briefing

Passive NYC

A snapshot of low energy building opportunities, barriers, & resources

New York City doesn't rest on its laurels. Passive House is a transformative notion and we're going to be leaders showing this can be done, and can be done everywhere.

- Bill de Blasio, NYC Mayor

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Credit: Handel Architects LLP
A rendering of Cornell Tech's residential tower on Roosevelt Island, which will be the first high-rise residential project built to the Passive House Standard in the world. Developers: Related Companies & Hudson Companies

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executive summary

New York City's commitment to an 80% reduction of carbon emissions by 2050 has quickly and dramatically raised the profile of the Passive House standard. As one of the few building energy standards with a record of delivering results that match such an aggressive goal, the Passive House standard was featured in Mayor de Blasio's climate action plan, *One City: Built to Last*, and has since been the subject of intense focus by public and private stakeholders in both the City and State.

As a partner in multiple City and State energy efficiency initiatives, the Building Energy Exchange set out to understand how a low energy building standard, like Passive House, might be applied across our building sector. In this briefing, we outline the guiding principles of the Passive House standard, review its successful application in other jurisdictions, take stock of the Passive House resources and projects in the city, and identify the major challenges and barriers to adoption.

Passive House is a rigorous and voluntary standard for energy efficiency in buildings. It depends on a well-insulated building envelope, air-tight components, and continuous ventilation that can save more than 70% of heating and cooling costs compared to a typical code compliant building. There is a small but growing population of passive projects in New York: nine Passive House Institute certified buildings in New York State and four in New York City. There are twenty more projects underway in the city, including several large-scale developments, which will create over 300,000 square feet of certified projects in the next few years. The majority of these projects are residential, often low-rise, and mostly in Brooklyn and Manhattan. Additionally, there are over 28 projects that have been built incorporating passive house principles. New York has one of the largest populations of certified passive house professionals in the country, with training courses offered by several organizations. This briefing examines some of the challenges inherent in building passive, including regulatory barriers, the lack of education, the lack of institutional support for high efficiency or passive projects, the need for a robust supply chain, and the uniquely dense urban fabric of the city.

To understand how to best support this growing movement, we examined transformative passive house policies from other cities, like Vancouver and San Francisco, and from pioneering European countries, like Germany, Austria, and Belgium. Many of these countries have either adopted Passive House standards for new construction or have created fast-track pathways for projects pursuing Passive House certification. We end this briefing by outlining near term steps the City and State might take to accelerate Passive House projects in New York. Other jurisdictions can offer pertinent examples and significant lessons, but New York City must develop a road map that suits the particular needs and challenges of the largest real estate market in North America. There are many potential components to the City's path forward, such as: leading adoption through public building retrofits and new construction; engaging the private sector through a low-energy building competition; removing regulatory barriers and creating code pathways for Passive House certification; creating direct incentives for builders and designers; and studying the plausibility of using Passive House within the major segments of City building stock.

The potential impact of Passive House is tremendous, providing one of the very few realistic paths to New York City reaching its climate action goals. This briefing draws on resources from New York and abroad and from the opinions of those in the city's passive house community, to better understand the challenges and possibilities of adopting low energy and passive design building standards.

overview

The good news is that the Passive House standard is applicable to the vast majority of New York City buildings. From single-family residences and large-scale multifamily buildings to schools and fire stations, the standard has the potential to greatly improve comfort for building occupants while massively reducing energy use. Building or retrofitting to the Passive House standard also improves the resiliency of buildings during natural disasters. However, buildings that include high-intensity uses, like data centers or trading floors, will find it far more difficult to meet the standard. Additionally, the low vacancy rate of New York City buildings presents an enormous challenge to completing the building exterior retrofits that would be necessary for these structures to meet Passive House requirements. Added to these are the challenges of meeting city building and energy codes simultaneously, scaling available education and resources, and increasing access to passive house components required to serve this market.

Whichever building types might benefit from Passive House standards, successful adoption would likely require a gradual ramp up of projects, including demonstration projects of different types and sizes that exemplify feasibility by revealing and resolving unexpected challenges.

There is promise in applying a low energy building standard, like Passive House, across the extremely diverse buildings that make up New York City, but also many challenges. Although the Building Energy Exchange (BEEx) will focus on delivering resources that assist stakeholders in the consideration and application of Passive House standards, it is our hope that this summary creates a strong foundation for the important conversation taking place among public and private stakeholders about how the building sector will contribute to New York City's climate action plan.

The Passive House standard is quickly becoming an important element of New York policy discussions. Mayor de Blasio's climate action plan, *One City: Built to Last*, estimates that the total carbon emissions of the building sector will need to be reduced 60% by 2050 to meet the overall city target of an 80% reduction by 2050. Virtually no other standard delivers buildings that meet this goal.

The Building Energy Exchange is working closely with the City and State on initiatives that are mapping the pathway for buildings to meet the 60% by 2050 reduction target. Most prominently, BEEx will be the central information hub for the Retrofit Accelerator, a sales-force style outreach and assistance program designed by the Mayor's Office of Sustainability. It is designed to foster thousands of energy retrofit projects throughout the city over the next decade. Account managers will guide building owners and operators towards both strategies that immediately lower their energy use, as well as carefully conducted long term plans that dramatically reduce energy consumption. BEEx will provide account managers with the resources needed to educate building decision makers and will provide actionable training and resources for designers and trades people.

With the Retrofit Accelerator in mind, BEEx undertook a high level exploration of the feasibility of applying the Passive House standard to New York City's diverse and complicated collection of buildings. Researching this briefing, BEEx consulted with the Passive House Institute (PHI) in Darmstadt, Germany; the local non-profit, New York Passive House; and with the Passive House Academy, a premier provider of Passive House certification and education in the U.S. and abroad, among others. Our staff has conducted broad research into the application of Passive House around the world, including attending the Passive House Institute international conference in Leipzig, Germany, traveling to Vancouver, Canada for the 2015 North American Passive House Network Conference, and joining a fact-finding mission to Brussels, Belgium where Passive House was recently mandated for all new buildings and substantial renovations.

This briefing is a snapshot in time from a great height. The application of passive design is continuously evolving, as are the many efforts to understand its applicability to various building types and remove barriers to implementation. Some of the information here will soon be out of date and BEEx is exploring ways of providing a living version of this information as an online resource. However, much of this briefing will remain pertinent over time and should provide building industry stakeholders with a reasonably strong understanding of both the promise and the challenge of implementing passive house design across the New York City building sector.

Passive House Basics

The Passive House standard is both a set of design principles and a voluntary standard for energy efficient buildings developed by the Passive House Institute in Darmstadt, Germany. Buildings adhering to the Passive House standard are well insulated, use dramatically less energy than typical buildings, often rely on renewable energy sources, and are more resilient against power outages and extreme weather. These design principles are also beneficial for occupants, providing excellent indoor air quality, improved thermal comfort, and high ventilation rates. The Passive House standard relies on several fundamentals: deep thermal insulation of the building envelope to minimize heat loss and gain; triple glazed windows with shading that modulate heat loss or gain; an airtight building envelope; minimized thermal bridges; and continuous ventilation with energy recovery. (See Figure 1)

The Passive House standard is first and foremost about occupant comfort. It is critical to remember that the “most efficient” building would be one without doors, windows, or occupants. Rather than ask how to produce the most efficient buildings, we should ask how to produce buildings that use the least amount of energy to provide the highest quality interior environment. Many of the performance standards and targets that have dominated the energy efficiency conversation to date address occupant comfort only obliquely, with the needs of the occupants acting as a kind of backstop to attempts at drawing down energy use. As a result, efficiency is often understood as something that largely detracts from, rather than contributes to, the needs and wants of the people and organizations that use buildings. Passive House effectively turns this conversation on its head, with guidelines that produce the greatest comfort for building occupants while using only a fraction of the energy a typical building consumes. This is easier to do in some buildings than others, but remains a fundamental – and fundamentally positive – distinction from the current paradigm.

Because the Passive House standard was first applied to small residential buildings, it is often assumed that the standard is only applicable to 1-4 family dwellings. But in fact the standard has been applied, with some variations, to the vast majority of building types, from civic and institutional centers to high-rise commercial and large multifamily buildings. (The name, "Passive House" probably contributes to this misunderstanding. ‘Passive Buildings’ might be a more accurate moniker.)

Having been developed in Germany, it is also often assumed that the standard is not applicable outside of cool-temperate climates, but this is also not the case. Projects have been certified in nearly every climate zone, from equatorial to arctic. In 2015, PHI configure their standards to include renewable energy use and generation, as well as climate-specific energy limits for retrofit projects.

PHI and PHIUS

In addition to the Passive House Institute in Germany, another major proponent of passive house design in North America is the Passive House Institute US (PHIUS), founded in 2007. Once a certifier for PHI, PHIUS now has a separate building performance standard: dubbed PHIUS+ 2015. Like PHI, PHIUS certifies projects and professionals and conducts training sessions for designers and tradespeople. A description of the PHI - PHIUS relationship, and a comparison of the two rating systems, can be found in the appendix.

New York Passive House, the local non-profit representing passive house interests in the NYC community, is affiliated with PHI. As such, this document generally discusses Passive House through the lens of the PHI standard.

