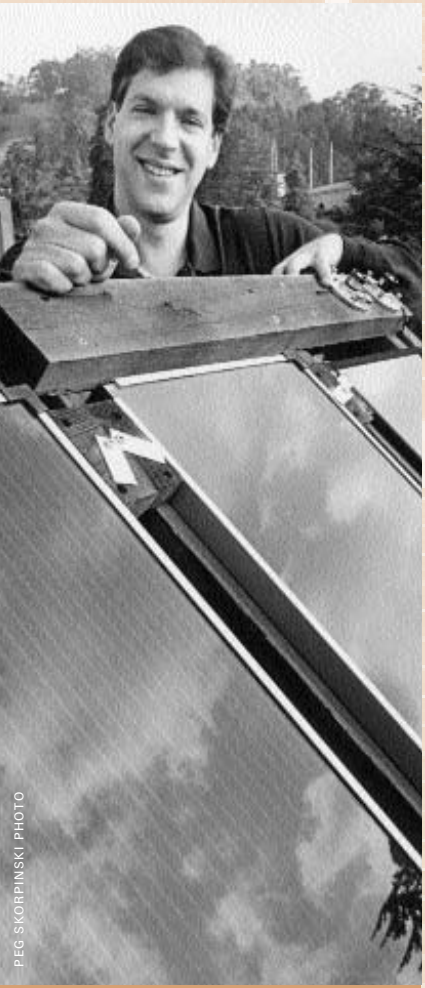
Hydrogen-powered vehicles do more than run on clean energy, they generate electricity

The fuel cell vehicle's day may be dawning



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High-efficiency solar panels, such as these, could be used to produce hydrogen to power a fuel cell vehicle.

For years, advocates of alternative energy have decried using oil to fuel our power plants and vehicles. Drilling for oil creates environmental havoc, critics charge. Burning oil produces noxious air emissions and contributes to global warming, they continue. Besides, our oil-guzzling ways make us dangerously dependent on foreign oil and the foreign powers that control it.

But solutions to America's thirst for speed, power, and electrical gadgetry have been elusive. Electric cars are often a big draw at auto shows, but such vehicles are still extremely scarce on the roadways. Electricity produced by wind and solar energy has, until recently, been more expensive than that produced by fossil fuel-powered plants. And while conservation has reduced our oil use significantly – especially in California – there are limits to how much Americans can keep the lights low, the appliances off, and their cars at home.

For many, this has looked like an unsolvable mess. But for Daniel Kammen, Berkeley professor of nuclear engineering, energy and resources, and public policy, the solution is simple: develop cars that not only run on "clean energy," but also generate "clean electricity." "And," says Kammen, "develop and promote them now."

Kammen, who directs the Renewable and Appropriate Energy Laboratory (RAEL), has been analyzing the benefits of such cars for years – one aspect of his ongoing work on the environmental, health, and economic impacts of energy use in industrialized nations and third world countries.

He and several colleagues released a paper last year showing that fuel cell vehicles (FCVs) – cars that generate electricity from fuel cells – can serve a dual role: powering your car as well as supplying electricity at competitive rates, especially in office buildings. "We surprised ourselves by the results," says Kammen with a grin. "We didn't realize the potential would be so great."

The idea of using fuel cells, which convert the energy in a fuel like hydrogen and oxygen into electricity, is not new. Back in 1839, Sir William Grove, an English scientist, discovered that by combining hydrogen and oxygen, he could produce water and electricity. Years later, in the 1950s, Francis Bacon used Grove's earlier discovery to develop a hydrogen-powered fuel cell that could power a vehicle. Then during the 1960s, Pratt & Whitney went a step further, and developed fuel cells to create electricity for the Apollo space missions.

"After that, some power companies expressed interest in using stacks of fuel cells to generate electricity," Kammen says, "but it was too costly. Now we're finding the real cost-effectiveness lies in having people generate their own electricity with their own fuel cells."

Fuel cells could provide a transition from fossil fuels to renewable sources of energy, according to Kammen, who has explored

the intersection of energy use and society since his graduate school days. Fuel cells use an electrochemical reaction to produce electricity, rather than moving parts, so the cells are quiet. And since there is no combustion, they generate no air pollution or greenhouse gases. And because fuel cells are so thin – as thin as a piece of paper – they can be stacked together to produce a lot of electricity within a small space. That stackability – or "scaleability" – means fuel-cell vehicles will have the get up and go that electric cars currently lack.

You can also produce extra electricity from them. Rather than thinking of fuel cells in the traditional model of energy production – in which a utility generates electricity from a centralized location, then transmits it to millions of consumers – Kammen envisions consumers using their FCVs to generate electricity for local neighborhoods and businesses right from their own garages.

Here's how it works. At the end of the day, you drive your FCV home from the office. The fuel cell you'd be using would, most likely, run on hydrogen, derived, at least initially, from natural gas supplied by filling stations. Once inside the garage, you plug your car into an electrical outlet – no ordinary electrical outlet, but one that sends electricity *into* the grid, rather than pulling it *out* of the grid. Then the fuel cells begin generating electricity.

Using FCVs to generate electricity for just one home is not all that efficient, Kammen concedes. But an FCV could easily generate enough electricity to light up several homes, even an office building. To do that, drivers would motor to work in their FCV, park in a fuel cell plug-in station, and pump electricity into the company's building.

It appears to be a clean, efficient solution. And, says Kammen, it's a solution that could put money back into consumers' pockets, if FCV consumers are reimbursed for their electricity, either by their utility company or their employer. In one back-of-the-envelope calculation, he predicted consumers could earn between $200 and $1,000 a year, rather than paying $500 to $1,200 in annual utility fees.

Equally important, such "distributed generation" (rather than centralized power production from a power plant) could "radically transform the way we see and use electricity," Kammen says. "If production is closer to where the electricity is used, we'll waste less electricity during transmission. What's more, we can avoid building new power plants and vastly increase the security and reliability of our electricity system."

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Kammen wires up a solar panel, adjusting the device that measures how much sunlight the panel absorbs; all this in the treetops of his Barrows Hall roof lab.

Consumers' fuel cell vehicles could generate electricity for local businesses right from their own garages.

Kammen knows that moving toward a world where energy production relies neither on internal combustion engines nor centralized power production is a Herculean undertaking – one that involves moving mountains in the form of car companies and government agencies, not to mention consumers. California, Kammen notes, may be the ideal place to start. The Zero Emissions Requirement of 1994 has made the need for clean-running cars mandatory; and the state-wide energy crisis of 2001 raised consumer awareness to new levels.

"Instead of revamping an inefficient, antiquated grid that relies on 1940s technologies, we should replace it with distributed generation," Kammen says. "And it doesn't have to be done overnight. We can update the system neighborhood by neighborhood, but only if the utilities or other startup companies are afforded the market opportunity."

Just how soon FCVs could be on the market is unclear. Several car companies say they will release FCVs in the next few years. And earlier this year the Bush administration announced it would back the development of "clean" vehicles powered by fuel cells. It could be, says Kammen, that we will see FCVs on the road by the end of next year. F

Written by Susan Davis, whose father helped design the Apollo fuel cells. A Bay Area writer and editor, Davis has written on environmental issues for Intel Corporation, Lawrence Berkeley National Laboratory, and The Nature Conservancy. She co-authored *The Sporting Life*, a book on the physics of sports, as well as several books on playing with children, and has contributed to *Sports Illustrated*, *Parenting*, and *Ladies Home Journal*.