

# THE URBAN REMODELER

It would be easy to dismiss Mitchell Joachim's fantastical vision for ecological supercities, with their flocks of jetpacks and mass-transit blimps that look like flying monster jellyfish, as science fiction—if he wasn't actually building them

Architect Mitchell Joachim points out, frequently and without prompting, that his futuristic proposals are always based on existing technologies. No wonder he feels the need to say it. Consider some of his ideas: jetpacks tethered together in swarms, houses grown from living trees, low-altitude blimps prowling New York City with chairs hanging below them for pedestrians to hop on and off (24/7 ski lifts on Broadway!), and WALL-E-like machines that erect buildings and bridges from recycled waste.

For Joachim, a 39-year-old professor of architecture at New York University, with graduate degrees from MIT, Harvard and Columbia, these concepts aren't Hollywood fluff but designs that could come to life today. Take his concept for waste-building machines, which he calls Rapid Ref(]use. Instead of the cubes of cardboard, plastic or steel that current recycling balers produce, Joachim's robots would grind and compress waste into I-beams, cruciform columns or even furniture components. The structures would be pressed or melted into shape or wrapped with metal bands, which is what recycling plants do now. All that would change is the shape—like switching the mold on a Play-Doh press, but on an industrial scale. "We could do it yesterday," Joachim insists.

His vision falls under the banner of Terreform ONE, a nonprofit design collective that Joachim co-founded to explore sustainable, fully integrated urban planning. If the same people who design the roads also design the cars, he says, and the same people who create the suburbs also plan for ways to feed and transport residents, our cities will become healthier, friendlier and more sustainable.

The group imagines how future cities might best serve their citizens on a large scale and then experiments with the small-scale materials and designs that it would take to make it happen. To this end, Terreform ONE hosts TerreFarm, an annual summer gathering

of architects and scientists who develop new urban farming techniques. For several weeks this summer, TerreFarm will convert a Brooklyn rooftop into a testbed for modular growing methods, designs for maximizing available sunlight, and ultra-lightweight soil mixes essential for rooftop gardens. They will also build full wall sections of Joachim's Fab Tree Hab, his proposal to create "living" homes by grafting trees together around scaffolds and growing them on-site.

Joachim's other plans tend to focus on mobility, since transportation both shapes and is shaped by urban design. In his vision, individual cars would be replaced by car-share systems that function like luggage carts at an airport. Pay, step into a smart car that communicates with the city grid, drive to your destination, and leave the car there. The cars would have soft, springy exteriors, inflatable protective bladders and transparent foil, which would enable them to bump together as they traveled in flocks. "The idea of sharp metal boxes is just done," Joachim says. "We design cars with the principle that no one would ever die in a car accident again."

Joachim's blimps would move like trolley cars. Their routes would be set by funicular cables, and they would float slowly enough that pedestrians would be able to hop on and off hanging chairs dangling above the ground. Unlike a trolley car, though, the blimps would also be able to cross rivers, gorges and other geographic features without bridges.

His jetpack designs are not the retro-futuristic rocket belts of the 1960s but more like the lightweight ducted-fan jetpacks scheduled to go on sale later this year from Martin Aircraft Company. For efficient commuting, Joachim's jetpacks—soft and flexible like his cars—would be towed in flocks by a plane or blimp. "Bump and glide," as Joachim describes it. From there, individuals could break off, power up, and fly safely to their homes or offices—like subways

in the sky. "It's hard to find people who don't want to be moving around in jetpacks in 20 years," he says. "As an architect, then, I'm responsible for thinking about what the implication of the jetpack is on the future city."

Joachim's willingness to forgo lucrative commercial projects in favor of running a nonprofit dedicated to the reimagining of a future he won't even be around for is, say his colleagues, exactly what makes him so vital. Traditionally, "cities are built incrementally by real-estate interests," says Richard Sommer,



the dean of architecture at the University of Toronto. "What's important about Mitchell's work is that he [takes] a visionary approach."

The vision part involves looking 150 years down the road and planning for how cities will have to operate within the environment if civilization is to endure. Even if the technologies exist today, Joachim says, no one can change the city tomorrow. "Once we heard about cellphones, it was about seven years before we started dropping the landline," he says. "It took about 15 years before you could buy a hybrid

car on every lot. It takes around 40 years to produce a large shift in the way buildings are constructed. Entire cities? It's 100, 150 years."

In the meantime, Joachim is busy producing the stuff that will get us there,

whether it's growing living walls, planting organic lettuce on urban rooftops, or making sure that when your grandkids are ready for their first jetpacks, their cities will be too.

—JOHN BRADLEY

**"AS AN ARCHITECT, I'M RESPONSIBLE FOR THINKING ABOUT WHAT THE IMPLICATION OF THE JETPACK IS ON THE FUTURE CITY."**

NICK KALOTERAKIS



# THE SAND SCULPTOR

With the Sahara desert rapidly encroaching on livestock-nourishing grassland, architect Magnus Larsson proposes a 3,728-mile-long barrier wall—built by bacteria

Could a student architecture project help save millions of Africans from the relentless advance of the Sahara desert, a phenomenon that's fueling drought, starvation and poverty? There's one that has people talking. Borrowing from an experimental solution for firming up building foundations in earthquake-prone areas, Swedish architect Magnus Larsson, 34, has proposed solidifying the sand dunes at the leading edge of the Sahara to create a habitable 3,728-mile-long desert-blocking wall.

Outlandish? Yes and no. In terms of science, the method is proven. Researchers at the University of California at Davis have been investigating the technique—which involves injecting the bacterium *Bacillus pasteurii* into the soil in a calcium-rich, alkaline mix—as a means to stabilize the ground in earthquake-prone regions. In the lab, it can solidify 32 square feet of soil in a matter of hours, although they estimate that it would take up to a few weeks for large-scale solidification.

