



ENERGY DESIGN

conference & expo



Residential Passive House Retrofit (EnerPHit)

The MinnePHit House

Case Study about the first cold-climate EnerPHit project in the World
Tim Eian, Dipl.-Ing., Certified Passive House Planner & Consultant

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code/energy** continuing education requirements.”

For additional continuing education approvals, please see your credit tracking card.

Learning Objectives

- **The Passive House building energy standards**
- **Residential Passive House retrofit design**
- **Strategies, materials and systems**
- **Challenges & Opportunities**
- **Certification**

Introduction



EnerPHit ✓

Quality-Approved
Energy Retrofit with
Passive House Components
Dr. Wolfgang Feist

The MinnePHit House Minneapolis, MN



before



after



before



after



before



after



Minneapolis
+ EnerPHit

= MinnePHit

The Passive House Standard

Passivhaus - Passive House



“A rigorous, voluntary building energy standard focusing on highest energy efficiency and quality of life at low operating cost.”

Passive House in 90 Seconds



Global Standard



Think globally, build locally.

Global Adoption



Third-Party Certified

Certification Documentation



Category	Value	Requirement
Space heating	14 kWh/m ² /a	14 kWh/m ² /a
Space cooling	5.5 kWh/m ² /a	5.5 kWh/m ² /a
Primary Energy	102 kWh/m ² /a	102 kWh/m ² /a
Airtightness	0.5 1/h	0.5 1/h

This building has been awarded the Certified Passive House by the Passive House Institute.



This certification is based solely on the design data and supplied by the client for the purpose of certification. The Passive House Institute has checked and approved the building's energy balances according to the above. This certification does not cover quality assurance or implementation. The Passive House Institute hereby certifies the building as a Certified Passive House.

Certificate-ID: 9689_PHI_PH_20141017_AM

Certificate

The Passive House Institute awards the seal "Certified Passive House" to the following building

24th Street Passive House #1, 749 24th St. North, La Crosse, WI 54601, USA

Client: Western Technical College
400 7th St. North, La Crosse, WI 54602, USA

Architect: Integrated Planning LLC
901 23rd Ave NE, Minneapolis, MN 55418, USA

Building: Integrated Planning LLC
Services: 901 23rd Ave NE, Minneapolis, MN 55418, USA



This building was designed to meet Passive House criteria as defined by the Passive House Institute. With appropriate on-site implementation, this building will have the following characteristics:

- Excellent thermal insulation and optimised connection details with respect to building envelope. The heating demand or heating load will be limited to **15 kWh per m² of living area and year or a heating load of 10 W/m²**.
- When outdoor temperatures are high, thermal comfort can be ensured with passive cooling. Minimal energy demand for cooling and dehumidification according to the location-specific requirements.
- A highly airtight building envelope, which eliminates draughts and reduces the heating energy demand. The air change rate through the envelope at a 50 Pascal pressure difference, as verified in accordance with ISO 9972, is less than **0.6 air changes per hour with respect to the building's volume**.
- A controlled ventilation system with high quality filters, highly efficient heat recovery and low electricity consumption, ensuring excellent indoor air quality with low energy consumption.
- A total primary energy demand for heating, domestic hot water, ventilation and other electric appliances during normal use of less than **120 kWh per m² of living area and year**.

This certificate is to be used only in combination with the associated certification documents, which describe the exact characteristics of the building.

Passive Houses offer high comfort throughout the year and can be heated or cooled with little effort, for example, by heating/cooling the supply air. Even in times of cold outdoor temperatures, the lighting environment of a Passive House is evenly warm on the inside and the internal surface temperatures are stable. The lighting environment of a Passive House is evenly warm on the inside and the internal surface temperatures are stable. Due to the highly airtight envelope, draughts are eliminated. The ventilation system constantly provides fresh air of excellent quality. Energy consumption for heating, domestic hot water, ventilation and other electric appliances is very low. Thanks to this, Passive Houses offer high comfort and future rises in energy prices. Moreover, the climate impact of Passive Houses is very low as they result in comparatively low levels of carbon dioxide (CO₂) and air pollutants.

