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Passive Building

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Most people agree that building green requires the efficient use of energy, water and other natural resources, and reducing waste and environmental degradation, while at the same time protecting occupant health and preserving open space. Many factors figure into this complex equation, none more dissected than in the third party rating system of the U.S. Green Building Council (USGBC), LEED (Leadership in Energy and Environmental Design), and its newer competitor, zero energy buildings (ZEBs).

When it comes to energy efficiency, however, neither attains the heights reached by the latest entrant in the green building arena, "passive houses." This article will explore them and what they could mean to the green building movement.

Passive Houses Defined

The term "passive house" refers to a rigorous, voluntary standard for building energy efficiency that results in buildings that require very little energy for heating and cooling. With components that boast exceptional efficiency and with ventilation systems that are state of the art, passive homes surpass LEED buildings and ZEBs by wide margins in energy efficiency.

Passive homes typically include the following components:

(1) They are tightly sealed and have superior insulation, with double the typical amount of insulation on roofs, walls and ground slabs.

(2) They are designed to minimize and control thermal bridges (i.e., areas within a building that are poor insulators, which allow heat to escape) and have continuous insulation with no gaps.

(3) Their air tightness is verified with blower door tests.[1]

(4) They have a ventilation system with a high efficiency heat exchange that integrates heating and cooling.

(5) They have high performance windows and doors that eliminate air leakage (the windows *can* be opened; the ventilation system adjusts).

Together, these components are integrated with an advanced energy modeling program called the "Passive House Planning Package" (PHPP), producing a building with an interior environment of high thermal comfort and air quality that requires very little energy to maintain. Where previously a 30 percent energy reduction compared to similar buildings was considered an enormous achievement, heating and cooling energy reduction in passive houses of up to 90 percent, radical by today's standards, is achievable.

Most disciples of energy efficiency in the green building movement would designate LEED certification, and specifically LEED platinum (the highest certification that can be achieved under the LEED system), the "gold standard" in green buildings. However, to adherents of passive houses, LEED energy standards are weak. Passive houses go beyond LEED and take energy efficiency to levels that have not been experienced in green building.

Beginning and Growth

Passive houses were conceived in the late 1980s by Swedish professor Bo Adamson of Lund University and Wolfgang Feist from Germany's Institute for Housing and the Environment. The first Passivhaus (German for "passive house") was constructed in Darmstadt, Germany in 1990.

In 1996, the Passivhaus-Institute was founded in Darmstadt. Since then, approximately 15,000 passive buildings have been built, most of them in Germany and Austria, and virtually all of them have been residential buildings.

In 2003, the first passive house in North America, referred to as the Smith House, was built in Urbana, Ill. In 2007, the Passive House Institute United States (PHIUS) was founded by Katrin Klingenberg and Michael Kernagis.[2] PHIUS is the official certifier of the passive house standard in the United States.

To become a certified passive house, a building must meet a very high energy efficiency standard.

First, it must not use more than 15 kilowatts (KW) of energy per square meter annually for heating. Second, the building's total energy consumption cannot use more than 120 KW of energy per square meter per year. Third, the building shell must not leak more air than 0.6 times the house volume per hour.

These standards are much higher than houses built to most normal building codes. In fact, a house built to the passive house standard results in a building that requires anywhere

between 75 and 90 percent less energy for heating and cooling than current new buildings that meet today's energy efficiency codes, a remarkable achievement.

While upfront costs tend to be 5 to 10 percent more than regular buildings, energy costs are so low that this results in a five to eight year payback. In addition, the passive house standard can be used when retrofitting existing buildings. Thus, this technology has the potential to radically reduce overall building energy use if existing buildings are retrofitted to meet the standard.

Best of all, the standard relies on existing technology and, given its short payback period, does not depend on government subsidies to make it competitive in the marketplace.

The passive building movement is exploding around the world and will soon take shape right in our backyard in Greenwood Heights, Brooklyn.[3] Ken Levenson of Levenson McDavid Architects, P.C.[4] will soon be breaking ground on the largest multi-family residential passive building in North America. The project is estimated to cost 7 percent more in meeting passive house certification standards, with a six-year payback.

Levenson believes that the economics for this type of building are so strong that he anticipates that within the next few years the USGBC will need to incorporate passive house certification as a LEED requirement or risk being viewed as having missed an opportunity.

Given the recent emphasis in improving energy efficiency in buildings as demonstrated by the American Recovery and Reinvestment Act,[5] which contains unprecedented federal government support for improving energy efficiency in buildings, it is possible that standards for passive building will be enacted in the near future.