In terms of geographic breadth, Larsson's proposal, which he submitted as a final-year project while studying at London's Architectural Association, is roughly on scale with the Green Wall of the Sahara, a 23-nation initiative already under way, to contain the spreading desert with a nine-mile-thick barrier of trees extending along the same stretch that Larsson is eyeing. In fact, Larsson sees his project as supporting the Green Wall, literally. His hardened sand wall—up to 1,000 feet deep in some places—would

KEVIN HAND

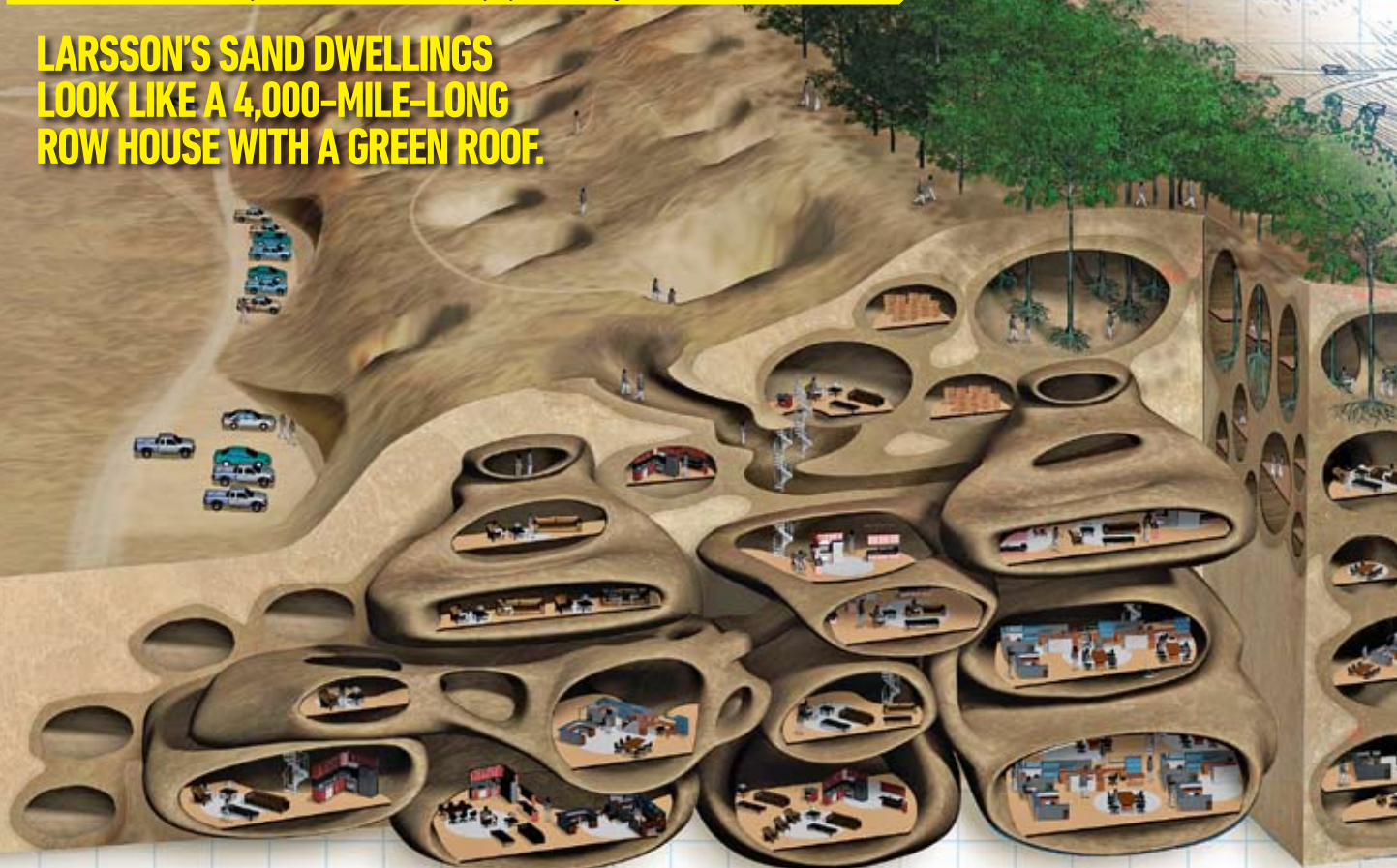
## THE LAZY ENVIRONMENTALIST: NO-SWEAT TIPS FOR GOING GREEN

### Turn Off Energy Hogs from Anywhere—Without Getting Up

For those foggy mornings when you leave the house without turning off the TV, Picowatt plugs let you remotely power down the tube, along with the rest of your electronics and lights. Plug Wi-Fi-enabled transmitters into your wall sockets and connect your electronics. The transmitters relay real-time energy usage and cost data to a personalized Picowatt Web page or to your phone. From there, it's just a few clicks to manage your home's energy consumption. \$80 per plug; [tenrehte.com](http://tenrehte.com)

Josh Dorfman is the author of *The Lazy Environmentalist: Your Guide to Easy, Stylish Green Living*.

**LARSSON'S SAND DWELLINGS  
LOOK LIKE A 4,000-MILE-LONG  
ROW HOUSE WITH A GREEN ROOF.**



provide a more stable base for the trees, with full-scale homes carved out of the dunes. In his drawings, the dwellings look like millions of row houses with green roofs keeping the desert at bay. Solidification, Larsson maintains, would pose few risks to the environment or human health, since it relies on harmless microbes naturally present in marshes and wetlands. The U.C. Davis method simply spurs the microbes to excrete extra calcium carbonate, bonding the sand together tightly like cement.

For now, Larsson is seeking funding for large-scale tests to demonstrate whether and how his method would work. Even if it does, he admits, the implementation would be financially daunting. "The cost would be a ridiculous figure," he says. "It's like asking what it would cost to build the Great Wall of China today. It wouldn't be cheap. But then again, any project attempting to tackle such an ambitious challenge is going to be expensive." —J.B.