Current Energy Code Challenges

The standards that currently dominate the energy efficiency conversation (not just in New York but across the country) are the “model” energy codes: the ASHRAE 90.1 standard and the International Energy Conservation Code (IECC), developed by the International Code Council (ICC.) These standards have been critical tools for states and cities and have made possible enormous progress across the country. However, as we desire greater efficiency from our buildings, the largely prescriptive approach to building systems taken by these standards has come under scrutiny. Additionally, the periodic delivery model of these standards leads to targets that are relative to an amorphous baseline. It is very common to see goals or targets such as “20% better than 90.1-2007”, with very few professionals having a concrete sense of what that means in terms of actual energy consumption or occupant comfort. These standards have traditionally focused on interior air temperature and humidity as the primary determinants of occupant comfort, with little or no regard for the critical role played by radiant temperature of surfaces, drafts, or moisture infiltration. As a result, it is common for these standards to produce buildings with features like exposed concrete slab edges or broad expanses of glass beside sedentary office workers. These qualities are detrimental to comfort and produce a greater reliance on HVAC systems than might otherwise be necessary.

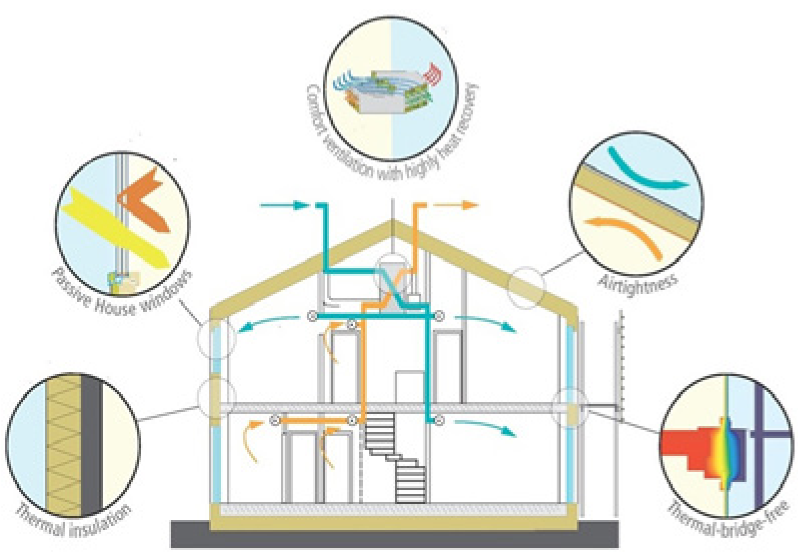
The other critical challenge of our current regulatory paradigm is the disconnect between the anticipated efficiency of our buildings and their actual energy use. A primary reason for this disconnect is the fact that “plug loads” are not regulated by building energy codes. For instance, an energy model of a LEED Platinum office building that expects to be “30% better than ASHRAE 90.1-2007,” does not anticipate the possibility that each occupant has three computers monitors and a personal printer. Another contributing factor to this disconnect is the prescriptive nature of the model energy codes. Because the ASHRAE and IECC standards focus on the performance of individual building components, rather than how these components work together holistically, the standards support a design approach that permits strong performance in one area in exchange for poor performance in another. Trading a mediocre envelope for a more efficient HVAC system is a common outcome. This prescriptive approach also does not account for the full impact of thermal bridges and air infiltration on energy use. In contrast, Passive House focuses on actual energy use (rather than the performance of individual components), encourages a high performance envelope, and limits the overall energy demand on the HVAC system. The disconnect between estimated and actual energy usage has far reaching impacts, placing energy efficiency projects at a distinct disadvantage when competing for capital funding. The effectiveness of Passive House in closing the gap between anticipated and actual energy usage is among its most powerful benefits.

Passive House also stands out because it is a set of design principles as well as a performance standard. Current energy codes dictate certain equipment and building component attributes, but they do not help design professionals determine how these components can work together. This prescriptive approach, coupled with the incremental raising of efficiency targets (i.e. 10% better than 90.1-2007, followed by a 20% target in the next cycle), leads to our current situation where the costs and challenges increase, while the benefits remain similar, or increase only slightly. The holistic approach required to meet the Passive House standard provides dramatic and tangible benefits both in terms of energy use and occupant comfort.

Resiliency & Net Zero

By designing buildings that need a minimal amount of energy to maintain comfort, Passive House buildings perform very well during blackouts and brownouts. A super insulated envelope allows building interiors to maintain habitable temperatures far longer than typical buildings when no power is available to run heating and cooling systems. Contrary to popular belief, passive buildings encourage operable windows, allowing for ventilation during times of crisis. A study by Urban Green Council suggests that during a blackout, high-performing buildings maintain their interior temperature considerably better than traditional buildings, staying at a habitable temperature for nearly a week in summer or winter, versus three days in a typical building[1].

Figure 1: Passive House Principles



Source: Passive House Institute

- **Thermal insulation:** optimizing thermal insulation of the entire building envelope minimizes heat loss and gain.
- **High performance windows & doors:** highly insulated, carefully shaded/oriented windows and doors, provide optimal solar heat gain.
- **Airtightness:** airtight envelopes prevent energy loss and moisture damage.
- **Thermally sound details:** reducing thermal breaks in the envelope minimizes energy loss, cold spots, and moisture problems.
- **Continuous ventilation:** constant ventilation with energy recovery delivers a healthy, comfortable interiors.
- **Comfort:** minimizing differences in surface temperatures and noise from heating and cooling systems ensures optimal interior comfort.

Due to their low energy use, passive buildings benefit greatly from the use of renewable sources and are far likelier to achieve net-zero energy status. PHI considers renewable demand and generation separately, and has unveiled a certification tier for projects that are roughly net-zero annually (Passive House Plus) and for those that produce significantly more energy than used annually (Passive House Premium). (See Table 1)

passive house principles

Passive House is both a set of design principles and a standard for building performance that results in a 70-90% reduction in energy used to heat and cool buildings, when compared to average buildings of a similar type. These buildings are more energy efficient, provide superior indoor air quality and comfort, and are more resilient against fluctuations in the power supply.

The key aspects of passive design include:

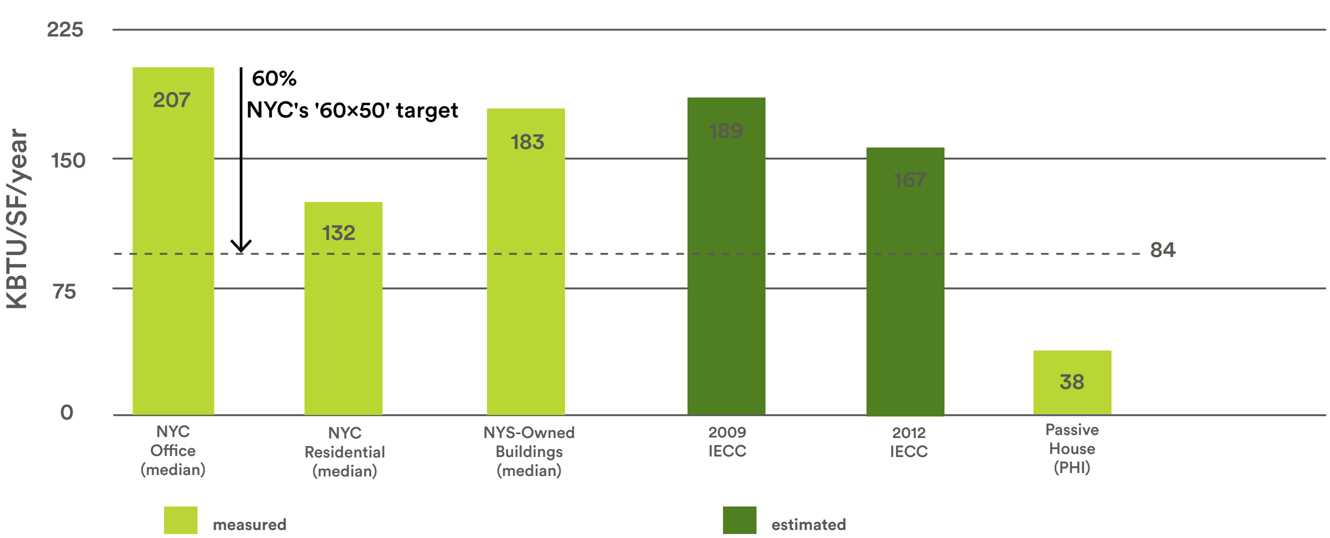
- **Thermal insulation:** an optimal level of thermal insulation of the building envelope minimizes heat loss. In summer, insulation and external shading prevent heat gain in the interior of the building.
- **High performance windows & doors:** windows in passive houses generally have triple glazing to prevent heat gain and to reduce drafts. Additionally, they are often oriented to benefit from solar energy during winter.
- **Airtightness:** an airtight building envelope prevents energy loss and moisture damage.
- **Thermal bridge-free construction:** reducing thermal bridges wherever possible limits unexpected heat loss, reduces drafts, and minimizes potential for condensation.
- **Ventilation with heat and energy recovery:** constant ventilation with heat and energy recovery provides passive houses with clean and fresh air, while recovering energy from exhaust air in winter and summer.

