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**Go Green, Get Rich**

Full coverage

## 8 technologies for a green future

These futuristic projects promise to make the world greener, while making entrepreneurs some green.

By [Saheli Datta](#) and [Todd Woody](#), Business 2.0 Magazine  
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**BUSINESS 2.0**  
 MAGAZINE

SAN FRANCISCO (Business 2.0 Magazine) -- The planet's most pressing environmental problems - global warming, energy shortages, over fishing, pollution - may seem just too big to be solved with today's technology. But don't despair: A lot of bright minds are working on futuristic projects that promise to make the world greener while making entrepreneurs some green.

It's save-the-world stuff like toxic-waste-eating trees, smart electricity grids, oceangoing robots, and floating environmental sensors. Then there's the alternative-energy home fueling station that could jump-start the long-awaited hydrogen economy. This technology may seem far out - but it will probably be here a lot sooner than you think.

### 1. Home hydrogen fueling station

What could be cooler - or greener - than a hydrogen car in your driveway? Try a solar-powered hydrogen fueling station in your garage. Scientists in Melbourne, Australia, have developed a prototype of such a device. It's about the size of a filing cabinet and runs on electricity generated by standard-issue rooftop solar panels.

The first version of the home fueling station is expected to produce enough hydrogen to give your runabout a range of some 100 miles without emitting a molecule of planet-warming greenhouse gas. Road trips are out of the question, but it's enough juice for running suburban errands or powering fleets of urban delivery trucks.

"You don't need a hydrogen infrastructure to introduce the hydrogen economy," says Sukhvinder Badwal, a veteran fuel-cell scientist leading the project at Australia's Commonwealth Scientific and Industrial Research Organisation.

The solar-fired fuel-station-in-a-box leapfrogs two big obstacles to the much-hyped hydrogen economy. One is the multibillion-dollar expense of building national networks of pipelines and fuel stations to replace the corner Chevron.

The other is the fact that today most hydrogen is produced by burning fossil fuel to create hydrogen gas - not exactly a clean and green process. The home hydrogen fuel station solves those problems in one package that Badwal hopes will ultimately sell for about \$500.

The heart of the fuel station is an electrolyzer - essentially a fuel cell run in reverse. An electric current from solar panels (a home wind turbine would also do the job) separates water into hydrogen and oxygen. The hydrogen is compressed and stored, ready for use in a fuel-cell car or an electric/hydrogen hybrid with an engine converted to run on the gas.

CSIRO is in talks with potential commercial partners, so Badwal's lab is off-limits to visitors. But on his computer screen, he reveals a box that would fit easily in the corner of a garage next to the mountain bikes.

Real-world tests of the home fueling system were to begin early this year at RMIT University in Melbourne, with commercial trials two years off. Obstacles remain, including the cost of hydrogen cars, but the technology could go a long way to making the family wagon carbon-neutral. (Read more about home hydrogen fueling stations on the [Green Wombat Blog](#)).

### 2. Environmental sensor networks

Call it the networked environment. Picture tiny - we're talking small as a dime - wireless sensors lining lake beds and ocean floors, buried in the ground, and floating in the air. All the time sniffing the air, water, and soil for chemicals and pollutants and detecting changes in temperature and pressure.

The payoff: real-time data on a variety of phenomena that affect the economy and society - climate change, hurricanes, air and water pollution. Scientists are capitalizing on advances in wireless tech and nanotechnology to build networks of these environmental sensors.



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Arizona State University scientist Joe Wang has already deployed them in San Diego Bay and the canals of Venice to keep watch on heavy-metal levels and mercury contamination. Researchers at the University of British Columbia and the University of California at Berkeley, meanwhile, have created a coin-size solar cell that could power the transmitters for sensor networks that one day might monitor a river or a bay for leaking pipelines.

Cooler yet are solar-powered sensors that hover in the air. Ensco, a technology company based in Falls Church, Va., is developing a beach-ball-size gadget that gets its juice from thin-film solar panels and would measure weather patterns by probing the curve of a jet stream or the interior of a hurricane.

### 3. Toxin-eating trees

Plant a forest, clean up a Superfund site. That's the idea behind phytoremediation, a technology that uses vegetation to absorb hazardous waste from industrial plants and other pollutants.

The technique has been around for years but hasn't proven very effective. Now there's a new twist that promises to make toxic dumping grounds green in more ways than one.

Researchers at York University in Britain have identified bacteria living in the roots of poplar trees that produce an enzyme that zaps residue from RDX, a chemical compound used by the military and industry. The scientists are working on ways to genetically engineer the enzyme to boost the tree's ability to suck up toxic waste. So don't be surprised if you start seeing forests sprouting on old military bases.

Meanwhile, a team from the University of Georgia has transplanted a gene from bacteria that helps neutralize mercury contamination into a common flower. The result: a solar-powered bioremediation system that smells nice too.

### 4. Nuclear waste neutralizer

Forget Three Mile Island, Chernobyl, and Homer Simpson. Nuclear energy is making a comeback, and it's now being touted as a greenhouse-gas-free solution to global warming. But one big problem remains: What to do with untold tons of radioactive waste that will be red-hot for hundreds of thousands of years?

The answer: Recycle it. But not with current nuclear-waste-reprocessing technology, which leaves behind an unfortunate by-product - weapons-grade plutonium. Instead, scientists at the government's Argonne National Lab near Chicago are devising a chemical technology called Urex+ that extracts reusable uranium and separates out cesium, allowing four times as much waste to be packed into nuclear burial grounds.

