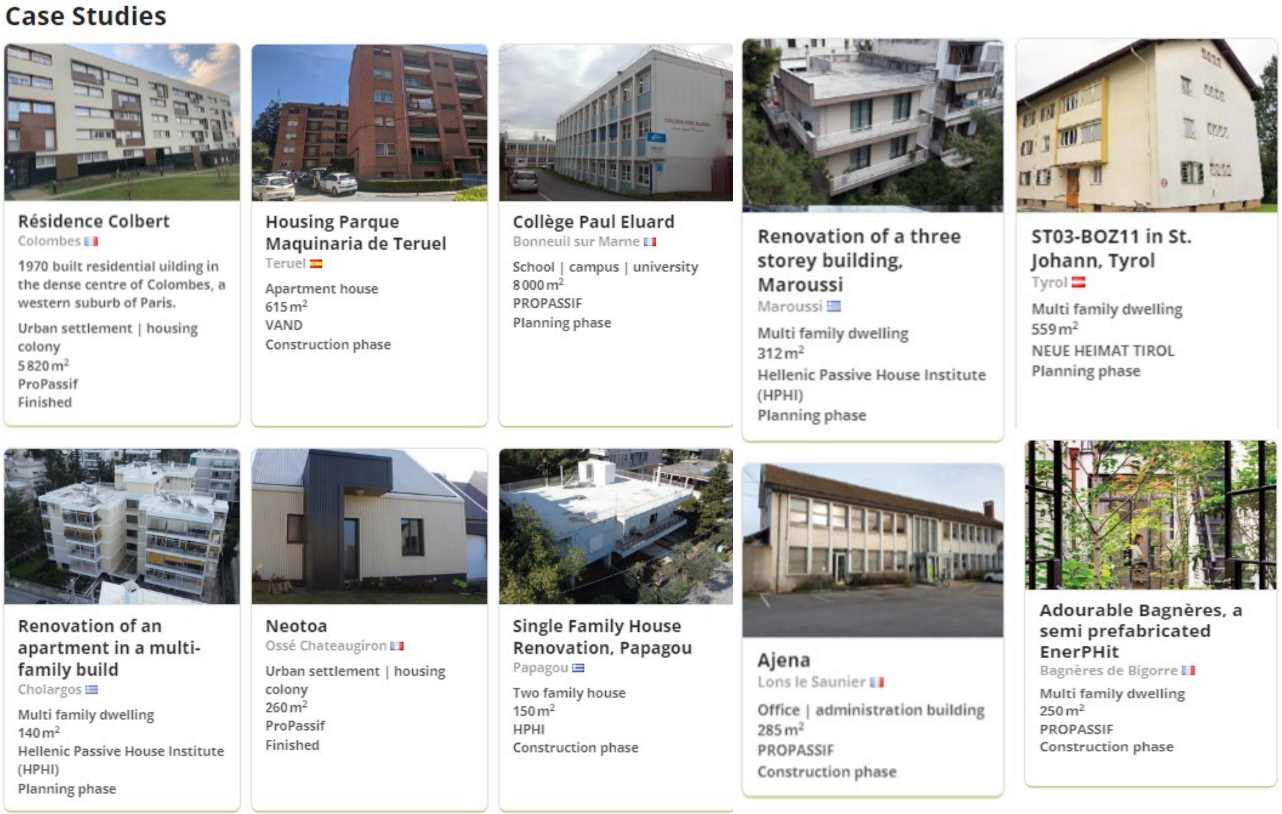
outPHit

3) Optional system features

- Step-by-Step retrofit connection concept
- RES implementation (PV or Solar thermal)
- Heating and DHW service solutions
- Maintenance services
- Efficiency design (PHPP calculation) or
- Funding application services
- Quality assurance services and Monitoring

Pilot Projects Wanted

outPHit



Case Studies

Résidence Colbert
Colombes
1970 built residential uilding in the dense centre of Colombes, a western suburb of Paris.
Urban settlement | housing colony
5 820 m²
ProPassif
Finished

Housing Parque Maquinaria de Teruel
Teruel
Apartment house
615 m²
VAND
Construction phase

Collège Paul Eluard
Bonneuil sur Marne
School | campus | university
8 000 m²
PROPASSIF
Planning phase

Renovation of a three storey building, Maroussi
Maroussi
Multi family dwelling
312 m²
Hellenic Passive House Institute (HPHI)
Planning phase

ST03-BOZ11 in St. Johann, Tyrol
Tyrol
Multi family dwelling
559 m²
NEUE HEIMAT TIROL
Planning phase

Renovation of an apartment in a multi-family build
Cholargos
Multi family dwelling
140 m²
Hellenic Passive House Institute (HPHI)
Planning phase

Neotoa
Ossé Chateaugiron
Urban settlement | housing colony
260 m²
ProPassif
Finished

Single Family House Renovation, Papagou
Papagou
Two family house
150 m²
HPHI
Construction phase

Ajena
Lons le Saunier
Office | administration building
285 m²
PROPASSIF
Construction phase

Adourable Bagnères, a semi prefabricated EnerPHit
Bagnères de Bigorre
Multi family dwelling
250 m²
PROPASSIF
Construction phase

Apartment Certification Pilot Program: “EnerPHit_partial”

The concept:

- The unit under consideration must be completely modernized using Passive House components.
- The rest of the building won't be taken into account in the certification.
  - *All requirements of the EnerPHit component method in the "Classic" class apply, except airtightness and primary energy.*
  - **Airtightness requirement**: qE50 <= 1.0 m3/(hm2) or documentation with proof of detailed airtighness planning and comprehensive photographic documentation of all relevant details and connections. This applies only to areas adjacent to outside air or to unconditioned spaces.
  - **Primary energy demand requirement**: if the heating, cooling and DHW systems are for the unit (decentralized), the EnerPHit criteria applies. If the systems are centralized (or shared with other units) and will not be renovated, the project can be certified if a variant using a hypothetical future supply system with heat pumps would fulfill the PE/PER requirement.
    - Connections towards adjacent conditioned spaces must be executed in a way that they do not increase the risk of mould growth in the adjacent apartments and so that, if possible, the insulation layer would be continuous if the adjacent apartment is renovated in the future.
    - The "Plus" and "Premium" classes are not applicable.

Interested? Engage a certifier, who will coordinate with PHI and can give more details, including the draft of the criteria. An official program depends on the pilot results.

