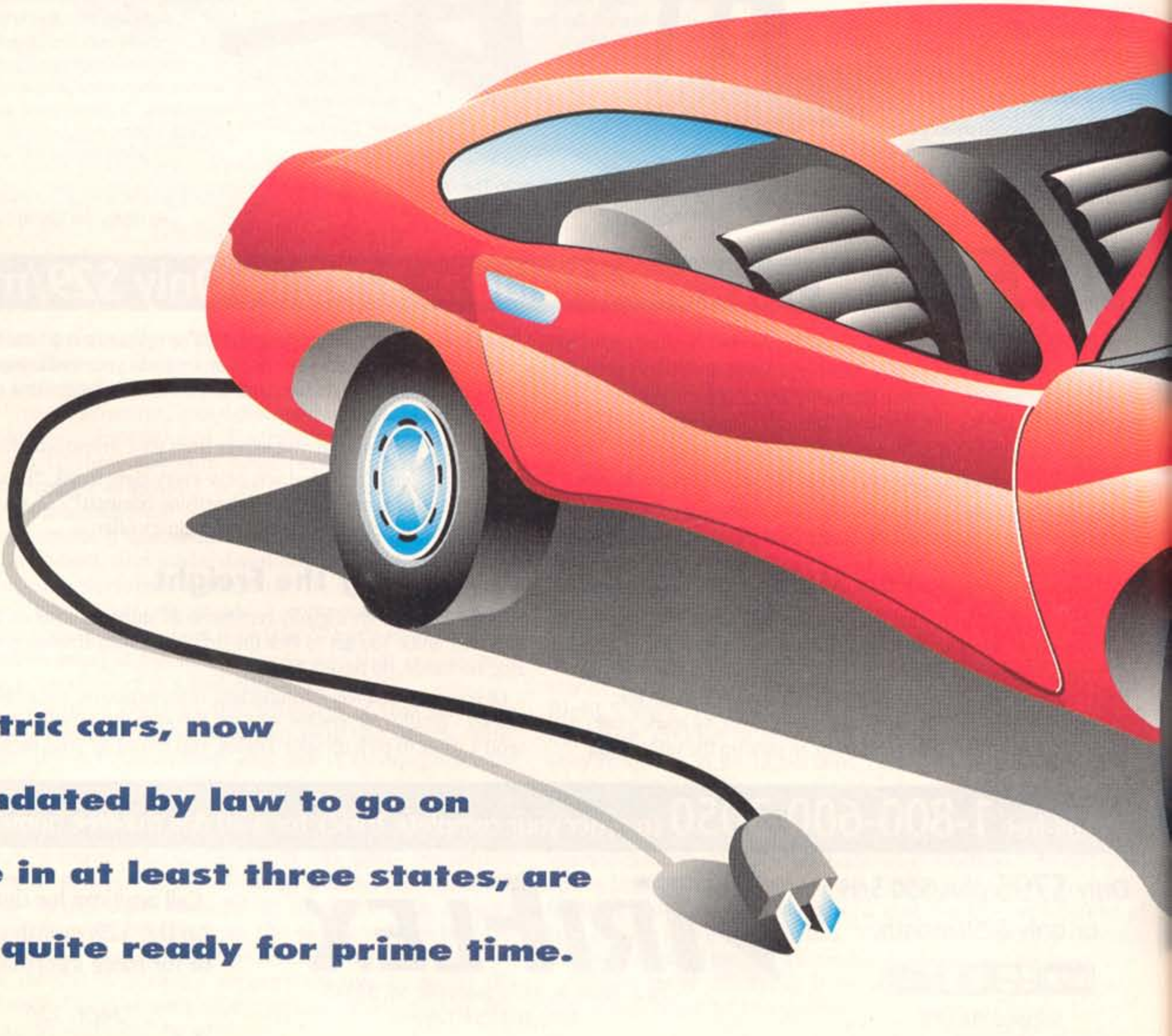
It's the BATTERY, Stupid!

BY STUART F. BROWN



Electric cars, now mandated by law to go on sale in at least three states, are not quite ready for prime time.

Inspired by the promise of a new age in which nonpolluting vehicles dominate the roads, several dozen demonstrators assembled in front of a government office building in downtown Los Angeles last spring carrying signs saying, "Stick to your guns CARB. Give us clean electric cars." CARB—the California Air Resources Board—is the agency charged with cleaning up the Golden State's polluted air.