Overall, passive design strives for a high level of occupant comfort and low energy demand. Passive design is low-tech and low maintenance, but relies on rigorous testing, quality control, and commissioning. The strict energy use limits make passive buildings ideal candidates for net-zero energy or net-positive energy certification. For example, the annual median source energy use intensity (EUI) for New York City commercial buildings is over 200 kBTU/SF, and the residential median is 132 kBTU/SF, while Passive House caps the EUI at 38 kBTU/SF. (See Fig. 2)

Energy Codes and Standards

The Passive House Institute, the founding organization in this field, has shown that optimum comfort and efficiency are achieved when the annual heating budget is 15 kWh per square meter, or 4.75 kBTU per square foot. Using this number as a starting point, PHI created the Passive House Standard, a continually evolving certification standard for passive projects. To ensure that Passive House principles are widely understood, PHI formally certifies organizations around the world

Figure 2: Source Energy Use Intensity (EUI) Comparison



Source: New York City Local Law 84 Benchmarking Report, 2013 to deliver training and professional exams and to certify projects. Besides the heating budget, the Passive House standard requires a cooling energy demand of less than 4.75 kBTU/SF/yr, with some allowances for dehumidification based on local climate, and an airtightness limit of 0.6 air changes per hour at 50 Pascals of pressure (ACH50). This contrasts with the New York State energy code, which until recently included a limit of only 7.0 ACH50 (IECC 2009), with the latest iteration (IECC 2012) requiring a limit of 3.0 ACH50. As these limits have never been enforced, it is almost certain that actual performance figures are far worse for the majority of buildings.

The Passive House cap on total primary energy demand (38 kWh/SF/yr) represents a different challenge. In residential buildings, this cap is relatively easy to meet, but in high intensity office buildings, this target will be challenging. Limiting heating and cooling energy demand is a logical extension of efforts undertaken for years to improve the efficiency of our buildings. But the total primary energy demand cap effectively limits "plug loads" (energy used by computers, printers, desk lamps, etc.), which are currently unregulated. The industry often sees access to energy as directly connected to business productivity and may not look favorably on efforts to curb these loads. However, the unregulated nature of these loads has led to profligacy, and there are significant and straightforward opportunities for savings with little or no impact on business processes.

In 2015, PHI modified the Passive House Standard to place greater emphasis on the use of renewable energy and to allow for variation in climate zones for retrofits. In the past, the primary energy demand of a Passive House project could not exceed 38 kBTU/SF/yr. To 'future-proof' Passive House projects, these criteria have been replaced by a renewable primary energy (PER) system that ensures that all primary energy for Passive House projects is from renewable sources. Along with the PER requirements, PHI has created new classes of Passive House certification. In addition to the original standard - Passive House 'Classic' - Passive House Plus and Passive House Premium have been added. Projects qualifying for the Plus and Premium categories must generate more renewable energy than they consume. A 'PER factor' is used to calculate the proportion of primary and secondary energy consumed, as well as the energy produced. This allows passive design to integrate naturally with net-zero goals. PHI has also introduced a Low Energy Building Standard for projects unable to achieve the Passive House Standard. (See Table 1)

Costs

According to the Pennsylvania Housing Finance Agency, the cost premium of Passive House projects was less than 2%[2]. Just as LEED certified buildings initially experienced cost premiums, and are now mostly cost equivalent to conventional buildings, passive projects experience a cost premium mainly due to lack of market penetration.

Traditional energy efficiency strategies add directly to project cost and pay for themselves over time through lower energy costs, or other financial benefits. Because of this paradigm, it is often assumed that the reductions in energy use realized by passive house projects are also the result of cost increases. However, passive house projects are generally cost competitive because the increased investment is focused on inexpensive materials like insulation and air barriers. Ad-

Table 1: Passive House Standard Criteria (Passive House Institute)

<table>
<tr><th></th><th>Heating Demand*</th><th>Cooling Demand*</th><th>Air-tightness (ACH @50 pascals)</th><th>Primary Energy Demand*</th><th>Renewable Primary Energy Demand*</th><th>Renewable Energy Generation*</th></tr>
<tr><td>Passive House Classic</td><td rowspan="3">4.75</td><td rowspan="3">4.75 (+ dehumidification contribution)</td><td rowspan="3">0.6</td><td>38</td><td>19</td><td>-</td></tr>
<tr><td>Passive House Plus</td><td>-</td><td>14</td><td>19</td></tr>
<tr><td>Passive House Premium</td><td>-</td><td>9.5</td><td>38</td></tr>
<tr><td>EnerPHit (existing buildings)</td><td>4.75 - 11 (per climate zone)</td><td>9.75 (+ dehumidification)</td><td>1.0</td><td>varies</td><td>38</td><td>varies</td></tr>
<tr><td>Low Energy Building Standard</td><td>9.5</td><td>Passive House requirement + 15</td><td>1.0</td><td>38</td><td>23.7</td><td>-</td></tr>
</table>

* KBTU/SF/yr

ditionally, the high performance envelope is offset by the decreased costs of heating and cooling systems. There are many examples of passive house style retrofits being cheaper than traditional projects because, for example, upgrading the envelope significantly beyond code requirements eliminates the need for supplemental heating & cooling systems. Cost of ownership should also be lower for a passive house because energy costs are massively reduced and because more dollars are invested in long-life components like windows.

Certification Process

Passive House certification involves extensive documentation, evaluation of the project's energy use, and testing of the airtightness and ventilation system. PHI makes it clear that the concept of passive house is not protected, and the process of designing a Passive House certified project is open to any building professional. However, PHI recommends consulting with an experienced or certified designer during the process. The most important criteria for passive house projects are: annual space heat demand, cooling demand, primary energy demand, and maximum air leakage allowance (See Table 1). PHI's Passive House Planning Package (PHPP) was developed as a design and verification modeling tool to enable designers to verify projects' performance in a streamlined and uniform way. The PHPP provides calculations for heating and cooling demands, renewable primary energy demand, and assessment of the annual renewable energy gains. The software requires inputs of project boundaries and dimensions, building materials and components, thermal bridge data, and blower door test results. Besides compliance within the PHPP software, PHI requires a third-party verified blower door pressure test and a commissioning report for the ventilation system by a certified professional. Details and plans of the project and building components are also required, ideally during the design phase. And finally, a declaration from the site supervisor to confirm that the plans and installed components have been documented correctly is needed.

Several PHI Certifiers offer a pre-certification assurance process during the design phase of the project to allow for feedback and corrections. This requires submitting preliminary documentation: site plans, photographs, proposed PHPP calculations, and component specifications. Interim blower door testing is also highly recommended after air and vapor barriers are complete, but before interior finishes are installed.

At the end of the process, the project may receive a certificate, certification booklet, and wall plaque. Once the project is complete, there is no further certification or monitoring required for Passive House buildings. (More detail on requirements can be found on the PHI website[3].) See Table 7 in the Appendix for an outline of the PHIUS+ certification process.

Credit: BarlisWedlick Architects LLC
A photograph of the Hudson Passive Project, the first Passive House certified project in New York State.

new york passive house projects

There are several passive house projects in New York City and State, some certified by the Passive House Institute, others pre-certified. Several projects have been certified by the Passive House Institute US (PHIUS), or have received pre-certification status according to the PHIUS+ standard. There are still more projects that have been built using passive design principles or components, but that are not pursuing certification. More details on these projects can be found in the appendix.

Achievements of Passive House in New York to date:

- The Passive House Institute has certified nine projects in New York State, making a total of 22,728 square feet of PHI certified buildings.
- Four PHI certified projects are in Brooklyn.
- Currently, all certified projects are residential, either multi- or single-family.
- PHI has pre-certified seven projects in New York that are currently in the development phase.
- More than 300,000 square feet of anticipated Passive House standard projects are in the design or construction phase in New York, including a 190,000 square feet high-rise on Roosevelt Island, which will be the tallest and first high-rise residential building in the world to be PHI-certified.
- Most of these developments are single or multi-family residential projects, in Manhattan, Brooklyn, and the Bronx.
- There are eight PHIUS+ projects in New York State totaling over 8,300 square feet, and eleven more that are pre-certified. Five of these pre-certified projects are in New York City.

The Passive House standard, or a similar system, could be applied to a broad array of New York City buildings, helping to set us on a path to greater resiliency and a lower carbon footprint. Since New York City is a unique market, it is important to first consider which segments of the New York City building industry are most suited to the application of Passive House. To make changes, we must identify how to stimulate the market to absorb this new way of thinking about buildings, at a speed that limits disruption while ensuring New York City remains a leader in the fight against climate change.

Passive High Rise: Cornell Tech
Cornell Tech's apartment tower on Roosevelt Island (see rendering, page 2) broke ground in the summer of 2015. When completed in 2017, it will be the first high-rise residential and tallest Passive House in the world. The 270,000 SF project (or about 190,00 SF of treated area, according to passive house calculations) has received design stage assurance from PHI and is aiming for Passive House certification once complete. The 270 foot tall, 352-unit project, designed by Handel Architects, is being developed by Related Companies in partnership with the Hudson Companies and Cornell Tech, the applied sciences campus of Cornell University. The building will house 530 residents in 26 stories, including several micro units. Features include triple-glazed windows, 15-inch walls, a prefabricated metal panel exterior, and a VRF mini-splits heating system.

challenges

Despite the potential of the Passive House standard, there are significant challenges to widespread adoption. Building professionals and policymakers cite several factors holding back the passive house movement in New York. While the passive house community in New York is strong – the largest concentration of Passive House trained professionals in the US, according to NYPH – with 50-100 PHI certified designers and consultants and just under 50 certified tradespeople, there is still much training to be done. There is also a need to support demonstration projects to provide living examples for the rest of the industry. New York City's vast existing building stock, as well as its robust and diverse building uses, provide several unique challenges to widespread implementation of passive house principles. The limited availability of key passive building components and equipment is also a challenge, as are certain existing regulations.