# DIAPER FARMER



Willem van Cotthem's super-soil harnesses the power of Pampers to turn dirt into lush gardens

When asked to imagine the Earth in 2040, many scientists describe a grim scenario, a landscape so bare and dry, it's almost uninhabitable. But that's not what Willem van Cotthem sees. "It will be a green world," says van Cotthem, a Belgian scientist turned social entrepreneur. "Tropical fruit can grow wherever it's warm." You still need water, but not much. A brief splash of rain every once in a while is enough. And voilà—from sandy soil, lush gardens grow.

The secret is hydrogels, powerfully absorbent polymers that can suck up hundreds of times their weight in water. Hydrogels have many applications today, from food processing to mopping up oil spills, but they are most familiar as the magic ingredient in disposable diapers. The difference with agricultural hydrogels is that they don't just trap moisture; they let it go again, very slowly, almost like time-release medication, into the root system of plants. That continuity of moisture is what brittle landscapes like deserts need to become fertile again. Water activates a mineralization process, setting free nutrients in the soil so that life can grow.

But water alone won't make gardens flourish in sand. So van Cotthem, an honorary professor of botany at Ghent University in Belgium who has helmed several international scientific panels studying desertification, invented a "soil conditioner" called Terracottem. It's an 8- to 12-inch layer of dirt impregnated with hydrogels, along with organic agents that nourish the natural bacteria in the soil.

Van Cotthem's early experiments with his soil are now literally bearing fruit on every continent except Antarctica. Where Terracottem sits, barren plots of land are now fertile, and have already changed lives. In 2005, UNICEF invited van Cotthem to oversee the construction of "family gardens" in the Sahawari refugee camps in Algeria. Since 1975, thousands of Africans in the camps have lived in tents and shacks, dependent on the World Food Program to provide them with dry and canned goods—a diet that left

them vulnerable to disease. Today more than 2,000 pocket gardens there provide healthy food.

If this technology is so miraculous, you might wonder, why wasn't it developed earlier? After all, disposable diapers have been around since the 1940s. Until only recently, though, hydrogels were toxic, and skeptics doubted that they could ever be made safe for consumption. There was no bigger skeptic than van Cotthem himself—so much so that the day a research engineer from a German diaper company walked into his lab and told him he'd cracked the nut, van Cotthem said to his face, "I don't believe you."

"OK," the engineer said. And he took out a spoon and ate the hydrogel. Van Cotthem was shocked. Then he said to his visitor, "Please come back in a couple of months so that I know you're still alive." Meanwhile, van Cotthem tested the samples, got promising results, and began researching the agricultural uses of hundreds of kinds of hydrogels. When the engineer returned alive, van Cotthem was convinced.

But new soil isn't enough—people still need something to grow in it. Realizing that half the world routinely throws out seeds that the other half needs, van Cotthem also launched a nonprofit organization called Seeds for Food that asks people to mail in their unwanted seeds. "My office right now is full of pumpkin seeds people sent in after Halloween," he says.

Scientists are exploring different uses for hydrogels. Enhanced soils, they believe, could be the key to farms in space. The recipe is simple: a few drops of water and glass-like marbles to provide a kind of scaffolding for roots in the soil. "Suddenly," van Cotthem explains, "you have a rich soil that can support almost anything." But his sights are set firmly on this star system. "I do see the possibility of achieving wonderful things in space," he says. "But let us first solve the problems here on Earth, starting with offering everyone the chance to produce their own food. And we are certainly in a position to do so."

—BRUCE GRIERSON

# THE BIG GUN

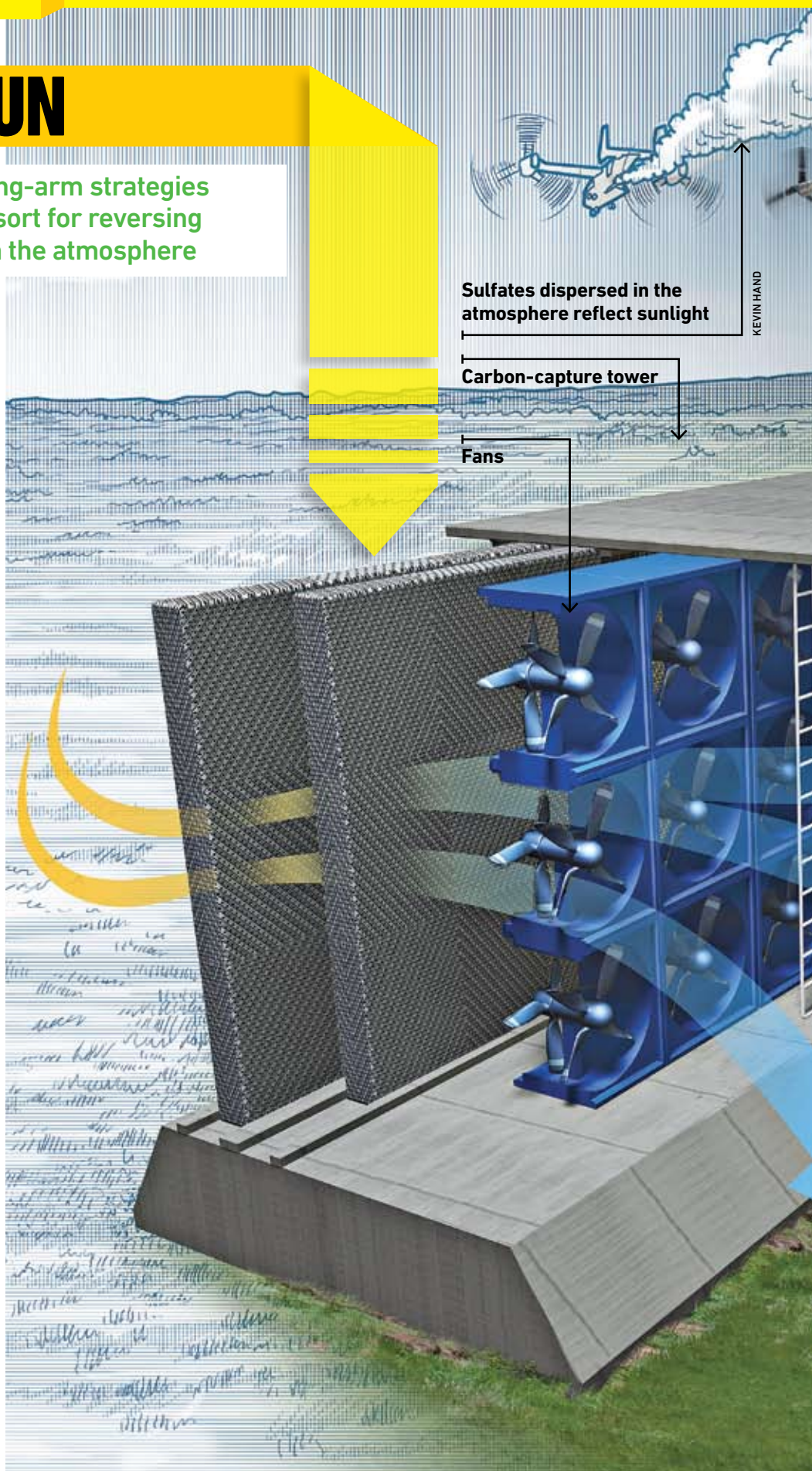
David Keith believes strong-arm strategies could soon be our last resort for reversing record levels of carbon in the atmosphere

