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Green homes

Home, green home

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Energy and the environment: Even as housing markets in many countries collapse, demand is growing for low-impact "green" homes

JEFF ROGERS welcomes visitors at the door of his newly renovated house, atop a sandy ridge on Cape Cod, Massachusetts. From outside the two-storey building seems unremarkable: its neat white trim, pale-yellow clapboard siding and shingle roof have been the local style for centuries.

But the house that Mr Rogers finished last year is anything but traditional. It uses no fossil fuel and generates its own electricity. It contains few toxic materials—adhesives, paints and insulation are all free of formaldehyde and contain low levels of volatile organic compounds, and nothing in the house produces carbon monoxide.

Despite housing a family of four, the house uses less than a third of the typical amount of water, thanks to modern appliances, dual-flush toilets and low-flow taps and showers. A geothermal heat pump heats and cools the house using groundwater; even though it has no air conditioning, the house is cool in the Cape's muggy summer heat. On the roof, photovoltaic solar panels sit next to arrays of water-heating tubes. Inside, the bright, warm lights recessed into the ceilings are low-energy light-emitting diodes (LEDs). Even the most traditional-looking elements are unusual: the roof shingles are made of recycled plastic and sawdust. This innocuous house on a quiet lane is, in fact, one of the greenest homes in America.

Although Mr Rogers runs a firm called New England Green Building, his house is within the budget of many homeowners. It is typical of a new generation of green homes that have a dramatically reduced environmental impact, but do not require big changes in their inhabitants' lives.

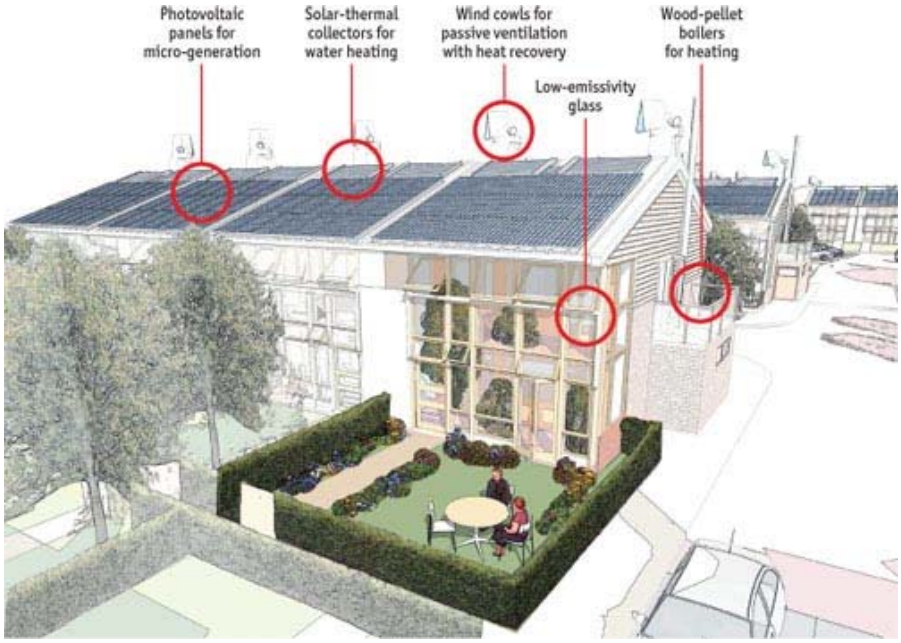
Indeed, a green-home boom is getting under way, thanks to rising energy prices, new standards (the European Union's Energy Performance of Buildings Directive, Britain's Code for Sustainable Homes and California's Green Building Standards Code, to name three recent examples), and improved technologies. Many of these technologies have been around for a while, but they are now ready for the mainstream. In 2007 McGraw Hill Construction, a research firm, reported that 40% of all renovation in America included some green features, mostly windows and heating/cooling systems. The company predicts green homes will account for 10% of all building starts in America by 2010, with new green homes worth $20 billion in that year. When housing arises from its torpor, it could find itself transformed.

