naphn 20 North American Passive House Network

Owner's **Manual**

JUNE 2020

NEW YORK STATE OF OPPORTUNITY. NYSERDA

ROCKWOOL™

Owning It

When our policymaker friends kept telling us that their biggest impediment to improving energy codes was 'developer push-back,' we knew we needed to introduce them to a new community so they could hear a new narrative.

From our experience in promoting Passive House in North America, we'd heard a very different story. Over the past decade, the Passive House community has had the privilege to work directly with owners and developers who are willing to build to the highest levels of efficiency. From our vantage point of implementing high-performance buildings - right at the pointy end of policy - we could see that policymakers weren't networking with the same group of particularly bold owners and developers that we were. We realized too that these owners and developers weren't connected to each other either. This lack of connection between policymakers and our more ambitious developers, and the lack of connection between these developers themselves, is what led NAPHN to convene the Owners & Developers Roundtable sessions at PH2020.

As we planned these Owner's & Developers Roundtable sessions, this Owner's Manual was designed as an added supplement to support the pioneering efforts by Passive House developers already blooming across North America. A set of articles was commissioned to provide insight into why developers are already building to the Passive House standard and how they're doing it, along with tips and tools they're using to monitor and measure their success. NAPHN is indebted to the experienced practitioners who contributed to this edition, including Philip Hayes, Zack Semke, Debra Little, Michael Ingui, Craig Stephenson, Beth Eckenrode, Terry Moore, Xavier Gaucher, Ken Levenson, Chie Kawahara and members of the North American Certifiers Circle. Additionally, Mary James provided invaluable technical editorial input for which NAPHN is immensely grateful.

It remains for me to thank our lead sponsors, Rockwool and NYSERDA, who provided support for this Owners Manual, without whom, we would not be able to provide this resource. We encourage you all to continue to support our work at NAPHN, as sponsors and members, so we may further accelerate your pioneering work in the field. We're delighted to continue building a more connected, integrated, and supportive network that supports your own efforts to Choose Your Future.

Bronwyn Barry, RA, CPHD
NAPHN Board President

naphn 20 North American Passive House

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2020 CONFERENCE

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At Schüco USA, we have positioned ourselves uniquely to combine the precision of German Engineering with the power of American Manufacturing. Our clients procure the industry-leading Schüco windows and doors directly from Schüco. With our U.S.-based fabrication, we eliminate the ever growing risk of off-shore procurement to our clients, while providing a quality product at a competitive price, made right here in America.

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At Schüco USA, we deliver precision and performance you expect from a Schüco product with the peace of mind and convenience of an all-American operation. Sustainable, high-performance solutions fused with a concept-to-delivery service model, help reduce risk, increase total property value and deliver resilient building now and for the future.

Our streamlined approach to project management translates to reliable workflows, increased accountability and better service.

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The Developer's POV

By Philip Hayes

There are three love languages that can appeal to developers, for which Passive House happens to be the best answer in all cases.

BEING REMARKABLE

All new developments will one day be competing in a crowded marketplace. Being able to stand out positively in the market is critical to maximizing and accelerating the return on investment. The trick is to minimize the risk associated with reaping the benefits of being remarkable; in this case Passive House allows the characteristics of being ahead of several trends.

Passive House is nontraditional, but also far less intimidating than most green building strategies. It is a great fit for multi-family and other residential project types, where the benefits are the most deeply felt.

Building codes are moving toward Passive House energy performance, and what used to be an outlier is becoming expected. However, there is still a huge gulf between the extreme energy performance of Passive House and the most stringent energy codes, and this gulf can be exploited to benefit your firm's public image. What's more, although energy efficiency is a topic that has generally been ignored by the public, the policy wedge of code-enforced energy performance is shining a bright light on your building's carbon footprint. In NYC the 80x50 Program (80% carbon reduction by 2050, similar to most major cities' carbon vision programs) has instituted a mandatory posted, carbon footprint letter grade, describing each building's energy performance for all to see. This restaurant style of posting a health grade creates a public exposure that is a great advantage to the low energy buildings who have fought so hard to appear "normal" to the market. Now the posted letter grade exposes some of the building's hidden attractiveness. As the public appreciation for sustainability grows daily, this type of green building attribute is not to be dismissed and is becoming a standard requirement by the market. A Passive House product naturally creates this optimistic market differentiation, at no extra charge.

Other attributes of Passive House buildings clearly stand out from the competition and are worth emphasizing, as real estate marketing devices. Consider the steady thermal comfort, improved indoor air quality, deeper window sills, high quality / durability of the construction, resiliency of the building, easy futurism, satisfaction of green living... and of course all while presenting as a traditional, approachable building.

THINKING LONG TERM

Benefits of a Passive House building repeat over time. These positive attributes should be heavily emphasized in the early planning stages with the developer, The most convincing attributes and values of a Passive House building include the physical durability, reduced risk by a higher quality of construction, reduced maintenance / life-cycle costs, low occupancy turnover by a higher quality of life and a perpetual energy savings that can be shared with tenants or used by the developer to shorten the R.O.I. (return on investment).

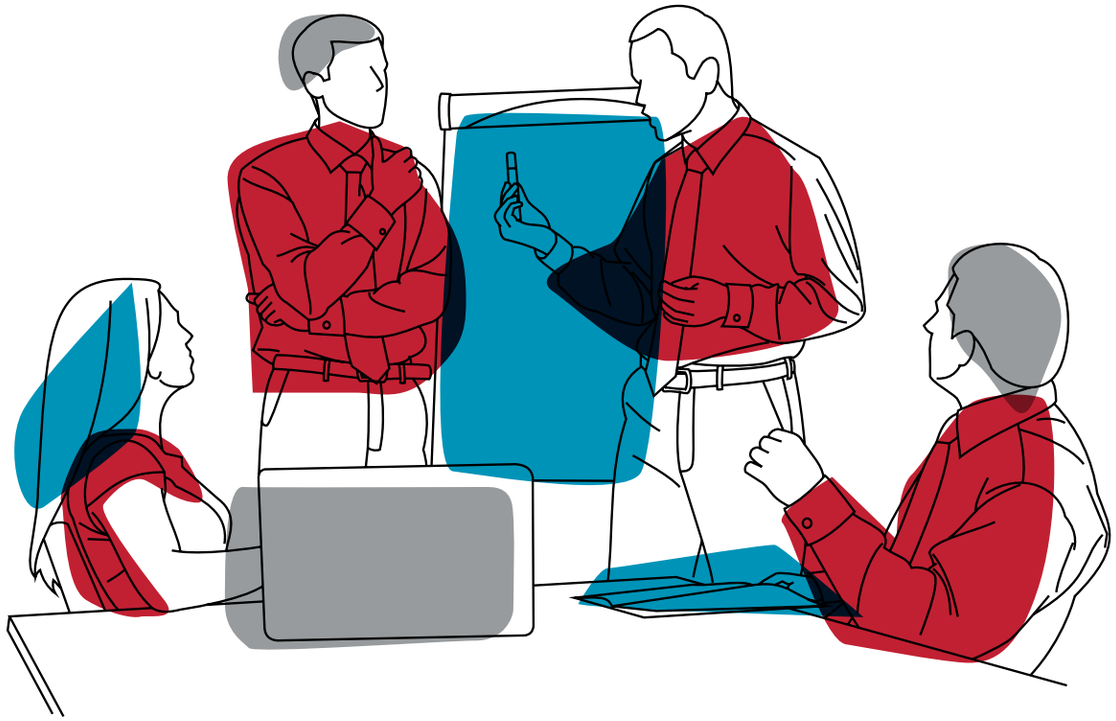
It is worth telling the story of how the Passive House creates these positive attributes, compared to traditional design and construction. The overarching concept is the higher quality construction required for certification, that leads to a better building product and yields measurably improved performance. The rigors of the Passive House construction verification and training lasts throughout the entire building process, and forces everyone on site to achieve a higher standard than the current industry expects.

