This is a response to Martin Holladay's critique of the Passive House movement, at the PHNW Spring 2011 meeting in Olympia, WA.

Here were Mr. Holladay's main bullet points.

What I like about the Passivhaus standard (2 slides)

1. It is based on the concepts championed by the North American pioneers of superinsulation.
2. It sets a high bar for airtightness.
3. It requires high-performance windows.
4. It addresses thermal bridging.
5. It focuses on envelope improvements rather than fancy equipment.
6. It sets an energy goal that is in the ballpark of what will be necessary to achieve necessary carbon reductions.
7. PHPP is a useful and accurate design tool.
8. The Passivhaus standard is now attracting wide attention, and designers are thinking and talking about design details in a new way. The number of Passivhaus buildings is growing.

Hooray!

Seven Passivhaus missteps (48 slides)

1. Calling these superinsulated houses "passive" is problematic.
2. The claim that these are "houses without heating systems" is false.
3. Delivering heat through ventilation ducts makes no sense.
4. The annual space heat limit of 15 kWh/m²·year is arbitrary.
5. PHPP has no cost-effectiveness feedback.
6. The standard has a small house penalty.
7. The standard doesn't distinguish between energy sources.

An all-or-nothing posture stifles legitimate questions.

My rejoinder:

1. "The Name."

Yeah we're stuck with the name. Yes it gets confused with passive solar, agreed that is an ongoing bummer. But there is validity to it, as I will explain below.

2. "No heating system."

Agreed, that's not right.

Some people write "No furnace or no conventional furnace." That could be considered true technically, but I agree it is misleading.

3. "Heat through ventilation ducts."
4. "Arbitrary annual heat demand criterion."

At the 2009 Passive House conference in Illinois, Jürgen Schnieders explained in the pre-conference workshop that yes, the idea of Passive House was to insulate to where the peak heating load could be met with ventilation airflow. But because they had more confidence in the accuracy of annual total heating calculation, they looked for what annual total heat demand correlated to that peak heat load and wrote the standard on that. Martin got that about right.

More recently the standard has been clarified so that you can meet it either by the annual heat demand criterion or the peak heat load criterion. (I have found it easier to meet the annual criterion, unless there are very few windows. Even triple-pane windows drive the peak heat load up.)

The assumptions that underlie the heat load criterion are broadly applicable. Also the concept that there is an economic optimum to reducing the load by passive methods (tightness, windows, insulation) and thereby minimizing the mechanical system is broadly applicable. I think it's generally true that you save the most energy feasible by insulating and tightening to the point where most of the heat can be delivered through ventilation system.

There is elegance to the idea of combining the ventilation and heating functions. It solves the problem that heat recovery ventilators blow cold (coolish) air on people for one thing. It's not required by the standard but it's the "signature move" that bolsters the economics and the comfort. I know supplemental heating for "problem areas" has been allowed at least since 2007, as there is a side-calculator in PHPP for it.

Yeah, you can do recirculation but you don't need to. Heat distribution is one of the things that really is pretty passive in a Passive House. Eliminating the extra distribution system (ducts or piping) and avoiding fan or pump energy for heat distribution forever is worth something.

I would admit, a detailed value engineering study might find a bit sweeter spot on a specific project. But as a general idea about where to aim for the economic optimum it seems like a pretty logical concept.

I have found that costs do ripple up if you back off the annual heat demand target by like a factor of 2 or 3. Now less than half the heat can be delivered by ventilation. You definitely need supplemental heat, and a distribution system for it, and the operating energy for that pump or fan in addition to the ventilation fan. Also the summer overheating gets worse, night flush cooling is no longer sufficient, so now you are looking at adding active cooling or thermal mass.

5. “No cost-effectiveness feedback in PHPP”

Martin looked at a few of the early cases where people were putting huge amounts of foam under the foundation in order to meet the Passive House standard, and did this interesting calculation that the marginal energy saved could be supplied more cheaply by buying PV instead of foam. (I will stipulate that.) Now he's generalizing from that and indicting Passive House in general.

I believe these are case-specific glitches or teething pains that do not call the whole scheme into question.

