Scalable, Affordable Net-Zero Homes

– IN THE EFFICIENCY GAME, SIMPLICITY WINS –

Dan Vastyan

To achieve net-zero status, a home must produce as much energy as it consumes, and this is typically via solar or wind.

"Net-zero has been an obtainable goal for decades, but usually at a prohibitive initial cost," said Tom Danielsen, founder of Danielsen Construction and Energy Management, in Altaville, CA.

Danielsen wanted to prove that by adopting net-zero as the goal early in the design process, the cost difference between a traditional home and a net-zero home can be mere pennies, without sacrificing comfort.

HABITAT FOR HUMANITY PILOT PROJECT

Danielsen has retrofitted many existing Habitat for Humanity houses with energy efficient upgrades. But it wasn't until recently that Danielsen took control of a new construction project, with plans to prove his "net-zero for pennies," hypothesis.

Danielsen presented the Habitat for Humanity board with his idea to build an experimental home in Calaveras County, CA. The goal was to: (a) prove that his net-zero construction method is replicable at scale; (b) prove that the home has a similar square-foot cost as traditionally-built homes; and (c) have an unbiased outsideparty measure the energy performance of the home. The board agreed.

Implementing experience

"In any discussion of how to make a home efficient, the three main topics are insulation, air sealing, and the HVAC system," said Danielsen.

He uses Owens Corning L77 BIB (blown in blanket) insulation in the ceilings (R-40) and walls (R-21). He installs AMSCO low-E, 366 glazed, dual-pane, argon-filled windows with a U factor of 0.24.

"When it comes to air sealing, the most critical areas are those that can't be accessed once construction is finished; the plumbing cutouts, framing cavities, wiring inlets and register exchanges."

"We're big believers in Fujitsu heat pump technology," said Danielsen. "That doesn't make us unique, but how we size and install them does."

Danielsen explained that heat pumps don't reach full efficiency until they've been running for 10 or 15 minutes. An oversized unit that cycles on and off never operates at its maximum efficiency. Consequently, he is very careful not to oversize heat pumps.

"Our ductwork layout is a radial design," he continued. "We run duct directly from the plenum to point of use. Air should move at 400-600 CFM, generating very little friction and conductive loss."

Finally, sealing ductwork and covering it with insulation is extremely important.

Got the green goods

Technical Specialty Solutions offered to donate a 2.76 kW solar array that was installed on the 1,250 square-foot house. The array would cover nearly all the power used in the home. Due to the project's small budget and the fact that the solar array was donated, it wasn't possible to install an array that would fully cover the home's entire electricity needs.

The heat pump is a single-zone 12,000 BTU/h Fujitsu H-Series system, offering up to 21.5 SEER.

Owens Corning L77 BIB (blown in blanket) insulation was used in the ceilings (R-40) and walls (R-21). (Courtesy image)

The 1,250 s.f. home features a 2.76kW photovoltaic solar array. The cost to build this pilot project house was $320k, but when built at scale (in a subdivision), the same home will be about $190k major cost savings on framing at scale. (Tom Danielsen)

"We install Fujitsu heat pumps because they heat extremely well," said Danielson. "Also, their tech support and warranty are the best in the business."

To round out the equipment list, Danielsen installed a 50-gallon Ruud heat pump water heater. LED lighting was used, and builder-grade, ENERGY STAR appliances were selected.

Torsten Glidden, a contractor for the U.S. Department of Energy's Building Technologies Office, installed a SiteSage energy monitoring system on the home's main breaker panel, allowing data collection from every circuit.

The experiment

Once the house was complete and occupied, occupants were encouraged to make their home comfortable. There were no restrictions on energy use. After a year of data collection, Danielsen had very specific numbers to compare against Pacific Gas & Electric's (PG&E) annual utility data for the property.

The data collected corroborated what appeared in PG&E's annual True-Up bill: extremely low household power utilization.

The results

Over the course of the year, the small solar array produced 4,571 kWh. The water heater consumed the most power, followed by the heat pump, the dryer, and so on.

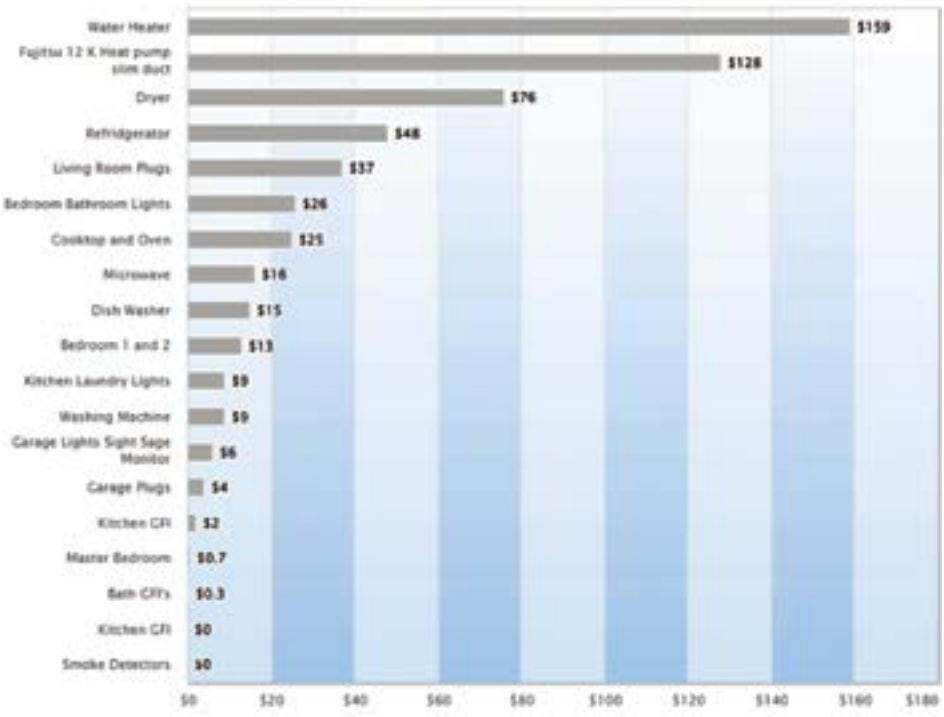
"We can see that the Fujitsu system uses between 400 and 600 Watts during the winter, and between 600 and 800 Watts in the summer," said Danielsen. "Over the course of the year, it consumed a little more than double the energy it took to operate the refrigerator. That's amazing."

The True-Up bill portrayed all energy consumption in

Cont'd on p.26

Affordable Net Zero Homes – Cont'd from p.25

ENERGY CONSUMPTION OF EACH APPLIANCE IN THE HOME



The data collection system displays power consumption from each circuit in the home. After solar generation, the Fujitsu mini-split consumed $128 of power over the course of the year. (Tom Danielsen)

dollar values, adjusted for the power generated by the solar array.

The homeowner's annual energy expense was $574. Hot water production cost was $159, heating and cooling accounted for $128, and the dryer consumed $76 worth of power.

"It costs less to power this house for a year than the average home in California for two months," said Danielsen. Habitat for Humanity could hardly believe the numbers were real.

"We're not doing anything crazy here, and even if the solar array hadn't been donated, this house would have cost roughly the same as a traditional home" said Danielsen. "There were no expensive building materials or methods used. We installed basic equipment, employed best practices and added a small photovoltaic array. In fact, if we could have added one more solar panel, this would be a true net-zero property."

Dan Vastyan is President of Common Ground, Uncommon Communications, LLC. ♻