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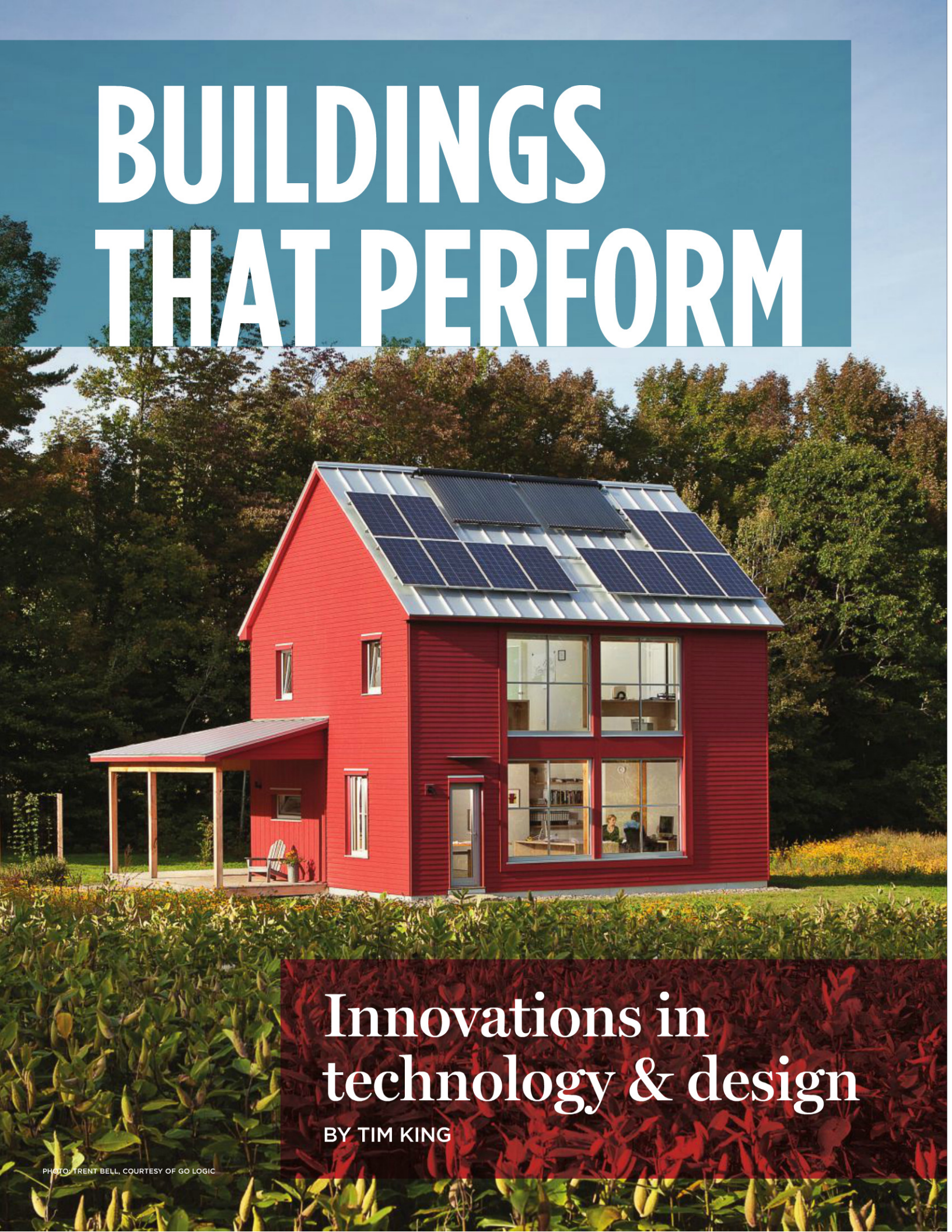
BUILDINGS THAT PERFORM



Innovations in technology & design

BY TIM KING

PHOTO: TRENT BELL, COURTESY OF GO LOGIC

THEY SURE DON'T build homes like they used to.

