HOME ECO-NOMICS; The Zero-Energy Solution

May 20, 2007
By MARK SVENVOLD

Mike Strizki's house, the house of the future, the revolutionary house that might very well change our lives forever, is an unremarkable two-story, 3,000-square-foot, white colonial-style kit home in front of which, one rainy day last November, were parked no fewer than seven trucks and cars, a pair of Jet Skis, a speedboat on a trailer, several golf carts, a small tractor, a couple of vans and an old dump truck rusting in the middle of the woods, like a major reworking of a Robert Frost poem. There was nothing odd, or futuristic, or exotically ''eco'' about the house -- no solar panels to be seen, no giant arrays of thermopane windows passively drinking up light and heat; yet here, I'd been told, in the Sourland Mountains in New Jersey, an hour from Manhattan, was a house that had the potential -- not long from now, not 20 years from now, but maybe within 5 to 10 years -- to help turn millions of American homes into fully self-sustaining power plants, each one capable of producing hydrogen to fuel cars as well.

A sign at the head of Strizki's long gravel driveway said, ''Welcome to the first solar-hydrogen residence in North America.'' Strizki, the 50-year-old director of residential and commercial systems for Advanced Solar Products, a solar installation company, designed a backyard power plant that provides all the house's energy, using a combination of solar panels and solar-generated hydrogen. Although he built the house 15 years ago, the power plant is a more recent addition, dedicated in October 2006. Strizki lives in the house with his wife, Ann, a 23-year-old son, two dogs and a cat. As it happens, there are several rival claimants to the title of first solar-hydrogen house, including the United States Merchant Marine Academy, which has an 800-square-foot, prefabricated solar-hydrogen-powered house on display at its campus in Kings Point, N.Y.; now occupied by a professor, it was dedicated as ''America's First Solar-Hydrogen Home'' in June 2006. But Strizki maintains that his system was the first to fuel an average-size American home in which a real American family actually lives.

Strizki gave me a tour. Outside, the sky was the color of hammered steel. There was a patch of lawn the size of a small putting green, a brick walkway leading to the door and, inside, the proverbial expansive American-home interior -- a cozy kitchen with all the usual appliances, a spacious living room with an enormous L-shaped leather couch, a big-screen television, a stereo, an office upstairs, washers and dryers downstairs: the full-on, living-large ensemble of modern comfort and convenience on display. If this was part of a revolution in green architecture, of an America still hopeful about its chances for a sustainable future -- a renewable America -- it was one that came equipped with a La-Z-Boy.

Back outside, Strizki, who is built like a bowling ball closing in on a strike, began a well-practiced patter that sprang readily from the microparticulars of photovoltaic cells and proton-exchange membranes to what he sees as the macro-, going-to-hell-in-a-handbasket range of problems that beset the globe: staggering energy demand in the face of diminishing resources; global warming; peaking fossil-fuel production; energy insecurity; and the specter of economic collapse as the world makes the painful shift from petroleum to whatever must, of necessity, come next. Strizki, whom many have described as a natural-born mechanical genius, has worked in obscurity on renewable-energy technology for most of his adult life. Lately, it seems, people have started to pay attention.

We walked from the house about 50 yards through maple and oak trees to a large metal outbuilding roughly the size of a barn and stopped in front of two key elements of the solar-hydrogen system. To my left, a 10-kilowatt array of solar panels completely covered the south-facing roof of the metal shed, the business end of his system, dully transforming the gauzy, rain-soaked sunlight into electricity. To my right, 10 large propane tanks sat filled with hydrogen. Almost everything I saw, Strizki explained, was overengineered and bigger than necessary for the job: the electrolyzer, used in industrial laboratories to generate hydrogen; the fuel cell, used by telecom companies to power remote cellphone towers; and, most conspicuously, the 10 hydrogen tanks. If patching together these disparate and cumbersome elements from heavy industry for a home seemed a little like hooking up a jet engine to run a scooter, it was just a natural stage, he said, in the development of a commercial product that would be streamlined and form-fitted for domestic use. ''When they build a computer chip,'' he explained, ''they build a big one.'' They call it a breadboard, ''and once they get the components the way they want it, they miniaturize it and then mass-produce it. This,'' Strizki said of his prototype solar-hydrogen system, ''this is our breadboard.''

