The Passive House Network

Passive House & Code, Ashrae and Other Green Standards

www.passivehousenetwork.org

Credit: Handel Architects

Tim Delhey Eian

Principal TE Studio, Dipl.-Ing., Certified Passive House Designer & Consultant

The Basics

The Passive House Network

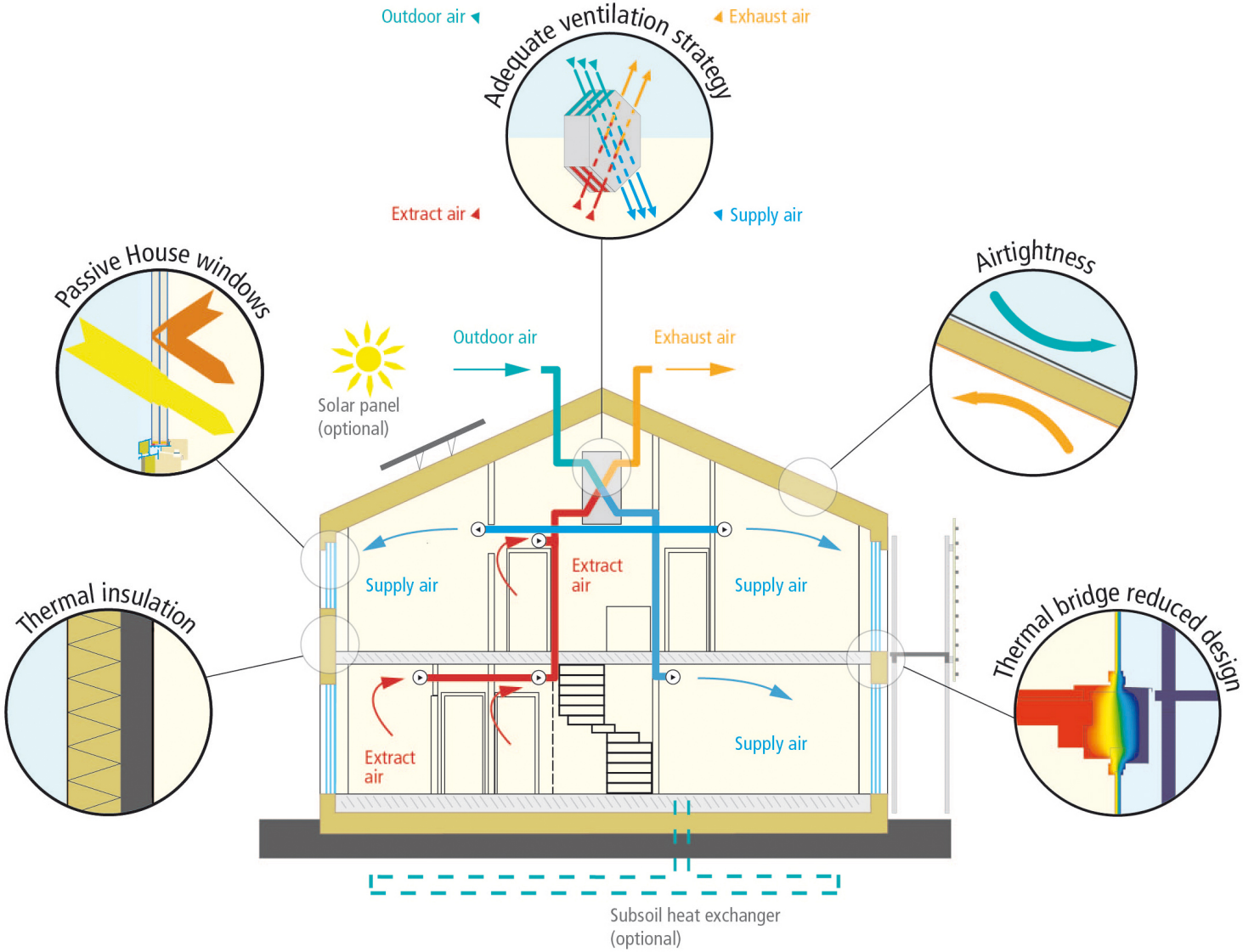
To understand how Passive House interacts with other building standards, it is imperative to first understand what it is:

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

Passive House

5 Basic Principles

The Passive House Network

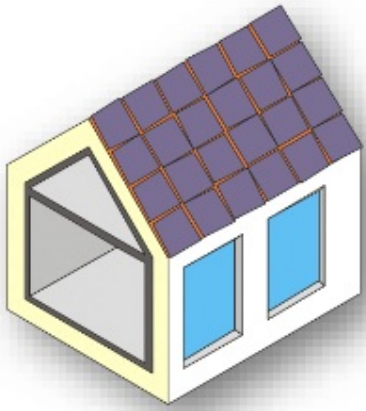


New Project Certification

The Passive House Network

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

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



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

Retrofit Certification: EnerPHit

The Passive House Network

Credit: Ryall Sheridan Architects

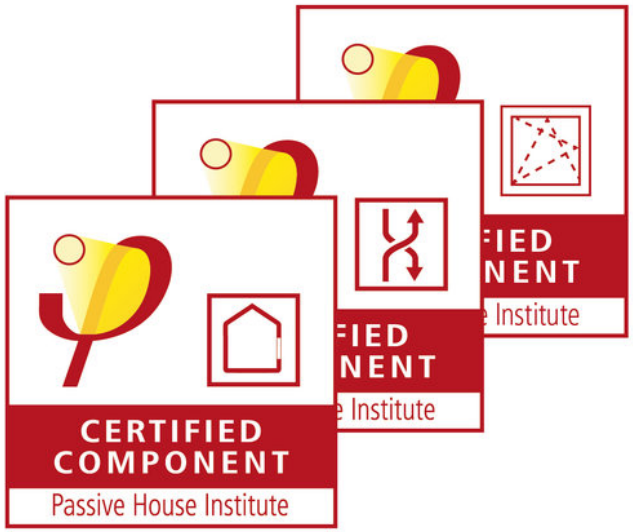
EnerPHit Certified Retrofit Passive House Institute | classic | plus | premium |

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

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

People and Product Certifications

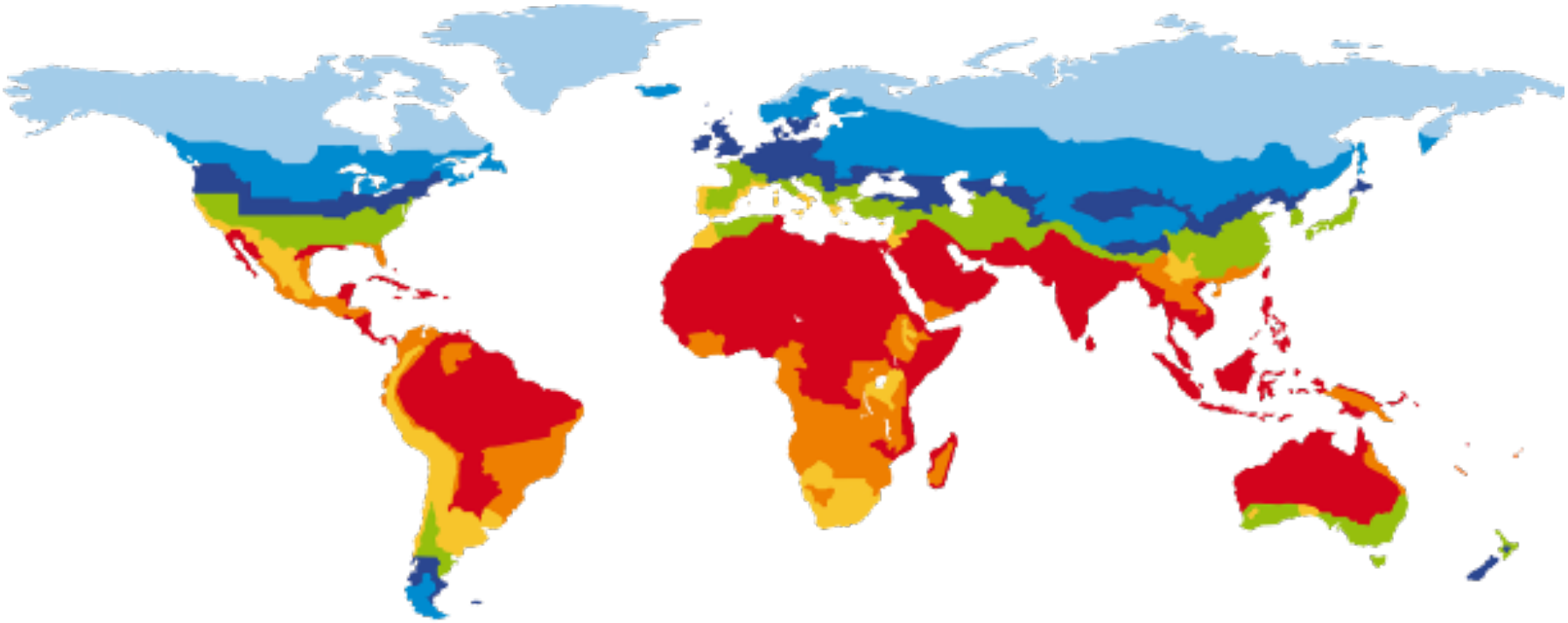
The Passive House Network



Eco System

Global, Climate Zone Specific Application

The Passive House Network



Support at Every Level

phmn PASSIVE HOUSE MINNESOTA

passivehouseminnesota.org

The Passive House Network

passivehousenetwork.org

Passive House Institute

passivehouse.com

International PASSIVE HOUSE Association iPHA

passivehouse-international.org

Training and Certification are…

The Passive House Network

- available for
  - Architects and Engineers
  - Contractors (Tradespersons)
  - Manufacturers/ suppliers, and components and assemblies
- beneficial and **foundational** for all in the building industry
- instrumental for delivering standards such as Architecture 2030, B3/ SB2030, LEED, Living Building Challenge and many others (as illustrated in this lecture)

Professional certification can be obtained not only by passing an exam but also by documentation of a completed certified Passive House project.

Resource: https://naphnetwork.org/education/overview/

Ecosystem for Sustainability

The Passive House Network

Passive House offers universal metrics and absolute targets based on building science.

Passive House provides powerful tools for practitioners.

Passive House is a global ecosystem for sustainable, energy efficient buildings, practitioners and suppliers.

Universal Metrics and Absolute Targets

Space Conditioning

The Passive House Network

≤ 4.75 kBtu/(sf yr)

≤ 15kWh/(m² a)

EnerPHit

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

≤ 7.9 kBtu/(sf yr)

≤ 25kWh/(m² a)

Total energy used to heat or cool a building.

Source Energy

The Passive House Network

≤ 38 kBtu/(sf yr)

≤ 120kWh/(m² a)

EnerPHit

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

varies

Total energy used to heat or cool a building.

Heating Load

The Passive House Network

≤ 3.17 Btu/(h sf)

≤ 10W/m²

Heating energy can be supplied through ventilation system.

Airtightness

The Passive House Network

≤0.6 ACH_{50}

≤1.0 ACH_{50}

EnerPHit

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

Measured with a blower door in the field.

Component Targets

The Passive House Network

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

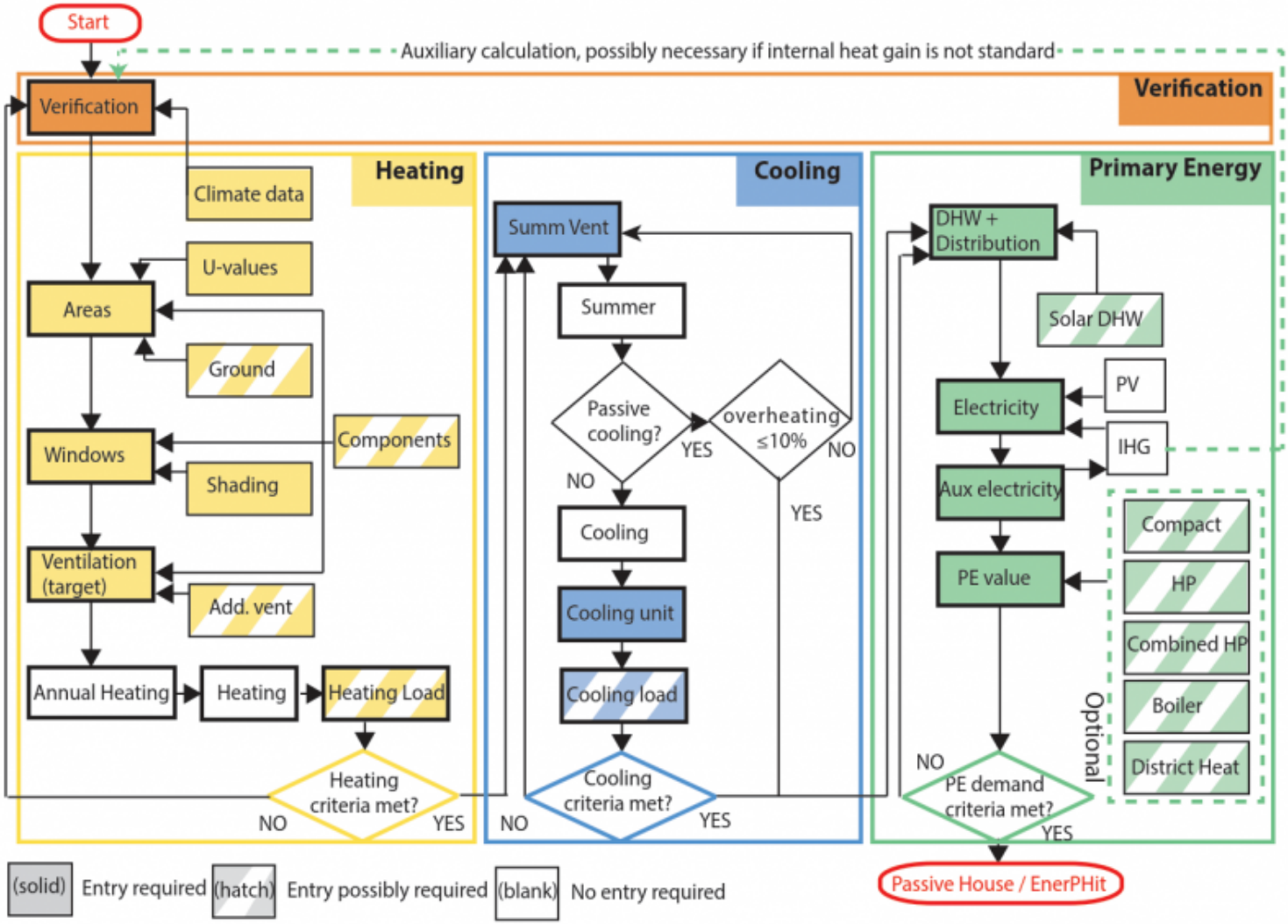
EnerPHit offers a Component Track.