High Energy Intensity Buildings

While the backbone of the Passive House standard is a strict limit on the energy used to heat and cool buildings, there is also a strict limit on total primary energy demand, including plug loads. The lack of regulation of plug loads in the US has led to significant inefficiencies. Corporations that have moderated energy used for computers, printers, and other devices routinely find that reductions of 30-50% can be achieved without compromising business functions. Nonetheless, applying a total energy demand cap to New York City buildings would require specific and extensive study, with any solution presumably brought very gradually into the market. Many of New York City's most visible buildings are the seats of high-profile industries, including finance, media, telecom, and health care. The energy use profile of these buildings differs dramatically from residential buildings, with many having local data centers and complex lighting and ventilation systems. While the principles of Passive House can be applied in virtually any situation to produce highly efficient buildings, the strict limits on energy demand are not always easily achieved by these high intensity office buildings, where occupants are densely packed and might work alongside data centers or broadcast studios. In the multifamily market, larger buildings are dominated by internal loads, reducing the impact of envelope improvements and typically requiring a focus on cooling in all seasons.

Existing Buildings

Perhaps one of the most significant challenges to adopting a passive standard, is its application to existing buildings. To address the unique challenges of retrofitting existing buildings, the Passive House Institute has developed a separate standard called EnerPHit. The EnerPHit standard has a strong track record in Europe for bringing ultra low energy use to a wide variety of existing building types. Recognizing that there are many fixed attributes of existing buildings (such as window location, massing, and orientation), the Passive House Institute has developed less restrictive criteria for heating and cooling energy use, and makes exceptions for projects with additional requirements or restrictions. The EnerPHit standard has been revised to include seven climate zones in the PHPP software, with appropriate heating and cooling energy limits for each zone. For example the heating energy limit in the 'arctic zone' is 11 kBTU/SF/yr, whereas in the 'warm zone', it is 4.75 kBTU/SF/yr. (See Table 2). The cooling energy limit remains the same as the Passive House requirement for new buildings. As with new buildings, the revised limit for primary energy demand is based on three renewable primary energy (PER) categories: Classic, Plus, and Premium. Unlike the PHI Standard for new buildings, the EnerPHit requirements for renewable energy are based on a series of calculations, yielding specific energy limits for each project.

Through a broad demonstration program called EuroPHit, the EnerPHit standard has been applied successfully to multiple building types across Europe. The EnerPHit standard can be achieved by using required components for a project or by achieving a certain energy demand based on the climate zone according to the PHPP modeling software. Pursuing EnerPHit is most feasible in situations where an entire building is unoccupied and available for extensive renovation. The pragmatic challenges of, for instance, upgrading a façade from the interior while the building remains occupied, can hardly be overstated. The creators of EnerPHit have recognized this and promote a long-term phasing plan that provides credit for reaching early milestones on the way to full EnerPHit certification. Careful study will be required to determine if requiring long term deep retrofit plans is feasible for New York City, and how such a system might be implemented and administered.

Supply Chain

With only a few hundred projects in the US following passive design standards, and with the majority those being small residential buildings, there are Passive House components that are difficult to obtain in the US, especially components for large, multi-story buildings. Companies looking to supply products to the US must navigate specific regulatory demands, must be confident that tradespeople are able to properly install and commission

Table 2: EnerPHit Criteria by Climate Zone

			Opaque Wall Insulation (R-Value)		Windows	Ventilation	
Climate Zone (according to PHPP)	Heating Demand (kBTU/SF/yr)	Cooling and Dehumidification Demand	Exterior	Interior	U- Value	Min. Heat Recovery	Min. Humidity Recovery
Arctic	11.0	Equivalent to Passive House requirement for new construction	63	23	0.08	80%	-
Cold	9.5		47	19	0.11	80%	-
Cool-temperate	7.9		38	16	0.15	75%	-
Warm-temperate	6.3		19	11	0.18	75%	-
Warm	4.7		11	8	0.22	-	-
Hot	-		11	8	0.22	-	60%
Very hot	-		23	13	0.18	-	60%

their products/systems, and must have adequate local representation to manage customer service demands, including maintenance and potential repairs. Current supply chain issues include:

Windows & Doors: A relative success story. Until recently, there were few options for Passive House certified high performance windows and doors. Today there are more than a dozen such manufacturers; however, specialty items like ADA compliant doors are not a standard offering and require customization, and there are no Passive House certified fire-rated windows available in the US.

Curtainwalls: Although several companies sell Passive House certified curtainwall products in Europe, none are currently available in the US. It is likely that a large market demand will be required to attract these products to our shores.

Tapes & Membranes: The strict air sealing requirements of passive house are often achieved using specialized membranes and sealing tapes. A limited number of these are available in the US, with more expected in our market in the near future.

Energy/Heat Recovery Ventilators: A key component of Passive House design, HRV/ERVs are sold by a limited number of companies, and only smaller units are available. Although very large units are available in Europe, US projects must string together several units to serve larger buildings.

Thermal Break Materials: Few fiber-reinforced composites and high-strength polyurethane materials that provide thermal breaks within structural systems (for instance, breaking the thermal bridge of a cantilevered balcony slab) are available in the US. The market would benefit from more options.

It is anticipated that market demand created by more and larger projects will resolve these supply chain issues, but a coordinated policy approach could help provide greater and quicker access.

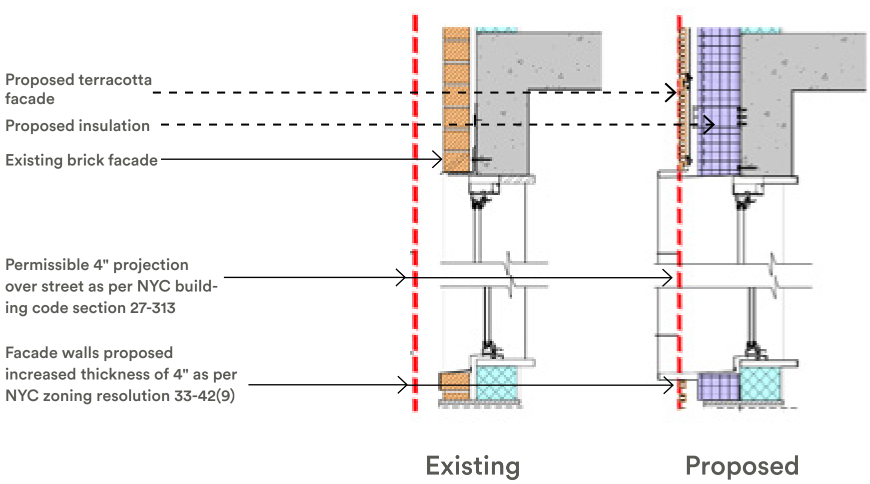
Regulatory Barriers

Building and energy codes present clear challenges to passive house designers, including:

Ventilation: Passive House standards require continuous mechanical ventilation that runs through an energy or heat recovery ventilator (ERV or HRV). However, New York building codes require minimum levels of exhaust and ventilation in residential units. This results in ventilation rates almost two times higher than the Passive House requirement. Using the Passive House standard for ventilation often requires special consideration from the City, with a licensed engineer who can design and attest to the validity of the ventilation system.

Exhaust Streams: Code requires the separation of kitchen and bathroom exhaust streams in a central ventilation system. This requirement unbalances the passive ventilation system, creating different flow rates and lowering energy recovery rates. Therefore, installing a passive ventilation system requires a variance from the City.

Figure 3: Facade Insulation for Multifamily Passive Retrofit Project



Driven in part by expensive Local Law 11 inspection and maintenance requirements, a 1960's, 142,000 SF, 200-unit, multifamily building in Midtown, is planning to replace its brick facade. Using a zoning code provision, Allen + Killcoyne Architects has designed a passive upgrade to the facade, adding insulation and improved windows to all 16 stories. This will also allow for an overhaul and reduction of the buildings mechanical system.

Credit: Allen + Killcoyne Architects
Section detail of brick facade replacement and insulation project

Table 3: Passive Regulation Survey (partial)

City or Municipality	Regulation	Year Program Implemented
US:		
New York, USA	The New York State Homes and Community Renewal Agency (HCR) provides financial support and tax credits to projects that aim to be more sustainable, including projects certified by the PHI or PHIUS Passive House standard. Additionally, Community Preservation Corporation (CPC) provides loans for energy efficient upgrades, including upgrades that achieve PHI or PHIUS+ standards, in multifamily units that service low and middle income families.	2015
Pennsylvania, USA	The state of Pennsylvania's Housing Finance Agency, offers tax credits for Passive House compliance for low-income, multi-family buildings. These developments do not have to be certified, but have to meet performance criteria with third-party consultants that are Passive House certified.	2015
San Francisco, CA, USA	Passive House or EnerPHit certification is eligible for priority processing from the planning department.	2014
Marin County, CA, USA	Building code amended to include the definition of a passive house building. The code encourages green building with creative incentives for compliance with one of several green building standards.	2014
Abroad:		
Vancouver, Canada	Sets Passive House as an alternative to LEED in their Green Buildings Policy for Rezoning. All planned developments requesting rezoning need to achieve LEED Gold status with a 22% reduction in energy costs, as compared to ASHRAE standards; or to achieve Passive House. To ensure there is no delay in processing applications for Passive Houses, the City of Vancouver provides training on passive design and construction to city staff.	2015
Brussels, Belgium	Brussels' PEB standard is a modified version of the Passive House standard that was formalized in 2009, at which point all new public buildings had to adhere to the standard by 2010. All new and heavily renovated buildings had to meet the PEB standard as of January 2015.	2015
Oslo, Norway	In Oslo, all new public buildings need to be built to the Passive House standard as of 2014.	2014
Villamediana de Iregua, Spain	This is the first Spanish municipality to adopt Passive House standards for all public buildings, and 10% of all housing within new urban developments.	2013
Tyrol, Austria	Energy Strategy Tyrol 2020 is a mix of energy efficiency policies and incentives focused on heating and cooling demands and renewable energy use – the maximum heating demand must be 25 kWh/m2/yr to avail of housing subsidies.	2013
Heidelberg, Germany	New municipal buildings are required to meet the Passive House criteria, verified by the PHPP. Plots of land bought from the city will be required to comply with Passive House. The city also has a new district that is entirely Passive House compliant.	2010

Windows: Passive House window requirements use European ISO metrics for window design and thermal resistance. Most US vendors do not provide ISO standards, so a translation is required.