And, if you speak with a growing number of Maine home builders, designers and architects, that's a good thing.

Blame it on our high fuel costs, cold climate, old housing stock or increasing awareness about the correlation between energy consumption and climate change, the winds of change are a'blowing across our state.

Slowly, but surely, Mainers seem to be starting to understand how their homes function and are taking steps to reduce how much energy (and money) they'll need to stay comfortable throughout the year.

The relationship between energy consumption and household budgets became painfully clear last year when skyrocketing oil prices forced some Mainers to make tough choices: eat or stay warm? Thankfully, fuel prices have recently dropped to near record lows. However, few believe that prices will remain this low forever.

The sting of last winter's perfect storm of high fuel prices and cold, snowy weather may not have repeated itself this year, but it seems to have sounded the alarm.

No matter how new or old, large or small, expensive or modestly priced the home, Mainers have come to the same conclusion: our houses consume *much* more energy than they should, and we need to do something about it.

Late to the party. But ready *(and able)* to get to work.

As with many things, the *future* – like a warm summer breeze – can often seem to take its own sweet time to arrive here in Maine.

Thankfully, just as the icy winds of winter eventually succumb to a wave of warmth from the south and west, the persistent efforts of a resilient group of building professionals are being felt inside warm, comfortable, energy efficient buildings of all types throughout the state.

Over the last decade, a small cadre of forward-thinking home designers, architects and builders have been actively leading the charge to get homeowners to completely rethink how, where and with what materials homes are built in Maine.

Across the wide spectrum of new homes being constructed—from the spacious to the more modest—these homes may differ in their physical size, but each one shares a common objective: provide the maximum amount of comfort for its residents using the least amount of energy.

This objective can be attained in several different ways —and to different degrees—depending on the individual homeowner's priorities.

On one end of the spectrum, a code-built home (the current, legal set of building codes) will provide homeowners with a solid, safe home that is insulated, ventilated and structurally sound. At the other end of the spectrum are high-performance homes. High performance homes are extremely well insulated and airtight.

Historically, these homes have been much more expensive to build. Homeowners understood this and knew that their higher up-front investment would pay dividends over the long term in the form of dramatically lower utility costs.

However, over the past 5-10 years, a combination of factors has driven down project costs to a point where a return on investment can be realistically achieved in a matter of months or years.

One major development that is helping to drive down new home construction costs—while actually improving quality—is the emergence of high performance, pre-fabricated building components.

Unlike past modular construction efforts that garnered a reputation for producing mainly low quality products, a new generation of builders, including the team behind BrightBuilt Home in Portland, are producing innovative, energy efficient building assemblies (off-site) that come together to create homes of higher quality than most traditional site-built homes.

"You wouldn't build cars one at a time, outside in a muddy field," explains Mike Maines. "The same principles apply to the construction of high performance houses. You can control quality and manage production schedules much more effectively by producing panels and other building components in a shop or factory environment."

The ultimate goal for the industry, stated as one of the guiding principles behind BrightBuilt Home's mission: *making sustainable, attainable – for everyone*, seems closer to becoming a reality than ever before.

When *"If it ain't broke, don't fix it"* don't work no more.

For generations, many of the building construction principles and practices being used to build homes in Maine were simply passed down verbally or by demonstration, unquestioned and quickly accepted as fact.

Up until about 20 years ago—when the Internet made knowledge sharing possible—if you walked onto any construction site in Maine and asked "*Why are you using this material or building something that way?*" you were most likely to get an answer such as, "*Because that's how we've done it before.*"

Here in Maine, as is the case in many other parts of the country, the top priority for home builders is to get the job done as quickly and efficiently as possible. Again, blame it on the weather, but the harsh reality for builders in Maine