In the 1992 film *Unforgiven*, Clint Eastwood spends most of the movie slowly and methodically avoiding violent confrontation with the bad guys before finally turning things around with a bloody burst of gunslinging. That's something like the approach of Canadian physicist and environmental scientist David Keith. Except that his villain is climate change, and while he's still doing everything he can to avoid a fight, Keith is also stockpiling ammo.

"If we do the job we should be doing on cutting emissions, and we are lucky, we won't need geoengineering," says Keith, a professor at the University of Calgary whose start-up company, Carbon Engineering, is developing commercial-scale devices to capture atmospheric carbon dioxide. That's the slow and methodical. "But if we can't control atmospheric CO<sub>2</sub> well enough, then we might want to do the solar stuff." That's the gunfight.

For several years now, Keith, who has served as a member of Canada's blue-ribbon panel on sustainable energy technology and as a member of U.S. National Academy of Sciences committees, has been the leading voice in the call for serious research into geoengineered schemes for cooling the planet. The most common example would be to scatter sulfates in the stratosphere to reflect sunlight away from the planet. The cooling would be immediate and global. We know this, Keith says, because it's happened before. When Mt. Pinatubo erupted in the Philippines in 1991, the resulting plume of sulfuric ash cooled the planet by about 1°F for a year. Carbon dioxide remains in the atmosphere for centuries, and even the most optimistic proposals for CO<sub>2</sub> sequestration would take decades to have an effect. Should we find ourselves faced with an immediate environmental emergency—a shifting Gulf Stream or an impending collapse of the Arctic ice sheets—effective "sunlight mediation" could theoretically be a quick retreat from the edge.

The immediate problems with this, however, are twofold. First, there's an obvious moral hurdle. Most people reflexively reject notions

