Intro to Passivhaus

Bringing German Energy Design Home (to where it all began)

Alaska, 2012

Image credit: http://spacesplacesandfaces.ca/2011/02/10/february-10-2011-canadas-first-passive-house

Intro & History

What is a Passive House and why should I care?
What is the big deal?
How does it work?
A very brief history
Why is this German?
Certification and organizations

Image credit: Karawitzarchitecture.com, architekten-stein-hemmes, key-architects.com

What is Passive House and why should I care?

First, let me sell you a car…




Here are the ‘MUST HAVE’ green features:

Bamboo fabric seats

A bike rack

Recycled tires

Low VOC ‘green’ paint

Images:http://www.google.com/search?q=hummer+images&hl=en&rlz=1C1AVSX_enUS382US384&prmd=ivnsfd&tbm=isch&tbo=u&source=univ&sa=X&ei=8_xfTrSkOoLeiAK-7YDTDg&ved=0CCcQsAQ&biw=1252&bih=632

That could be a Tesla Model S…

Image credit: http://www.pickaride.com/articles/nyc-hummer-limousine-rental-service-nyc-hummer-limousine-rental-service.html

Or a Hummer!

Isn’t this one Public Transport…?

What is missing is the Miles Per Gallon

(or Kilometers Per Liter!)

Image credit: http://www.pickaride.com/articles/nyc-hummer-limousine-rental-service-nyc-hummer-limousine-rental-service.html

Passive House = MPG!

'Passive House' is *not an energy standard* but an integrated concept assuring the highest level of comfort.

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

These are the numbers that make that possible:

Heating Energy Use:	15 kWh/m^{2}yr or 4.75 kBTU/hr.ft^2
Peak Heat Load:	10 W/m^2 or 3.2 BTU/hr.ft^2
Total Primary Energy Use:	120 kWh/m^{2}yr or 38 kBTU/ft^{2}yr
Air-tightness:	n_{50} < 0.6 ACH (a typical residence is 5)

Text quotes: http://passipedia.passiv.de/passipedia_en/basics/the_passive_house_-_definition

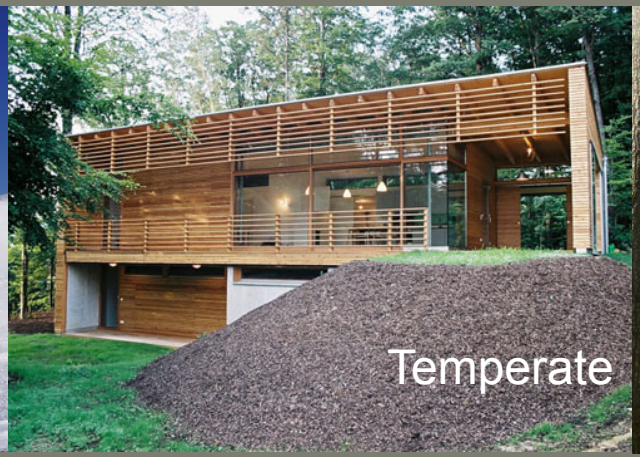
PH applies to any building type, style and size

HAUS means ‘building’

Image credits: Riedberg School, Dorm and Duplexes, all in Frankfurt: Bronwyn Barry. Offices: unknown