Issued:
Darmstadt, 17.10.2014
Wolfgang Feist
Dr. Wolfgang Feist

Certificate-ID: 9689_PHI_PH_20141017_AM

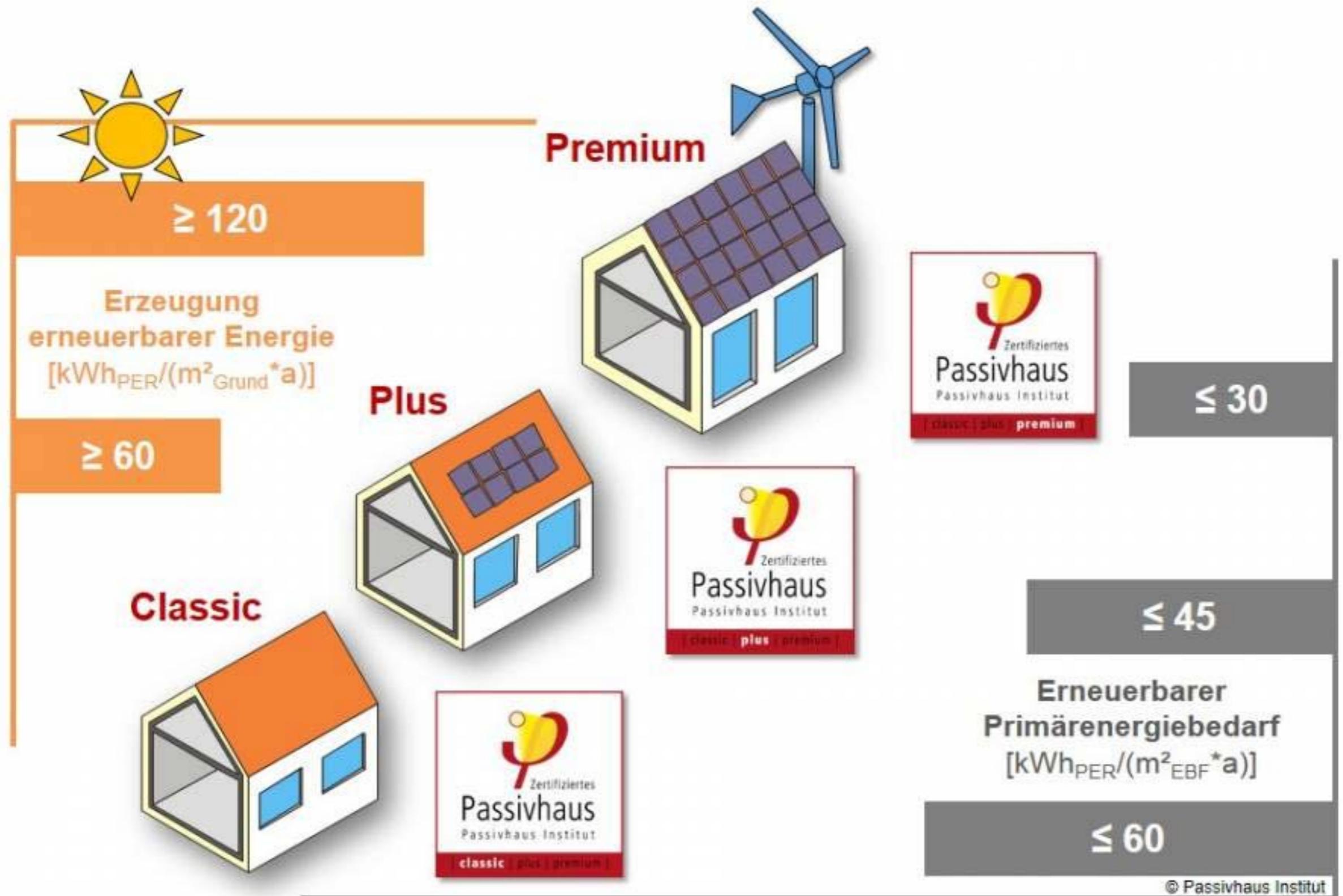


Passive House Institute

Tool



The Path to Ultimate Sustainability



Global Climate Specificity

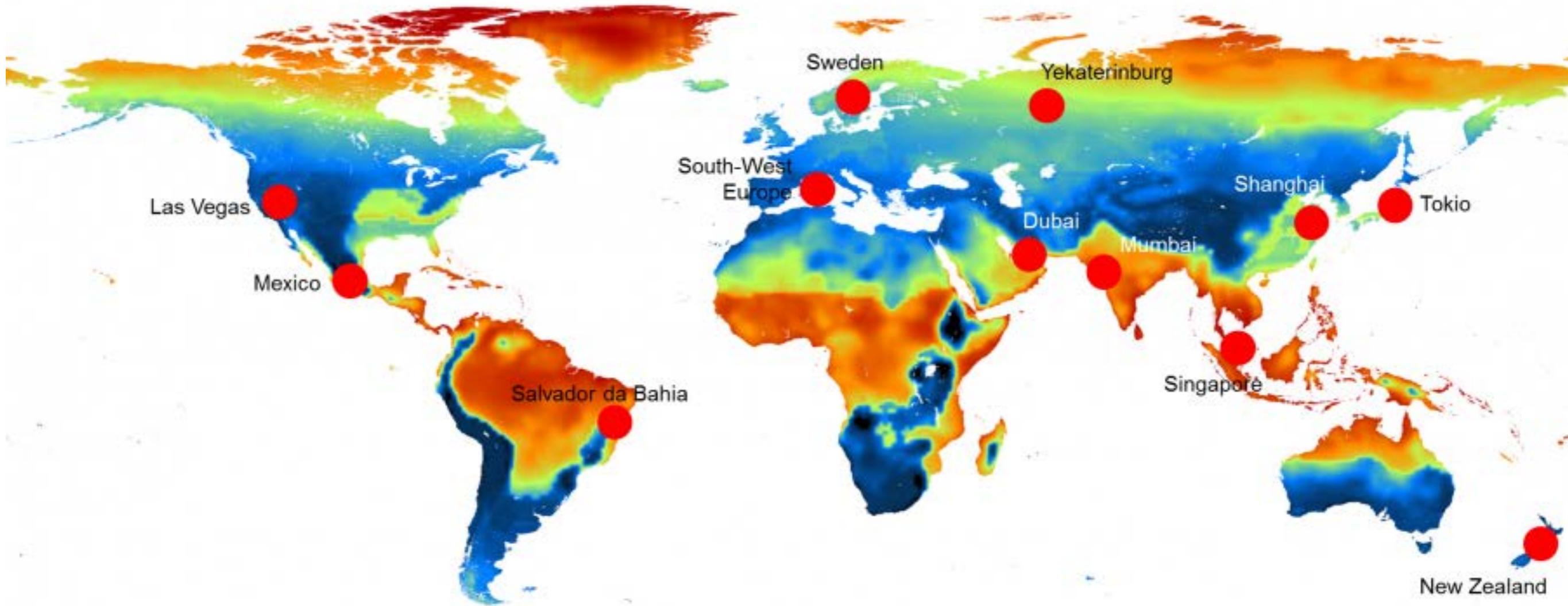


Illustration © Passive House Institute

Climate-Specific Requirements

Climate zone according to PHPP	Opaque envelope ¹ against...				Windows (including exterior doors)				Ventilation		
	...ground	...ambient air			Overall ⁴			Glazing ⁵	Solar load ⁶	Min. heat recovery rate ⁷	Min. humidity recovery rate ⁸
	Insulation	Exterior insulation	Interior insulation ²	Exterior paint ³	Max. heat transfer coefficient ($U_{D/W,installed}$)			Solar heat gain coefficient (g-value)	Max. specific solar load during cooling period		
	Max. heat transfer coefficient (U-value)			Cool colours						[W/(m ² K)]	
	[W/(m ² K)]			-	[W/(m ² K)]			-	[kWh/m ² a]	%	
											