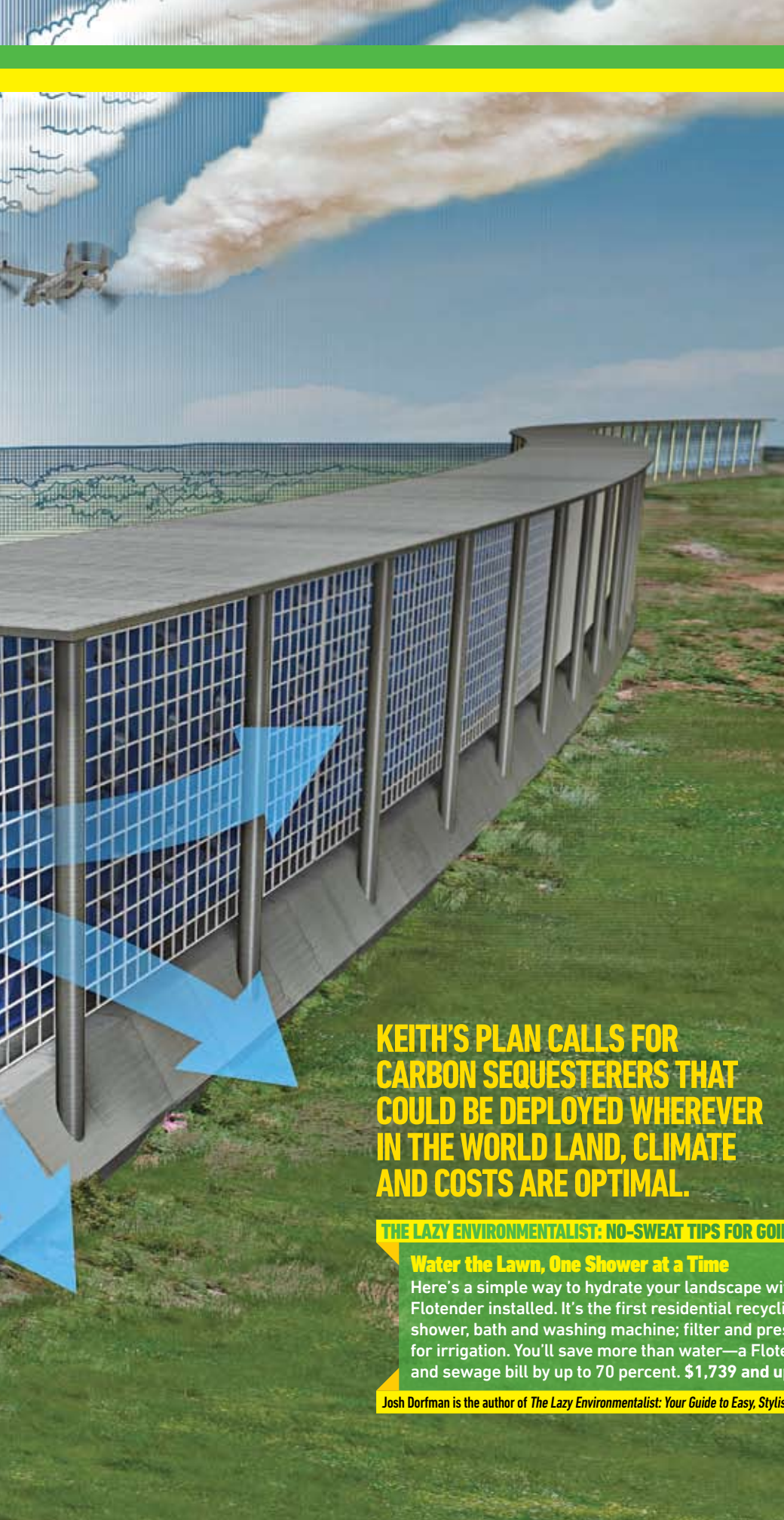


Sulfates dispersed in the atmosphere reflect sunlight

Carbon-capture tower

Fans

KEVIN HAND



of geoengineering for fear that they may cause more harm than good, and undermine efforts to reduce carbon emissions. The other drawback is that the method would be cheap and easy enough that even a rogue nation could pull it off, which leaves open the very real possibility of unilateral action with global consequences.

The real hope is to refine geoengineering methods and develop standards while simultaneously working toward a future in which they would never have to be used. That's where Keith's carbon-sequestration technology comes in. Most carbon-capture systems propose sequestering CO<sub>2</sub> from large facilities such as power plants. Keith's plan, however, is more mobile, calling for towers that could be deployed wherever in the world land, climate, and labor costs are optimal.

These carbon suckers would employ fans to move air through a solution of sodium hydroxide, which absorbs the CO<sub>2</sub>. Inside, lime bonds with the carbon dioxide to form solid calcium carbonate. The reaction releases the sodium hydroxide for reuse in the first step, while the CO<sub>2</sub> could be stored in underground reservoirs that once housed oil and gas or be recycled into gasoline [see page 53].

Keith has proven this process with a test tower 20 feet tall and four feet wide that can capture two tons of CO<sub>2</sub> per square foot annually (roughly equivalent to the yearly output of one American) using less than 100 kilowatt-hours of electricity per ton. His company expects to spend about \$5 million over the next three years refining the technology and investigating how best to scale it up—way up. The ultimate goal is for fields of towers some 300 feet long and 60 feet tall, scrubbing up to 1.1 million tons of carbon a year.

Keith admits that his carbon scrubber is no silver bullet. "We have patents and new ideas," he says, "but the thing you have to get right is cutting emissions. Unless you do that, CO<sub>2</sub> removal will be irrelevant." And if we don't do it quickly enough, the guns may have to come out.—J.B.

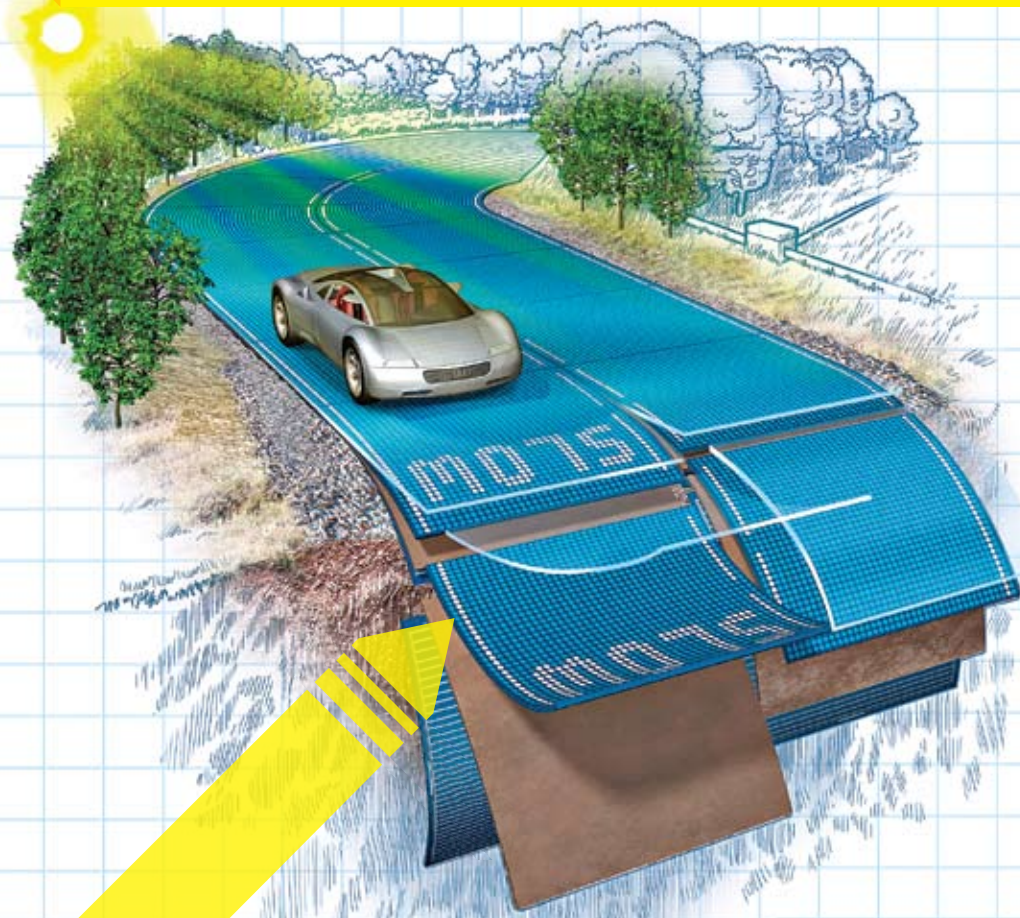
**KEITH'S PLAN CALLS FOR CARBON SEQUESTERERS THAT COULD BE DEPLOYED WHEREVER IN THE WORLD LAND, CLIMATE AND COSTS ARE OPTIMAL.**