DOING THE RIGHT THING

Some portion of the developer's decisions will be driven by the social responsibility of the project and the legacy of what that investment gives to the community and world. Even if only for the public relations story the building can tell, Passive House is a great opportunity for leverage. This is a good opportunity to revisit its long list of positive environmental attributes, including reducing fossil fuel use, close to net-zero energy use, durability of the construction, lower maintenance, reduced material waste, etc.

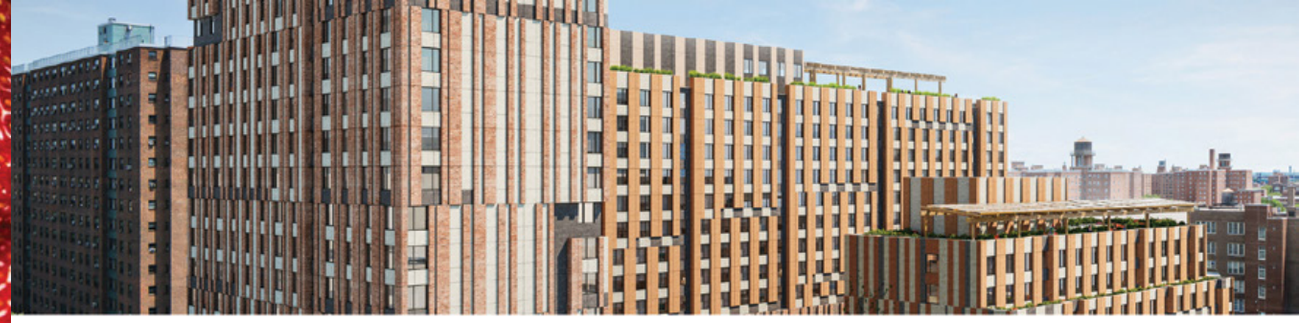
The less obvious list of positive attributes is the pricing flexibility Passive House offers the developer. Timothy McDonald of Onion Flats developed his multi-family project in Philadelphia so efficiently that he and the tenants were able to take advantage of the utility cost savings. Tenants are charged a flat $40 per month for electricity, which is more than their utility bill, but only a third of what they would normally pay. This shared savings is a win-win for landlords and tenants. It gives the developer flexibility in pricing the units, allowing him or her to better react to a changing market.

In short, Passive House affords the developer to build affordably. The additional revenue stream from the electricity charges on the leases creates new value from the affordable apartment units, yielding more realized income without raising the rents.



How to ensure success

- ✓ Assemble a trained Passive House build team. This looks a little different than standard teams, requiring the contractor and the key-trades to have actual Passive House training certifications, at least for the managers, foremen and other supervisorial positions.
- ✓ Ensure the construction schedule and budget includes time for multiple sessions of on-site training for 100% of the workers.
- ✓ Hire experienced QA/QC members, whose sole purpose is to manage on-site mock-ups of envelope assemblies, on-site training, on-site proctoring / verification of the work, conducting blower door testing at many stages and regular roundtable discussions with 100% of the team (construction and design).



Whether you are a developer, tenant, building owner, or technology provider, NYSERDA has a path to help you reach your goals.

Buildings of Excellence
Recognizes eligible architects and developers whose projects simulate the design, construction, and operation of very low- or zero-carbon emitting multifamily buildings.

Clean Heating and Cooling
Assists communities with the implementation of multi-year, community-based outreach and education campaigns that increase customer awareness of clean heating and cooling technologies, reduce installed costs, and jump-start the market.

Commercial Tenant
Supports energy efficiency in commercial tenant spaces in New York State. Tenants and landlords can work with consultants to identify energy saving opportunities at any point of a lease lifecycle.

Multifamily Performance
Offers support to owners, facility managers, and condo/co-op boards of affordable multifamily buildings with five or more units who want to make their existing buildings more energy efficient.

Real Time Energy Management
Supports real time energy management (RTEM) system and service providers who help eligible commercial facilities in New York State with selecting appropriate RTEM systems and offers cost-sharing incentives for installing the systems.

RetrofitNY
Spearheads the creation of standardized and scalable solutions to renovate multifamily buildings to achieve or approach net-zero energy use while improving residents' comfort and buildings' energy performance.

Learn more at nyserda.ny.gov/All-Programs

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Unlocking Value:

By Zack Semke, Passive House Accelerator/ Zola Windows

One of the hurdles for potential developers of Passive House projects is the upfront cost "delta"—real or perceived—between Passive House and conventional construction.

Yes, Passive House buildings are a better product and therefore worthy of investment, but where will the extra dollars come from? And what if the ongoing and long term financial benefits of the investment accrue not to the developer but instead to the tenants or to the next buyer? Unless the developer is confident that the market will properly value the benefits of Passive House—in the form of higher rents, lower vacancies, or higher sales price—then how can she justify the extra cost?

In truth, any extra cost for Passive House projects is usually small, and, in some regions, even nonexistent. (See the story about the Pennsylvania Housing Finance Agency in 2019's NAPHN Policy Resource Guide for a compelling example.) But even where the construction cost delta is real, it is far from unsurmountable. In fact, there are several resources out there to assist developers with it. I'll outline a few US-based ones here.

TAP LOCAL INCENTIVES

A patchwork of incentives—both financial and regulatory—is beginning to develop across the US to support Passive House development. For example, in Seattle, Passive House projects receive expedited permitting and eligibility for siting in higher density multifamily zones in the city. In Massachusetts, the Mass Save program (https://www.masssave.com/saving/residential-rebates/passive-house-incentives) provides a $3,000/unit incentive for certified Passive House multifamily buildings, significant monetary support for feasibility studies and energy modeling, and a net performance bonused on monitored energy use data. New York takes it a step further with NYSERDA's Buildings of Excellence competition (https://www.nyserda.ny.gov/All-Programs/Programs/Multifamily-Buildings-of-Excellence) that awards up to $1 million to exemplary Passive House projects.