Part 2: Case Studies

Case Studies

Historic Masonry (interior)

Wood-Framed (exterior)

Concrete Frame & Masonry (interior & exterior)

Masonry Case Study

Case Study: Historic Masonry

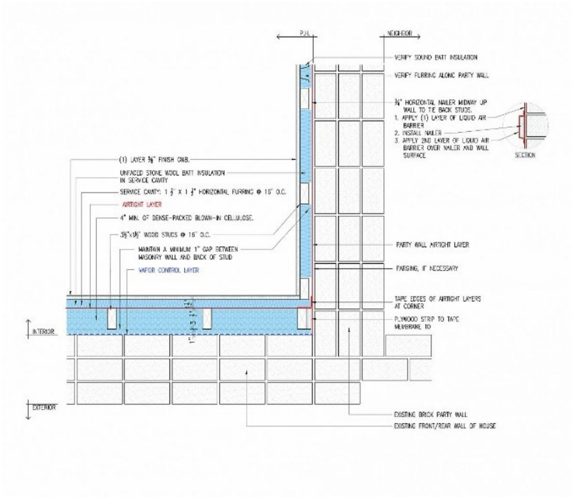
- ➔ Buildings often need help
- ➔ Gut reno allows structural issues to be addressed

EnerPHit Row House

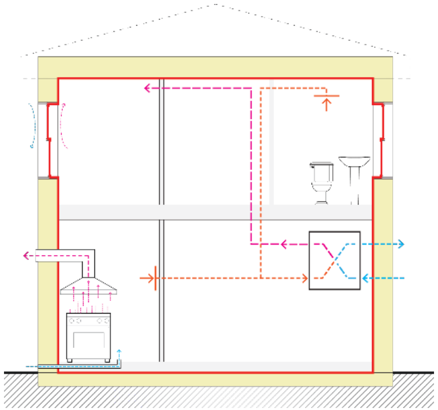
- Floor slabs ~ R20
- Walls ~ R20
- Roof ~ R50 -R70
- Windows ~ u 0.14

The Approach

Interior Air Sealing and Insulation + PH Windows



ERV + Range Exhaust



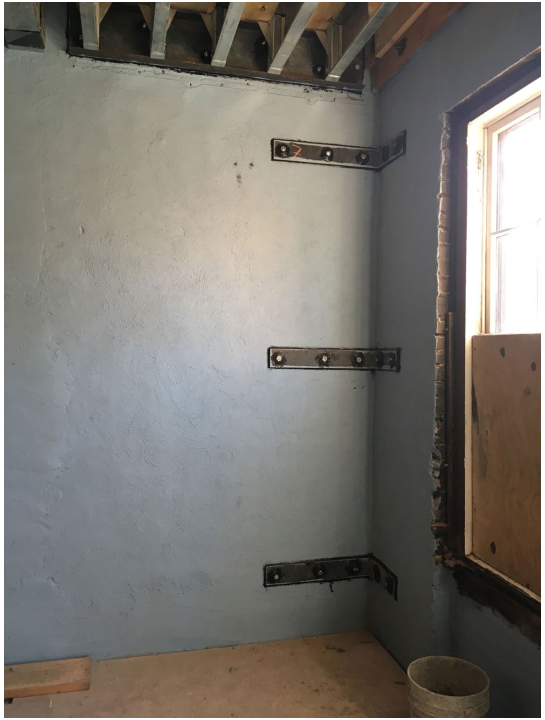
Heat Pump Heating/Cooling/DHW

Repair

Interior Airtightness

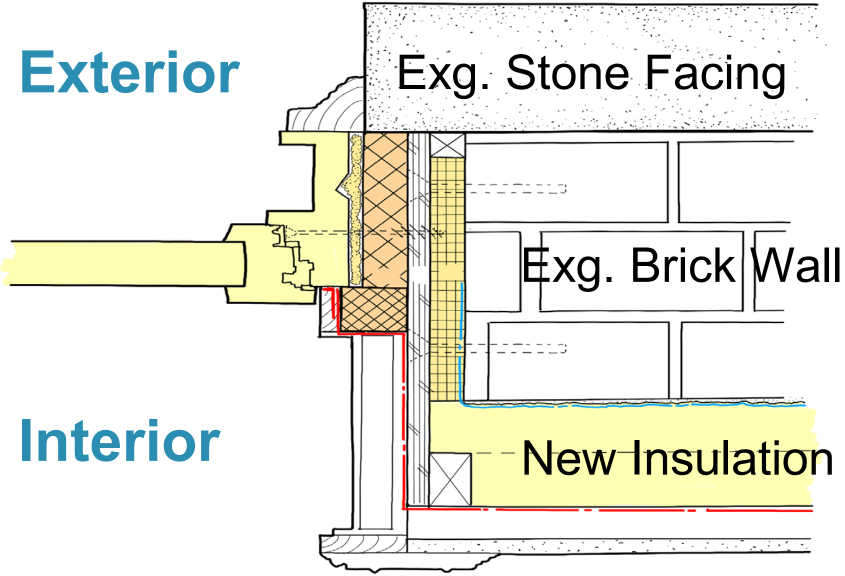
Interior Airtightness

Interior Airtightness



Interior Insulation

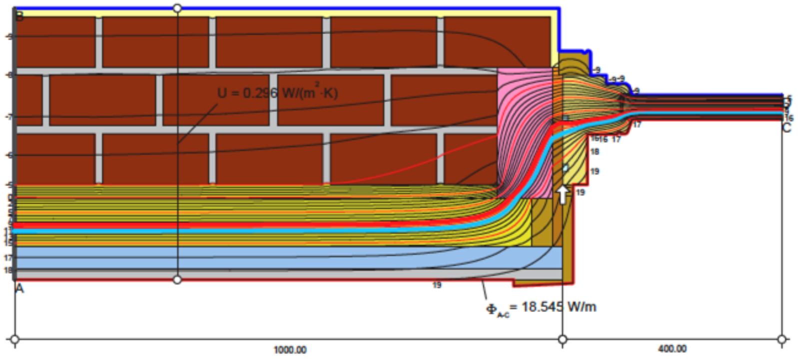
Source: bldgtyp, llc



Interior Insulation

Source: Kevin Brennan

Window Installations

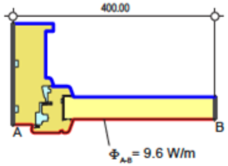


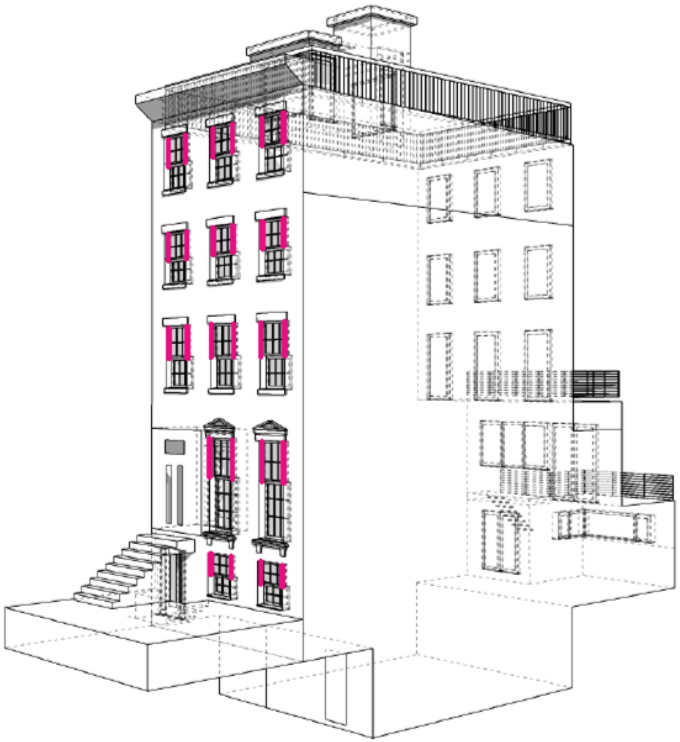
$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{18.545}{30.000} - 0.296 \cdot 1.000 - \frac{9.555}{30.000} = 0.004\ W/(m \cdot K)$$

	Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
🟦	Exterior, normal		-10.000	0.040	
🟥	Interior, normal, horizontal		20.000	0.130	
⬛	Symmetry/Model section	0.000			

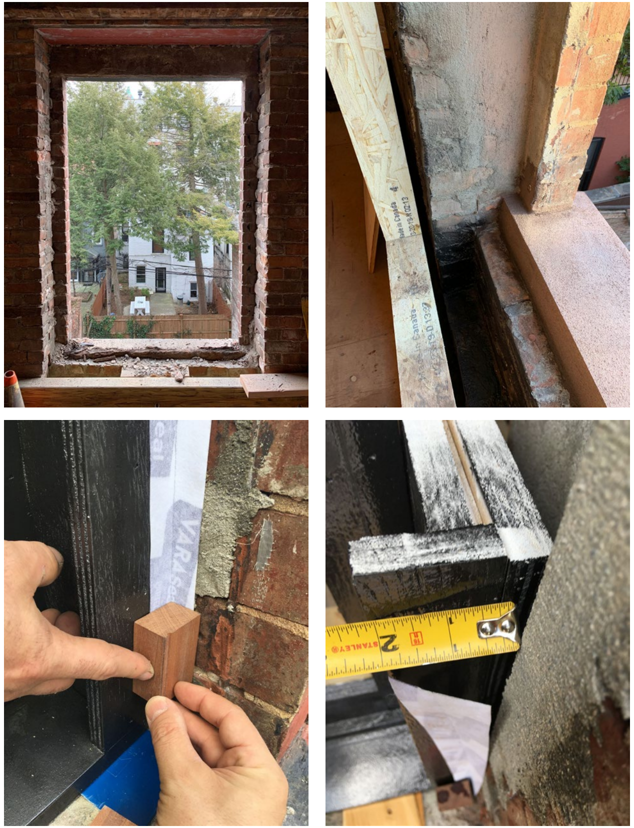
	Material	λ[W/(m·K)]	ε
🟦	Air layer, unventilated, horizontal, thickness: 40 mm	0.222	0.900
🟫	Brick (Common) [R-0.2/in]	0.720	0.900
🟨	Cellulose (Denspack) [R-3.7/in]	0.040	0.900
🟫	EPDM (ethylene propylene diene monomer)	0.250	0.900
⬜	GWB (Typ) [R-0.85/in]	0.170	0.900
⬜	Mortar - Portland Cement-Lime	0.431	0.900
🟫	PVC, flexible (PVC-P) 40% softener	0.140	0.900
🟨	Panel	0.035	0.900
🟧	Plywood (Typ) [R-1.2/in]	0.119	0.900
🟪	Silicone, pure	0.350	0.900
🟨	Softwood 500, typical construction timber	0.130	0.900
🟨	Stucco [R-0.2/in]	0.722	0.900
🟨	Wd Stud, Cellulose, 16in OC [R-2.93/in]	0.049	0.900
🟫	Wood, Coniferous (Softwood) [R-1.03/in]	0.140	0.900
🟥	XPS, [R-5.0/in]	0.029	0.900
🟧	ccSPF [R-6.5/in]	0.022	0.900
🟦	Unventilated air cavity *		

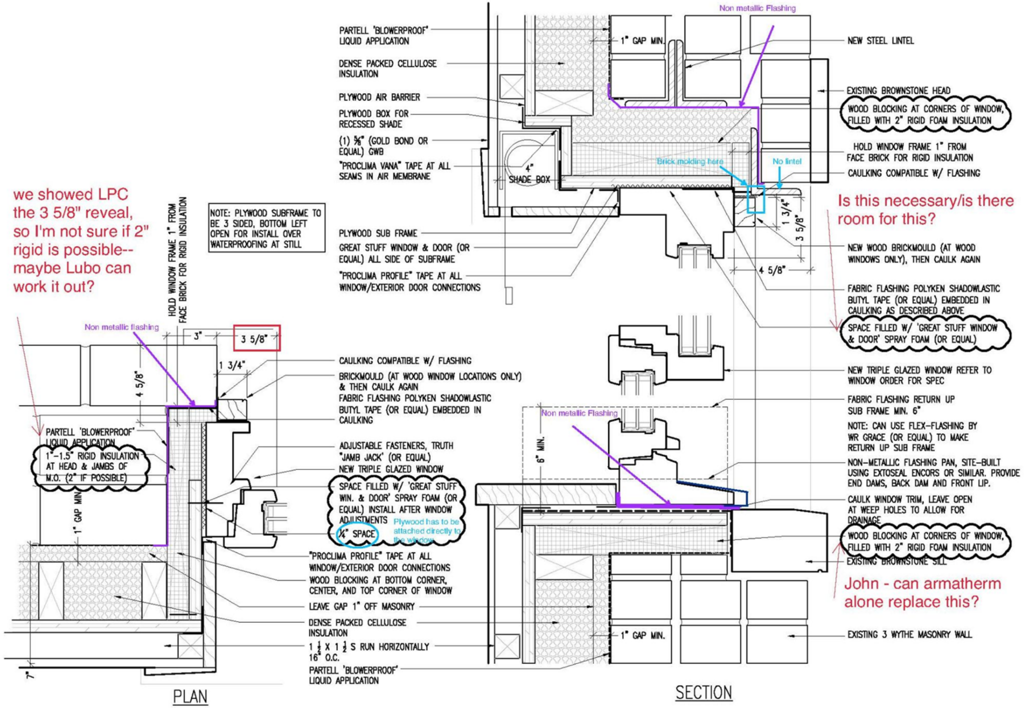
* Simplified approach





Window Installations





we showed LPC the 3 5/8" reveal, so I'm not sure if 2" rigid is possible--maybe Lubo can work it out?

Is this necessary/is there room for this?

John - can armatherm alone replace this?

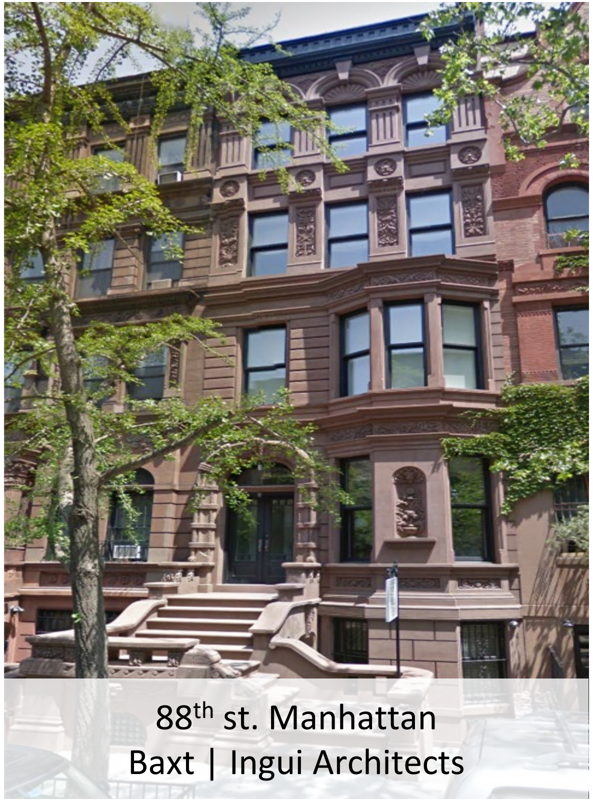
2 A-512 WINDOW INSTALL DETAIL

N.T.S.