And works for any climate…

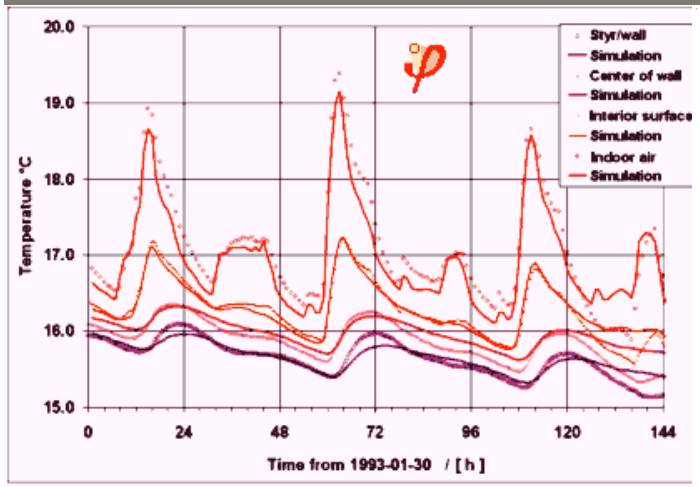
Hot, cold, humid or dry

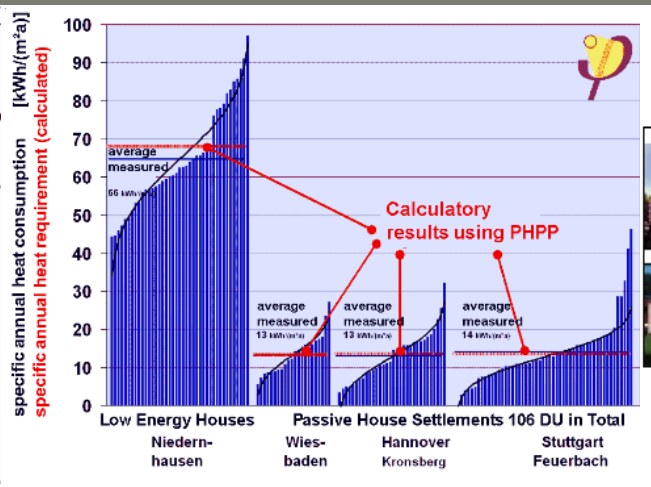


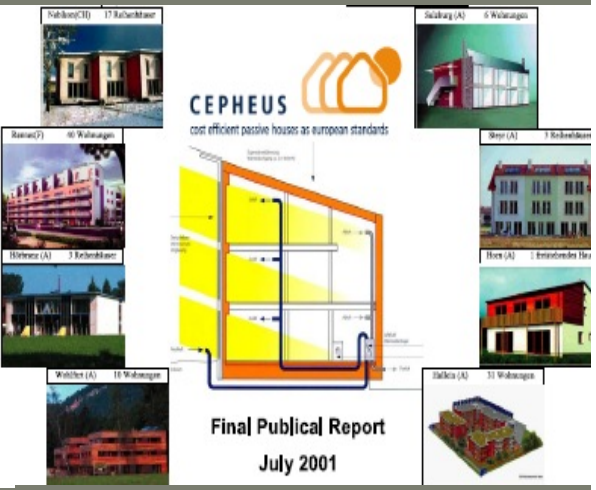
1:DI Wilhelm Hofbauer via Austria Passive House Whistler, 2: Maschin Architektur, Photo: Peter Jacadofsky, 3: Corey Saft

So what's the big deal?

Isn't this just another energy metric?







Passive House is:

Predictable

Reliable

Verified

1 & 2: http://passipedia.passiv.de/passipedia_en 3: http://www.passiv.de/07_eng/news/CEPHEUS_final_short.pdf

A very brief History:

Passive Houses have not been "invented" by anyone – in fact, the Passive House principle was discovered. W. Feist, Passipedia



