Developments in Federal
and State Law

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Editor

ENVIRONMENTAL
LAW IN
NEW YORK

ARNOLD & PORTER LLP

LexisNexis™

Volume 26, No. 3

March 2015

AN INTRODUCTION TO PASSIVE HOUSE PRINCIPLES AND POLICY

Viewpoint

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IN THIS ISSUE

The drive for greater energy efficiency in buildings has intensified with rising concern over climate change caused by carbon emissions. The U.S. Energy Information Administration (EIA) estimates that buildings account for approximately 40% of all energy consumption in the United States.[1]

Meaningfully reducing carbon emissions therefore will require new design and construction approaches for new buildings as well as for retrofits of existing buildings.

Policymakers are slowly but surely taking heed, and are gradually transforming the approaches to setting code, policy, and incentives from prescriptive to performance-based strategies. The difference between these approaches will be discussed later in this article.

Passive house—or more accurately passive building—has been a catalyst for this change in approach in the United States and internationally. The term passive building comprises both a set of design principles (or a design methodology) and a quantifiable performance standard that can be implemented in all building types (not only houses, but also apartment buildings, office buildings, schools, etc.). Buildings that meet the standard use dramatically (up to 80%) less energy than conventional code buildings, and provide greater comfort and excellent indoor air quality. Because of the way they are designed and constructed, they also provide greater resiliency—for example, comfortable temperatures can be maintained even during a power outage.

Passive building lowers the amount of operating energy in the most cost-effective way by applying conservation measures first. In doing so, passive building makes it practical to supply all of a building's energy needs with relatively low levels of renewable sources. As a result, passive building is increasingly the foundation for so-called net zero energy and net positive energy buildings.

Passive building therefore will be a key factor in meeting the daunting global challenge of reducing carbon emissions. From a political point of view, it provides an effective means of mitigation while also providing greater energy independence. From the home or building owner's perspective, its built-in resiliency facilitates adaptation to weather extremes that can no longer be prevented.

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[1] *How much energy is consumed in residential and commercial buildings in the United States?*, EIA, http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1 (last visited Jan. 20, 2015).

This article will explain passive building, explore the evolution of energy codes and standards, and set forth our outlook on where they need to go.

Passive Building: An Overview

A passive building relies on a few foundation principles to achieve extreme energy efficiency, comfort, and resiliency:

- Superinsulation: It employs high levels of continuous insulation through its entire envelope.
- Thermal Bridge-Free: It is designed to eliminate thermal bridges. (A thermal bridge is a highly conductive material that extends from within a building's envelope to the outside air.)
- Airtightness: Its building envelope is extremely airtight, preventing infiltration of outside air and loss of conditioned air.
- High-Performance Components: It employs high-performance windows (typically triple-paned for cold climates) and doors.
- Energy Recovery Ventilation: It uses some form of balanced heat- and moisture-recovery ventilation in most climates and either eliminates or at least minimizes a conventional space conditioning system.
- Solar gain, if available, is managed to exploit the sun's energy for heating purposes and to minimize it in cooling seasons.

A passive building is inherently both effective and low-tech, with few moving parts. It is durable and has minimal maintenance needs.

Passive design strategy carefully models and balances a comprehensive set of factors—including heat emissions from appliances and occupants—to keep the building at comfortable and consistent indoor temperatures throughout the heating and cooling seasons, using as little active energy input as possible. A passive building requires careful computer modeling at the design stage. The passive building designer uses software to adjust multiple variables—insulation R-values, wall construction parameters, etc.—until the design model meets the energy performance targets.

Passive building does not radically differ from conventional building, but it does require special balancing and care through both the design and construction stages. High levels of airtightness and insulation require advanced modeling to avoid moisture issues. Construction crews must learn and apply different approaches to air sealing and other processes, and to sequencing construction. As a result, to assure performance, a project should undergo stringent third-party quality assurance and quality control inspections, including final testing and commissioning of the mechanical systems.

The importance of quality assurance and quality control needs to be part of any policy or code that requires or recommends passive building.

Passive building does not dictate an aesthetic—it has been successfully applied in traditional as well as contemporary and minimalist designs.

In terms of building costs, single-family passive homes have typically cost 10–15% more than conventional buildings. For architects and builders, costs tend to run higher on first projects and come down steadily with experience. Moreover, as the market for high-performance windows and other components has grown, their cost has also come down, a trend that continues.

Larger buildings are more economical candidates for passive building for a variety of technical reasons, including economy of scale and a more favorable volume-to-surface-area ratio. Passive design multifamily projects have cost approximately 5% more than conventional multifamily buildings. A recently completed passive apartment building in Brooklyn, referred to in the *One City, Built to Last* report[2] that the New York City Mayor's Office published in 2014, did not have a cost premium compared to a conventional building.

It is not surprising, then, that passive building has caught policymakers' attention.

A Brief History of Passive House and Passive Building

In 1970, the White House Council on Environmental Quality issued its First Annual Report along with a presidential message to Congress.[3] The report included comprehensive analysis of the environmental threats facing the United States and made the case for the establishment of the Environmental Protection Agency (EPA). Notably, the report called attention to the possibility of climate change.

The establishment of the EPA and growing attention to environmental issues, combined with the Organization of the Petroleum Exporting Countries (OPEC) oil embargo in 1973, led to significant government funding of energy efficiency research.

