FUELING THE FUTURE

Fossil fuels may go the way of the dinosaur.

BY ROBERT C. STEMPEL

■ I spent the first 35 years of my career helping to bring people great transportation options. I've spent the last 10 trying to ensure that my children, and their grandchildren, enjoy even better ones.

Better options are essential. Today there are more than 6 billion people on the planet. Only about 12 percent have

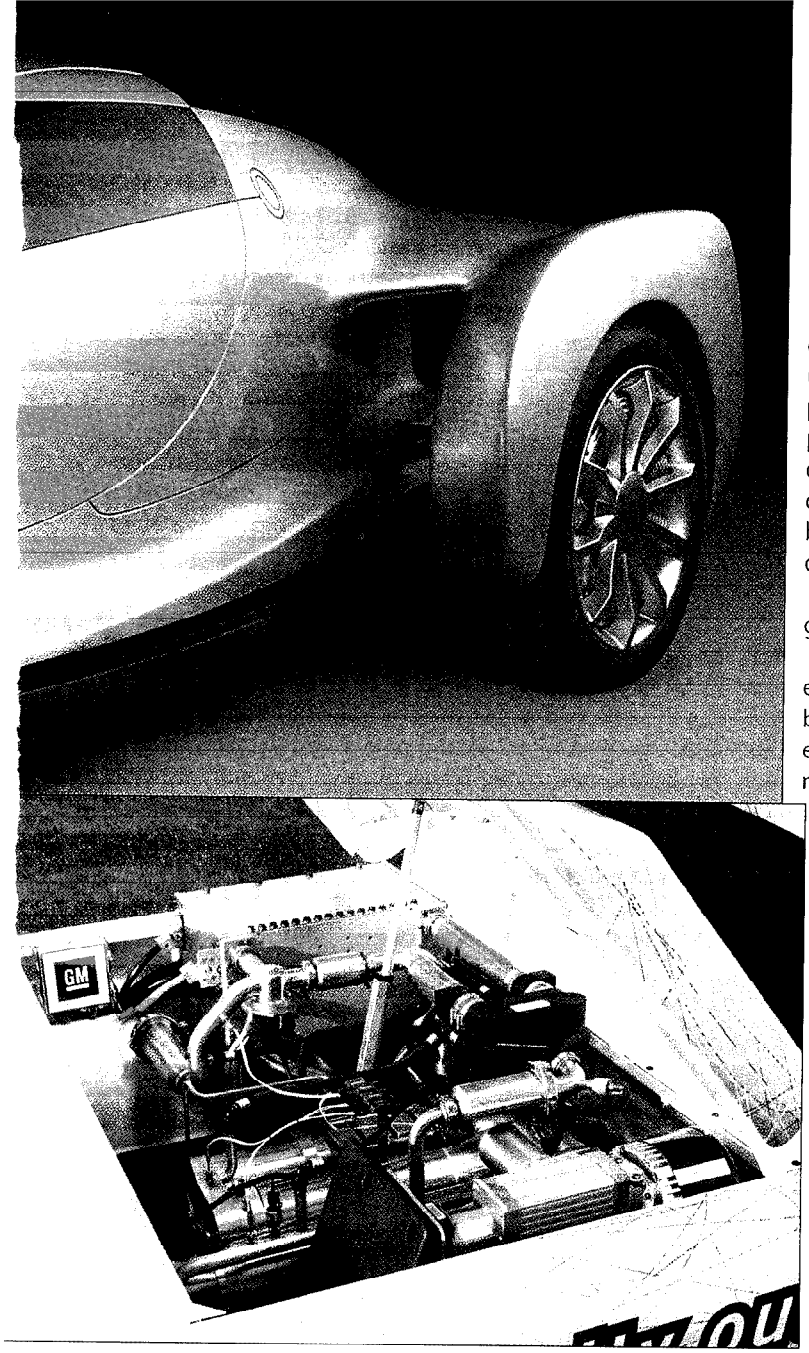
ALTERNATIVE FUELS

powered vehicles. The math is sobering: What happens when even a fraction of the other 88 percent become mobilized?

Clearly, the energy needs of the future cannot be met long-term with only fossil fuels. And as clean as today's LEV and ULEV cars and trucks have become—and they are remarkably clean—Mother Earth may not tolerate another 400 million to 500 million gas-burning vehicles.