Historic Buildings: The New York City Landmarks Preservation Commission often requires a hearing before new windows can be installed in a Passive House retrofit in which windows change operation (e.g. from a traditional double hung window to a simulated version). This slows the permitting process and is especially challenging for designated landmarks.

Additionally, passive design often relies on overhangs and external shading to achieve lower energy use. This is difficult to do in New York City without violating lot lines and zoning requirements. Fire code restrictions dictate what insulation can be used on mid to high-rise building exteriors, restricting options available for building envelopes.

Education

There are significant knowledge gaps about passive design and construction among building stakeholders. The successful introduction of a passive house standard across the New York City building sector will require extensive education of virtually every stakeholder group, from owners and designers to tenants and contractors. This effort will likely be similar to the introduction of the US Green Building Council's LEED building rating standard to the marketplace. There are currently a number of existing educational programs delivered regularly in New York City, which are outlined later in this briefing; and New York State currently provides financial support for some training programs. If not renewed, however, this subsidy for training tuition will expire at the end of 2016. Education will raise interest and drive demand for passive design and will also reduce friction for projects in flight. In the coming months, the Building Energy Exchange will be developing resources that help decision makers determine whether Passive House certification makes sense for their projects, and how to pursue certification effectively.

passive regulation survey

Several cities and regions around the world have integrated passive or low energy design standards into their codes and regulations. In New York City, the Passive House Standard was referenced in Mayor de Blasio's climate action plan. In Marin Country and San Francisco, California, the Passive House Standard is currently part of planning policy. Some of the frontrunners in the passive house movement are European cities like Brussels, Belgium; Heidelberg, Germany; and Tyrol, Austria. Other aspiring cities and regions not listed in Table 3 include Aquitaine, France; Burgas, Bulgaria; Cesena, Italy; Wales, UK; and Zagreb, Croatia. Most of these cities have in place government initiatives and legislation, often beginning with public buildings. Table 3 is an initial sample of various municipal and regional passive standard initiatives. More information can be found on the International Passive House Association's (iPHA) website.

lessons from brussels

The Brussels Capital Region has experienced an energy revolution in the last ten years, transforming themselves into one of the front-runners in the passive house movement. Over ten million square feet of passive house buildings have been built or retrofitted in the region as of 2014. Through major government initiatives and financial support, Brussels is demonstrating that passive house design can be affordable, practical, and efficient. The region has accomplished this through a combination of extensive training and support for professionals and tradespeople interested in low energy buildings; a leading-edge competition to provide built examples; a coordinated effort between government agencies; and the development of a robust supply chain of energy efficient components.

BatEx Competition

The Brussels-Capital Region began a call for 'Exemplary Building' (Bâtiments Exemplaires, or BatEx) projects in 2007. The goal was to stimulate demand in the sustainable buildings market, to demonstrate the technical and financial feasibility of green construction, and to recognize excellence in innovation and creativity for environmental performance and energy efficiency. The Region's objectives were to disseminate knowledge, to stimulate the building and design communities, and to create public awareness and ownership through demonstration. In the long-term, the program is creating market demand for energy efficient buildings, and in the short term, the city is reaching a critical mass of energy efficient buildings needed to start progressing towards the European Union's Directive of all new buildings being nearly zero energy by 2020.

To be selected for BatEx, a project design had to fulfill four criteria:

- Strive towards defined passive standards
- Prioritize environmentally friendly construction materials with minimal impact on nature and biodiversity
- Demonstrate good architectural quality and integration with the existing urban fabric
- Be replicable in technical and financial terms

After 6 calls for projects, BatEx has granted $36 million to 243 projects over seven years. The grants are open to a wide variety of projects and developers; effectively all projects being built or renovated in the Brussels-Capital Region are eligible. Submissions may be new construction or renovations, single-family or collective housing, public facilities, office, commercial, or industrial use. The size of the participating projects varies widely from as small as 1,300 square feet to 108,000 square feet, and 39% were renovations.

The winning teams sign contracts with Brussels Environment Administration and receive subsidies once projects are underway. Winning projects must be completed within four years of the award and provide energy consumption reports to the government for the first five years. After construction, the project is evaluated for its energy efficiency and is then labeled an exemplary building. Once the site is officially recognized, the winners receive additional publicity and technical support. The winners receive a grant of approximately $12/SF for the design and implementation of the project. Awards are capped at $200,000 per project, with 10% allocated to the project's design and engineering and 90% to construction.

Of the winning projects, more than half are designed to the Passive House standard for energy use: a total area of almost 4 million square feet by 2017. While the Passive House standard was an optional goal, more and more projects chose it as their target each year of the competition.

The selected projects include affordable housing units (66% of which achieve Passive House Standards), hospitals and schools (a quarter of the winning projects are dedicated to public use), iconic and historic office and retail buildings, and 1,866 housing units. The BatEx tenders have been distribution between public, private, and non-profit projects. The most economically disadvantaged municipalities in the region have been the most active in applying for BatEx support. The initiative is better known in younger and lower-income neighborhoods than in older and wealthier communities.

Passive 2015: The Brussels Standard

Having created a passive design context through the competition, the Brussels Capital region moved to codify a low-energy standard for the city in 2009, with the ‘Passive 2015’ agreement being formally signed in 2012. The Brussels’ standard - ‘Performance Énergétique des Bâtiments’ or PEB - is in anticipation of the EU Directive on nearly zero energy buildings.

The PEB ‘Passive 2015’ standard is a modified version of PHI’s Passive House standard, dealing with net heating and cooling requirements, primary energy consumption, ventilation, and airtightness of new housing, offices and schools, and heavily renovated projects. The requirements are the outcome of negotiations between the government, passive standard authorities, and professional stakeholders about how to adapt the standard to the dense urban fabric of Brussels.
Both the Passive House standard and the PEB require an annual net heating requirement of less than 15 kWh/m2, or 4.75 kBTU/SF, with an allowance for overheating (above 77° F) allowed for 5% of the year. PEB requires an annual net cooling requirement of 4.75 kBTU/SF for only schools and offices, whereas Passive House requires the cooling limit for all building types. The airtightness requirements remain the same (0.6 air changes per hour at ACH50), but will be phased in over four years. For residential buildings, the annual primary energy demand (heating, cooling, hot water, ventilation, pumps, and fans, but not lighting or plug loads) is 45 kWh/m2 or 14 kBTU/SF (compared to 19 kBTU/SF for PHI's Passive House Standard, which includes lighting and plug loads). For offices and schools, the annual requirement is under 26 to 30 kBTU/SF, depending on the compactness of the structure. The standard also provides an alternative ‘Track B’ for projects that face challenges achieving the standard (i.e. size, orientation, shading) and require custom criteria. For existing building renovations, each requirement is multiplied by a factor of 1.2, except the overheating limit.

When the standard was formalized in 2009, the Brussels government required all new public buildings to lead by example and be built to the standard starting in 2010. As of January, 2015, all new and heavily renovated buildings are required to meet the Brussels Passive standard, a goal that the city has laid the groundwork for several years in advance. This process included training, technical support, and all the education that the BatEx projects have provided, over the past seven years.

path forward

Learning from the experience of passive house designers in Brussels, and the efforts of similar cities, provides us with tools for the future success of low energy design in New York. A road map for New York City might include the following components:

Public Buildings Leadership: If New York City required most new, public buildings to meet a passive-type standard, and some portion of existing public buildings be retrofitted to meet an EnerPHit-type standard, it would provide a dramatic demonstration of feasibility. Such a program would provide opportunities for sharing lessons across the real estate sector and drive market demand for high performance products. The Design Excellence program, administered by the New York City Department of Design and Construction, or an update to Local Law 86 of 2005 might be appropriate vehicles to drive such a campaign.

Exemplary NYC: A multi-year competition, similar to the Brussels Exemplary Buildings program, might be a very effective means of introducing passive design to the broader market. If several tiers of low energy targets were adopted (as in Brussels), it would allow the private sector to assist the City in determining the most cost effective low energy targets for the greatest number of buildings. Additionally, it would provide an excellent vehicle to absorb and broadcast lessons for the entire sector. The key components of the Brussels program include: i) a multi-year effort with significant financial and regulatory incentives, ii) design excellence and other factors alongside energy performance, iii) extensive training and resources for industry stakeholders, and iv) transparent sharing of outcomes and performance that celebrates and promotes the participants.

Passive Code Pathway: The City might study the feasibility of allowing Passive House certification as an alternate pathway to the current energy code. This relatively simple move would provide an easy road map for building owners looking to demonstrate leadership, while eliminating the need for double compliance (both PH certification and energy code) that is currently required.

