

## IN PRACTICE

### Building the Future: A Builder's Personal Dream Home Hits HERS 35 (Part 2)

“As green builders, we talk a lot about the energy savings and the environmental value of our sustainable, high-performance approach. Yet there’s a difference between green building and just energy-efficiency. Working with a green builder means you get the value of our experience in energy efficiency plus our expertise with ventilation, moisture control, and avoiding toxic materials,” noted Mike Trolle, Principal at BPC Green Builders, LLC (<http://www.bpcgreenbuilders.com/principals.htm>).

When it came to time to build his own house, Trolle wanted the best in performance, efficiency, and health. Winner of the 2013 “Lowest HERS Index without Renewable

Technologies” in the CT Zero Energy Challenge, Trolle’s residence in Danbury, Connecticut represents a pinnacle in applied high performance lessons and field work (see Figure 3).

Earning a final Home Energy Rating System (HERS) Index of 35, the Trolle Residence is also a certified Passive House through the Passive House Institute US (PHIUS), an ENERGY STAR® Certified Home, a certified Zero Energy Ready Home through the Department of Energy’s Building America program, and is certified under the US



Figure 3. Exterior shot of the Trolle Residence. Trolle’s company, BPC Green Builders, has earned multiple Silver, Gold, and Platinum Leadership in Energy and Environmental Design (LEED)® for Homes certifications, and a National Green Building Standard™ (NGBS) Emerald certification. Regionally, BPC projects have been awarded “Best Energy Efficient & Green Home” in Connecticut for 2004 and 2006 (HOBBI Awards), “Best Green Renovation” in Connecticut for 2011 (Home Builders Association of CT), and “Best Use of Advanced Building Technology” Green Home of the Year Awards program (*Green Builder* magazine). Trolle put the lessons from these projects together, resulting in the high performance of his personal residence. Photo courtesy Mike Trolle.

Environmental Protection Agency’s (EPA) Indoor airPLUS program. Trolle’s home earned a HERS 35 without the use of renewables.

After establishing a comprehensive and continuous envelope insulation strategy and achieving an air tightness rating of 0.46 ACH50, Trolle tackled the home’s conditioning plan.

#### A Single Mitsubishi Heat Pump Conditions the Home

All of Trolle’s efforts in insulation and air sealing paid off when it came to the home’s heating, ventilation, and air conditioning (HVAC) system (refer to Figure 4).

“One of the most impressive applications of mini-split heat pumps is in the Trolle Residence,” said Robb A. Aldrich Senior Mechanical Engineer, Steven Winter Associates, Inc. (SWA). “The entire home is heated by 1 little heat pump, and they were fine all winter. We had below zero weather, which in Connecticut is kind of rare. Mike had no problems with capacity.” (See Figure 6.)

Trolle’s home does not have a back-up resistance unit. Up to half of the home’s heating is supplied through solar heat gain. For mechanical heating, the entire needs of the home are met via a Mitsubishi mini-split heat pump. The single unit is located in the great room of the home. For distribution, BPC installed a 10”/8” diameter duct system that pulls conditioned fresh air from the living room to other parts of the home using a 250 cfm inline Panasonic fan. SWA is closely monitoring the system’s performance. The home also has a Zehnder energy recovery ventilator (ERV).

“During the coldest month of the year, our total monthly bill was \$60 in electrical charges for heating,” Trolle stated. “Winter presented a great chance to test and see if the temperature was uniform in the home. I went around the house measuring surface temperatures. It was exciting to see the interior face of exterior walls measuring at the same temperature as the air, that the slab was also the same temperature, and that there was no difference between the first and second floors.”

With the arrival of cooling season, Trolle noted that temperature distribution is a little less even between floors of the home; on average the second floor is 3° degrees warmer. “As a result, we are overcooling our first floor to reduce the second floor temperature. We are thinking about going to a higher CFM fan to get more air to the second floor and adding a dehumidifier to increase comfort at higher temperatures.”

## Hard Work Helped Circumvent Perceived Cost Barriers

Cost is relentlessly cited as a barrier to the popularity of high performance homes. For Trolle, the main obstacle was the market itself, as land and existing homes were expensive. "Existing homes are valued more highly than I think they should be, given their very poor energy efficiency. This made it difficult to find an affordable building site," Trolle noted. Tireless searching and lots of legwork finally led Trolle to a summer cottage in a Danbury lake community, which offered land and a building site for far less than other options.