A hearing room inside was packed with environmental officials, engineers, politicians, battery manufacturers and—above all—representatives from every corner of the global auto industry. After hearing two days of overwhelming evidence to the contrary, the CARB board of directors chose to accept its own technical staff's optimistic assessment and decided that acceptable electric vehicles (EVs) are just around the corner.

Therefore, the officials reasoned, there was no need to change the "zero-emission vehicle," or ZEV mandate, dictating that two percent, or about 30,000, of the 1998 cars and light trucks sold in the Golden State must be battery-electric powered. The percentage jumps to 10 by the year 2003.

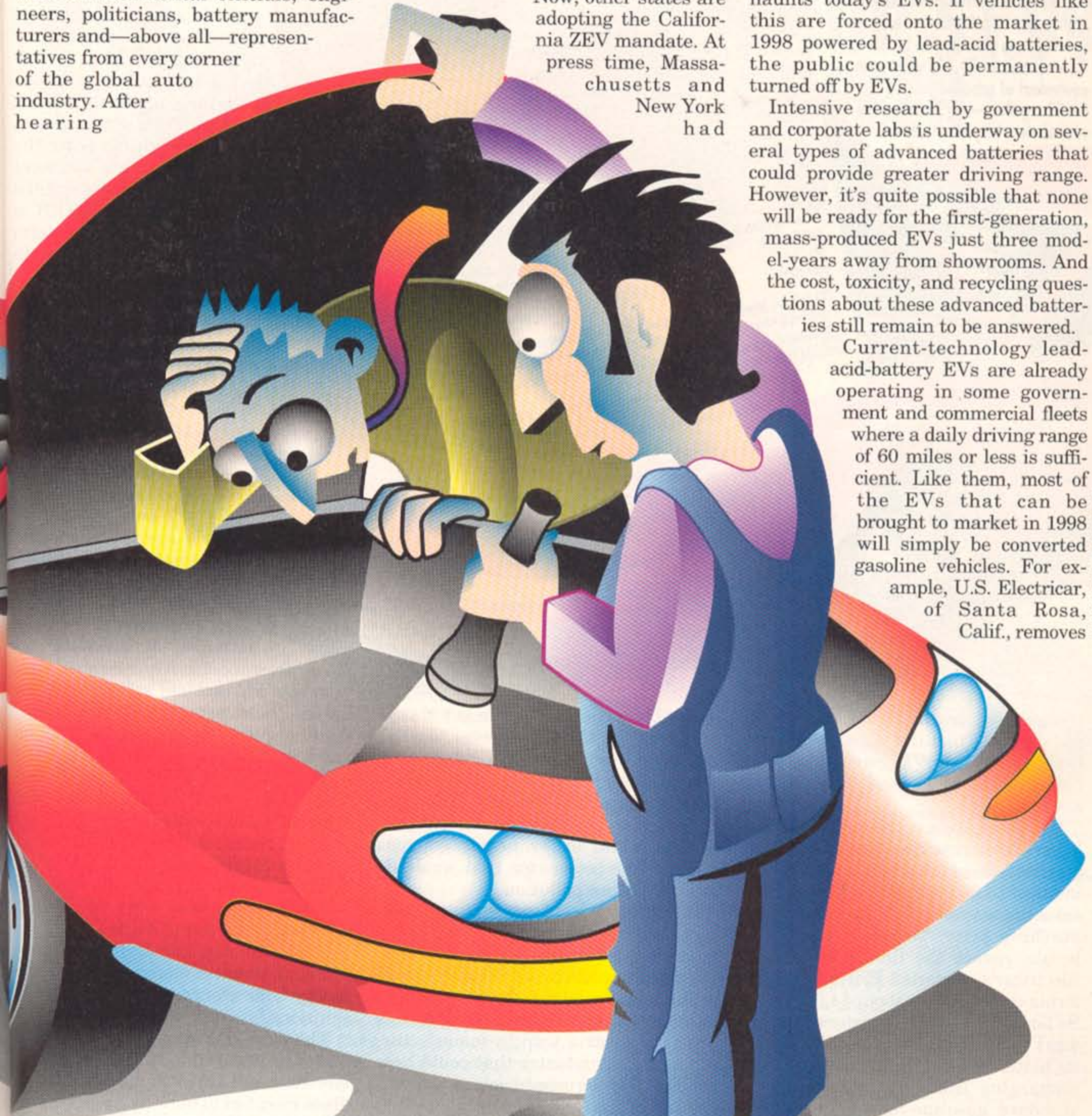
Now, other states are adopting the California ZEV mandate. At press time, Massachusetts and New York had signed on, and as many as ten other pollution-afflicted Northeastern states and the District of Columbia could also shortly follow suit.

