

# F.V.E.A.A. NEWSLETTER

## July 1992

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<p><b>NEXT MEETING</b></p> <p>July 17th @ 7:30 College of Dupage Student Resource Center Room 1046</p> <p>Use Lambert Rd. Entrance, Lot 7 at the Southeast corner of 22nd &amp; Lambert <b>Nonmembers are always welcome!</b></p>
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## MEMBERSHIP INFORMATION

Membership to the Fox Valley Electric Auto Association is open to the public. Anyone interested in electric vehicles or electric transportation are encouraged to join. The cost to join is \$15 per year from November to November. If joining in the middle of the year the cost is \$1.25 for every month remaining til November of that year. The cost for new members joining this month is \$5.00.

## Fox Valley Electric Auto Association

336 McKee Street  
Batavia, IL 60510



### First Class

**ADDRESS  
CORRECTION  
REQUESTED**

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## PREZSEZ

Recently the FVEAA has been present and active in two events in Wisconsin. The Midwest Renewable Energy Fair in Amherst and the Milwaukee Summerfest. At these two events, as with others that I have been active in, it is common to be interviewed by the media, as Bill Shafer and John Emde will testify to.

One question that is inevitably asked is "Why have the large automakers been so slow to develop electric vehicles?" One theory is that the oil companies have a great deal of influence with the carmakers. But this really doesn't hold water in mind. If you think about it, GM, for one, is the largest corporation in the world. If they see an opportunity to make money they would surely take it. And if they missed it, the Japanese would create twice the opportunity out of it. OS why? I believe that they're scared! Currently car manufacturers make a majority of their profits, not on the sale of the automobile but on the after market sale. The service, tune-ups, broken part replacements, etc. Look at the price of a replacement tail light. Tell me their isn't a hefty profit built into that price. Hey, their entitled. They're in business like everyone else.

However EVs pose a threat to this philosophy. As we know, EVs practically eliminate service except tires and brakes, which is all done by third party businesses like Midas. So where is their piece of the pie if EVs take off?

If they mass produce EVs in large numbers, by all rights the cost of the vehicle should be less than that for a comparable internal combustion automobile, because of fewer parts and complexity. However, they can't offer as low a profit margin and still finish the year with the same chunk of change.

So it's entirely possible that the cost of a big three EV may never come down to what we are use to! Just Fuel for thought!

Enjoy,

Douglas F. Marsh  
President

## FVEAA APPEARS AT AMHERST ALTERNATIVE ENERGY FAIR

Two FVEAA members had their electric cars at the Alternative Energy Fair in Amherst, Wisconsin June 19-21. Johanna Helenowska's FIAT which she recently purchased and Steve Clark's UNIQUE MOBILITY Elektrek were transported for exhibition at the event. These two vehicles represented contrasting electric car approaches.

Johanna's car was typical of the usual recycling and repowering of a conventional car for electric drive with its 36-volt parallel battery banks, aircraft-style starter-generator, and a power transistor controller. Steve's car was representative of a purpose-designed electric vehicle with its 96-volt battery contained in a central tunnel, fiberglass body, and Soleq controller. Both cars attracted considerable attention.

Three electric cars from California companies were an addition to this year's event. Mike Brown of Electro-Automotive had a converted VW Rabbit vehicle which he called a "PLUGZ BUNNY" and a display of EV components which included an Advanced DC motor, Curtis PMC controller, and other EV components offered by his company. Solar Electric had a modified Fiero similar to the car they built for "Naked Gun 2 1/2" which featured hood and rear deck solar panels. Also there was an 'LECTRIC LEOPARD and, of course, the usual CITICAR.

There were 5 presentations of electric car topics at this year's event compared with only one last year. In addition to my Mazda conversion project, 4 other subjects were covered. Mike Brown talked about vehicle conversions, Michael Hacklemann discussed his electric car work, and presentations were made by two other participants.

