Passive House Standard – "Heating a Home with a Hair Dryer."

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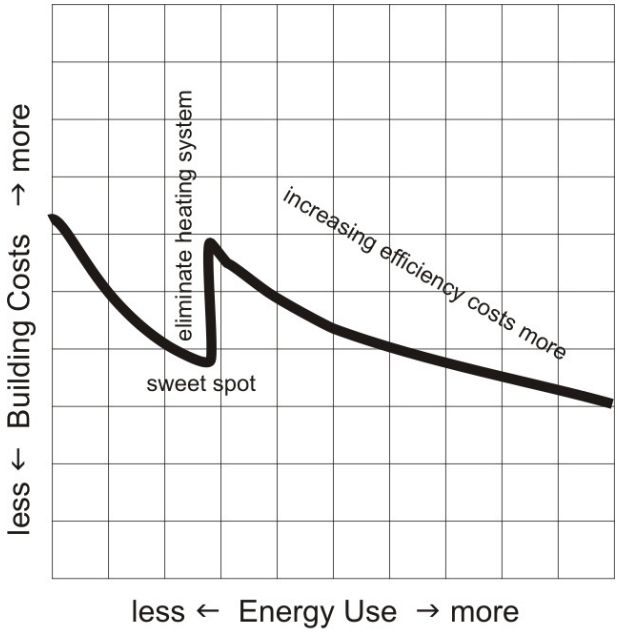
This is not the Time for "Incrementalism."

With potentially catastrophic climate change, severe economic decline, a need for green collar jobs, and increasing energy prices, we need to build carbon-neutral buildings, not buildings that are merely x% "better than code." After all, a code building is the worst building you can legally build. Why work from that standard?

Goal – To Radically Reduce Building Energy Use - 70 to 90% below Conventional Buildings.

At this level of efficiency, we can eliminate the conventional heating system. That offsets any extra costs in building an energy-efficient envelope.



Big savings can cost less than small savings, if you consider the overall system. - Amory Lovins

Passive House

Europe has 20,000 Passive Homes, and the EU adopted a resolution to make Passive House mandatory in 2012.

Definition – Thermal comfort through passive means.

A Passive House is a very well-insulated, virtually air-tight building that is primarily heated by internal gains from people, cooking, appliances, other electrical equipment, etc. (and by passive solar gain if available).

A Passive House is a comprehensive system or minimizing heat transfer through the building envelope by transmission and in/exfiltration. High performance triple-glazed windows, super-insulation, an airtight building shell, limitation of thermal bridging and balanced energy recovery ventilation make possible extraordinary reductions in energy use and carbon emission.

A Passive House's heat demand is so small that internal heat and passive solar gains typically supply all of it. If a Passive House needs auxiliary heat, it can provide it with an extremely small source.

"Passive" describes how a PH building captures and uses "passive" energy supplied by typical activities in a building instead of relying predominantly on "active" systems to bring a building to "zero" energy.

The name “Passive House” comes from the German “passivhaus;” however, “haus” in German means “building.” Thus, “House” in “Passive House” refers to all types of buildings--not just houses or residential buildings.
Passive Houses both cut heat loss in winter and heat gain in summer. A Passive House avoids undesirable (summer) heat gain through superinsulation and elimination of thermal bridges. Thoughtful window orientation and shading also help minimize cooling load.

Passive Houses rely on a HRV or ERV to provide a constant, balanced fresh air supply. The result is an impressive system that not only saves up to 90% of space heating costs, but also provides superior indoor air quality.

Passive House Standards – required for certification by PHIUS

1. Airtight (infiltration and exfiltration) is **≤ 0.6 ACH @ 50 Pa**.
2. Specific heat (and cooling) demand is **≤ 15 kWh/m²a** (= 1.39 kWh/s.f. or 4,756 Btu/s.f. per year).
3. Total building primary energy consumption is **≤ 120 kWh/m²a** (= 11.15 kWh/s.f. or 38,048 Btu/s.f. per year).

Note: Passive House retrofit standard same except specific heat (and cooling) demand is ≤ 25 kWh/m²a (= 2.32 kWh/s.f. or 11,100 Btu/s.f. per year).

Recommendations for Meeting PH Standards

Note that these express the underlying principles that apply in all climates, but they are not requirements. PH has only 3 requirements. It is not a prescriptive approach. These recommendations are based on 18 years of experience and 15,000 Passive Houses. Reference values are for Central European and US Pacific Northwest climates.

1. Small buildings: 370 s.f./occupant default (w/ range of 200-500 s.f. per person).
2. Compact building shape: low ratio of building volume to surface area of exterior.
3. Envelope “opaque elements” (walls, floor, and ceiling) heat transmission should be at least R-38.
4. Envelope “transparent elements” (windows) heat transmission at least R-7.
5. Eliminate or severely limit thermal bridges (“thermal defects”).
6. Highly efficient heat recovery: 75% thermal efficiency with minimal electrical consumption.
7. Heating load ≤ 10 W/m²h (1.76 BTU per s.f. per hour). This is derived from 3 separate values. First, fresh air supply of 1000 cubic feet per hour per person for good indoor air quality. Second, the specific heat capacity of air. Third, the amount you can increase the temperature of fresh air temperature without burning dust in the air. From these 3 factors, we know that we can supply 300 W of heat per hour per person by a fresh air heating system. Since we assume not more than 360 square feet per person, the maximum specific heat load is 1.76 BTU per s.f. per hour.
8. Efficient appliances and lighting to minimize electrical consumption.
9. Domestic hot water generation/distribution systems have minimal heat losses.