#### **THE LAZY ENVIRONMENTALIST: NO-SWEAT TIPS FOR GOING GREEN**

##### **Water the Lawn, One Shower at a Time**

Here's a simple way to hydrate your landscape without lifting a finger: Have a Flotender installed. It's the first residential recycling system to capture water from the shower, bath and washing machine; filter and pressurize it; and channel it to the yard for irrigation. You'll save more than water—a Flotender can reduce your annual water and sewage bill by up to 70 percent. **\$1,739 and up; [flotender.com](http://flotender.com)**

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# THE SOLAR ROADRUNNER

Highways baking in the hot sun are wasted energy. Scott Brusaw's solution? Make them out of solar panels

**The road ahead** is paved with photovoltaics. That's how Scott Brusaw sees it, anyway. His company, Solar Roadways, is embedding PV cells and LED lights into panels engineered to withstand the forces of traffic. The lights would allow for "smart" roadways and parking lots with changeable signage, while the cells would generate enough energy to power businesses, cities and, eventually, the entire country.

Each 12-by-12-foot Solar Roadway panel would produce about 7,600 watt-hours a day, based on an average of four hours of sunlight. At that rate, a one-mile stretch of four-lane highway could power about 500 homes. "If we could ever replace all the roads in the U.S., then, yeah, we would produce more electricity than we use as a nation," says Brusaw, an electrical engineer who completed his first prototype panel in

February with funding from the U.S. Department of Transportation.

Brusaw's goal is to get the cost per panel under \$10,000. That's roughly three times the cost of asphalt. But he wants to make panels that last three times longer than asphalt roads, which have to be resurfaced every 10 years in many places. "Then the cost is about the same," he says. "But that's just a break-even. We're also generating electricity."

The key to commercial viability will be the panels' glass. It must be textured for traction, embedded with heating elements for melting away ice and snow, and able to survive years of traffic. "The toughest is going to be that fast lane on the highway," Brusaw says, "where you've got a 40-ton truck, maybe with snow chains. It will have to be able to withstand all that." At the same time, it has to be self-cleaning if sunlight is to reach the PV cells; Brusaw points to experimental hydrophilic glass that uses sunlight to break down organic dirt, and rainwater to wash it away without streaking.

Next up for Solar Roadways will be qualifying for Phase II funding, a two-year, \$750,000 deal to develop a commercial plan for the panels. At the end of those two years, Brusaw would like to be ready for testing in parking lots, which he sees as the perfect proving grounds for the lights and the power-generation system. Directional arrows and parking lines could be reconfigured to deal with busy times, and the electricity generated could feed adjacent businesses. "I talked to the guy in charge of power for Wal-Mart," Brusaw says. "Superstores are roughly 200,000 square feet, and parking lots are about four times that. I crunched the numbers for an 800,000-square-foot lot and told him how much power it could generate even if it was completely full of cars. It was 10 times the power they use."

Brusaw wants to start smaller, though—on the scale of, say, a fast-food restaurant. A McDonald's retrofitted with a solar parking lot could take itself largely or entirely off the grid or become a site for recharging electric vehicles (while the owners stopped inside for food, naturally). "Even the best electric cars have a range of about three hours," he explains. "But if all I have to do is find a McDonald's, I could drive from Idaho to the southern tip of Florida." Improbable? Yes. But "Billions of watts served" would be a cool new tagline.—J.B.

## THE LAZY ENVIRONMENTALIST: NO-SWEAT TIPS FOR GOING GREEN

### Get Paid to Save Money on Your Utility Bill

The My Emissions Exchange Web site challenges homeowners to conserve energy and calculates the equivalent amount of carbon emissions avoided. Reduce your electric bill by about \$200, for instance, and you'll generate a carbon credit, which is equal to roughly one ton of carbon saved. My Emissions Exchange sells the credit on your behalf on the voluntary carbon market at a going rate of between \$10 and \$25, taking a 20 percent cut on all sales. The rest goes into your PayPal account. [MyEmissionsExchange.com](http://MyEmissionsExchange.com)

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# THE CARBON SLAYER

Jeffrey Martin's closed-loop plan for recycling heat-trapping carbon emissions into gasoline

**Into the category** of things that sound too good to be true, add Green Freedom. If the scientists behind this federally funded proposal are correct, we'll be able to continue driving gas-powered cars and flying in gas-powered aircraft indefinitely, in a closed, net-zero-emissions system that won't contribute to global warming.

An outgrowth of research into cleaner fuels for the U.S. Air Force, Green Freedom proposes a network of nuclear power plants that would capture carbon dioxide from the atmosphere and chemically convert it into gasoline, all with existing technologies. "We're not taking anything out of the ground, not making things any worse, not using fossil fuel to create fuel," explains F. Jeffrey Martin,

the Los Alamos National Laboratory nuclear scientist behind the proposal. "The whole thing is carbon-neutral."

By that, Martin means that the system releases only as much carbon as it captures. Since mobile sources, such as vehicles and planes, account for half of all carbon emissions, his recycling program, if rolled out nationwide, could dramatically reduce the strain on the environment and allow sequestration technologies to start cleaning up the atmosphere instead of just slowing the rate at which we damage it.