Such technology would at last make a nuke-plant-building boom ecologically feasible, but that's far from the only benefit. It would also leave the plutonium encased in other elements, rendering it all but useless to terrorists, North Korean dictators, and other evildoers. In addition, plans are afoot for a new type of nuclear reactor that could burn the reprocessed waste as fuel. But the inevitable fight over a nuclear revival is some time off - it'll be five to 10 years before the waste-reprocessing technologies are ready for prime time.

### 5. Autonomous ocean robots

The world's seas are in an ocean of trouble: climate change, vanishing fish, coral bleaching. Just keeping tabs on an airless environment that covers three-quarters of the earth's surface is a bit like exploring a distant planet. Which means it's best to send in the robots.

Unfortunately, today most oceangoing bots are big, dumb, and expensive. They need to be tethered to boats and operated by humans who collect paychecks. But not the Starbug. Under development in Australia, the 4-foot-long yellow robot operates autonomously and is highly maneuverable, thanks to its innovative thruster technology and robotic vision.

According to the robot's designer, scientist Matthew Dunbabin of CSIRO, the Starbug will monitor water quality, map fish habitats, and survey threatened coral reefs. It could also be deployed to detect drops in fish populations, as well as being dispatched to help with underwater gas and oil exploration.

Rather than relying on costly sonar, the Starbug "sees" its surroundings. Its cameras and the onboard Linux operating system let the robot identify and count, for instance, marine pests that are killing off parts of the Great Barrier Reef, a 135,000-square-mile ecological cash cow that generates \$8.3 billion annually in tourism revenue.

With the robot's initial cost at an estimated \$24,000, Dunbabin envisions fleets of Starbugs launched from shore or small boats. His team is now building the next-generation Starbug, which should start rolling off the assembly line late this year.

### 6. Sonic water purifier

Here's a sci-fi solution for an age-old problem that leaves 1.1 billion people without access to clean water: Beam ultrasound waves into polluted water, blowing up the cellular walls and carbon bonds of contaminants. What's left is a cool drink of fresh H<sub>2</sub>O.

Filters and chemicals are normally used to purify dirty water, but researchers are experimenting with ultrasound technology as a cheaper alternative. Ultrasound waves have already been used to break up sewage in sanitation systems.

Now that the probes that produce the sound waves are getting more powerful, however, scientists are retooling the devices to decontaminate large tanks of water, a process called sonolysis.

The goal is twofold. First, portable sonolysis machines could be deployed to isolated villages in developing countries. In urban areas, meanwhile, sonolysis could treat water tainted with industrial pollution. Scientists like Villanova University's Rominder Suri are studying how sound waves can break down chemicals into less harmful components, detoxifying wastewater.

## 7. Endangered-species tracker

Old: Save the whales! New: Web 2.0 those whales, and then clone 'em! There are more than 16,000 known threatened animal and plant species; their plights worsen each year as deforestation, development, and climate change take their toll.

Conservationists are looking to tag endangered animals like the Amazon's piglike white-lipped peccary with radio frequency ID tags and GPS sensors, and then use Web 2.0 mashup techniques to overlay their locations and map details of their habitats and habits with other landscape features. The plan is to identify and design better wildlife preserves to ensure the survival of species edging toward extinction.

For animals on the brink of oblivion, brave-new-world steps are being contemplated. In 2003, scientists cloned an endangered banteng cow, and XY Inc. of Fort Collins, Colo., has developed sperm-sorting technology that could one day be used for sex selection in endangered species to boost captive breeding programs. India, meanwhile, is setting up a laboratory to cryopreserve the sperm and DNA of rare Bengal tigers and other animals so they can eventually be cloned.

## 8. The interactive, renewable smart power grid

California utility [Pacific Gas & Electric \(Charts\)](#) is developing the electricity grid of the future, one that will look more like the Internet - distributed, interactive, open-source - than the dumb, one-way network of today that pushes dinosaur molecules from a carbon-spewing power plant to your home.

Hal LaFlash, PG&E's director of renewable-energy policy and planning, gave *Business 2.0* a preview of the technologies and energy sources that utilities will tap for the power grid of tomorrow.

**Solar stations** Large-scale plants using new thermal and photovoltaic technologies will operate in Southern California and the desert Southwest.

**Solar buildings** As solar cells are integrated into rooftops, walls, and windows, homes and office towers will become miniature power stations, generating their own electricity and feeding excess power back into the grid.

**Wind power** Anywhere the wind blows is a potential site for a turbine, but the Great Plains is the place utilities are eyeing for giant wind farms.

**Wave power** PG&E is looking at the Northern California coast for potential sites for wave energy generators. The Northeast coast is another prime source of as-yet-untapped wave power.

**Cow power** California has 1.7 million cows and more than 2,000 dairies. A dozen dairies have already installed methane digesters to turn cow manure - a source of one of the most destructive greenhouse gases - into electricity. The digester extracts methane gas from cow poop and uses it to power an electricity-generating turbine. Other dairies have plans to produce a bovine biogas that will be piped to power plants.

**Car power** PG&E is developing technology that will allow future "plug-in" hybrid vehicles not only to recharge their batteries but also to feed electricity back into the power grid during peak demand.

**Clean-coal plants** Located mainly in the East and Midwest, these plants will gasify coal, stripping it of pollutants. Carbon dioxide will be captured before it can be released into the atmosphere.

**Smart grids** Interactive power grids will communicate with smart agents embedded in household appliances, allowing power to be distributed where it is needed most.

*For the latest news on green tech, turn to Todd Woody's blog, the Green Wombat: [BUSINESS2.COM/GREENWOMBAT](http://BUSINESS2.COM/GREENWOMBAT).*

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