President Marsh was there on Thursday and arranged the exhibit set-up. I arrived on Friday, and John Emde assisted with the display on Saturday. The exhibit made good use of the two FVEAA banners obtained by Ken Woods. The three of us distributed a lot of hand-out material and answered questions about our Organization. We also had an opportunity to sell a few EV Books, "ELECTRIC VEHICLES UNPLUGGED" written by Doug Marsh and "WHY WAIT FOR DETROIT". The Twin Cities area was represented by several persons who seemed interested in establishing a similar group there. There were also several persons from the Chicago area who heard about the FVEAA for the first time.

Our appearance at the Fair did help make the FVEAA better-known to those who attended. Most of the persons at the Fair were from the Wisconsin area. The FVEAA cannot effectively assist these persons who want to undertake a project. Also, FVEAA conversions are an effective URBAN TRANSPORTATION TOOL in Chicago and its suburban area where driving missions are well within the capability of our cars. In the Amherst area driving distances are much greater. Typically, a one-way trip there is about 15 miles. These two factors should be considered by the membership when deciding FVEAA participation in future events such as this.

Bill Shafer

## WANNA BUY A DAF?

License plate 137EL has been transferred and the insurance policy changed now that my Mazda conversion project is complete. I am willing to sell my 1966 DAF which was converted to electric power in 1974 to someone who can use the components for a project. The car is suffering from terminal structural rust which was the major reason for the project.

The 48-volt electrical system consists of a 400-amp, aircraft starter-generator that may need new brushes, a power transistor controller, a Ken Myers-built battery charger for both the 48 and 12 volt systems, a 28-volt vacuum pump, 8 deep discharge batteries that are not very good and a 12-volt auxiliary battery that is ok, a 28-volt blower, voltmeter, shunt & ammeter, auxiliary relays, and 1/0 power cables. At 45 volts, the motor runs at 3000 RPM. Curb weight of the converted car is 1980 lbs.

I estimate the new value of these electrical parts to be about \$ 1500. My asking price for the car and components is \$ 1,000. The offer is good until my birthday on August 1st after which I'll dismantle the electrical system and keep the components for a possible future project of my own.

Bill Shafer  
308 South East Avenue  
Oak Park, IL 60302  
(708) 383-0186

## FOR SALE Electric E-20 Riding Mower

Does not run - also has snowblower & extra parts for same. Contact:

Gerald Robson  
329 E. Monroe St.  
Box 84  
Spring Green, WI  
53588  
(608) 568-2661  
(800) 487-3816

## Transportation notes

Chicago Tribune, Sunday, July 5, 1992  
Automotive innovations

Conceptor Industries Inc., a subsidiary of Canadian auto parts manufacturer Magna International Inc., has developed the first fully certified electric van, capable of 55 miles per hour. The van was developed under a grant from the Electric Power Research Institute, a U.S. utilities industry agency

American Flywheel Systems of Seattle says it received a patent on technology for an electric car battery that may provide a driving range of up to 600 miles on a single charge. Automakers should have demonstration units within a year, the company said.

## Electric cars getting a 'jump start'

Chicago Tribune, Sunday, June 28, 1992

Burbank, Calif. (Reuters) - California has launched a consortium of major companies and government agencies to develop technology for electric-powered vehicles.

"It helps to jump-start a new global industry," said Lon Bell, president of the consortium, CALSTART.

The group, which includes companies such as General Motors Corp., Lockheed Corp., Southern California Edison and Pacific Gas & Electric, will seek to use aerospace and computer technology industries to speed the development of electric vehicles and advanced mass transportation systems.

CALSTART Chairman Michael Reevey said the effort could lead to the creation of as many as 55,000 engineering and manufacturing jobs.

The consortium will seek to develop technologies to make electric vehicles, which currently are characterized by high cost and limited driving range, more attractive to consumers, Bell said.

"It is my belief that much of the technology needed to make ...consumers prefer electric vehicles is [available] in California today," Bell said at CALSTART's headquarters, an empty Lockheed plant in Burbank, a Los Angeles suburb.