Already, the European Parliament has proposed that new buildings meet passive-house standards by 2011.[6] In the United States, passive houses have been built in Massachusetts, California and Ohio, among other states.[7] New York may wish to consider following these states' example in leading the way in the next revolution in green building.

LEED vs. ZEB vs. Passive

LEED, by far the most widely used green building rating system today, is an example of an integrated approach to sustainable development.

LEED is a green building rating system that addresses six major areas: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process. LEED uses a point system for specific steps taken in connection with a project in these categories. While the energy use of a building is considered, it is only one category, and apart from meeting a prerequisite for building energy efficiency, a building that is LEED certified does not have to meet a particular

energy efficiency standard (although buildings can receive more points if they become more energy efficient).

Zero energy buildings, or ZEBs, are one step up from LEED in building energy efficiency, with the amount of energy produced by the building being equal to the amount of energy consumed, thus a net zero energy building. Generally, this energy is provided by on-site renewable sources such as solar photovoltaic panels or wind.

However, some buildings are considered ZEBs even though the energy is generated off-site. A ZEB may retain its zero energy building designation if 100 percent of the energy it purchases comes from renewable sources.

In 2008, the U.S. Department of Energy, Energy Efficiency and Renewable Energy, Zero Energy Home program funded $148 million in research monies into development of ZEBs.[8] Industrial associations, like the American Institute of Architects (AIA), are driving the construction industry toward ZEBs.

Among the organizations working toward promoting ZEBS are the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and the Illuminating Engineering Society of North America (IESNA). Aimed at educating the building community and the public about sustainable design and environmental stewardship, the BASF Near-Zero Energy home in Paterson, N.J. was designed as part of BASF's Better Home, Better Planet Initiative.[9] It has achieved a LEED for Homes Platinum designation from the USGBC.

In contrast to LEED, which focuses on aspects of green building in addition to energy efficiency, and ZEBs, which focus on generating a sufficient amount of renewable energy to power a building, passive energy building is focused on one thing: achieving a massive reduction in the amount of energy it takes to heat and cool a building.

It does this by focusing on the building envelope to minimize heating and cooling losses while optimizing passive gains, such as passive solar (i.e., solar energy that is absorbed through glass and other building materials). By doing this, it achieves a 75–90 percent reduction in the energy required to heat and cool a building.

Because it does not focus on energy production, it avoids the high upfront investment costs that typically apply to buildings that choose to install renewable sources of energy such as photovoltaics, windmills and geothermal systems.

Why Passive Works Better

LEED principles adhere to sustainability concepts through a focus on indoor air quality, water and energy efficiency, construction materials, indeed, a holistic approach to the environment.

LEED allows the builder to cherry-pick from menu items with the goal of reducing energy

use below the minimum required by law, thus, achieving a sufficient number of credits for the targeted level of certification—LEED Certified, Silver, Gold or Platinum.

However, apart from requiring that buildings meet a certain floor for energy efficiency (for example, in the case of new buildings, LEED requires that they be 14 percent more efficient than the 2004 ASHRAE 90.1 building standard), they are not required to improve on this standard and they are not required to confirm after the building is constructed whether it is operating as efficiently as designed.

Many states and municipalities are enacting laws requiring that new or substantially renovated buildings conform to a certain LEED standard. While these buildings are certainly improvements over those not built to LEED standards, some have raised questions whether these buildings are truly energy efficient.[10]

In contrast to LEED, ZEBs focus on the building itself, the goal being to reduce or completely eliminate energy use and greenhouse gas emissions for a building's life cycle, thus lowering its ecological effect throughout its life. Thus, in contrast to LEED, ZEBs are not required to do such things as use recycled building material, reduce construction or demolition waste, or have a groundwater recovery system.

However, a major downside to ZEBs is that virtually all forms of renewable energy have relatively high upfront costs and typically have a long payback period. Thus, at this time, they are dependent on government subsidies and tax incentives to be commercially viable.

In contrast to both of these models, passive buildings must achieve an extremely high rate of energy efficiency to become certified. In addition, they have a high rate of predictability with respect to energy costs because the PHPP energy modeling truly integrates all building components in a very specific, precise and accurate manner.

The PHPP allows the architect/engineer to optimize the building components on an individual unit cost/overall building efficiency basis. Passive house supporters say that the high predictability of the PHPP makes the passive house standard the least risky approach to dramatic energy and cost savings.

Existing New York Laws

New York state got out front on green building design and construction with two new laws enacted last fall, the Green Building Construction Act[11] and the Green Residential Building Act.[12]

The Green Building Construction Act requires all new construction and substantial reconstruction projects undertaken by the state to comply with certain green building principles that minimize energy consumption and use resources efficiently. It authorizes the New York State Department of Environmental Conservation (DEC), in consultation with

the New York State Energy Research and Development Authority (NYSERDA), to promulgate rules and regulations concerning these building principles.