Barrier Removal: Several regulatory barriers to the application of Passive House could be removed through internal City rule-making. A small task force dedicated to this effort, or an existing group, such as the DOB's Buildings Sustainability Board, could provide guidance on appropriate modifications.

Credit: Jordan Parnass Digital Architecture
Renderings of the interior of a 30,000 SF tech incubator in the Bronx, pre-certified by PHI

Active Incentives: The deep energy use reduction of Passive House might be rewarded with access to greater incentives from NYSERDA and/or the relevant utilities. Targeted incentives, in addition to direct financial awards, might drive demand in the private sector and might include additional funding toward training and tool development.

Market Research: The City and State might direct specific study of the impacts of Passive House requirements on each major building industry segment. This might include a high level look at the specific challenges of retrofits, the feasibility of introducing plug load regulations, the impact of passive house style ventilation requirements in multifamily buildings, and the performance of passive buildings in brownouts and blackouts. Coupled with the lessons gleaned from a Brussels-style competition, such research would provide strong guidance for appropriate regulations for buildings between now and 2050.

conclusion

To reach the projected carbon reduction goals of the Mayor's *One City: Built to Last* plan, New York City needs to build on our existing position of leadership. It is essential that we transform the majority of our buildings into low and net-zero energy use. While improvements to the energy code are underway, these are incremental, and the buildings created with it will lock in relatively high carbon emissions for the next few decades, as compared to the dramatic reduction in emissions that can be achieved by passive buildings.

By creating multiple pathways to certification and lowering code barriers, we can accelerate progress towards optimal energy efficiency. In the near term, BEEx will create short primer courses on passive building strategies for building owners, building managers, architects, engineers, and other stakeholders who drive demand in the real estate sector. Additionally, BEEx will develop interactive exhibits that visualize the guiding principles of passive design and will work with stakeholders to determine which technical resources would be most effective in reducing friction for passive projects. The Passive House standard is poised to play a significant role in the future of New York City buildings.

It is the standard that:

- most cost effectively produces ultra low energy buildings with nonpareil interior comfort
- best positions our buildings to achieve net zero energy status
- most improves resiliency
- most reliably delivers actual outcomes on par with estimated benefits

While there remain challenges to implementing passive principles, particularly in certain building sector segments like high intensity office buildings, it is clear that the passive approach can be applied to a broad spectrum of New York City buildings and could play an important part in New York City achieving its climate action goals.

This briefing was created to act as a foundation for the dialog that must occur to determine if and how passive design will be incorporated into City and State programs and regulations. New York City occupies a global leadership position on energy efficiency in the built environment. Due to *PlaNYC* and it's subsequent updates, the *Greener, Greater Buildings Plan*, and Mayor de Blasio's groundbreaking climate action plan, *One City: Built to Last*, communities around the world look to public and private stakeholders in the New York City building industry for guidance and inspiration. Incorporating Passive House principles into the suite of pathways available to the building industry will dramatically improve our ability to meet our climate action goals and cement our status as the city with some of the most progressive thinking on this topic. As the details of this Passive House pathway emerge, the Building Energy Exchange looks forward to developing resources that smooth implementation and ensure that the promise of Passive House is realized.

Credit: think! architecture and design pllc
A rendering of the Hanac Inc. Corona Residence Team Credits in Queens, New York.

appendix

Existing Passive House Projects

Although there are many projects in New York designed with passive principles, there are only nine PHI certified projects in New York State, four of which are in New York City, in Brooklyn specifically. PHIUS also has eight PHIUS + certified projects in New York State. There are many more projects that use aspects of passive design and are not certified. Most of the projects listed below are residential. Barring a few, they are single-family homes, some retrofitted and some newly constructed.

Table 4: Passive House Certified Projects in New York State

Name	Type	Size (SF)	Year of construction/ renovation	Location	Certification Standard
331 8th Street	Terraced home	2,680	2012	Brooklyn, NY	PHI Certified EnerPHit retrofit
23 Park Place	110 year old terraced home	2,203	2012	Brooklyn, NY	PHI Certified EnerPHit retrofit
20 Garden Place	Terraced brownstone home	—	2014	Brooklyn, NY	PHI Certified EnerPHit retrofit
951 Pacific Street	Terraced home	3,735	2013	Brooklyn, NY	PHI Certified Passive House
Hudson Passive Project	Single family home	1,571	2010	Claverack, NY	PHI & PHIUS Certified Passive House
Mamaroneck Passive House	Single family terraced house	3,929	2012	Mamaroneck, NY	PHI Certified EnerPHit retrofit
Orient Artist Point	Single family home	880	2011	Orient, NY	PHI Certified Passive House
140 Ridge Road	Single family home	2,585	2012	Shodack Landing, NY	PHI Certified Passive House
Hall Hill House	Single family home	1,614	2014	Ancrum, NY	PHI Certified Passive House
Omega Women's Leadership Center	Commercial	—	2011	Rhinebeck, NY	PHIUS Certified Passive House
Rachel Carson Way (7 homes)	7 single family homes	948 to 1,267	—	Ithaca, NY	PHIUS Certified Passive House
	Total square footage	**> 28,066**			

Credit: Baxt Ingui Architects
Rear facade of an Upper West Side townhouse renovated to Passive House Standard

Anticipated Passive House Projects

Several passive or low-energy projects are under construction in New York – some of these have received design stage assurance from PHI. Several have yet to pursue certification, but are designed to be low-energy and high performance. The majority of these projects are low-rise residential, with notable exceptions being the Cornell Tech residential high-rise, the Tech Incubator in the Bronx, the Ambulance Station in Brooklyn, and a multifamily unit in Midtown Manhattan.

In addition to the projects listed here, there are 13 projects in various stages of development that have been given Design Stage Assurance by PHI, creating an additional 88,440 square feet of new passive projects. There are five projects in New York State that are pre-certified by PHIUS, and there are many other passive house projects within the city that are in the design stage and are aiming for high performance. The majority of these are residential, primarily in Manhattan or Brooklyn.

Table 5: Anticipated Passive House Projects in New York City

Name	Type	SF	Location	Type of Certification
Chevra Hatzalah Ambulance Station	Commercial	7,222	Brooklyn, NY	PHI Design Stage Assurance
330 Van Brunt Street	Single family home	1,830	Brooklyn, NY	PHI Design Stage Assurance
439 Bergen Street	3 unit townhouse	2,335	Brooklyn, NY	PHI Design Stage Assurance
206 E 20th Street	2 unit townhouse	3,358	Manhattan, NY	PHI Design stage Assurance
Cornell Tech Residential	352 unit high rise	181,350	Roosevelt Island, NY	PHI Design Stage Assurance
Bronx Tech Incubator	Office	23,000	Bronx, NY	PHI Design Stage Assurance
105 West Oak Street	Single family home	3,907	Ramsey, NJ	PHI Design Stage Assurance
Hanac Senior Housing	68 unit multifamily	57,675	Queens, NY	PHI Design Stage Assurance
Staten Island (4 homes)	Single family home(s)	—	Staten Island, NY	PHIUS Pre-certification
Beach Green North	101 unit multifamily	93,000	Queens, NY	PHIUS Pre-certification
	Total square footage	**>373,677**		

Passive Design Projects in New York

In addition to the projects listed above, there are other high performance buildings achieving close to passive standards. These buildings often participate in PHI's Passive House Days, which are held annually to allow owners and builders to showcase their passive design projects. Certified and uncertified projects are opened up for tours every November across the world. Twenty-nine of these projects are listed in Table 6. There are over 28 additional projects in New York built to passive standards, or with passive components. The majority of these projects are small residential buildings in Brooklyn, with the exception of a few larger multifamily buildings. This list is far from complete; more projects are emerging in the city every day.

Table 6: Non-certified passive design projects in New York City (Partial)

Name	Type	Size (SF)	Location	Status
174 Grand Street	Mixed use: retail and residential single-family	2,400	Brooklyn, NY	Completed
152 Freeman Street	7 unit apartment building	4,900	Brooklyn, NY	Completed
154 Underhill Avenue	2 unit townhouse	2,700	Brooklyn, NY	Completed
138 Sackett Street	7 unit apartment building	7,395	Brooklyn, NY	Completed
107 Union Street	2 unit apartment building	3,186	Brooklyn, NY	Completed
96 St. Mark's Avenue	4 unit apartment building	3,900	Brooklyn, NY	Completed
228 Washington Avenue	5 unit townhouse	3,745	Brooklyn, NY	Completed
Bright 'n Green	6 unit apartment building	4,811	Brooklyn, NY	Completed
United Revival Housing	24 unit rental housing building	23,422	Brooklyn, NY	Completed
255 Columbia Street	13 unit apartment building	15,187	Brooklyn, NY	Completed
Knickerbocker Com-mons	24 unit apartment building	29,705	Brooklyn, NY	Completed
The Mennonite	24 unit apartment building	28,000	Brooklyn, NY	Completed
78 3rd Place	2 family townhouse	3,100	Brooklyn, NY	Completed
25 West 88th Street	Single family townhouse	5,941	Manhattan, NY	Completed
25 West 88th Street	4 unit townhouse	6,100	Manhattan, NY	Completed
45-12 11th Street	3 unit townhouse	—	Queens, NY	Completed
210 Pacific Street	10 unit apartment building	21,000	Brooklyn, NY	Under construction
229 Stratford Road	Single family home	2,320	Brooklyn, NY	Under construction
146 Willow Street	Single family home	7,800	Brooklyn, NY	Under construction
852 St. John's Place	7 unit apartment building	5,800	Brooklyn, NY	Under construction
Perch Harlem	40 unit apartment building	—	Manhattan, NY	Under construction
11 West 126th Street	6 unit apartment building	—	Manhattan, NY	Under construction
340 E 34th Street	200 unit multifamily	142,000	Manhattan, NY	Under construction
465 Washington Street	7 unit apartment building	—	Manhattan, NY	Under construction
Harlem Passive House	6 unit multifamily	11,413	Manhattan, NY	Under construction
53 West 71st Street	4 unit apartment building	—	Manhattan, NY	Under construction
40 Cambridge Place	2 unit townhouse	3,150	Brooklyn, NY	Under renovation

Resources

Organizations

Passive House Institute (PHI)
Led by Dr. Wolfgang Feist, PHI is one of the primary organizations in the passive movement. Since the 1990s, PHI has been at the cutting edge of passive house standards and design, products, and construction concepts. It has provided technical support and consultancy for a huge variety of Passive House projects, including multifamily buildings, office towers, schools, civic buildings, and retrofits. PHI continues to do research and develop software tools, to host the annual International Passive House Conference, and to independently certify buildings and building components. PHI provides consulting services to manufacturers of energy-efficient products and to building project teams seeking Passive House certification.