Arctic	Determined in PHPP from project specific heating and cooling degree days against ground.	0.09	0.25	-	0.45	0.50	0.60	$U_g - g*0.7 \leq 0$	100	80%	-
Cold		0.12	0.30	-	0.65	0.70	0.80	$U_g - g*1.0 \leq 0$		80%	-
Cool-temperate		0.15	0.35	-	0.85	1.00	1.10	$U_g - g*1.6 \leq 0$		75%	-
Warm-temperate		0.30	0.50	-	1.05	1.10	1.20	$U_g - g*2.8 \leq -1$		75%	-
Warm		0.50	0.75	-	1.25	1.30	1.40	-		-	-
Hot		0.50	0.75	Yes	1.25	1.30	1.40	-		-	60 % (humid climate)
Very hot		0.25	0.45	Yes	1.05	1.10	1.20	-		-	60 % (humid climate)

Energy Modeling



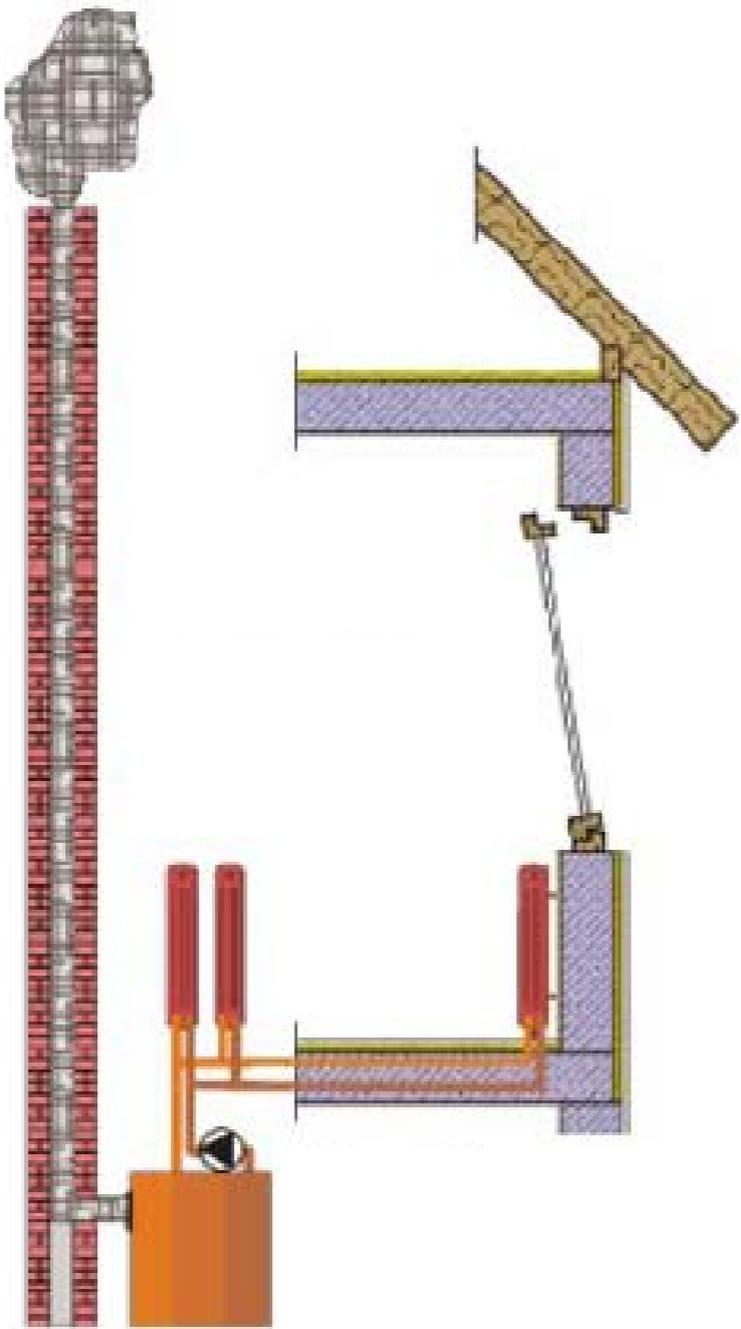
Basic Concept

Conservation first

➔ Minimize losses

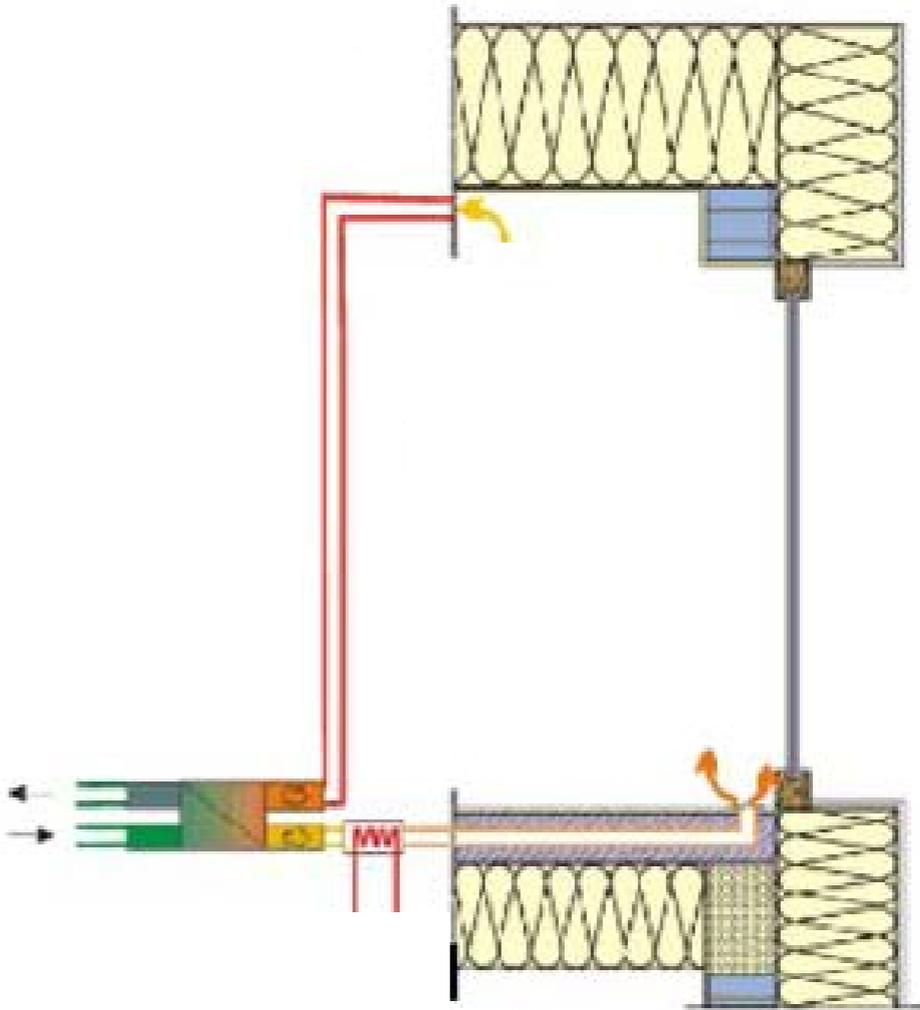
➔ Maximize (free) gains

Active vs. Passive



Active: 25-125 kBtu/(sf yr)

85 - 450 kWh/(m² a), typically found in the U.S.