It's an action that may end up leaving environmental regulators with a black eye. Why? The next-generation batteries that would make EVs viable just aren't ready for prime time.

At the turn of the century, battery-electric cars vied with internal-combustion-powered cars for popularity, but their limited driving range hampered them. The same problem haunts today's EVs. If vehicles like this are forced onto the market in 1998 powered by lead-acid batteries, the public could be permanently turned off by EVs.

Intensive research by government and corporate labs is underway on several types of advanced batteries that could provide greater driving range. However, it's quite possible that none will be ready for the first-generation, mass-produced EVs just three model-years away from showrooms. And the cost, toxicity, and recycling questions about these advanced batteries still remain to be answered.

Current-technology lead-acid-battery EVs are already operating in some government and commercial fleets where a daily driving range of 60 miles or less is sufficient. Like them, most of the EVs that can be brought to market in 1998 will simply be converted gasoline vehicles. For example, U.S. Electricar, of Santa Rosa, Calif., removes



ILLUSTRATIONS BY NED SHAW

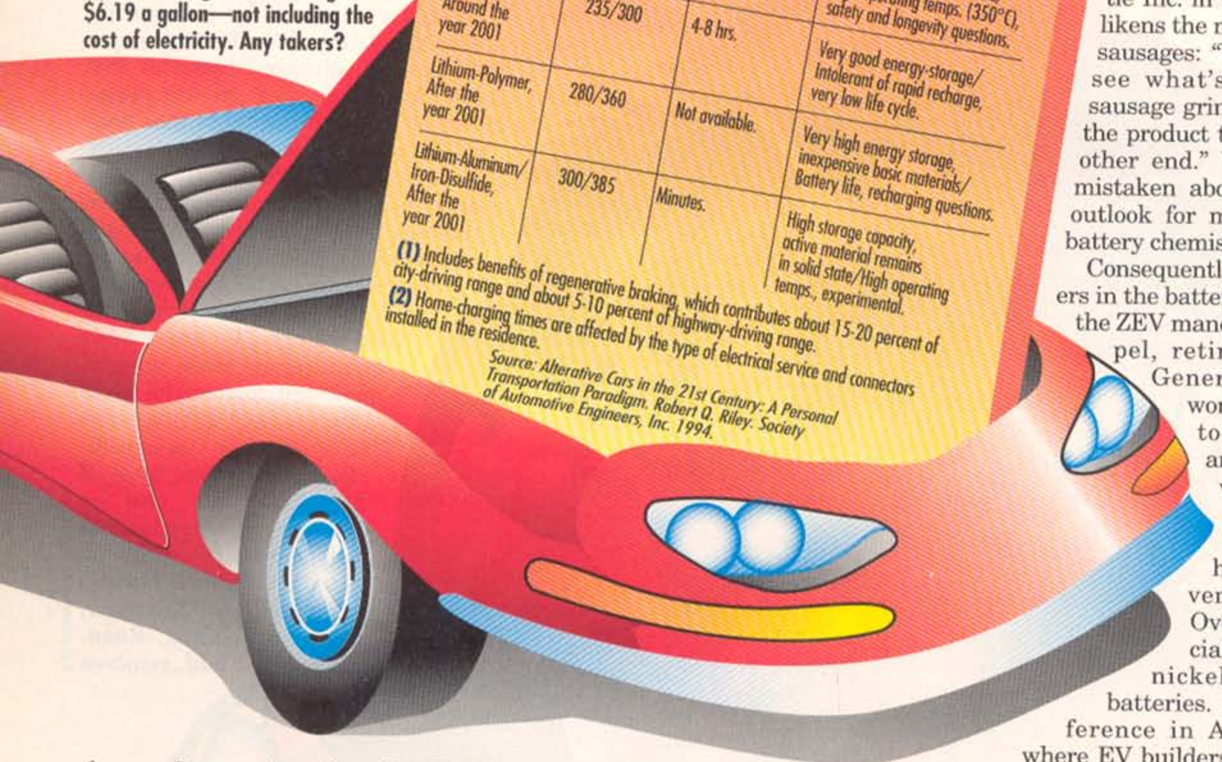
BATTERIES BY THE NUMBERS

How far will EVs go? This table compares the driving range of GM's 2,970-pound Impact—which has a 1,100-pound lead-acid battery pack—with its approximate range using seven other battery types of the same weight. Factors including personal driving style and the use of powered accessories, such as air conditioners and heaters, have a major effect on the actual range an EV can provide. And the newer batteries that would produce better mileage are costly: For example, 35 Nicad batteries for Chrysler's TEVan cost $38,5000. Battery cost in relation to battery life in this case equates to $0.31/mile—the equivalent of gasoline costing $6.19 a gallon—not including the cost of electricity. Any takers?

BATTERY TYPE/ AVAILABILITY	EPA CITY/ HWY MILES (1)	RECHARGE TIME (2)	ADVANTAGES/ DISADVANTAGES
Lead-Acid, Now	70/90	8-12 hrs. standard, 2-3 hrs. with smart charger.	Low cost, established technology/Poor energy storage, low life.
Nickel-Iron, Now	100/129	4-5 hrs. standard, 1-2 hrs. with smart charger.	Long life, compact, production ready/ Costly.
Nickel-Cadmium, Now	110/135	6-8 hrs. standard, 20 mins. to 80 percent capacity.	Established technology, reliable, tolerates rapid charge/Costly.
Nickel-Metal Hydride, Imminent	160/205	One hour to full capacity with smart charger.	Fair energy storage, long life, maintenance-free/Costs uncertain.