We need cleaner, renewable alternatives and we need them now. My company, Energy Conversion Devices (ECD), and other alternate-energy

Robert C. "Bob" Stempel has had a long, illustrious and successful career in the auto industry. Before joining Energy Conversion Devices, he was the chief executive officer of General Motors.



Hydrogen-powered fuel cells are still very much in the experimental stage. This GM power unit, for instance, is still far too expensive for everyman. We're years away from having these in our garages.

companies are working hard to bring them to market. And the progress has been amazing. For years there has been discussion of using alternative-energy sources such as hydrogen power, photovoltaics and long-life batteries—it sounded like sci-fi, far-off kinds of stuff. Now those technologies have not only been proven viable, they're being introduced into the marketplace.

The Hydrogen Economy Is Here

Let me share my vision of the future of energy—not just energy for vehicles, but energy to power homes and portable electronics, almost all of the types of energy that touch your daily life.

Every day people ask me about the so-called "hydrogen economy." When's it coming? What will it be like?

The hydrogen economy is here. You're experiencing it every day. Today, nickel-metal-hydride (NiMH) batteries are used in billions of consumer products—a technology, by the way, that ECD pioneered. They can be found in tens of millions of laptops, tens of millions of cellphones and countless other portable electronic products. I'd be surprised if anyone reading this magazine doesn't own something that uses NiMH batteries.

The hydride in NiMH batteries stores, you guessed it, hydrogen.

NiMH batteries provide more than twice the energy and life cycle of conventional lead-acid batteries. They're maintenance-free. And their environmental impact is much more benign. Remember when you had to make sure you ran down the batteries in your cellphone or your laptop so that they'd take a full charge? And a full charge lasted maybe half as long as it does now? NiMH technology changed all that.

So the hydrogen economy has started. And the applications of hydrogen as a major energy source are about to expand exponentially.

The Fuel Cell Future

Virtually every major automaker is in the process of bringing hybrid vehicles to market. You've most likely been reading about hybrids for some time. They combine a small internal-combustion engine with a rechargeable electric drive system. Energy from the engine and braking systems is used to charge the battery system, which powers the electric drive.

Typically, hybrid vehicles achieve about 20 to 30 percent greater fuel efficiency over conventional drive systems and significantly reduce emissions. Huge advances when you consider how many millions of dollars are spent each year to eke out fractions of a mile per gallon in fuel economy through design features such as underbody airflow management and low-drag disc brakes.

The Honda Civic and Toyota Prius are already on the road. Ford, General Motors, DaimlerChrysler and others have announced additional higher-volume hybrid production programs that will enter showrooms over the next 12 to 24 months. By some estimates, there will be more than 200,000 hybrid vehicles on the road by 2005 and more than a million by the end of the decade.

But that's just the beginning. Soon you'll have the option of powering the internal-combustion engines

"If you remember your high school science, you know hydrogen is our most plentiful element."

in these hybrid vehicles with hydrogen. And by the end of the decade you may be able to purchase fuel cell vehicles, which won't require an internal-combustion engine at all. They'll be powered by hydrogen, which is cheap, safe and exceptionally clean: The only emissions will be water vapor. Your tailpipe will be turned into a drainpipe.

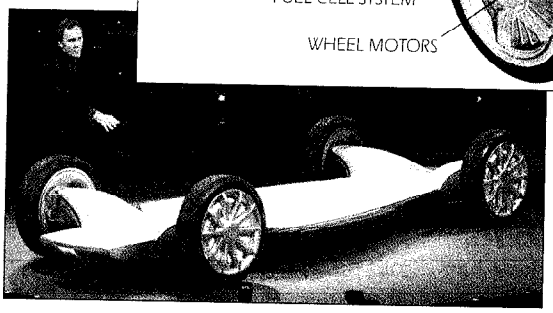
Hydrogen, for those of you who still remember high school science, is the Earth's most plentiful element. It's present in water. And also in petroleum and natural gas products. It's everywhere. As they say, that's the good news.