Additional window recommendations

1. Triple-pane glazing (although some PH advocates believe double-panes are sufficient and even preferable in some mild climates).
2. High solar energy transmittance (SHGC ≥ 50%) if facing South.
3. Insulated frames to avoid radiant asymmetry and condensation.
4. 63ºF inside surface temperature even if only 14ºF outside temperature.

Basic Passive House Principles – Keep the Heat in!

- Super insulation
- No thermal bridging
- Advanced window and door technology
- Airtight construction
- Efficient heat recovery ventilation
- Compact and simple building shape
- Passive solar design
- Minimal space heating
- Energy-efficient appliances

Comparison with standards in popular building energy-efficiency programs

PH is not an energy performance standard, rather it is a concept. The concept is to achieve the highest thermal comfort at little cost. Lower cost measures are passive measures. Passive measures are airtightness, insulation, elimination of thermal bridges, heat recovery from ventilation air, and passive solar. Ultimately, we reduce heating/cooling loads by passive means at the lowest cost.

Comparing PH certification standards with **2008 Oregon Energy Code** (OEC), **NW Energy Star** (NWES), **Oregon High Performance Home** (OHPH). Again, note that PH is not a prescriptive path. The PH values are for illustration and comparison.

Element	**PH**	**2008 OEC**	**NWES**	**OHPH**
Ceiling	R-38	R-38	R-38/49	R-49
Walls	R-38	R-21	R-21	R-24?
Floor	R-38	R-15/30	R-15/38	R-15/38
Window area	No limit	No limit	≤21% fl area	≤16% fl area
Window U	0.14	0.35	0.32	0.32 avg.
Furnace eff.	No furnace	90% AFUE	90% AFUE	92% AFUE
Ducts	Inside	sealant/no test	mastic/testing	Inside
Airsealing	≤.6 ACH/50	no test	7 ACH/50	5 ACH/50
Ventilation	HRV or ERV	bath fan/window	whole house + spot	HRV or ERV

A Passive House design would put you well on your way to achieving **LEED-H** Platinum and may be the best way to approach the Cascadia Region Green Building Council's **Living Building Challenge**.

History – Conceived in the US and improved by Europe.

1. PH based on 1970s US/Canadian superinsulation research (e.g., The Small Homes Council of the U. of Illinois' "Low-Cal House")
2. William A. Shurcliff, Harvard physicist's "Superinsulated and Double-Envelope Homes" and passive solar books in early/mid-1980s
3. New, rigorous energy standard in Sweden and Denmark leads Bo Adamson of Sweden and physicist Wolfgang Feist of Germany to design and build first passivhaus to meet and even exceed the new standard. Four-unit row house building in 1991 in Darmstadt, Kranichstein, Germany: 70-80% reduction in total energy use and 90-95% reduction in heating/cooling energy.
4. Amory Lovins visits Feist in 1995 and encourages Feist to redesign some details to reduce costs and think of his work as the solution instead of merely a scientific experiment. Feist remembers Lovins saying, "No, this is not just a scientific experiment, this is the solution. You just need to redesign the details in order to reduce the additional costs, and I'm convinced that is possible."
5. PH working group develops PHPP, and Dr. Feist starts the PH Institute (PHI) in 1996.
6. European Union conducts CEPHEUS ("Cost Efficient Passive House as European Standards") project building 221 PHs in 5 countries.
7. 5,000 PH in Europe by 2005, and 15,000 PH worldwide by 2008, primarily in Europe.
8. German-trained Chicago architect Katrin Klingenberg builds first PH in US in 2003, and founds PHIUS (PHI United States) in 2007.
9. PHI authorizes PHIUS to certify PHs in USA in 2008.
10. 10 PHs in USA by 2008 showcased in PHIUS' first book, Homes for a Changing Climate: Passive Houses in the U.S.
11. PHIUS has trained 40 consultants by end of 2008 and incorporated as a national nonprofit organization.

Passive House Software Tool

Passive House Planning Package (PHPP) is the Excel-based energy modeling tool that is used to verify a building meets Passive House standards. Additionally, it is a powerful design tool. Unlike many other energy modeling programs, users can see all of the formulas used for calculations PHPP performs. Many energy-efficiency experts believe it is the most comprehensive and powerful energy modeling software available today. Soon, Passive House Institute US will sell a version using imperial values with climate data for 30 US cities. PHPP 2007 costs $190 and includes a printed manual with excellent advice and illustrations.

PHPP condenses information needed for certification of a Passive House on the first "Verification" page. Although there are 32 pages you can complete, typically in our climate, you will focus on about 7: **Verification, Areas** (of walls, windows, etc.), **U-values** (of each of those components and sub-assemblies), **Windows, Ventilation, Annual Heat Demand, and Heating Load.**

On the **Climate Data** page, PHPP includes detailed climate data for many US cities (including Portland and Seattle), and Passive House Institute US is working to provide climate data for most medium and large US cities.