Through the 1970s and 1980s, building science research in the United States and Canada spawned the key principles underpinning what we now call passive house or passive

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[2] N.Y.C. MAYOR'S OFFICE OF LONG-TERM PLANNING AND SUSTAINABILITY, ONE CITY, BUILT TO LAST: TRANSFORMING NEW YORK CITY'S BUILDINGS FOR A LOW-CARBON FUTURE (undated), http://www.nyc.gov/html/builttolast/assets/downloads/pdf/OneCity.pdf.

[3] THE FIRST ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY TOGETHER WITH THE PRESIDENT'S MESSAGE TO CONGRESS (Aug. 1970), *available at* http://www.slideshare.net/whitehouse/august-1970-environmental-quality-the-first-annual-report-of.

building—including superinsulation, airtightness, maximizing solar gain for heating if available, and energy recovery ventilation.

The terms "passive structure" and "passive house" were first used in the 1970s by Canadian researchers on the team of Rob Dumont[4] at the Saskatchewan Research Council, and later were used in the 1980s in the United States by the noted physicist William Shurcliff.[5]

Shurcliff distinguished passive house from the "passive solar" movement of the time. The passive solar approach differed from modern passive building in that it focused on "mass and glass"—using large southern exposures to absorb solar energy and large interior masses to store it. While it led to important discoveries, passive solar design ultimately produced a lot of homes that had overheating problems and were cooling off too quickly because building envelope components were not insulated enough.

Shurcliff's concept of passive house was more holistic. It relied on superinsulation, airtightness, and the other key principles mentioned earlier to retain some moderate solar gains through normally sized windows supplemented by existing internal gains from appliances and people. This move away from mass and glass allowed passive house to avoid the severe temperature swings and comfort issues in classic passive solar buildings.

And Shurcliff's concept correctly called for and predicted improvement in components and materials that would ultimately lead to the ability to design and build structures without thermal bridging and that would minimize—and, in some cases, eliminate—"active" mechanical systems for heating and cooling.

By the end of the 1980s, an estimated 10,000 "superinsulated buildings" or "passive houses" had been built in the United States and Canada. At least one source estimated that there were 30,000 of these buildings.[6] These buildings neared the performance levels of today's passive house buildings.

With political change and the availability of relatively cheap energy in the United States in the 1980s and 1990s, the drive toward energy efficiency and conservation in general waned.

Europeans, however, took to heart the principles of low-energy buildings. For example, German physicist Wolfgang Feist and Swedish physicist Bo Adamson collaborated to refine the principles pioneered in the United States into a design methodology. They paired the design methodology with an energy performance target.

Their work resulted in the first convincing proof of concept in Europe: a four-townhouse development in Kranichstein in Darmstadt, Germany that was completed in 1991.[7] That project established that passive house principles could be applied to meet energy performance targets—at least in the central Germany climate zone where the project was developed. (The project also spotlighted the need Shurcliff had identified for mass-produced high performance windows and components to achieve this optimized performance and to make passive building cost effective.)

Passive building has evolved differently in different parts of Europe since then—according to market, governmental, cultural, and climate conditions—but it is a widely accepted best building practice as the underpinning for reaching the European goal (discussed below) of requiring all construction to be Nearly Zero-Energy Buildings by 2020.

Meanwhile, here in the United States, passive building has been rediscovered and has grown substantially over the past decade. For it to go mainstream and cut substantially into carbon emissions, policy and code approaches must also evolve, and we must arrive at a globally applicable formula. Europe will serve as a good example to investigate, if not follow.

First, though, it is worth looking at the history of energy codes and metrics in the United States. Such codes have largely been based on prescriptive standards. The following overview will highlight some current hurdles to implementing performance-based energy targets in the U.S. Performance-based standards are a necessary precursor to widespread adoption of passive house principles in the U.S.

Building Energy Codes in the United States—The Prescriptive Path

The history of U.S. energy codes began, like the history of passive houses, with the oil embargo of 1973.[8] The first commercial energy efficiency design guidelines were established by ASHRAE (the American Society of Heating, Refrigerating, and Air-Conditioning Engineers) and published in 1975 as Standard 90-75. Subsequent iterations were incorporated into the Model Energy Code (MEC). The MEC is the predecessor to today's ASHRAE 90.1, the recognized standard.

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[4] *Passive Solar Heating—Results from Two Saskatchewan Residences*, at 7, 8, *in* RENEWABLE ALTERNATIVES, PROCEEDINGS OF THE FOURTH ANNUAL CONFERENCE OF THE SOLAR ENERGY SOCIETY OF CANADA INC. (Aug. 20–24, 1978), *available at* http://www.phius.org/documents/Passive%20Solar%20Heating-Results%20Rob%20Dumont%201978.pdf.

[5] WILLIAM A. SHURCLIFF, SUPER INSULATED HOUSES AND AIR-TO-AIR HEAT EXCHANGERS (1988).

[6] *See* J. D. NED NISSON & GAUTAM DUTT, THE SUPERINSULATED HOME BOOK (1985).

[7] Wolfgang Feist, *Cost Efficient Passive Houses in Central European Climate*, *in* ACEEE PROCEEDINGS (1998), *available at* http://www.aceee.org/files/proceedings/1998/data/papers/0508.PDF.

[8] *See* ALLIANCE TO SAVE ENERGY, THE HISTORY OF ENERGY EFFICIENCY 6 (Jan. 2013), *available at* http://www.meede.org/wp-content/uploads/01.2013_The-History-of-Energy-Efficiency.pdf.