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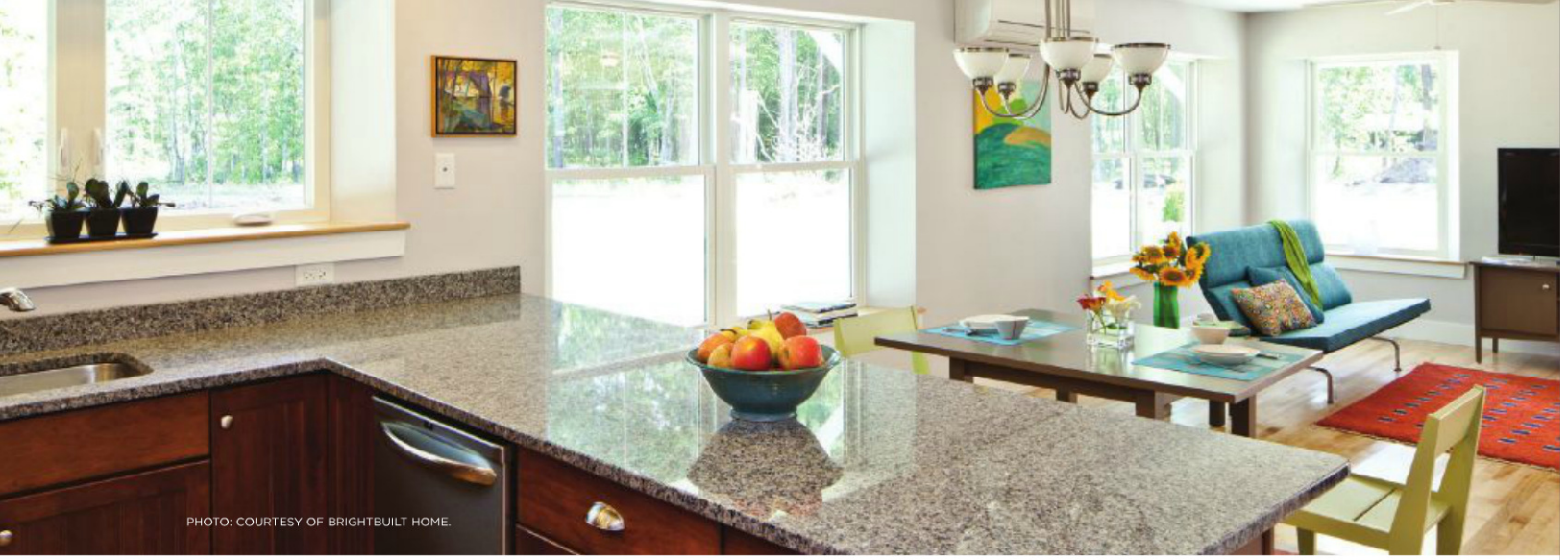

PHOTO: COURTESY OF BRIGHTBUILT HOME.

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is that there is a limited amount of time to work comfortably and safely outside.

With winter always a little more than a few weeks away, the pressure to complete as many projects as possible is key to a construction crew's profitability. As a result, there's usually very little time for experimentation with new systems, products and techniques. If something worked, it worked and that was that. Good enough was good enough.

The way it was: Burn all you want. We'll make more.

It's not that homes in Maine were built shoddily in the past —although I'm sure some were—but for the vast majority of human history, private homes simply weren't expected to *perform* in any way other than by keeping us dry, warmer than we would be outside and safe from intruders. If homeowners wanted to feel "safer" they installed better locks.

If residents wanted to feel "warmer" they just put another log on the fire…or in modern times, they turned up the thermostat.

Back in the day, when our sources of heat energy (wood, coal, oil) were abundant, inexpensive and thought to have no effect on our environment, building and living in a "good enough" house might have actually been *good enough*.

Today, based on what we know about the fragility of our natural resources and the impact that combustion based heating systems have had on our environment, good enough—isn't.

This awareness, combined with unstable energy costs and the shrinking incomes of many American families, and most Mainers, is forcing people to take a new, hard look at how well their homes perform.

Whether they are motivated by reducing their carbon footprint or simply trying to reduce their utility bill each month, Mainers are demanding homes that can deliver.