While BPC prefers to retain designers and architects, in this case, to help save money, Trolle designed the home himself using SoftPlan Architectural Design Software. Trolle also ran his home through PHIUS software and pre-certified the home.

## Despite Thorough Planning, There are Always Surprises

Viewed in retrospect, Trolle noted one aspect of the project he would do differently, as well as a few positive and negative product performance results.

Trolle revisited his determination to recycle the original cottage's foundation. "I kept only the concrete block foundation and the framed floor above it. In retrospect, I doubt that I should have kept either," Trolle recorded in the home's blog. "The block foundation was never waterproofed, and has no footing drain, so it will always be somewhat damp. This led to a damp floor deck above during construction which required care to prevent mold. Also, the floor framing wasn't completely square, and was structurally insufficient without reinforcement. Bottom line is that it would have been easier, and perhaps even cheaper, just to have started from scratch."

With SWA and SiteSage monitors in place, Trolle has been able to keep a close eye on all of the home's performance aspects. Over the winter, he was surprised at the amount of energy used by the Zehnder ERV in defrost mode.

High on the list of positive surprises, Trolle is impressed with the windows selected from Klearwall (Munster Joinery), which are manufactured in Ireland (see Figure 5). "I'm increasingly using European windows," Trolle said. "In European windows, if you're interested in economy but still want high performance, you go for their PVC line, which is nothing like US vinyl windows. The frame has a 0.16 U-