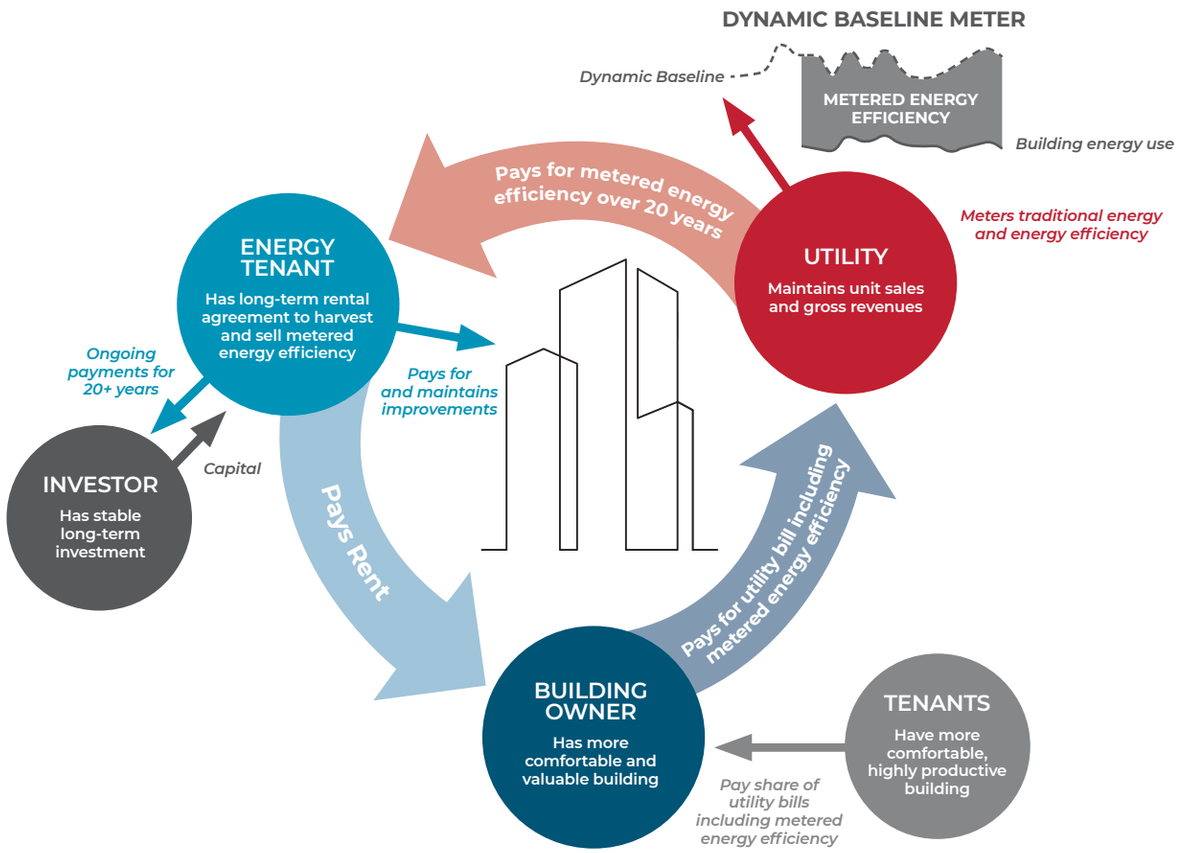
To the degree that incentives like these can add to a deal's equity, they can leverage increased financing, providing more capital and flexibility to the Passive House developer. As more cities, counties, and states recognize the societal benefits of Passive House buildings, hopefully incentive programs like these will spread. For now, access to incentives really depends on where your project is located.

BORROW AT A DISCOUNT—FANNIE MAE GREEN MORTGAGE LOANS

If you are familiar with multifamily building development in the U.S., you know that Fannie Mae is a critical player, providing liquidity to support affordability in the housing market. Through Fannie Mae's Delegated Underwriting and Servicing (DUS) model, major lenders underwrite and originate multifamily loans that are then purchased by Fannie Mae and used to securitize the issuance of mortgage-backed securities that are sold to investors.

What you may not know is that Fannie Mae is the world's largest issuer of green bonds, with $75 billion sold since 2012. These green bonds are backed by Fannie Mae's green mortgage loans made through its Green Rewards program (for incremental efficiency improvements) and its Green Building Certification program (in which Passive House plays a starring role). If you work with one of Fannie Mae's DUS lenders to finance your multifamily Passive House project, you may be eligible for preferential pricing on your mortgage loan. Details vary, but for a typical multifamily property, the discount can be substantial. Reach out to a DUS Lender to learn more: https://multifamily.fanniemae.com/about-multifamily/our-partners/dus-lenders.

Fannie Mae annually assesses the multifamily certifications available in the market to tier certifications based on energy performance. The top group is Towards Zero, followed by Groups 1, 2, and 3. As of the 2019 update to Fannie's Mae's Form 4250, Passive House (including EnerPHit), Living Building Challenge, ILFI Zero Energy, and LEED Zero Energy are the only certifications in the "Towards Zero" tier.



Learn more at:
https://multifamily.fanniemae.com/green-services

TIE IT TO THE TAX BILL—PACE (PROPERTY ASSESSED CLEAN ENERGY)

Under PACE, a property owner borrows capital to invest in energy efficiency, water efficiency, renewable energy generation, seismic upgrades, and more. (Details of which improvements qualify vary state-by-state.) The rates for this financing are competitive, and the term can be as long as 30 years. For efficiency and renewable energy investments, cash flow can be positive from the start, with utility bill savings plus energy generation revenue outweighing the cost of debt service. What makes PACE special is that the loan is tied to the property, not the owner. Payments are typically assessed along with the tax bill, allowing the property owner to pass on the cost of efficiency improvements to the tenants who benefit from those improvements via their triple net payments. Under PACE, the loan obligation stays with the building, regardless of changes in ownership or turnover of tenants.

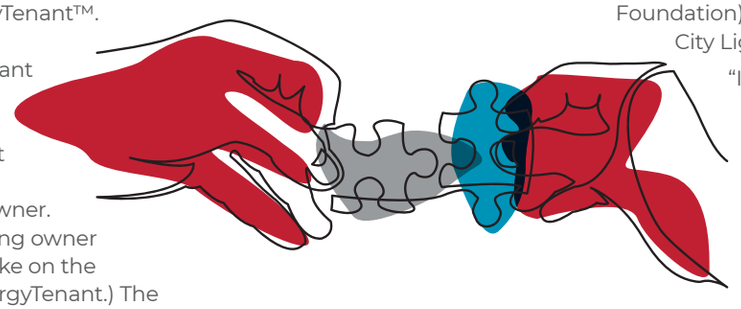
About 75% of the states in the US allow Commercial PACE financing, although less than half have active programs. In the most recent example of PACE progress, Shift Zero, https://shiftzero.org/ the Washington state-based zero carbon building alliance, succeeded at passing PACE financing legislation that was signed into law by Governor Jay Inslee this spring, thanks to work by Alex Winn and Shift Zero's "CPACE-R" Task Force. (The "R" in CPACE-R stands for resilience.) Under Washington's legislation, climate resilience investments like the tidal hardening of buildings to prepare for sea level rise can also be financed by PACE. Super-efficient and "passively survivable" Passive House buildings are perfectly suited for PACE.

Learn more about PACE and the solutions provided by this unique financing structure here: https://pacenation.org/webinars/

BUILD A "NEGAWATT" POWER PLANT

MEETS (Metered Energy Efficiency Transaction Structure) is particularly exciting because it addresses the two most critical "split incentive" dilemmas in building energy efficiency investments: 1. The owner who wants to sell before her energy efficiency investments have paid back, and 2. The owner who can't benefit from the energy savings of her energy efficiency investments because her tenants pay the energy bills (and therefore realize the savings).

The MEETS model begins with energy efficiency project developer, called the EnergyTenant™. The EnergyTenant signs a long term agreement with the building owner. (The building owner can also take on the role of EnergyTenant.) The EnergyTenant pays for, installs, and maintains the energy efficiency improvements in the building, like bringing it to the Passive House standard. Just like any tenant improvement, these upgrades immediately belong to the building owner. The energy efficiency is then metered by a dynamic baseline meter that determines the delta between the actual use of the building and the modeled energy use of the building had it been built to code minimum, or, in the case of retrofitted building, had it not been improved.



