Energy Design Update

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IN DEPTH

Clearing the Hurdles: Award-Winning Cottle Home Goes on a Multi-Year Journey to Zero Net Energy (Part Two)

"One of the insights we came away from the Cottle Zero Net Energy Home with is that, with the right understanding and design approach, accomplishing a true high performance shell is becoming pretty easy. However, mechanical systems remain challenging," says Allen Gilliland, Certified Passive House Designer and Certified Green Building Professional, One Sky Homes. "Mechanical systems have never been well designed in residential structures; really no attention has been paid to them. Now with super insulated buildings and high performance shells, when you add ventilation to the mix, you're dealing with new mechanical design challenges: very low space conditioning loads that require new systems approaches and differential room loads that still require adequate heating/cooling distribution to achieve comfort levels people are going to expect. In systems, everything has changed, and with a high performance building, occupant comfort expectations are elevated as well, as they should be."

These lessons were brought into sharp focus as planning for Cottle, the Grand Award Winner in the Custom Builders category at the September 23, 2014, Department Of Energy (DOE) Housing Innovation Awards, went forward (see Figure 1). Not only did One Sky have a cutting edge mechanical system to design, required ventilation complicated the

Figure 1. The Cottle Zero Net Energy Home, by One Sky Homes, in San Jose, California, has earned a US Department of Energy (DOE) Zero Energy Ready Home Program certification; ENERGY STAR® Certified Homes Version 3.0 certification; EPA Indoor airPLUS certification; Passive House Institute U.S. Standard (PHIUS+) certification; US Green Building Council (USGBC)® LEED for Homes, Platinum Certification; and, was the Grand Award Winner in the Custom Builders category at the September 23, 2014 DOE Housing Innovation Awards. Photo courtesy One Sky Homes.

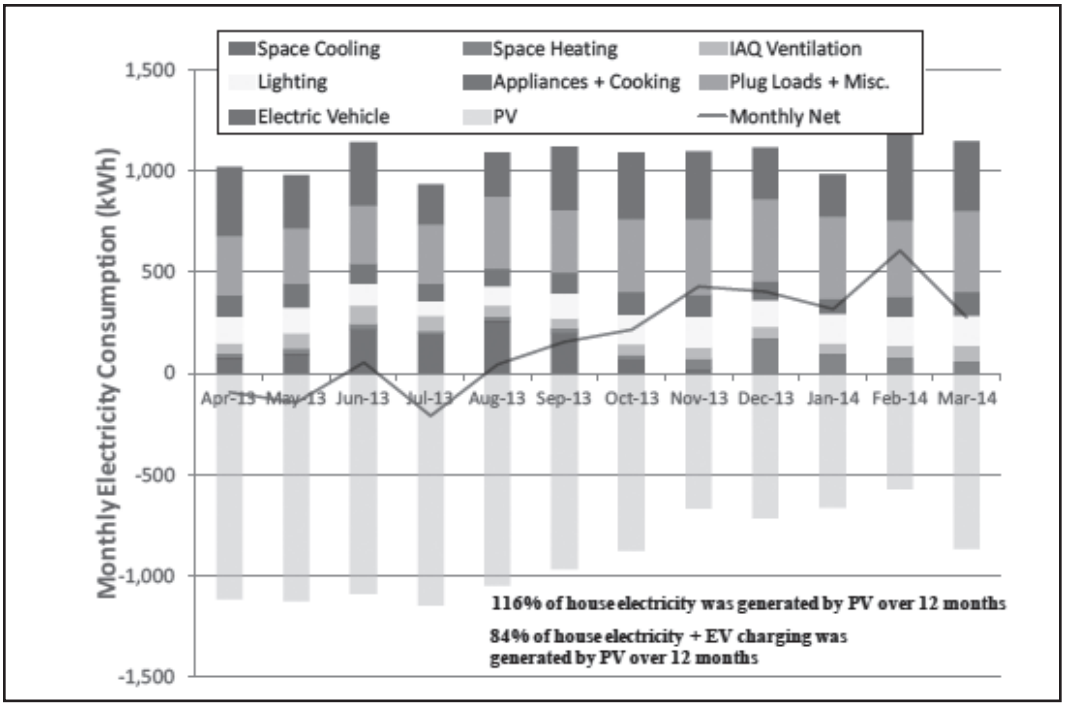

Figure 2. Monthly electricity consumption by end use and PV electricity generation (monthly net electricity shown as black line). Graphic courtesy Davis Energy Group, from *Cottle Zero Net Energy Home Monitoring Performance Evaluation Report*, 12 Months Occupancy, July 28, 2014.

mechanical system plans. Ventilation was critical, given the tightness of the home, while achieving the right levels of air exchange and adequate internal distribution became the design challenge.

"One of the things in passive house, as with many new things, is lots of 'irrational exuberance,' with ideas like the home will heat and cool itself. Hah! Or that, as a consequence of our super-tight home, we can put a simple heat pump on the downstairs wall of a typical 2-story 2,000 square foot American home and the occupants will be comfortable," explains Gilliland. "It's NOT that simple." The physics of heat flow and distribution remain the same, even though loads are low. The mechanical system still has to get heat where the load is. Gilliland feels that early thinking about super insulated buildings, which held as a mantra, 'Who cares what you do with the home, it's so well insulated,' has proved to be inaccurate. "You can't just say 'Let's put a heat pump on the center wall and we'll all be comfortable.' You need as much, if not more, mechanical design in these buildings, because in super insulated buildings you have an envelope and shell that is far more sensitive to changes in thermal energy flow," Gilliland states. A high performance home is more sensitive to internal gains and solar gains. As a consequence, if builders neglect thinking about loads, particularly cooling loads, high performance homes are very prone to overheating, or at a minimum, experiencing discomforting temperature variation between sections of the building. Aggregate loads on a passive house are often 1/10th to 1/5th those of a "normal" home, but still can cause occupant comfort issues. For example, the northeast corner of a home with lots of glazing, versus a southwestern room with lots of glazing, will experience very different space conditioning loads from solar gains and transmission losses. "These issue are complicated by higher occupant expectations," Gilliland adds. "If you don't understand room loads, it also becomes more challenging because equipment options at our disposal are different and fewer."