The approach of specifying a fixed energy ratio per square foot—a *performance-based* approach—was part of the first federal legislation and national building energy code in 1976. The initial version of that legislation required all buildings to meet a specific energy target per square foot as modeled and verified by a computer model.[9] In the face of strong opposition from the building industry, the performance modeling requirements were removed and replaced by voluntary measures. Unfortunately, the failure to pass such legislation and the resistance by the building industry has had a lasting impact on how building energy codes are written today.

While alternate performance-based paths exist in current codes and government efficiency programs, they are not generally encouraged or required. In 1994, the nonprofit International Code Council (ICC) was founded. In 1998, ICC published the first edition of the International Energy Conservation Code (IECC), another successor to the MEC. The IECC has been revised in three-year code cycles. The IECC today governs residential and commercial construction and has been adopted by many states around the country. The energy improvements of these codes, by percentage, over the first guidelines published by ASHRAE in Standard 90-75, are shown in Figure 1.

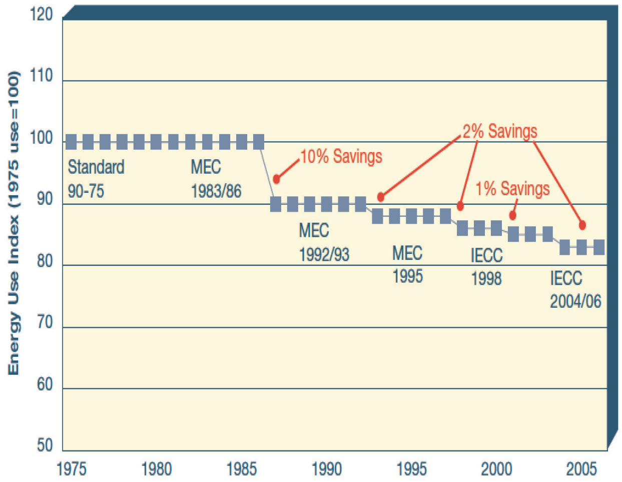

Figure 1: Residential Energy Code Stringency (Measured on a Code-to-Code Basis); Source: Pacific Northwest National Laboratory for U.S. Department of Energy's Building Energy Codes Program.

This method of incrementally tightening energy use in buildings has been mainly based on a *prescriptive* approach in energy guidelines and codes. For example, the code might require installing a certain amount of insulation for walls in a certain climate. Or it might require a certain efficiency rating for mechanical systems. The builder community has continued to lobby for prescriptive measures, which it believes are easier to communicate and implement.

While it is true that the incremental prescriptive approach is relatively easy to communicate and understand for the building industry and consumers, accurately measuring and quantifying actual performance improvement are virtually impossible under a prescriptive regime. In addition, applying this linear, additive approach of individual measures fails to look at buildings as systems, and does not account for energy synergies unless a building system is modeled intentionally to exploit them during the design process.

Typically, as today's codes are written, success is assessed in a rather imprecise way by measuring the improvement against a previous level of efficiency in percent savings over that baseline, rather than in absolute kilowatt-hour (kWh) savings. After a few code cycles, the baseline might be redefined. The baseline becomes a moving target, making it impossible to compare percentage reduction assessments from earlier baselines.

Despite such arguments against the prevailing prescriptive codes, RESNET—the Residential Energy Network, a nonprofit entity that develops standards for building energy efficiency rating and certification systems in the United States—designed a comprehensive label and measuring stick to communicate energy savings in new homes as a percentage above an agreed-upon code baseline. RESNET has successfully established this standard, called the Home Energy Rating Score (HERS) rating.

HERS has gained fairly wide acceptance in the marketplace and has made its way into policies and REACH codes (optional standards with requirements that exceed those of mandatory building codes) nationwide. Unfortunately, the HERS baseline is undergoing revision, and how existing ratings will be interpreted when the new baseline is released is still an open question.

A Shift to a Performance-Based Approach—Architecture 2030

In general, a performance-based metric is a more meaningful, objective, and accurate way to account for energy and carbon reductions. Such a metric therefore should be established in place of prescriptive standards.

One story of an effort to shift the market to a performance-based standard involves the architect Edward Mazria, who in 2003 founded the organization Architecture 2030 in response to the climate change crisis and to advocate for urgently needed carbon reductions. Mazria clearly identified the contributions of the building sector in terms of carbon and highlighted the immense overall carbon reduction potential if that contribution were significantly reduced.

For example, in 2010, U.S. buildings accounted for 41% of the U.S.'s energy consumption and contributed 7.4% of global

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[9] *See* ALLIANCE TO SAVE ENERGY, THE HISTORY OF ENERGY EFFICIENCY 9 (Jan. 2013), *available at* http://www.meede.org/wp-content/uploads/01.2013_The-History-of-Energy-Efficiency.pdf.

carbon emissions.[10] In fact, U.S. buildings' carbon emissions rank third after the United States' and China's total national emissions. (The U.S. and China are the two largest national sources of carbon dioxide emissions.) As Figure 2 shows, U.S. buildings' emissions have in recent years exceeded the combined total emissions of Japan, France, and the United Kingdom.[11]

