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Proposed New England Passivehouse Amendment

A Focus on Primary Energy and Resource Equity

Origins

This document emerges from a facilitated discussion amongst a small group of energy efficient building enthusiasts that included a number of the early Passivehouse consultants in the northeast. At that discussion, it was proposed that the best way to work with perceived issues with the Passivehouse standard (PH std) was to propose a regional amendment as is commonly done to codes and standards. The author is grateful for this community of practitioners and others who engaged thoughtfully.

Intent

The intent of this document is to propose a draft amendment to the PH std that addresses the deficiencies of the PH std, while building on the immense knowledge base of the Passivhaus Institut and the PHPP tool it has developed. Therefore, the proposal herein deviates the minimum amount from the existing standard in order to accomplish its goals. It can be argued that PHPP and much else from the PH std should be abandoned and a new start made – this is *not* that path.

The principal deficiencies identified are:
- the PH std has the same annual heating and cooling demand (AHD, ACD) limits anywhere, which leads to extreme solutions in severe climates.
- the resultant focus on meeting the AHD limit in the more severe climates diverts focus from the overall primary energy consumption of the building and its occupants.
- the PH std limits are set per unit of usable floor area (TFA), which creates the perverse incentive that larger houses meet the std more easily. Perhaps more fundamentally, the PH std, as most if not all other standards, sidesteps the core issue of resource use equity.
- the PH std counts solar input from direct gain solar heating and solar thermal hot water but does not count solar electricity to be used in meeting the std.
- the PH std does not require performance reporting beyond the 0.6 ACH50 blower door test.

This amendment is envisioned to apply to structures residential in nature in New England. There may be other heating-dominated climates in North America in which this amendment is applicable. The fundamental guiding principles – that what matters is primary energy, and it should be allocated per person, not per floor area – are applicable anywhere.

Making the Case – Why Primary Energy

The impact of building energy on the terrestrial environment and the atmosphere is proportional to primary energy consumption (PEC), not site energy demand. In climates substantially colder than central Germany, the AHD of the PH std becomes the most challenging criterion of the standard, leading to some extreme solutions and shifting focus from primary energy. It can lead to buildings with excess south glazing, with increased heating season temperature swings (and higher cost). It can lead to quantities of insulation that likely exceed any defensible rationale when compared to investments in renewable energy.

The 15 kWh/m2/year AHD arose from the focus on driving the design heating load low enough to deliver the heat in the ventilation air. This is defined as 10W/m2, and in central Germany this yields 15 kWh/m2/year AHD. It is extremely challenging to accomplish a design heating load of 10W/m2 in the New England climate, and it's not necessary to achieve the PEC limit in the PH std. It is demonstrable both in PHPP and in actual houses that the PEC attributable to heating is 25-30% of the total PEC. At some point it's important to shift both attention and investment from further reductions in AHD to reductions in overall PEC. A simple example is shifting investment in further AHD reduction to reducing the PEC of domestic hot water (DHW).

Another reason to abandon the AHD criterion is that meeting it in New England is dependent on having a properly oriented, unshaded building, because the energy balance through the glazing is critical to achieving the AHD criterion. This shifts our focus to new construction on open sites, yet the climate challenge means we need to address our existing housing stock, much of which has random orientation and significant shading.

Eliminating the AHD criterion does not mean abandoning high performance building envelopes. The argument has been advanced that achieving the AHD criterion is necessary to ensure comfort and building durability. Over thirty years of North American experience that long pre-dates the PH std shows that both can be achieved with a less aggressive level of what has been called superinsulation. Therefore, the amendment includes a design heating demand limit (DHD) rather than an AHD limit. This ensures a very high performing building envelope, while allowing a building with less than optimal orientation and shading to achieve the PH std.

The argument for eliminating the ACD in New England is that cooling doesn't account for a large enough proportion of house energy usage to focus on this as a criterion. The frequency of overheating is retained as is. If a cooling system is provided, cooling energy is calculated and incorporated into PEC calculation as is. In addition, it is proposed that a separate dehumidification calculation be developed and incorporated into the PEC calculation.

Making the Case – Why Resource Equity

It will strike some as inappropriate to bring the ethical consideration of equity into the discussion. However, US house size per occupant has increased three-fold since 1950 and this trend largely erases gains in enclosure efficiency. It is acknowledged that larger houses use more resources both in construction and ongoing maintenance and repair, and because they have a lower enclosure area to usable floor area ratio it is easier to achieve the PH std with a larger house.

Do we prefer a 5,000 ft2 Passivehouse to a 1,200 ft2 house that meets Energy Star? Why is a household with more economic resources permitted to have more environmental impact? The concept of a maximum ecological footprint per person introduces the idea that each of us is responsible for our own impact, and that we each get the same "budget" to spend. In the amended PH std, this budget is primary energy consumption, and it's per person, not per ft2. This makes the standard easier, not harder, to achieve as house size diminishes. It has a secondary effect of eliminating the quest to incorporate as many ft2 of treated floor area as possible in a design – designers won't be penalized for some double-height space, or using a walk-in closet instead of a standard two foot deep closet.