Energy Design Update

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Compounding this challenge, mechanical ventilation systems are new and expensive. While great at getting air in, the biggest challenge lies in doing it well for a modest cost. Gilliland elaborates on the evolution in mechanicals within One Sky's research and development. "What's happened by lowering loads in these homes is that, all of a sudden, heat pumps become great space conditioning systems because they heat and cool and are really high performance." With new technology offering wider climate zone application for heat pumps and with the advancement of full-split systems with incorporated DC inverter technology, borrowed from mini-splits, Gilliland sees a growing market for heat pump technology. Gilliland also hopes for further integration in mechanicals. "What if we could add continuous mechanical ventilation and night ventilation (an economizer function) to a heat pump, and have an integrated system? The idea is to have a smart damper operating between recirculation and fresh air modes, similar to a car's conditioning system. With the new generation of heat pumps, all of the controllers are smart. If we put together an integrated space conditioning and ventilation system that includes night ventilation cooling – an economizer function – then bingo! We've taken 3 separate systems, integrated them into 1, and simplified and reduced cost. In the mechanical world these are things converging."

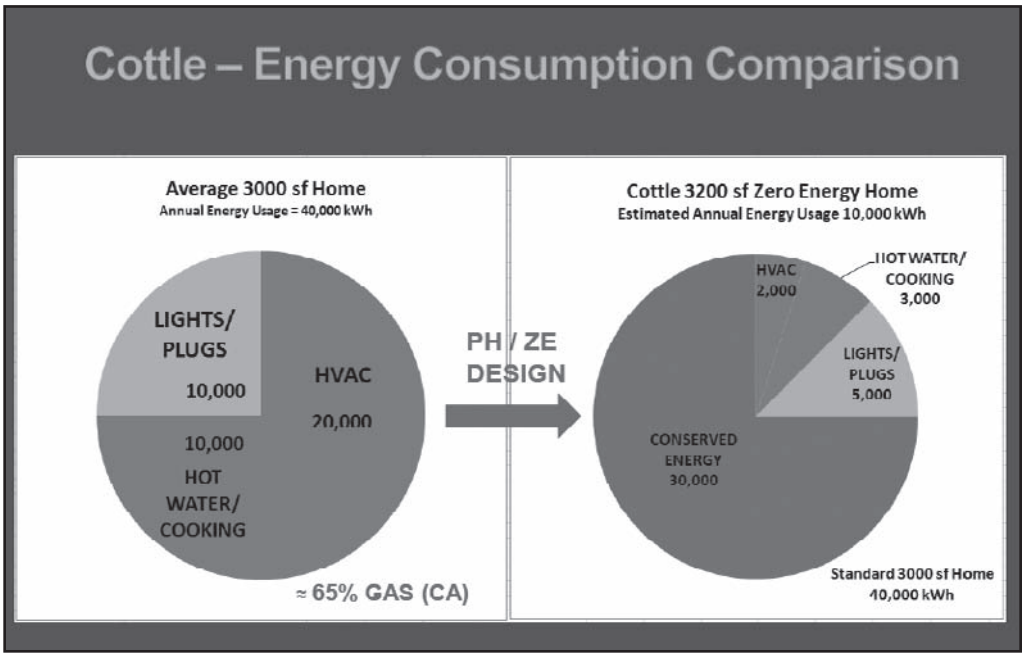

Figure 3. Energy consumption comparison. Figure courtesy Allen Gilliland and Davis Energy Group, from "Cottle Zero Energy Home" presentation.

After Research and Development Comes Data

Upon completion in 2012, One Sky put Cottle to the test, evaluating how successful their experiment had been. A typical 3,000 square foot home would use about 40,000 kWh of electricity (or natural gas equivalent) annually, with half of that consumed by heating and cooling. The One Sky Zero Energy Home uses only 9,000 to 10,000 kWh of energy a year, with only 2,000 kWh of that total used for heating and cooling (see Figure 2).

"The temperature and air quality, and thermal comfort, is unmatched," notes Gilliland, who lived in the house during the 2012 test period. "It just doesn't change. You set the thermostat where you're comfortable and the house is always where you want it, with no hot or cold spots, even in front of windows. It's consistent. The acoustic ambiance is amazingly quiet. You filter out all of the exterior noise due to highly insulated wall cavities and windows. Overall, it's a peaceful home with amazing comfort levels, while energy consumption is really low."

A report compiled by the Davis Energy Group (DEG) for the Pacific Gas and Electric Company's® Zero Net Energy Program evaluated distribution of all electricity consumption by end-use over the 2012 monitoring period. Similar to what was observed in the previous interim monitoring report, heating and cooling represented less than 1/4 of total electricity use. Forty-one percent of electricity is attributed to miscellaneous electrical loads, including plug loads and other uses not accounted for in the other major end-uses (see Figure 3). During the occupied period, a substantial portion of "Other" use was due to electrical vehicle charging, for the Nissan Leaf, sold as a component of the house (see Figure 4).

Figure 4. An electric vehicle, the Nissan Leaf, was included with the home. The garage was built with a charging station, as well as being pre-wired for an optional second charging station. Photo courtesy One Sky Homes.