Powerful Tool

Passive House Planning Package

Comprehensive Modeling

The Passive House Network



PHPP Variants

The Passive House Network

Variant calculation

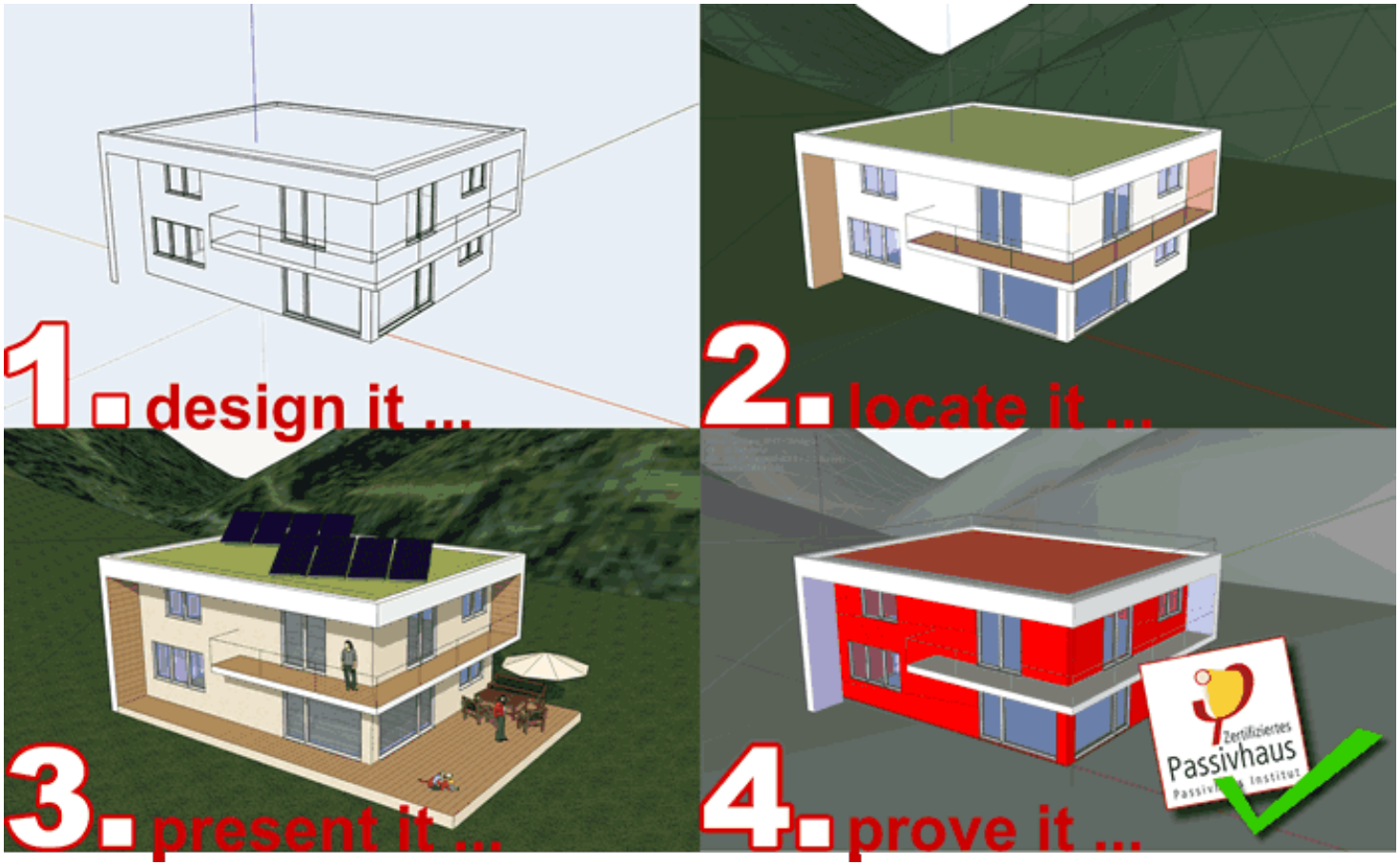
Semi Detached Example / Climate: Fairfield / TFA: 80 m² / Heating: 29.4 kWh/(m²a) / Freq. overheating: 0 % / PER: kWh/(m²a)

		Active				
	Select the active variant here >>>>>>>	6-Deep EWI (CO2 priority)	Base Case	Light	Deep IWI (Cost priority)	
Results	**Units**	6	1	2	3	
Heating demand	kWh/(m²a)	**29.4**	151.9	146.0	96.5	
Heating load	W/m²	**14.6**	67.2	52.0	33.8	
Cooling & dehum. demand	kWh/(m²a)					
Cooling load	W/m²					
Frequency of overheating (> 25 °C)	%	**0.0**	0.0	0.0	0.0	
PER demand	kWh/(m²a)					
Passive House Classic?	yes / no					
Final energy		-	-	-	-	
User determined results		-	-	-	-	
% solar and internal heat gains	%	0.4	14%	16%	20%	
total solar and internal heat gains	kWh/a	1743.3	1956.9	1956.8	1682.2	
solar heat gains	kWh/a	688.5	888.9	888.9	646.5	
internal heat gains	kWh/a	1068.1	1068.1	1068.1	1036.2	
U value Wall		0.087	1.351	0.471	0.318	

Input variables		**Units**	**Value**	**1**	**2**	**3**	
	Building assembly layers	U-Value					
a	Internal Wall Ins	W/(mK)	0.043	0.043	0.043	0.043	
		mm	0	0	0	100	
b	Cavity Wall Ins, PU	W/(mK)	0.032	0.281	0.032	0.281	Red is recently updated for Cost priority
		mm	50	50	50	50	
c	External Wall Ins	W/(mK)	0.032	0.032	0.032	0.032	
		mm	300	0	0	0	
d	Loft Ins over joists	W/(mK)	0.04	0.04	0.04	0.04	
		mm	250	100	150	150	
e	Suspended Floor Ins	W/(mK)	0.04	0.04	0.04	0.04	

VE and Alternates

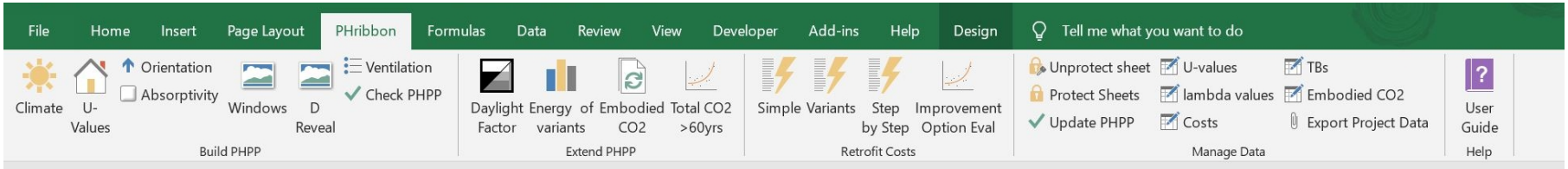
Design PH

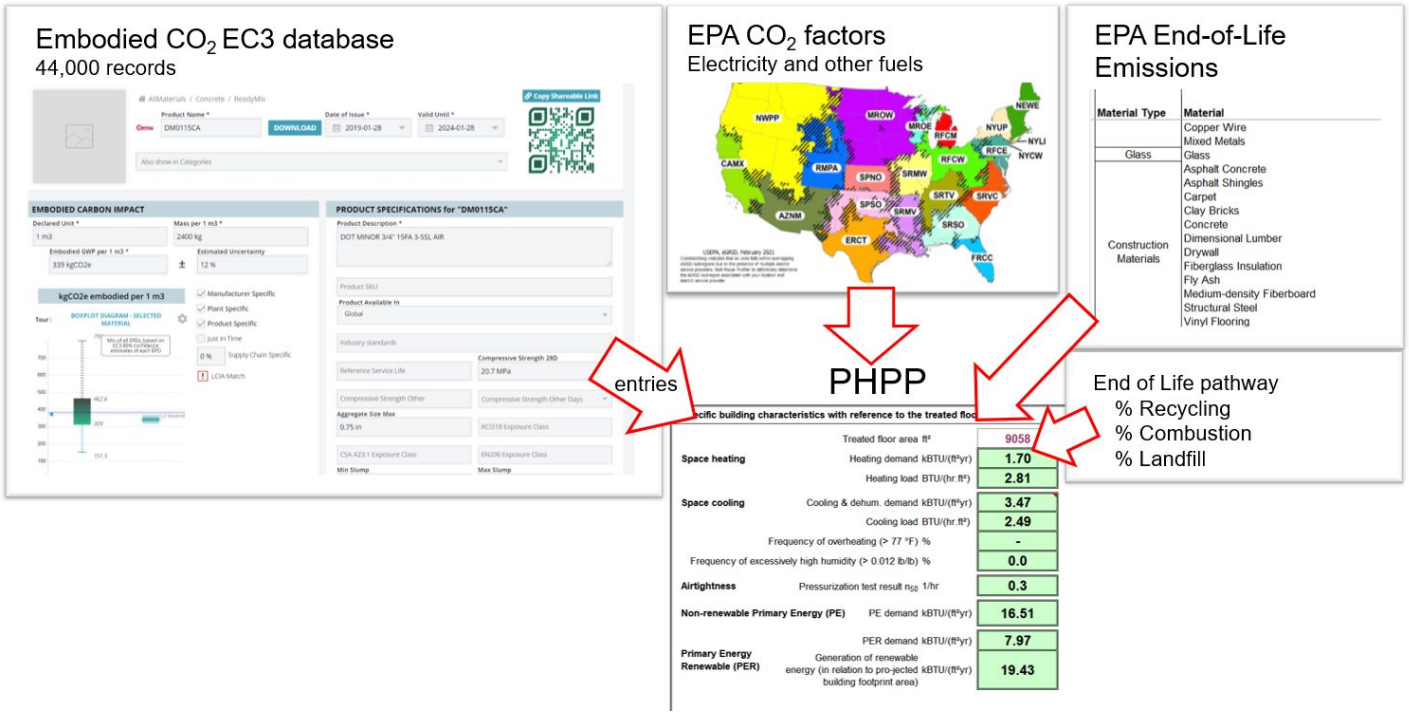


SketchUp to PHPP

PH Ribbon

The Passive House Network





Embodied Energy Calculation inside PHPP

Delivery

Principles and Metrics…

The Passive House Network

- Apply to all building types, anywhere in the world
- Are based on universal building science principles to deliver
  - optimized energy efficiency and a sustainable carbon footprint
  - superior human well-being and comfort
  - optimized life cycle cost
- Do not constitute an arbitrary, or proprietary approach and metrics
- Set absolute targets and provide measurable results with over 30 years of a proven track record, a vetted set of tools, countless case studies and field studies all over the world, and an engaged Institute stakeholder with practitioner organizations in many places in the world including the U.S.
- Are the foundation for Climate-neutrality in the built environment
- Are endorsed by the UN as a solution for the sustainable future of buildings

Resource: https://passivehouse.com, https://passivehouse-database.org/index.php?lang=en, https://theclimatecenter.org/north-americas-global-centres-excellence-building/

