

# Energy Design Update

The Monthly Newsletter on Energy-Efficient Housing

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## IN DEPTH

### Homes for Health

#### Examining Field Evidence on Health Benefits from Energy Efficiency Upgrades (Part One)

Traditionally, placing a value on an energy efficient home upgrade is framed in terms of return on investment. This makes sense – measuring dollars saved through energy conservation is relatively concrete. Energy savings over time is the benchmark value proposition touted during most “green” renovations (see Figure 1). But is this too narrow a focus? By concentrating solely on potential benefits to the pocketbook, are we leaving out discussion of benefits for the homeowner?

“We have a strong case that health benefits are created during energy efficient upgrades,” says Ellen R. Tohn, Tohn Environmental Strategies LLC. “We can argue about how much, or for whom, but it is unquestionably true that we are making healthier homes when we follow best practices. Unfortunately, this really important message is not widely understood.”



**Figure 1.** Orness Plaza, a public housing complex in Mankato, Minnesota. Between 2010 and 2012, the property was renovated to meet Enterprise Green Communities criteria and LEED® Silver certification. The photos document HVAC improvements that were part of the renovations, including range hoods that vent outdoors. The project was part of a US Department of Housing and Urban Development (HUD)-funded research project that the National Center for Healthy Housing (NCHH) conducted. Photo courtesy Blumenthals/Architecture.

Codes are increasingly aimed beyond energy savings and toward better indoor living environments. Indoor air quality (IAQ) and ventilation standards are a hallmark of this direction. Yet bringing health and wellbeing into a home renovation conversation often gets ephemeral. Can health benefits be quantified? Are they evidenced in the field, and, if so, how can they be demonstrated? How is a health benefit even appropriately defined?

The industry lacks a good summary report that would allow builders and renovators to support whether or not energy efficiency upgrades are beneficial for a homeowner's health.

Under contract from the US Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL), a team from the National Center for Healthy Housing (NCHH) and Tohn Environmental Strategies set out to address the evidence for health benefits from renovations. The partnership mined completed field studies to determine and quantify what occupant health and indoor environmental outcomes result from energy efficiency or home performance upgrades, and how indoor environmental conditions can affect health. Their findings, *Home Rx: The Health Benefits of Home Performance*, were released December 2016. (Full report available at <http://www.energystar.gov/hhp>.)

While many individual studies evaluate the effects of residential energy efficiency on indoor environmental quality and occupant health, there had not been a systematic review of results in order to summarize current knowledge and identify research gaps.

“The DOE Home Performance with ENERGY STAR® and Better Buildings programs really wanted to look at the health impact of their work,” says Jonathan Wilson, MPP, Chief Financial Officer and Director of Research at NCHH. “They felt strongly that not only are their programs improving energy efficiency, there is also pretty good evidence that as we tighten a home and improve ventilation, we create potential health benefits for many residents.”

For their assessment, the *Home Rx* team categorized completed field studies into 4 broad groups.

- Projects labeled as “Base Energy Efficiency” covered research projects that included at least two of three core energy efficiency elements: air sealing, insulation, and heating upgrades (see Figure 2).



**Figure 2.** Orness Plaza, a public housing complex in Mankato, Minnesota. Between 2010 and 2012, the property was renovated to meet Enterprise Green Communities criteria and LEED® Silver certification. The addition of a carbon monoxide detector can have profound benefits in a living space. Projects involving simple enhancements, such as air sealing, addition of insulation, or heating upgrades were also evaluated for health benefits. Photo courtesy the National Center for Healthy Housing.

## Energy Design Update

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- “Enhanced Energy Efficiency” projects included research wherein the energy efficiency measures involved air sealing, insulation, and heating upgrades, and added elements to address moisture, ventilation, or other issues. In some cases, additional services were provided to further improve the indoor environment such as air filtration and carpet removal to address allergens.
- “Green Renovation/Construction” projects were selected for review since they include elements that go beyond the standard activities of home performance contractors, including use of low-polluting building materials, mold removal, carpet replacement, pest exclusion and integrated pest management, and smoke-free housing policies in multifamily buildings. The team felt green renovations offered a unique view into framing the potential benefits of energy efficiency/home performance when coupled with other home renovation.
- “Potential Supplemental Home Performance Services” included reviews of research for three specific activities that have been studied independent of other renovation or construction work: (1) stand-alone in-room air filtration equipment, (2) gas-to-electric stove replacements, and (3) wood stove upgrades to cleaner-burning wood stoves.

With available studies classified into one of these four categories, the *Home Rx* team evaluated whether benefits to health were demonstrated in each. Among available research, 40 studies were selected that met the necessary criteria.

“We narrowed our focus to studies that had some relationship between energy efficiency and health status, and confined our observations to whatever was being expressly presented. For example, one study looked at cardiovascular health specifically, and a number of studies looked at respiratory health, especially asthma, but also general upper respiratory health, such as colds, and sinus infections,” explains Wilson.

### Reported health measures and indoor air quality measures improved in a majority of the studies, following efficiency upgrades.

“In all but two of these studies, there was a significant improvement in at least one self-reported measure of respiratory health following the completion of work. These outcomes held true across the spectrum of categories: from base energy

efficiency packages to new green construction and supplemental services (*Home Rx*).”