Greenery can be hard to define, so the emergence of credible certifiers is clarifying things. The most stringent form of certification is the German Passivhaus standard, which applies to buildings that reduce their energy requirements so dramatically—by 90% compared with standard construction—that they can forgo heating and cooling systems. In 2007 the United States Green Building Council released a version of its LEED green-building standard that applies to homes. (Mr Rogers's home is certified as LEED Platinum, the highest standard available.) And for more than a decade, America's Environmental Protection Agency has offered Energy Star for Homes, a label indicating specific features meant to reduce energy use. Sam Rashkin, the programme's director, expects nearly 1m American homes to carry the label by the end of this year.

Market forces are at play, too. Mr Rogers says his 2,100-square-foot house—just under the average for new homes in America—cost $75,000, or 23%, more to build impeccably green than it would have otherwise. He received $35,000 in rebates and incentives from state and federal governments, and he expects to recoup the rest in avoided energy costs within five years. Given the recent spike in energy prices, it may not take that long.

Systems, like Mr Rogers's solar panels, that enable homes to generate their own electricity may get a lot of attention, but finding ways to reduce the need for energy in the first place is just as important. Green homes start with a sealed envelope: places where air can flow between the interior and exterior are carefully blocked. Sustainable Spaces, a company in San Francisco that assesses the environmental performance of houses, measures how airtight a home is using a device called a "calibrated blower door"—an adjustable barrier that suspends a powerful fan in a blocked doorway. Matt Golden, the company's founder, says that a typical home exchanges around 35% of its air with the outside each hour, whereas carefully sealed "green" homes rate around 7%. (This correspondent's Victorian home scored an abysmal 80%.)

The holes in the envelope that cannot be eliminated are getting tighter too: windows have improved enormously in the past three decades, thanks to low-emissivity or "low-e" coatings that selectively allow different amounts of heat and visible light to pass through; multiple panes of glass and plastic film filled with insulating argon or krypton; insulating frames with integrated thermal breaks; and tight seals on closed windows. Even aluminium spacers between panes have been replaced with plastic because they conduct too much heat. But there is more to come.



Upgrading windows

Electrochromic glass, with changeable opacity, is one new avenue of exploration. Some of the most promising is produced by a firm called Sage Electrochromics, based in Minnesota. Its product, which consists of sheets of glass with a metal-oxide coating, was first used in skylights in 2003. When a voltage is applied across the coating, the window darkens, allowing less light to enter but still permitting a view. America's Department of Energy (which developed low-e coatings in the 1970s) has used this glass, along with an insulated sash, to develop a "zero-energy" window that saves more energy in reduced heating and lighting than it needs to operate.

John Van Dine, Sage's founder, says his company is about to invest in a new production facility that should reduce costs enough to make electrochromic windows competitive for homes by 2010. The company is also working on

continuously variable darkening (current models have only two settings) and windows that are powered entirely by self-contained solar cells.

An even bigger leap may come from refining an older idea. Sheets of glass separated by a vacuum could bring windows' insulating properties up to par with insulated walls, yet allow them to be nearly as thin as single panes of glass. The idea of vacuum-insulated panes has been around for nearly a century, and NSG/Pilkington, a Japanese firm that is one of the biggest glassmakers in the world, has sold such panes since 1996. But they remain a technical challenge: the difference in temperature causes the inner and outer sheets of glass to expand by different amounts, so that NSG/Pilkington's windows can be used only where the temperature difference is less than 35ºC, which rules out many homes in need of insulation.

David Stark thinks he has a solution. His company, EverSealed Windows, based in Colorado, has patented a metal baffle bonded to both sheets of glass that allows them to expand and contract separately, while maintaining a vacuum that he says will last for decades. Mr Stark says vacuum-insulated windows at competitive prices could be on the market in three years. This could precipitate a big shift in the window industry, and its focus on spacers, adhesives and sealants: "All of that goes out the window," he says.

Once the home has been duly sealed, the flow of air, moisture and heat in and out of it can be carefully controlled. Mr Rogers's home features a heat-recovery ventilator—a device in his basement that filters incoming air and exchanges heat between incoming and outgoing air. Such devices can remove stale air from a home while retaining 85% of its heat. Steve Harris, a principal at ZEDfactory, an architectural firm based near London that designs green residences (pictured), prefers to use a special heat-exchanging wind cowl his company has developed. It uses no electricity, yet is able to recover 70% of the heat of outgoing air. The device, an angular scoop on the top of a home, has become a signature of the firm's style, and will soon be commercialised for broader use.