The Green Residential Building Act establishes a green residential building grant program authorizing NYSERDA to encourage the use of certain design and construction techniques in the construction and renovation of residential buildings that achieve energy efficiency, reduce greenhouse gases, conserve natural resources, reduce waste, create a healthy indoor living environment and incorporate products that are environmentally responsible. NYSERDA is authorized to provide incentives for owners of residential buildings that have been constructed or renovated pursuant to these green building standards between Jan. 1, 2010, and Oct. 31, 2013.

In addition, New York offers a number of tax incentives to developers through its Green Building Tax Credit Program,[13] which was launched in 2000, as well as laws passed in 2008 that allow tax abatements in New York City for the installation of solar generation systems for residential buildings[14] and green roofs.[15] By offering clear, though limited, incentive payments for construction or renovation of green building, New York has moved to the forefront of states that are implementing green building standards and may be poised to set more stringent energy efficient standards in the near future.

Although this is a good start, it is not enough. Most experts believe that if significant climate disruption is to be avoided, greenhouse gas emissions will have to be reduced by approximately 80 percent from current levels.

Currently, the state Legislature is considering passing a bill that would require that New York reduce its greenhouse gas emissions by 80 percent by 2050.[16] In addition, it is likely within the next 12 to 18 months that the U.S. Congress will pass a comprehensive greenhouse gas cap-and-trade program.

Given that greenhouse gas emissions come primarily from energy production from fossil fuels, the way to reduce these emissions is to use less energy, which means using energy more efficiently. And because buildings use almost 40 percent of energy produced in their operations and are responsible for virtually the same amount of overall carbon emissions,[17] buildings must radically reduce the amount of energy they use if greenhouse gases are to be reduced. Given this reality, passive buildings offer an intriguing possibility.

To this end, New York may wish to consider encouraging the voluntary adoption of passive house standards by builders and owners through public education and outreach and offering continuing education courses on passive building for engineers and architects. It may also want to adopt a goal of incorporating passive house standards into the state building code within the next decade or sooner.

To reach this goal, the state should consider sponsoring demonstration projects for all building types.

Finally, NYSERDA and other related state agencies should consider offering incentives for passive house projects and the state may wish to enact tax credits for buildings that achieve at least a 75 to 90 percent energy savings compared to standard buildings.

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Endnotes:

1. A "blower door" is a diagnostic tool designed to measure the air tightness of buildings. It consists of a calibrated fan for measuring an airflow rate, and a pressure-sensing device to measure the air pressure created by the fan flow.

2. Information about PHIUS is available at http://www.passivehouse.us/passiveHouse/PHIUSHome.html.

3. Greenwood Heights is an area of Brooklyn, N.Y., situated south of Park Slope and between Sunset Park and Windsor Terrance.

4. Levenson McDavid Architects P.C. is an architectural firm located in Brooklyn, N.Y. Ken Levenson, one of the principals, agreed to be interviewed for this article.

5. Pub. L. 111-5 (2009).

6. Elizabeth Rosenthal, "No Furnaces but Heat Aplenty in Passive Houses," New York Times, Dec. 26, 2008, available at http://www.nytimes.com/2008/12/27/world/europe/27house.html.

7. Id.

8. Budget of the U.S. Government, FY 2008: Dept. of Energy, available at http://www.gpoaccess.gov/usbudget/fy08/pdf/budget/energy.pdf

9. In 2007, the home was donated to St. Michael's Housing Authority. See "BASF Near-Zero Energy Home Earns LEED Platinum Coordination," Green Progress, Jan. 24, 2007, available at http://www.greenprogress.com/green_building_article.php?id=538.

10. See, e.g., Henry Gifford, "A Better Way to Rate Green Buildings: LEED sets the standard for green building, but do green buildings actually save any energy?" (2008), available at http://greenlineblog.com/henry-gifford-suggests-a-better-way-to-rate-green-buildings.

11. L. 2008, ch. 565; N.Y. Energy Law Art. 13.

12. L. 2008, ch. 631; Pub. Auth. L. §1872.

13. N.Y. Tax Law §19.

14. L. 2008, ch. 452; Pub. Serv. Law §66-j.

15. L. 2008, ch. 461; Real Prop. Tax Law §499.

16. See The Global Warming Pollution Control Act (S. 4315/A.7572), available at http://assembly.state.ny.us/leg/?bn=A07572&sh=t.

17. U.S. Environmental Protection Agency, Buildings and the Environment: A Statistical Summary (December 2004), available at http://epa.gov/greenbuilding/pubs/gbstats.pdf.