CALSTART will focus on developing components for electric cars that can be sold to major carmakers in the U.S. and overseas, Bell said. The consortium will seek to adapt technology from the aerospace industry, such as electric motor controllers, charging systems, heating, ventilation and cooling systems and vehicle coatings, he said.

He said CALSTART plans to have a prototype electric car developed between 1994 and 1996 and a bus within six months.

CALSTART also plans to install a statewide network of 150 electric car charging stations, with the first expected to be in place before July, he said.

The group has attracted \$14 million in cash and research and development support. It wants \$6 million in state and federal funds, Bell said.

## HALF & HALF

Air/Water pollution report  
June 8, 1992

Rudolf Gunnerman, a Sparks, Nev., inventor, has a Porsche 944 and Dodge Shadow that he says can operate on a mixture of half gasoline and half water. Gunnerman says the vehicles have lower emissions of tailpipe pollutants and get higher mileage, with the Porsche going from 20 mpg to 50 mpg. Gunnerman says he spent six years and \$2 million to develop the 50-50 system, which could be applied to most vehicles for an estimated \$1,000. He said he's kept quiet about the developments until now because "people do not believe what I'm doing. You ask the auto companies, they say it's impossible."

## What Will You Do When You Cannot Drive to Work

Valley Industrial Assoc. Newsletter

The 1990 Amendments to the Federal Clean Air Act identify Northern Illinois as a "severe non-attainment area" for ozone pollution and require action to reduce the pollution. Ozone pollution in Northern Illinois is 50% higher than the federal minimum standard. Since automobile exhaust is the major source of ozone pollution, the Amendments require employers with 100 or more employees to reduce ozone pollution by reducing the number of employees who drive to work.

November 1, 1992 is the first milestone date, because on that date the State of Illinois will submit an implementation plan for approval by the Federal Environmental Protection Agency. The plan has already been drafted as legislation, is on Governor Edgar's desk and is waiting for him to introduce it in the General Assembly.

The legislation enacts two average vehicle occupancy (AVO) zones, one ozone for the City of Chicago and one separate zone for the suburban areas in the six county metropolitan area. This two-zone approach makes sense because it recognizes that Chicago and the suburbs have different land use densities, different residential distribution and different access to public transportation.

The Clean Air Amendments are based on two key factors: (1) average vehicle occupancy and (2) employer trip reduction requirement. The average vehicle occupancy (AVO) is the average number of persons in a motor vehicle being driven during the time period from 6:00 to 10:00 A.M. The goal of the Clean Air Act is to increase average vehicle occupancy by decreasing the number of vehicles being driven.

The employer trip reduction requirement (ETR) is the method to reduce the number of cars being driven. The Clean Air Amendments require employers, with 100 or more employees, to submit a plan and describe action they will take to change employees from driving alone, during the peak period of 6:00 to 10:00 A.M. to using carpools, van pools, public transit or flexible work hours.

ETR is a shift in basic responsibility for employee commuting. In the past, the employer had no responsibility for how employees got to work. Now, the Clean Air Amendments make the employer fully responsible for planning and implementing how employees will get to work.

The amount of action that employers will be required to take depends upon the manner in which the average vehicle occupancy is defined (AVO). The draft legislation recommended to the Governor enacts two AVO zones and makes sense for implementation by employers in Northern Illinois.

## MAZDA MX-5 EV

The Australian, March 5, 1992

MAZDA Motor Corp. has announced it will develop an electric car based on the MX-5 Miata with Chugoku Electric Power Co.

Mazda expects to produce three research cars by the end of this year after an investment of about \$A1.5 million.

Using a nickel-cadmium battery, the electric MX-5 will be capable of speeds up to 140km/h. Mazda said the car would be able to climb a 22 degree grade and accelerate to 40km/h in four second, with a cruising range of 190km.

The electric MX-5 will weigh about 1350kg. compared with about 950kg for the normal roadster.

Chugoku will supply the battery charging equipment and is developing a speedometer that will show how much power is left in the batteries.

The electric car will be equipped with energy-saving AIR-CONDITIONING and POWER STEERING units.

Another aim of the project is the development of a POWER-SAVING lighting system.