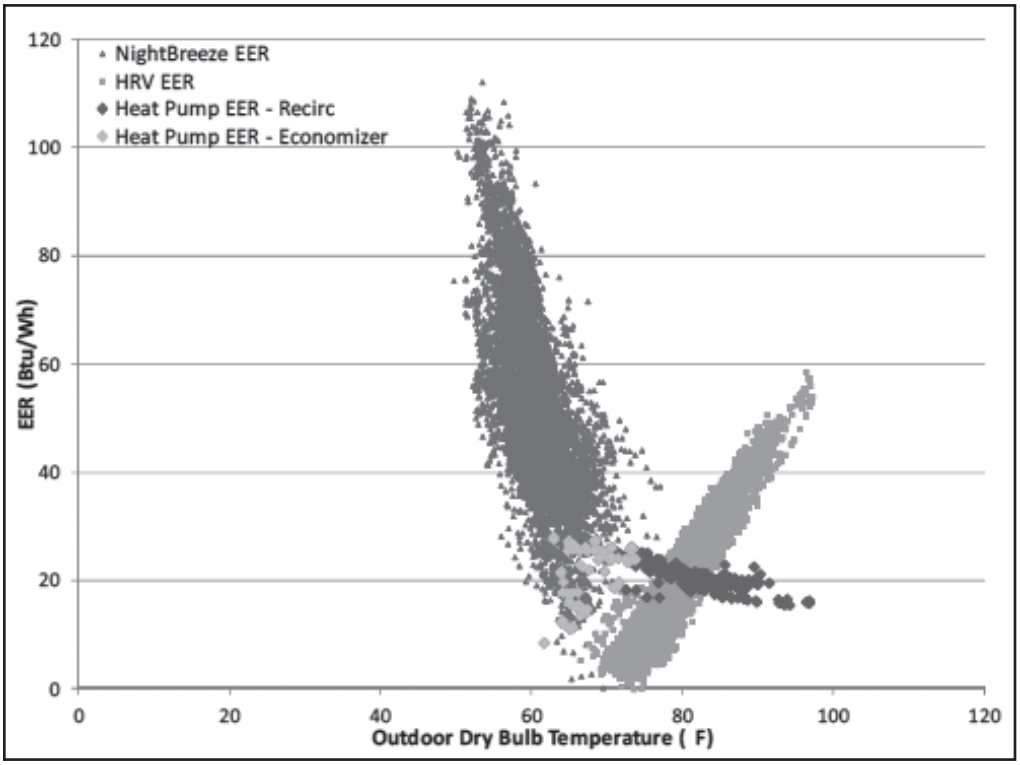

Figure 5. Cooling EER comparison calculated at 15 minutes timestep for full load operation. The graph compares full load cooling performance EER versus outdoor air temperature for heat pump, NB ventilation cooling system, and the HRV. EER is calculated at 15 minute intervals. For the heat pump full load is calculated as any 15 minute period during which the heat pump is operation for at least 90% of the time. For the NB system EER is calculated as the ratio of delivered cooling energy and fan power. For the HRV, EER is calculated as the ratio of sensible cooling load reduction by tempering outdoor air (based on the difference between supply air temperature and outdoor air temperature) and the average power of the HRV less the power of a standard exhaust fan used for mechanical ventilation (0.3W/cfm). Graph shows EERs at 15 minute time-step interval. Graphic courtesy Davis Energy Group.

DEG specifically charted cooling system efficiencies to evaluate night ventilation performance. On average, the night cooling ventilation system operated at 714 cfm, eliminating 100 kBtu daily from the house. The night ventilation cooling system's performance was extensively measured and showed dramatic results. It completely eliminated overheating and met 98% of the home's total cooling demand, with a measured coefficient of performance (COP) of 14. DEG compared full load cooling performance Energy Efficiency Ratio (EER) versus outdoor air temperature for heat pump, night ventilation cooling system, and the heat recovery ventilator (HRV). EER was calculated at 15-minute intervals. For the heat pump full load was calculated as any 15-minute period during which the heat pump was in operation for at least 90% of the time. For the night ventilation system, EER was calculated as the ratio of delivered cooling energy and fan power (see Figure 5). For the HRV, EER was calculated as the ratio of sensible cooling load reduction by tempering outdoor air (based on the difference between supply air temperature and outdoor air temperature) and the average power of the HRV less the power of a standard exhaust fan used for mechanical ventilation (0.3W/cfm). Over the monitoring period the average night ventilation cooling system EER was 53 (see Figure 6). Average system EER for the heat pump and the HRV was 21 and 19, respectively. Over the entire monitoring period in 2012, photovoltaic (PV) production exceeded total house electricity consumption by 100%. During the occupied periods production was still 50% greater than total electricity use.

Pacific Gas and Electric Company continued funding research at the Cottle house in 2013. During this time, the home had been purchased and was occupied by a family of 5. The 6.4-kW PV system (28 x 230-W panels) used at Cottle produced 11,000 kWh/year in 2013 to meet 113% of domestic demand; the extra power was used for charging the homeowners' electric car (see Figure 7). One electric car charging station is installed in the garage and wiring is in place to install a second one. The solar PV system is grid-tied, but could be upgraded with an inverter that will support independent operation in case of grid failure. Without the PV system, the energy efficiency upgrades would save a homeowner a calculated $1,095, compared to a home built to the 2009 IECC. With the PV system, homeowners are expected to save about $2,900 a year when compared to owners of a code-built home.

To help moderate loads, all of the home's appliances, including the clothes washer, dishwasher, and refrigerator, are ENERGY STAR® rated. The home's lighting includes 40%

	Average EER	Average TAO	N[1]
NightBreeze	53.3	60.4	6285
Heat Pump	20.6	78.7	251
HRV	19.2	78.8	4238

[1]N=Sample size as 15 minute intervals

Figure 6. Graphic shows average daily EER for the three systems versus daily maximum outdoor air temperature. Over the monitoring period the average NB EER was 53. Average system EER for the heat pump and the HRV was a rounded figure of 21 and 19, respectively. Graphic courtesy Davis Energy Group, from *Cottle Residential Monitoring Draft Performance Evaluation Report*, December 21, 2012.

Figure 7. Installation shot of Cottle's solar photovoltaic (PV) panels. Photo courtesy One Sky Homes.

CFL, 40% LED, and 20% halogen kitchen task and accent lights. Vacancy sensor controls were installed in all rooms. Closet lights, heat lamps, and other utility lighting were installed with count-down timer controls. All exterior lighting is ENERGY STAR rated and is on timers with photocell shut offs.

According to the Pacific Gas report, the project achieved zero net energy over the 12-month monitoring period (April 1, 2013 – March 31, 2014) by various metrics, including the following:

- TDV Energy (gas + electricity less electric vehicle charging): On an annual basis, the house produced 12 kBtu/ft2 (28%) more TDV energy than it consumed.
- Site Electricity (electricity only less electric vehicle charging): On an annual basis, the house produced 1,492 kWh (16%) more electricity than it consumed.
- Source Energy (gas + electricity less electric vehicle charging): On an annual basis, the house produced 8,994 kBtu (11%) more source energy than it consumed.