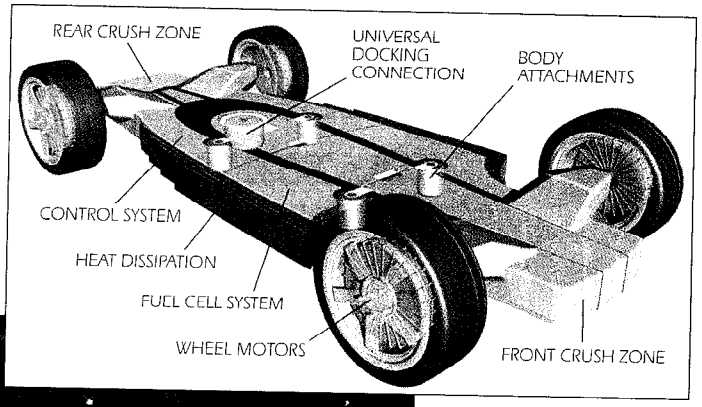
You'll also remember that hydrogen is highly volatile in its gaseous state. For years this was the hydrogen economy's biggest roadblock. Those of us in the car business knew that until someone came up with a way to carry hydrogen in a vehicle safely, vehicles powered by fuel cells would remain just a dream.

Then someone told me about a scientist, Stanford R. Ovshinsky, who had developed a way to store hydrogen as a solid at room temperature—actually at any temperature—and suddenly the path to the future went from an obstacle course to a racetrack. Stan is now ECD's president and chief executive officer. He was recently named by *Time* magazine as a "Hero

Outside The Box

When the first New York Auto Show opened, just over a century ago, the dozens of automobiles on display were evenly divided between steam, electric and gasoline power. At this year's North American International Auto Show in Detroit, virtually all of the 700 vehicles on display were powered by internal combustion. The discovery of cheap oil transformed the auto industry early on and, because of that, motor-vehicle design has remained essentially the same since the dawn of the automobile: With few exceptions modern passenger vehicles are configured around an engine mounted up front with a driveshaft or shafts delivering power to the wheels. But what if the automobile were invented today, and instead of internal combustion, its power came from a device called the fuel cell?





Larry Burns, General Motors' director of advanced research, recently provided one answer: the Autonomy. This General Motors prototype looks not so much like a car as it does King Kong's roller skate. The prototype is the working half of a 21st century "green machine," a high-tech chassis made of advanced polymers wrapped around a fuel cell powertrain. At its simplest, the fuel cell combines hydrogen and oxygen, producing water—and a flow of electric current used to run an electric motor. Or, in the case of Autonomy, four 25-hp motors, one attached to each wheel. Because electric power generates most of its torque at takeoff, the boost is equal to that of a much larger internal-combustion engine.

A close inspection of the 6-in.-thick Autonomy platform reveals four mounting points onto which a body can be attached. It might look like a conventional sedan, coupe, pickup or sport utility vehicle—or it might take a new form, perhaps incorporating a new approach to safety. Indeed, it would be possible to have several different bodies, Burns suggests. A motorist could switch between forms as needed.

Several automakers, including Ford, Honda and Daimler-Chrysler, promise to put fairly conventional-looking fuel cell vehicles into limited production by 2004, though few expect to see sizable numbers of them on the road before decade's end. The technology still needs plenty of work to bring down size and cost, notes Tom Moore, head of Chrysler's advanced technology unit. He cautions, "Fuel is a bigger issue than the fuel cell technology itself."

Chrysler's own "What if?" approach uses a solution as unconventional as GM's Autonomy. Chrysler's prototype Natrium minivan carries 48 gal. of sodium borohydride, a hydrogenated version of borax laundry powder, mixed with water. Step on the accelerator and a catalyst strips away the hydrogen, feeding it to the fuel cell stack. The used slurry is stored until it's time to refuel, when it's swapped for a fresh load—and recycled.

—Paul A. Eisenstein

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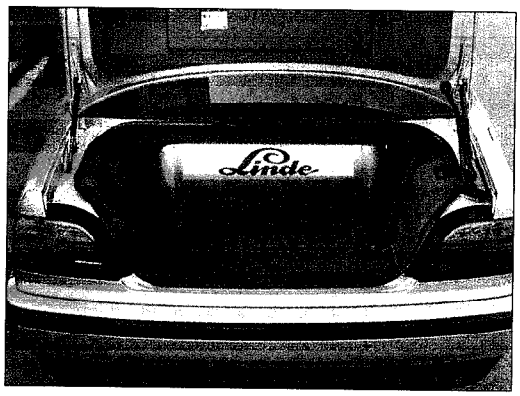
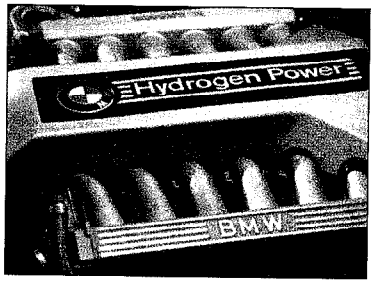




BMW, for one, is experimenting with using hydrogen in "conventional" engines. Storage and refueling are stumbling blocks.

of the Planet," and his vision is one of the reasons I joined the company.