Ready for the Next 100 Years

Park Pl. Brooklyn
Fabrica 718 Architects
ZeroEnergy Design: PH Engineering

8th St. Brooklyn
Red Top Architects
Baukraft Engineering



88th st. Manhattan
Baxt | Ingui Architects

Wood Frame Case Study

Case Study: Wood-framed Retrofit

- ➔ Historic wood-framed building (ca 1915) in Northern New Jersey (Climate Zone 5A)

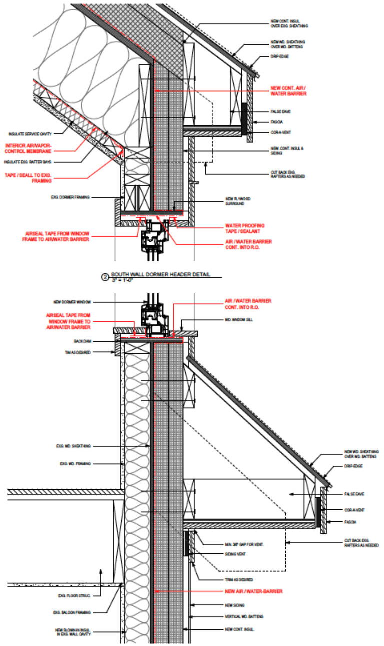
Owner’s Brief

Reasons for Renovating

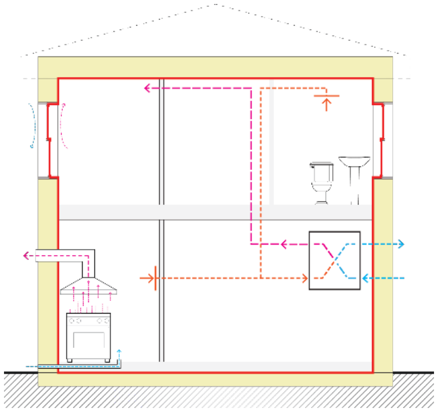
- Provide additional conditioned living space.
- Improve indoor air quality, thermal comfort, and acoustic isolation inside the house.
- Drastically reduce energy usage and carbon footprint, taking into account embodied carbon in products and procedures.
- Reduce exterior maintenance while protecting house from moisture, insects, etc.
- Provide back-up power during outage.
- All this while maintaining charm of 107 year old house.

The Approach

Exterior Air Barrier + Insulation + High-performance Windows



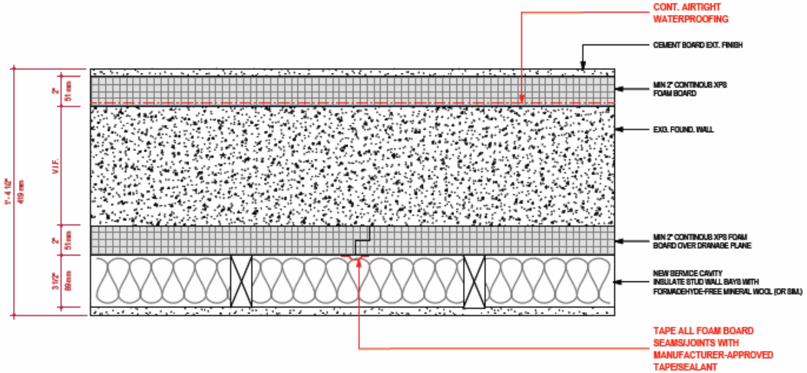
ERV + Range Exhaust



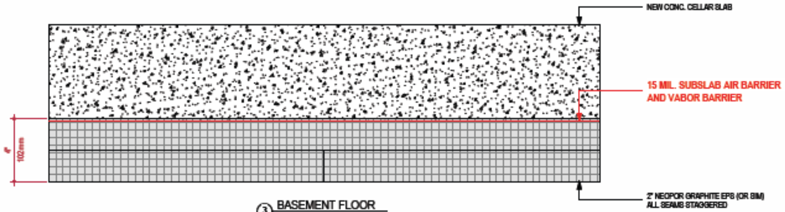
Heat Pump Heating/Cooling/DHW

Basement Air Sealing + Insulation

Source: Roger Gutzweiler

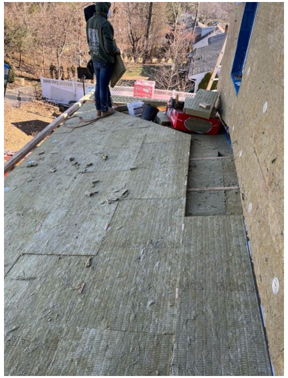


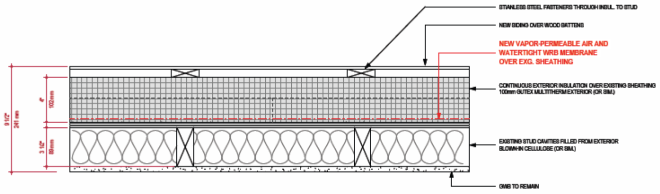
② BELOW GRADE WALL
3" = 1'-0"



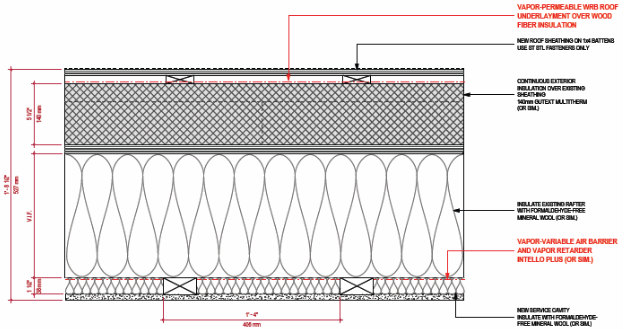
③ BASEMENT FLOOR
3" = 1'-0"

Above Grade Air Sealing + Insulation





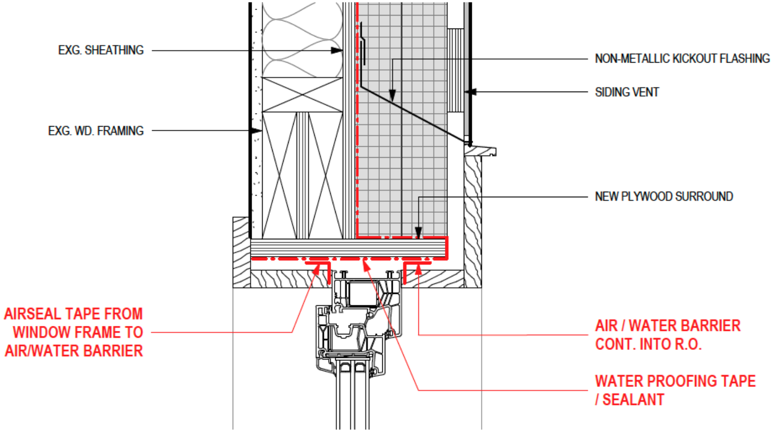
① ABOVE GRADE WALL
3" = 1'-0"