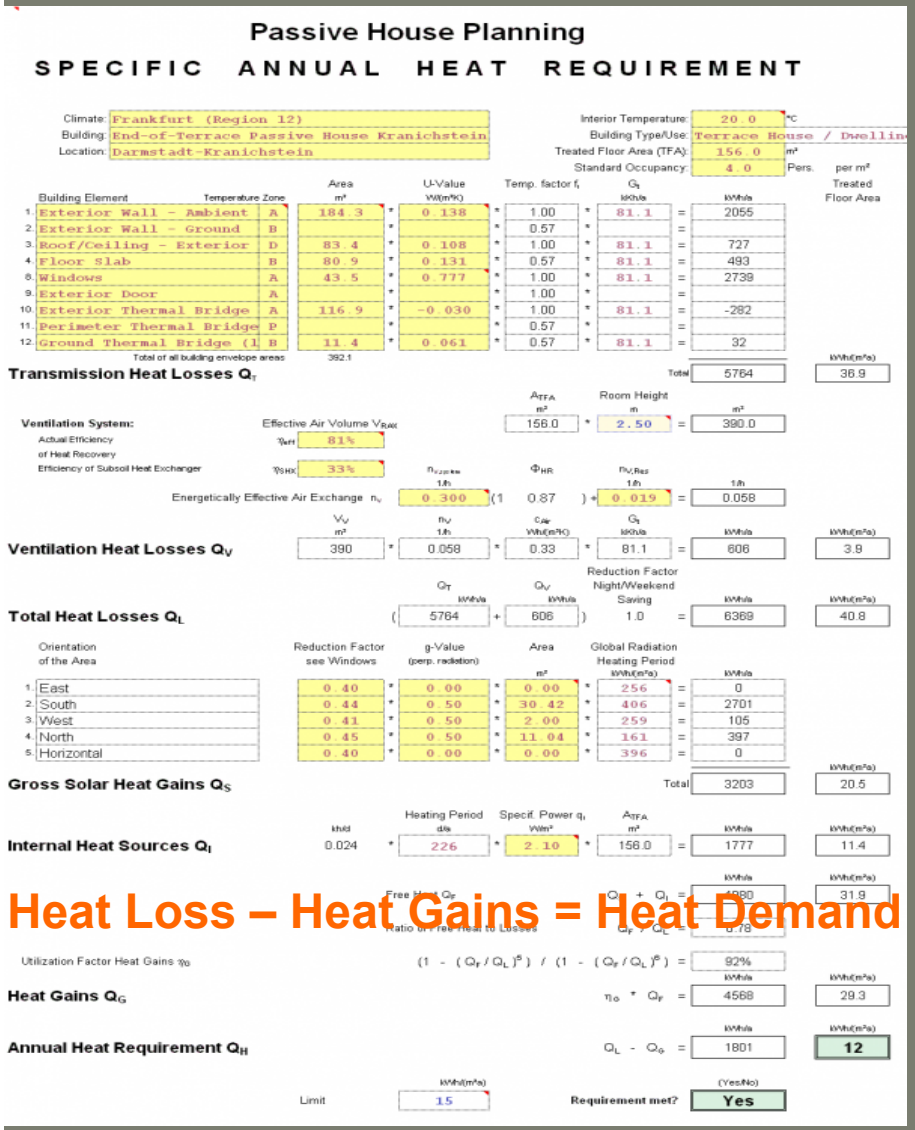

Canadians helped invent a house so efficient you could heat it with a hair dryer. Then we forgot about it.

The world would have forgotten the Saskatchewan house, too, were it not for a quirky German physicist interested in energy-saving buildings. After studying the Saskatchewan house and a handful of similar buildings, Dr. Wolfgang Feist wrote a mathematically precise -- and elegantly simple -- criterion for designing buildings that require less than a tenth of the energy of average buildings. He called it the Passivhaus standard.

By Monte Paulsen, 25 Jan 2011, TheTyee.ca

Image credit 1,3, 4: passipedia.de, Image 2: http://thetyee.ca/News/2011/01/25/Passivhaus/

So how does it work?



Passive House Planning

SPECIFIC ANNUAL HEAT REQUIREMENT

Climate: Frankfurt (Region 12) | Interior Temperature: 20.0 °C
Building: End-of-Terrace Passive House Kranichstein | Building Type/Use: Terrace House / Dwellin
Location: Darmstadt-Kranichstein | Treated Floor Area (TFA): 156.0 m²
Standard Occupancy: 4.0 Pers.