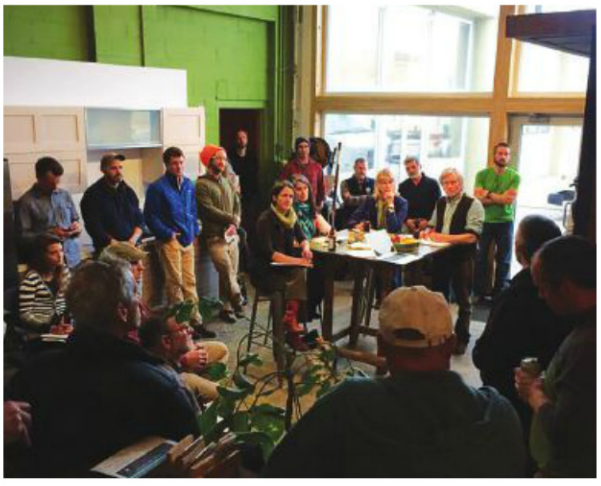
Made in Maine, schooled in European efficiency.

Fortunately, there are already quite a few talented, knowledgeable building professionals who have been honing their skills on innovative construction projects throughout Maine and beyond for many years. You could say they were "green before green was cool."

No longer relegated to the fringe by self-proclaimed "*real builders*," these men and women are now in high demand and collectively changing the way that new homes are made, and existing homes are made better—one project at a time.

For the past several years, many of these forward- thinking practitioners, employed by companies such as Briburn, BuildingWorks, Kolbert Building, Horizon Residential Energy Services, ReVision Energy, Rick Renner Architects, Taggart Construction and others, have met monthly at the Performance Building Supply store in Portland to share ideas, information and best building practices.

Each month, attendees of the Building Science Discussion Group will often include professionals who represent different aspects of the construction process. As a result, architects and designers can glean important, hands-on knowledge from renovation experts and contractors. Insulation and weatherization specialists can talk with energy auditors and remodelers about new products for sealing,



Attendees at a recent Building Science Discussion Group meeting at Performance Building Supply in Portland share ideas and best practices advancing their collective knowledge of cutting edge and tried-and-true techniques.

PHOTO: KATHERINE KRANICH

insulating and analyzing performance.

This cross-pollination of knowledge among different factions of the industry allows "what's working" to spread throughout the region faster and relegate "what's not" to the trash bin faster as well. More importantly, as homeowners, we all benefit from this Darwinian process.

Here are few examples of what you can expect from Maine homes in the future.

Passivhaus – Das ist gut. Das ist sehr gut!

Based on the same building science principles that have existed since humans first started constructing their own shelters, the Passive House (Passivhaus in German) methodology minimizes heat loss within a structure, making it easier to maintain a comfortable internal air temperature.

Not to be confused with passive solar design, which primarily focuses on the building site, climate and materials for its heat, passive houses can be built virtually anywhere. While many certified passive house projects may incorporate solar-friendly features (such as placing high efficiency windows on the south side of the building) what makes a passive house *"passive"* is the minimal amount of energy it requires to remain at a comfortable temperature, regardless of the outdoor weather conditions.

Where our ancient ancestors were able to achieve a high degree of thermal insulation by building the walls of their homes against (or into) the earth, today, advanced building materials such as polyiso foam insulation, intelligent membranes, tapes and other sealants accomplish an even greater degree of thermal protection.

Originating in Germany in the early 1990s, the Passive House concept has developed into an internationally recognized, rigorous design and construction methodology for creating buildings that require very little energy for space heating or cooling.

Here in Maine, and across the country, the Passive House ideal is working its way into many discussions about precisely how to produce high-performance, energy efficient buildings.

passivhausMAINE, an associate of the North American Passive House Network and the Northeast Sustainable Energy Association (NESEA) works to educate, inform and support the passive house-inspired building community in Maine. The group is committed to decreasing home heating costs, carbon emissions and Maine's dependency on fossil fuels.