Delivery and Certification…

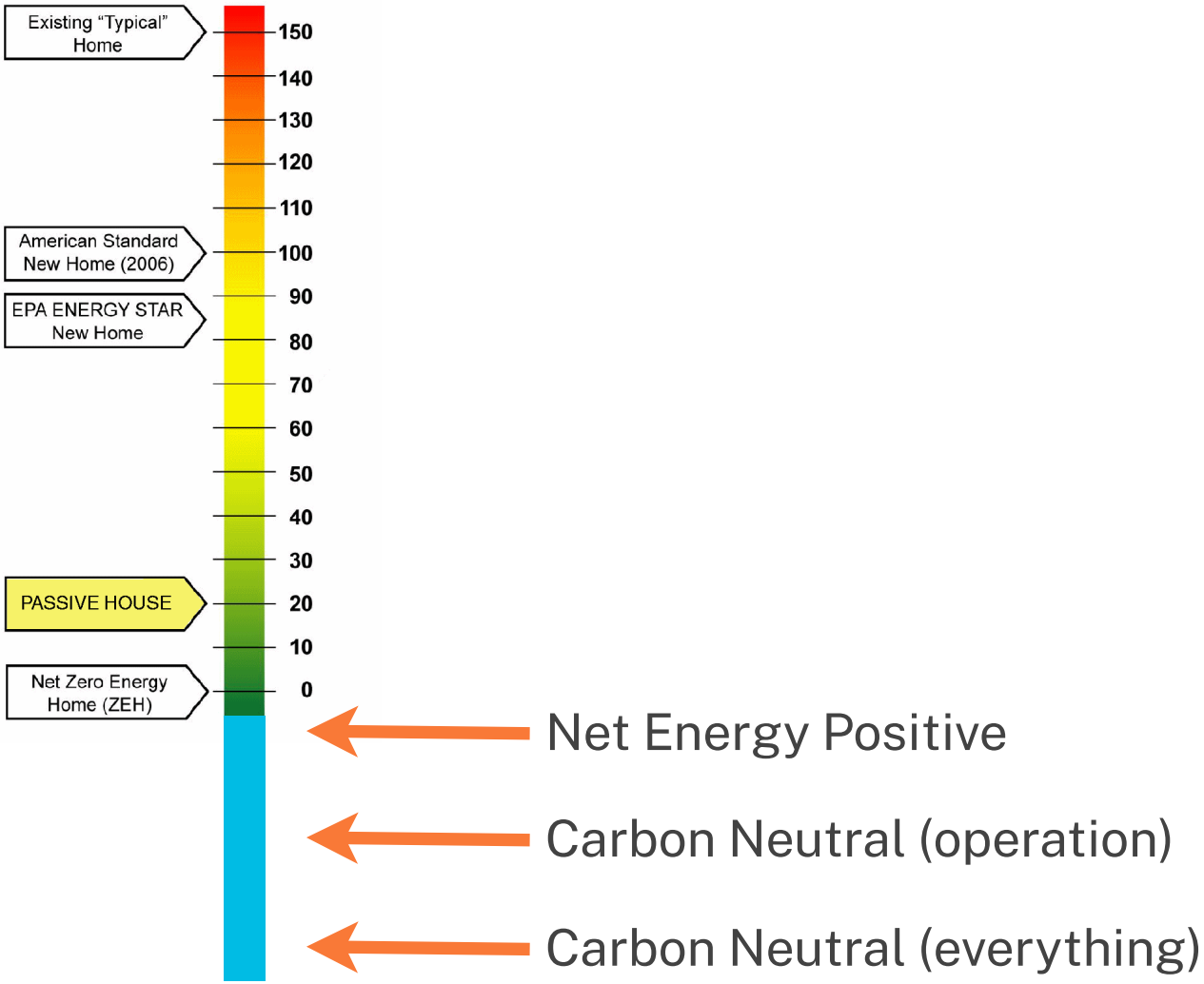
The Passive House Network

- Are most cost-effective when implemented right from the outset and executed with the help of trained and experienced professionals
- Do not rely on outside consultants and raters and can be integrated into the architectural practice
- Do not require certified practitioners, or building certification (project certification is not compulsory but advised and has proven to deliver better project outcomes when compared to non-certified projects)
- Are not prescriptive in regards to the design, engineering, construction and materialities of buildings, e.g. it provides a lot of flexibility to developers, architects and engineers
- Include modeling with the PHPP, which maximizes investment value through transparent accounting and reporting of meaningful results, as well as variant analysis
- Provide the best life-cycle cost in the industry

Key Benefits

Up to 80% of Energy Savings (Before Renewables)

The Passive House Network



HERS-Index-equation-from-RESNET-standards

Comfort

The Passive House Network

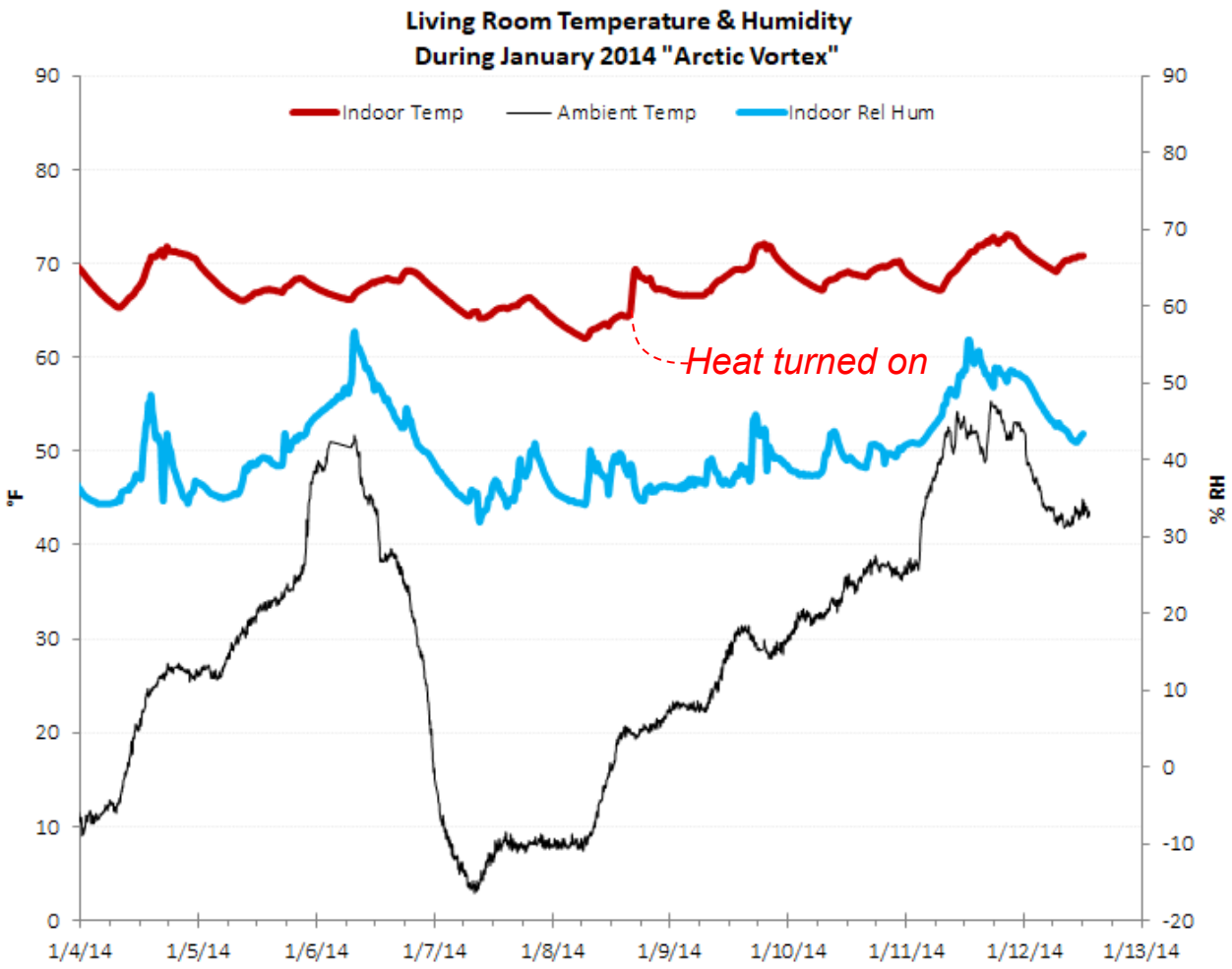
Steady Temperatures

Peace and Quiet

Controlled and Filtered Indoor Air

The Passive House Network

Resilience

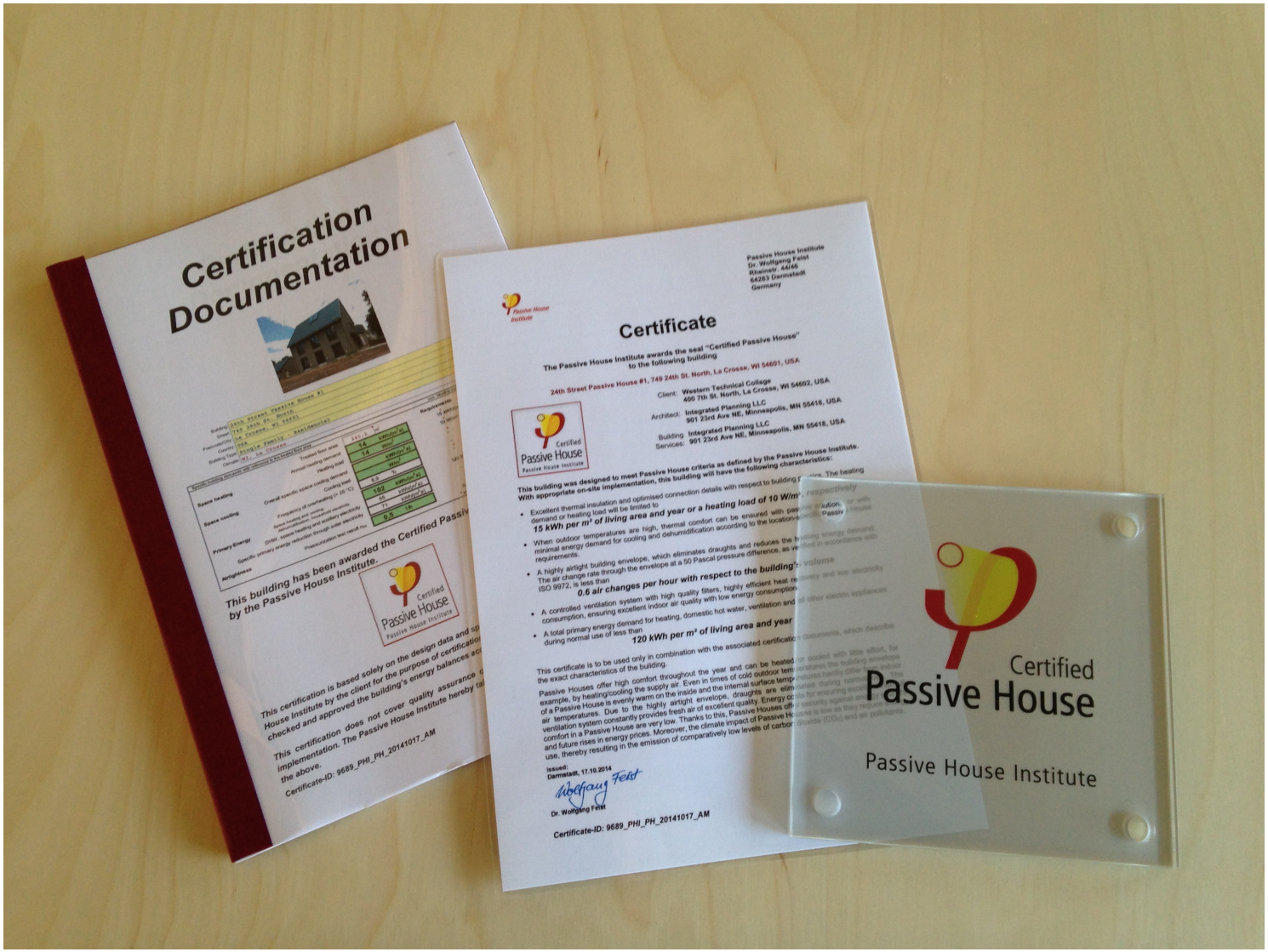


Cramer Silkworth, Baukraft Engineering, Brooklyn, NY

Economy

Third Party Verification

The Passive House Network



Building Quality

The Passive House Network

Smart Use of Resources

The Passive House Network

Environmental Justice

Meaningful Climate Action

The Passive House Network

Passive House and Code

Passive House Targets and Practices…

The Passive House Network

- Generally exceed energy code minimums
- Do not compete with energy codes
- Create more energy efficient, comfortable, economical, resilient, climate-appropriate and sustainable buildings than code minimums
- Have inspired Energy Codes and Reach Codes
- Have effectively become code in some markets

Passive House In Action: 4 Examples

The Passive House Network

Tools	Key Element	Brussels	New York	Vancouver	Pennsylvania
Policy	Top-down alignment of goals and policies	✓	✓	✓	✓
	Bold policies and plans	✓	✓	✓	
Codes	Step codes with time-dependent performance targets	✓	✓	✓	
	Passive House code compliance path	✓	✓	✓	
	Compliance targets based on performance metrics	✓	✓	✓	
	Energy modeling alignment	✓	✓	✓	
Catalysts	Leading by example	✓	✓	✓	✓
	Financial incentives	✓	✓	✓	✓
	Nonfinancial incentives	✓	✓	✓	
	Competitions for cash and other awards	✓	✓	✓	✓
	Early examples of success	✓	✓	✓	✓
Capacity	Outreach and awareness	✓	✓	✓	
	Workforce education and training	✓	✓	✓	
	Expert advisors	✓	✓	✓	
	Supply chain development	✓	✓	✓	