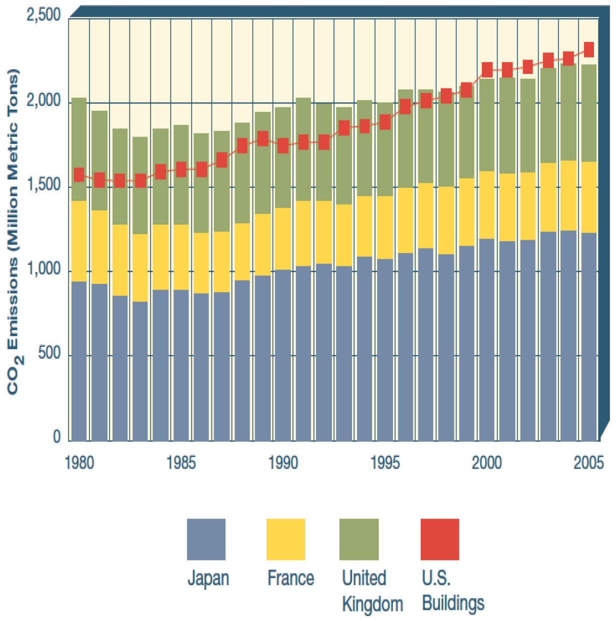

Figure 2: CO_2 Emissions of U.S. Buildings Relative to Japan, France, and the United Kingdom Total Emissions; Source: Energy Efficiency and Renewable Energy, U.S. Dept. of Energy.

Mazria proposed to follow the carbon reduction targets set by the Intergovernmental Panel on Climate Change (IPCC)—a level that was intended to limit temperature rise below 2°C and therefore avoid the worst-case scenarios of climate change. He drew up a reduction master plan that specified percentage reductions below average energy consumption to eventually reach zero carbon emissions from new buildings by 2030.[12]

Instead of relating improvements to a non-absolute changing code baseline, Mazria followed what had been the customary energy code approach in Europe (and what was rejected in the United States). He identified an absolute energy use ratio for current average baseline construction at the time. Reductions in energy consumption were measured against this baseline, and the goal was to achieve carbon neutrality by 2030, with interim goals of an 80% reduction in carbon emissions by 2020 and a 90% reduction by 2025.

This concept of an energy use ratio is also known as "Energy Use Intensity" or EUI. It is calculated by dividing the total energy used in a building by the floor reference area.

Mazria also distinguishes between two types of energy—site and source energy. This distinction is critical in the discussion about carbon emissions reductions. *Site* energy is the energy that is consumed on site once the energy has been delivered. *Source* energy includes energies used from conversion and transportation: the energy used to get resources to the power plant and to generate the energy, and the energy that is needed or lost during the delivery process. To assess carbon emissions accurately one must account for all energy and its related emissions along the way until the energy reaches the consumer, not only what is consumed on site.

Site and source energy accounting can differ greatly based on the fuel mix of the grid. Different fuels emit different amounts of carbon dioxide when energy is generated from them. Generally, burning fossil results in higher carbon emissions, and renewable sources result in very low to no emissions.

In the United States, on a national average fuel mix basis, the source energy that is needed to produce and deliver 1 kWh of electricity is 3.1 kWh, rounded down.[13] This amounts to a significantly greater amount of carbon emissions than if one only looked at the energy consumed on site.

In other countries, that number might be lower or higher, depending on the specific fuel mix that their grids employ. A higher percentage of renewable energy production brings the source energy number lower as less energy has to be used to "make" wind energy, for example. Storage and line delivery losses still apply if renewable energies are not produced and used on site.

Identifying accurate source energy consumption in buildings on an EUI basis is the key indicator for equivalent carbon emissions. We can now calculate equivalent emissions to the pound and match our personal allowed carbon budget to the goals of the IPCC. If an effective carbon verification system in the form of mandatory reductions were in place, it not only would help quantify reductions on a per-building basis but also would enable some form of carbon calculation in building taxation or a trading system.

Passive building standards facilitate just that. They employ an absolute performance-based source energy metric. They follow the same concept as the 2030 challenge master plan: the source energy target is determined to specifically limit carbon

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[10] BUILDINGS TECHNOLOGIES PROGRAM, U.S. DEPT. OF ENERGY, 2011 BUILDINGS ENERGY DATA BOOK tbls. 1.1.3, 1.4.1 (Mar. 2012), http://buildingsdatabook.eren.doe.gov/docs%5CDataBooks%5C2011_BEDB.pdf.

[11] ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEPT. OF ENERGY, ENERGY EFFICIENCY TRENDS IN RESIDENTIAL AND COMMERCIAL BUILDINGS (Oct. 2008), http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/bt_stateindustry.pdf.

[12] *See The 2030 Challenge*, ARCHITECTURE 2030, http://architecture2030.org/2030_challenge/the_2030_challenge (last visited Jan. 20, 2015).

[13] M. DERU & P. TORCELLINI, NAT'L RENEWABLE ENERGY LAB., TECH. REP. NREL/TP-550-38617, SOURCE ENERGY AND EMISSION FACTORS FOR ENERGY USE IN BUILDINGS (June 2007), http://www.nrel.gov/docs/fy07osti/38617.pdf.

emissions on a per-person or per-square-foot basis to match global carbon reduction goals of the IPCC.

If passive buildings were written into code today all building projects—both renovation of old buildings and construction of new ones—would have to meet the 2030 challenge of 80% carbon reduction. Such buildings would be "zero energy ready." Adding a small, cost-effective renewable system between today and 2030 would take homes to zero emissions and beyond.

The Rise of Passive Building Standards and Verification Tools

Building energy codes in Europe have traditionally followed the performance-based model rather than the prescriptive model, and are characterized by their use of absolute energy metrics (e.g., EUIs) as benchmarks.