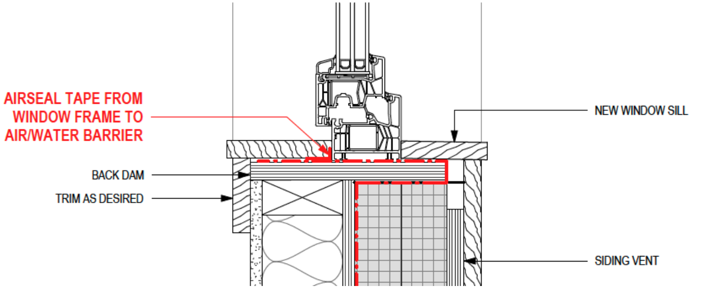


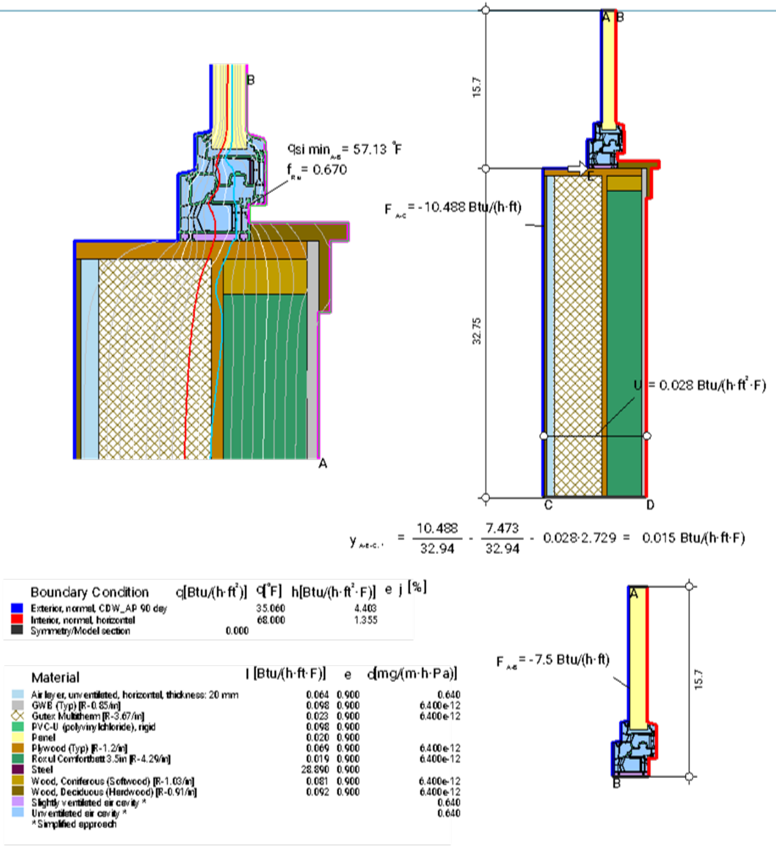
⑥ ROOF (MAIN)
3" = 1'-0"

Source: Roger Gutzweiler

Window Installation







$$y_{A-E-C,I} = \frac{10.488}{32.94} - \frac{7.473}{32.94} - 0.028 \cdot 2.729 = 0.015 \text{ Btu/(h·ft·F)}$$

	Boundary Condition	q[Btu/(h·ft²)]	q[°F]	h[Btu/(h·ft²·F)]	e	j [%]
🟦	Exterior, normal, CDW_AP 90 day		35.060	4.403		
🟥	Interior, normal, horizontal		68.000	1.355		
■	Symmetry/Model section	0.000				

	Material	l [Btu/(h·ft·F)]	e	d[mg/(m·h·Pa)]
🟦	Air layer, unventilated, horizontal, thickness: 20 mm	0.064	0.900	0.640
■	GWB (Typ) [R-0.85/in]	0.098	0.900	6.400e-12
▨	Gutex Multitherm [R-3.67/in]	0.023	0.900	6.400e-12
🟩	PVC-U (polyvinylchloride), rigid	0.098	0.900	
🟨	Panel	0.020	0.900	
🟧	Plywood (Typ) [R-1.2/in]	0.069	0.900	6.400e-12
🟩	Roxul Comfortbatt 3.5in [R-4.29/in]	0.019	0.900	6.400e-12
🟪	Steel	28.890	0.900	
🟨	Wood, Coniferous (Softwood) [R-1.03/in]	0.081	0.900	6.400e-12
🟫	Wood, Deciduous (Hardwood) [R-0.91/in]	0.092	0.900	6.400e-12
🟪	Slightly ventilated air cavity *			0.640
🟦	Unventilated air cavity *			0.640

* Simplified approach

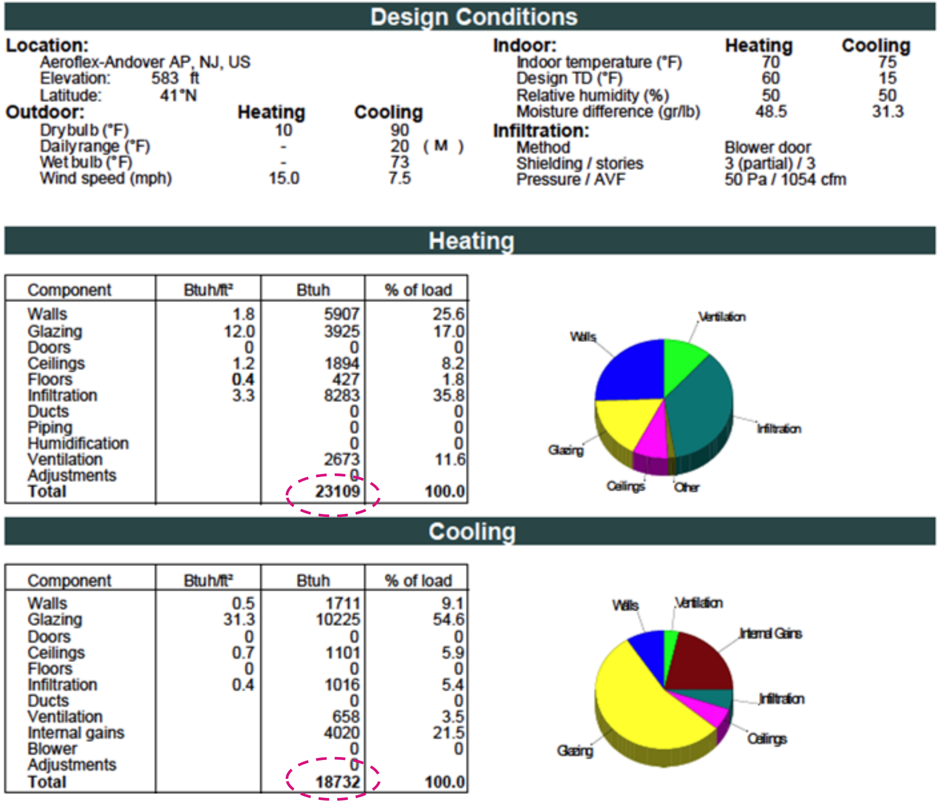
Heat Pump Heating and Cooling

Three stories over conditioned basement

~3,800 sf

Peak Heating Load: 23,100 Btu/h

Peak Cooling Load: 18,700 Btu/h



Design Conditions

Location:
Aeroflex-Andover AP, NJ, US
Elevation: 583 ft
Latitude: 41°N

Outdoor:	**Heating**	**Cooling**
Drybulb (°F)	10	90
Dailyrange (°F)	-	20 (M)
Wet bulb (°F)	-	73
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	60	15
Relative humidity (%)	50	50
Moisture difference (gr/lb)	48.5	31.3