I would say PHPP gives very good feedback on the effectiveness side anyway. You can look at just about anything that affects energy performance and see how much energy it saves or doesn't. I think Dylan Lamar said something like you couldn't do cost effectiveness tradeoffs without PHPP.

The cost and financial side of things is indeed, not integrated, and has to be done as a side calculation. I think integrated economics is not a common feature of energy software. Randy Foster has made an accessory spreadsheet that nails the economic analysis for residential.

What happened in some early cases, and I am still running into this, is that people had their designs mostly locked in, heard about Passive House, and then "made it fit." Clients, you know how it is.

I think people don't have a feel for the power of the simple and compact shape. Super-insulated and super-air-tight skin is expensive skin and so simplifying the thermal envelope and enclosing the most floor space you can with it saves money at every step, from design to construction, air-sealing, and on through the whole life of the building.

I used Dylan's trick of drawing a Sketchup of the thermal boundary for a design I was sent. It had 29 surfaces versus the minimum 6. There are bump-outs on bump-outs (See Figure 1.) A rectangular box with the same treated floor area would have had 19% less envelope area.

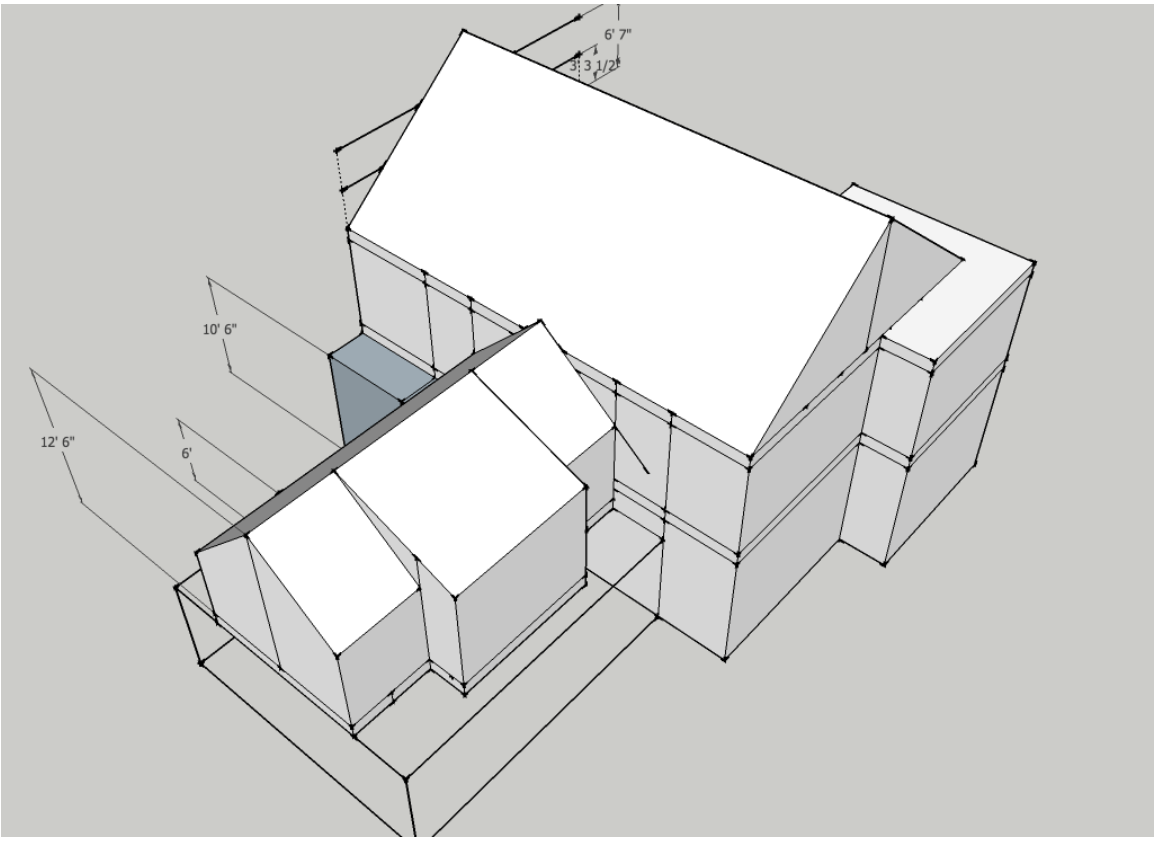

Figure 1. Fancy thermal envelope -> pricey Passive House.