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"We are anticipating growth in the number of construction projects here in Maine that use the voluntary building standards of Passive House," says Naomi C.O. Beal, director of passivhausMAINE. "This includes the increased use of building materials and components, such as cross laminated timbers (CLTs), that are Maine-based, enhance building performance and contribute to a more sustainable and low carbon construction process."

Passive House in Practice.

Alan Gibson, Principal of GO Logic (pron. GEE-Oh) in Belfast, Maine has been helping Mainers create homes that achieve the holy trinity of new construction—high quality design, highly efficient energy use and affordability—for over two decades.

"We design homes with a highly insulated, airtight building envelope according to the Passive House standard. This reduces our heating load requirements by 80-90% compared to a code-compliant built house," says Gibson.

This dramatic reduction allows GO Logic to prescribe high-efficiency heating equipment for their Passive House homes that would likely prove inadequate in an older, under-insulated home.

"Because we've reduced the amount of heat energy needed to maintain a comfortable temperature inside the home by so much, we're able to specify much smaller, super-efficient heating and cooling equipment—such as electric powered heat pumps—that can deliver the right amount of heat exactly where and when it's needed."

In the passive house world, it's not that "less is more" it's that "less is really all you need."

The ideal - A home that creates more energy than it consumes.

A few years ago, Briburn, a Portland-based architectural firm, designed what has now become the first net-positive Passive House building in the state.

Built to exacting specifications, including siting the building to maximize its proximity to the sun, and with a roof filled with a 19.4 kW array of solar panels, the Viridescent House (cover), located on the Falmouth campus of TideSmart Global, actually generates twice as much energy as it consumes.

In order to create the airtight exterior shell required to

achieve this level of efficiency, construction crews were instructed to think of the building as a ship. Hence, the mantra for the project, "If it leaks, we sink," was born. Other high-performance construction proponents agree.

"I cringe whenever I hear people say '*The house needs to breathe*,'" says Mike Maines, a Certified Passive House Consultant and Principal of Michael Maines Residential Design.

"In the old days when walls were built without any insulation at all, air could move through the assembly without doing any harm. As soon as insulation is added, you need to stop the airflow or you risk problems caused by water accumulation. For a building to be energy efficient, it needs to be as airtight as possible."

Walking the walk inside the Viridescent House.

Through the combination of thoughtful site planning that takes advantage of passive solar gains, the use of super insulation materials, creating an airtight building envelope and the installation of high efficiency windows and doors, buildings built to the Passive House standard are able provide a comfortable, healthy living environment using only a fraction of the energy that a comparably sized "code-built" home would require.

Before the building was even completed, Chris Briley, the principal architect on the project, led a group through the Falmouth Viridescent House. Although it wouldn't have been considered by many to be *warm* at the time, the inside temperature of 50 °(F) was noticeably more comfortable than it was outside at the time 20 °(F).

Incredibly, Briley later informed the group that there actually wasn't any externally sourced heat being pumped into the building yet. A combination of passive solar gains from the day and the combined mass (and body heat) of the group was all that was needed to create the temperature difference.

"You could probably heat this place with a hair dryer when it's finished," quipped Briley at the end of the tour.

Better performing homes, for everyone.

While the ultra-modern look of the Viridescent House will likely appeal to a specific type of homebuyer, its futuristic stylings may not be for everyone.

The good news is that many of the leading-edge solutions that were initially developed to address problems such as

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heat loss, moisture buildup and ventilation in high-end, uber-efficient specialty homes, are now being used to build less ostentatious, more affordable homes, too.

One example of this can be found in Scarborough, where Habitat for Humanity of Greater Portland is currently in the process of building an entire neighborhood of moderately sized homes for low-income families who may not otherwise be able to afford a home of their own.

Designed and constructed to meet strict energy performance standards established by the EPA, Habitat's ENERGY STAR certified homes will perform better than more than 75% of homes nationwide.