Infiltration:
Method: Blower door
Shielding / stories: 3 (partial) / 3
Pressure / AVF: 50 Pa / 1054 cfm

Heating

Component	Btuh/ft²	Btuh	% of load
Walls	1.8	5907	25.6
Glazing	12.0	3925	17.0
Doors	0	0	0
Ceilings	1.2	1894	8.2
Floors	0.4	427	1.8
Infiltration	3.3	8283	35.8
Ducts		0	0
Piping		0	0
Humidification		0	0
Ventilation		2673	11.6
Adjustments		0	
Total		23109	100.0

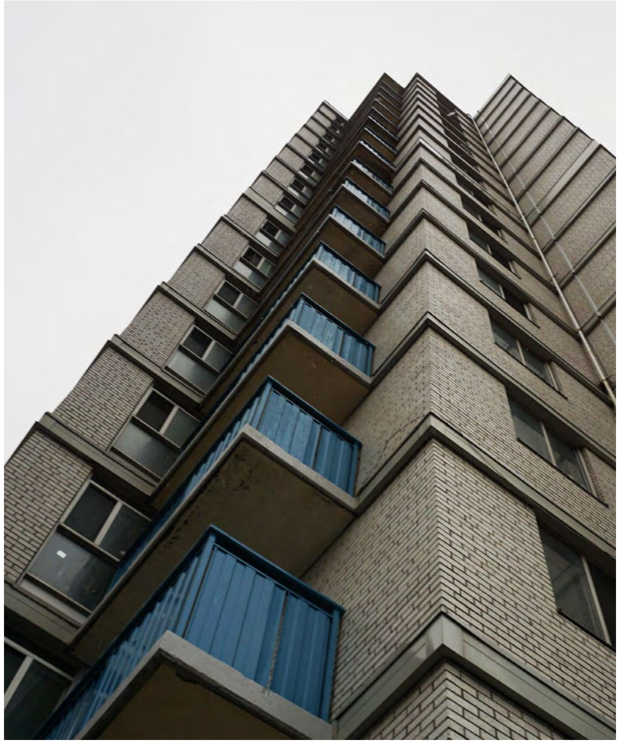
Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	0.5	1711	9.1
Glazing	31.3	10225	54.6
Doors	0	0	0
Ceilings	0.7	1101	5.9
Floors	0	0	0
Infiltration	0.4	1016	5.4
Ducts		0	0
Ventilation		658	3.5
Internal gains		4020	21.5
Blower		0	0
Adjustments		0	
Total		18732	100.0

Before and After

Multifamily Case Study

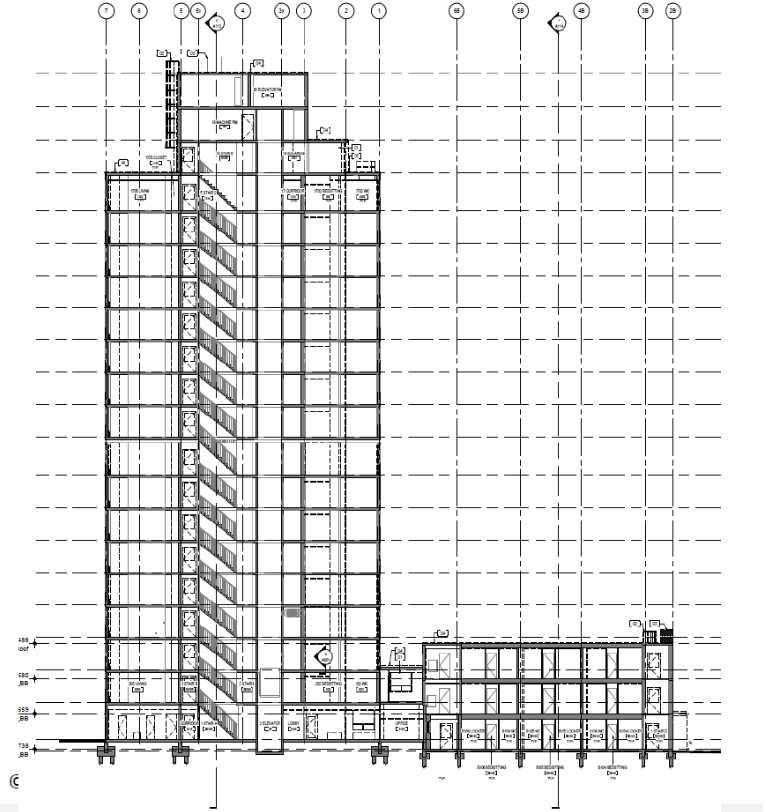
Ken Soble Tower

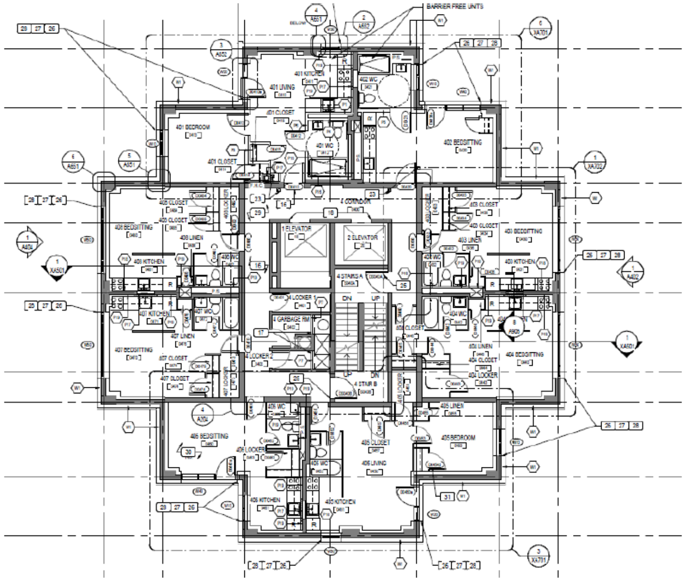


ERA Architects

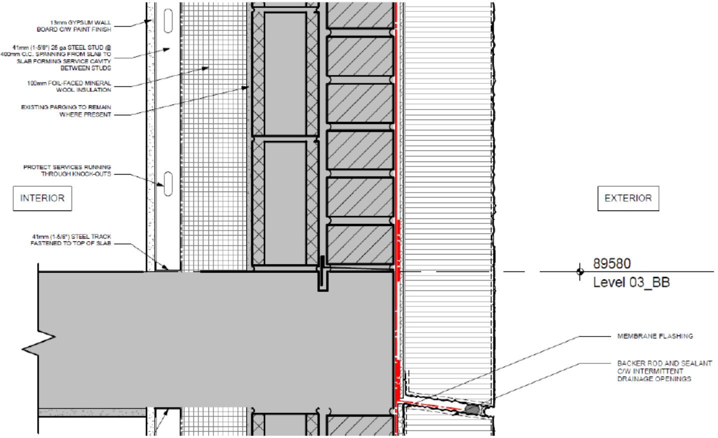
18 story, (58,000 SF TFA) 146 unit social housing. Built in 1967. City Housing Hamilton, Ontario