Including electric vehicle charging, the house produced 95% of total TDV energy, 84% of total site electricity, and 81% of total source energy needs over the 12-month monitoring period. Actual total house electricity use tracked very well with BEopt™ modeling estimates, within 1%; however, differences by end-use were very large in certain cases. Actual plugs and miscellaneous loads were 14% higher than forecasts, while actual lighting and appliance use were approximately 20% lower. This end-use includes use of an all-electric vehicle. Actual thermostat set points also differed from settings assumed in the energy model. Measured average cooling set points are 8°F lower than those assumed for California Title 24, which would result in higher actual cooling energy use compared to the model. Although heating thermostat set points are higher than 2008 Title 24 assumptions, actual heating energy use is much lower than estimates. DEG felt that heat recovery via the HRV may be one reason for this discrepancy

Over 12 months, including electric vehicle charging, this project was very close to achieving net zero TDV with 95% of total TDV consumption offset by PV generation. Removing electric vehicle charging, which represented more than a quarter of annual TDV energy use, the project achieves net zero TDV with 128% of TDV energy use offset by PV generation. Miscellaneous electric loads and electric vehicle charging combined represent over half of total TDV energy use at Cottle. Regulated loads such as space heating, space cooling, indoor air quality (IAQ) ventilation, and water heating only contribute 21% of the total.

Over 12 months, 81% of total source energy needs were offset from the 5.5 kW DC rated PV system. Removing electric vehicle charging usage brings this offset percentage up to 111%. Natural gas use is only 6% of total source energy use.

Monitored energy use was also compared to the Passive House program targets and model estimates made by the program software, the Passive House Planning Package (PHPP). Actual annual home primary energy use (less electric vehicle charging) was 15% lower than the threshold and 17% higher than original estimates.

Forget Technical, Marketing is the Real Challenge

While positioning strategically to be leaders in the field, marketing is often the hard, intangible part of mastering high performance building.

"We made Cottle look like a fine custom home, an executive home that fits into the neighborhood," recounts Gilliland. This involved a stone exterior, and in the kitchen, granite, a Wolf® range, and a Sub-Zero® Refrigerator (see Figure 8). "We had USGBC® Leadership in Energy and Environmental Design (LEED) posters and info-graphics outlining all of the home's performance features. In the end, the buyer came in and saw a gorgeous house and didn't pay attention to energy.

Figure 8. Despite excelling in energy conservation and on-site production, aesthetic features, such as the high-end kitchen appliances and pleasing design, ultimately drove the current homeowners to purchase the Cottle Zero Net Energy Home. Balancing appeal while selling performance remains a challenge for high performance homebuilding. Photo courtesy One Sky Homes.

This is a case that shows you what happens in the marketplace. People still want a home to look good." (Refer to Figure 9.)

"If we take these principles, like those developed from the DOE ZNE Ready program, Building Science Corporation, and Passive House, then the technical side of it is actually becoming easy to do," Gilliland cautions. "The marketplace for us is still a challenge, with respect to public understanding, let alone acceptance of zero energy or building performance as a concept. The public doesn't have a vocabulary; they feel like they were sold a bill of goods with energy performance and 'green' several years ago. It's really hard."

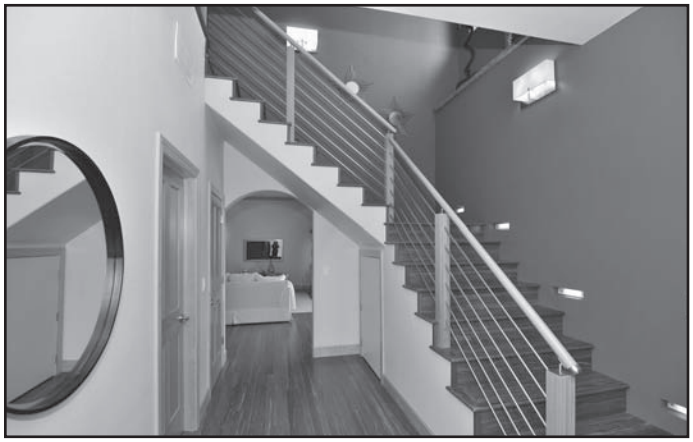

Figure 9. Interior details and finishes at Cottle Zero Net Energy Home. Photo courtesy One Sky Homes.

Lessons from Cottle

The main challenge for One Sky during Cottle's construction was the absence of design guidance. That has since changed. "A lot more in best practices have been published," notes Gilliland. "In practice, the most challenging thing was really air sealing. When you don't design for something, it doesn't get taken care of. Thermal bridging is the other aspect that gets ignored." For Gilliland, mastering a home's envelope is about taking care of the big 3: air control, water control, and thermal control. "We need to address all of these, while making it simple to build. To succeed, you really need an architect with buy-in. Our company is a design-build company for that reason." Up front integrative design goes a long way to securing real home performance. As the construction process proceeds, having a team that understands the particular elements is just as important (refer to Figure 10).

Gilliland drove his point home. "Let's look at over-framing a roof. Ninety-nine out of 100 architects would say, 'Why would I do that?' Simply because they haven't had to deal with air sealing or minimizing thermal bridging in the field, the language of energy conservation is hard to get. Non-thermally broken projecting structural members and cantilevered decks all exist because architects don't have thermal bridging on their radar." With an approach that takes into account hurdles to building performance, One Sky has found it actually simplifies construction.

"2'x4' outrigger or ladder framing is easily created on top of a roof. Exterior insulation is then added. It's simple and cost effective. 2'x6' advanced framing is trivial, it doesn't add cost, it is simple and helps insulate. Easy. Use your sheathing, build a continuous box. Dramatically simplify. Those are functions of design, and are mastered up front. But the right design sequence is not going to happen unless you care."

"The big thing is understanding these things at the very beginning and designing that way," emphasizes Gilliland. "You can't come in at the end and say, now we want to air seal; that will be a disaster. Building performance criteria and best practices need to be part of the original design. That's how this ratchet in performance is going to happen. Your incremental capital cost becomes very low by doing that."

Gilliland acknowledges that homebuilders concerned with home performance and energy efficiency are fighting the momentum of how things have always been done. "It's a conservative industry because builders assume a great deal of risk: if we build something we're responsible for it," stresses Gilliland. "A builder looks at a new assembly, or a new product, and is justifiably hesitant to try it. You're not going to try something totally new because you assume the risk and are legally responsible for the result."