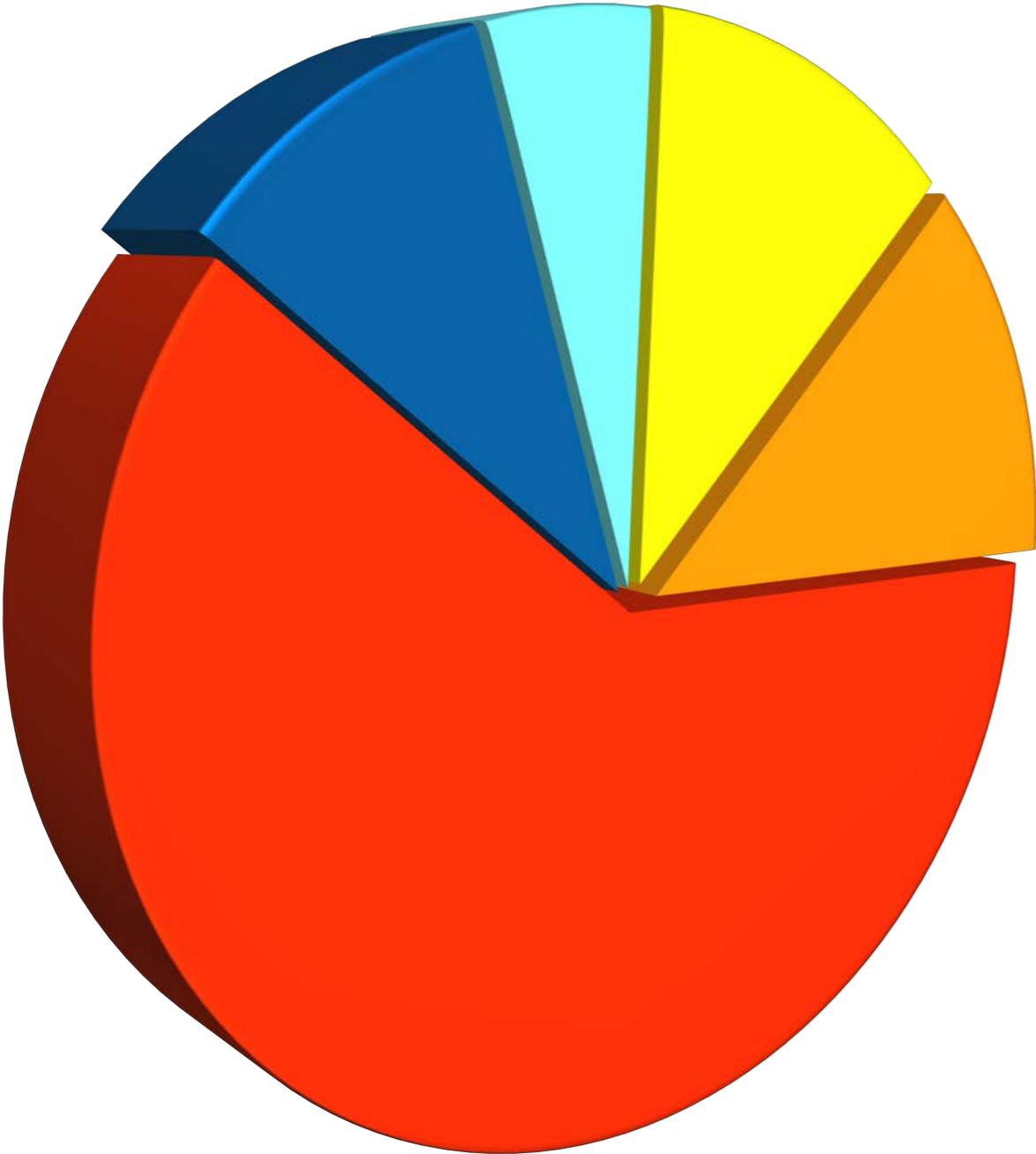


Passive: 4.75 kBtu/(sf yr)