Refueling the solid-storage hydrogen canisters in your fuel cell-powered vehicle will be quick and simple—and take about the same amount of time as refueling with gasoline does now. ECD has demonstrated that you can crush hydrogen canisters, drop them, drive objects through them, expose them to fire and even handle the hydride compound inside—with no adverse effects on the human body or to water, air or soil.

And That's Just Automobiles

So much attention has been devoted to the application of fuel cells to automobiles that few people realize that their application will be a lot broader. In fact, the first consumer fuel cell products won't be automobiles. Some fuel cell manufacturers are planning to offer stand-alone fuel cell products that will be available even sooner.

One big application will be portable energy-generation devices. These could be used at construction sites, as primary power sources for remote homes and businesses not connected to a main grid, as backup power sources for businesses, in homes and hospitals to provide uninterrupted service when the grid goes down, and in places where rolling blackouts and brownouts are a fact of life.

Globally, the implications are more profound than in the United States. Today, in the States, the overwhelming majority of homes and businesses are connected to the grid. In many developing nations, the percentage is very small.

I am not alone in forecasting that these countries will bypass the development of a hard-wired electrical grid completely and move directly to fuel cell and other energy-generating technologies. It's a better, faster and cheaper solution than stringing thousands of miles of cable across, in some cases, almost impassable terrain.

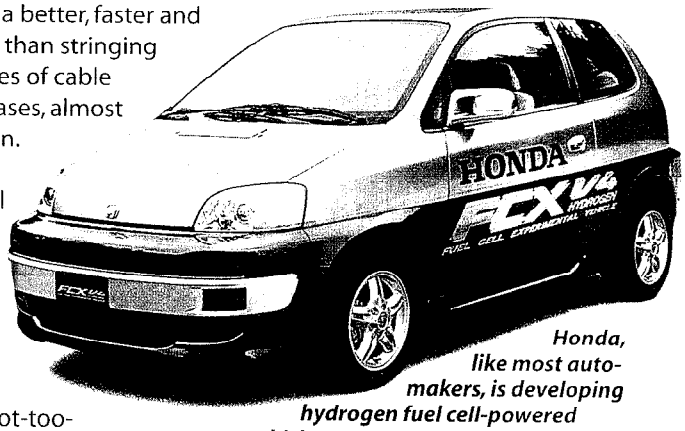
Ultimately, I expect to see fuel cells in places where batteries are used today. Your cellphone, for example, might be fuel cell powered in the not-too-distant future. The science for making it happen is already there, and the hardware isn't far behind.

Harvesting The Sun

Earlier, I mentioned other energy technologies. Photovoltaics—systems that convert sunlight into electricity—are another "future" technology that is here today.

A number of municipalities use photovoltaics to provide primary or supplemental power for many homes and businesses. If you've been out on the water recently, you've probably noticed that navigation buoys are powered by photovoltaics. They've been used for a long time in military applications as well. In Operation Desert Storm, field radios were powered by lightweight ECD photovoltaic packs.

As with fuel cells, the scale of photovoltaic applications is being ratcheted up tremendously. Recently, ECD teamed up with Texaco to provide the power to extrude crude oil from the ground in a 500-acre oilfield in Bakersfield, Calif. Previously, to power the steam generators, one barrel of oil would be burned for every three barrels brought to the surface. Using ECD's photovoltaic technology, the energy to extract the crude will come from the sun, which will not only help conserve resources but also reduce emissions and noise pollution.



Honda, like most automakers, is developing hydrogen fuel cell-powered vehicles. Toyota even has a bus.

The Giant Steps Of Progress

Forty-five years ago people might have imagined vehicles that didn't pollute, and buildings and cities powered by the sun. It would be fun to go back through old issues of POPULAR MECHANICS and read the different predictions about how society was going to get there.

Now, those dreams are realized. The problems technology has helped create, technology is cleaning up. Smokestacks no longer represent energy being wasted. Auto emissions will cease to be an environmental issue. The devices that make our lives easier are increasingly free of wire tethers. And yet our society has achieved all of this not by moving backward, but by moving forward. **PM**

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