Sodium Sulfur, Around the year 2001	200/257	6-8 hrs. standard, 2-3 hrs. possible.	Good energy storage, inexpensive basic materials/ High operating temps. (350°C), safety and longevity questions.
Zinc-Air, Around the year 2001	235/300	4-8 hrs.	Very good energy-storage/ Intolerant of rapid recharge, very low life cycle.
Lithium-Polymer, After the year 2001	280/360	Not available.	Very high energy storage, inexpensive basic materials/ Battery life, recharging questions.
Lithium-Aluminum/ Iron-Disulfide, After the year 2001	300/385	Minutes.	High storage capacity, active material remains in solid state/High operating temps., experimental.

(1) Includes benefits of regenerative braking, which contributes about 15-20 percent of city-driving range and about 5-10 percent of highway-driving range.
(2) Home-charging times are affected by the type of electrical service and connectors installed in the residence.

Source: Alterative Cars in the 21st Century: A Personal Transportation Paradigm. Robert Q. Riley. Society of Automotive Engineers, Inc. 1994.



executive officer. "Now, it seems our standard has pushed that research to new levels, making electric cars more possible than ever before."

To be fair, California's forced march into the world of EVs has stimulated innovation. The motors, power controllers, and other components needed to make EVs work have matured rapidly. Jeffrey Bentley, director of technology and product development at Arthur D. Little Inc. in Cambridge, Mass., likens the mandate to making sausages: "You don't want to see what's going into the sausage grinder, but you want the product that comes out the other end." Yet the CARB is mistaken about the near-term outlook for major advances in battery chemistry (see table).

Consequently, some key players in the battery business oppose the ZEV mandate. Robert Stempel, retired chairman of General Motors, now works as a consultant to the automaker and to Energy Conversion Devices in Troy, Mich. The two companies have formed a joint venture called GM Ovonics to commercialize and produce nickel-metal hydride batteries. At a recent conference in Anaheim, Calif., where EV builders and makers displayed their wares, the company announced plans to begin manufacturing the batteries in 1996. Though considered one of the most promising alternatives to lead-acid, these batteries still may not prove workable by 1998.

Even Stempel, whose background includes involvement in the GM solar-powered Sunraycer and the GM Impact EV projects,is leery of CARB's ZEV policy. He says "While I believe in electric vehicles, the California sales mandate dictates electric vehicle technology and eliminates other possible solutions."