Chad Mullin, construction manager for the project, puts it this way, "We want the houses that we build for our new homeowners to be a blessing and not a burden for them. If we can build a home that is super tight and energy efficient, the homeowner will spend much less to keep the house warm in winter and cool in the summer. The money they save can then be put in the bank, used for food or clothing or to help pay for a child's college education."

By implementing advanced framing techniques that minimize heat loss, air sealing, insulating exterior walls on both the inside and outside, along with countless other "little" things that are necessary to create an airtight, yet healthy living space, these homes will require only a fraction of the energy that a similar sized "code-built" home would use.

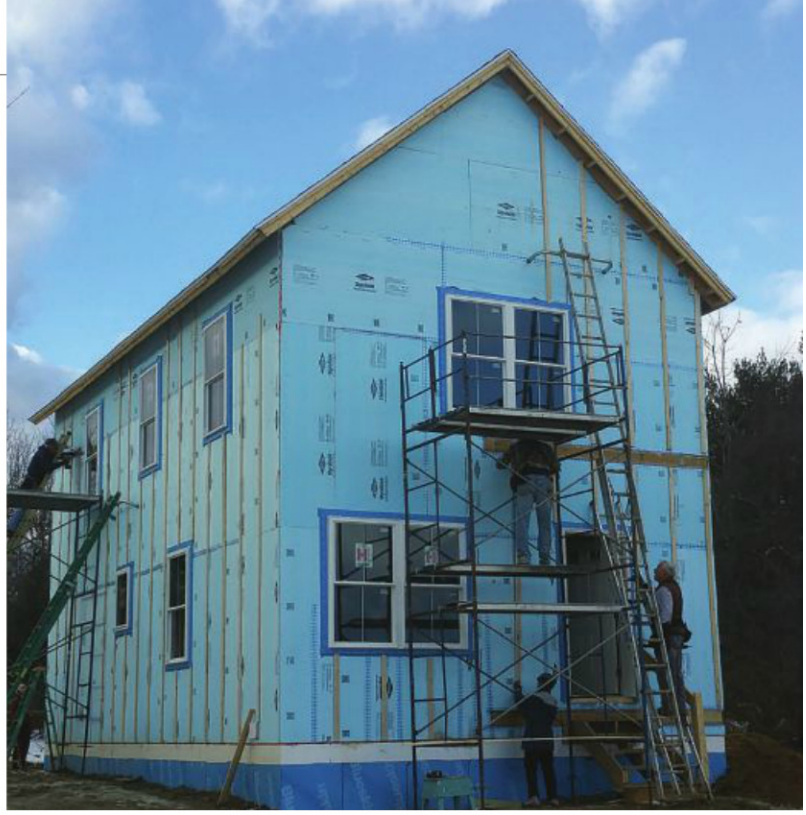
In fact, the concrete basements of these homes alone, insulated to R-22 by using interlocking, insulated concrete forms (ICFs), are more resistant to heat loss than the finished, exterior walls of the vast majority of Maine homes with (R-13) traditional fiberglass insulation.

What lies beneath. The silent, heat sucking basement.

Many homeowners may not realize how much of an impact an uninsulated concrete foundation can have on energy use. It may seem counter-intuitive to the average person, but a typical 8" cast-in-place basement wall provides approximately the same resistance to heat loss (R-Value) as a pane of glass (R-1.5).

One of the main reasons homeowners are not aware of the amount of energy that is constantly being lost through their basement walls is that it is usually being replenished (continuously) by heat radiating from oil and gas-fired furnaces and boilers.

Without a source—in this case, heat from an inefficient combustion appliance—the temperature of most basements would eventually match the ambient temperature of the material surrounding it. Here in Maine, soils can freeze all the way down to a depth of 4' (frost line) during the winter. Even during the warmer months, soil temperatures generally remain between 47°-50°F. Brrrr.



A Habitat for Humanity development in Scarborough uses new construction methods that meet ENERGY STAR standards, ensuring that the homes are 75% more efficient than an average house.

PHOTO: TIM KING

Model behavior: What a well performing home should look like.

