F. V. E. A. A. NEWSLETER

MARCH 1991

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NEXT MEETING
MARCH 15th 7:30 P.M. SHARP
Room 157, doors open @ 7:00
Use Northeast entrance of
Building K, College of DuPage
22nd & Lambert, Glen Ellyn
Nonmembers are always welcome

Newsletter items must be submitted to the Editor by the first friday of the month

THE PREZSEZ

The FVEAA was at the Midwest Environmental & Renewable Energy Expo during its two-day run. A report on the event will be made at the March 13 meeting. Thanks to Ray Oviyach for having the Triton car at the exhibit and helping to man the booth. Also thanks to Rich Sachtschale for booth manning help, and to FVEAA members who dropped by.

We have not yet settled on our summer 91 activities. Ken Woods will provide info on a possible Naperville event and we need member's ideas and recommendations.

Our technical discussion will feature discussion of Part II of the series of car conversion papers which is included in this newsletter.

Bill

F. V. E. A. A.

FOX VALLEY ELECTRIC AUTO ASSOCIATION
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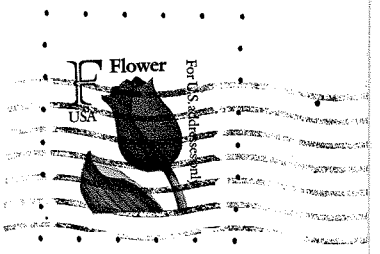

FIRST CLASS

ADDRESS CORRECTION REQUESTED

JOHN EMDE
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MINUTES OF FEBRUARY 15, 1991 FVEAA MEETING

The meeting was called to order at 7:34PM. There were 15 members and 2 guests present. Treasurer Vana reported a savings account balance of $ 934.27 and a checking account balance of $ 2047.12.

President Shafer complimented Richard Sachtschale, the new editor of the FVEAA Newsletter, on the February issue - his initial effort. It was received by the membership on Monday.

President Shafer reviewed technical information received which included:

Electric & Hybrid Vehicle book from the SAE.
SAE Proceedings on Electric & Hybrid Vehicle meeting.
Switched Mode Battery Charger publication.
Solar-electric car info from Arizona Energy Office.
Auto Conversion Manual written by Bill Palmer.

President Shafer reported on FVEAA particiption in the Midwest Environmental and Renewable Energy Expo that will be held at Triton Community College on February 23 and 24th. The FVEAA has been alloted 2 booth spaces to exhibit the Triton Fiat and Shafer's DAF. President Shafer will also present each day a tutorial program titled RECYCLING AND REPOWERING A CONVENTIONAL CAR FOR ELECTRIC DRIVE. He asked for members to help man the exhibit.

Member Woods reported no further information on the energy event at Argonne on February 26th. No FVEAA participation is planned.

Members Stockberger and Corel discussed the functioning of the FVEAA power transistor controller, answering questions raised about its design and application.

The meeting was adjourned at 9:58PM.

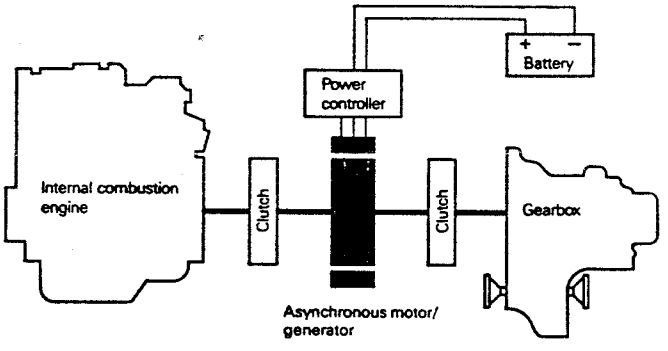
Submitted by,
William H. Shafer
William H Shafer
(For Paul who is
still in Florida)

A car for all conditions:

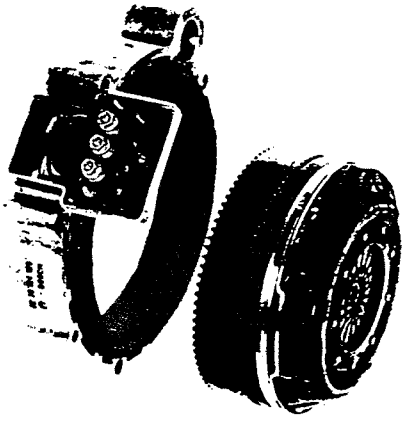
A hybrid drive comprising both electric drive and internal combustion engine can if suitably designed combine the advantages of the conventional vehicle drive system (large cruising range good performance) with those of a purely electric drive (low noise and exhaust emissions conservation of petroleum resources)