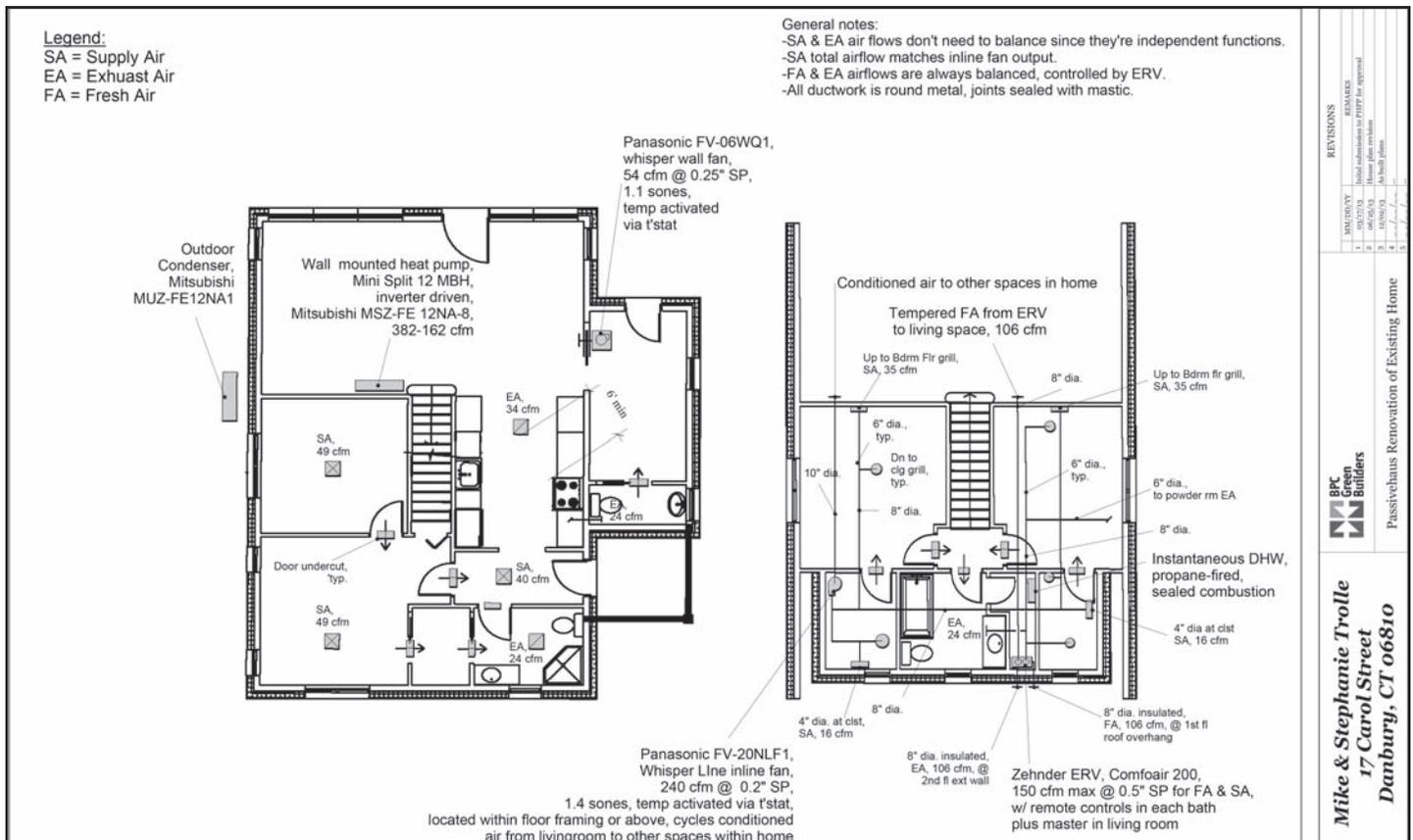


Figure 4. Mechanical plan, as built, for the Trolle Residence. Figure courtesy Mike Trolle.



Figure 5. The Klearwall (Munster Joinery) windows selected for the project have proved exceptional, both in U-value, air sealing capabilities, and solar heat gain. Photo courtesy Mike Trolle. To view a video of the home, visit <https://www.youtube.com/watch?v=qaLMY9QfNTc> online.

value. The windows offer tilt and turn operation, with exceptional air sealing; they've just been wonderful, and as a builder, it is key to note that they adjust in so many places. I've been really happy."

### Trolle Sees Passive as Path to the Future

"In America, we have this idea that a dream home has to be large and elaborate. You might be surprised how nice it is to live in a modest-sized home with wonderful performance features," Trolle concluded. "I believe that the Passive House program is a leading force behind the rapid increase in both technical sophistication and public momentum for energy ef-

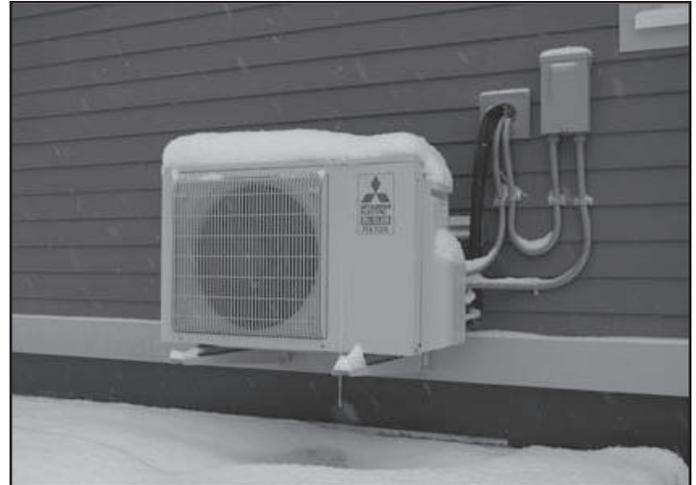


Figure 6. Mitsubishi mini-split heat pump at the Trolle Residence. Photo courtesy Mike Trolle.

ficient housing. As such, I want to participate not just as a builder but as a homeowner."

*Energy Design Update* sincerely thanks Mike Trolle, BPC Green Builders, LLC, Robb Aldrich, and Steven Winter Associates, Inc., for sharing this story with us. BPC Green Builders can be visited online at <http://www.bpcgreenbuilders.com/>. To learn more about the CT Zero Energy Challenge, go to <https://www.ctzeroenergychallenge.com/>. Information about Passive House Institute US (PHIUS) certification is available online at <http://www.passivehouse.us/passiveHouse/PHIUSHome.html>. Information about the Zero Energy Ready Home certification, formerly the Challenge Home, from the Department of Energy's Building America program, is online at <http://energy.gov/eere/buildings/zero-energy-ready-home>.