When Cottle first took shape 7 years ago, there was an almost total absence of guidelines on high performance building. Gilliland is encouraged by the boom in research, tools, and guides to help homebuilders. With a continued emphasis on integration and synergy between vendors, architects, the contractor, and systems, he is also optimistic about home perfor-

Figure 10. For homeowners, the foundation system extends the "main floor feeling" to notoriously cold, moldy northern basements. Epitome has a model home, located at 7319 Hwy 51 South, Minocqua, Wisconsin, open since 2010. Photo courtesy Composite Panel Systems, LLC, Fiber-Tech Industries, Inc., and Ashland Performance Materials.

mance making the next leap forward. Gilliland looks forward to further evolution and integration in mechanical systems and products. "Better process, better buildings," he concludes.

Energy Design Update thanks Gilliland and Davis Energy Group for sharing the story behind Cottle and for making in-depth data available to us. Allen Gilliland is a licensed California contractor, a Certified Green Building Professional, a Certified Passive House Designer and US Department of Energy Building America Partner. He regularly participates in regional, national, and international Passive House conferences and speaks to local building professional and student groups about high-performance building. He leads One Sky Homes' Design-Build team, which focuses exclusively on Net Zero Energy and Passive House projects in Silicon Valley. Visit One Sky online at *http://oneskyhomes.com/welcome/*. To view the Cottle Zero Net Energy Home profile, visit: *http://www1.eere.energy.gov/buildings/residential/pdfs/doe_ch_case_studies/2014hiawinner_onesky_092014.pdf*

IN DEVELOPMENT

So Long, Concrete: Epitome Foundation Walls Challenge the Standard

There is a new challenger on the horizon, offering competition to the domain of poured-concrete foundation walls, a staple in residential home building. Epitome quality foundation walls, by Composite Panel Systems, LLC, (CPS) burst onto the scene at the American Institute of Architects (AIA) Convention and Expo in June, 2014. Months later, Epitome gained further recognition at the CAMX 2014 awards, held in Orlando, Florida in October 2014. CAMX, hosted by the American Composites Manufacturers Association (ACMA), awarded its first-ever Unsurpassed Innovation Award to the Epitome product, honoring it as a "composites product that demonstrates a novel design incorporating low-cost materials for high-volume applications, or with high-performance applications with low-volume materials that delivers an innovative product with the potential to significantly impact existing markets or open new markets." Additionally, Epitome earned a second award, the Award for Composites Excellence (ACE), in the Infinite Possibility for Market Growth category.

Epitome quality foundation walls, invented by Glenn Schiffmann, of Eagle River, Wisconsin, use fiberglass, insulation, and resin to create manufactured foundation walls. CPS partners with panel-systems fabricator, Fiber-Tech Industries, Inc., and fire-retardant resin-systems supplier, Ashland Performance Materials, a commercial unit of Ashland Inc. (NYSE: ASH) (refer to Figure 11). "Think of them essentially as a foam-filled fiberglass sandwich panel, something used in a wide variety of industry applications today, such as aerospace, military, and boats. The innovation that Epitome came up with is the integrated stud cavity, which makes the product not only unique, but useful and builder friendly," noted Thom Johnson of Ashland Performance Materials.

Each highly insulated, fire-resistant panel incorporates nominally sized studs at 16" on center, a vapor barrier, top plate, and continuous insulation. The wall systems are designed with exceptional strength in mind, and can withstand 6 times the pressure of a sand backfill load and 6 times the most extreme house load. The panels have an inherent R-16.5 insulation value and create an airtight transition between the floor and foundation. Additional insulation up to R-30 can be accommodated. Epitome also passes the National Fire Protection Association's (NFPA) 286 room corner burn test and therefore panels do not require covering with a thermal barrier, such as drywall, prior to occupancy. The technology is currently approved for use in Wisconsin and announcement of its compliance, on a national level, with the International Building Code and 2012 International Residential Code, will be made in 2015.

Energy Design Update had the privilege of speaking with Schiffmann, Johnson, and Scott Weber, to learn more about Epitome.

What inspired the Epitome system?

GS: The genesis of the idea was fostered through years of experience in the building and construction in-

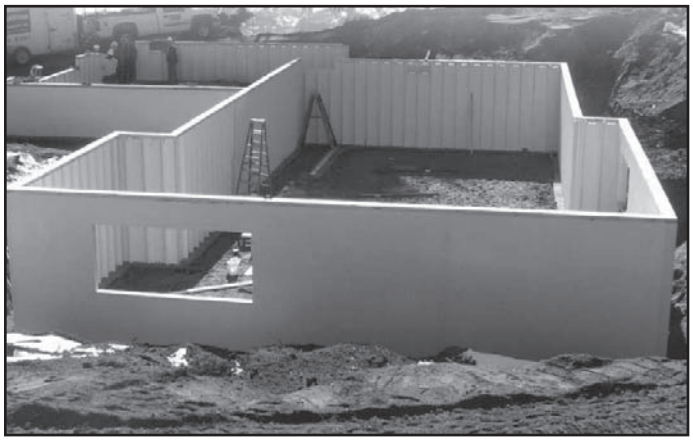

Figure 11. Epitome quality foundation walls, by Composite Panel Systems, LLC, utilize fi berglass and composite technology to create a higher performance, strong, and resilient foundation wall system. Each 24' Epitome Quality Foundation Wall section withstands greater than 500,000 pounds of downforce providing a max allowable load of 8900 PLF. Photo courtesy Composite Panel Systems, LLC, Fiber-Tech Industries, Inc., and Ashland Performance Materials.

dustry. I was a general contractor for 25 years, as well as a component manufacturer for over 25 years. I studied multiple foundations during that time, and in addition to those 2 things, tinkered in composites with my dad (Gary Schiffmann) for over 30 years. I wanted to know if there was a better way to build foundations than poured concrete foundation walls. In my efforts, I studied wood foundations closely, as well as block, poured, and open wall systems. While there are not a lot of technical problems with wood foundations, they are very difficult to sell to end users, general contractors, and homeowners. There are concerns about moisture, mold, termites, and putting wood underground. I built a few homes using insulating concrete forms (ICFs), but was not enamored with the kit process associated with it. While ICFs offer great insulating benefits, they have some drawbacks: structural deficits, as they lack the ability to take full loads of concrete, and potential cold joints, which can result during the process of pouring in and layering concrete. Additionally, they are expensive, and a builder must drywall the interior before they can gain a Certificate of Occupancy (CO). It is also difficult to protect polystyrene exposed on the exterior from environmental factors, whether that is UV degradation or a weed eater. Given the drawbacks, I moved away from ICFs and studied the Superior Walls® product (*http://www.superiorwalls.com/*). This precast, premanufactured concrete foundation system has some great benefits in speed, efficiency, and strength, but there are drawbacks here, too. The walls are very heavy, difficult to move around, and difficult to modify should you need too.