While different studies focused on different demographics – children, the elderly, people with existing health conditions, or building residents – the most common outcome was that respondents reported a general health improvement after work was complete. In three studies, the respondents reported that their mental health improved. Of the studies that did not specifically target respiratory issues, seven reported improvements in lower respiratory symptoms, while four studies reported improvements in blood pressure or other cardiovascular issues. Reductions in outcomes such as upper respiratory symptoms and headaches also were reported.

“I could imagine cleaner indoor air quality affecting respiratory health, but was surprised by the cardiovascular results,” says Wilson. “I would hypothesize that these benefits are part of better comfort. As a home is tightened and maintains a more narrow temperature and condition range, this would place less stress on the body.” (See Figure 3.)

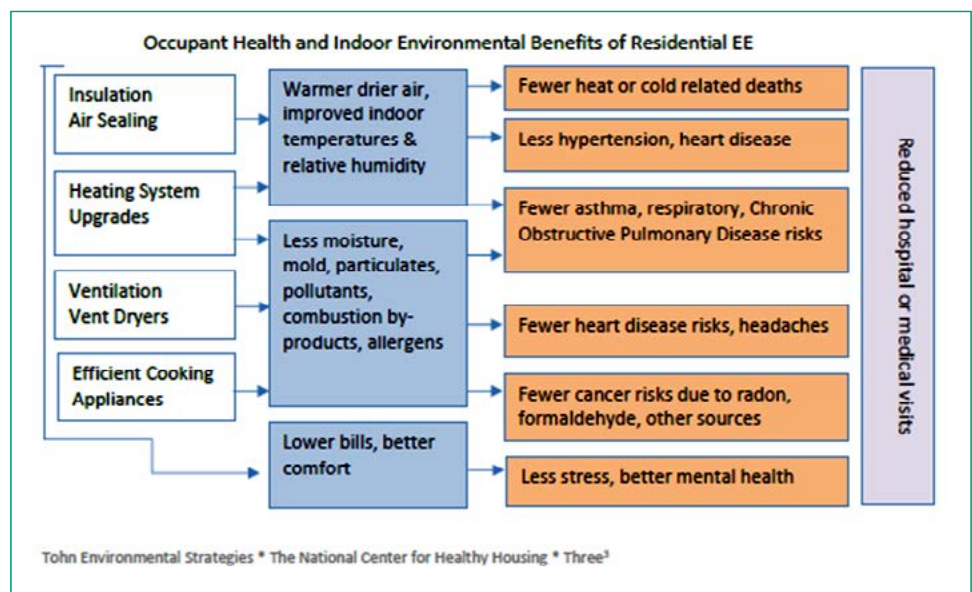


Figure 3. Occupant health and indoor environmental benefits of residential energy efficiency. Figure courtesy E4theFuture. Figure from E4theFuture report, “Occupant Health Benefits of Residential Energy Efficiency,” November 2016, and available at <http://bit.ly/2gCVxDF>. For further information, also see <http://bit.ly/2jfcO6O>.

“Beyond expected benefits to respiratory conditions, such as allergies and asthma, we see other health improvements, like less headaches and hypertension,” Tohn notes. Tohn, in collaboration with E4TheFuture, Inc., released a study further analyzing resident health impacts as presented in the *Home Rx* report (“Occupant Health Benefits of Residential Energy Efficiency,” November 2016, available at <http://bit.ly/2gCVxDF>). “Several studies asked occupants to rate their general health scale both before





**Figure 4.** Orness Plaza, a public housing complex in Mankato, Minnesota, was renovated to meet Enterprise Green Communities criteria and LEED® Silver certification. HVAC improvements included range hoods that vent outdoors. Photo courtesy Blumenthals/Architecture.

and after energy efficiency upgrades. Interestingly, we see big improvements to the self-reported health score after the upgrade,” Tohn says. While self-reporting on health may seem unreliable, it is actually an accurate predictor indicating less chronic diseases and reduced health-care use. Not only are improvements to overall physical health reported by residents, particularly in low-income homes, there was a 48% reduction in self-reported poor mental health days after weatherization.” (Tonn B, Rose W, Hawkins B, Conlon B. (2014) *Health and household-related benefits attributable to the weatherization assistance program*. Oak Ridge National Laboratory. Env Sciences Division. ORNL/TM-2014/345.)

### All levels of efficiency upgrades produced some health benefits.

In field studies evaluating base energy efficiency work, such as work done under DOE’s Weatherization Assistance Program, improved general health, reductions in some asthma symptoms, fewer cases of hypertension and upper respiratory risks, and some improvements in indoor air quality contaminants were reported. Meanwhile, enhanced energy efficiency upgrades, similar to those required by Home Performance

with ENERGY STAR, were shown to reduce indoor air contaminants linked to chronic illnesses, to control environmental contaminants like dust mites, mold, and moisture that can trigger respiratory symptoms, and to improve symptoms of asthma and other respiratory health conditions. Data collected from green renovations and green new construction projects also demonstrated a reduction in indoor air pollutants, leading to improvements in asthma symptoms, blood pressure, and fatigue.

“When we move from doing energy efficiency to a more comprehensive green renovation, we tend to get more health improvements because green involves more work,” notes Tohn. “While efficiency upgrades will tune equipment and provide weatherization, a green renovation is doing source control by removing old carpets harboring allergens and pest contaminants, fixing chronic moisture problems, and attacking pest infestations, and enhancing

ventilation. What we can’t remove, we ventilate to reduce. So it makes sense that in larger green renovations we see some even more powerful results.”