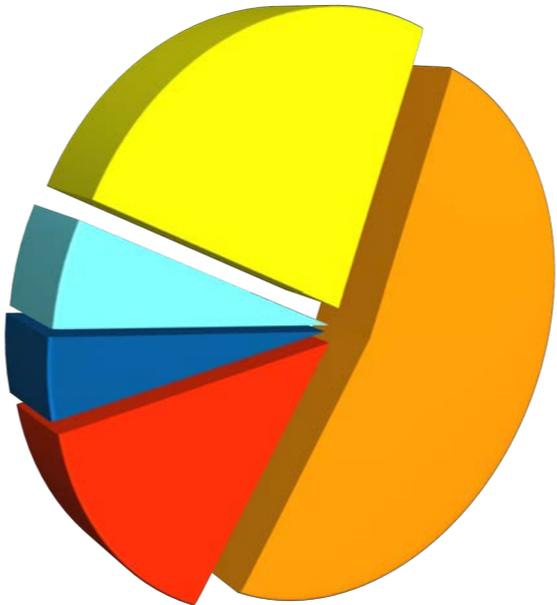
15kWh/(m² a), maximum target

Energy Footprint

- Heating (active)
- Hot water (active)
- Cooling (active)
- Household Electricity
- Heat & hot water (passive)



Code



Passive House

- ➔ up to 95% less heating energy
- ➔ 50 to 75% less total energy

Metrics

Energy per Square Foot and Year

Gas mileage for buildings.

Space Conditioning Energy Targets



$\leq 4.75 \text{ kBtu}/(\text{sf yr})$

$\leq 15 \text{ kWh}/(\text{m}^2 \text{ a})$



$\leq 9.5 \text{ kBtu}/(\text{sf yr})$

$\leq 30 \text{ kWh}/(\text{m}^2 \text{ a})$



$\leq 7.9 \text{ kBtu}/(\text{sf yr})$

$\leq 25 \text{ kWh}/(\text{m}^2 \text{ a})$

Total energy used to heat or cool a building.

Source Energy Targets



$\leq 38 \text{ kBtu}/(\text{sf yr})$

$\leq 120 \text{ kWh}/(\text{m}^2 \text{ a})$



varies

$\leq 120 \text{ kWh}/(\text{m}^2 \text{ a}) + ((\text{QH} - 15 \text{ kWh}/(\text{m}^2 \text{ a})) * 1.2)$

Total energy used to heat or cool a building.

Heating Load Target (suggested)



$\leq 3.17 \text{ Btu}/(\text{h sf})$

$\leq 10\text{W}/\text{m}^2$

Heating energy can be supplied through ventilation system.

Airtightness Targets



≤ 0.6 ACH₅₀



≤ 1.0 ACH₅₀



Measured with a blower door in the field.

Component Targets

- Maximum U-values
- Minimum R-values
- SHGC requirements
- Minimum heat-recovery rates

EnerPHit offers a Component Track.

Component Targets

Climate zone	Hygiene ¹	Comfort ²			
	Min. temperature factor	Max. thermal transfer coefficient			
	$f_{Rsi}=0.25 \text{ m}^2\text{K/W}$	U-value			
	□	[W/(m ² K)]			
					
Arctic	0.80	0.45	0.50	0.60	0.35
Cold	0.75	0.65	0.70	0.80	0.50
Cool-temperate	0.70	0.85	1.00	1.10	0.65
Warm-temperate	0.60	1.10	1.15	1.25	0.85
Warm	0.55	-	1.30	1.40	-
Hot	-	-	1.30	1.40	-
Very hot	-	-	1.10	1.20	-

Predictable Outcome & Measurable Results

AS (Optiwin & 16" SIP).xls

Passive House Planning

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: Annual Heat Demand: kWh/m² Heating Degree Hours:

Climate:	Minneapolis, MN										
Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	g-Value	Reduction Factor for Solar Radiation	Window Area	Window U-Value	Glazing Area	Average Global Radiation
maximum:	kWh/m ²	0.75	0.95	0.85	0.554			m ²	W/m ² K	m ²	kWh/m ²
North	116	0.99	0.95	0.85	0.554	0.51	0.44	3.45	0.79	1.9	116
East	351	0.98	0.95	0.85	0.581	0.51	0.46	4.15	0.77	2.4	351
South	745	0.85	0.95	0.85	0.657	0.51	0.45	15.54	0.79	10.2	745
West	348	0.98	0.95	0.85	0.517	0.51	0.41	6.92	0.84	3.6	348
Horizontal	521	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	521
Total or Average Value for All Windows:						0.51	0.44	30.05	0.80	18.1	