The catch? To collect and process enough CO<sub>2</sub> to fuel the entire country, would require building 500 new nuclear power plants, each with the ability to produce 714,000 gallons of

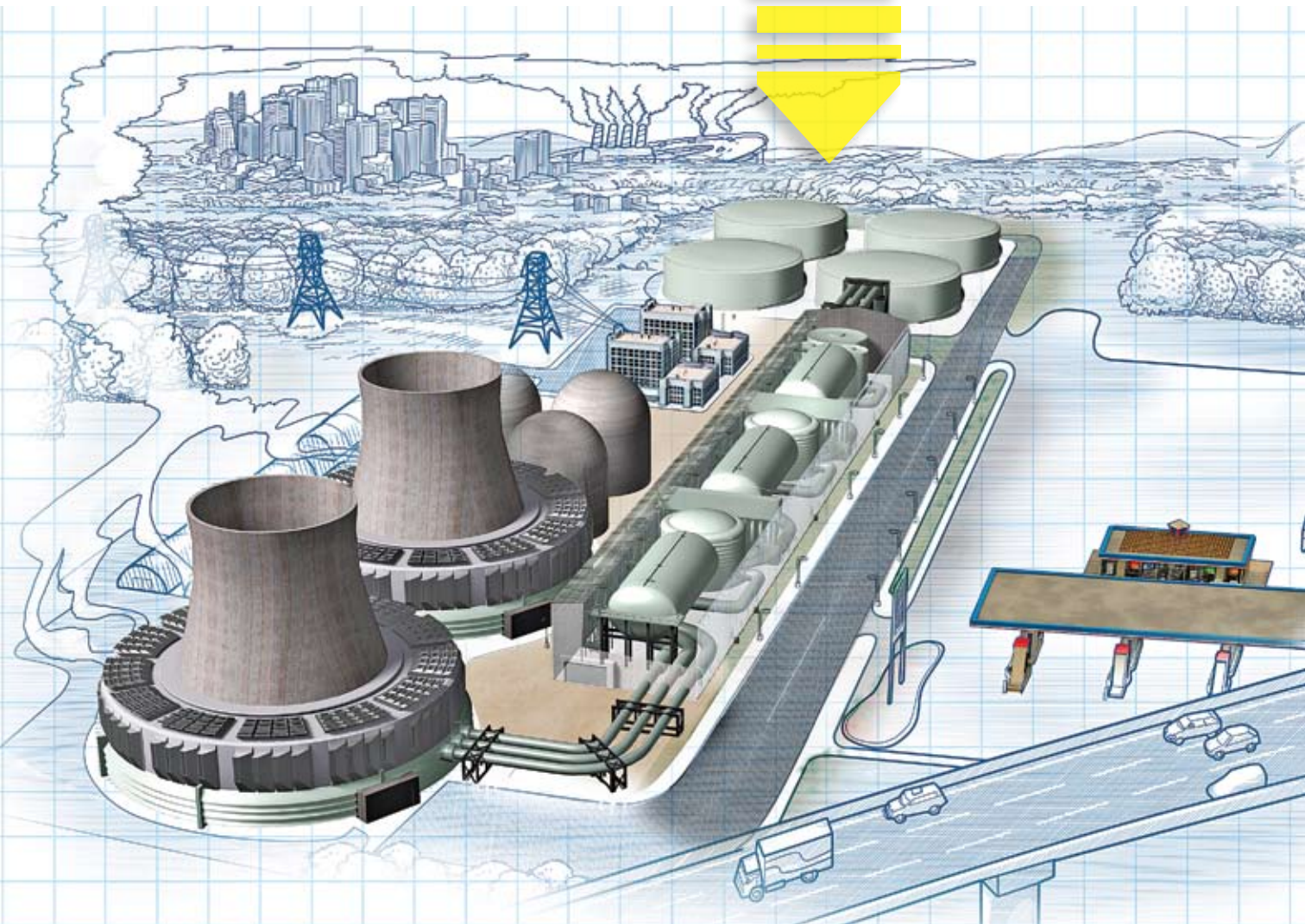
gas. Today there are only 104 nuclear plants, and those would need to be retrofitted. "We haven't built a nuclear power plant in the U.S. in 30 years," Martin says, "so we'll have to get through that transition first." In the meantime, he believes, we could offset our annual declines in domestic gas production with just nine new plants.

The key is turning nuclear cooling towers into giant CO<sub>2</sub> suckers. Normally, the towers inhale air to cool hot water from the reactors. With Green Freedom, they would pass the air over a solution of potassium carbonate added to the cooling liquid. "Potassium carbonate is like a vacuum for CO<sub>2</sub>," Martin explains. To extract the CO<sub>2</sub> for recycling, he proposes an energy-efficient electrochemical process that produces only hydrogen as a by-product.

With earmarked funds secured by Texas senator Kay Bailey Hutchison, Green Freedom has plans to build a demonstration facility at a nuclear power plant set for construction in West Texas. If all goes as planned, the plant will begin producing power and gas in 2018, serving as a model for the rest of the country.—J.B.

**Nuclear cooling towers, which can be as tall as 650 feet and as wide as 330 feet, would suck in carbon dioxide from the air.**

KEVIN HAND



# THE NUCLEAR REVIVALIST

For environmentalist Jesse Ausubel, going green means land conservation and energy efficiency—and forgetting “boutique” renewables like windmills and biofuels

**It's 2070.** You're on a train from New York to Boston. If you could see outside, it would be mostly open landscape. Maybe a nuclear plant or two, but otherwise green space—none of the urban sprawl, wind farms, solar arrays or biomass operations we've been taught to expect from an ecologically responsible future. But you can't see outside, because you're underground, traveling 300 miles an hour on a maglev train alongside superconducting pipes transporting the energy from those nuclear plants.

This is 2070 as Jesse Ausubel sees it, anyway, and his vision—a brazenly pragmatic one that puts land conservation and energy efficiency above all else—isn't making him a lot of friends in the environmental movement. “Some of my colleagues have put forth what are called green or renewable solutions or technologies, and they're OK at a boutique scale—single households,” says Ausubel, who is director of the Program for the Human Environment at the Rockefeller University in New York City. “But when you look at two billion households, you find out that the solution isn't green at all. Things that work on a boutique scale don't necessarily work for billions of people and terawatts of power.”