Here's how the solar-hydrogen house works. The solar panels above Strizki's garage generate electricity, which goes directly to power his house. For about seven months of the year, the panels are designed to make more electricity than the house needs, as much as 60 percent more during the summertime. Strizki's system takes this extra electricity and runs it through an electrolyzer, which uses technology invented in the mid-19th century to convert electricity and water into a modest quantity of hydrogen -- the energy equivalent of about a gallon of gasoline each summer day -- which is then sent to the tanks outside. In this inaugural shakedown year, Strizki had to purchase his hydrogen (19,000 cubic feet of it, at a total cost of about $2,000) to prime his empty tanks. According to Strizki, that's the last fuel bill he will ever have. Though he will continue to monitor the system, measuring the amount of hydrogen produced, the hydrogen should act like a natural battery bank that never dies or degrades. During the winter months, the solar panels should still provide about 60 percent of the power to the house, he said. It's then that the accumulated hydrogen will be siphoned from the storage tanks to a fuel cell, which will simply reverse the process of the electrolyzer, reconfiguring the hydrogen back to water and electricity.

Although it can stand alone completely off the main power grid, Strizki's system is ''grid-tied,'' which means that with the flick of a switch in his basement, he can connect to the grid for backup power or to sell electricity to the local power company. As a final touch, there is a geothermal component to the scheme. Six feet beneath the lawn, freon gas circulates through a radiatorlike grill of copper tubes, bringing the ground temperature -- at that depth it remains a constant 56 degrees -- into the house. In winter, some of the stored hydrogen powers a heat pump that steps up the temperature in the Strizkis' house another 12 degrees. During the 90-degree days of a New Jersey summer, they use that steady 56-degree ground temperature to stay cool and comfortable.

Solar power, of course, in one form or another has been around for thousands of years. The Anasazi Indians of the American Southwest incorporated passive solar design into their cliff dwellings. Leonardo da Vinci drew up plans (never materialized) for a kind of solar-concentrating industrial furnace. The basic properties of active solar photovoltaics were described in the 19th century; photovoltaic solar panels have been around since the 1950s. There is nothing new, in short, in Mike Strizki's backyard. Even his method of using hydrogen to store solar-generated electricity was studied more than 120 years earlier by the French inventor Augustin Mouchot, who once made ice with a solar-powered steam engine. Strizki's principal achievement lies in inventing a clever system from components that were already at hand.

Although 19,000 cubic feet of hydrogen may sound like a lot, it really isn't. It is, Strizki explained, the energy equivalent of only about a single tank of gasoline in a large S.U.V., yet this would be more than enough hydrogen to provide the house with all the heating, cooking, hot water and additional electrical power needed to last through the dark winter months. Soon, he said, the same amount of hydrogen could be stored in a single tank at high pressure, substantially reducing the ''storage footprint.'' But for now he chose 10 tanks at low pressure, in part to avoid alarming New Jersey's building inspectors with the prospect of pressurized hydrogen.

Above us, the clouds seemed to have dropped a few feet closer to our heads. A light rain began to fall. ''The thing is,'' Strizki told me, ''dark days like this don't affect me.'' ''Because of the hydrogen?'' I asked. ''Because of the hydrogen,'' he said.

The implications of the solar-hydrogen house are immense. Eventually, it seems, for the price of a home-improvement loan, millions of homeowners could install solar-hydrogen systems, with zero emissions, generating 100-percent clean renewable energy. It is all part of a new trend toward ''distributed generation,'' whereby homes, businesses, schools, factories and retail outlets might one day produce their own electricity while remaining tied to the grid -- capable, that is, of reducing the load on the grid when it really needs it, such as during peak summer months, when demand for air-conditioning skyrockets. This potential for ''peak shaving,'' as it's called, remains one of the most attractive features of the growing solar movement. A recent M.I.T. study, for instance, found that adding a gigawatt of solar power -- the equivalent of 100,000 10-kilowatt solar panels like the one that powers the Strizki house -- to the New England region would shave peak pricing and thus lower utility rates for all of the area's customers by 2 to 5 percent. The solar-hydrogen home can also generate fuel for transportation. Strizki's house has a hydrogen fueling station that he uses to fill an experimental hydrogen car, the New Jersey Genesis, which has a range of 300 miles. Since Americans, it turns out, drive on average no more than 33 miles per day, theoretically the home hydrogen-fueling station could in the future satisfy the commuting needs of millions.

