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Is Passive House the solution to our climate crisis?

- *Key design breakthroughs center on the skeleton, skin and respiratory systems of buildings.*

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The message from scientists is clear: The planet is on a finite greenhouse gas budget and the longer we wait to reduce emissions, the faster we'll have to reduce later to avoid catastrophic climate change. Time is of the essence.

While we have made remarkable progress over the past decade in delivering more energy-efficient buildings, we are moving too slowly given the urgency of the climate crisis. According to the U.S. Energy Information Agency's 2014 projection for building energy use, efficiency gains will be offset by the 60 billion square feet that will be added to U.S. building stock between 2005 and 2030.

That's not good enough. If we're serious about our climate goals, we need to bend the building energy use curve downward.

The good news is that we — architects, engineers and builders — can transform building energy performance today. Passive House (aka Passivhaus) design and construction, for example, can reduce overall energy consumption by up to 75 percent and launch the built environment toward the Zero Net Carbon goal recently announced by the World Green Building Council, Architecture 2030 and others. And we can do this cost-effectively and predictably.

Never mind the gap

Ever since the New Buildings Institute published its 2008 paper documenting the performance gap between modeled and actual energy use of LEED buildings, the predictability of performance in LEED and other high-performance buildings has been the topic of much study and debate.

There is no such debate with Passive House performance. The consistent finding is that Passive House modeling (via the Passive House Planning Package or PHPP) is highly correlated with actual building performance.

Research from Germany bears this out. Data from independent researchers, shared by Passivhaus Institut, compares the heat consumption of four developments: three Passive House settlements and one non-Passive House settlement (though still fairly energy efficient.) Their findings:

1Passive House radically outperforms conventional energy-efficient buildings, by up to 80 percent in heat consumption.

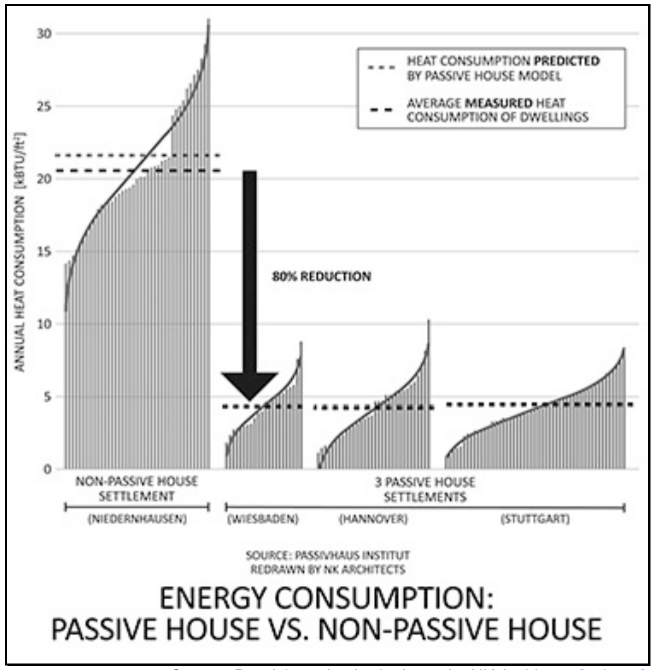
2Occupant behavior varies widely. It is normal to see a swing in energy use of around 50 percent for identical units within a settlement. The S-curves that emerge for each development illustrate the variance between energy "misers" and energy "hogs" across functionally identical units within a community.

3Passive House modeling has strong predictive power. The PHPP model's predicted heating consumption for the three Passive House settlements is nearly identical to the actual average heating consumption of each.

Predictable performance

Passive House models are highly correlated with actual building energy performance for two reasons.

First, the data inputs for the PHPP performance model exactly correspond to the actual building materials and assemblies used in a Passive House project. And these assemblies control convection, conduction, radiation, and the movement of heat, air and moisture.



Source: Passivhaus Institut/redrawn by NK Architects [enlarge]

Passive House uses 80 percent less energy for heating than traditionally built structures.

Second, Passive House quiets the volatility (measured in temperature deltas, moisture gradients and air leakage rates) that we see in non-Passive House buildings. Energy models of stable systems are more accurate than energy models of volatile ones. So, the quiet and comfortable interior environment in a Passive House is a boon for both the occupant and the modeler.

The key design breakthroughs of Passive House center on the skeleton, skin and respiratory system of buildings.

SKELETON

For centuries we have ignored the thermal (and condensation) implications of the structural elements of our buildings, blithely allowing beams to jut through walls without a care for the energy transferred through these thermal bridges. In fact, steel beams thrusting through otherwise decent exterior walls can still be seen as a signature architectural gesture today.

But even far less egregious examples of thermal bridging, like wood studs in a wall, dramatically reduce the overall performance of the building envelope.

If not detailed properly with thermal breaks between inside and outside, the skeleton of a building can undermine energy performance, yet thermal bridging is either ignored or incompletely accounted for by many modeling protocols and by many designers.

Passive House is the gold standard of thermal bridge-free design, dramatically improving energy performance, predictably.

SKIN AND RESPIRATORY SYSTEM

In a Passive House, building envelope and ventilation function together as a system. Airtight construction is central to this system because it limits the movement of air, and the heat and moisture that air carries, through the building envelope. This dramatically reduces the loss of thermal energy from buildings, especially when combined with a thick sweater of insulation. It also protects the integrity of building assemblies, limiting the movement of moisture into wall cavities where it can cause mold and rot.

Equally important are the health implications of this approach. Airtight construction stops random, uncontrolled air leaks through cracks in building materials and enables designers to bring filtered fresh air in through balanced ventilation with heat recovery. This approach delivers superior indoor air quality to building interiors. (This is why the 2017 Washington Code will require DOAS, or Dedicated Outdoor Air Systems, in commercial buildings.)

The heat recovery of ventilation air brings major energy performance benefits as well. And because the airtight envelope eliminates random air and heat leaks, the system becomes easier to model: predictable energy performance.

At what cost?

I'm often asked, what does Passive House cost? What's the premium?

It really depends on the building typology and program, of course. And if Passive House is tacked on late in project development as an afterthought it can be expensive. But when part of an integrated design approach, Passive House's "premium" can be negligible.

Recently released data from the Pennsylvania Housing Finance Agency illustrates the point. In 2015 and 2016, the agency received 179 project proposals for Low Income Housing Tax Credits: 59 of those proposals were for Passive House projects and 120 were for conventional buildings. The average projected construction cost for the Passive House buildings was $171/square foot, compared to $168/square foot for the conventional projects. That's a difference of just 1.8 percent.

Revolutionary efficiency, predictable performance and negligible cost premium? That sounds like a pathway to move our industry from being part of the climate problem to being part of the climate solution. And not a moment too soon.

Tim Weyand is CEO of NK Architects in Seattle.

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