Additionally, research evaluating stand-alone home services and upgrades showed improvement by reducing air contaminants. In-room HEPA (high-efficiency particulate air) air cleaners, replacement of gas stoves with electric stoves, and upgrades from older wood stoves to cleaner burning models helped reduce respiratory risks (see Figure 4).

“I was particularly struck by the benefits seen for respiratory health, especially from incorporating energy recovery ventilators (ERVs) and heat recovery ventilators (HRVs),” Wilson notes. “Overall, with improved ventilation there is evidence of improved IAQ and resident health. If we can ventilate strategically, so it’s done in a way where we’re not losing energy efficiency benefits yet we’re having better air changes and bringing in more fresh air, that’s a win-win.”

Article will continue in the May 2017 issue of *Energy Design Update*. Part 2 will examine how ventilation and indoor environmental quality are critical pieces of the healthy home puzzle and discuss conclusions about health and efficiency results.

## IN BRIEF

### From the Drawing Board: Architect highlights build experience with Passive House, Build SMART panels

“As energy consumption and building performance become of more concern to design professionals and the public at large, architects and contractors must address the evolving baseline criteria established by building codes and more stringent requirements for passive house and net zero buildings,” writes David Herron, AIA, principal at herron + partners. In an article for the December 2016 issue of *Technique* (full text available at <https://www.aia.org/articles/54241-how-to-build-a-passive-house-using-a-prefabr>) Herron offers an architect’s point of view on achieving passive house certification using a prefabricated panelized system.

The project, Mission Cliffs, in the Kansas City area, was done in partnership with general contractor Prairie Design Build, and used Build SMART (<https://www.buildsmartna.com>) prefabricated high-performance panel system.

On top of its modified conventional residential foundation, rated at R-15, the prefabricated panels for Mission Cliffs used two-by-four structural wood frame (Lamco finger-jointed engineered lumber), with 7/16-inch OSB sheathing as the air barrier layer, 5-1/2 inches of expanded polystyrene foam as the thermal layer, and another layer of 7/16 inch-Zip System OSB wall sheathing serving as the nail base and exterior water barrier. With additional insulation added, the wall’s total insulative value comes in at R-38.

“Perhaps the most important aspect of the Build SMART panels system is that the doors and windows come pre-installed and air-tightened,” Herron notes. For Mis-

sion Cliffs, each triple pane Klearwall PassiV Future Proof window, certified as a passive house-suitable component by the Passivhaus Institut, was installed in an opening prepped with Prosoco™ R-Guard FastFlash fluid-applied flashing. Prosoco R-Guard AirDam is used to the interior for a ready-tight seal. This system is designed to withstand the 155-mph wind-driven rain of a Category 5 hurricane, as well as to facilitate passing of the 0.6 ACH50 passive house air leakage blower door test, according to Herron. “Since window openings are the most difficult areas in terms of air and water tightness, the pre-installed window panels eliminate a lot of the headache of tracking and resolving leaks,” Herron states.

To seal each panel together and to the decking Prosoco R-Guard Joint and Seam Filler was applied at the inner OSB air barrier layer, to create a seal at the base, and carried vertically up the adjacent panel, creating a continuous seal along the OSB.

Herron and his team applied spray foam to the EPS to allow it to bond to the next panel and taped each panel joint using ZIP System™ Tape.

Prairie Design Build estimates that using Build SMART panels will shave about two months off the construction schedule, significantly reduce weather delay, and reduce project management and security costs. Passive House Institute US estimates a Home Energy Rating System® (HERS) Index rating from the low 40s to 20s, depending on the climate zone. “Therefore, according to the HERS Index, we are conservatively estimating a home that is 60% more energy efficient than a home constructed in 2006, and 90 percent more efficient than the typical resale home,” concludes Herron.

### Big Doors and Tiny Homes Team to Solve Small Spaces

The ability to bring the outdoors in, and for a building to reflect its surroundings, has risen as a priority for homeowners. Outdoor rooms not only enhance a structure’s footprint, they also provide ventilation, fresh air, and daylight, and connect occupants to nature.

Harnessing a home’s surroundings is doubly important when it comes to tiny homes. When high-profile client Deion Sanders partnered with Tiny House Nation to create his 600-square foot home, Tiny House Nation turned to LaCantina Doors (<http://www.lacantinadoors.com>) for a product that would span the entire front of the structure (see Figure 5).



**Figure 5.** Big doors, provided by LaCantina, transformed a small space for Deion Sanders’ Tiny House in Texas. Photo courtesy LaCantina Doors.

### Sidebar 1. Intelli-Balance™ 100 by Panasonic Eco Solutions North America

Intelli-Balance™ 100 is a customizable, high performance, high efficiency Energy Recovery Ventilator (ERV) designed to help meet ASHRAE 62.2 requirements. This unique and cost effective ERV was engineered total versatility and installation flexibility in any climate zone. Built-in controls minimize the time it takes to determine desired airflow, as well as verify and maintain performance.