Perhaps most important, Strizki's system can be adapted to existing homes. The system, in other words, doesn't dictate a radical change in architectural style. If you don't have a house that incorporates passive solar design -- banks of south-facing windows for collecting heat and light, heat-retaining stone flooring -- no matter. By installing a solar-hydrogen system, almost any house, it seems, could go seriously green -- and without a whiff of the sacrifice or changes in lifestyle that sometimes come from the more puritanical quarters of the environmental movement. The Strizki home offers a greener world and the continued pursuit of happiness. Indeed, its premise and secret promise is to recommend two things that are dear to many Americans anyway: energy independence and the permission to keep all one's toys.

Is all of this too good to be true? Well, yes, according to Howard C. Hayden, a solar skeptic, a nuclear-power advocate and the author of ''The Solar Fraud: Why Solar Energy Won't Run the World.'' Hayden says he believes that Strizki couldn't possibly generate enough hydrogen from his solar panels to last him through the winter -- particularly not without the help of the geothermal system installed back when the house was built. Hayden doubts Strizki's claim that he will generate the energy equivalent of about a gallon of gasoline in stored hydrogen per day; even if he does, Hayden says, when you allow for an efficiency loss of 50 percent, Strizki will be able to store only 17 kilowatt-hours per day. ''He's not going to get enough energy out of his 10-kilowatt system'' to power the house and car year round. ''It's not going to happen.''

But according to Scott Samuelsen, director of the National Fuel Cell Research Center at the University of California at Irvine, the technology works. Samuelsen and a team of engineers fed several months of data from two conventional California homes into a computer model that simulated a solar-hydrogen system very much like Strizki's and found that it could provide enough energy for the houses throughout the year. The comparison is skewed, of course, because in the temperate Pacific climate, homes generally consume about 60 percent of what mid-Atlantic homes do, according to Department of Energy statistics. Still, the results were robust enough to prompt Samuelsen, who is characteristically measured in his statements, to declare that solar hydrogen ''is the means by which residential homes will be powered in the future and probably small-to-medium commercial buildings as well.''

In a year of unprecedented ''green'' awareness -- green advertising campaigns, a green issue of Sports Illustrated -- the big promise of renewables, from biofuels to wind and solar, is their capacity to generate another kind of green, a fact that has not been lost on Wall Street. Though solar is just a tiny fraction of the United States' $1.2 trillion energy market, and less than .05 percent of the world's share of generated electricity, demand for solar power is so off the charts in America, Japan and Europe (cold, cloudy Germany is a dominant force in the world market) that there is currently a worldwide shortage in the basic substrate used to manufacture photovoltaic cells -- processed silicon -- which has pushed up its price.

''The stars are aligned right now,'' Jean-Marc E. O'Brien of Ardour Capital Investments told me. The high prices of oil, gasoline and natural gas have concentrated more private-sector investment into R&D. So have concerns about energy security, an increasing corporate awareness that global warming affects the bottom line and a legislative push at the state level to subsidize renewable energy. Big investment houses have moved into solar- and wind-power project financing. According to The Economist, total investments of all kinds in renewable energy rose to an estimated $63 billion in 2006, from $30 billion in 2004. The smart money, as they say, is positioning itself toward a new energy paradigm.

In the spring of last year, as Mike Strizki was midway through the four-year, red-tape-delayed process of installing the solar-hydrogen system for his house, things ground to a halt. One of the key hurdles came in the form of officials enforcing the New Jersey building code, who balked at storing hydrogen in used propane tanks. Help came in the form of Gian-Paolo Caminiti, a former psychotherapist who branched off into management training and human resources, and had gotten to know Strizki after he'd installed a solar-power system in Caminiti's home. ''There were no rules and regulations for building a hydrogen system in a residential environment,'' said Caminiti, who set up a meeting with state officials and got everyone talking again. Soon both sides hammered out an agreement that would bring the solar-hydrogen house up to code. Caminiti now works for Strizki as his chief operations officer at Renewable Energy International, the company that Strizki set up to bring his solar-hydrogen system to market. Others have joined in the effort. They include an inventor-entrepreneur named Steven Amendola, and Lyle Rawlings, Strizki's boss at Advanced Solar Products, whom many regard as the founding father of renewable-energy legislation in New Jersey -- now the fastest-growing solar market in the country.