After reliability and durability tests of the three prototypes, the partners will decide whether to produce the car in commercial volumes. The first batch could be put into service by Chugoku Electric Power Co. a Mazda spokesman said.

Mazda has aggressively pursued hydrogen rotary-engine technology as the company's primary alternative energy powerplant.

"The hydrogen rotary is still our main environmentally friendly engine." a Mazda spokesman said.

"But this is for the 21 century. In the shorter term, an electric car is more feasible."

## UK-DEVELOPED ELECTRIC VEHICLE NEARS PRODUCTION

Engineering, Dec. '91

The first pre-production prototypes of a new electric vehicle, the QT-50, are being built by HIL Electric of Newcastle prior to mass-production scheduled for late 1993 in eastern Germany. Using a 120 V sodium-sulphur battery pack from ABB, mechanicals from the Volvo 440, a switched reluctance motor, and chassis and bodies designed by Styling International of Leamington Spa, the first 50 vans will go on field trials for major fleet operators including the Royal Mail and SWEB.

Managing director John Holden expects production to reach 50,000 units per year by 1996, with a quarter of sales in Germany. The QT-50 and its sister model, the Concept van, will sell for 8000 pounds and the batteries for a further 3000 pounds. Battery life is expected to be between four and six years. It weighs 1750 kg, can carry 500 kg, reaches 68 mph with a claimed range of 200 miles and accelerates from 0 to 30 mph in 12 seconds.

So far 1.3 million pounds has been invested and a joint venture agreement has been set up with a Singapore company which will begin manufacture in Malaysia in 1994, with 10,000 units per year capacity. Next year HIL Electric will unveil a vehicle powered by solid Polymer Fuel Cells being developed at Loughborough University.

## Electric Cars get new battery

The Institute, July/August 1992  
Publication of IEEE

**Battery of the moment.** Matsushita Battery Industrial Co. in Osaka, Japan, claims its new sealed nickel-metal-hydrate battery is the world's first for an electric vehicle. The technology has many of the attractive features of nickel-cadmium, such as high energy and power densities, but it dispenses with cadmium, a toxic pollutant. The Matsushita battery has an energy density of about 70 Wh/kg and a relatively high and uniform power density of up to 180 W/kg. The 11-kg, 6-V battery has a capacity of 130 ampere hours, Matsushita said, and a temperature range of -20 degrees to 60 degrees C.

Nickel-metal-hydrate batteries have been used in a limited way to power mobile communications and computer equipment, but like many advanced batteries have found only limited acceptance because of several problems. Most have relatively short lifetimes of less than 500 charge-discharge cycles, although Matsushita claims its battery has a lifetime of 1500 cycles. High cost has been another problem, however, and Matsushita did not estimate what its new battery would cost in production.

## Electric Conversations

By Douglas F. Marsh

In recent conversation with Tom Spicer, organizer of the University of Illinois at Chicago's Solar race vehicle program, he informed that every member of last year's team that has graduated has received nice jobs as a result of their experience. One member, a communications major is now employed by Saturn in their marketing program, and was hired as a result of his experience with the solar vehicle because the production version of the Impact is expected to carry the Saturn nameplate.

Recently BMW announced that it would be opening a manufacturing facility in South Carolina and that one of the vehicles slated for production there is the BMW E2. The E2 is BMW's electric geared for the U.S. with a range of 272 miles at 45 mph and a top speed of 75 that can be held on a 4% grade.

The Environmental Defense Fund (EDF), the environmental organization that stopped the use of DDT and is now noted for its work with large corporations to change their environmental ways, is now joining forces with GM to help the giant realize profits from environmental practices, namely environmentally responsible vehicles. EDF is most recently noted turning the McDonald's Corporation around and making the Hamburger giant realize millions in profit in recycling practices.

## Poor Attendance at Alternative Fuel Exhibit

By Douglas F. Marsh

Wisconsin governor Tommy Thompson's alternative fuel exhibit was the largest assembly of alternative fueled vehicles in history, but attendance was sparse. The idea was to have the exhibit utilize the crowd of Milwaukee's Summerfest, however the display area was outside the summerfest grounds and few realized it was open to the public.