The best-known green-home technology must surely be the compact-fluorescent light bulb, the very icon of green living. Yet the technology that will eventually eclipse it now makes economic sense, with the long-anticipated arrival of LEDs—a 40-year-old technology—in home lighting. Compact fluorescents use about one-third as much electricity as incandescent bulbs to produce the same amount of light. But new LEDs use just 12% and can produce light of similar quality to warm halogen bulbs. With lifetimes measured in decades, they are a clear improvement over incandescent bulbs. "It's the difference between a cellphone and the old rotary phones," says Gary Trott, an executive at Cree, an LED manufacturer in North Carolina. Last year Cree began selling a dimmable LED version of common recessed ceiling fixtures. The firm estimates that under typical conditions, these lights could pay for themselves in five years, and save hundreds—or, where lights are left on more, thousands—of dollars over their lifespan.

The LED is poised to revolutionise the lighting industry. Philips, a big Dutch electronics firm which claims to have made one out of every four lights worldwide, says sales of LED lighting grew by 30% last year in an overall market that was worth €700m ($960m). Thanks to a string of acquisitions, its "green lighting" sales grew by 17% last year, with the strongest growth, tellingly, in home lighting.

Another iconic green-home feature is a sleek, black photovoltaic panel on the roof, quietly turning sunlight into electricity. In most modern home-power systems, any excess power can feed into the grid during the day, and the house draws power from the grid only when needed. A true net-zero-energy house requires some onsite power source. Nonetheless, enthusiasm for solar power is not always rational: only with incentives from governments and utilities does it make sense for most homeowners, who sometimes rush into it rather than doing other things first. "No one should be allowed to put a solar system on until every light is a compact fluorescent, and every duct is sealed," says Matt Golden, Sustainable Spaces' founder, who points out that simple measures to reduce demand can be hundreds of times more cost-effective than solar panels.

Once a house is sealed, producing its own power and using it efficiently, its inhabitants are the weak link.

Still, solar power is approaching the point where it will be competitive without subsidies. Mr Harris, at ZEDfactory, says the simple solar-photovoltaic systems his firm sells, which cost around £11,000 ($20,000) installed, pay for themselves without subsidies within seven years—the average period most British homebuyers stay in a house. Directly heating water with solar-thermal energy makes sense more often, especially in areas that do not freeze. Solar water-heaters have recently become mandatory on new construction in Hawaii, and China is now the biggest user of solar-heated water in homes.

But are the residents green?

Once the house is sealed, producing its own power and using it efficiently, its inhabitants become the weak link. Lucid Design Group, a software company in Oakland, California, is trying to fix that. It has developed a web-based

dashboard that uses the data from building-management systems to plot real-time electricity, water and gas usage. Simply visualising energy use this way can prompt homeowners to reduce their usage, says Joe Gotshall, a manager at the company. Lucid's dashboard was first used to pit groups of university students against one another in green dormitories at Oberlin College in Ohio. Mr Gotshall says the competition reduced energy consumption by 55%.

This approach may soon become possible on a much bigger scale when Greenbox, a Silicon Valley start-up, launches its first product in January. Presently in beta testing in Oklahoma, its online dashboard collects data from a new generation of smart meters being rolled out by utilities throughout America. It allows users to see exactly when they are consuming energy and what they are paying for it at any moment, rewarding behavioural change with visible results. Matthew Smith from Greenbox says that using the dashboard in his own home motivated him to spend $20 and 15 minutes plugging in a few power strips to allow him to switch off appliances when not in use. He saw immediately that he would save $100 each year thereafter.

Why had Mr Smith not done this before? Homeowners, it seems, apply unreasonably high discount rates when considering going green. Consumers also tend to undervalue a reduction in their exposure to energy-price increases. But that will soon be difficult to ignore. "When we first started," says ZEDfactory's Mr Harris, "we were very much the loonies in the corner that people giggled about." This winter, the only people laughing will be those who have followed their advice.

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