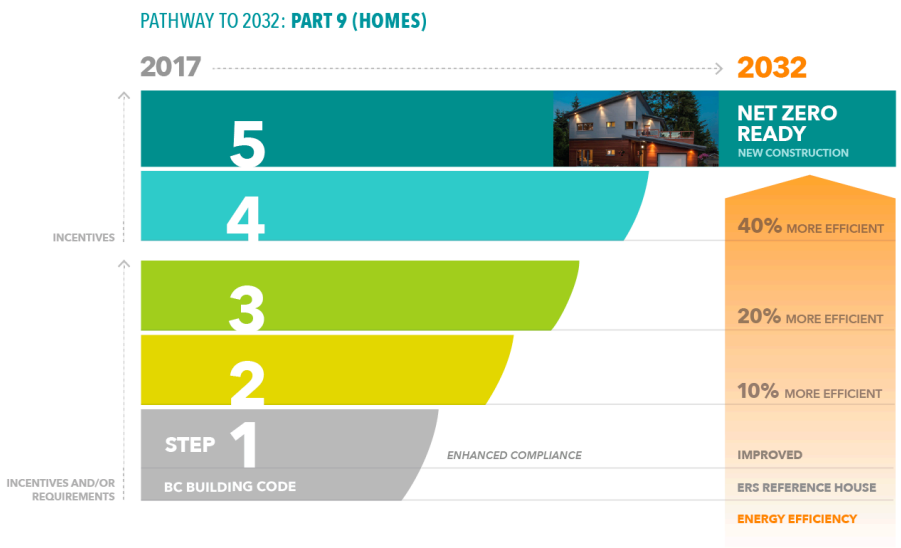
New York: Integrated State and Local Effort

The Passive House Network

- Aligned state and local goals, policy directives, and strategic plans
- Performance-based step codes – AND – alternative, compliance path for PH
- Time-dependent targets with penalties for noncompliance
- Outreach and stakeholder engagement
- Training and education funding
- Knowledgeable advisors
- Commitment to passive house strategies for all new and retrofit buildings
- Financial and non-financial incentives
- Requirement to provide performance and cost data
- Supply chain / market transformation support

British Columbia: Step Codes 2017-2032

The Passive House Network



*To comply with the BC Energy Step Code, builders must use **energy software modeling** and **on-site testing** to demonstrate that both their design and the constructed building meet the requirements of the standard. They may use any materials or construction methods to do so.*

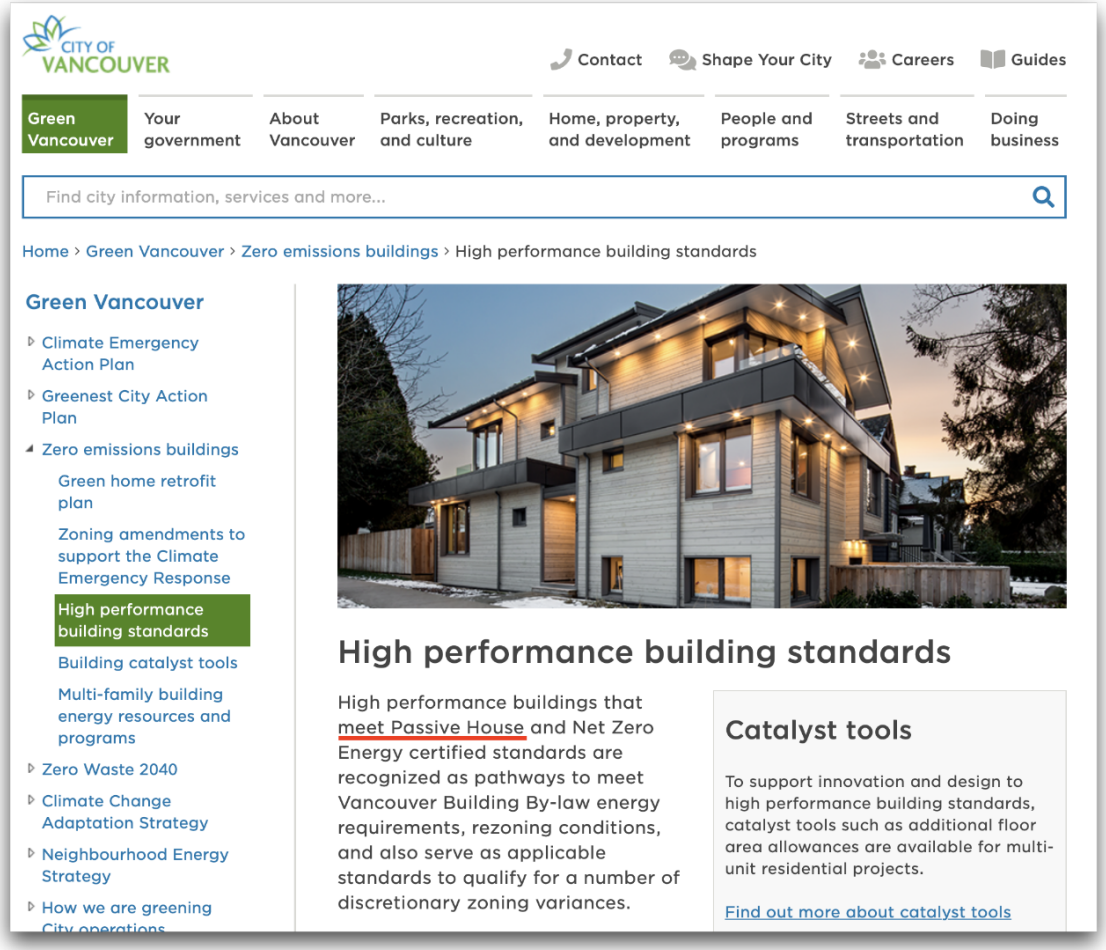
*This approach echoes that taken by many green-building certification programs, including Natural Resources Canada's Energy Star for New Homes™ and R-2000™ programs, and **Passive House Institute (in Darmstadt) certification**, as well as the Canadian Home Building Association's Net Zero Home™ and Net Zero Ready Home™ programs.*

Resource: http://www.energystepcode.ca/how-it-works/

City of Vancouver

The Passive House Network

With Passive House



Passive House and ASHRAE

BSR/ ASHRAE 227P: Passive Building Standard

The Passive House Network

This standard provides requirements for the design of buildings that have exceptionally low energy usage and that are durable, resilient, comfortable, and healthy. 227P can become reference and code-enforceable.

> 227P is based on, informed and inspired by the Passive House building energy standard (as well as PHIUS+ in the US).

Resource: https://www.ashrae.org/news/esociety/new-ashrae-passive-building-standard-to-boost-use-of-strategy

ANSI/ ASHRAE 140-2017

The Passive House Network

In January 2019, the Passive House Planning Package (PHPP) version 9.6 was successfully evaluated in accordance with ANSI/ASHRAE Standard 140, a comparative testing method for building energy programs.

> The results for the Passive House Planning Package energy modeling tool agreed very well with those of the reference software.

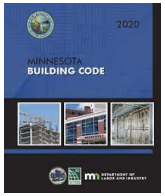
Resource: https://passiv.de/downloads/04_PHPP9_ASHRAE140_Summary.pdf

Passive House and Other Building Standards

Passive House…

The Passive House Network

- Is focused on
  - energy efficiency and carbon footprint
  - human comfort and well being
  - optimized life cycle cost and value
- Offers crosswalks and is s synergetic with other sustainable building standards

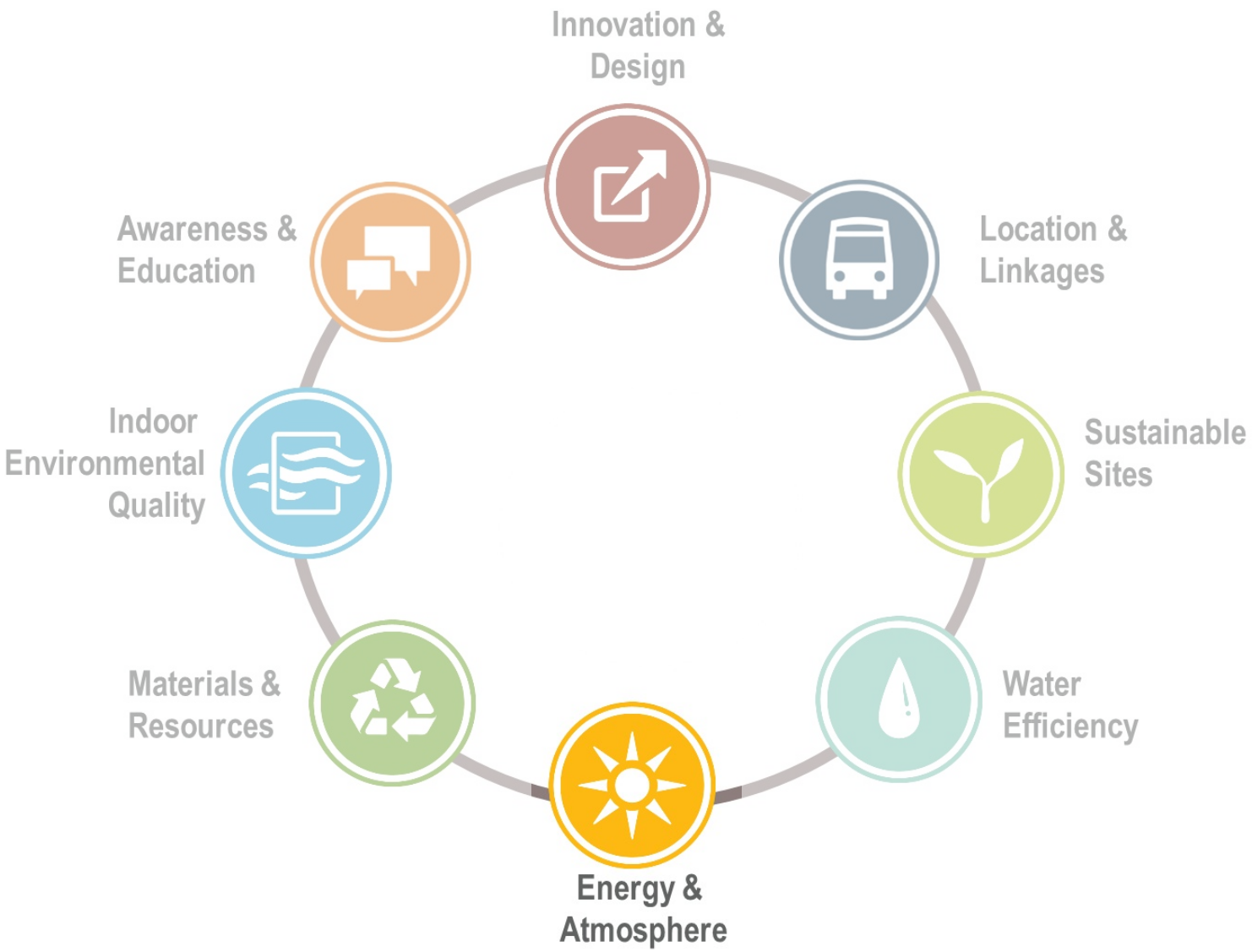


- Offers third-party certification (but does not require it)

Crosswalks

LEED - USGBC v4

The Passive House Network



LEED BD+C: New Construction

The Passive House Network

Percent Above ASHRAE 90.1-2010

Created on Jan 11, 2019 · LEED Interpretation

ID#10486 - Passive House Cert for v4

Climate Zones 1A, 2A: 24%

Climate Zones 2B, 3B: 27%

Climate Zones 3A, 4: 31%

Climate Zones 4C, 5: 30%

Climate Zones 6, 7, 8: 38%

Applicable Credits

Annual energy use

Energy & atmosphere

Up to 30 points

LEED BD+C: Multifamily Midrise ▪ V4 - LEED V4

Optimize energy performance

Energy & atmosphere

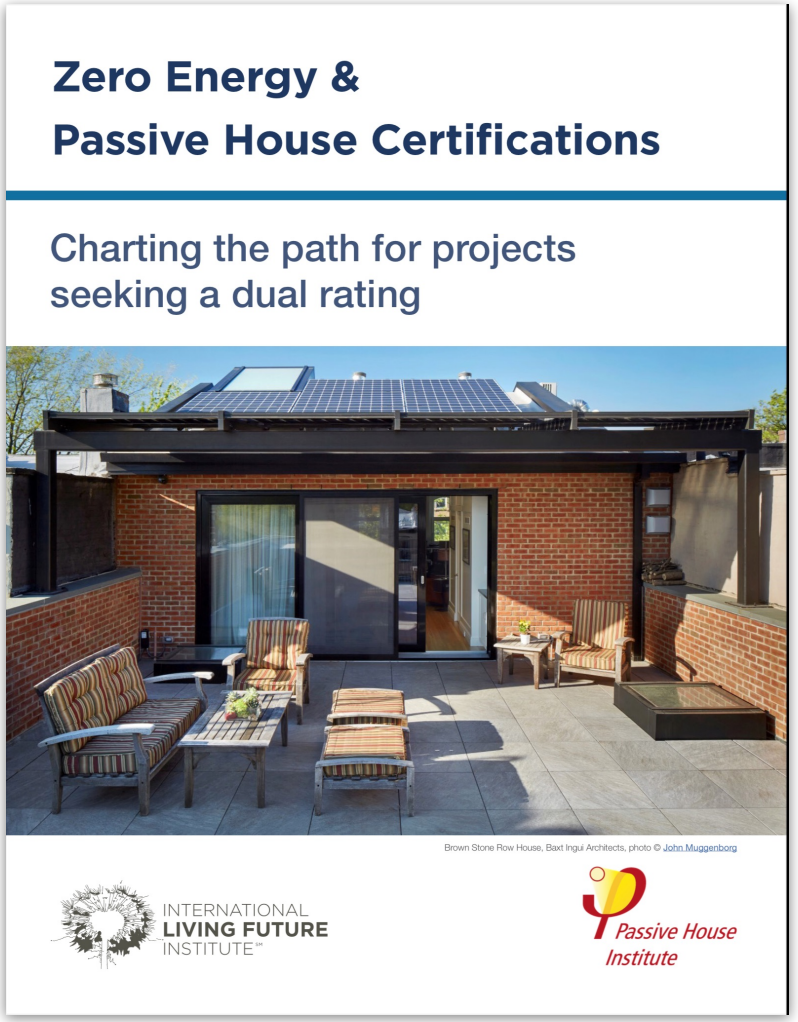
Up to 18 points

LEED BD+C: New Construction, LEED BD+C: Core And Shell, LEED BD+C: Warehouses And Distribution Centers, LEED BD+C: Hospitality ▪ V4 - LEED V4

ILFI: Living Building Challenge

ZERO ENERGY CERTIFICATION

LIVING BUILDING CHALLENGE™



Living Building Challenge

The Passive House Network

> This crosswalk between the International Living Future Institute (ILFI) and the PHI offers guidance for buildings seeking to benefit from both certification schemes by choosing the high energy efficiency of a Passive House complemented with renewables as a compliance pathway to reach Zero Energy.