The meter reports the energy efficiency, or "negawatts", to the utility in the form of kilowatt hours or therms. The utility signs a long-term contract, or Power Purchase Agreement, with the Energy Tenant to buy the energy efficiency, just as if it were buying energy from a traditional energy generator. In fact, stakeholders are now referring to this resource as "Efficiency Energy." The EnergyTenant then takes a portion of revenue it receives from the utility to pay rent to the building owner. The utility charges the building at retail rates for the metered energy efficiency plus the building's traditional energy use. The building's actual tenants don't see any changes—they just get to be in a better building. They pay the same energy bill that they would have paid if the building had not been improved.

If the building is sold, the MEETS framework stays in place. The EnergyTenant agreement continues with the new owner; it is an asset that increases the building's value.

In summary, under MEETS: an outside investor invests capital at no cost to the building owner; this EnergyTenant's rent payments increase the building owner's net operating income (NOI); tenants are happier; the energy efficiency investments into the building increase its residual value at point of sale; and the building's marketability is increased.

The MEETS model was piloted at the Bullitt Center in Seattle—one of the world's first Living Buildings—thanks to work by Rob Harmon (MEETS Coalition), Denis Hayes (Bullitt Foundation), and Seattle City Light.

"I think MEETS is the most important policy innovation in building efficiency in many decades," Hayes said. "The split incentive problem means that tenants, who have not made any investment in efficiency, reap all the benefits of lower utility bills. This results in a zero-sum game for everyone else. For anyone to gain, someone has to lose. Often the loser is the electric utility, which does not want to give money so that its customers will buy less of the only product it sells. By clearly eliminating the split incentive problem, MEETS makes it possible to design win-win-win solutions—solutions that provide net benefits to every party. MEETS also provides a new income stream against which investors are willing to invest."

Seattle City Light has now expanded MEETS (under a new name, Energy Efficiency as a Service, or EEaS) to include 30 additional buildings. Meanwhile, Rob Harmon is hard at work at introducing MEETS to other utilities and regions around the US.

(http://www.meetscoalition.org/)

PASSIVE HOUSE BUILDINGS ARE A BETTER PRODUCT

As powerful as incentives, favorable loan rates, PACE financing, and agreements between utilities, building owners, and energy investors can be for supporting the development of Passive House buildings, the most powerful factor boils down to one simple truth: these are better buildings that make for happier tenants and owners. The smart money is on Passive House investment.

SAVING THE PLANET STARTS WITH GREATER BUILDING EFFICIENCY

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Appraised Value

By Debra Little, AjO.earth

How we can support accurate valuations.

Passive House delivers energy savings and beyond-energy benefits including quality, durability and aesthetics that should be recognized in appraisals. Homeowners and builders deserve the certainty that their investments will pay off. Appraisers need to understand the differentiating performance assets and their benefits. Communication and documentation begins with us.

Appraisals aren't a passive process! Property owners can often do more to inform and support fair valuations. Define the assets with project details lists, documentation of energy savings and other proof of performance.

BE ENGAGED IN THE APPRAISAL PROCESS

- **Plan ample time** for completion. Appraisers need to expend extra effort in research and analysis for special properties.
- When ordering an appraisal **notify the lender that this is a special property type** that will require an appraiser who is **competent** in high performance building. Deliver a letter to assert this request. See example at https://ajo.earth/appraised-value/
- In your first conversation, describe the efficiency features and ask about their experience with similar homes. Check their familiarity with performance principles and the consideration of operational savings in the income approach.
- During the inspection **provide the appraiser with relevant documentation.** Be present as a guide; clarify the performance assets and their various benefits including energy savings, durability, health, comfort, etc. They'll want to understand your motivations and personal experience (if built). Engage enough to be confident in their level of comprehension as they go forward in their market research and analysis.
- **Review the completed appraisal.** By hiring a qualified appraiser and leading with clear communication you've taken reasonable steps to support a fair-valued outcome. In the unfortunate instance that you perceive a lack of professional effort you have the option to contest the appraisal. This is not the same as disagreeing with the value conclusion; there should be a valid concern regarding their competency or work ethic.

Nurturing Great Contractors

By Michael Ingui, Baxt|Ingui Architects

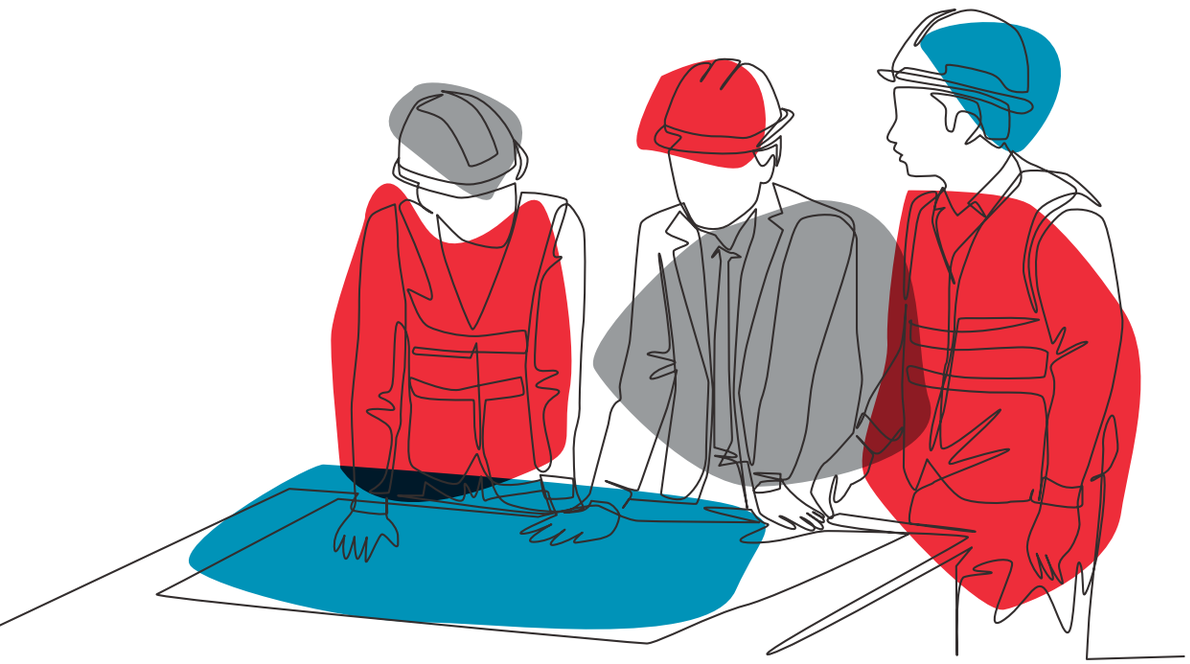
An essential ingredient to the success of any Passive House project is the craft that goes into it.

If it's true that the "devil's in the details", then it's doubly so in our world, and the execution of Passive House assemblies in the field will make or break a project. But how can we nurture contractors' and subcontractors' learning and practice, particularly when Passive House construction is still so new to so many?

One of the questions we are asked most often at Baxt Ingui is, "How do you find good Passive House contractors?" When we were first introduced to Passive House, none of the contractors we had worked with were familiar with the concepts, but we knew that they were all good builders and craftspeople and felt that this, along with the willingness to learn, were the only essential factors. Put a builder who enjoys their craft and takes pride in what they build into a Passive House training session and they almost immediately fall in love. Many of the same contractors are now on their third or fourth Passive House project with us.