Weighing all these ideas, I attended the NAHB International Builders' Show® in Orlando, Florida. While standing between the Superior Walls and structural insulated panels (SIPs) booth, I asked myself why we couldn't incorporate composites and fiberglass, and bring those benefits into a foundation application. I drew up designs at my hotel room, and a week afterwards, my dad had built the first prototypes using polystyrene and epoxy products and varying fiberglass. We experimented for 6 to 7 months before we started to identify that the product was good, and if it was good for us, it would probably be good for others, too. The Epitome quality wall is designed to fit into existing residential applications, and only requires tools that people are familiar with and that carpenters have readily available. We wanted a product that would flow into the construction process naturally, without taking tradesmen too far away from what they know. This wasn't designed in a lab or outside of the industry; Epitome was designed by builders for builders with a comprehensive knowledge of what homeowners and builders desire.

Epitome is more innovation than invention – it makes use of products that are already in your home, and have a proven track record for a number of years. We simply combined them in a new way.

What are some of the benefits that Epitome brings to the table? Has the Epitome system been monitored in any homes? How is it performing?

GS: Data and feedback from homeowners is positive; they are taking a look at energy bills, the difference in usable space it affords them, and the environment it creates. One of the fundamental and inescapable truths of concrete is its associated inefficiencies. Because concrete has been the norm for many, many years hard questions were never really asked about it, with the exception of the ICF industry.

Our product has no concrete and the benefit to the homeowner is a warm, dry, comfortable living environment, as well as a more usable, healthy living space. Concrete is very good in many applications but since it is a porous material, it allows vapor transfer and requires extensive damp proofing systems. Concrete basement walls notoriously create a damp interior on the lower level which makes for an unfriendly space. This moisture also leads to mold growth. Composite panels greatly reduce all of those concerns: there is no food source for mold growth and the material is impermeable in relation to vapor transfusion. It greatly reduces the amount of moisture penetration from the exterior.

SW: The Epitome system also eliminates thermal bridging. Besides avoiding concrete, we have also eliminated wood and steel in the wall, thereby eliminating the greatest contributors to thermal bridging.

GS: One of the benefits of using a composite material is its ability to withstand extremely harsh environments and tremendous temperature variation. When you think about areas where composites excel, like the aeronautical industry or aerospace industry, think of the temperatures you're seeing and the speeds and pressures the material is exposed to. Epitome harnesses that same material. In construction applications, composites exhibit the ability to withstand extreme temperature changes with very favorable expansion and contraction factors. One of the biggest issues we deal with in construction is vapor transfer. In northern Wisconsin, we put vapor barriers on the interior of wall; in the south, it's on the exterior, but vapor transfer will continue to occur, as it moves from from warm to cold and from cold to warm. Composites are extremely water resistant, as witnessed by their use in the marine industry, meaning we have a product that now can separate the interior environment from the exterior. That's truly remarkable.

TJ: Composites are also stronger for lateral soil loads. We all know that concrete has excellent compression strength; it is a best fit in the industry for things like airport runways and

Figure 12. For homeowners, the foundation system extends the "main floor feeling" to notoriously cold, moldy northern basements. Epitome has a model home, located at 7319 Hwy 51 South, Minocqua, Wisconsin, open since 2010. Photo courtesy Composite Panel Systems, LLC, Fiber-Tech Industries, Inc., and Ashland Performance Materials.

roads. Yet concrete is fairly brittle and tends to crack when lateral loads are applied.

We've all seen homes that, within the first few years, have cracks in the floor and walls, depending on surrounding soil and loads. This creates a huge market for waterproofing and fixing leaks, but we accept it, because it's the nature of the beast. With Epitome, we have figured out structural performance without the drawbacks of concrete.

SW: The benefits I really see with Epitome are the healthier environment and additional living space. There is not a product out there where you can achieve R-30 in as little as 7". Epitome walls allow that luxury. You can easily get R-30 in 7"; to accomplish that with traditional materials, your walls can be as wide as 14" to 16". The slimmer space buys more square footage for a basement. With Epitome's resistance to vapor transfusion, this mitigates mold as well as being antimicrobial.

What should an interested builder know?

GS: There are several advantages to the builder when using Epitome – one of the primary benefits is speed. What may take 2 weeks to install a typical concrete foundation can be done with our foundation system in a few hours. Constructing your typical concrete wall involves setting forms, oiling the forms, placing the material, striping forms, cutting wall ties, waterproofing and insulating, stud framing, top plating, and all the various other tasks required. This easily takes 2 weeks, and involves coordination of the general contractor (GC) with all of the activities. With each task, you face potential workmanship issues. There are a lot of 'grief' factors for the GC. When our product goes in, it goes in within a few hours and incorporates structural stud framing, insulating, air sealing, double top plates, vapor barrier and waterproofing. What's more, it is immediately energy code compliant throughout the entire United States. Since Epitome foundation walls are manufactured offsite, material overages/shortages, product quality, and workmanship issues are governed by our stringent quality control program. Its manufacturing process is similar to that of plywood – we make the same thing over and over, so the process literally is a science. Other systems don't necessarily have that benefit. Other benefits to a GC are vast. Required tools are common. Any modifications or accommodations are done onsite and can easily be done with readily available tools.

Where can you purchase Epitome? What accreditations does it meet?

GS: Epitome has nationwide approval under the 2012 IECC. Our initial sales focus will be the Midwest, with a controlled roll-out focusing on northern regions first.