#### Features:

- Designed for multi-family dwellings and new air tight homes built to meet energy efficiency standards.
- Engineered for use in any North American Climate Zone. Two (2) revolutionary DC motors with Smart Flow™ technology ensure optimum CFM output.
- Pick-A-Flow speed selector (50 to 100 CFM) provides customizable airflow to create balanced, positive, or negative pressure within the home.
- Exclusive built-in ASHRAE 62.2 timing function helps ensure code compliance.
- MERV 8 filter included; optional MERV 8 and MERV 13 replacements available.
- Connect to existing ductwork or use as a stand-alone, whole-house ventilation solution.
- Can be used to meet green building code requirements and helps minimize the impact to a HERS index.
- Patented exchange capillary core recovers heat and moisture.
- On-wall or ceiling mount capability.
- Four integrated dual 4" or 6" duct adapters (2 exhaust, 2 supply).
- Intelli-Balance 100 includes a built-in Pick-A-Flow™ speed selector that provides the unique ability to select a required supply (50-60-70-80-90-100 CFM) and exhaust airflow (50-60-70-80-90-100 CFM), with the turn of a dial.

Visit Panasonic online at <http://shop.panasonic.com/about-us-latest-news-press-releases/01202017-bestofaward.html>.

LaCantina's multi-panel door systems come in multi-slide and folding options, and are unique for their narrow frame and profile. "Products and systems with more glass allow for more natural light to save on energy costs," notes Benjamin Woo, Marketing Director at LaCantina. "With the ability to replace a wall with glass, not only do we have the benefit of natural light, but also fresh air for ventilation."

Not only can multi-panel door systems improve important indoor health metrics, like indoor air quality, as enhancements in manufacturing and technology have augmented door efficiency, these systems can occupy a greater area in the building envelope without compromising overall home performance. Thermally broken frames and advanced glazing packages allow for U-factors below 0.30.

"Our clad multi-panel systems can pass Title 24 with standard glass," says Woo.

LaCantina is no stranger to the tiny home movement, having partnered with multiple other projects, including Cocoon9 and He Shed/She Shed (<http://www.lacantinadoors.com/blog/entry/lacantina-teams-up-with-cocoon9-for-dwell-on-design-la> and <http://www.lacantinadoors.com/why-lacantina/video/he-shed-she-shed-baller-backyard-bars>).

### Best of IBS® Awards for 2017 Recognize Innovation

The National Association of Home Builders® (NAHB) named the winning products in its fifth annual Best of IBS Awards during the NAHB International Builders' Show® (IBS) in Orlando, Florida. The awards were presented during a ceremony on the final day of the show, January 12, 2017.

This year's Best of IBS Awards received over 400 entries. Decided by a panel of independent judges made up of attending reporters and building professionals, the awards were given in nine categories, plus an overall Best in Show award.

#### The winners were:

- Best in Show Winner: AquaBoy® Pro II by Aquarius Brands
- Best Kitchen Product: AquaBoy® Pro II by Aquarius Brands
- Best Bath Product: Marble Attache by Daltile



**Figure 6.** Intelli-Balance™ 100 by Panasonic Eco Solutions North America, winner for Best Energy Efficient Product, International Builders' Show® 2017. Photo from <http://shop.panasonic.com/about-us-latest-news-press-releases/01202017-bestofaward.html>.



## Sidebar 2. Greyder Water Systems

The Greyder HOME, Greyder Water System's next generation residential greywater system, recycles shower and bath water so that it can be reused for toilet flushing or for irrigation. The patent-pending Greyder HOME is the first of its kind: a cost effective energy efficient water savings solution that is easy to install, capable of meeting water quality standards of major markets, while requiring little maintenance, and having a small footprint in the home.

Additionally, the Greyder Home:

- Supplies all of the water required for a typical household's toilet flushing.
- Reduces indoor water consumption by 25-30%.
- Provides superior water quality – designed to meet NSF 350 standards.
- Capable of reducing hot water heating costs by 20-25% with drain water heat recovery.

In order to meet reliability and ease of use goals demanded by the residential market place, Greyder developed its proprietary filtration and treatment innovation, designed and tested within its patent-pending Greyder HOME product. The Greyder HOME will be launched first to production builders in markets with established professional maintenance and service providers. The Greyder HOME greywater system is a best fit when installed in newly built homes and major renovations as the system requires plumbing to be installed from bathrooms to the system.

Visit Greyder online at <http://greyder.com>.

- Best Home Technology Product: Biorev 360 by Biorev LLC
- Best Indoor Living Product: Brinks Home Security Array Deadbolt by Hampton Products International
- Best Outdoor Living Product: OUTDECO Decorative Panels by Outdeco USA LLC
- Best Window and Door Product: MultiGlide Door by Andersen Windows Inc.
- Most Innovative Building Product: Regal Aluminum Railing w/LED by Regal Ideas Inc.

In the category for Best Energy Efficient Product, 7 products were announced as finalists:

- Trilogy 45 Q Mode (QE) by ClimateMaster Inc
- Pro High-Flow Combo by Enviro Water Solutions LLC
- Geo Dream Heating Film by Geo Dream Heat Products Inc
- ODL Tubular Skylight by ODL Tubular Skylight
- Intelli-Balance™ 100 by Panasonic Eco Solutions North America
- Rhino Headers by Rhino Steel Corporation

- WaterWay Rainscreen & Ventilation Mats by Stuc-O-Flex Int'l Inc
- Intelli-Balance™ 100 by Panasonic Eco Solutions North America earned the top spot in the category for 2017 (see Sidebar 1 and Figure 6).

