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It just gets better: NIST net-zero house quadruples energy surplus in second year

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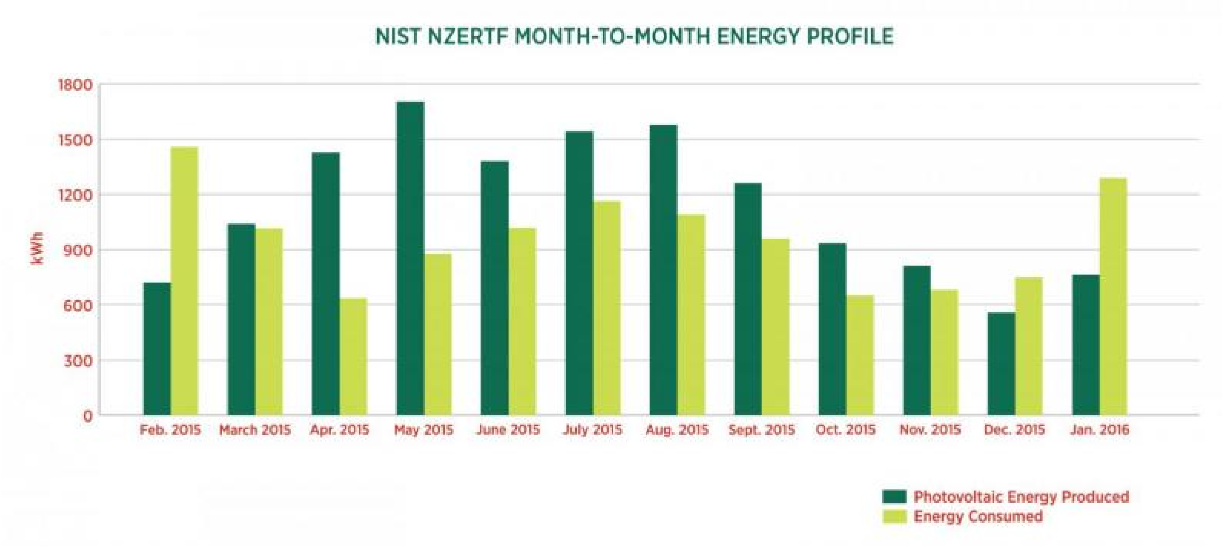

Energy use and production for NIST's Net-Zero Energy Residential Test Facility in Gaithersburg, Md., from February 2015 to January 2016.

Tweaking ventilation and temperature control systems along with a mild winter helped the experimental net-zero-energy house at the National Institute of Standards and Technology (NIST) quadruple the amount of surplus energy it sent to the power grid during its second year-long demonstration.

On top of eliminating an annual electricity bill of about $3,670—the average for a similarly-sized home in Montgomery County, Md.—the 2,139-kilowatt-hour energy surplus garnered a refund check of about $80 from the local utility. From Feb. 1, 2015, to Jan. 31, 2016, the two-story, four-bedroom house's rooftop solar power system generated a total of 13,717 kilowatt hours of electricity—equivalent to the energy generated by burning more than seven tons of coal or about 1,000 gallons of oil.

The energy surplus jumped 1,655 kilowatt hours over the previous test year. More than 90 percent of this increase stems from reduced energy use, achieved without sacrificing indoor comfort. A slight gain in energy generated by the photovoltaic solar panels—about 140 kilowatt hours—accounts for the remainder.

Milder weather during the second year-long testing of NIST's Net-Zero Energy Residential Test Facility (NZERTF) contributed to about half of the drop in energy use, according to a computer modeling study by NIST economist Joshua Kneifel. The other half of energy savings results from efficiency-improving adjustments in a house already designed to be 60 percent more energy efficient than houses built to meet the requirements of the 2012 version of the International Energy Conservation Code (IECC).

Updated about every three years, the IECC is a model efficiency code often incorporated into state regulations.

Hunter Fanney, who leads the research at the NZERTF, credits two technical tweaks for the most significant gains in efficiency.

He attributes the majority of the savings to changes in the control logic associated with the house's heating system. During both demonstration periods the same air-to-air heat pump system was used to heat and cool the house. During the heating season, the system extracts heat from the outdoor air to warm the indoor air, and then delivers the heat to the interior of the house.

"During the first year the control logic was 'overanxious' during cold-weather conditions," Fanney explained. "It often energized the back-up electric resistance heating system, even though the heat pump was capable of maintaining the desired indoor temperature. So, we switched to a 'more patient' control strategy that greatly reduced the use of less-efficient electric resistance heat yet maintained the same comfort levels within the home."

NIST researchers also dialed down the NZERTF's outdoor ventilation rate by 25 percent, lowering it to the rate required by ASHRAE Standard 62.2-2010. During the first year, the NIST team chose not to modify vendor specifications for any control associated with the house's various systems. Reducing the vendor-prescribed ventilation rate so that it met—but did not exceed—the standard trimmed energy consumption by about 3 percent, Fanney says.

The 2,700 square-foot (252-square-meter) test house features the full array of modern amenities and would blend in nicely in a new suburban subdivision. The NZERTF meets U.S. Green Building Council LEED Platinum standards—the highest rating for sustainable structures. In addition to energy-efficient construction and appliances, it features energy-generating technologies, such as solar water heating and a solar photovoltaic system consisting of 32 panels, each producing 320 watts of electricity.

The NZERTF is home to computer-simulated versions of two working parents and two children, ages 8 and 14. Their daily routines and energy-consuming habits are scripted and imitated by computer, based on occupant profiles developed by the Department of Energy. Members of the virtual family bathe, shower, cook, turn on lights when they enter rooms, do laundry, and relax by watching TV, listening to music, posting on Facebook, and playing video games. Computers even control devices that mimic the heat and moisture released by the virtual family's breathing and perspiring.

On the basis of two years of performance results, Fanney surmises that the NZERTF's photovoltaic system could be downsized by as much as 20 to 25 percent and, most years, the house still would reach its net-zero goal—producing as much energy as is consumes over 12 months. The results also suggest that a net-zero-energy house could be built on a less-than-optimal site—not facing true south, for example—and still meet its goal, he says.

That change would significantly reduce the front-end costs of building a net-zero-energy house, shortening the payback period for recovering the additional investments necessary to meet the goal.

Other efforts to make achieving this goal easier and more cost-efficient will progress as technology becomes more energy efficient and as research at the NZERTF and elsewhere point to new opportunities for reducing energy use and improving onsite energy production, Fanney says.

More information: To learn more, go to the NZERTF web site.

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