During the time the "passive house" building science principles were developed in North America in the 1970s and 1980s, the concept of a *peak load* criterion for energy efficiency was also born. In simple terms, peak load is the amount of energy it takes to heat a building within a specified comfort range on the coldest day (based on ASHRAE design data) in a given climate zone. (This criterion would be for a heating-dominated climate; in a cooling-dominated climate, it would be the energy required to cool the building within a specified comfort range on the hottest day.)

Under the IECC code, if a home is designed to achieve a very low peak load of 1 watt per square foot, the home does not have to comply with the IECC's prescriptive requirements. This tiny provision essentially provides the original core passive house definition; one could argue that passive building is already included in the IECC as an alternate performance path.

This provision never was broadly implemented because the concept of peak load is difficult for a layperson to understand. In addition, the 1-watt-per-square-foot peak load metric is in practice extremely difficult to meet in the North American climate zones and remains more an aspirational goal than a realistic one. The target really would have to be revisited and modified to be a useful provision—but it could be done, as we will see.

A major step forward came when passive house principles and the peak load concept were combined with the European convention of an absolute energy metric. In the late 1980s and early 1990s, the European scientists Feist and Adamson, with government funding, translated the early passive house principles and peak loads of 1 watt per square foot or 10 watts per square meter to their climate and into an absolute energy metric and annual demand equivalent (15 kWh per square meter per year).[14]

Joining those two concepts, passive building and an absolute measurable energy metric as baseline, was the breakthrough that made the package relatively simple to communicate to practitioners, consumers, and policymakers. Today the passive building principles and energy metrics at the core of the certification criteria of various passive house groups follow such performance-based target metrics.

The German Passivhaus Institute contends that the developed number (the 15 kWh per square meter per year) is an absolute measure applicable in all climate zones. But others, including the Passive House Institute US (PHIUS), the Swiss MINERGIE,[15] and some Scandinavian groups, have adapted the standard to their specific climates and conditions.[16]

Regardless of the target number, what distinguishes passive house are the fundamental principles enumerated earlier, and a design methodology that aims at an objective, measurable outcome and energy target.

The Nuts and Bolts of Passive House

The specifics of the passive house design methodology—the components of underlying calculations and building science definitions—are already widely accepted and codified and publicly available in protocols and standards maintained by organizations such as ASHRAE and the International Organization for Standardization (ISO). The building science underlying passive building has been long established as best building science practice.

To get a passive building project certified, one currently has to use one of two software tools to submit an energy model. One is WUFI Passive (from Fraunhofer Institute for Building Physics in partnership with PHIUS), and the other is the Passive House Planning Package, a Microsoft Excel-based tool published by Passivhaus Institut in Germany. These tools give designers the ability to organize and apply the design methodology and to change parameters and calculate how it affects progress toward the target energy goals. The tools are critical to allow designers to optimize the design for best cost effectiveness.

Those specialized energy models go beyond typical building energy balancing. They add and combine additional calculations that are characteristic for ultra-low-load homes. They can account for savings on a much more precise level.

For certification and verification purposes, the existing passive house standards and benchmarks are built into these tools. Green checkmarks appear once all targets have been met for the design.

Understanding the role of these tools is important to policy and code makers. Setting a stringent and practical standard

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[14] Wolfgang Feist, *Cost Efficient Passive Houses in Central European Climate*, at 5.91, *in* ACEEE PROCEEDINGS (1998), http://www.aceee.org/files/proceedings/1998/data/papers/0508.PDF.

[15] MINERGIE, http://www.minergie.ch (last visited Jan. 20, 2015).

[16] Rolf Jacobson, Passive House Certification in Scandinavia (Oct. 17, 2013) (presentation at 8th Annual North American Passive House Conference), *available at* http://www.phius.org/NAPHC2013/jacobson.pdf.

requires an understanding of how the standard is met and how it is going to be verified. The availability of proper tools to meet standards on a cost-effective basis must be considered hand in hand with the standard itself. It must be practical to meet an energy standard for it to be widely implemented.

Integrated specialized passive design tools—such as WUFI Passive—are necessary for the design team for a variety of reasons. The tool documents the design process—all its iterations and the decisions made. For the final design, it lists all required specifications for wall assemblies and systems; it checks the energy metrics and verifies that the standards are met.

But they are also risk management tools. Verification of well-insulated buildings should always involve dynamic modeling to assure condensation-free assemblies and comfort conditions in the various zones of the building.

Another policy/code concern is materials requirements or recommendations. Passive house/passive building largely leaves those decisions to the designer, and negates the need for policymakers to prescribe such choices. As long as the overall energy performance target is met, designers can use their discretion. In some cases it may make more sense to invest in top-end windows; other circumstances call for investing in more insulation. All needed materials are readily available on the North American market.

How Passive Building Programs Can Work with LEED and Similar Programs

Passive guidelines are strictly concerned only with the thermal performance of a material on a whole-building basis and are not concerned with other factors such as general sustainability that might govern the choice of one material over another.

The U.S. Green Building Council's LEED (Leadership in Energy & Environmental Design) Green Building Rating Systems are voluntary rating systems but have been very successfully adopted by municipalities as requirements to build beyond the code minimum. It is the U.S. Green Building Council's opinion that the country needs both green building codes and voluntary rating programs that go beyond what the code requires.