For the vast majority of home construction over the last 100+ years, architects and designers were confined to designing homes based on a few key factors (1) the existence and ease of access to specific types of building materials (2) the cost of construction relative to the market value of other homes in the area, and (3) the budget of the homeowner.

With very few exceptions, homes built in New England are fundamentally the same, as are the similarities between homes built in the south and the west. To some degree, best practices have allowed some methods to continue while others, presumably, have been tried and failed. This type of evolution by trial and error is not only painfully slow, it is also expensive.

One of the biggest advantages that home builders and designers have today is the ability to develop, evaluate, compare and implement new and innovative construction techniques using software programs that mimic or "model" construction materials according to their physical properties. For example, how resistant the material is to heat loss (R-value).

Energy modeling software helps determine the total energy use of a home and evaluate different heating and cooling systems and building assemblies. The reporting tools and graphical summaries allow everyone—architect, builder and homeowner—involved in the project to be on the same page throughout the entire construction process.

Got a Question? Just ask the WUFI.

If you're not a building science nerd, you've likely never heard of a software program called WUFI® (pron. "Woo-Fee"). Don't let the name fool you. It may sound like something a child might call their favorite stuffed animal, but these tools are all business, and they are revolutionizing home building.

WUFI, developed in Germany at the Fraunhofer Institute, is actually an acronym which, when translated, means heat and moisture transiency. Nothing warm and fuzzy there.

WUFI and its ilk: WUFI Plus, WUFI 2D and WUFI Passive are all powerful, number crunching beasts that can calculate (among other things) exactly how moisture and heat flow will affect the construction materials used in a particular building over time.

These types of incredibly powerful and increasingly easy to use tools can now allow architects and home designers to accurately compare and determine which combination of construction materials, equipment and design elements will create the most energy efficient space—before anything ever gets built.

"It used to be very difficult for us to try and explain to clients how making changes to the building's design, components and assemblies would impact their energy use over time," says Chris Briley, a founding partner and principal architect at BRIBURN.

"With this information (literally) right there in front of them, it becomes much easier for our clients to make better, informed decisions about what stays and what gets modified or removed from the plan."

Some Maine home designers are so confident with the accuracy of the models they create for clients, they're offering to step up and pay the difference in utility costs if the models turn out to be wrong.

"We know exactly how our homes are going to function," says Matt Nolette, principal of Cardinal Point Design.

Nolette uses another popular energy modeling tool, the Passive House Planning Package (PHPP) to help him predict the future.

"We can project the heating and cooling costs for each home we build. So we tell our customers that we'll pay for anything that exceeds the modeled costs over the next three years. That's how much we believe in what we are building for them."

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Seeing the invisible. New tech makes it possible.

Many times, especially when working with an existing home, it can be physically impossible to locate where a building component may be failing or where an insulation deficiency is causing more heat loss than it should. Quite often, these problems are located behind finished walls, ceilings and floors.

Once the stuff of science fiction comic book fantasy, hand-held devices such as heat seeking thermal imaging cameras are becoming one of the most useful devices on a building professional's tool belt. There's even an app-powered attachment available now for Apple® and Android™ mobile devices. The FLIR ONE™ personal thermal imager sells for around $250.

"Being able to capture and share full color images of the otherwise invisible air leaks occurring in a wall assembly is an incredibly effective way to communicate with the client about what's going on," says Claire Betze, of BuildingWorks, LLC of Freeport.

"You still need to do a lot of poking and prodding in and around basements, crawlspaces and attics to fully understand what's happening inside the home," she says.

"But these devices [thermal imaging cameras, blower doors, scoping cameras] can help us to locate problem areas and isolate specific issues faster. Once addressed, we can provide the client with a visual, quantifiable measurement of the conditions before and after the work was done. That's a real game-changer in this business."

Not only are the newer thermal imaging cameras now being sold by companies such as FLIR® Systems and others, more accurate, simpler to operate, and easier to download information from, they are also becoming more affordable.