	Building Element	Temperature Zone	Area m²	U-Value W/(m²K)	Temp. factor f_t	Q_t kWh/a	kWh/a	per m² Treated Floor Area
1.	Exterior Wall - Ambient	A	184.3	0.138	1.00	81.1	2055	
2.	Exterior Wall - Ground	B			0.57			
3.	Roof/Ceiling - Exterior	D	83.4	0.108	1.00	81.1	727	
4.	Floor Slab	B	80.9	0.131	0.57	81.1	493	
8.	Windows	A	43.5	0.777	1.00	81.1	2739	
9.	Exterior Door	A			1.00			
10.	Exterior Thermal Bridge	A	116.9	-0.030	1.00	81.1	-282	
11.	Perimeter Thermal Bridge	P			0.57			
12.	Ground Thermal Bridge (1	B	11.4	0.061	0.57	81.1	32	
	Total of all building envelope areas		392.1					

Transmission Heat Losses Q_T — Total 5764 kWh/a — 36.9 kWh/(m²a)

Ventilation System: Actual Efficiency of Heat Recovery 81% | Efficiency of Subsoil Heat Exchanger 33%
Effective Air Volume V_{RAK}: A_{TFA} 156.0 m² × Room Height 2.50 m = 390.0 m³
Energetically Effective Air Exchange n_v: 0.300 1/h (1 − 0.87) + 0.019 1/h = 0.058 1/h

Ventilation Heat Losses Q_V — V_V 390 m³ × n_v 0.058 1/h × c_{Air} 0.33 Wh/(m³K) × G_t 81.1 kKh/a = 606 kWh/a — 3.9 kWh/(m²a)

Total Heat Losses Q_L — (Q_T 5764 + Q_V 606) kWh/a × Reduction Factor Night/Weekend Saving 1.0 = 6369 kWh/a — 40.8 kWh/(m²a)

	Orientation of the Area	Reduction Factor see Windows	g-Value (perp. radiation)	Area m²	Global Radiation Heating Period kWh/(m²a)	kWh/a
1.	East	0.40	0.00	0.00	256	0
2.	South	0.44	0.50	30.42	406	2701
3.	West	0.41	0.50	2.00	259	105
4.	North	0.45	0.50	11.04	161	397
5.	Horizontal	0.40	0.00	0.00	396	0

Gross Solar Heat Gains Q_S — Total 3203 kWh/a — 20.5 kWh/(m²a)

Internal Heat Sources Q_I — 0.024 kh/d × Heating Period 226 d/a × Specif. Power q_i 2.10 W/m² × A_{TFA} 156.0 m² = 1777 kWh/a — 11.4 kWh/(m²a)

Free Heat Q_F = Q_S + Q_I = 4980 kWh/a — 31.9 kWh/(m²a)
Ratio of Free Heat to Losses Q_F / Q_L = 0.78

Heat Loss – Heat Gains = Heat Demand

Utilization Factor Heat Gains η_G: $(1 - (Q_F / Q_L)^5) / (1 - (Q_F / Q_L)^6)$ = 92%

Heat Gains Q_G — η_G × Q_F = 4568 kWh/a — 29.3 kWh/(m²a)

Annual Heat Requirement Q_H — Q_L − Q_G = 1801 kWh/a — 12 kWh/(m²a)

Limit 15 kWh/(m²a) — Requirement met? Yes (Yes/No)

Mostly very quietly and efficiently!

Achieving Passive House is not difficult, but does require:

Use of the PHPP
Integrated Design
Attention to detail

http://passipedia.passiv.de/passipedia_en/planning/calculating_energy_efficiency/phpp_-_the_passive_house_planning_package

First, add a down comforter

‘Super’ is relative to each climate!