Compared to the passive building guidelines, which focus on modeled and measured energy consumption, LEED is an all-inclusive rating system that aims to assess and improve all aspects of sustainable construction, including impacts on health, energy, water, and resource efficiency. LEED is a point-based system that follows the prescriptive path.

Despite fundamental differences, in practice the passive house and LEED programs can be complementary. Designing and constructing a passive building earns, along the way, a substantial number of LEED points.

In addition, LEED does not include its own energy-specific metric or methodology, but refers to other ratings and design methods such as Energy Star and the U.S. Department of Energy's DOE Zero Energy Ready Home (ZERH) program. Because certification through Passive House Institute US's PHIUS+ certification program also earns ZERH status through a partnership with the Department of Energy, this is another area of overlap.

In general, therefore, it is not necessary to choose either passive house or adherence to LEED or other energy labels and ratings. Passive house offers a system to manage the complexity of all factors involved in designing most cost effectively on the path to zero energy. Passive house principles and performance standards provide design freedom within those parameters and can therefore follow any other green rating system and their requirements.

In fact, passive building—because it drastically cuts the energy any building will need from the start—is a logical first step in all green building and rating programs. Zero/positive energy buildings that are also resilient cannot be achieved cost effectively if passive design principles are ignored.

Passive Building Certifying Bodies

Three organizations currently offer passive building certification systems in the United States that aim to verify energy performance and accompanying carbon reductions within their criteria.

Passive House Institute US (PHIUS) is the leading passive house and building certification provider in the United States. Founded in 2003, this nonprofit organization is an established education, certification, and research institute based in Chicago, Illinois.[17]

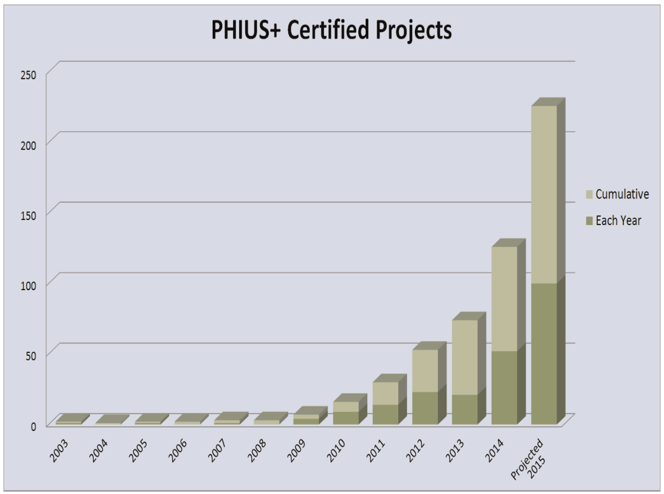

Figure 3: PHIUS+ Certified Projects; Source: PHIUS.

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[17] Passive House Institute US, http://www.phius.org/ (last visited Jan. 20, 2015).

PHIUS began certifying projects in 2012 under its PHIUS+ program. All certified projects are documented in an online database.[18] The total of fully certified projects for the period of January 2012 through December of 2014 was 129, which includes 114 passive homes, 8 multifamily passive buildings, 7 passive commercial buildings. There were also several retrofits. (If the count includes all units in certified multifamily buildings and projects currently underway but not yet fully certified, the total number of projects and units to date is approaching 1,000 nationwide.)

PHIUS is the only U.S.-based passive house organization. It has the support of and partners with Building Science Corporation, one of the leading building science consulting companies in the country. PHIUS is also the only organization that follows U.S. conventions and industry standards for third-party verification and is recognized by the U.S. Department of Energy.

The second organization offering passive house certification in the United States is the German **Passivhaus Institut (PHI)**, a private research and certification institution based in Darmstadt. PHI offers its certification internationally through selected contractors in a variety of countries. Their international database lists approximately 720 projects certified worldwide, most of which are in Germany and Austria. The published number of projects certified in the U.S. was 20 at the time of this writing.[19]

A third organization offering passive house certification in the United States is the Swiss-based **MINERGIE® Building Agency**, which offers the Minergie-P program, a passive house-based rating system promoted by the Swiss government. There are only a few projects in the U.S. that have attained Minergie-P certification, and no database listing U.S. projects is available.[20]

The two European programs offer certifications essentially unaltered from what are offered in Europe.

International Efforts to Establish Passive Building Energy Standards

There is only one planet and one atmosphere, and that atmosphere is the ultimate public commons. To be sure, not all parts of the nation or the planet will be affected equally by climate change, but no locale will be untouched. Moreover, ethically, all nations need to contribute their share to preserve this commons. Ultimately, a global energy efficiency target for buildings is the ideal, and efforts toward that end are ongoing.

The German passivhaus standard brought forward by PHI was first adopted by many municipalities in Germany and Austria in the early 2000s. Those success stories were picked up by European policy experts who started to include them in their reports and to advocate for passive and zero energy buildings in codes.[21] There has been wide agreement in Europe that low-load passive building principles should become best practices worldwide if the global climate goals are to be reached.

In 2010, the European Union was preparing to amend its Building Directive regarding energy use as a response to such calls. The opening page of the amendment reads: "An efficient, prudent, rational and sustainable utilization of energy applies, inter alia, to oil products, natural gas, and solid fuels, which are essential sources of energy, but also the leading sources of carbon dioxide emissions." It further states:

> Together with an increased use of energy from renewable sources, measures taken to reduce energy consumption in the Union would allow the Union to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), and to honour both its long term commitment to maintain the global temperature rise below 2°C, and its commitment to reduce, by 2020, overall greenhouse gas emissions by at least 20% below 1990 levels, and by 30% in the event of an international agreement being reached.[22]

Based on earlier successes in setting standards for impressive carbon emissions reductions and accounting for such carbon savings, advocates proposed the German passivhaus standard as the basis for the European Building Directive standard scheduled to take effect in 2018 for all public buildings, and 2020 for all other buildings in the European Union.