With all the venture capital flying around, you'd think these men would have been flush with office suites and spanking new laboratories, but they operated out of bedroom offices and borrowed garage space, printing their business cards on home computers. Meanwhile, Strizki regaled me with stories about energy-saving technologies -- from the electric trolley to the electric car -- that had been quietly withheld, removed or in some way derailed from production. He is particularly wary of big investors wresting control of his invention. ''We're not going to sell anything out,'' he told me. ''We're not running the risk of someone coming in as a front company and buying our technology off the market and shelving it.'' He prefers, he said, to run a little lean and wait for an angel investor, someone who can afford $2 million to $5 million to help roll out a solar-hydrogen system as a retail product without asking for too much in return.

But even if Strizki's solar-hydrogen system were to hit the market intact, is it economically feasible? Would it simply cost too much for the average homeowner to install? Is hydrogen storage safe? Will solar power be competitive with fossil fuels? Then there is perhaps the more fundamental question of inertia. According to a recent study by the Shelton Group, which monitors consumer attitudes toward energy, 58 percent of Americans cannot name a single form of renewable energy. Are we ready to make the jump to something that most people can't even name?

The cost of solar power is a bedeviling problem, and 90 percent of it must be paid upfront at installation: Strizki's system, not including the geothermal component or hydrogen-fueled appliances, cost $500,000. Donations from others and a New Jersey Board of Public Utilities grant of $225,000 reduced his out-of-pocket costs to $100,000. As a unique, first instance of applied technology, it was, like all prototypes, expensive. But the ''experience curve'' -- the value of all the lessons learned in getting a bona fide, certified, code-approved working system up and running -- would soon bear fruit, Strizki claimed, reducing the total cost of the very next solar-hydrogen house to about $100,000, an 80 percent cost reduction just one generation beyond the prototype. According to Travis Bradford, author of ''Solar Revolution: The Economic Transformation of the Global Energy Industry,'' the cost of solar has been dropping by 5 or 6 percent a year, and as the popularity of solar increases, its costs will continue to go down.

Still, as some have noted, $100,000, amortized over the life span of the system, works out to about $4,000 a year on energy, plus the costs of replacing parts. This is quite a bit more than the $1,800 a year average homeowners spend on all their home energy needs. That is true, Bradford says, only if you decide not to calculate all the ways that Strizki's system can save money. ''If you refuel your car at home with hydrogen,'' Bradford explains, ''you can add your annual gasoline costs'' -- about $3,400 per year for the average homeowner, according to Department of Energy figures -- ''to what you save on home energy. Then the savings easily approach $5,000 per year.'' Perhaps most important, Bradford observes, ''purchasing the solar-hydrogen system insulates you from any future price increases'' in home heating or transportation fuels.

Yes, these new technologies, as their opponents claim, are more expensive. But economies of scale coupled with the increased price of fossil fuel, Bradford says, will inevitably make solar competitive, as it already is in Japan and Germany, where energy costs are high. ''Let's do a thought experiment,'' he said. ''Let's say that 5 percent of homeowners in America would willingly pay more for a home with solar panels -- for reasons that have nothing to do with cost-effectiveness. Let's say there are 100 million homes in America. Five percent of that is five million homes. But right now there are only 50,000 solar homes in America, so you'd need to build or install 100 times the current number of solar homes in America before you'd exhaust the number of people who are willing to pay more for a solar home. And by the time you reach five million, the economies of scale really kick in, and you've solved the so-called cost-effectiveness problem.''

''And if my mother were a car,'' Howard Hayden retorts, ''she'd have wheels.'' There are too many ''ifs,'' according to Hayden, in Bradford's cost analysis to give it credence. Even a solar advocate like Lyle Rawlings considers Bradford's estimates overly optimistic. Still, Rawlings says, even some fraction of 1 percent -- a few hundred thousand homes -- might be enough to kick-start the economies of scale in favor of the solar-hydrogen house.

But for Hayden, Strizki's system -- and solar power in general -- can never be cost-effective. Hayden doesn't buy the argument that the price of solar power will plummet. He agrees with Bradford that the price of solar panels has declined steadily, though not precipitously, by about 5 percent per year. So if this decline continues, and if energy prices continue to rise, won't solar power become affordable? ''Yes,'' Hayden says. ''And if you extrapolate your growth curve from when you were 12 to when you were 13, you'd be 64 feet tall.'' Hayden, in other words, doesn't think the price will continue to drop, mostly because of manufacturing costs. ''Eventually, even with the improvement in efficiencies,'' Hayden maintains, ''you will not be able to surmount the costs of silicon. You get down to an irreducible minimum -- the price of manufacturing the solar panels -- which will continue to be the main price-barrier.''