In the category for Best Green Building Product, 5 products were singled out as finalists:

- Bissell Commercial Push Power Sweeper by Bissell Big Green Commercial
- Centennial Wood Reclaimed Wood Planks by Centennial Woods
- ChargePoint Home by ChargePoint
- The Greyder HOME by Greyder Water Systems
- Combination Boiler by Noritz America Corporation



**Figure 7.** The Greyder HOME by Greyder Water Systems, winner for Best Green Building Product, International Builders' Show® 2017. Photo from <http://greyder.com>.

The Greyder HOME by Greyder Water Systems received the judges' nod for top spot in the category for 2017 (see Sidebar 2 and Figure 7).

"We've seen a wide range of innovative new products this year at IBS, but these award winners really do stand out," said Ann Garvey, NAHB's 2016 Conventions and Meetings Committee Chair and principal of A&J Construction & Consulting in Charlotte, Michigan. "I'm proud that Design & Construction Week is the event where our exhibitors bring their A game so our builders and remodelers can bring the latest and best products and services to their clients."

Awards were given to exhibitors with a product or line that shows the best combination of design, functionality and innovation, as well as its usefulness to consumers and/or home builders.

Press release courtesy NAHB and available at <https://www.nahb.org/en/news-and-publications/press-releases/2017/01/nahb-announces-best-of-ibs-product-winners-at-2017-international-builders-show.aspx>.

## Zola Windows Reveals New Triple Pane Aluminum System

Zola European Windows announced its new Thermo Alu75 system in January 2017, unveiling contemporary triple pane,



**Figure 8.** Zola European Windows announced its new Thermo Alu75 system in January 2017, unveiling contemporary triple pane, thermally broken aluminum windows and doors. Photo courtesy Zola European Windows.



**Figure 9.** The Thermo Alu75 creates a modern profile without compromising performance, offering R-11 and R-15 glass options. Photo courtesy Zola European Windows.

thermally broken aluminum windows and doors (<http://www.zolawindows.com/thermoalu75/>). (See Figure 8.) With R-11 glass standard and R-15 quad glass optional, Thermo Alu75 can also meet extremely large sizes. Supported by careful design and German precision hardware, the Thermo Alu75 offers expansive and versatile configurations, including Tilt & Turn windows (up to 5' x 9') and Lift & Slide units up to 11' high and 30' wide, creating a wide, seamless transition between inside and out. It integrates seamlessly with Zola's matching Thermo Alu Lift & Slide Doors and Breeze Panel™ folding wall systems, ideal for commercial or residential applications.

The Thermo Alu75 frame incorporates a three-chamber thermal break, creating a barrier in between inner and outer window framing members that will reduce thermal transmission and enhance insulating ability. The end result is supe-

rior interior comfort and energy savings. Combined with its multiple lock systems and triple air seals, the window exceeds ENERGY STAR® requirements by over 50%.

“Zola's Thermo Alu75 excels due to its flexibility in design and performance. It can be delivered with triple and quad glazing for the highest performance, and adapts to many architectural styles. Traditional designs enjoy the availability of divided lites, while modern designs make use of fully concealed hinge systems, a recessed install, and Thermo Alu75's ability to carry huge pieces of glazing to be architecturally striking,” says Florian Speier, vice president and head of product development for Zola Windows. (See Figure 9.)

Offering as an installation method the option to embed part of the frame in the wall, leaving only two inches of frame visible from the exterior for an operable window, and 1/8" for a fixed window, the Thermo Alu75 creates a modern profile without compromising performance. Each window and door is entirely custom manufactured and can be configured into a wide variety of combinations. A color palette of over 300 options, with an array of custom textures and effects, complements the design flexibility.

### **ORNL Announces New Technology to Hunt Down Air Leaks**

On December 7, 2016, researchers at Oak Ridge National Laboratory (ORNL) announced development of a novel, non-toxic fluorescent air leak detection system that can find cracks in walls and roofs in existing and new buildings. In laboratory experiments, ORNL's Diana Hun and Brenda Smith used an off-the-shelf humidifier to release a water-based solution of commercially available riboflavin (Vitamin B2) supplement against a plywood wall with cracks. When the room was pressurized, tiny vitamin droplets were pulled to the leak points where they accumulated. The vitamins remained invisible unless revealed under ultraviolet light when they fluoresced. “Our system is ideal for occupied buildings, because the solution won't harm furniture, for instance, plus the vitamin particles are not visible or harmful to occupants,” Hun said. Repair of a leaky home could yield a \$450 per year energy savings with a 2.5-year payback. The ORNL-developed system could be used in other spaces such as storage containers.

For more on this advance, see [https://www.youtube.com/watch?v=6yOY7BTQ\\_YE](https://www.youtube.com/watch?v=6yOY7BTQ_YE).

### **2016 Closed with High Builder Confidence, Mixed Economic Predictions for Housing**

On December 15, 2016 the National Association of Home Builders® (NAHB) reported that builder confidence in the market for newly-built single-family homes jumped seven points to a level of 70 on the National Association of Home



Builders/Wells Fargo Housing Market Index (HMI). This is the highest reading since July 2005.

“This notable rise in builder sentiment is largely attributable to a post-election bounce, as builders are hopeful that President-elect Trump will follow through on his pledge to cut burdensome regulations that are harming small businesses and housing affordability,” said NAHB Chairman Ed Brady, a home builder and developer from Bloomington, Illinois. “This is particularly important, given that a recent NAHB study shows that regulatory costs for home building have increased 29% in the past 5 years.”