Crosswalk:

- **Zero Energy (ZE) Certification:** "The annual site energy generation reported in PHPP can be used to predict potential achievement of ZE when compared to estimates of annual energy demand. (PHPP v9.6, PER worksheet, cell S85)
- Actual Performance: Validated after 12-month

Resource: https://living-future.org/wp-content/uploads/2019/07/ZeroEnergyPHI_Crosswalk.pdf

Enterprise Green Communities

The Passive House Network

> Passive House takes building performance further and delivers it with confidence; it enables strong control of the indoor environment (air quality, temperature and humidity comfort).

- **MN Overlay Criteria 5.2b: Moving to Zero Energy:**
  Near Zero Certification with PH certification (18 points)

Other Synergies:

- Healthy Living Environment via airtightness and ventilation with absolute performance targets
- Energy Efficiency via energy modeling and absolute performance targets
- Third party certification

Resource: https://www.enterprisecommunity.org/solutions-and-innovation/green-communities and http://mnhousing.gov/get/MHFA_247757

Minneapolis Sustainable Homes Policy

The Passive House Network

- Financial support of affordable single family certified Passive House homes in Minneapolis
- Ratified in 2020
- Total of $5M
- Up to 20% of cost, or max. $90k per unit

Synergies

Giga RESET

> Passive House enables superior and effective control of the indoor environment (air quality, temperature and humidity comfort) and energy efficiency of the building, which supports key parameters of the RESET standard.

- **Materials** via implied best practices for airtight building envelope
- **Air** via infiltration, airtightness and ventilation with absolute performance targets
- **Water** in regards to the energy efficiency of the water system
- **Energy** via the enhanced building envelope with energy efficiency targets
- **Circularity** (not directly)
- Third party certification

Resource: https://www.reset.build

IWBI: WELL

The Passive House Network

> Passive House enables superior and effective control of the indoor environment.

- **Infiltration management and air quality** via airtightness and ventilation with absolute performance targets
- **Thermal comfort, humidity and moisture management** via enhanced building envelope with energy efficiency targets
- **Combustion minimization** (Passive House buildings are more often than not all-electric)
- **Daylighting, operable windows and glare control** via passive solar and shading approach
- **External and internal noise** via building envelope and internal equipment noise requirements
- Third party certification

Resource: https://www.wellcertified.com

Energy Star and DOE Zero Energy Ready Home

The Passive House Network

> Passive House takes building performance further and delivers it with confidence; it enables strong control of the indoor environment (air quality, temperature and humidity comfort).

- Airtightness and ventilation with absolute performance targets
- Energy modeling and absolute performance targets with similar metrics
- Integration and accounting of renewables via Passive House Plus and Premium
- Third party certification

Resources:
Homes https://www.energystar.gov/newhomes?s=mega
Commercial Buildings https://www.energystar.gov/buildings?s=mega

B3, SB2030 and Architecture 2030

The Passive House Network

> A Passive House approach enables the design team to reach building performance targets sooner, with confidence, and **without the requirement for on-site renewable systems**.

Efficiency via energy modeling with absolute performance targets

- **Carbon-neutrality** via carbon-accounting with absolute targets (PER metric)
- **Embodied energy/ Carbon accounting** via phRibbon plugin
- Third party certification

Resources: https://www.b3mn.org/2030energystandard/ and https://architecture2030.org

B3 & SB2030

The Passive House Network

"Yes, Passive House certification can definitely be dovetailed into B3/ SB2030 projects and we encourage that approach because PH certification typically results in very high performance projects. We estimate that PH projects will often meet or even exceed SB 2030 required levels of on-site energy efficiency.

CSBR and CEE are working together currently to find a way to minimize redundancy between the two programs, for example by accepting standard PH energy models (PHPP or WUFI Passive) as a compliance path. "

Rolf Jacobson, U of M CSBR October 2021

2030 Challenge

The Passive House Network

Can I just buy renewable energy for my project and meet the 2030 Challenge?

No, Architecture 2030 advocates that the 2030 Challenge energy reductions be met firstly through energy-efficient design strategies. These are low-cost and/or no-cost options, which include proper orientation, daylighting and passive heating and cooling strategies, etc. Secondly, Architecture 2030 recommends applying energy-efficient technologies and systems, which include high-efficiency mechanical equipment and on-site renewable energy generation. Once all energy-efficient design strategies and technologies are exhausted, Architecture 2030 recommends purchasing off-site renewable energy and/or renewable energy credits for the project's remaining energy needs.

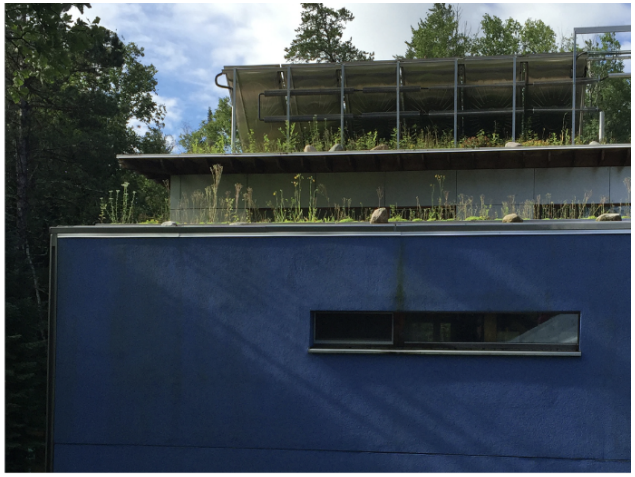
Examples and Key Benefits

Proof of Concept 2006: Waldsee BioHaus

The Passive House Network

Environmental Living Center

The Passive House Network



Field Data

The Passive House Network

10 Years of Data

Calculated Site Energy

- PHPP: 30.6 kWh/ (m^2 a), **9.7 kBTU/ sf year**

Meter Readings

- 2006-07: 47.3 (issue: storage tank removal)
- 2007-08: 36.8 kWh/ (m^2 a), **11.7 kBTU/ sf year**
- 2008-09: 36.0 kWh/ (m^2 a), **11.4 kBTU/ sf year**
- 2009-10: 32.9 kWh/ (m^2 a), **10.4 kBTU/ sf year**
- 2010-11: 31.9 kWh/ (m^2 a), **10.1 kBTU/ sf year**
- 2011-12: 32.3 kWh/ (m^2 a), **10.2 kBTU/ sf year**
- 2012-13: 31.5 kWh/ (m^2 a), **10.0 kBTU/ sf year**
- 2013-14: 33.3 kWh/ (m^2 a), **10.6 kBTU/ sf year**
- 2014-15: 33.8 kWh/ (m^2 a), **10.7 kBTU/ sf year**
- 2015-16: 31.3 kWh/ (m^2 a), **9.9 kBTU/ sf year**

Passive House Works in Cold Climates

The Passive House Network

- Trailblazing project
- Built and operational for over 15 years, now
- Demonstrates that the Passive House energy efficiency strategy delivers 90% reduction of heat load in very cold climates

Passive House works (even) in US climate zone 7!

Passivhaus Institut
Dr. Wolfgang Feist
Rheinstr. 44/46
D-64283 Darmstadt

Certificate

The Passive House Institute awards the building
das BioHaus - the Environmental Living Center at the Waldsee
8659 Thorsonveien NE, Bemidji, MN 56601, Minnesota/USA

Principal: **Concordia Language Villages**
8659 Thorsonveien NE, Bemidji, MN 56601, Minnesota/USA

Architect: **Intep, LLC**
301 White Street, Minneapolis/Watertown, MN 55388, Minnesota/USA

Mechanical Services: **Intep, GmbH**
Innere Wiener Strasse 11, D-81667 München, Germany

the certificate

Quality Approved Passive House

The planning of this building meets the criteria for Passive Houses set up by the Passive House Institute.
With appropriate execution it will conform to the following standards:

- The building features excellent heat insulation all around and first grade component joint details in regard to building physics. Estival sun protection has been considered. Heat requirement is limited to

15 kWh per m² living area and year

- The building shell features excellent air tightness proven according to ISO 9972 which guarantees to be free of draught as well as little energy consumption. Air change rate of the building shell at 50 pascal pressure differential is limited to

0,6 ach, in reference to the building's volume

- The building features a controlled ventilation system with high class filters, highly efficient heat recovery and low electric power consumption. Thus, excellent air quality together with low energy consumption are achieved.
- The demand in primary energy for heating, warm water, ventilation and household electricity totals with standard use less than

120 kWh per m² living area and year

This certificate is to be used together with the certification documents only. From these the precise data of the building can be obtained.

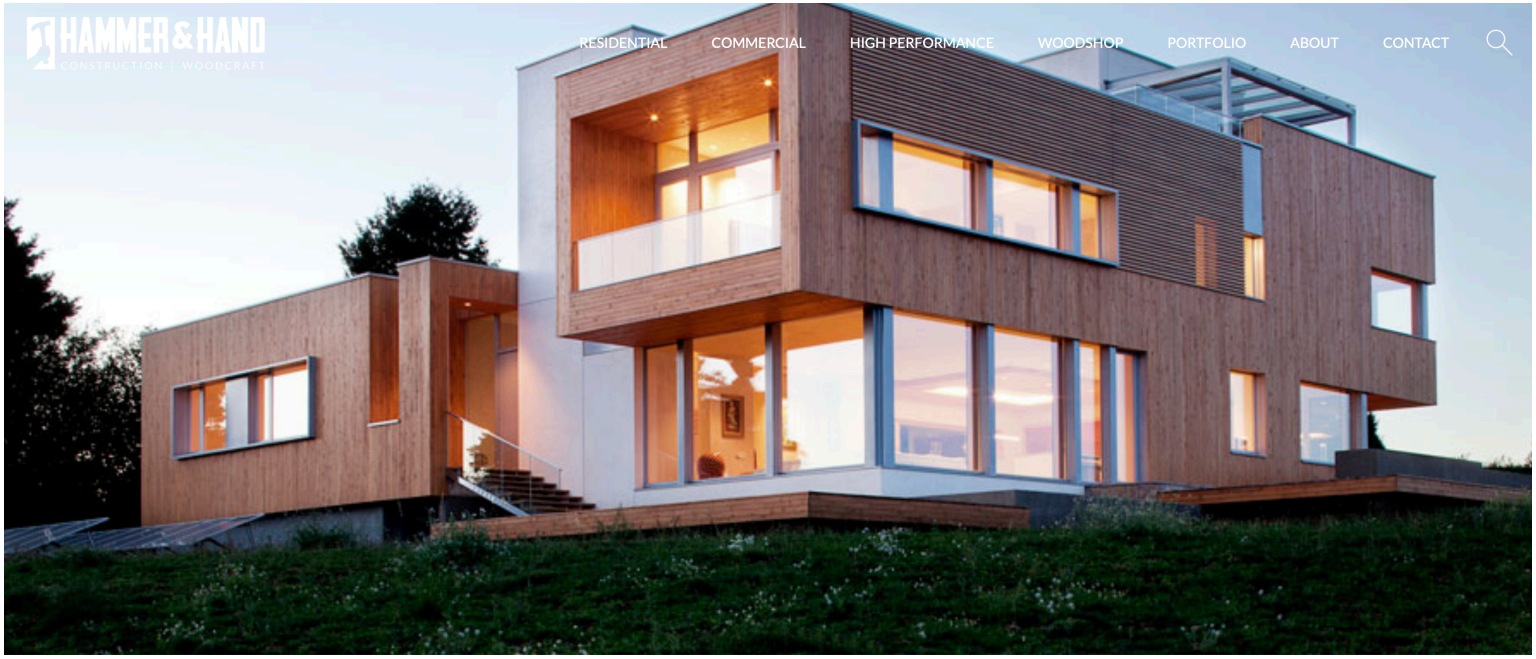
Passive Houses offer high comfort in summer as well as in winter conditions and can be heated with little effort, e.g. by heating of supply air. The building shell of a Passive House is evenly warm on the inside, inside surface temperatures are hardly different from room air temperatures. By means of the high grade air tightness drought appearance is impossible in normal use. The ventilation system steadily provides good air quality. Heating costs in a Passive House are very low. Due to little energy consumption Passive Houses offer a high rate security against future rise in energy prices and energy scarceness. Moreover the environment is ideally protected as energy ressources are spent very economically and only small amounts of carbondioxide (CO_2) and other concentrations are emitted.

issued:
Darmstadt, April 12, 2006

Dr. Wolfgang Feist

Synergy with Multiple Certifications

The Passive House Network



KARUNA HOUSE

CERTIFICATIONS:
Passive House,
Minergie-P-ECO,
LEED for Homes Platinum,
DOE Zero Energy Ready Home,
Earth Advantage Platinum

AWARDS:
2015 First Place, Single Family, PHIUS Passive Projects Competition
2014 Beyond Green Award, National Institute of Building Sciences,
2014 Green Home of the Year Award, Green Builder Magazine, "Best Building Science,"
2013 AIA Portland Design Award, 2030 Challenge, Excellence in Residential Net-Zero

Designed by Holst Architecture, Built by Hammer & Hand

Passive House + LEED

The Passive House Network

ZeroEnergy DESIGN

HOME PORTFOLIO SERVICES FI

PASSIVE HOUSE RETREAT - NEW ENGLAND

This private retreat and vacation residence located in a beautiful community on the New England coast features high performance and efficient use of space in a small package.