It's important to understand and to know that bringing a building product through standards right now is a pretty tall order. It's a hard road to become an accepted building product. The tests, expense, and scrutiny are substantial. If wood were a new building product being advanced for approval today, it would never be approved.

SW: There are 3 big areas a product has to meet or exceed: structure, fire, and water. The Epitome system is tremendously strong from a house load perspective, taking nearly 27,000 lbs per linear foot, and from a tension perspective, where it is 3 times strong as concrete, bearing 33,000 lbs per linear foot). Honestly, the soil beneath the footing becomes the limiting factor; the wall is not the limiting factor for strength. Epitome is rated as fire resistant and water resistant by means of surpassing the NFPA 286 fire test and water resistive ASTM E331. It also achieves the 2012 IECC requirements for insulating foundations in a cost effective way, and with the convenience of rapid assembly.

GS: We are very, very proud of the fact that we didn't just stick with meeting minimum standards in getting Epitome approved. We wanted to have a product that has the longevity needed, that is a safe product, and one that can be put into anybody's home. We went through a lengthy material selection process for the best raw materials and composites that would meet our need to build and produce a safe product for end users (see Figure 12).

Energy Design Update thanks Schiffmann, Johnson, and Weber for sharing the story behind Epitome with us, as well as allowing us a peak at the development of this product. To learn more, or for product inquiries, visit: *http://compositepanelsystems.com/products/*.

IN PRACTICE

New Home in Taos Brings Holistic Approach to Sustainability (Part 1)

Sidebar 1

Ulibarri Residence

Completion date:	Spring 2014	
Location:	Taos, New Mexico	
Certifications:	Passive House Certified / Passive House Academy Emerald – National Home Builders Association	
Areas:	3 bedroom / 2 bath 1,632 sq. ft. / Heated 1,238 sq. ft. / Garage & Portals 2,870 sq. ft. / Total Roofed	
Components:	Walls: Wood frame & EPS / R-58.5	*U- 0.097 W/(m²K)*
	Floor: Slab / R-35.7	*U-0.159 W/(m²K)*
	Roof: Wood Frame & EPS / R-96.2	*U- 0.059 W/(m²K)*
	Windows & Doors: Zola ThermoPlus Clad / R-8.1	
Systems:	Ventilation: Zehnder 350 ERV Heating: In-floor hydronic radiant w/ Elecro-Industries boiler Photovoltaic: 1.87 KW Enphase micoinverter Domestic Hot Water: Solar /Caleffi system / 80 gallons storage Energy Monitoring: E-Gauge	
Finishes:	Walls: Earth pigmented plaster Ceiling: Birch Plywood Casement: Custom bamboo plywood Floor: Stained Concrete	

"As you are designing a building from the durability and energy perspective, you start thinking of social sustainability as well," remarks Jonah Stanford, Principal at NEEDBASED, Inc., in Santa Fe, New Mexico. When approached by clients to design and consult on a net zero energy Passive House for a senior co-housing community, Stanford decided the time was right to address the next horizon in holistic living. The clients wanted the highest performance possible – a building that would conserve energy, be stable, and accommodate a wide variety of needs, allowing them to age in place.

The site selected for the project was Valverde Commons, an adult co-housing community 15 minutes' walk from Taos, New Mexico's historic plaza. The 28 home sites loosely ring a commonly held 4-acre meadow and border 10 acres of farmland, community gardens, and public-access open space protected by a conservation easement. The community's Common House, a co-housing standard, includes a kitchen and space for meals, classes and events. Walking paths meander between the homes serving to connect community buildings the private spaces.

The home for clients Ross and Kristin Ulibarri earned a Build Green NM Certification Program ANSI National Green Building Standard™ Emerald Level (see Sidebar 1 and Figure 13). With a Home Energy Rating System (HERS) score of 18 and building leakage measured at 0.32 ACH 50, the home is also a Quality Approved Passive House by the Passive House Academy (Passivhaus Institut). To qualify, the residence had to demonstrate:

- Excellent thermal insulation and optimized connection details with respect to building physics. High thermal comfort during the summer has been considered and the heating demand or heating load will be limited to 15 kWh per mÇ of living area and year or 10 W/mÇ.
- A highly airtight building envelope, which eliminates draughts and reduces the heating energy demand: The air change rate through the envelope at a 50 Pascal pressure difference, as verified in accordance with ISO 9972, is less than 0.6 air changes per hour with respect to the building's volume.
- A controlled ventilation system with high quality filters, highly efficient heat recovery, and low electricity consumption, ensuring excellent indoor air quality with low energy consumption.
- A total primary energy demand for heating, domestic hot water, ventilation and all other electric appliances during normal use of less than 120 kWh per mÇ of living area and year.

Prioritizing energy conservation techniques – passive strategies – over complex mechanical systems that require active operation and maintenance, was given precedence.

Figure 13. The Ulibarri Residence in Valverde Commons, near Taos' historic plaza. Photo courtesy Jonah Stanford and NEEDBASED, Inc.

Monitored since completion via eGauge, from March 2014 to December 2014, energy used equaled 2.75 MWh, or approximately $288.63 used; energy generated was 2.69 MWh, or $282.21 saved. The home's energy profile shows a net of 61.1 kWh bought, or a total spent for energy costs of $6.41.

Stanford's clients, the Ulibarris, were exceptionally familiar with sustainable building. For 37 years, the Ulibarris had lived in a passive adobe home they had built themselves from onsite mud plaster and timber. While the home exemplified traditional adobe construction, it was still subject to intensive temperature swings and required heavy maintenance. "Realizing their new home was really fun for them," notes Stanford. "So many of the aspects of Passive House, like the consistency and stability of interior air temperatures and indoor air quality, were new. Because of our building strategies, we weren't limited to glazing on 1 side of the building. These aspects were really appreciated by the clients because they had gone through the process of a 'traditional' environmental home."

"Our house was built with our spirit of activism," notes Ross Ulibarri. "We not only wanted a nice home, but we were also interested in furthering sustainable housing by building a cutting-edge home. We plan to use our house as an educational tool as much possible."