That said, from the early days of our involvement with Passive House we were eager to nurture a community of praxis - a form of reflection and action directed at the structures to be transformed - with our builder and craftspeople collaborators. Together with our contractors, we developed a model—one that is readily replicable by other architects and developers—called the "contractors' collective", which I'll share here.

Because our office's first Passive House project—the first Passive House in Manhattan, incidentally—ultimately achieved certification, it can be labeled a success. But the process was difficult, with many mistakes that had to be rectified and weeks of wasted time. We had fallen in love with the Passive House concept, but we also realized that completing a Passive House anywhere near cost neutral was impossible if we did not create a repeatable, systematic approach. The GC on this project was confident enough to open the site up to other GC's, to share our collective lessons learned. This transparent sharing, dirty laundry and all, became the inspiration for the contractors' collective.



On our next Passive House project, we spent a lot of time picking apart the details, the products, and the build sequence. Before the bid process, we invited six contractors, two Passive House consultants, and two engineers into the site to get their opinions. The meeting cost us a bit of money and time but was well worth it. As you may expect, this first meeting started off awkwardly, with a few stragglers outside waiting to see who went in before entering. Many of the contractors who attended had known of each other for years but had never met. Many of them competed fiercely with one another for work. The meeting was at 10:00 AM and was to last no more than 30 minutes. It lasted over 2 hours, with cell phone photos being shown, details being sketched all over the walls, debates on methods to pursue, and 4 pages of red marks and notes for what we could be doing better. It was exhilarating for everybody.

Given the success of this process, as well as the availability of Passive House tradesperson training in New York, we added a couple of preconditions for bidders to Baxt Ingui Passive House jobs. First, contractors and key subs have to have taken the tradesperson training. Second, everyone needs to agree to share their mistakes and successes in the contractors' collective meetings.

The next contractors' collective had almost 30 people in attendance and ended up with everyone requesting for the next one to be at the end of the day to incorporate drinks afterwards. The next contractors' collective grew to almost 50 and went quite late at the bar afterwards. The most recent contractors' collective was in a house where we kept a lot of historic detail and was within 8 blocks of five other Passive House projects being completed. All of the houses were using different air sealing methods and different products; a few changed the sequence of installation,; and one was using a new liquid-applied product that had just started selling in the U.S. There was quite a lot to talk about, debate, and document, which resulted in, yet again, a much better detail set that everyone would use the next time.

We have all found these sessions to be truly fun and incredibly valuable on so many levels. This is something that could occur in anyone's design-and-build circle, and I highly recommend it.

SMOOTHING CERTIFICATION:
Top 5 Tips

Free Advice from three North American Passive House Certifiers

Monte Paulsen, RDH Building Science Inc.

Commit early. Commit to PHI Building Certification before you design the building. Hire an architect and builder based on a contractual commitment to achieve certification at the lowest practical cost. This will help focus the design process.

Aim low. Plan for 10 or 12 kWh, not 14.9. Building performance never improves during construction.

Specify early. Choose PHI certified windows and mechanical equipment at the beginning of the design process.

Recycle details. Adopt junctions and window installs that have been modelled for other projects.

Get help. Hire a PHI-accredited Building Certifier at the beginning of the process. Ask for guidance on whatever you don't understand. It's much less expensive to pay for help at pre-design.

Andrew Peel, Peel Passive House Consulting

Engage your certifier early.

Work with your certifier to review and agree on early design elements and decisions.

Review the requirements and clarify questions, doubts, and concerns with your certifier whenever they arise.

Conduct between one and three Design Stage Reviews during design to ensure the project remains on track for certification

Start building the submission package on day 1.

Tad Everhart, CertiPHIers Cooperative

Carefully review PHI's free online Criteria and Building Certification Guide.

Engage your Certifier early, communicate as often as needed to understand certification requirements, and don't be shy to ask questions and share concerns with your Certifier.

Communicate basic design and component choices early, but also plan at least one to three careful reviews during design to ensure the building remains certifiable.

Passive House is a team sport. Work problems together. Enjoy collaborating for the best result.

Plan on substantial time and effort working with your Certifier and providing files and documentation your Certifier requires. Make sure the owner understands your duties to the Certifier and adequately compensates you for your time and effort.

Essential Certification Resources

Click the links to get information online.

- BASIC REQUIREMENTS
- CLASSIC, PLUS or PREMIUM?
- Where to START?
- PHI's CERTIFICATION GUIDE
- FIND A CERTIFIER
- TOOLS & AIDS
- VENTILATION SYSTEM CHECKLIST
- AIRTIGHTNESS TEST REPORT CHECKLIST

Continuous Monitoring for Passive House Buildings

By Craig Stevenson & Beth Eckenrode

There is a growing interest in the use of technology to continuously monitor performance during operations, ensuring that goals set in design are met and sustained over the life of buildings. What separates performance-based s tandards from prescriptive-based standards is an expectation of performance during operations.

The challenge is to make certain that project teams fully contemplate, as early as pre-planning, how a building will measure and verify building performance during operations. This measurement and verification planning must include use cases connecting monitoring devices to goals set in planning. The following steps are the most critical moves a team should make to bring effective continuous monitoring to any Passive House project.

STEP 1 - DISCOVERY CHARRETTE FACILITATION

A Facilitate a Discovery charrette and an Owner sustainability alignment charrette.

- The purpose of a Discovery charrette is to set and refine owner's goals and expectations regarding the three critical success factors of a project: first costs, long-term operating costs, and building performance criteria.
- The Discovery process is an initial step to identify, convene and align developers, key stakeholders, and project team members around the project's aspirational vision, goals, guiding principles, project boundaries, and any identified building certification standards (i.e. Passive House, WELL Building, RESET Air, Living Building Challenge, Fitwel, LEED etc.). The Discovery process establishes a strong foundation for an integrated design process for the purpose of achieving optimal economic, environmental, and social impact. Content is kept at a high level and is not intended to review programs in great depth.

STEP 2 - OWNER'S PROJECT REQUIREMENTS (OPR) REPORT DEVELOPMENT

- Memorialize the goals set in the Discovery charrette using an Owner's Project Requirements (OPR) document. The goals in an OPR are metrics-based. They are not long narratives detailing aspirational interests. They are performance criteria that are expected to be measured during operations.
- The OPR is a "living" document that is updated and revised throughout the design and construction development cycle and circulated to the entire project team.

STEP 3 - SMART BUILDING MANAGEMENT SYSTEM (SBMS) ESSENTIALS

Below are the minimum infrastructure components and the design support required for building owners to continuously monitor the performance of any Passive House building. The approach outlined below establishes the protocols necessary for owners to maintain control and transparency over their building performance data. This list may be modified to incorporate an unlimited number of additional meters and sensors to provide feedback loops on almost any criteria of building performance. The components detailed below should be specified and included in most projects as the minimum equipment list for an Open Integrated Smart Building Management System.

The coordination and design of the Smart Building Management System mentioned below should be accomplished by the sustainability professional accountable to the owner for aligning all team members to operating performance metrics.