The client sought a two bedroom, two bath home that was right sized for their family - nothing more, nothing less. They also had a goal of minimizing the home's energy use.

PASSIVE HOUSE. A sleek, simple, gable roofed structure was designed and proposed with the Passive House standard, which is a building performance standard that yields an extremely low-energy home. A combination of exceptional insulation, air sealing, high performance windows, and solar gain reduces the space conditioning requirements to a mere fraction of a typical home, and uses only a very small heating system. The clients, whose extended families

SERVICES

PASSIVE HOUSE DESIGN

IMAGES

Photo Gallery

CERTIFICATIONS

U.S. GREEN BUILDING COUNCIL LEED GOLD USGBC

PH + PHIUS + GreenStar

The Passive House Network

PH + Enterprise Green Communities

The Passive House Network

Organization Name: Curtis + Ginsberg Architects
Project Title: Beach Green Dunes II
Project Location: Far Rockaway, Queens

EnerPHit Pilot Project

The Passive House Network

Certificate

Certificate ID: 5583_PHI_EP-Pilot_20130110_STh

Passive House Institute
Dr. Wolfgang Feist
Rheinstraße 44/46
64283 Darmstadt, Germany

The Passive House Institute hereby awards the EnerPHit Pilot Project certificate to the following building:

EnerPHit Pilot Project in Minneapolis, 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA

EnerPHit Pilot Project
Passive House Institute

Client:	Paul&Desiree Brazelton 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA
Architecture:	Tim Eian - TE Studio, Ltd. 212 2nd St.SE #222, MN 55414 Minneapolis, USA
Building Services:	TE Studio, Zehnder USA, Paul Brazelton

This building was designed to meet the Passive House component energy retrofit criteria as defined by the Passive House Institute Darmstadt. Given appropriate on-site implementation, this building has the following characteristics:

Building characteristics:	Achieved	Required	
Annual specific space heating demand	27 kWh/(m²a)	≤ 25 kWh/(m²a)	-[1]
Annual specific primary energy demand[2] for heating, DHW, ventilation and all other electric appliances for standard use	120 kWh/(m²a)	≤ 134 kWh/(m²a)	✓
Airtightness of building envelope n_{50} as per test result	0.7 h^{-1}	≤ 1.0 h^{-1}	✓
Mean value of individual building component thermal protection :			
Exterior insulation to ambient Thermal transmittance (U-value)	0.11 W/(m²K)		✓
Exterior insulation to ground Thermal transmittance (U-value)	0.17 W/(m²K)		-
Interior insulation to ground Thermal transmittance (U-value)	0.17 W/(m²K)		✓
Thermal bridges Δ_U Building envelope (window installation excluded)	0.01 W/(m²K)	No limiting value	
Windows Thermal transmittance $U_{w,installed}$	0.77 W/(m²K)		✓[2]
Exterior doors Thermal transmittance $U_{d,installed}$	0.79 W/(m²K)		✓
Ventilation unit Effective efficiency of heat recovery	89 %		✓

[1] Limiting value is not relevant. [2] Improved windows ($U_{w,installed}$ = 0.65 W/(m²K)) are recommended in order to meet comfort criteria in winter conditions as optimal thermal comfort directly near window areas cannot currently be guaranteed. Thick curtains or use of floor heating is thus recommended.

Certification criteria met? Selection of the evalulation method		
	Space heating demand	
	Component quality	✓