Passive House Certification

The Passivhaus Institute (PHI) certifies all Passive Houses in Europe. PHI authorized Passive House Institute United States (PHIUS) in 2008 to certify Passive Houses in the US. PHIUS will perform this service at its cost which is expected to be under $1,000.00 for most homes.

PHIUS has completed training two classes of Passive House Consultants. Currently, the class is three, 3-day sessions in Urbana. PHIUS hopes to begin regional trainings. After completing the classes, students must pass a test and design a Passive House that is built and certified before they are Passive House Consultants.

Additional Points

Importance of Passive House in Pacific Northwest

There is a coincidence (and synergy) of favorable climate, political climate, local knowledge, and public acceptance. Marine Climate and east-of-Cascades cold climate are easy to build for because of low HDD and low summer humidity.

PH is a very green building strategy.

PH evaluates every material in 8 separate measures: Primary Energy Content, Global Warming Potential, Acidification Potential, Work Expenditure, Workplace Hazard, Disposal and Reuse Potential, and User Repair Possibilities.

PH gains are immediately available and integral to creating a green collar economy.

Other than higher-performance windows and doors, we already use all of the building materials need to construct Passive Houses in conventional construction. Simply add superior design, energy modeling (PHPP), and care in assembly for airtightness.

Resources

1. Passive House Institute US: www.passivehouse.us
2. Passive House Institute: www.passivehouse.com
3. Cost Efficient Passive Houses as European Standards (CEPHEUS): www.cepheus.de/eng
4. http://www.energieinstitut.at/Retrofit/
5. “Houses You Can Heat with a Hair Dryer” by Rachel Wagner in Fine Homebuilding magazine 194: 22-24 (3/5/08) at http://www.taunton.com/finehomebuilding/how-to/departments/cross-section/super-insulated-energy-efficient-house.aspx
6. “The Passive House: Green Without Gizmos” by Jefferson Kolle in Fine Homebuilding magazine 210:48-58 (3/11/10) at http://www.passivehouse.us/passiveHouse/Articles.html
7. “Passive Acceptance” by Jacob Gordon in Dwell magazine (November, 2009) at http://www.dwell.com/articles/passive-acceptance.html

8. "Passive House Takes Root in the United States" by Mike Kernagis in Home Energy magazine Climate Solutions Special Issue at http://www.homeenergy.org/article_preview.php?id=485&article_title=Passive_House_Takes_Root_in_the_United_States\
9. "No Furnaces but Heat Aplenty in "Passive Houses" by Elisabeth Rosenthal, New York Times, December 27, 2008 at http://www.nytimes.com/2008/12/27/world/europe/27house.html?_r=1&em
10. "Snug and Tight" by Mika Grondahl, New York Times, April 30, 2009 at http://www.nytimes.com/interactive/2009/04/30/business/energy-environment/20090430_businessofgreen_house.html?scp=1&sq=snug%20and%20tight&st=cse
11. "Homes Go From 'Superefficient" to Zero Carbon Emissions in Europe" by New York Times, August, 2009 at http://www.buildinggreen.com/auth/article.cfm/2010/3/31/Passive-House-Arrives-in-North-America-Could-It-Revolutionize-the-Way-We-Build/
12. "Be Aggressive About Passive" in Time magazine at http://www.time.com/specials/2007/environment/article/0,28804,1602354_1603074_1603747,00.html
13. "Hybrid Homes" in Newsweek magazine at http://www.newsweek.com/id/150106
14. "Where there is Urgency, There is Opportunity" in Sustainable Industries magazine at http://www.sustainableindustries.com/commentary/40450292.html
15. Isover marketing brochure at http://www.isover.com/SiteContent/view.do?navId=14
16. "Passive House Arrives in North America: Could It Revolutionize the Way We Build?" in Environmental Building News at http://www.buildinggreen.com/auth/article.cfm/2010/3/31/Passive-House-Arrives-in-North-America-Could-It-Revolutionize-the-Way-We-Build/
17. Chapter 4: "Our Leaky Homes" in Heat: How to Stop the Planet from Burning by George Monbiot (South End Press, 2007)
18. Chapter 10: "The Energy Impact of Buildings: High Performance Building and Passive Houses (p.155) in Plan C: Community Survival Strategies for Peak Oil and Climate Change by Pat Murphy (New Society Press, 2008)
19. Chapter 1: "The Passivhaus Concept and European Residential Design" in Green Building Trends: Europe by Jerry Yudelson (2009) at http://www.greenbuildconsult.com/books/info/green-building-trends-europe/
20. Details for Passive Houses: A catalogue of ecologically rated constructions by Austrian Institute for Healthy and Ecological Building, Springer Wien, New York, 2008 ($80 through Amazon books)
21. Homes for a Changing Climate: Passive Houses in the U.S. by Katrin Klingenberg, Mike Kernagis, and Mary James, Low Carbon Productions, 2008 ($25 through PHIUS)