PHI is also responsible for the Passive House Planning Package (PHPP) software, which is used for the planning and verification of Passive House standard energy requirements.

PHI also developed the EnerPHit certification system for existing building retrofits, carried out with Passive House methodology and components. EnerPHit criteria are outlined in Table 2.
Website: passiv.de

International Passive House Association (iPHA)
iPHA is a communication platform for members of the passive house community, connecting professionals, constructors, manufacturers, and technical experts. iPHA connects the various international organizations that uphold Passive House standards, builds awareness, and showcases completed projects and expertise.
Website: passivehouse-international.org

New York Passive House (NYPH)
NYPH is a non-profit that is affiliated with the International Passive House Association (iPHA). NYPH is dedicated to promoting the Passive House building energy standard in New York City and State through public outreach, education, professional and technical support, and advocacy.
Website: nypassivehouse.org

North American Passive House Network (NAPHN)
NAPHN is a cooperative that supports all regional passive house member organizations to promote their activities, coordinate events, and share knowledge. NAPHN also holds an annual conference to achieve Passive House certification.
Website: naphnetwork.org

Passive House Alliance US (PHAUS)
Passive House Alliance US is a networking organization for PHIUS certified professionals. PHAUS has a network of local chapters that develop educational forums and other events.
Website: phius.org/alliance/home

Passive House Institute US (PHIUS)
PHIUS formed in 2007 to provide research, training, certification, and outreach in the United States. PHIUS has developed its own certification standard: PHIUS+, which has been heavily updated in 2015 to account for climate specific passive requirements. PHIUS hosts the North American Passive House Conference every year, and focuses on advocacy and research. As of 2015, there are several PHIUS-certified projects in New York State, but none in New York City, although several projects are pre-certified.
Website: phius.org

Online Resources

Besides the organizations listed above, there are several additional online resources for interested passive house professionals.

Passive House Database
The Passive House Database is a global database of passive house projects, completed or under construction, with details provided by the project owner or architect. Each project is required to present documentation on the thermal envelope, mechanical systems, PHPP values, and pictures. The projects listed are both Passive House certified and uncertified projects built to passive house standards or with passive house components.
Website: passivhausprojekte.de

Passipedia
Passipedia is a comprehensive online database of articles on passive house issues – a kind of passive house wiki. Passipedia provides up-to-date, scientific articles ranging from the basics of passive house to more complex articles about PHPP tools, international cooperations, and publications.
Website: passipedia.org

PassREg
PassREg is a project working towards implementing Nearly Zero Energy Buildings (NZEBs) through the European Union. PassREg highlights successful projects, or regions and municipalities, and showcases best practice examples and strategies.
Website: passreg.eu

PHI and PHIUS

Once the building science that undergirds passive house principles is understood, we must determine how these principles might be applied across the building industry. Though following very similar principles, Passive House Institute (PHI) and Passive House Institute US (PHIUS) have different approaches to implementation. As early as 2008, PHIUS was certified by PHI to certify Passive House projects and deliver education and professional exams. The organizations have since differed on several issues, most prominently on whether heating and cooling demands for new construction should vary according to location (PHIUS) or not (PHI). In 2011, PHIUS issued a separate, internally developed building performance standard called PHIUS+. That same year, PHI chose not to continue their relationship with PHIUS. The result is that there are currently two different "Passive House" standards available in the US market that have very similar names but distinctly different performance thresholds and process requirements.

Regardless of one's position on the PHI vs. PHIUS debate, the presence of two separate systems is confusing to many, and extra care should be taken to understand any technical differences and how they might be applied to various jurisdictions or building types. A detailed outline of these differences is beyond the purview of this briefing but a high level comparison of the certification processes are provided in Table 7.

The PHI standard retains the well known Passive House performance requirements and the PHPP software package developed over 25 years of research. PHI also certifies products, like windows, that meet specific performance criteria. There are roughly 1,800 projects formally certified by PHI. However, this figure does not include the thousands of projects built to Passive House standards in places like Brussels and Heidelberg, which have adopted passive requirements but have instituted their own verification processes. PHIUS recently released PHIUS+ 2015, a new version of their standard with new energy modeling software called WUFI Passive. Like PHI, PHIUS certifies products for meeting performance criteria and professionals to assess projects. To date, more than 150 projects have been certified under the PHIUS+ standard, and their staff is heavily involved in advocacy for passive house legislation in many communities in the US.

The principles of passive design are not proprietary. The Brussels region is an example of this, where the broad principles of PHI's Passive House standard were adopted, with compliance demonstrated through their own energy modeling tools. PHI points out in their own materials that passive principles were discovered, not invented. The matter before industry stakeholders is how to best incorporate these principles to provide nonpareil thermal comfort with very low energy use. We hope this document will help advance this dialogue.

Table 7: Comparison of PHI Passive House Standard and PHIUS+ 2015

	PHI Passive House Standard	PHIUS+ 2015
Performance Criteria	• Annual heating & cooling demand • Renewable primary energy demand, per area (maximum allowable total energy demand) • Airtightness • Renewable energy generation (optional)	• Climate zone-specific annual heating & cooling demand • Peak heating & cooling load • Airtightness • Primary energy demand, per person • DOE ZERH requirements (duct leakage, IAPlus and hot water requirements, etc.)
Climate Zones	Seven climate zones within the EnerPHit standard for renovations	1000+ locations with climate-specific criteria within the US, including four in NYC alone.
Required documentation	PHPP energy model data, site plans and drawings, component specifications, photographs, third-party blower door test, ventilation commissioning, contractor declaration	Energy model data (WUFI passive), site plans and drawings, component specifications, photographs, airtightness reports, ventilation commissioning, contractor declaration, PHIUS+ Rater results
Pre-certification process	Voluntary, but highly recommended, pre-certification is available to verify and adjust the project documentation. This process can identify corrections and improvements to be made during the design and construction phases.	Prior to construction, the project team submits energy models, drawings and specifications for the quality assurance and quality control (QA/QC) process. Once the design review is completed, the project receives pre-certification status.
Testing/Review process	After the preliminary assessment of the planning and design documents, the client will receive corrections and suggestions. Once construction is complete, the project requires a third-party verified blower door test and a commissioning report for the ventilation system. After a final declaration from the site supervisor, the project may be certified.	The second part of the QA/QC process occurs during construction, when a third-party PHIUS+ rater will report deviations from plans and performs blower door and commissioning tests on the completed project. Once the on-site verification is complete, the project may be certified.
Post-certification monitoring	None	None

Training

PHA
Passive House Academy (PHA), a global training and consulting organization, holds several training sessions in New York in conjunction with the Association for Energy Affordability. These include a Passive House primer, a PHPP workshop, a course on thermal bridging, a course for tradespeople, and a course for consultants. All of their programs are accredited by the AIA, and the courses for tradespeople and consultants are also accredited by the PHI.
Website: passivehouseacademy.com

475 High Performance Building Supply
475 is a private company selling energy efficient components and delivering training. They aim to move US construction markets to high-performance and low-energy or passive house projects. 475 provides a series of courses (online and in the city) about airtightness, ventilation, and heat recovery. Their space in Brooklyn also hosts many of the PHA courses offered in New York.
Website: foursevenfive.com

PHIUS
Passive House Institute US (PHIUS) provides several training courses for certified Passive House consultants and certified builders, both online and in person. PHIUS's Certified Passive House Consultant (CPHC) training takes place three or four times a year, online and in person. PHIUS also offers training for PHIUS+ Verifiers for large buildings, WUFI Passive software, and PHIUS Certified Builder Training in New York.
Website: phius.org

Incentive Programs

Although NYSERDA, Con Edison, National Grid, and New York's housing corporations all have programs with financial or technical support for energy efficiency improvements, there are no programs dedicated specifically to passive house projects. The majority of available incentives are prescriptive rather than performance-based.

NYSERDA
The New York State Energy and Research Development Authority (NYSERDA) has several programs designed to support low-energy or energy efficient buildings. NYSERDA also subsidizes several passive house training courses for consultants, designers, and contractors in New York State.

Many NYSERDA programs focus on minimum performance standards, such as ENERGY STAR® for equipment, appliances, and homes. They provide rewards in the form of rebates, cash rewards, installation fees, and performance testing.