issued:
Darmstadt, 10.01.2013

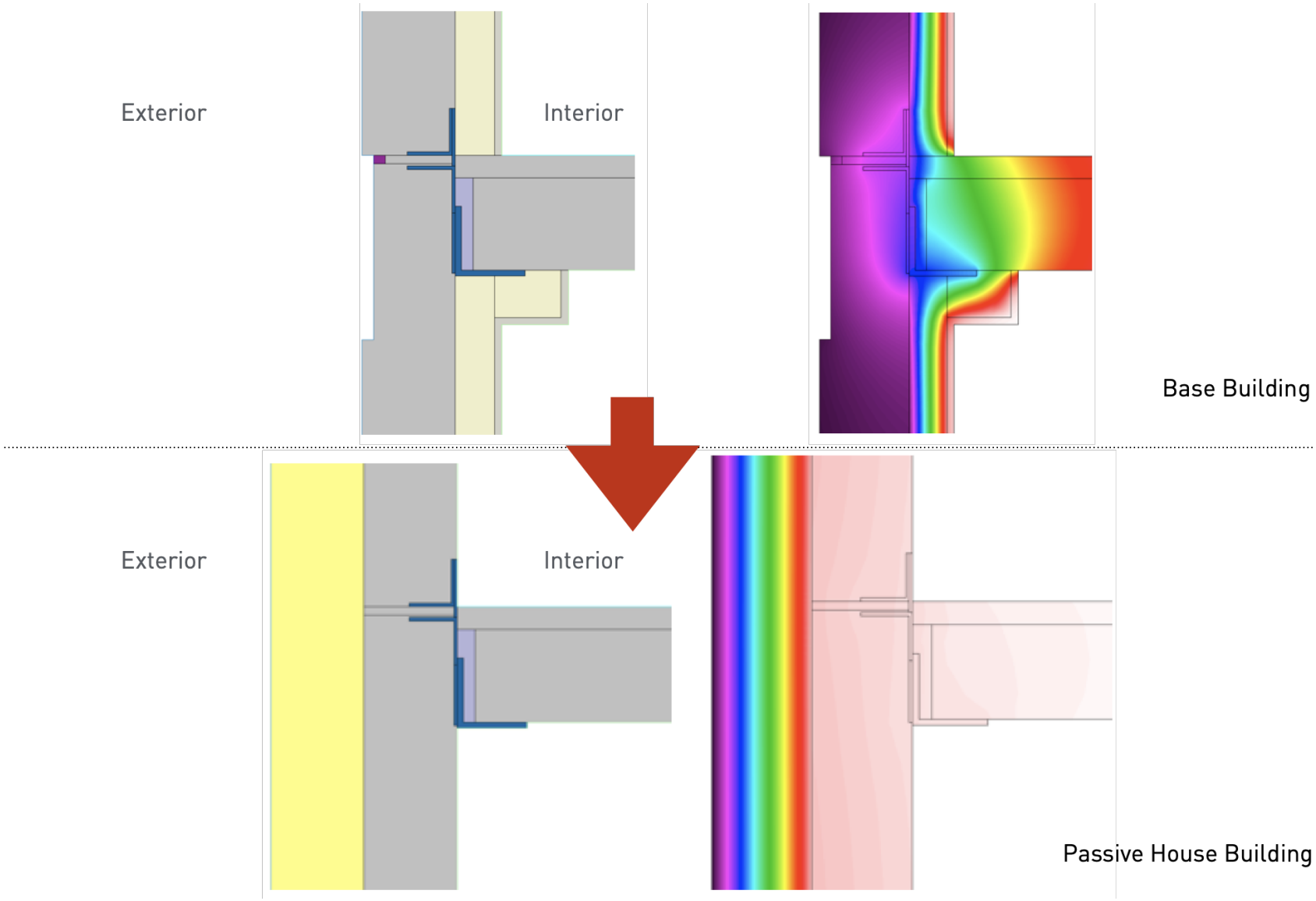
Dr. Wolfgang Feist

State of South Dakota: Student Housing

The Passive House Network

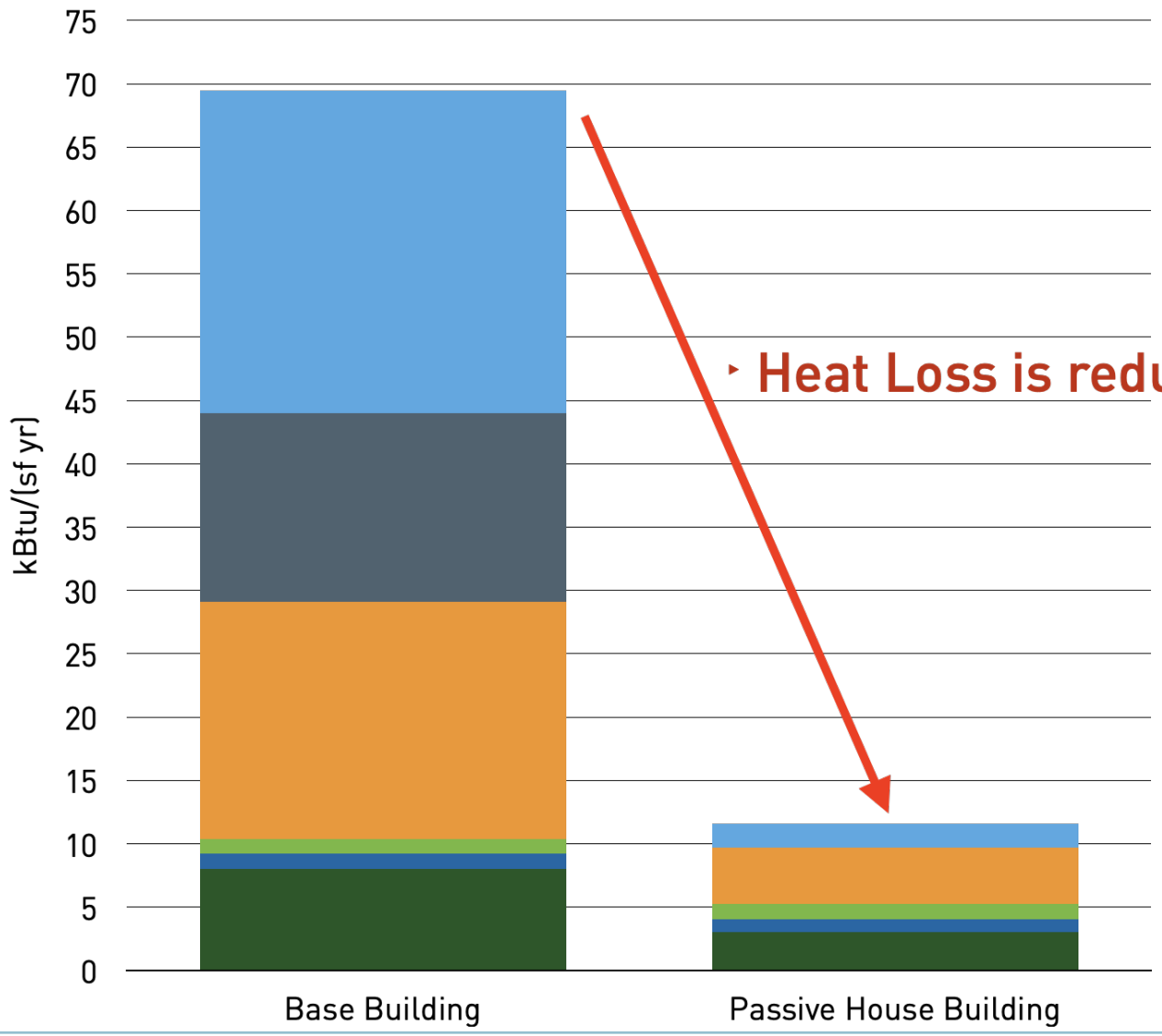
Thermal Bridges are a Big Problem

The Passive House Network



Lower Heat Loss

The Passive House Network

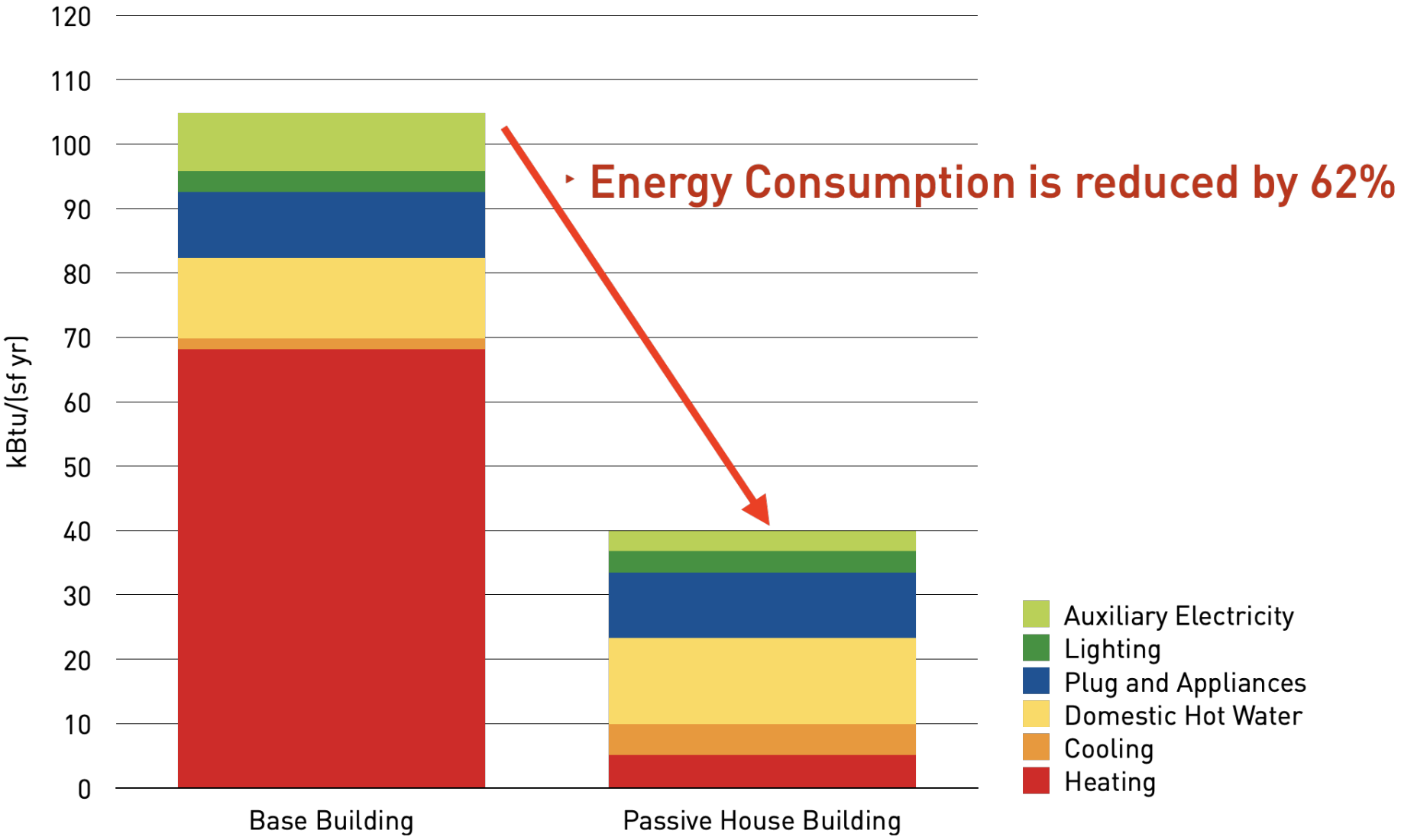


- LEED causes building to be over-ventilated!
- Major thermal bridges
- Poor R-values
- Poor components

- Heat Loss is reduced by 72%

Lower Energy Consumption

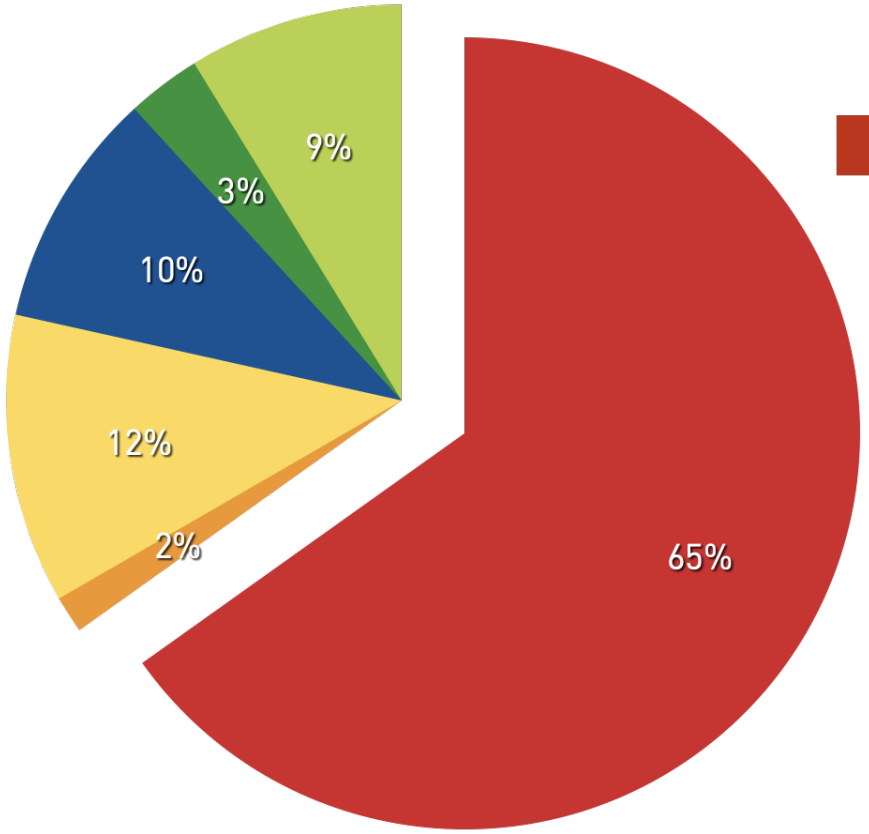
The Passive House Network



Sustainable Energy Loads and Flow

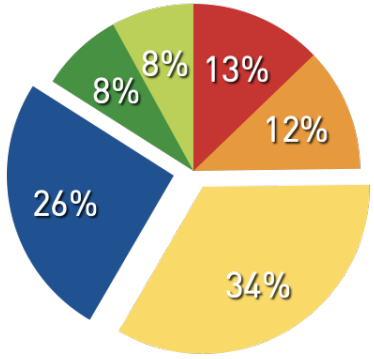
The Passive House Network

Base Building



Heating
Cooling
Domestic Hot Water
Plug and Appliances
Lighting
Auxiliary Electricity

Passive House Building

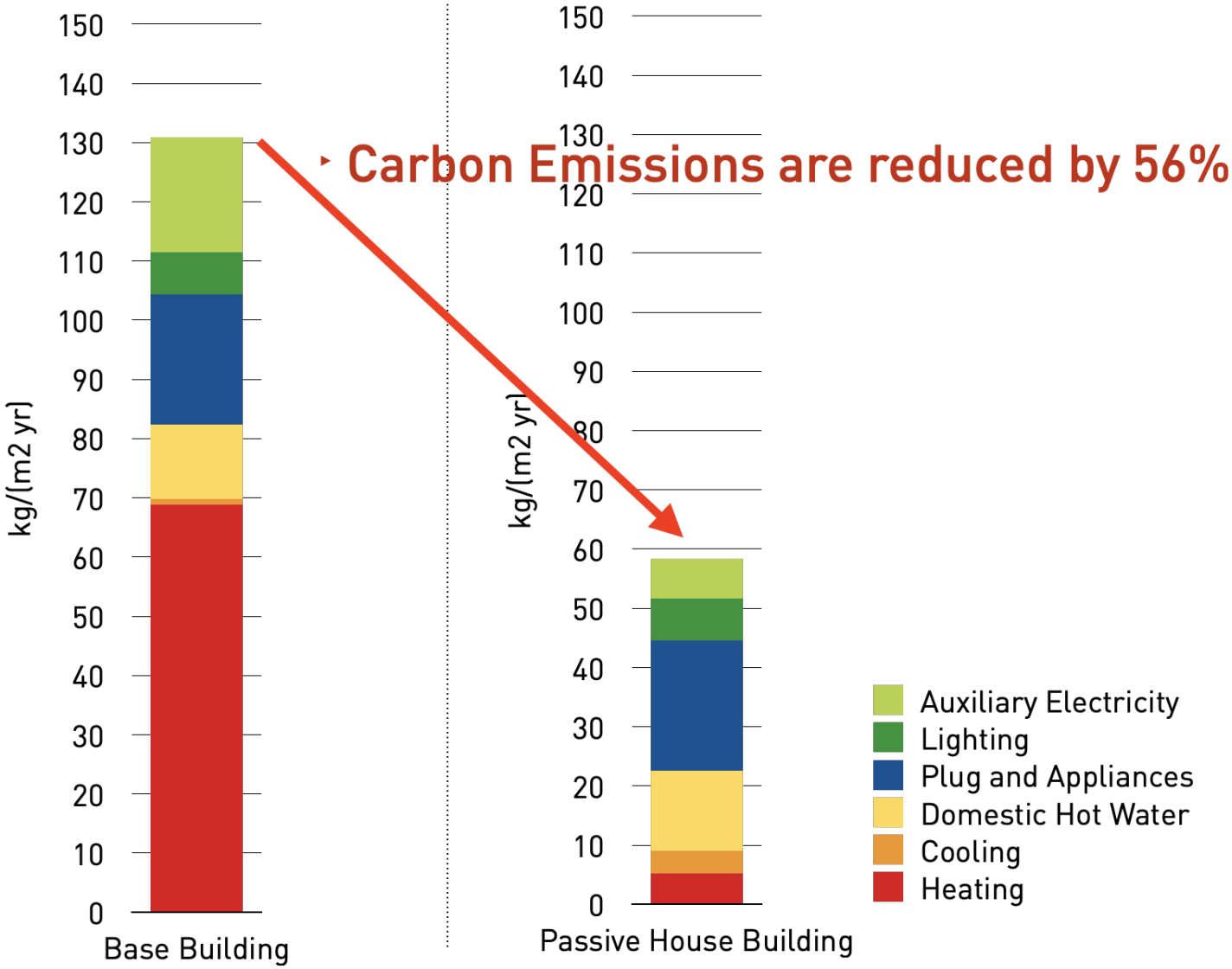


➡ Focus on heating load

➡ Focus on plug loads and domestic hot water

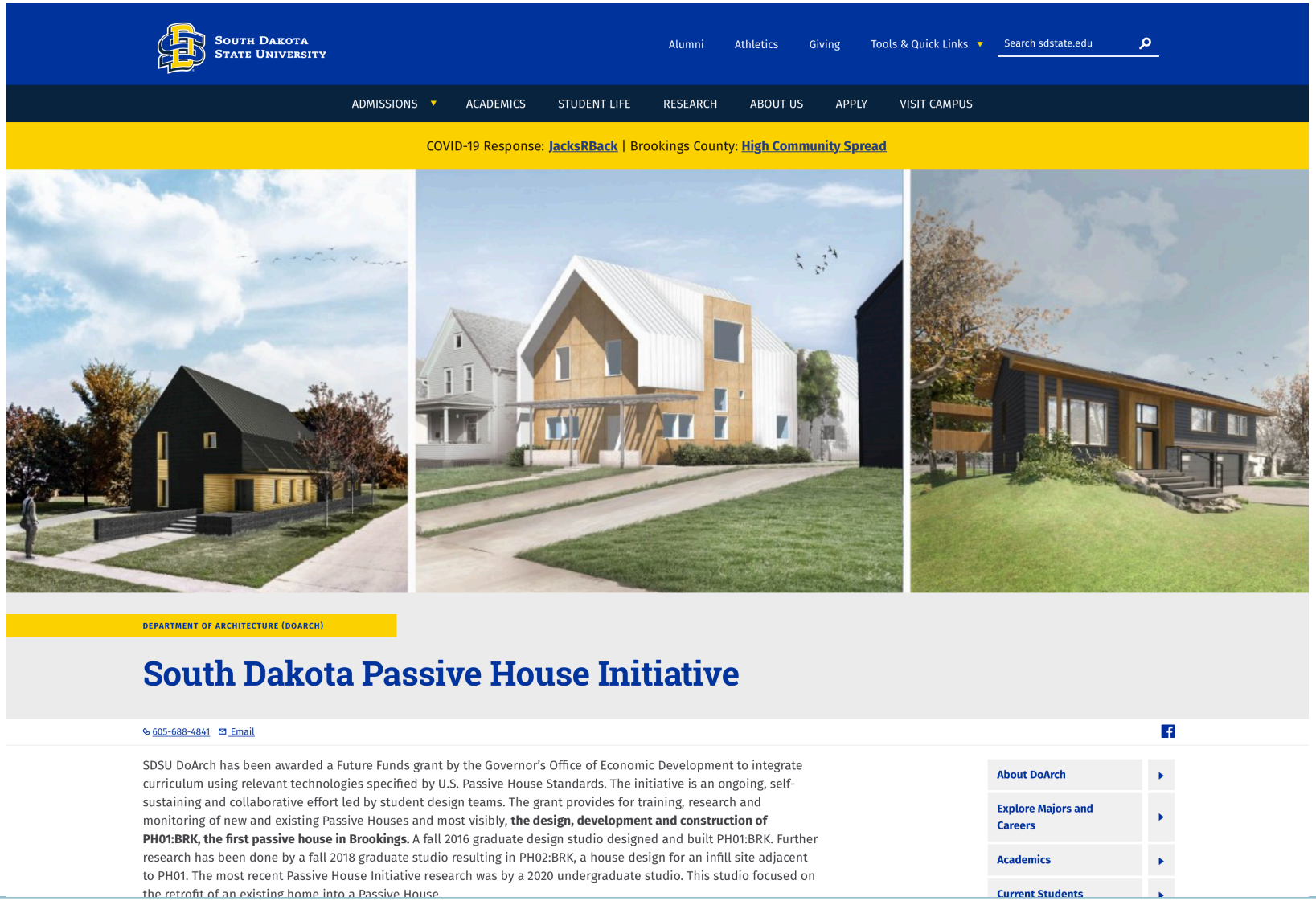
Lower Carbon Emissions

The Passive House Network



South Dakota Passive House

The Passive House Network



Good Energy Haus: Passive House Plus

The Passive House Network

Negative HERS with Passive House

The Passive House Network

DPIS BUILDER SERVICES
SINGLE SOURCE SOLUTION

Generic (Generic)
3406 Benjamin St NE
Minneapolis, MN 55418

HouseRater ID: #143659
Builder: Tanner Construction LLC
Building Code: ICF MN Baseline
Gas Utility: Not Installed
Electric Utility: Xcel Energy
Site Walk Date: 2/10/2020
Inspected By: Matt Dries

HERS INDEX: -8

10 20 30 40 50 60 70 80 90 100

Zero Energy Building (0) **American Standard Building (100)**

RESNET Ratings provide a relative energy use index called the HERS Index, which represents the home's energy usage as a percentage of the energy usage of the "American Standard Building."