- Tridium Niagara JACE 8005 controller, IO34 Input/output module, computer node, building enclosure cabinet for the JACE and I/O controller including power supply and associated hardware, or equal. Tridium Niagara JACE programming will be required to integrate the meters and sensors.
- Coordinate the integration of the Building Automation and Direct Digital Controls system; ensure specifications are developed to deliver an Open Integrated control system and include all necessary hardware.
- Coordinate the design and implementation of the Measurement and Verification system; ensure specifications include all hardware required to sensor, continuously monitor, and display data in an integrated performance dashboard.
- Primary source digital utility meters for electric, gas, domestic water, and any other source of energy into the building.
- Indoor air quality RESET Air certified 5-parameter (PM2.5/PM10 + CO2 + TVOC + Temperature + RH detector) monitors that support the design of RESET Air v2.0 standard.
- Weather Station transmitter (Air Pressure, Temperature, Humidity, Rainfall, Wind Speed, Wind Direction).
- Coordinate the design and implementation of the converged information technology network system for the enterprise and operational technology networks. The converged network should provide the flexibility necessary to easily add or remove sensors and monitors as required by building owners and tenants over the life of the building.

Once the project goals are set and systems designed and selected, they may be implemented in the following phases.

sBMS BUILDING INFRASTRUCTURE PHASE—installed during construction

The sBMS Building Infrastructure Phase includes the base installation of the Integrated Performance Dashboard, including software and hardware for real-time energy and indoor air quality (IAQ) monitoring for the building. The

system receives real-time data from digital utility meters, IAQ sensors, outdoor air quality station, weather station, building automation systems, and other building sensors and stores the data on a real-time time-series database historian and analytic platform.

sBMS MEASUREMENT AND VERIFICATION PHASE—executed post-occupancy

The sBMS Measurement and Verification phase organizes the collected data to be used in conjunction with the whole-building sustainability model to analyze current building performance and verify design, construction, and operation activities to achieve the goals set by the Owner. At this phase, the whole-building model will transform into an operational whole-building model and continue to be used in future planning to predict energy consumption and IAQ resulting from continued renovations and operations. It is at this stage that integrated dynamic performance targets will be displayed against trended performance data.

sBMS MONITORING-BASED COMMISSIONING PHASE—reviewed during first year of occupancy

The sBMS Monitoring-Based Commissioning phase ensures that the energy efficiency and IAQ goals are maintained. In this phase, the Integrated Dashboard displays live real-time data including Energy Star Portfolio Manager rating, utility consumption, CO2 emission data, predictive utility consumption markers, electric demand, average zone temperature and relative humidity vs. set points, and weather forecast. Goals and targets developed by the Owner are dynamically displayed for comparative analysis against actual performance metrics.

The path to achieving carbon neutral building stock begins with replicable practices that can be applied and developed across the State.

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PASSIVE HOUSE SERVICES

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Passive House is the most stringent energy efficiency certification available. Yet it also offers extreme flexibility to the design team since certification is performance-based, rather than prescriptive. Involvement of a Certified Passive House Designer from the beginning of the process significantly increases the project team's chances for success and can minimize the total cost.

Our Services Include:

Design Charrette: Half-day strategic planning session with the project team to review project goals, incentive program requirements, and strategies to achieve performance criteria and targets.

Design Analysis: Review of architectural plans and specs during design development and provide suggestions for meeting air tightness requirements, efficiency levels, and mechanical system design.

Modeling: An array of modeling services are utilized to review heating/cooling demand and load, as well as the primary energy consumption of the building(s). Our modeling capabilities include 3-D thermal, Passive House Analysis, daylighting, solar feasibility, moisture analysis, and net zero calculations.

On-Site Contractor Training: Ensure the whole team understands the level of quality and detail Passive House demands.

Testing & Commissioning: SWA is equipped to provide all testing and verification services necessary for certification and to ensure systems are installed as specified.

Certification Support: All specification, calculations, and testing results for Passive House Certification provided to certifying body.

CONSULTANT CERTIFIED PASSIVE HOUSE CONSULTANT

PASSIVE HOUSE CERTIFIER Passive House Institute accredited

Steven Winter Associates is now a Passive House Certifier!

Earning Passive House Certification increases dilligence and accountability compared to only designing to the Passive House standard. It helps ensure the building performs to the high standard it was built to and is required for certain incentive programs.

SWA's practical experience allows us to easily spot issues and provide technical advice to remediate so your project stays on-track. We are experts in large-scale Passive House projects and can help you achieve certification for your next new contstruction project or existing building rehab.


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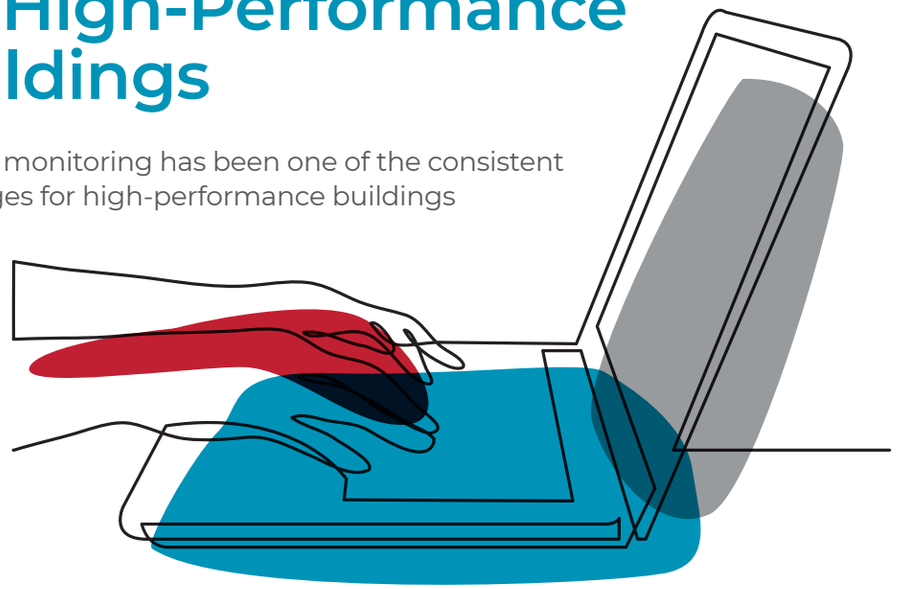
Monitoring Equipment for High-Performance Buildings

By Terry Moore, MCCI Corporation

Remote monitoring has been one of the consistent challenges for high-performance buildings



Available technologies have typically been top-down systems, where a central data-acquisition system (DAS) records data from dedicated sensors. These systems have demonstrated the utility of building monitoring, but have typically been too expensive and complex for residential and smaller commercial applications.

With the introduction of low-power wireless networks, new opportunities arise for monitoring high-performance buildings in real time. Although the technology is still being developed, the last few years have seen impressive proofs of concept, using the new networks and open-source technology. This shift is akin to the shift that happened between 2006 and 2016, from proprietary operating systems in data centers to open-source operating systems in the cloud, allowing monitoring for a wider range of projects than was economically possible in the past.

These new technologies augment the framework defined for commercial buildings by the U.S. Department of Energy Building Technologies Office (BTO). Their two Performance Metrics Tiers represent two fundamental approaches to monitoring buildings. The work done for Tier 1 systems is primarily manual and involves collating existing data to prepare periodic reports for building management. The work done for Tier 2 systems is automated, but typically is tied to a dedicated DAS or BMS, often using internet-derived technologies like BACnet. In these systems, the sensors are somewhat subordinate to, and dependent upon, the central DAS for their function. Both Tier 1 and Tier 2 are top-down approaches; they depend on a person or system to correlate the data and prepare the reports.