While prices for many of these types of diagnostic tools have certainly dropped significantly over the past 5-10 years, they are still not cheap. However, the cost/benefit justification for purchasing a new thermal imaging camera for less than $3,000 today is much easier to swallow than it would have been just a few years ago, when almost every thermal imaging camera on the market sold for 2x to 3x that much.

Better information = better decisions.

Armed with this type of detailed information about their homes, homeowners can partner with a firm that special-

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izes in making energy efficiency improvements, sometimes referred to as deep-energy retrofits, and not only identify specific areas of concern, but also prioritize which improvements will provide the best return on investment.

For example, a homeowner may learn that spending $1,000 to air seal and insulate their attic will save more energy than spending $3,000 to replace all the windows in the house.

That's exactly how Tyler Kidder, a Falmouth homeowner we first profiled in this magazine last year, determined where she was going to focus her time, energy and money to turn her outdated, drafty bungalow into an energy sipping dream home.

I recently followed up with Kidder to find out how she has fared since the renovation work—which included replacing the old inefficient oil boiler with a pair of strategically located, mini-split ductless heat pumps—was completed. Here's what she had to say:

"Since we took out the old boiler, the only fuel we use now is electricity, so keep in mind that these numbers include running everything in the house that requires power: heating, appliances, plug loads, cooking and hot water. Last year, (2014-15) my average electricity bill for the year was about $161/month. So far, this heating season (2015-16) my average monthly cost is $108." Kidder went on to give some perspective on "what might have been" if she had not taken the steps she did to weatherize her home.

"Adjusting to take the current, relatively low price of oil ($2/gallon) into consideration, based on how much energy I was using before doing the air sealing, insulating and installing the heat pumps, I still would have been paying an average of more than $200/month in oil (for heat and hot water) plus another $20-40 in electricity for cooking and plug loads. So even with the current 'cheap oil' prices, I'm still saving money each month. When oil prices rebound, the savings will look even better."

An "Energy Awakening" arrives in Maine.

Whether planning to purchase an existing home or considering constructing a new one, most people have focused primarily on acquisition costs (cost of construction, mortgage amount, taxes) without considering what impact the operational costs (utilities, maintenance) will have on their monthly household budget.

That's why, when oil prices first rose and then remained at nearly $4.00 a gallon between 2010 and 2015, homeowners

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throughout Maine were trying to do everything they could to keep every ounce of heat in their homes. Many had created a budget based on the assumption that the cost of energy would always remain the same.

History has shown that this is very rarely the case.

Building or buying a new home? Keep it real.

During the heyday of the "bigger is better" home building period during the late '80s and '90s, I can remember driving with my dad through a newly developed neighborhood of "McMansions" in Massachusetts.

At the time, I remember looking out at these huge, gorgeous homes with both envy and jealousy, knowing that I'd probably never be able to earn enough money to live in one myself.

With my eyes wide and mouth agape, I recall saying something like, "Wouldn't it be great to live in a house like that?" to which my dad, always the pragmatist, replied, "Maybe. But I'd sure hate to be the one that has to pay to heat it."

Make efficiency and comfort the top priorities.

No matter the size of your house (or your paycheck), spending less money to keep it warm in the winter and cooler in summer should be the goal of every Mainer.

While it is true that the "energy burden" (the percentage of total income that is used for energy costs) that is placed on low-income households is often disproportionally high, no one likes to pay more than they have to. Remember, the least expensive – and cleanest – type of energy is the type that's never produced in the first place.

Here in Maine, there are programs offered through Efficiency Maine, an independent trust that works to promote the adoption of more efficient and cost-effective energy use, that provide a number of rebates, low-interest financing options and other incentives to help Maine homeowners pay for making energy related improvements to their homes.

Efficiency Maine also makes it easy for homeowners to find qualified, local contractors that specialize in services such as insulation, air sealing and energy audits. G&HM

Tim King is a sustainability-minded, freelance writer from Scarborough, Maine.