PERCENT BETTER THAN CODE

Total Energy usage	65.55%
Natural Gas usage	NaN%
Electric usage	65.55%

Rebate Programs

Xcel MN Electric

$115 Electric

$115 Est. Total Rebate

Certificate

Certified Passive House Plus

Herz & Lang GmbH
Die Planer für energieeffizientes Bauen
Ritzensonnenhalb 5a
87480 Weitnau, Germany

Authorised by:
Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Good Energy Haus
3406 Benjamin St. NE, 55418 Minneapolis, USA

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

Client	Amy & Tim Eian 3406 Benjamin St. NE 55418 Minneapolis, United States of America
Architect	TE Studio, Ltd. 901 23rd Ave. NE 55418 Minneapolis, United States of America
Building Services	TE Studio, Ltd. 901 23rd Ave. NE 55418 Minneapolis, United States of America
Energy Consultant	TE Studio, Ltd. 901 23rd Ave. NE 55418 Minneapolis, 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 Plus' standard:

Building quality			This building		Criteria	Alternative criteria
Heating						
	Heating demand	[kWh/(m²a)]	14	≤	15	-
	Heating load	[W/m²]	19	≤	-	10
Cooling						
	Cooling + dehumidification demand	[kWh/(m²a)]	6	≤	15	15
	Cooling load	[W/m²]	9	≤	-	10
	Frequency of overheating (> 25 °C)	[%]	-	≤	-	
	Frequency of excessively high humidity	[%]	0	≤	10	
Airtightness						
	Pressurization test result (n_{50})	[1/h]	0.2	≤	0.6	
Non-renewable primary energy (PE)						
	PE demand	[kWh/(m²a)]	80	≤	-	
Renewable primary energy (PER)						
	PER-demand	[kWh/(m²a)]	37	≤	45	37
	Generation (reference to ground area)	[kWh/(m²a)]	104	≥	60	48

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

Weitnau, 30. October 2020
Certifier: Florian Lang - Raphaël Vibert, Herz & Lang GmbH

www.passivehouse.com 28430_HuL_PH_20201030_FL

Bright Haus: Affordable Housing

The Passive House Network

MINNESOTA green communities™

PHI Low Energy Building

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

Hook and Ladder Apartments, MPLS

The Passive House Network

More Resilient Building Envelope

The Passive House Network

Building Envelope	Base	Passive House
Exterior Walls	R-22 (h sf °F)/Btu	R-45 (h sf °F)/Btu
Roof	R-40 (h sf °F)/Btu	R-65 (h sf °F)/Btu
Slab	R-10 (h sf °F)/Btu	R-25 (h sf °F)/Btu
Windows	U-Factor: 0.30 Btu/(h sf °F) SHGC: 30%	U-Factor: 0.14 Btu/(h sf °F) SHGC: 26%
Thermal Bridges	No consideration	Thermal bridge free design
Airtightness	No consideration	ACH_{50}: 0.2 $^{1}/_{h}$ (Preset and field-measured)

Lower Site Energy

The Passive House Network

	Heating Energy (kBTU/ yr)	Total Energy (kWh/ yr)	Total Energy (kBTU/ yr)	Energy Use Index (kWh/ gsf)	Energy Use Index (kBTU/ gsf)
US existing					78.8
Base	116,360	581,254	1,983,795	9.5	32.6
Passive House	3,792	196,024	669,021	3.2	6.6
Passive House Savings Potential	**-112,568 (-97%)**	**-385,230**	**-1,314,774**	**-66%**	**-66% (-92% vs. existing)**

- **Site Energy Demand is reduced by 66%, or more**

Lower Source Energy

The Passive House Network

	Total source energy (kWh/ yr)	Source Energy Use Index (kWh/ gsf)	Source Energy Use Index (kBTU/ gsf)
US existing			127.9
Base	1,106,432	18.2	62.0
Passive House	401,686	6.6	22.5
Passive House Savings Potential	**-704,746**	**-64%**	**-64% (-82% versus existing)**

- **Source Energy Demand is reduced by 64%, or more**

Lower Carbon Emissions

The Passive House Network

	Total CO_2 Impact (tons CO_2 equ.)	CO_2 Impact Index (kg CO_2 equ./ gsf)
Base	184	3.03
Passive House	109	1.79
Passive House Savings Potential	**-75**	**-41%**

- **Carbon Emissions are reduced by 41%, or more**

Lower Energy Cost

The Passive House Network

	Cost Index ($/ gsf)
Base	0.482
Passive House	0.328
Passive House Savings	**-32%**

- **Energy Cost are reduced by 32%, or more**

Lower Life Cycle Cost

The Passive House Network

	60 years	50 years	40 years	30 years	20 years	10 years
Passive House savings potential (high)	6.36%	7.03%	3.95%	3.13%	1.31%	-5.40%
Passive House savings potential (low)	11.95%	12.87%	9.00%	8.63%	6.05%	-0.08%

- Life Cycle Cost are cheaper than conventional building.

Elliot Tower, MPLS (EnerPHit)

The Passive House Network

EnerPHit

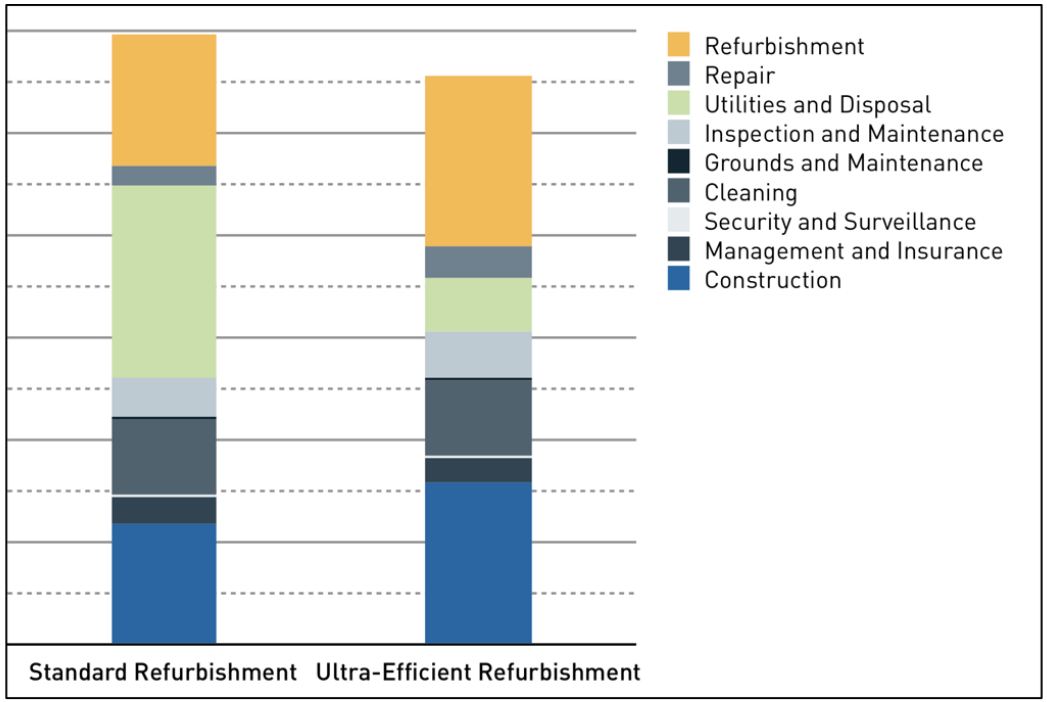
Quality-Approved
Energy Retrofit with
Passive House Components
Dr. Wolfgang Feist

Ultra-Efficiency Paradigm Shift

The Passive House Network

Cheaper Than a Conventional Fix

The Passive House Network



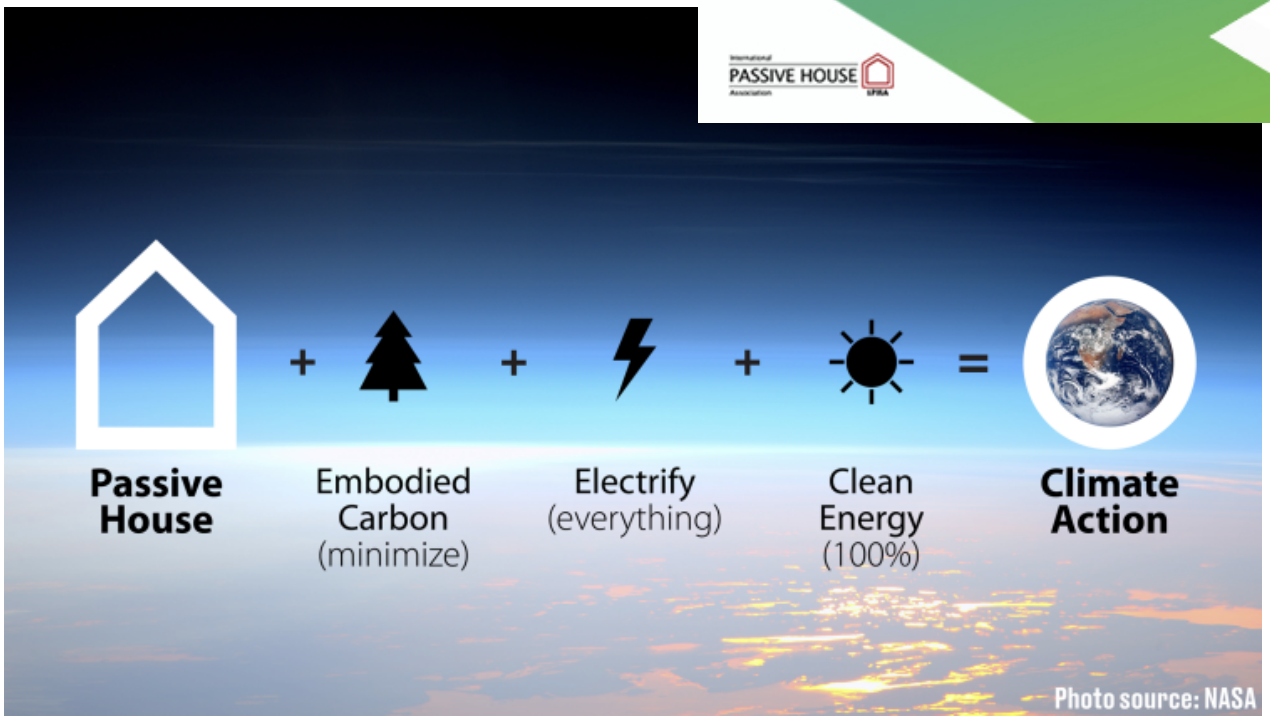
	60 years	50 years	40 years	30 years	20 years	10 years
Savings Potential	7.8%	**6.9%**	3.8%	4.9%	2.5%	-9.5%

- Life Cycle Cost are cheaper than "just fixing" the building.

Passive House and Climate Neutrality

Passive House = Foundation for Climate Action Plans

The Passive House Network



Resources

Learn More. Connect to the Community.

The Passive House Network

PASSIVE HOUSE MINNESOTA

local news + education + training + advocacy + network + first stop for national and international community connection
passivehouseminnesota.org

The Passive House Network

North American news + online resources + education + training + conferences + network + youtube
passivehousenetwork.org

International PASSIVE HOUSE Association iPHA

PASSIPEDIA The Passive House Resource

International news + online resources + education + software + international conferences + international connection
passivehouse-international.org/
passipedia.org/

PASSIVE HOUSE ACCELERATOR

weekly spotlight series + online resources + network + youtube + podcast
passivehouseaccelerator.com

THANK YOU

The Passive House Network

www.passivehousenetwork.org

PHMN PASSIVE HOUSE MINNESOTA

www.passivehouseminnesota.org

Passive House Institute

International PASSIVE HOUSE Association iPHA

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