The new wireless networks allow for a bottom-up approach. The sensors operate independently of any central management system. Sensors transmit data periodically based on local conditions; cloud-based communication software routes the data to where it's needed. Crucially, the data is encrypted, and the sensors are isolated from the public internet. Standardized non-proprietary receivers collect the data and forward to a networking system in the cloud, which takes care of routing the data from the sensors to one or more applications that need the data. The management of remote sensors is separated from the data storage and reporting functions, allowing lower cost by more effective division of function. There's not yet an accepted term for these systems; let's call them "sensor nets".

With this background, let's compare the three approaches (see chart). The approach to choose in 2020 depends very much on the project budget and the level of interest in pioneering new technology. For large commercial installations, especially where there's existing infrastructure, a BTO Tier 2 system is relatively inexpensive compared to overall project costs. For smaller residential and commercial projects, a Sensor Net approach is worth considering. BTO Tier 2 systems are not in reach economically, and BTO Tier 1 systems imply manual efforts for the life of the building. The key is to find a vendor with experience deploying these kinds of systems, so that you're not pioneering the approach on your own.

THREE MONITORING APPROACHES

	Building Technologies Office (BTO) Tier 1	Building Technologies Office (BTO) Tier 2	Sensor Nets
Data updates	Monthly or Annual	Daily or Hourly	Real Time
Data source	Manual (utility bills, walk-through).	Automated with dedicated equipment.	Automated with open-source standards.
Additional Equipment	None	System-specific sensors, wiring, on-site DAS.	Sensors from multiple vendors; wireless gateways as needed.
Reporting Technique	Off-line reports	DAS dashboards and off-line report.	Real-time dashboards, online database of building data. Reports generated by consultants/data scientists.
Cost of Installation	Minimal	Substantial: typically $20k to $25k entry.	Very low: typically $1k entry.
Cost of Operation	Modest (fees for consultants to process data).	Varies a lot, but annual service and maintenance fees are typically a substantial percentage of the cost of installation.	Very low. DIY is possible for IT-savvy management team.[1]
Extensibility to other monitoring requirements	Minimal	Modest. Possible, but the focus of providers is on the larger customers.	Substantial. New wireless networks have substantial capacity for periodic environmental data; one receiver cantypically carry tens of thousands of data points per day for multiple disparate uses.
Long term financial commitment	Ongoing. If you stop funding the labor for the reports, you lose all data.	Generally on-going with substantial labor cost. Either requires dedicated staff or regular fees to technical experts. Reports are bundled with system service.	Modest. Fundamental costs of the system are very low; if you can't afford reports, you can still get (and track) real-time data.
Ability to handle additional monitoring needs (landscaping, operations, etc.)	None	Modest; systems are normally focused on building management and use corporate networks for connectivity.	Yes; open, secure networks allow for multiple use.
Pros	Very little time needed from operating management.	Well suited for larger organizations and institutions with many buildings. Substantial experience and installation history.	Open, flexible, allows incremental install, can avoid vendor lock-in.

[1]If completely DIY, basic operating cost is typically $40 to $50 per month. MCCI's experience is that keeping systems running takes minutes/month, especially if there's shared infrastructure.

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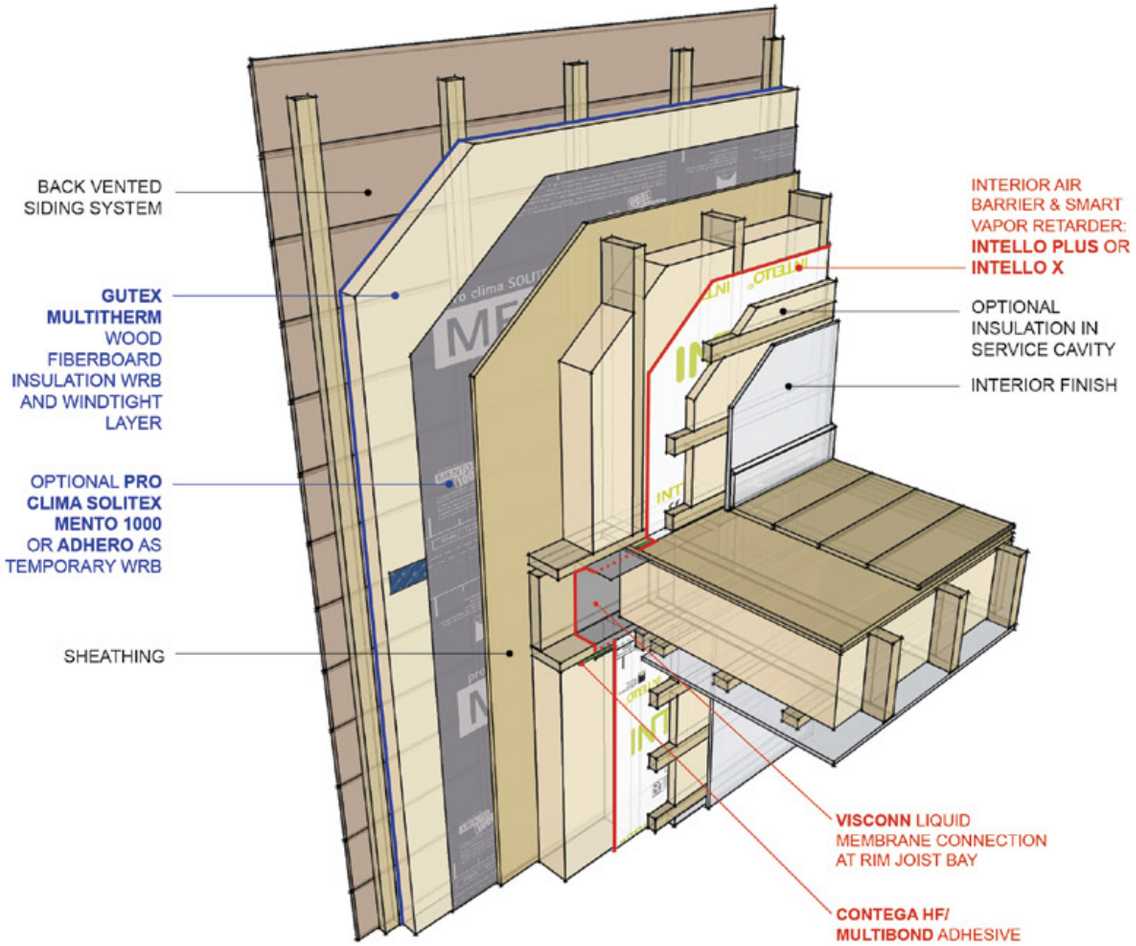
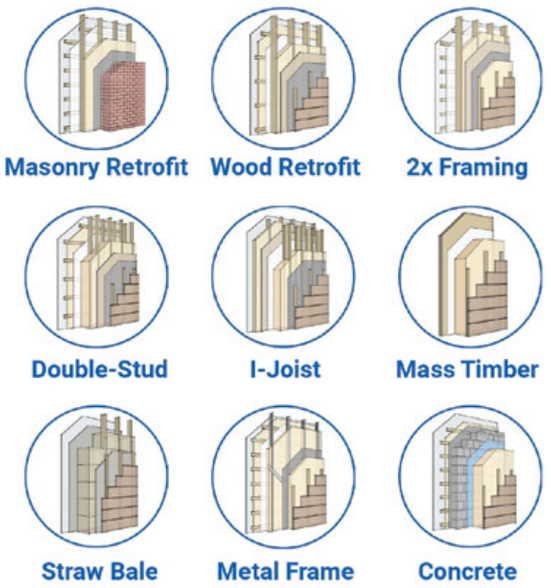


WHAT IS THE SMART ENCLOSURE?