Form

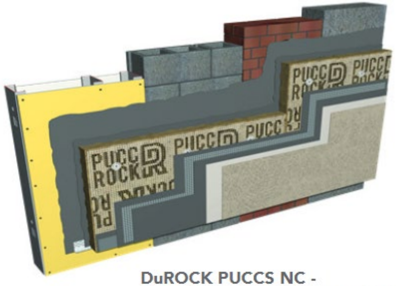




Typical Walls: R43



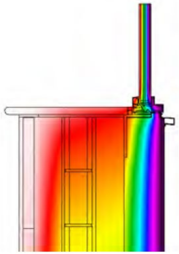

Balcony Demolition



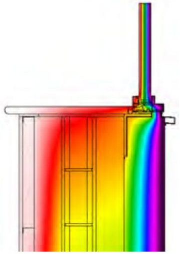
DuROCK PUCCS NC -
Non combustible Rainscreen EIFS used on the Ken Soble Tower


Mineral wool being Installed

Windows

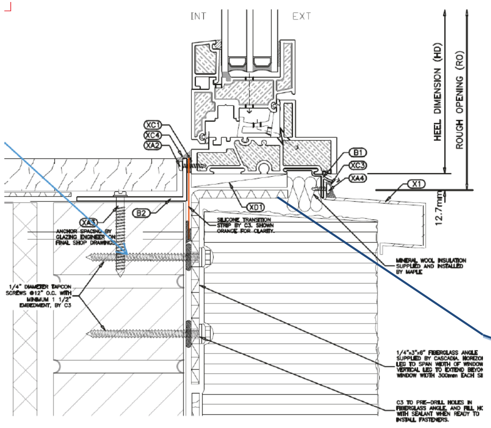


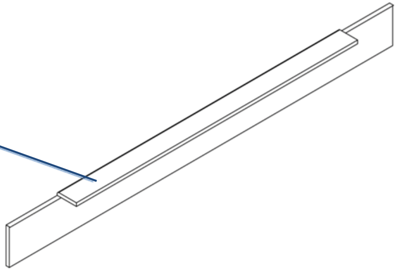
Fiberglass Angle



Steel Angle

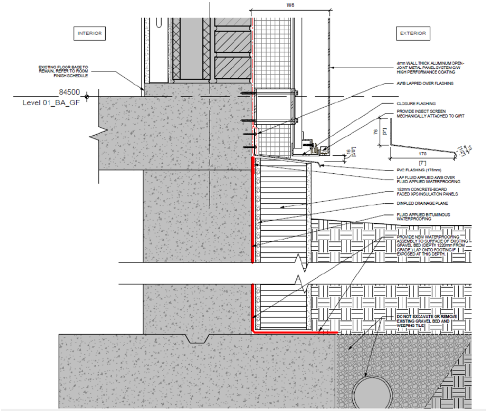
	Psi- Value (W/mK)	Heating Demand (kWh/m²a)
Window Sill Detail - Steel Angle	0.114	
Window Sill Detail - Fiberglass Angle	0.086	-0.16





Description of Window Frame Manufacturer	**Cascadia Windows Ltd.**
Window Name	Universal Window (Fiberglass Frame with Tri-Seal Super Spacer)
Frame U-Value (Uf)	0.88 W/(m²K) (Operable) 0.81 W/(m²K) (Fixed)
Glass Description	Argon Filled 6 mm Low-E Cardinal 270 | 11 mm spacer | 6 mm Cardinal 180 | 11 mm spacer | 6 mm Low-E Cardinal i89
Glazing u-value (Ug)	0.72 W/(m²K) and 0.70 W/(m²K) depending on orientation
g-value of glass	0.38 and 0.50 depending on orientation

Ground: R1.5 & Roof R43



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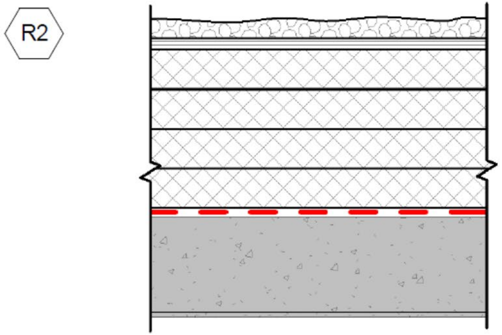
The existing foundation and floor was left untouched in the retrofit. 152 mm thick XPS perimeter insulation was added to the exterior of the foundation, from the ground slab to the footings of the building.

Thermal bridge studies were done to ensure the surface temperature in the residential spaces would stay above the minimum Frsi values.

PROPOSED ROOF ASSEMBLIES - INVERTED ROOF



R VALUE: 43.02

ABOVE
- RIVERSTONE GRAVEL BALLAST
- FILTER FABRIC
- 400mm (4 LAYERS OF 100mm) EXTRUDED POLYSTYRENE RIGID INSULATION
- FLUID-APPLIED POLYURETHANE ROOF MEMBRANE
- EXISTING CONCRETE SLAB AND STRUCTURE
- EXISTING PLASTER CEILING

BELOW

© ERA Architects

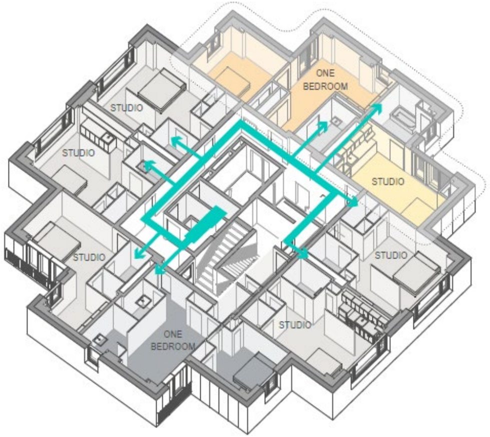
The installed roof was an inverted roof with 400 mm (16”) of rigid polystyrene insulation. A fluid applied membrane was applied to create a new air barrier, and all penetrations (drains, roof anchors, etc) were addressed in the thermal bridges.

Quality Control: Mock -Ups & Blower Door Testing: 0.2 ACH 50!