Transmission Losses	Heat Gains Solar Radiation
kWh/a	kWh/a
296	90
349	342
1336	2657
630	505
0	0
2611	3594

Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Window Rough Openings		Installed		Glazing		Frame		g-Value	U-Value		Window Frame Dimensions				Installation				Ψ-Value		Window Area
					Width	Height	in Area in the Areas worksheet	Nr.	Select glazing from the WinType worksheet	Nr.	Select window from the WinType worksheet	Nr.		Perpendicular Radiation	Glazing	Frames	Width - Left	Width - Right	Width - Below	Width - Above	Left 1/0	Right 1/0	Sill 1/0	Head 1/0	Ψ _{Space}	
23	1 NIWinAAa	0	90	North	0.838	0.914	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	0.8
24	0 NIWinABa	0	90	North	0.000	0.000	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	0.0
25	1 NIWinACa	0	90	North	0.838	1.143	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
26	0 NIWinBAa	0	90	North	0.000	0.000	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	0.0
27	1 NIWinBBA	0	90	North	0.838	0.914	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	0.8
28	1 NIWinBCa	0	90	North	0.838	1.143	North Wa	1	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
29	1 EIWinADa	90	90	East	0.838	1.143	East Wall	2	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
30	1 EIWinAEa	90	90	East	0.838	1.524	East Wall	2	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.3
31	1 EIWinBDA	90	90	East	0.838	1.143	East Wall	2	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
32	1 EIWinBEa	90	90	East	0.838	1.143	East Wall	2	Sanco SIV	10	OPTWIN	94	0.51	0.50	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
33	1 SIWinAFa	180	90	South	0.838	1.143	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
34	1 SIWinAGa	180	90	South	0.838	1.143	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
35	1 SIWinAHc	180	90	South	0.838	1.829	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	0	1	1	1	0.028	-0.001	1.5
36	1 SIWinAJb	180	90	South	1.829	1.829	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	0	1	1	0.028	-0.001	3.3
37	1 SIWinAKc	180	90	South	0.838	1.829	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	0	1	1	1	0.028	-0.001	1.5
38	1 SIWinALb	180	90	South	1.524	1.829	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	0	1	1	0.028	-0.001	2.8
39	1 SIWinBFA	180	90	South	0.838	1.320	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.1
40	1 SIWinBGA	180	90	South	0.838	1.320	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.1
41	1 SIWinBHa	180	90	South	0.838	1.320	South Wa	3	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.1
42	1 SIWinBJa	180	90	South	0.838	1.320	West Wall	4	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.1
43	1 WIWinAMc	270	90	West	0.838	1.320	West Wall	4	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	0	1	1	1	0.028	-0.001	1.1
44	1 WIWinANb	270	90	West	1.524	1.320	West Wall	4	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	0	1	1	0.028	-0.001	2.0
45	1 WIWinAOa	270	90	West	0.914	2.057	West Wall	4	Sanco SIV	9	Fiberglass	9	0.51	0.60	0.75	0.20	0.20	1.00	0.20	1	1	1	1	0.030	0.050	1.9
46	1 WIWinBKa	270	90	West	0.838	1.143	West Wall	4	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0
47	1 WIWinBLa	270	90	West	0.838	1.143	West Wall	4	Sanco SIV	9	OPTWIN	94	0.51	0.60	0.95	0.12	0.12	0.11	0.12	1	1	1	1	0.028	-0.001	1.0

Ready | Brief Instructions | Verification | cTFA | Areas | U-List | U-Values | Ground | cWindows | Windows | WinType | Shading | Ventilation | Annual Heat Demand | Monthly Method | Heating Load | Summer | Shading-S | SummVent | Cooling | CoC

Sum=100 | SCRL | CAPS | NUM

Passive House Planning Package - PHPP

Key Benefits

Highest Comfort



Superior Indoor Environmental Quality



Ecology and Resource Efficiency



Cheapest Life Cycle Cost



The MinnePHit Project

Where are we?

what we got



1935