Two of the FVEAA's vehicles were on display in the Midwest Renewable Energy Association both provided by the state of Wisconsin. Both Steve Clarks and Joanna Helenowska's vehicles were transported from the Energy Fair in Amherst to Milwaukee for the event.

Each of the big three automakers were present, including GM's electric prototype the Impact. Because of sparse attendance some rides were given in the vehicle.

Neither Chrysler or Ford displayed an electric but were in full force with their ethanol and methanol fueled vehicles.

## Clean Air Grand Prix

from Promotional material 7/10/92

The First Annual Clean Air Grand Prix--an electric car race and trade show--lines up this Labor Day Weekend, September 3-6, 1992, at the Road Atlanta/Lanier Raceway complex. This one of America's Premier racing complexes, an appropriate place to celebrate the dawn of a new era in clean transportation.

**ATLANTA CHALLENGE:** Electric vehicles will compete for endurance on Atlanta's roadways, with celebrity drivers testing today's EV technology.

**ELECTRIC SHOOT-OUT:** An electric car will challenge a matching gasoline powered car in head-to-head competition.

**ROAD ATLANTA CHALLENGE:** This famous 2.5 mile road course will be the site of a challenge race in which electric cars will achieve speeds of over 100 miles per hour.

**LANIER RACEWAY:** This beautiful 3/8 mile oval track which hosts NASCAR Busch Grand National racing will be the exciting venue for electric car competition. Competitors will compete in both Open and Stock Divisions.

**DIVISIONS** See both standard and open division entries from sprint cars to pickup trucks.

**TRADE SHOW:** Exhibits will be open all weekend at Lanier Raceway showing the latest in electric vehicle technology and giving visitors a glimpse into the automotive industry of tomorrow.

## Why Wait for Detroit? Second Edition

Steve McCrea's second edition of Why Wait for Detroit? is now available. Contact Douglas F. Marsh for copies.



*Technician at Argonne National Laboratory prepares one cell of a bipolar Li/FeS<sub>2</sub> battery used to power an electric vehicle.*

# Environmental Concerns Drive Advanced Battery Research

Electric vehicles require development of new automotive batteries, control systems, and establishment of a support infrastructure.

*By Tim Studt, Senior Editor, R&D Magazine*

# R&D

There is more battery research in progress right now than at any other time in history. The increasing demand for automotive vehicles that emit less air pollution than existing internal combustion vehicles is driving much of this research.

"Battery research goes in cycles," says Kevin Myles, director of battery research at Argonne (IL) National Laboratory (ANL). "Current interest in air pollution is putting more emphasis on automotive applications, rather than other areas, such as electric utility power."

California, the traditional leader in setting air quality and vehicle emission standards, requires that 2% of all new vehicles sold in the state in 1998—that's about 40,000 cars and trucks—emit zero emissions. That quota increases to 10% in 2003. A consortium of New England states has followed California's lead, and other states are expected to adopt similar standards.

With the technologies that automo-

tive designers have to choose from, only electric vehicles (EVs) currently fit those standards. Even taking into account the utility power plant emissions associated with generating the electricity needed to charge batteries, the California Air Resources Board estimates that EVs result in 98% less hydrocarbon emissions/mile than gasoline powered vehicles. They also achieve 89% less nitrogen oxides, 99% less carbon monoxide, and more than 50% less carbon dioxide.

To satisfy future EV requirements, research is being directed at several areas—toward improving conventional lead-acid batteries; developing new material batteries, such as nickel-iron, sodium-sulfur, lithium-sulfur, and lithium-polymer batteries; and even improving the traditionally expensive fuel cell derivitizations (see table).

In all of these systems, success depends upon developing a system that can deliver an adequate driving range, has a long service life, and is reason-

ably priced. "Current lead-acid batteries can only give you a 100-km range before you need to recharge them," says Argonne's Myles. "They also need to be replaced after 40,000 km at a battery-pack replacement cost of \$1,500."