Air testing at window

Air tightness guarded floor by floor testing

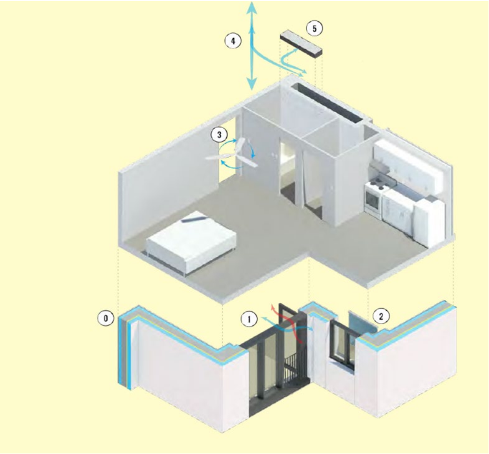
Ventilation: units / common areas / trash chute



Cooking: electric with filtered recirculation hood & general PH ventilation.
Clothes Dryers: elec condensing ventless.

Ventilation Unit	Electrical Efficiency	Effective Heat Recovery Efficiency
Swegon - GOLD RX 50	0.45	84%
Swegon - GOLD RX 50	0.45	84%
Swegon - GOLD RX 12	0.49	84%
Zehnder ComfoAir Q600 ST ERV	0.22	78%
Zehnder - ComfoAir160 ERV, ComfoD160 ERV, ComfoD150 ERV	0.33	80%
RenewAire EV Premium L	0.52	58%

Heating & Cooling



Cooling Strategy

1. PH envelope
2. Low solar heat gain glazing
3. interior shading
4. ceiling fans
5. central tempered ventilation air
6. decentralized VAV boost per unit controls

Space Heating Strategy: centralized heat pump tempered ventilation air with elec resistance boost at each unit.

DHW: condensing gas boilers with drain water heat recovery at all showers/baths

Finished Product

Next Steps

EnerPHit Next Steps

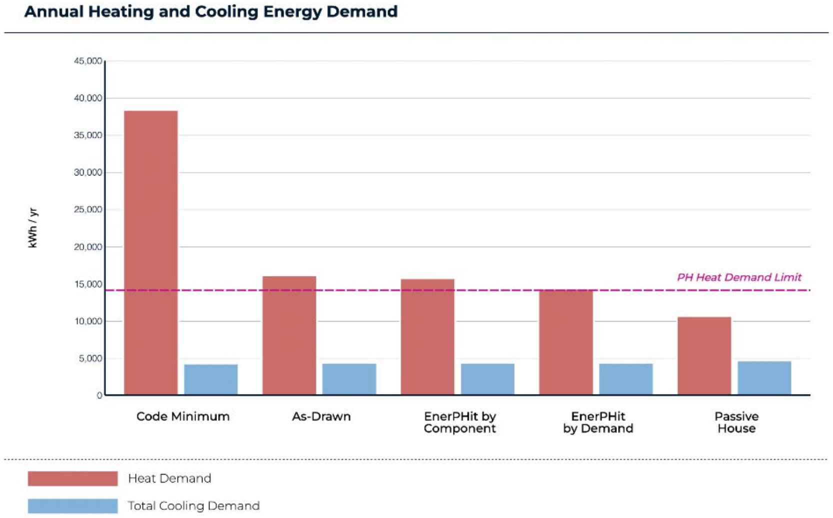
- ➔ Use the PHPP as a design tool
- ➔ Start working with a certifier early in the process
- ➔ Leverage your community

NORTH AMERICAN CERTIFIERS CIRCLE
PASSIVE HOUSE
CERTIFIER
Passive House Institute accredited

EnerPHit

- Resilient
- Excellent Occupant Comfort
- Good Indoor Air Quality
- Durable (Low Moisture Risk)
- Low Operational Energy

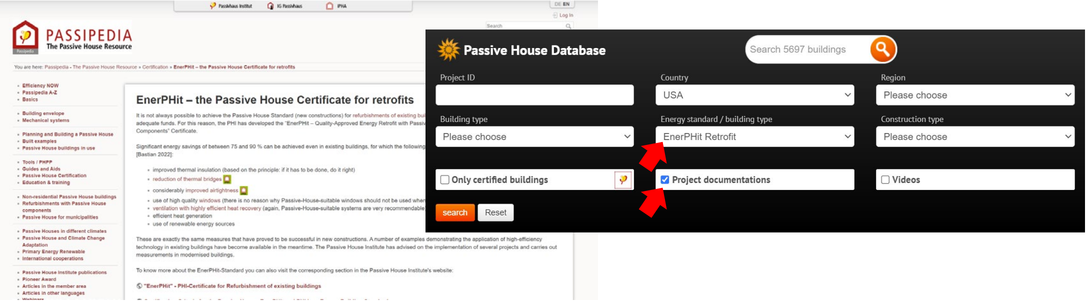
The basic principle which should be applied for each structural intervention in an existing building is 'if it has to be done, it should be done properly.'
-Wolfgang Feist


Annual Heating and Cooling Energy Demand

EnerPHit Resources

EnerPHit Resources

Websites



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The Passive House Resource

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EnerPHit – the Passive House Certificate for retrofits

It is not always possible to achieve the Passive House Standard (new constructions) for refurbishments of existing bui adequate funds. For this reason, the PHI has developed the "EnerPHit – Quality-Approved Energy Retrofit with Passiv Components" Certificate.

Significant energy savings of between 75 and 90 % can be achieved even in existing buildings, for which the following [Bastian 2022]:

- improved thermal insulation (based on the principle: if it has to be done, do it right)
- reduction of thermal bridges
- considerably improved airtightness
- use of high quality windows (there is no reason why Passive-House-suitable windows should not be used when
- ventilation with highly efficient heat recovery (again, Passive-House-suitable systems are very recommendable
- efficient heat generation
- use of renewable energy sources

These are exactly the same measures that have proved to be successful in new constructions. A number of examples demonstrating the application of high-efficiency technology in existing buildings have become available in the meantime. The Passive House Institute has advised on the implementation of several projects and carries out measurements in modernised buildings.

To know more about the EnerPHit-Standard you can also visit the corresponding section in the Passive House Institute's website:

"EnerPHit" - PHI-Certificate for Refurbishment of existing buildings

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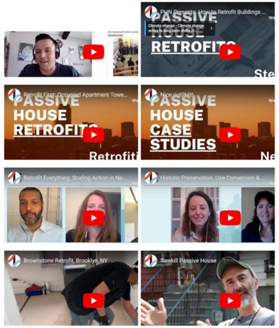

Links

Websites

- https://passipedia.org/certification/enerphit
- https://passivehouse-database.org/
- https://passivehouseaccelerator.com

Videos

- https://passivehousenetwork.org/video-library/#renovation

Publications

- https://passivehousenetwork.org/wp-content/uploads/2023/11/03_building_criteria_ip_en-PHI.pdf
- https://be-exchange.org/lowcarbonmultifamily-main/
- https://be-exchange.org/report/hpd-ll97-decarbonization-roadmap/
- https://greenbuildingunited.org/newsroom97/it-s-here-the-passive-rowhouse-manual
- https://475.supply/products/smart-enclosure-system-download
- https://www.ribabooks.com/enerphit-a-step-by-step-guide-to-low-energy-retrofit_9781859468197

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Thank you!

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