“Though this significant increase in builder confidence could be considered an outlier, the fact remains that the economic fundamentals continue to look good for housing,” said NAHB Chief Economist Robert Dietz. “The rise in the HMI is consistent with recent gains for the stock market and consumer confidence. At the same time, builders remain sensitive to rising mortgage rates and continue to deal with shortages of lots and labor.”

However, despite builder confidence and the rise in housing starts, *The Wall Street Journal* reports that economists question whether the construction uptick will be sustained over the longer term, citing the much smaller increase in permits, as well as an anticipated rise in mortgage rates that could dampen home buyer enthusiasm.

Permits have been growing at a milder pace than starts through 2016. Still, building permits issued for privately owned housing units rose 0.3% in October from the prior month to a seasonally adjusted annual rate of 1.229 million, the highest pace in nearly a year. Permits for single-family homes, about 60% of all permits, rose 2.7% to a rate of 762,000.

“Both single and multifamily starts now stand well above the pace implied by permits, and a correction over the next couple of months is inevitable,” Ian Shepherdson, chief economist at Pantheon Macroeconomics, told *The Wall Street Journal*.

Relatively stronger momentum for single-family home construction suggests that builders are responding to rising prices and steady demand for that segment.

Sales of existing homes, about 90% of the housing market, posted strong growth for 2016, reaching a post-recession peak in June 2016, according to the National Association of Realtors.

The US Census Bureau’s latest report on building permits and housing starts can be accessed at <http://www.census.gov/construction/nrc/pdf/newresconst.pdf>. For the full *The Wall Street Journal* article, please see <http://www.wsj.com/articles/us-housing-starts-rose-in-october-1479389564>.

## ASHRAE, ADI Offer New Duct Sizing Calculator

On December 20, 2016, a new duct sizing calculator from ASHRAE and the Air Distribution Institute (ADI) was unveiled. The calculator allows heating, ventilation, and air

conditioning (HVAC) air distribution system designers to more accurately size ducts, especially flex ducts under varying amounts of compression, based on research results.

The Duct Size Calculator is a quick reference tool for approximating duct sizes and equivalent sizes of sheet metal duct versus flexible duct. The calculator uses information from ASHRAE Research Project 1333, HVAC Duct Efficiency Measures, and was developed with funding support from ASHRAE and ADI. ASHRAE Technical Committee 5.2, Duct Design, sponsored the project.

“While the calculator resembles a wheel similar to those used during the days of slide rules, it incorporates three new fields for equivalent duct sizing,” said Chris Van Rite, developer of the calculator. “These new fields help demonstrate the significant loss of airflow due to improper installation of flexible ducts.”

The calculator includes fields for 4%, 15%, and 30% compression in flexible ducts. Van Rite notes that the calculations used to create these size references are based on straight line compression as performed in the laboratory on a flat surface. Field installed flexible ducts with bends, kinks, and excessive lengths will have additional resistance, which will result in diminished airflow.

“The use of this tool allows duct designers to account for less than optimum installation and gives a more accurate design to installed performance correlation,” Van Rite said.

ASHRAE research has quantified the effects of compression (not stretching) flexible duct, which increases the roughness and therefore the friction loss inside a flexible duct. Airflow testing follows protocols prescribed by ANSI/ASHRAE Standard 120-2008, *Method of Testing to Determine Flow Resistance of HVAC Ducts and Fittings*.

Testing at Lawrence Berkeley National Laboratory and at Texas A&M University, along with data analysis by Tennessee Technical University, has quantified the adverse effects of compression on airflow. Those correlations agreed closely with the equations published in Chapter 21 of the 2013 ASHRAE Handbook, Fundamentals, so the equations were used to create the new calculator, he said.

The Duct Size Calculator features inch-pound (I-P) units on one side and the International System of Units (SI) on the other.

The cost of the calculator is \$34, ASHRAE members (\$40, non-members). To order, visit [www.ashrae.org/bookstore](http://www.ashrae.org/bookstore) or contact ASHRAE Customer Contact Center at 1-800-527-4723 (United States and Canada) or 404-636-8400 (worldwide) or fax 678-539-2129.

Press release courtesy ASHRAE.

## Pono Home of Hawaii Offers Behind the Scenes Report on Energy Efficiency Efforts

In Hawaii, where energy costs can soar beyond three times those experienced in the continental US, efficiency measures offer

faster paybacks and should attract more takers. Yet the success of efficiency programs, even in Hawaii, remains mixed at best.

Pono Home Founder Scott Cooney decided to study what efficiency programs had had success in his market and offered his summary. (For access to Cooney's full report, visit <http://ponohome.com/case-studies/>).

"Over the first 2.5 years in business, we've learned several lessons in overcoming these obstacles," Cooney notes. "First: language. 'Low flow' devices will sell to about 5% of the market. 'High efficiency' devices will sell to substantially more. The old low flow devices used old hardware – shower head designs made to run on 2.5 gallons per minute. Sometimes a restrictor device was placed inside the pipe to reduce the flow of water to the shower head. In these cases, water pressure could only be described as wimpy, and only the hardest-core environmentalists could be expected to live with the sacrifice.

The second lesson we've learned over the years is that people will love efficiency products – so long as they get to see them in action first and have the power to make their own decision on them. People like technology and new products, especially when there are multiple benefits in it for them. So in the case of hardware installed inside the home, give people a 'test drive.' We offered to install LEDs, high-efficiency

showerheads, and other devices and turn them on to show the resident, with the caveat that if they didn't like them, we would replace them with the old device, no questions asked. This tactic was exceptionally successful.