Notes from the Field

NEEDBASED, Inc., provides integrated design services that prioritize environmental, social, and economic sustainability. Principal Jonah Stanford is a Certified Passive House Consultant and AIA Associate Member. He designed New Mexico's first Certified Passive House, has been board president of Passive House Institute US, and helped found Passive House NM. He presents widely on

Figure 14. Jonah Stanford used ZIP System® panels to ensure airtightness in the home's roof and shell. Photo courtesy Jonah Stanford and NEEDBASED, Inc.

Passive House design, zero-energy buildings, and resilient affordable housing. ***Energy Design Update*** had the pleasure of speaking with Stanford to recap the project and summarize lessons learned.

1. Keep it simple!

For the Ulibarri project, Stanford used ZIP System® panels (*http://www.huberwood.com/zipsystem/home-zip-system*) (see Figure 14), integrating airtightness naturally into the building's roof and shell. The slab's airtightness comes from application of a reinforced poly material more puncture resistant than a typical poly.

"When you view construction photos of the roof and walls, you see how simplified the layers are," notes Stanford. "That makes performance easily achievable. Yet the question then becomes how to introduce architectural interest to simple forms? I found that you can be pretty creative about how things attach and fit. If you notice on the steel structures at the Ulibarri's, they are all independent structures from the home's envelope, meaning no risk of thermal bridging (see Figure 15). You

Figure 15. Interesting aesthetic details draw the eye, but don't drag down the building's performance. "If you notice on the steel structures at the Ulibarri's, they are all independent structures from the home's envelope, meaning no risk of thermal bridging," notes Stanford. Photo courtesy Jonah Stanford and NEEDBASED, Inc.

can still create interesting aesthetic features, like portals, and keep them independent from the thermal envelope."

2. Use shading.

"Our New Mexico environment is prone to overheating. It is so easy for us to introduce a solar gain and mitigate our heating load, but it is something else entirely to design a home that doesn't need any cooling. We have no cooling system in the Ulibarri's residence," says Stanford. "Typically, what I've seen is that when I get a heating load down to this level then I start creating a cooling load. This project is probably the first one, from learning and experience, where I was able to design completely static shading to protect the building. This has important long term building performance impacts if you contemplate the possibility of your clients having physical disabilities in the future."

In February's issue of ***Energy Design Update***, we'll take up the list of lessons again, as Stanford shares his insights and experience with regard to mechanical systems, home performance data, and the importance of adaptable design in sustainable building. Please refer to Figure 16 to view plans for the Ulibarri's residence.

Energy Design Update wishes to thank Jonah Stanford, Principal at NEEDBASED, Inc., in Santa Fe, New Mexico, for sharing this project with us. Visit NEEDBASED, Inc. online at *http://www.needbased.com/*.

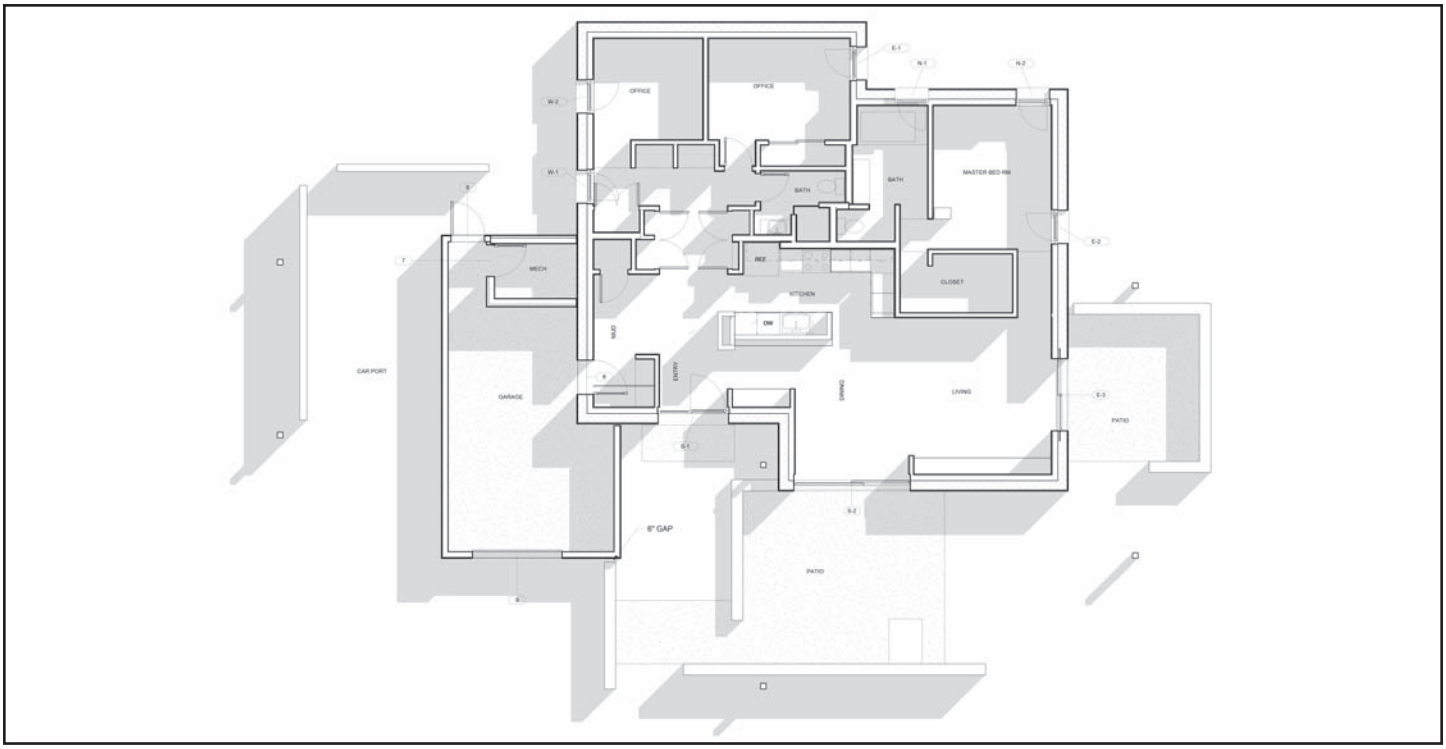

Figure 16. Floor plan for Ulibarri Residence. The home embraces adaptable design to allow residents to age in place, making the home a true long-term location for its owners. Plan courtesy Jonah Stanford and NEEDBASED, Inc.