Components of the Amendment

1 – Primary energy consumption is the principal focus, and to address resource use equity, the limit set is per occupant rather than per unit of floor area. Number of bedrooms is used as the surrogate for number of occupants: occupants = bedrooms + 1, similar to the ASHRAE 62.2 residential ventilation approach.
2 – The heating and cooling annual demand limits are eliminated. There is a design heating demand (DHD) limit, which is 30W/m2 (9.5 BTU/hr/ft2) based on Treated Floor Area (TFA). This DHD is ***not*** the result shown in cell Q90 in the Heat Load worksheet in PHPP, it is the larger of the two results calculated in cells P64 and R64, ***before*** solar and internal gains are calculated. As such, it is not directly comparable to the 10W/m2 limit in PHPP, which is a net heating load after gains are added.
3 – Domestic hot water (DHW) use per occupant is raised from the German 6.6 gallon per day (gpd) per occupant to 10 gpd/occupant. This is lower than typical US usage, yet well within measured data representative of energy conscious Americans.
4 – Electrical usage for appliances, plug loads, and lighting is calculated according to the current PH std, except for houses/apartments with less than 35 m2/occupant (377 ft2/occupant) as determined in the present PH std, which fixes the occupancy at TFA/35 m2. This is primarily to ensure sufficient electrical usage is counted in small houses and apartments.
5 – Solar electric (PV) generation is counted to offset up to twenty percent of the primary energy consumption limit. This limit is imposed so as to treat PV in a similar fashion to solar DHW, in that it represents an estimate of the system output that is used contemporaneously on site. It also is intended to ensure that poor buildings aren't made eligible by large PV systems. The PV offset is calculated with a PE Factor of 0.7 as defined in PHPP, which means that each kWh of PV generated electricity offsets 2 kWh of

primary energy, assuming the PHPP PE Factor of 2.7 is used for grid power (some argue it is higher in the US – this needs vetting for New England.)
6 – A dehumidification load calculation is added. The load calculation method needs to be developed.
7 – Certification is renewed annually after submission of actual energy usage data (intent is to build a database, not to revoke certification.)

Process (this assumes PHPP is used in the normal manner except where noted)

1 – Determine the number of occupants by counting bedrooms and adding one to the total. Defining a bedroom is a slippery part of this amendment. A bedroom is a room with a door that meets egress requirements, code minimum for size, has a code minimum window for light and vent, and is consistent with being called a bedroom for the purposes of a real estate transaction, property assessment, or sewage capacity.
2 – Calculate the primary energy consumption limit as follows:
PEC limit = 2,650 kWh/year (9 MMBTU/year) + 3,650 kWh/year (12.5 MMBTU/year) x number of bedrooms. This algorithm was developed by taking the PEC limit of 120 kWh/m2/year and using the following table of house size:

Bedrooms	TFA, m2	TFA, ft2
1	55	592
2	86	926
3	117	1,259
4	146	1,572
5	175	1,884

The resulting PEC limits are shown in the following table:

Bedrooms	kWh/year	MMBTU/year
1	6,300	21.5
2	9,950	34.0
3	13,600	46.4
4	17,250	58.9
5	20,900	71.3

3 – Calculate the design heating demand (DHD) in PHPP, using the larger of the results shown . The limit is 30W/m2 of TFA (9.5 BTU/hr/ft2) as shown in the cells P64 and R64 in the Heat Load worksheet.
4 – Calculate annual cooling demand (ACD) in the normal manner in PHPP. This is not proposed to be amended because primary energy used for cooling in houses in the northeast is much less than that used for heating, and cooling energy is being accounted for in the PE calculation. Calculate annual dehumidification demand (ADD) (method TBD).

5 – Calculate DHW energy by setting the gpd per occupant to 10 and keeping the service temperature at 140˚F.
6 – Calculate Auxiliary Electricity in the normal manner in PHPP.
7 – Calculate Electricity for appliances, lighting, and plug loads as follows:
If TFA/35 m2 (377 ft2)< number of occupants, where the number of occupants is equal to number of bedrooms plus one, calculate electric usage based on the number of occupants (small houses and apartments). If TFA/35 m2 > number of occupants, then calculate the number of occupants as TFA/35 m2, as PHPP presently calculates it in Verification Mode.
8 – Add all primary energy usage together – check against PEC limit.
9 – If over, choose how to reduce PEC – reduce heating or cooling demand with design changes; use more efficient space conditioning or ventilation equipment; use solar hot water; use solar electricity up to twenty percent of PEC limit.
10 – If the AHD and the PE max limits are met, and the blower door test is successful, then the building gets a Passive House certification. To retain that certification, actual energy usage must be reported annually.

Expectation and Aspiration

Other countries and regions of countries have modified the Passivehouse standard to suit their goals. This proposal aspires to change how people (especially New Englanders) think about minimizing the environmental impact of houses and people. Minimizing primary energy consumption and basing the standard on occupancy rather than on area will evolve an already robust standard to a more effective and more ethical level.

It is not expected that the organizations maintaining the existing standard will welcome or adopt the key aspects of this standard. If Passive House New England, which is not aligned with either PHI or PHIUS, sees value in this proposal, it may begin to develop its own certification process. At the least, the aspiration is that this proposal may guide a well-focused and thoughtful exploration of how to live ethically and effectively on this planet for practitioners and clients, rather than aiming blindly at what are ultimately arbitrary numbers despite our best intentions.