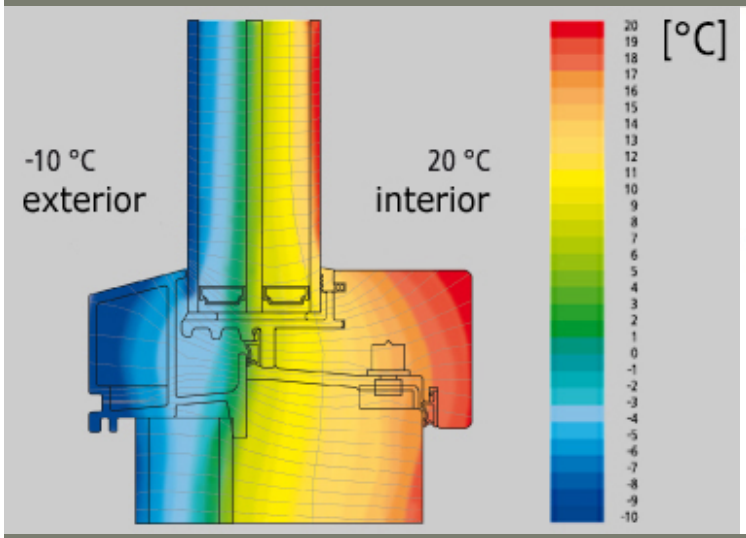


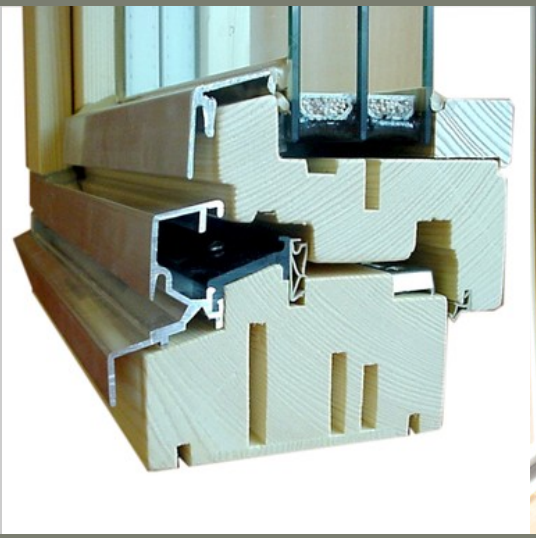
Super-insulate

Image 1: Quantum Builders, Image 2: Passipedia.passiv.de, Image 3: www.sustainableconstructionblog.com

Specify really good windows

Triple glazing is the new normal



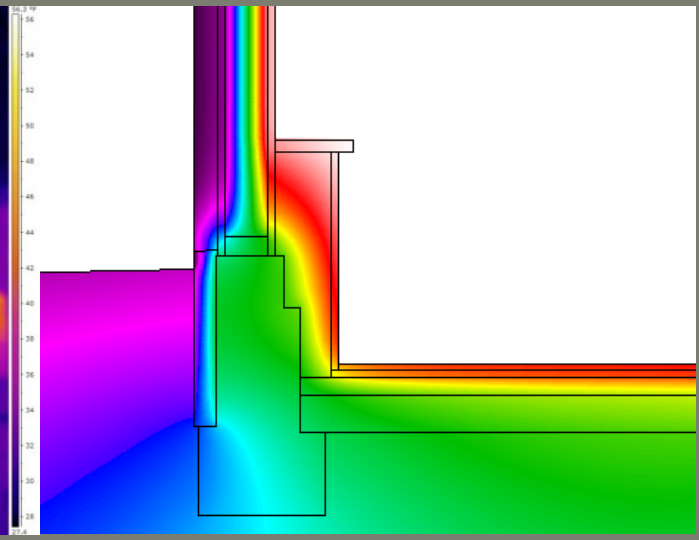


Consider them part of your heating system

Image 1: Enersign.de, Image 2: passivehausfenster.at , Image 3: optiwin-usa.com

Eliminate the weak junctions:

Remove the path of least resistance



No Thermal Bridges

Architecture and Image credit: Loading Dock 5 via Treehugger: www.loadingdock5.com, Therm file: Bronwyn Barry

Plug up the leaks:

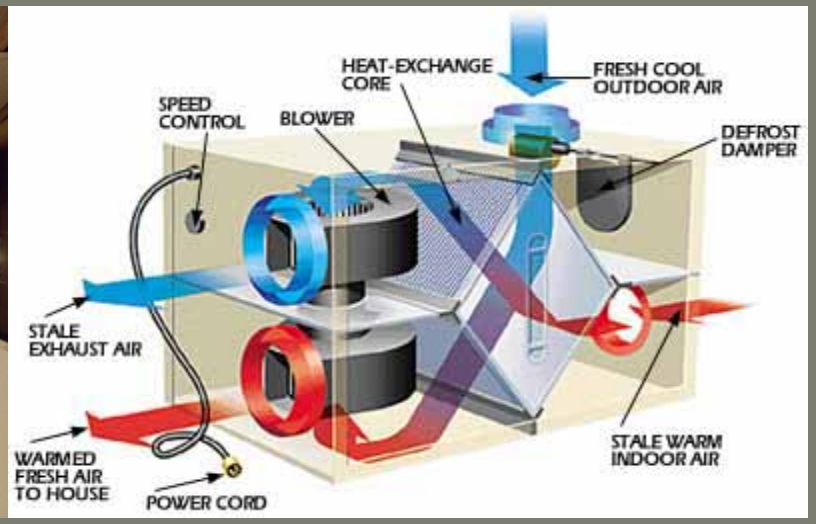
A hole in a super-insulated bucket is still a hole!

Airtight to < 0.6 ach n50pa

Image credits: Quantum Builders for Sustainable Living Inc.

Plan your ventilation

Constant supply of fresh air



Heat | Energy recovery ventilators are often used (but not a requirement)

Images: Ultimate Air unit, Tad Everhart's Zehnder ERV, google images for HRV

And then size the mechanicals as needed

(The proverbial PH heating with a ‘hairdryer’ concept.)




Optimized mechanical systems save money now - and later!

Image 1: www.postgreenhomes.com, 2. passivehouseinthewoods.com Nu-heat mats, 3. passivehouse.greenhaus.org, 4. www.artisansgroup.com

How do the certifications work?

"Yes, it's good to have certification. But it's by far not the most important thing in the world." Wolfgang Feist

Your building can receive this plaque from any number of International Certifying Bodies, including the PHI

Architects, designers and building professionals can obtain this credential from any number of certified international training organizations

And there may be other certification options available….

Logos: www.passivehouse.com

So what makes this German?

And not Swedish, Canadian or North American?

The Passivhaus Institute was founded in Darmstadt, Germany in 1996, by Dr. Wolfgang Feist, as an independent research institution. It employs physicists, mathematicians and civil, mechanical and environmental engineers, performing research and development on highly efficient energy use.

Image credit: Passive House Institute, Germany

A few PH organizations

International, National, Regional, Local

International Certifying Bodies:
(Visit www.passivehouse.com to view the growing list.)

North American training and certifying bodies:

Passive House Academy | PHIUS Passive House Institute US | CanPHI Canadian Passive House Institute

North American Interest Groups and Trade

aphn American Passive House Network | PASSIVE BUILDINGS CANADA | PH Passive House ALLIANCE

Regional and Local organizations:

Passive House Northwest | PHnw | PHCA | NYPH | PASSIVEhouse NEW ENGLAND | passivhaus MAINE

The American Passive House Network

Across the country and around the world

Passive House Northwest PHnw

www.phnw.org

PHCA

www.passivehousecal.org

NYPH

www.nypassivehouse.org

aphn American Passive House Network

www.aphnetwork.org

Thank you!

Questions?

A few more resources and some of my favorite PH blogs:

www.bruteforcecollaborative.com
www.treehugger.com

And organizations:

www.passivehousecal.org
www.nypassivehouse.org
www.phnw.org

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Image credit: The Jewel Box Passive House by the Artisans Group www.artisansgroup.com