Simultaneously a technology-loving futurist and an ardent naturalist, Ausubel points out that a wind farm delivering the same energy as a 1,000-megawatt nuclear plant would cover 308 square miles; a solar plant, 58. Even organic farming, he suggests, is justifiable in the context of landscape preservation only if the per-acre yields equal those of conventional farming.

Dismissing moves toward renewable and organic initiatives as misguided flies in the face of green dogma. Papers and presentations with titles

like “Fallout from Renewables and Consequent Directions for Energy Research” and “Does Climate Still Matter?” haven't helped Ausubel's standing in the mainstream green movement.

But although environmentalists may disagree with him, they can't simply write him off. In addition to his role at Rockefeller, Ausubel is vice president of programs for the Alfred P. Sloan Foundation, where he oversees the Census of Marine Life, a 10-year, 80-plus-nation effort to catalog the biodiversity of the world's oceans. As a fellow at the National Academy of Sciences in the late 1970s, he was, he says, “one of the first half dozen or so people to be paid full time to work on global warming.” He was also one of the organizers of the first U.N. World Climate Conference in 1979. The man has earned the right to have opinions.

Ausubel has spent most of his career modeling a future that assumes a population of about 10 billion—what many experts believe the world will bear over the next century—and reasoning backward from there to explain how such a world could be powered and fed, and how much land could be spared for nature.

Part of what alarms his critics is how *un-*alarmist his conclusions have turned out to be. For example, instead of using policy to change how people will behave in the future, Ausubel prefers exploring technological responses to what he believes people are going to do regardless. His favorite defense of this laissez-faire approach is to explain that, absent any policy dictating that it should happen, energy consumption over the past 100 years has steadily “decarbonized.” That is, humankind has moved to fuel sources with progressively better ratios of carbon atoms to

hydrogen atoms—wood at 10:1, coal at 2:1, oil at 1:2, natural gas at 1:4 and, eventually (in the future Ausubel envisions) 100 percent hydrogen. He thinks technology inevitably improves things. “That's not to say I don't worry about the downsides of technology,” he says. “A lot of my work is about that. But my general interest is new and high-tech ways of dealing with problems.”

The high-tech world in 2070, as Ausubel sees it, will look something like this:

**ENERGY:** Within a few decades, after methane plants have replaced coal plants, according to Ausubel's decarbonization model, the move is on to full nuclear. His plants would produce electricity during peak daytime hours and be used to dissociate water to make hydrogen by night. “With the nuclear industry making two products instead of just one,” he says, “the economics become more attractive.”

Where to get all the uranium for the hundreds of new nuclear plants that Ausubel's world would require? Extracting it from oceans, he believes, could supply enough energy for 10,000 years or more. The low concentrations in seawater—about 3.3 parts per billion—make the extraction process difficult, but Japanese researchers have successfully mined uranium from ocean currents, although not yet at costs that would be economically feasible.

**NUCLEAR WASTE:** Ausubel cites Russian and British research into “self-sinking balls” of nuclear waste with shells most likely made of tungsten and heated by their radioactive contents to the point where, once disposed of in deep holes in the Earth's crust, they would melt the surrounding lithosphere and bury themselves several miles deep. “Nuclear waste is hot and heavy,” he says. “The idea of self-sinking capsules takes the heat and gravity as positive attributes. The idea is quite straightforward.”

While the capsules remain theoretical for now, Michael Ojovan, an engineer at the University of Sheffield in England who has published extensively on the concept, says that in addition to removing waste, acoustic monitoring of the capsules could reveal data about the

## THE LAZY ENVIRONMENTALIST: NO-SWEAT TIPS FOR GOING GREEN

### Pawn Your Old Electronics

As a lazy environmentalist, chances are you could use some added incentive to recycle your used electronics. So here it is: *Gazelle.com*, a service that pays you for your unwanted gadgets and keeps them out of landfills. Type your device's model number into the site's search box and fill out a few fields relating to its condition. *Gazelle* displays your device's market value and sends you a prepaid shipping box. Once the company verifies the device's condition, it cuts you a check—on average \$100. [gazelle.com](http://gazelle.com)

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structure of the Earth's interior. "The [scientific] importance of launching such a capsule is on the order of an expedition to Mars," he says.

**TRANSPORTATION:** It's all fuel-cell cars and planes (using hydrogen from the nuclear plants) and maglev trains. "Take the problem of airport congestion," Ausubel says. "Having planes take off every 20 or 30 seconds is hard. But you could subtract all those shuttle flights from high-flux routes like New York-Boston by connecting them with maglevs. Put those shuttle routes underground with the maglevs, and save the runway slots for the routes where

you can't justify building expensive tunnels."

And why tunnels? "I want to leave the surface alone. Disturb it as little as possible." In fact, he has even proposed dual-use tunnels that would put both the maglevs and the superconducting lines of a future energy grid underground.

Train tunnels, of course, are older than the New York subway. China's commercial maglev train can zip passengers along at 300 miles an hour, and the U.S. Department of Energy is pouring millions of dollars of economic-stimulus funds into superconductor research. It all comes back to Ausubel's core concepts: The best way to save

nature is to stop extending into it. The best way to limit human encroachment on nature is through hyper-efficient land use. And the best route to maximum efficiency is through technology. "A lot of other people who come from strictly biological or ecological backgrounds just don't like machines," he says. "I do."—J.B.

What to do with nuclear waste? One proposal is to bury it 37 miles beneath the ocean floor, letting its radioactive heat melt through the rock.

Lagoon in the Pacific Ocean

Nuclear barge

Borehole

Tungsten shell

Radioactive waste melts rock as it descends until it reaches the lithosphere, 37 miles down

Disposal shaft

1 mile (surface to bottom of lagoon)

Basaltic rock