The third lesson dovetails nicely with [Dr. Doug] McKenzie-Mohr's findings. Referrals turned out to be the only reliably effective way to market this program. Despite the significant savings potential and the fact that the program was 100% subsidized, getting our foot in the door was exceptionally difficult. One of the challenges, as we found out along the way, is that there have been scams of companies offering free audits of a home, only to 'case the joint,' as several of our potential customers referred to it. Once someone had upgraded their home and had a chance to see LEDs in action, it was common to see that person sending us to friends and family."

In his program, Cooney found that LEDs and high efficiency shower heads were among the highest rated and most successful energy efficiency upgrades. Customers often weren't aware that saving money also means saving energy. Direct install programs, though more expensive, are superior for quality control.

To read Cooney's article for Clean Technica, go to <https://cleantechnica.com/2016/12/01/residential-energy-efficiency-direct-install-programs-case-study/>.

## IN PRACTICE

### A Closer Look at Efficiency and Performance in TNAH® 2017

Each year during the International Builder's Show® (IBS), The New American Home® (TNAH) is unveiled. Presented by the National Association of Home Builders® (NAHB) Leading Suppliers Council and *Professional Builder* magazine, TNAH displays new products, innovative construction methods, energy efficiency, and the latest design trends.

For IBS 2017, the show home, "Palm Court," located in Lake Nona Golf & Country Club in Orlando, Florida, was designed and built by Phil Kean Design Group (PKDG) (<http://philkeandesigns.com>), of Winter Park, Florida (see Figure 10). For TNAH 2017's design, Phil Kean Design Group (PKDG) wanted to break the mold of modern architecture and produce a never-before-seen home plan. From this conception, the 8,753-square-foot, one-level contemporary home was realized as

a series of pods, three attached and three detached, connected by outdoor living spaces and breezeways.



**Figure 10.** "Palm Court," the 2017 New American Home®, presented by the National Association of Home Builders® (NAHB) Leading Suppliers Council and Professional Builder magazine. Photo from Phil Kean Design Group; available online at <http://philkeandesigns.com/portfolio/the-new-american-home-2017-custom-residence/>.

### Sidebar 3. The New American Home® 2017 Home Specifications

#### Thermal Shell

- Unvented and air sealed attic with average R-21 Icynene.
- WinDoor windows and patio doors with Low-E Solar-Ban 70XL coating and argon gas fill to limit solar heat gain air tightness.
- Openings and penetrations sealed to achieve 4.73 natural air changes under blower door testing at 50 Pa.
- Light colored exterior to assist in reflecting the sun.
- cfiFoam core filled CMU with Fi Foil and 3/4" unfaced extruded polystyrene foam board wall insulation system on exterior masonry walls (R16.2).
- Large overhangs to aid in protecting the home from the harsh Florida sun.
- ENERGY STAR® rated roof to aid in keeping the home cool.

#### HVAC

- Space conditioning provided by Trane XV20I Variable Speed 19 – 19.25 SEER.
- Variable speed compressors in outdoor heat pump units adds quiet efficiency.
- Mechanical ventilation provided by Honeywell DR90 Ventilating Dehumidification System (see Figure 11).
- Space conditioning system by Trane U.S. Inc. located entirely within conditioned space.

#### Hot Water

Propane-fueled Bosch tankless water heaters (EF = 0.95) provides the hot water.

#### Electrical

- 100% of all interior and exterior lamps, provided by Progress Lighting, are energy efficient LED lighting.
- 17.1 kW Solar Photovoltaic (PV) system.
- ENERGY STAR-rated appliances: including dishwasher, refrigerator, freezer, and clothes washers provided by SubZero.

In tandem with groundbreaking design, PKDG also wanted “Net Zero” status for TNAH 2017. Known for its specialty in sustainable architecture, PKDG’s 2012 New American Home was designated the “Greenest Home in the State of Florida, 2012.”

From the start, TNAH 2017 was designed to exceed the requirements for certification to the Emerald level of the National Green Building Standard™. The home also aimed for certification with ENERGY STAR® as well as the Indoor airPLUS program.

To achieve these goals, Two Trails, Inc. (<http://www.twotrails.com>), the third-party certifier on the project, worked closely with the Leading Suppliers Council to ensure energy efficiency and innovation targets were hit. Before adding solar photovoltaic (PV) capacity, the home’s Home Energy Rating System® (HERS) Index was 54, which is 46% more efficient than an



**Figure 11.** Honeywell’s TrueDRY™ DR90 Dehumidification System was used for The New American Home® 2017. Image from <http://yourhome.honeywell.com/en/products/dehumidifier/truedry-dr90-dehumidification-system>.

average new home. With 17.1 kW of PV added, TNAH 2016 earned a confirmed HERS Index of 0, and is expected to consume 122% less energy than if it were built to 2009 IECC code requirements. The home is designed to provide over \$5,497 in annual energy savings to the homeowner.

To meet these energy goals, the TNAH team needed to create a perfect balance between the radical design plan (see Figure 12) and highly efficient systems and materials (for further home specifications, see Sidebar 3).

“From our perspective, the way the home was podded allowed us to really do fun things with our heating, ventilation, and air conditioning (HVAC) design,” explains Drew Smith, Principal and Chief Operating Officer of Two Trails, Inc. “We were able to zone in a way that pods could be shut off, only running in dehumidification or maintenance mode when not occupied. The 3 front



guest suites, 2 rear rooms, and casita could be shut off separately, and the house could be taken down to public spaces. This allowed for very conservative energy usage on those particular spots.”

