The Passive House standard

Energy Efficiency
+
Comfort
+
Quality Assurance
Andrew Michler

Certified Passive House Consultant / Chair Passive House Rocky Mountains

Owner Baosol Design

Author [ours] Hyperlocalization of Architecture

Designed and built first certified International Passive House in Colorado
40% all human carbon emission from building operations

5-8% all human carbon emissions from building materials

WTF?
What is Passive House?

A voluntary international Performance Standard

Rigorous Design Process

Rigorous Certification Process

Encourages integrated design

Provides an optimizable design process
What is Passive House?

Certified through static energy modeling and verification

High-performance continuous thermal envelope

High-performance windows and doors

Thermal bridges eliminated or accounted for

Airtight building envelope

Ventilation system with high-efficiency heat recovery
“Passive” is to make use of first sources of heat before introducing artificial means. (works in reverse for cooling too)

Innovation of building through the centuries

19th  20th  21st
Passive House goes beyond net zero energy
Why Passive House?

Too many ‘Eco’ but uncomfortable buildings

Design solution to provide ideal indoor conditions for people with least amount of energy input

Deep cut in carbon emissions for life of building

Physics based feedback

Make zero energy grid friendly (renewable primary energy)
Some points of Passive House

Air tightness is as important as insulation

Comfort is as important as energy savings

Envelope > Complex Equipment

Near zero > “Net zero”

A systems approach demands Integrated Design Management

The performance gap is very real
“In Britain, an evaluation of 50 ‘leading-edge modern buildings,’ from supermarkets to health care centers, reported that they ‘were routinely using up to 3.5 times more energy than their design had allowed for’ — and producing on average 3.8 times the predicted carbon emissions”


The performance gap is very real
Some points of Passive House

Passive House measured performance less than 5% variance from modeling

Cascading effects throughout the building process from design to durability.

Provides high value to investment to building owner. Costs 5-10% over code for homes, 0-5% commercial.

Makes you a better designer
Passive House as a thermal battery
Continuous Insulation
Thermal Bridge Free
Reduced Heat and Cooling
Equipment Heat Source
Occupant Heat Source
High Performance Windows
Solar Heat Gain
Fresh Air Exchange
Heat or Energy Recovery Ventilator
Foundation Insulation
Passive House requirements

Metrics – Energy

Heating Demand: 4.75 kWh/(f².yr)  
OR Heating Load: 3.15 W/f²

Cooling Demand: 4.75 kWh/(f².yr)  
OR Cooling Load: 3.15 W/f²

Airtightness n50: 0.6 ach

Primary Energy: 37 kWh/(f².yr)
Passive House requirements

Metrics – Comfort

- **Air temperature:** design set point 68 F
- **Overheating:** less than 10% of the year over 78 F
- **Surface temps:** min 62 F
- **Fresh Air:** Effective ventilation required for all rooms
- **Indoor RH:** Not below 30%
- **Moisture:** must rule out excessive buildup in elements
- **Habitable rooms:** at least one opening window
- **Controls:** users must be able to operate
- **Sound:** ≤ 25 db(A) from the ventilation system
- **Draughts:** no draughts to be perceived
Passive House Certification

Use Passive House Planning Package energy modeling (Passive House Consultant)

Passive House certified components - particularly Heat Recovery Ventilation

Airtightness test (third party)

HRV commissioning report

Third party verification (Passive House Certifier)

Passivhaus Institut verification
Passive House outcomes

Meaningful energy demand reductions **75 - 90%**

Meaningful CO2 emission reductions **60 - 75%**

Exceptional comfort – even ambient and radiant temps

Free from condensation, dampness and mold issue

Constant fresh air at a comfortable temperature

Quiet
Passive House success

10,000 certified projects and estimated 50,000 total projects (both certified and not)

Projects in every climate zone- from Dubai to Antarctica

Can be made with almost any material

Can be built at almost any scale

First Passive House functions with no degradation of performance after 25 years
Passive House Meets Pueblo

Northern New Mexico has one of the oldest design traditions in the United States. A new culture intersecting for the past 500 years has led to distinctive architecture that speaks as much to the arid Southwest region as it does the people who live there. The adobe building still dominates in the United States in the Taos Pueblo (inhabitants), built with a stepped, deep form and massive adobe brick walls. When the Spaniards controlled the region, they brought the Mission, with long front porches, tall windows, and intricate woodwork. The missions brought manufactured materials like corrugated metal and standardized lumber and tile, leading to the Territorial style. Many new buildings in the region are a mix of these influences. It is in this rich building that NidoGardens Inc.—a design firm where I work under my colleague, architect Sarah Standiford—built three certified Passive Houses—the Balance House, the Taos House, and the Olsen House. For these projects, we were looking for a clean, energy-efficient system for building homes that would also be highly adaptable. We prefer a contemporary design approach that draws on traditional qualities like the passive roof, natural materials, and, of course, the gracefully thick walls that are ubiquitous in the Southwest. We have found that we can

Three projects by a Santa Fe architect demonstrate how well this performance standard and the local architectural styles work together

BY ANDREW MICKLER
The first fully functioning Passive House was actually a polar ship and not a house: the Fram of Fridtjof Nansen (1883).