It is one thing to extol or doubt the cost-effectiveness of solar panels, the primary component of the solar-hydrogen house, but what about the hydrogen? It is unfair, for instance, to mention the Hindenburg disaster, the fiery destruction of the hydrogen-filled dirigible over Lakehurst, N.J., in 1937. Although new evidence suggests that hydrogen was not the primary cause of the disaster, the Hindenburg's spectacularly filmed crash cast a long shadow in the public mind over hydrogen as a dangerous and tricky material to handle. Is adding hydrogen to solar power a complication of an already complex idea -- the technological equivalent of stuffing something tasty like a turkey with a duck and a chicken and adding, for good measure, a stick of dynamite? Arguments about efficiency losses, cost-benefit analyses and the like are more or less beside the point if hydrogen is a substance that might blow you to smithereens.

This is what Joseph J. Romm, who was acting assistant secretary of energy for energy efficiency and renewable energy during the Clinton administration, seems to suggest. Romm is an environmental pragmatist. He says he believes that the problems of global warming are urgent and that hydrogen technologies are too remote in time to be of any real help. The author of ''The Hype About Hydrogen: Fact and Fiction in the Race to Save the Climate,'' he has traveled the country speaking against hydrogen, arguing that as energy pathways, fuel cells and the like are extremely inefficient and expensive. He also mentions the safety issue, and the Hindenburg seems to float ominously into the debate.

''Hydrogen is odorless,'' Romm says. ''And it's invisible. And it burns invisibly and it leaks through anything.'' Romm praises Strizki's use of solar and geothermal components, but has nothing good to say about hydrogen. ''I'm not going to dispute those who say you can work with hydrogen safely,'' Romm told me, ''but there's a big difference between hydrogen in an industrial setting and hydrogen being made by your next-door neighbor with his dogs and little kids.'' He says, ''The last thing you want is somebody making hydrogen in his garage. If there was a leak -- if you collected any amount of gas -- you would never know it, and any spark at all sets it off. So I would go to the local zoning board to stop my neighbor from putting in a hydrogen generation system.''

John Turner, an electrochemist who has been working with fuel cells and hydrogen production for 28 years as a principal scientist at the National Renewable Energy Laboratory, disagrees. ''I think Romm greatly overstates hydrogen's risk,'' Turner says, explaining that it is very difficult, in fact, for hydrogen to accumulate anywhere because it diffuses so rapidly. ''All energy carriers,'' Turner adds, ''are by their very nature dangerous. Gasoline? Incredibly dangerous,'' he says. ''It's a poisonous, carcinogenic, flammable liquid. I'll bet that Romm sits on 20 gallons of it every day.''

''In terms of safety,'' Turner says, ''hydrogen is something we can deal with.'' The fact is that Strizki's system has passed New Jersey's building code, one of the toughest in the nation. ''I want to put an exclamation point on that,'' Scott Samuelsen observes. ''Passing the code is the most important aspect of the story for the American homeowner and energy consumer.''

The debate between hydrogen advocates and skeptics, the hands-on hydrogen-friendly inventors like Strizki and the pragmatists like Romm, is really a debate about what form a new energy paradigm will take. It resembles resource debates reaching back more than a hundred years, with coal giving way in the 20th century to petroleum, for instance, which then had to make room for natural gas. Rival technologies threaten what Romm calls ''incumbent energy regimes.''

It made me think back to my first visit to Strizki's house. He was in his big metal garage, leaning over his fuel-cell car, the amazing aluminum-framed Genesis, and talking about ''greater truths,'' which is something he likes to do, at times with a kind of exasperated flourish, as if rehearsing for his own filibuster scene in ''Mr. Strizki Goes to Washington.'' ''The solar-hydrogen house,'' he told me, choosing his words carefully, ''is an incredibly disruptive technology.

''You can go out and buy an oil well,'' Strizki went on to say. ''You can buy a coal mine, but it's a little hard to buy a piece of the sun. It's like buying air. It's going to inspire some radical changes. And the people who have the monopolies are going to have a hard time giving that up.''

Mark Svenvold is the author of ''Big Weather: Chasing Tornadoes in the Heart of America.'' His ''Empire Burlesque'' won the 2007 Journal Award in Poetry.