Dampers were installed to control flow to different portions of the house.

“Trane was great with the products they gave us, including the energy recovery ventilator (ERV) and essential dehumidification units,” Smith notes. “The entire house is breathing 24/7 as needed, with humidity maintained at 50% or below. This also allows the AC to run less if we keep the humidity down.” A MERV 13 system filters out pollens and dust.

A lot of things went into TNAH 2017’s energy design to maximize the home’s efficiency while holding it to its net zero goals. “Because of trying to hit zero energy, though insulation is not as big a deal in Florida as most other US climate zones, we used 3 different wall insulations to be able to optimize insulation values without decreasing any living area,” says Smith. PKDG didn’t want to add thickness to walls that would infringe on the size of interior spaces, so the team settled on injected foam in cells of block walls, using  $\frac{3}{4}$ ” Greenguard XPS board on the inside of block walls, with furring strips from foam to

block and Fi Foil shield product between strips. Wall insulation values topped out at R-16.2; most builders in Florida are happy with R-4. “Bringing walls to R-16 was important for the energy side, plus it makes for a very tight envelope, and that very tight house a lot has to do with the foam on block walls, filling every cavity and void,” Smith concludes. Exaggerated overhangs and extremely efficient glass with very good solar heat gain coefficients (SHGC) supported the envelope’s performance.

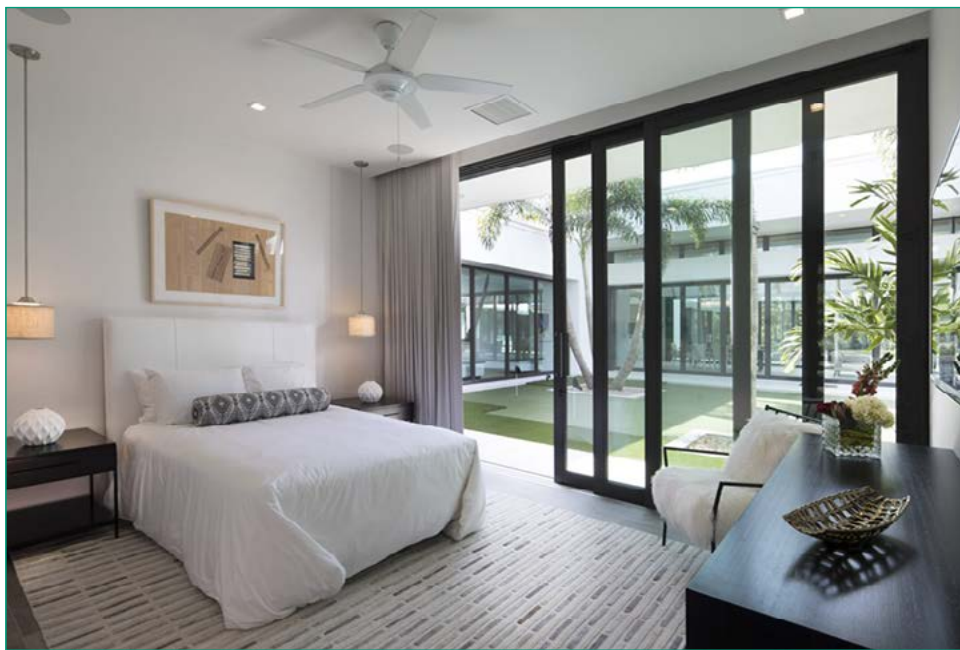
A lot of takeaways from TNAH 2017 are design related. PKDG demonstrated the flexibility of LED lighting, using solely LED bulbs across a variety of fixtures and color palettes. “Anymore you can really achieve any color; you can get the same warm lighting as you’re used to with incandescent bulbs,” Smith says.

To preserve indoor air quality, TNAH 2017 uses solid surfaces only and no wall-to-wall carpet. The home also features a central vacuum system. “I’m a big proponent of central vacuums to minimize dust and the system at TNAH takes it to a whole no level, with houses and fixed fittings built into each living area, eliminating the need to haul hoses between spaces,” says Smith.

Given the unique integration of indoor and outdoor living spaces at TNAH 2017, sustainable landscape design was moved to the forefront. Tropical plants that brought in color while having minimal water demands enhanced the design of the home. “When we talk drought tolerant, everyone’s perception is there will be no color except green, but that’s clearly not true,” Smith emphasizes.

The design showcased through TNAH 2017 will be used by PKDG in future homes. “There’s lots you can do with this house and plan when re-built,” Smith concludes. “The pods allow for exceptional flexibility and this house would function very well under several different HVAC schemes, including a mini-split or individual pod units that could really change the AC design and allows us to push the envelope further.”

To learn more about TNAH 2017, visit [http://www.tnah.com/showpage\\_details.aspx?showpageID=32195](http://www.tnah.com/showpage_details.aspx?showpageID=32195).



**Figure 12.** The layout for the 2017 New American Home® was styled as “Pod Living,” where unused rooms could be closed off when not in use. This posed some challenges but also offered unique opportunities for energy efficiency. Photo from Phil Kean Design Group; for further images of the home online go to <http://philkeandesigns.com/portfolio/the-new-american-home-2017-custom-residence/>.

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