The NYSERDA Low Rise New Construction program (for homes three stories or lower) offers incentives that ratchet upward with tiers of energy efficiency performance that passive house projects can directly benefit from.

NYSERDA is planning several initiatives for 2016-2018, which may indirectly or directly support Passive House. Many of the proposed strategies under the Clean Energy Fund (CEF) may support Passive House, including standardizing tools and practices, piloting and publicizing these tools and methods, and creating certification processes for projects and providers.

In 2015, NYSERDA awarded FXFOWLE Architects a research grant to study the adaptation of a 500,000 square feet multifamily project in Queens, currently in the design phase to meet the Passive House Standard. NYSERDA hopes the results will inform ongoing efforts to support energy efficiency and passive house projects.
Website: nyserda.ny.gov

Con Edison
Con Edison provides several rebate programs for prescriptive upgrades to residential, commercial, and industrial buildings. They also run a demand management program with NYSERDA. While none of the programs specifically benefit passive house projects, developers may benefit from rebates for energy efficient equipment or for participating in energy audits.
Website: coned.com

National Grid
The National Grid awards cash rebates to multifamily buildings with natural gas boilers, furnaces, water heaters, insulation, etc,. They provide rebates for other gas-saving measures through their Energy Efficiency Services. They also offer a rebate program for lighting, HVAC, and variable speed motor upgrades for large commercial spaces. While none of the programs are specifically geared towards low-energy or passive buildings, some of the rebates for insulation and high-efficiency heaters may be applicable.
Website: nationalgridus.com

Financing

There are several options available for financial support of energy efficient upgrades and retrofitting projects. Some of these are prescriptive, relating to local laws 43 and 87, while others are more performance based. There are currently no specific funding programs for passive house projects. NYCEEC stands out for its custom support for sustainable buildings, having recently provided a mortgage for a multi-family passive project in Harlem. Nevertheless, passive projects can take advantage of loans via energy benchmarking and audits.

NYCEEC
The New York City Energy Efficiency Corporation (NYCEEC) provides financing solutions for clean energy projects and upgrades, including several passive house projects in New York. NYCEEC also provides loans to owners of multifamily homes and commercial offices for energy retrofits under their Direct Loan Program. In partnership with BuildForward, NYCEEC is currently a lender for a multifamily passive house building in Harlem. As part of the Retrofit Accelerator, NYCEEC plans to provide targeted financing for low energy passive design projects.
Website: nyceec.com

BuildForward
BuildForward is a construction loan and architecture advisory firm that focuses and supports energy efficient construction. The firm connects a community of lenders to energy efficient projects and oversees each project to ensure a base level of energy savings. Qualifying projects have to meet the BuildForward standards through modeled and actual energy savings. For the Harlem multifamily project, BuildForward will monitor the building's performance for five years after construction.
Website: buildforward.com

CPC
Community Preservation Corporation's (CPC) Green Financing Initiative provides loans for energy efficient upgrades for large multifamily units that service low and middle income families. Their recent RFP for affordable rental construction includes PHI and PHIUS+ certification as acceptable green building standards.
Website: communityp.com

Fannie Mae
Fannie Mae's M-PIRE (Multifamily Property Improvements to Reduce Energy) Loan Program provides additional mortgage loans for owners aiming to make energy and water-saving upgrades in compliance with LL 43, 84 and 87 (laws pertaining to clean heating oil, energy benchmarking, and energy audits). Completed renovations have to undertake an ASHRAE II energy audit and track energy and water usage with ENERGY STAR® Portfolio Manager.

More recently, Fannie Mae's Green Rewards multifamily financing program provides extra loan proceeds and a lower interest rate to owners looking to make energy or water-saving renovations. Projects need to demonstrate a 20% improvement through the ENERGY STAR® tracking program to be eligible.

HDC
New York City Housing and Development Corporation's (HDC) Program for Energy Retrofit Loans helps finance capital improvement projects to help multifamily projects comply with LL 43 and 87 (clean heating oil and energy audits). Projects require an ASHRAE Level III Audit and ongoing benchmarking. The HDC and the Housing Preservation and Development (HPD) recently began the Green Housing Preservation Program targeting small- to mid-sized multifamily properties. It will support energy and water saving upgrades, improve building conditions, preserve affordability and reduce GHGs. As part of the Mayor's One City climate action plan, the initiative aims to address affordability and rising utility costs and to increase resilience. NYCEEC is also providing funding for this program.
Website: nychdc.com

NYSHCR
New York State Homes and Community Renewal (NYSHCR) offers tax credits and financial assistance to projects that pursue sustainable certification, including both PHI and PHIUS standards.
Website: nyshcr.org

Zoning

Passive house and other low energy projects are eligible for NYC zoning benefits under the Zone Green program. Recognizing that floor-area-ratio calculations encourage thin walls that maximize rentable floor area, Zone Green allows projects to deduct some portion of their exterior wall insulation from floor area calculations. Existing buildings can add up to 8" of exterior insulation within their property line. New buildings can deduct insulation greater than 8" and less than 16" in depth from floor area calculations as long as they demonstrate the walls are 20% better than code and the building as a whole is 10% more energy efficient than code. More details here: http://www.nyc.gov/html/dcp/html/greenbuildings/index.shtml

Table 8: Available NYC Training

Course	Duration	Organization	Location
Primer	6.5 hours	PHA	Brooklyn, NY
Tradesperson Course	5 days	PHA	Bronx, NY
Consultant and Designer Course	8 days	PHA	Brooklyn, NY
Design PH Master Class	1 day	PHA	Brooklyn, NY
Passive House Modeling with PHPP	3 days	PHA	Brooklyn, NY
Thermal Bridge Modeling	2 days	PHA	Brooklyn, NY
PHIUS Certified Passive House Consultant Training (CPHC) Phase I	Eight 3-hour sessions	PHIUS	Online
PHIUS CPHC Training Phase II	5 days	PHIUS	New York, NY
Certified Builders Training	4 days	PHIUS	New York, NY
WUFI Training	3 days	PHIUS	New York, NY
Various webinars and presentations	Ad hoc	475 High Performance Building Supply	Brooklyn, NY
WUFI Pro	1 day	475 High Performance Building Supply	Brooklyn, NY

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glossary

80 by 50
New York City's goal of reducing GHG emissions by 80 percent, relative to a 2005 baseline, by 2050.

ASHRAE 90.1
The American Society of Heating, Refrigerating, & Air-conditioning Engineers (ASHRAE)'s Energy Standard for Buildings (except low-rise residential buildings). It is used as the alternative to IECC in NYS.

ACH50
Air changes per hour at 50 Pascals of air pressure.

BatEx
A building design competition held in the Brussels Capital Region to stimulate the demand and for knowledge of low-energy buildings

Blower door
A tool used to identify air leaks in a building envelope by measuring the amount of air needed to keep the building at 50 Pascals.

Commissioning
The process of verifying that a system works in the way it was designed to, or to meet user needs. In the case of Passive House certification, the ventilation system of a project has to be commissioned before the project can be certified.

ERV
Energy Recovery Ventilator. ERVs reclaim energy from stale indoor air and temper incoming fresh air to the desired temperature. They are also known as HRVs, or Heat Recovery Ventilators, when used in heating load-dominant buildings.

EUI
Energy Use Intensity. Expressed as the energy consumed by a building per square foot per year (Imperial: kBTU/SF/yr; Metric: kWH/SM/yr).

HVAC
Heating, ventilation, and air conditioning system.

IECC
International Energy Conservation Code. The 2012 version, developed by the International Code Council, is the standard adopted by New York State.

ISO
International Organization for Standardization. It's used as the European standard for windows.

kBTU
A unit of energy; a thousand British thermal units.

kWh
Kilowatt hour.

Net Zero Energy Building
A building with zero net energy consumption. This means the amount of energy used over one year is equivalent to the amount of renewable energy created on site over that same year. The energy consumed and produced is not always coincidental.

NFRC
The National Fenestration Rating Council creates the US standard for windows.

One City: Built to Last
NYC Mayor de Blasio's plan for reducing greenhouse gas emissions to achieve New York's 80 by 50 goals.

Passive House Standard
This is a voluntary standard for highly energy efficient buildings created by the Passive House Institute. Buildings that pursue the Passive House standard are required to adhere to strict heating cooling, airtightness and primary energy restrictions. As a result, it saves up to 90% of heating and cooling costs. Certified buildings are referred to as 'Passive House buildings' or 'PHI certified buildings'.

Passive House
Used in this briefing, "passive house" or "passive design" refers to projects, standards, or components that are inspired by Passive House design, but not affiliated with any certification or certifying body.

PHI
The Passive House Institute, based in Germany.

PHIUS
Passive House Institute US, based in Chicago, IL.

PHIUS+ 2015 Standard
The PHIUS+ 2015 standard is a passive certification standard for buildings developed by PHIUS, consisting of a set of heating and cooling energy requirements based on climate zone. This is the newest version of the PHIUS+ certification standard.

PHPP
Tool created by and for PHI projects to design and model energy use. The most recent version of the PHPP tool can be used on EnerPHit projects as well.

WUFI
Planning tool that calculates the hygrothermal performance of a building.

WUFI Passive
Combines balanced verification procedures for passive houses with hygrothermal simulation.

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The Building Energy Exchange connects the New York real estate communities to energy and lighting efficiency solutions through exhibitions, education, technology demonstrations, and research. We identify opportunities, navigate barriers to adoption, broker relationships, and showcase best practices at our resource center in the Surrogate's Courthouse.

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