Because of these problems and the weight penalties associated with lead-acid battery packs, conventional lead-acid batteries don't hold much long-term promise for powering EVs. But, lead-acid batteries and the infrastructure associated with their manufacture and maintenance are well established, so advanced lead-acid batteries hold the most promise for short-term use as electric vehicle power sources.

The Advanced Lead-Acid Battery Consortium, a group of battery manufacturers, users, and suppliers organized by the International Lead Zinc Research Organization (ILZRO), Research Triangle Park, NC, is helping to develop lead-acid battery technologies that bring performance levels up to those needed for a viable EV.

Advanced valve-regulated batteries (VRBs) are one candidate for short-term EV use. VRBs are an advanced form of lead-acid technology derived from the traditional flooded systems. VRBs were first commercialized in 1973 and have since been developed in various configurations and sizes. They incorporate flooded lead-acid electrochemistry, but also utilize gas recombination to yield products with high specific energies.

One factor limiting the energy output of lead-acid batteries is the utilization level of the positive active material. In a flooded system, this utilization is about 30%, while in a VRB, it is about 30% to 40%. Improvements in VRBs can raise that to about 60%, according to ILRZO sources.

ILRZO's research aimed at this goal over the next three years is focused on generating a higher internal surface area during discharge cycles by changing the composition of the materials, such as by using



Argonne researcher holds cut-away of Li/FeS<sub>2</sub> electric vehicle battery, revealing three elements of the bipolar stack.

batteries or systems. GM developed its Impact vehicle that, while powered by conventional lead-acid batteries, integrates numerous design features to improve overall performance of the vehicle. These improvements have raised the daily vehicle range from the current 100-km standard for conventional lead-acid batteries to more than 160 km, says GM.

Chrysler is concentrating its research on a nickel-iron battery system that also extends the EV's range to

more than 160 km, but with only two-thirds of the lead-acid battery weight. Ford's research focus is on a sodium-sulfur battery system that it believes will extend EV range to 320 km.

The USABC partners intend to focus their research on demonstrating the feasibility of sodium-sulfur battery production at the pilot plant scale by 1994. While sodium-sulfur batteries currently cost four times as much to manufacture as nickel-iron, they have the potential to cost less in production quantities.

"The advanced lead-acid, nickel-iron, and sodium-sulfur battery systems are near-term developments that will satisfy EV requirements through the end of this decade," says Myles. "Mid-term systems [available between the year 2000 and 2005] include lithium-sulfur, while long-term systems [available in 2010] involve lithium-polymer and nickel-metal-hydride systems."

In 1991, the United States Advanced Battery Consortium (USABC) was established, uniting General Motors, Ford, and Chrysler with the U.S. Dept. of Energy (DOE) and the electric utilities (through the Electric Power Research Institute) in a joint R&D effort to identify and develop the most promising advanced battery technologies for future EVs. Initial funding was \$260 million, with 50% coming from the DOE.

General Motors, Ford, and Chrysler each have EV programs in progress that focus on development of new

A bipolar Li/FeS<sub>2</sub> battery developed by ANL researchers for EV applications received an R&D 100 Award in 1991. This battery fulfills all the performance requirements of an EV—it has a range up to 640 km, a service life of about 160,000 km, and a weight that is about 25% of a lead-acid battery. It also can be recharged up to 1,000 times. A replacement battery pack should run about

### New Batteries on the Horizon

	Relative energy capacity	Relative peak power	Availability
Lead-acid	1	1	Now
Nickel-iron	1.5	1.3	1993
Sodium-sulfur	2 to 3	2.5	1995 to 2000
Lithium-iron monosulfide	2 to 3	1.8	1995 to 2000
Lithium-iron disulfide	3 to 5	6 to 7	2000+
Lithium-polymer	3 to 5	3 to 4	2000+

Source: Electric Power Research Institute

## 'EV range is not limited by the power source—it's determined by the distance between refueling opportunities,' says GM's Baker.

\$2,000 to \$4,000 in production quantities.