When you combine fancy design with Passive House there is a premium. But is that Passive House's fault or the design's fault? As a Passive House Consultant, I say it's the design's fault.

5. Don't save Btu's at a greater cost than PV. PV energy price today is the long-term upper limit on energy prices.

This is an economic forecast, so let's talk about the future. As best I can tell, where we are going, within the life of buildings built today, is 80% less energy. Right now PV is built using fossil fuel energy, so it seems like its price could rise as that subsidy is withdrawn.

The clearest thinking I have found on this is the idea of energy return on energy invested (EROI or EROEI). Right now with our mostly fossil fuel mix we are at about 25:1 ? I seem to remember the minimum necessary for urbanism is estimated to be 5:1 ? [Hall et al, Energies 2009, 2, pp.25-47] Renewable energy technologies I think are high single digits? [Bankier & Gale Energy Bulletin, June 16 2006],[Hagens, The Oil Drum, Oct 19 2006] When we have to make renewables with renewables let's say our EROEI drops from 24:1 to 8:1 (factor of three.) Some combination of the following two things would have to happen: Let's say "energy returned" is like our income, and the inverse, "energy invested" is a proxy for energy prices.

Either our income drops by a factor of three, or energy prices go up by a factor of three. Probably we're looking at long-term structural stagflation or alternating price spikes and recessions. Let's build Passive Houses while we still can. If we are lucky Iraq could delay Peak Oil a decade, but again I'm thinking life-of-building long term here, like four to seven generations.

The passive survivability argument is powerful one for me. Other words for that are resilience, comfort security. I think the longevity argument for insulation over PV is real and worth paying more for. I am leery of the high-tech PV + heat pump strategy long-term, but I know that if I have built a Passive House, I will be okay. A Passive House is better than a garden variety net-zero house because it is more passive, more resilient, lower-tech or at least not fully committed to a Bright Green, high-tech, smart-grid, globalized future. Insulation works day and night, summer and winter. It works during grid outages, which standard grid-tied PV does not, by the way. (You need batteries for that plus an upgraded inverter/charger which adds several dollars per watt.) US grid outages are increasing due to disinvestment in maintenance according to IEEE (see Figure 2.)

Net zero via PV is also a better deal for the utility than it is for the building owner, because PV produces energy when they need it, not when you need it. Utilities want peak load shaving and PV is good for that. It will not keep your house comfy in November. Passive House is a better deal for the building owner.

I also think that from a policy point of view Passive House is the right platform for net zero because it doesn't depend on the energy production being any particular scale. Passive House works for site, district, or large-plant energy production. Any building can do its part by saving energy, not all can produce it.