“... The sides of the ship were lined with tarred felt, then came a space with cork padding, next a deal panelling, then a thick layer of felt, next air-tight linoleum, and last of all an inner panelling. The ceiling of the saloon and cabins ... gave a total thickness of about 15 inches. ... The skylight which was most exposed to the cold was protected by three panes of glass one within the other, and in various other ways. ... The Fram is a comfortable abode. Whether the thermometer stands at 22° above zero or at 22° below it, we have no fire in the stove. The ventilation is excellent, especially since we rigged up the air sail, which sends a whole winter’s cold in through the ventilator; yet in spite of this we sit here warm and comfortable, with only a lamp burning. I am thinking of having the stove removed altogether; it is only in the way.“
(from Nansen: “Farthest North”, Brockhaus, 1897)
Unter [www.passivhausprojekte.de](http://www.passivhausprojekte.de) dokumentierte Passivhäuser:

By 2017-04:

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Countries mentioned in the image include:

- DE: Germany
- CA: Canada
- NZ: New Zealand
- L: Liechtenstein
- LV: Latvia
- MX: Mexico
- ID: Indonesia
- VAE: United Arab Emirates
- AT: Austria
- IE: Ireland
- PL: Poland
- CZ: Czech Republic
- EE: Estonia
- TW: Taiwan
- KA: Kazakhstan
- FR: France
- BE: Belgium
- CH: Switzerland
- KR: Korea
- PT: Portugal
- UA: Ukraine
- UK: United Kingdom
- HU: Hungary
- SE: Sweden
- AU: Australia
- SI: Slovenia
- TR: Turkey
- ZY: Zambia
- US: United States
- JP: Japan
- RO: Romania
- IT: Italy
- NL: Netherlands
- SK: Slovakia
- BU: Bulgaria
- MK: Macedonia
- HR: Croatia
- ES: Spain
- DK: Denmark
- CN: China
- LT: Lithuania
- FI: Finland
- RS: Serbia
Raiffeisenhaus Bank Tower
21 stories (78m) high with 6 levels (20m) below ground
sensitive
creative
Mineral wool: 2” rigid, OSB outboard/ 2x6, GWB inboard

- Mineral wool does the job
- Diagram of assembly:
BahnStadt
Heidelberg Mixed Use Passive House Community
5000 live, 7500 work
Eurogate Neighborhood
Passive House District
5000 residents, 8000 workers
*faircompanies
## Specific building demands with reference to the treated floor area

<table>
<thead>
<tr>
<th></th>
<th>Treated floor area</th>
<th>Requirements</th>
<th>Fulfilled?*</th>
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<tbody>
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<td><strong>Space heating</strong></td>
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<tr>
<td>Heating demand</td>
<td>1.41</td>
<td>30% of 4.75 kBTU/(ft²yr)</td>
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<td>Heating load</td>
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<td>126% of 3.17 BTU/(hr.ft²)</td>
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<td><strong>Space cooling</strong></td>
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<td>Overall specif. space cooling demand</td>
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<tr>
<td>Cooling load</td>
<td>BTU/(hr.ft²)</td>
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<tr>
<td>Frequency of overheating (&gt; 77 °F)</td>
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<td><strong>Primary energy</strong></td>
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<td>Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances</td>
<td>16.0 kBTU/(ft²yr)</td>
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<td>DHW, space heating and auxiliary electricity</td>
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<td>Specific primary energy reduction through solar electricity</td>
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<td><strong>Airtightness</strong></td>
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* empty field: data missing; *: no requirement

Passive House? | yes |
Optimize the envelope early in the development
Costs are based on complexity and experience
There is math behind nearly every decision path.
You have to understand things as systems
You link these systems together
What at first seems very hard quickly becomes second nature
You will never see a building the same way again
Baosol Adaptive Design
www.baosol.com

Passive House Rocky Mountains
www.phrockymountains.com

Passivhaus Days
November 10-12th