The Li/FeS<sub>2</sub> batteries, like the sodium-sulfur products, operate at high temperature (425 C), so insulating factors have to be considered in their development.

These batteries feature a bipolar design that permits the cells to be stacked so that they are internally connected for direct current flow (see accompanying photo).

Development of lithium-polymer systems are much farther off in the future. Initial development of these devices is focused on small

electronic device power supplies, such as those for laptop computers. Most current development is directed at ways to dissipate the heat generated during operation to prevent degradation of the polymer electrolyte.



General Motor's electrically powered HX3 hybrid vehicle has a small gasoline engine that recharges a battery pack during long trips, while the battery alone is used for short trips.

fuel efficiency of gasoline engines, will continue research interest.

Development of the battery itself is just one part of the overall EV program. Some of the most critical components are the power controller and the electric drive motor. Researchers at Westinghouse Electric Corp., Pittsburgh, and Chrysler Corp., Highland Park, MI, recently announced a multi-million dollar program to develop a control system that can double the rate of acceleration and range of current EVs.

The inherently high cost of fuel cells as EV power supplies will keep them out of the battery competition for some time. However, their performance characteristics, such as a 320,000-km service life and twice the

Westinghouse's system uses an ac motor in place of the heavier dc motors now used in many EVs, according to Ted Foster, general manager of the Westinghouse Research Center's Electronics, Information, and Sciences Div. "The ac motor's simpler design promises lower cost, higher efficiency, and more power per pound," says Foster.

EV propulsion systems also need regenerative braking systems that return the vehicle's kinetic energy to the battery to further enhance the vehicle's driving range.

"The limitations of EV vehicles are not solely in the characteristics of the battery system, but are due also to limitations in the infrastructure," says Kenneth Baker, manager of GM's Electric Vehicle Div. "That's because vehicle range is not limited by the technology of the power source—it's determined by the distance between refueling opportunities."

To establish a system that efficiently handles the refueling and maintenance of even a small number of EVs requires substantial development of support systems.

"We're committed to deliver an EV by the mid '90s," says Baker. "We need the infrastructure ready by the time of the first car. And that is only about 25,000 hours away." R&D

### Japan Charges Up Battery Projects

In Japan, MITI's Agency of Industrial Science and Technology is launching a \$108 million, 10-year battery development project. Initial planning starts this year; research begins in 1993.

Yoshisue Tsunoda, an agency official, explains that its program is not exclusively for batteries for electric cars, but to advance battery technology in general. The tentative goal is a 100-liter, 20-kW battery with an energy density of 120 kW-hrs/kg. The agency expects to focus on lithium-based systems, but it will also look at sodium-sulfur and zinc-bromine batteries. There will be no work on lead-acid batteries.

Japan's major battery makers are expected to join, but the major auto makers may not.

Nissan Motor Co. and Japan Storage Battery Co. are working on new batteries and a charging system that they claim can recharge nickel-cadmium batteries to 40% of capacity in six min and lead-acid batteries to the same level in 12 min.

Their new Ni-Cd battery has molybdenum and other unspecified elements added to the anode. The electrodes of their lead-acid battery are

composed of a larger number of thinner plates than usual. For both batteries, slim cases and a fan dissipate heat generated during charging, allowing the batteries to take a quick charge without damage. Remaining challenges center on reducing costs.

Isuzu Motors Ltd. and Fuji Electrochemical Co. are working on a new type of battery which they claim can be recharged in just 30 sec. The battery uses solid electrodes of highly concentrated activated carbon immersed in an electrolyte. It stores an electric charge much like a condenser. One of the challenges in this design was controlling the delivery of the stored power.

Sanyo Electric Co. has proposed using a small fuel cell to power an electric car. The firm has developed a prototype solar-hybrid car which uses a combination of solar cells and a 250-W phosphoric acid fuel cell to recharge a Ni-Cd battery that drives the car's electric motor. Sanyo believes that fuel cell technology could eventually power electric cars, but admits that it is not yet economically competitive with lead-acid batteries.

—Dennis Normile

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