NINE ASSEMBLY TYPES



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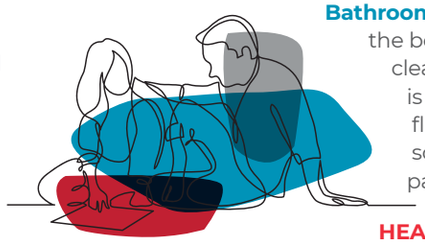
Your Passive House Operator's Manual

By Ken Levenson, Chie Kawahara, and Xavier Gaucher

Living and working in a Passive House building has so many advantages: stable thermal comfort, fresh hygienic indoor air, and peace and quiet.

However, no matter how "passive" your building may be, it's still a complete system that periodically needs attention to ensure it performs as designed—and that attention mostly needs to go to the building's few moving parts. So here is a simple checklist to ensure you are getting the performance you deserve.

VENTILATION



Your ventilation system should always be running. It should be quiet enough that you don't hear it and passive heat recovery should be efficient enough that the supply air temperature never feels noticeable (Neither too hot, nor too cold.). Air should be circulating at the velocity that meets Passive House specifications.

Commissioning Report: You should have a commissioning report from the certification process verifying the flow rates to each supply outlet and from each exhaust grille. Be sure you have a copy for reference in the future.

Filters: Whether the system is centralized or decentralized, you should have filters that help keep the indoor air quality high and the heat exchange units functioning properly.

- **Changing Filters:** Filters need to be cleaned and then ultimately changed out on a regular schedule. Typically changing them every six months is adequate, but if you are in an area of high pollution, they may need to be changed every three months or less. Keep spare clean filters on-hand so that changing them isn't delayed. Follow the manufacturers' recommendations for cleaning and changing. If it's not your job, make sure the maintenance crews are doing their job.
- **Wildfires?** If you live in an area that may be occasionally submerged in wildfire smoke for days or weeks, then you need really good filters, changed often along with potentially other purification devices added. This filtration, coupled with the overall building airtightness, will provide the best indoor air quality.

Cooking? Many Passive Houses do not have high-powered exhaust-only fan hoods and instead utilize a recirculating hood with a charcoal filter. Be sure to use the recirculating hood and switch your ventilation system to 'boost' mode during cooking to eliminate particulates and clear out any residual smells faster.

Bathroom Ventilation Boosts? Use the boost mode to more quickly clear steam and/or smells, if that is an option. Otherwise typical flow rates should clear the air soon enough, with just a little patience.

HEATING, COOLING

These are the active systems that may require particular vigilance. If your building is certified, you should have properly sized systems that deliver just enough heat and cooling, and not too much. An oversized cooling system can be problematic, because the least amount of cooling it can provide is too much and can lead to overcycling. If systems are sized right for the tiny loads required, regular maintenance check-ups should be all that is needed for many years of service. Just set the thermostat to your desired temperature and enjoy the consistent comfort.

Are you in a location with cool, dry nights? Hopefully "night-flushing" was part of the Passive House design certification specifications, which utilizes the "free cooling" of natural ventilation overnight. Use it when you can by opening windows as needed to produce natural cross ventilation, or by ensuring that your ventilation system utilizes the bypass mode, if available.

HUMIDITY

If you're in the desert, humidification is what you need. In hot and humid climates (or just summers), dehumidification is likely required. No matter the climate, with a little bit of oversight, Passive Houses can easily be maintained in a very comfortable and healthy indoor range of 40-60% relative humidity year-round.

Dehumidification: In hot and humid climates, the cooling system may not provide sufficient dehumidification to keep the living spaces comfortable, as it's likely not going to run enough.

- Provide an ERV core in the ventilation system to passively preserve humidity levels as much as possible.
- Use the air conditioning. Be comfortable and let that bit of cooling do as much double duty of dehumidification as it can.
- If it's still uncomfortably humid, you need a dehumidifier made for the job.

SHADING

Shading is a key aspect of minimizing cooling loads on hot days. Some Passive House buildings are designed so that the building structure itself provides sufficient shading, and additional shading is not needed. Some residential Passive House designs do require a seasonal plan for shading, which should be managed.

Exterior Shading: Exterior shading is much more effective than interior shading.

- Were the shading trees planted per the overall design? If there should be a tree shading your building and it's not there, get one.
- If exterior shades were designed, were they installed? If so, use them and keep out unwanted solar heat gains. Consider installing an automatic system that tracks with the sun year-round.
- Skylights? Often skylights should have exterior shades installed in the spring and then removed in the autumn.

Interior Shading: If there is no exterior shading and interior shading was part of the design, then utilizing that interior shading is a must. Be sure the blinds are installed and work. Ideally, they would be automated as well, but lowering the blinds as needed to protect from afternoon sun in the summer should be part of anyone's routine.

DOMESTIC HOT WATER

Normal maintenance is all that is required.

- Maximum water temperature should be at the design temperature, 140 F.

OPERABLE WINDOWS & EXTERIOR DOORS (AIRTIGHTNESS)

The hardware can be the weak point in otherwise robust windows and exterior doors If that hardware isn't working properly, the unit may not close fully and the gasketing effectiveness, providing airtightness, will degrade. Just as car tires need to be realigned occasionally, your hardware will need adjusting from time to time, particularly for oversized units, to maintain proper seals.

- Be aware of how the window or door feels when it closes fully. The locking mechanism can compensate and hold it tightly in place, but with very big units even that may not be enough.

MONITORING

Monitoring the performance of your Passive House building is always a good idea. Like the gauges on your car, while the building should be running to plan, it's better to know if it's not. (See other articles on this topic included in this Owner's Manual.)

- Energy Use: If you're using more energy than planned maybe some of the equipment is not meeting specifications or needs a repair.
- Indoor Air Quality: With Covid-19, radon, wildfires, and humidity levels all ongoing concerns that directly affect health, a system that alerts you to check your filters, or boost your ventilation rates, or check your humidity controls is useful in any building. In a Passive House, these checks should be predictable, but monitoring can keep you ready.

A CHECKLIST TO HELP YOU MANAGE AND MAINTAIN YOUR PASSIVE HOUSE:

Spring

- ☐ Replace filters in the HRV/ERV after the winter fireplace smoke season and before your allergy season begins.
- ☐ Install exterior shades/ sails over unshaded windows, and skylights before summer.

Summer

- ☐ Pay attention to the weather forecast for night flushing.

Fall

- ☐ Remove exterior shading around the fall equinox or after the last heatwave, whichever is later.
- ☐ Replace filters in the HRV/ERV system.
- ☐ Clean the HRV exhaust registers to remove dust and oil (Important: note the exact setting and put it back to the same opening size.)

Winter

- ☐ Should be smooth sailing...enjoy.

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Analyze your portfolio's energy use or carbon emissions and identify inefficient systems and maintenance practices.

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Improve building performance with innovative solutions that will help you meet your energy or emissions targets on-time and on-budget.

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