The attempt to base the directive on the German standard ultimately failed because it would have been pegged to a specific and proprietary standard maintained by a private entity—Passivhaus Institut.

Instead, the European Union settled on describing a 2020 general target of what it calls "Nearly Zero-Energy Buildings" (NZEB), to be achieved by employing a combination of energy efficiency targets (including passive building measures) and increasing renewable energy supplies while specifying that energy efficiency measures need to be cost optimal. It also allowed member states to choose energy targets that would permit going beyond cost optimal and increase energy efficiencies further.

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[18] *Certified Projects Database*, PHIUS, http://www.phius.org/phius-certification-for-buildings-and-products/certified-projects-database (last visited Jan. 20, 2015).

[19] *See* PASSIVE HOUSE INSTITUTE, http://www.passiv.de/en/index.php (last visited Jan. 20, 2015).

[20] *See* MINERGIE, http://www.minergie.ch/ (last visited Jan. 20, 2015).

[21] *See* Jens Laustsen, Implementation of Passive and Zero Energy Buildings in Europe, PHIUS Washington (Oct. 28–29, 2011), *available at* http://www.phius.org/NAPHC2011/LaustenJens.pdf.

[22] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings (Recast) (European Building Directive), 2010 O.J. (L 153/13), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN.

The most impressive development in the implementation of passive building standards and their adoption into codes happened a few years ago in Belgium. The Belgian Passiefhuis-Platform and Plate-forme Maison Passive, founded around the time Passive House Institute US was founded, had similarly embarked on an independent path from the German Passivhaus Institut. All certified passive houses in Belgium are independently certified through these national organizations.

The two groups were tremendously successful in delivering training specifically for their cultural and code contexts, providing ongoing building science research, and facilitating proof of concept projects. These efforts were so successful, in fact, that they convinced the Belgian government in 2013 to write a modified, Belgian-specific version of passive construction principles into law.[23] Starting in 2015, all new and retrofit construction in Belgium must meet the Belgian version of passive building standards and metrics. The law specifies the exact energy metrics in kWh per square meter for heating demand and source energy and airtightness levels without naming any proprietary programs or verification software tools.

That said, requiring such levels of efficiency by code does not, as mentioned earlier, come without risk—and that risk needs to be minimized. In Belgium, designers must submit a dynamic energy model (generated by software such as WUFI Passive) to verify not only that the specified energy metrics are met but also that all other related building science and comfort risks are addressed.

In any case, the European Building Directive and the Belgian legislation are now setting the standard for national policy responses to carbon reduction and climate change.

The State of the States: U.S. Policy

In general, U.S. energy efficiency regulations are lagging behind European efforts. And the United States has a lot of work to do by most accounts. For example, in the U.S., energy use per person for all purposes—housing, work, transportation, food, water, etc.—is approximately six times an environmental target formulated by the Swiss Federal Institute of Technology in Zürich. The target is the underpinning of a project known as the 2,000-Watt Society. The 2,000-Watt Society target is a per-person energy usage limit of 2,000 watts (48 kWh per day). The 2,000-watt target is consistent with achieving the IPCC recommendations (carbon reduction goals intended to limit global warming to 2^{o}C).

To reduce the U.S.'s per-capita load is a serious challenge. Countries that have accepted the challenge learned quickly that it requires dramatic changes in how we think about energy, including how we trade, evaluate, store, and distribute it. The situation demands the rethinking of the entire energy use and delivery system. In Germany, one of the countries in Europe that have accepted this challenge, the magnitude of the change required is expressed in the term "Energiewende," which roughly translates into "Energy Revolution."

Here in the United States, some cities and states are taking a leadership role. In New York City, for example, Mayor DeBlasio's office issued the *One City, Built to Last* report in 2014.[24] It highlighted the crucial role of buildings in any effort to meet carbon reduction targets, which the *One City* report pegs as 80% below 2005 emissions levels by 2050. New York City codified this target in a law enacted late in 2014.[25]

In keeping with the notion of the public commons, however, we need measurable, practical, and enforceable national standards that are consistent with overall carbon reduction goals. The U.S. must meet the standards and hold other members of the global community to those targets.

For that reason, we believe the U.S. would be wise to take the Belgian example mentioned earlier as a lesson. PHIUS, for its part, has taken a cue from Belgium by delivering training that has been customized according to the unique climate and market challenges across North America.

Furthermore, after much experience building and consulting on projects from Wisconsin's North Woods to Louisiana, and from the Pacific Northwest to Maine, PHIUS has concluded that a single numerical energy target (the 15 kWh per square meter per year mentioned earlier) is not scientifically defensible for all climate zones.

In addition, materials science, materials costs, and other significant factors—including climates—will inevitably vary over time, changing the best way to optimize conservation and achieve cost effectiveness.

To address this variability, PHIUS has for the past two-and-a-half years been researching and modeling to produce a formula that will be used to generate climate-specific energy use goals. In some cases, the target will be somewhat easier to reach, removing disincentives. In others, however, the targets will become more stringent because research has found that the German passive building standard, while stringent, actually allows designers in mild climates to leave cost-effective energy savings on the table.