"U.S. Grid Gets Less Reliable"
IEEE Spectrum January 2011

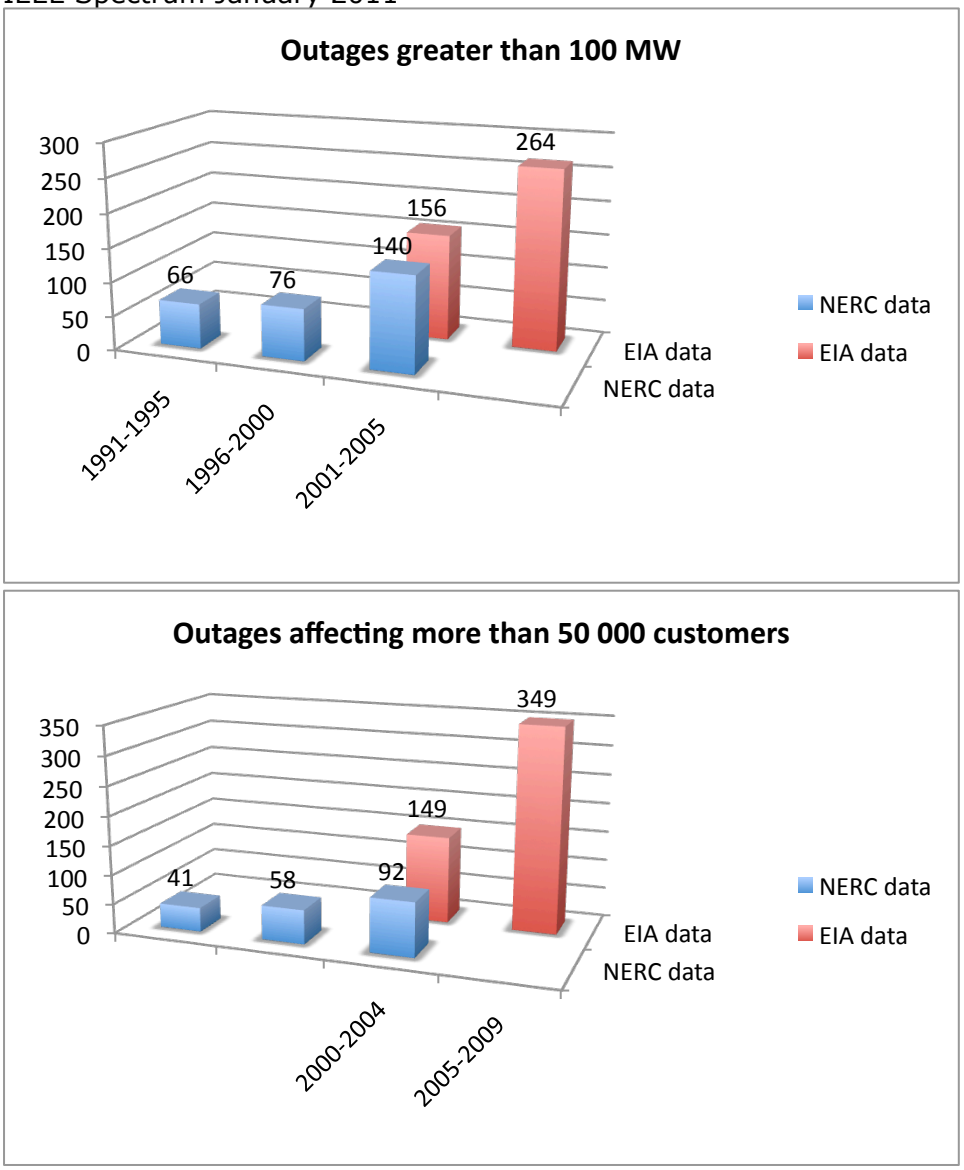

Figure 2. Net zero strategy depends on grid, trend ugly.

Net zero has a different goal than the Passive House criteria. It's sole metric is annual net site energy. Passive House looks at annual net source energy AND has this separate and stringent limit on energy for space conditioning. (That requirement is exactly what drives the focus on envelope improvements, which Martin was positive on at the beginning of his talk, but then he complained it was arbitrary and difficult.) So, given the different goals, at some times and places, net-zero and Passive House part ways or find some daylight between them. The Net-zero perspective is not the only rational perspective.

But I think it is fair to say that, by-and-large, Passive House is the most cost-effective platform for net-zero, if the Passive House designs are done in a way that achieves those modest cost premiums we like to talk about. Even in the cases that bothered Martin, I doubt if it missed by much in terms of % of construction budget.

I will credit Martin with raising my consciousness on doing net-zero math, especially if it appeals to the client and the site is suitable. But site net-zero is not the only rational way to size PV either. (I only want enough to take the fridge off-grid.)

As to being foam hogs, in the past I have argued there is no better use for petroleum than foam insulation. But I am sensitive to the frown power on foam. I was impressed with the Artisan Group truss & fiberglass floor over crawlspace.

6. "The small house penalty. The universal standard across climates. Per square foot vs. per person."

These are fairness concerns. So let's talk about fairness.

First of all the universal standard across climates is how the marketplace has already shaken down. Everybody insulates their house until their energy bill is about the same $1500 per year or whatever it is. Minnesotans already use double-pane windows. All that Passive House is saying is, everybody needs to crank down on energy use even more. It's not a harsh climate penalty. It's a mild climate break. Why should there be harsh climate breaks? How is that fair? We all share the same atmosphere. Why should we subsidize staying in harsh climates versus moving to milder ones?