The ZEV category was conceived from the outset to include only battery-electric cars. Internal-combustion engines modified to burn hydrogen, for example, could have trouble qualifying as ZEVs because their exhaust contains minuscule amounts of burned lubricat-

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the gasoline engines from Geo Prizm sedans and installs electric powertrains. These EVs, currently sold only in fleets of at least 30 cars, cost $30,000 each.

Subsidies reduce the price of EVs; buyers of electric cars qualify for a 10 percent federal tax credit, up to a maximum of $4,000. California also offers a sales tax exemption on a portion of the purchase price. Together, these tax breaks reduce the final cost of U.S. Electricar's converted Prizms to California customers by about $4,000 each. So for $26,000, fleet operators can buy a car that will go 40 to 70 miles before its batteries need up to eight hours of recharging time. By comparison, a standard gasoline-fueled Prizm can travel about 350 miles on a tank of gas and costs about $14,000.

EVs, as they exist now, will not come close to satisfying the typical driver's expectations of how a car should perform. The CARB, however, doesn't make the limitations of EVs clear to the general public. The policy error here is promoting the sale of technologically immature battery-electric vehicles, when other power sources might make better cars that would do more to reduce pollution.

California's legal push to put battery-EVs on the road as quickly as possible is a response to the state's severe transportation-related smog problems. Economic development is another major driver. State officials promote electric vehicle manufacturing as a new industry that could help replace the aerospace jobs lost with the end of the Cold War.

"Carmakers' research into electric cars made us believe that they could be a reality when we adopted the emission standard," says James D. Boyd, CARB

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ing oil. Fuel cells, other than those fed by pure hydrogen gas, may also run afoul of the mandate. Is this any way to encourage technological progress?

Engineers unencumbered by politics and ideology approach the problem of developing low-pollution vehicles in an entirely different way. The number one question a methodical engineer asks is, what's the most practical energy source for clean vehicles? One environmentally unfashionable, but inevitable, answer: Don't overlook petrochemicals.

Much of the original excitement about electric vehicles was sparked by energy-efficient engineering specialists like Paul MacCready of AeroVironment Inc., who headed the team that developed the GM Sunraycer car and the brisk-performing GM Impact prototype.

It's ironic that MacCready argues against battery EVs as a marketable alternative for today's family car. He offers an illuminating perspective on the usefulness of chemical fuels. A rubber band, he notes, can store sufficient mechanical energy to lift its own weight one-half mile. A lead-acid battery stores enough energy to lift itself ten miles. A quantity of gasoline, however, can lift its weight 1,000 miles. MacCready observes that even a threefold increase in the energy density of lead-acid batteries—which nobody is promising—would still make them only 1/33rd as good an energy-storage medium, pound for pound, as gasoline.

MacCready and many other engineers view high-energy-density liquid chemicals such as gasoline and diesel fuel as the most practical propellants for a cleaner future. Burned at a miserly rate by hybrid vehicles (see "Emerging Technologies for the Supercar," June '94) with small, constant-speed piston or turbine engines powering electric drivetrains, these chemicals may make better environmental sense than a symbolic fleet of underachieving battery- powered cars.

The illogic of California's ZEV mandate requires manufacturers to build electric cars, but nobody is obliged to buy them. And despite CARB's EV boosterism, there's very little convincing evidence that many people actually want to own an electric vehicle. The result could be dealer lots filled with rows of unsold battery-mobiles.

Robin Segal, a doctoral candidate at the University of Pennsylvania's Wharton School of Business, published a study last year based on questionnaires completed by 662 California residents who were asked about their attitudes toward purchasing electric, natural gas, or gasoline-fueled vehicles. "In market simulations run using vehicles described by representatives from the electric utility industry as well as from the American automobile industry, the electric vehicle market potential will not exceed about one percent," the study concludes.

CARB, and the regulatory agencies of other states, err when they use the term ZEV. No vehicle—other than perhaps the bicycle—operates without some impact on the environment, whether during its manufacture, operation, or ultimate disposal when worn out. "Zero emissions" is a label born of politics and junk science that should be immediately retired.

Government owes the public straight talk about the realities of emerging transportation technology. And it should stick to mandating results, not commanding inventions of its own choosing. As a maxim attributed to NASA engineers during the early days of the space program says: "There's no such thing as a scheduled breakthrough." PS