The effort has been conducted in partnership with Building Science Corporation, with funding from the U.S. Department of Energy. The intent is to revisit and update the formula every three to five years.

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[23] Belgisch Staatsblad, Art. 7 ff., http://www.brusselpassief.be/fr.

[24] N.Y.C. Mayor's Office of Long-Term Planning and Sustainability, One City, Built to Last: Transforming New York City's Buildings for a Low-Carbon Future (undated), http://www.nyc.gov/html/builttolast/assets/downloads/pdf/OneCity.pdf.

[25] N.Y.C. Local Law 66 of 2014.

The results of the study have been peer-reviewed and revisions are underway. The first draft is available for download.[26] The revised study will be made available when complete.

Passive building principles make sense regardless of whether a numerical target for carbon emissions reductions applies. But it is PHIUS's hope and belief that this publicly available formula can become the basis for a national verified building energy performance standard that achieves required global carbon reductions.

Katrin Klingenberg is a co-founder and the Executive Director of Passive House Institute US (PHIUS). She designed and built the very first home built in the United States to the Passive House standard. Mike Knezovich is Director of Communications at PHIUS.

LEGAL DEVELOPMENTS

ENERGY

Appellate Division Ruled That Indian Point Nuclear Plants Were Exempt From Coastal Management Plan Review

The Appellate Division, Third Department, held that the Indian Point nuclear power plants were exempt from New York's Coastal Management Plan (CMP). In doing so, the Appellate Division reversed the Supreme Court, Albany County, which in December 2013 upheld a New York State Department of State (DOS) determination that the plants did not qualify for the CMP's exemptions. The CMP provides that projects identified as grandfathered pursuant to the State Environmental Quality Review Act (SEQRA) at the time of its 1976 enactment and projects for which a final environmental impact statement (FEIS) was prepared prior to the effective date of the CMP regulations are not subject to review of their consistency with the CMP. DOS concluded that the Indian Point power plants were not eligible for either of these exemptions and that renewal of their federal operating licenses would therefore require consistency review. The Appellate Division concluded that the DOS interpretation of the exemption for projects for which an FEIS was prepared prior to the effective date of the CMP regulations "offends the plain meaning of its language, is irrational and cannot be sustained." FEISs for the two power plants had been completed in 1972 and 1975—prior to the 1982 effective date of the CMP consistency regulations—plainly bringing the plants within the scope of the exemption. The Appellate Division said, moreover, that there was no basis for injecting a requirement that the FEISs have been prepared pursuant to SEQRA, as DOS urged. The court also held that Section 8-0111(5) of the Environmental Conservation Law—which makes SEQRA applicable to modifications of pre-1976 "actions"—did not apply. Because the CMP exempted the plants from DOS consistency review, there was no state "action" to which this exception to SEQRA's grandfathering provisions could apply. The court noted, however, that its decision should not be read to preclude DOS from amending the CMP to require consistency review in cases such as this one. *Matter of Entergy Nuclear Operation, Inc. v. New York State Department of State*, 2014 N.Y. App. Div. LEXIS 8686 (3d Dept. Dec. 11, 2014). [*Editor's Note:* This proceeding was previously covered in the March 2014 issue of *Environmental Law in New York*.]

HAZARDOUS SUBSTANCES

Federal Court Dismissed CERCLA Cost Recovery Claim for Site in Brownfield Cleanup Program But Allowed Contribution Claim to Proceed

Current and former owners and the prospective developer of a property in Manhattan sued Consolidated Edison Company of New York, Inc. (Con Edison) in the federal district court for the Southern District of New York. The plaintiffs sought response costs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and indemnification and restitution pursuant to state law. Con Edison was a successor to companies that operated a manufactured gas plant at the site that caused substantial contamination. Plaintiffs alleged that they had incurred $3.6 million in remediation costs and expected to spend a total of $24 million. In 2010, after successfully challenging an earlier determination that the site was not eligible for the New York State Brownfield Cleanup Program (BCP), the plaintiffs were accepted into the BCP. They subsequently entered into a Brownfield Site Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (DEC). The BCP regulations explicitly deemed the BCA to be an administrative settlement of liability for purposes of CERCLA contribution protection. The district court therefore ruled that the plaintiffs who were parties to the BCA could only pursue a CERCLA contribution claim under Section 113 and were barred from pursuing a CERCLA Section 107 cost recovery claim even if some costs would only be recoverable through a Section 107 claim. The court rejected the arguments of the parties to the BCA that the BCA was not an administrative settlement of liability because it was voluntary and involved only a future release of liability upon completion of the remediation. The court also rejected Con Edison's assertion that the Section 113 claim was untimely because the plaintiffs had been accepted into the BCP upon the 2010 court decision affirming their eligibility, which was more than three years prior to their commencement of the lawsuit. The court said that entry into the BCP did not itself resolve liability; the statute of limitations was only triggered on the BCA's effective date. The district court dismissed the Section 113 action of the

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[26] GRAHAM S. WRIGHT ET AL., BUILDING TECHNOLOGIES PROGRAM, U.S. DEPT. OF ENERGY, CLIMATE-SPECIFIC PASSIVE BUILDING STANDARDS (DRAFT) (Oct. 2014), http://www.buildingscience.com/documents/bareports/ba-1405-draft-climate-specific-passive-building-standards.