The ethic implied in the Passive House Standard is that: Operating energy per square foot of conditioned floor space is a fair basis for comparing buildings for energy use - regardless of size, where they are, or what they are used for. This is not the only possible view of fairness but I like it.

"Per square foot vs. per person."

There is a guideline in the Passive House standard for residential square feet per person, but they did not make it a hard and fast part of the standard, wisely I believe. How would you enforce it? From a building code perspective this is a post-occupancy matter that designers and builders can't control. It would get complicated for commercial buildings (libraries have many square feet per person, but are awesome.) I think there are serious liability and civil liberties concerns around rationing energy per person.

"The small house penalty."

The embedded concept of fairness based on operating energy per usable floor area – that concept, plus physics, leads to the logical consequence known as the "small house penalty." *Que sera, sera*.

I say it's not a small house penalty. It's a detachment penalty - a single-family detachment penalty. This goes to Design again. Detachment in cold climates is a premium feature (one that the Smith House has.)

It's not a small-house penalty. It's a cohousing price break.
I believe Toby Hemenway is right that the future is large houses on large lots, less lawn and more gardens.

Some of my colleagues in Portland are in favor of large-house penalties. That could be a mistake. They are trying to ding single-family McMansions, fine. But, if as a side effect, it were to force multifamily or boarding house projects go beyond Passive House performance, I would be against it.

7. "Passive House Standard doesn't distinguish between energy sources."

What? It's just about the only one that does. You get credit for renewables with respect to the Primary (source) energy criterion. PHPP2007 manual page 162: "The specific [per square foot] primary energy demand describes the amount of non-renewable primary [source] energy which is necessary for providing the energy carrier [e.g. electricity]. It considers the energy content of the raw materials as well as the losses from distribution, conversion, and delivery to the end-user [at the site]." See? Only the non-renewable part of the energy counts towards the limit. For biomass they give an 80% discount.

<u>However</u>, you do NOT get credit for renewables towards the space conditioning requirement, that is, the annual heat demand or peak heat load criterion. The only gains which count against the heat losses are internal heat gain and passive solar. You may only use passive techniques (insulation, air sealing, windows, shading, heat recovery) to meet this requirement. This is a feature of the standard, not a bug.

Stifling legitimate questions

Martin disagrees with Dr. Feist and said as I recall, "you don't need 0.6 ACH50 air tightness for moisture protection in a super-insulated building, 2.0 is good enough."

Firstly I have not detected any degree of stiflement on Mr. Holladay's part. I will agree it is difficult to get the Passive House Institute to return emails and phone calls.

Secondly, in the current litigation climate it's good to know we might be erring on the side of caution. Thanks Martin! If I get hauled into mold court I'll be sure to mention that you thought 0.6 was overkill.

Conclusion

The logic in a nutshell is that you can afford more insulation than you think. Keep insulating to the point where the peak heat load is so low you can use a small cheap heater for almost the whole building, and piggyback on the fresh air ventilation system for distribution.

Net-zero is more arbitrary than this. Why zero? Why not 20 kBtu/ft2/year net usage? Why not 5 kBtu/ft2/yr net production? The only reason for a target of zero is that at zero you don't have to explain how much energy is a Btu or a kWh or a therm. The logic of net zero is marketing psychology. I have talked to people who reason that the PV array should be three times the size of what you need for net zero, because about 1/3 of the energy you use is for transportation and 1/3 is embodied in the stuff you buy, and you should make up for that as well in order to be completely righteous.

The Passive House Standard is fine. It isn't wrong just because it's not the same as the net-zero standard. "Excess" insulation is not a waste of resources, it's an investment in long-term thermal comfort insurance.

I wish there were more Martin Holladays out there blasting the gasfrackers, the shale oilers, the algal biodiesel, the thoriumheads, the clean coalers, the cellulosic ethanol - all this other stuff that's so much more overhyped and deserving of blasting than Passive House.

Graham S. Wright