Vehicles equipped with such drive systems are thus far more flexible than electric vehicles they are often just as versatile as vehicles with an internal combustion engine and consequently are not confined from the outset to the second car market

Hybrid drives thus have far more extensive potential applications than electric drives higher production rates could in principle therefore be achieved leading to low manufacturing costs



In the course of years of research work VW and Bosch have developed an energy saving hybrid drive In this so called single-shaft system a 1.6 litre VW catalyst diesel engine is connected on an shaft to a 6 kW asynchronous motor/generator and a 5-speed manual gearbox As shown in the illustration there is an automatic clutch on either side of the electric motor The two clutches are integrated into the rotor of tha asynchronous motor/generator producing an extremely compact construction and increasing the length of the entire engine/gearbox drive unit by only 58 mm The weight of the motor/generator including the two clutches ist only 29 kg



Asynchronous motor/ generator (6 kW, 72 V)

A joint development by VW Bosch and LUK
The rotor with two integrated clutches permits a highly compact construction The motor/generator replaces
- the starter and
- the flywheel

and acts as
- 6 kW drive motor and
- generator for regenerative braking

The 12 V alternator too is no longer required

FVEAA ELECTRIC CAR CONVERSION MANUAL
PART II, MOTOR & BATTERY SELECTION AND PLACEMENT

In Part I data was provided for budgeting and car selection. Calculations will be made for battery selection and placement in this part. It will also include data related to motor and control selection. For purposes of illustration, conversion of a 1980 Mazda RX-7 will be used. While this is not the ideal car for recycling and repowering, it was was recently acquired by the author for $ 300 because it had a blown rotary engine and will illustrate the steps applicable to any project.

The essential data relating to the original car are as follows:

Gross Vehicle Weight (GVW)	2805 Lbs
Curb Weight	2380 "
Weight Distribution (Front/Rear)	52/48 %
Gross Weight, Front & Rear	1700 Lbs
Acceleration 0-60 MPH	8.6 Seconds
Engine Torque @ 2750 Rpm	133 Foot-Pounds
Engine RPM Redline	6000 RPM
Axle Ratio	4.076:1

The first step is to calculate the weight of the converted car:

Curb Weight	2380 Lbs
Subtract engine-related components removed	-300 (Est)
	2080
Add electric motor & adapter	80
	2160
Add 11 batteries & cables @ 72 Lbs	792
	2952
Add controller, charger & misc	68
	3020
Add driver	180
Converted GVW	3200 Lbs

The batteries make up 25% of the total weight. The car will be heavier and range lower than desirable. Previous FVEAA studies arrived at a GVW of 2500 pounds for a typical converted car with batteries making up 33% of the total.

The calculations indicate suspension changes will be required since GVW exceeds original specifications.

The next step is to specify acceleration performance and calculate motor and controller requirements. Desired performance is 0-30 Mph in 6 seconds (t). The average acceleration (a) will be 7.3 Feet/Sec-sec. During this acceleration the car will move 132 feet (d).

Calculate Mass	M = Weight/32	= 3200/32	= 100
Calculate Force	F = Ma	= (100)(7.3)	= 730 Lbs
Calculate Power	P = F d/t	= (730)(132)/6	= 16060 Ft-Lbs/Sec
Calculate HP	HP = P/550	= 16060/550	= 29 Horsepower
Calculate P	Kw = 0.746 HP	= (29)(0.746)	= 21.8 Kw
Current @ 50 volts	= P/V	= 21800/50	= 435 Amps

Although it is a 60-volt system, a 10 volt drop thru connecting cables and devices is used to calculate motor terminal voltage during peak load. Use of a 500-amp, 60-volt motor controller is indicated.

The motor to be used should have a rated speed about the same as the original engine (6000 RPM). The author has a Westinghouse aircraft DC generator rated 400 Amps, 30 Volts, 3000/8000 Rpm which will be used.

The next step is to determine battery placement. 36 inches is available over the front axle which will be adequate for 5 Type GC-2 deep discharge (Golf Cart) type batteries. Each of these batteries has a width of 183 mm, a length of 264 mm and a height of 280mm. The auxiliary battery will also be located in front. The remaining 5 power batteries can be placed in a 36-inch space just behind the rear axle in a well now occupied by the gas tank and spare tire. This arrangement will retain the front-rear weight distribution ratio.

Each battery is rated to deliver 75 amps for 140 minutes which yields an energy-storage capability of (75)(140)(6) = 1.26 Kwh. Based on FVEAA experience that energy consumption can be expected to be about 0.5 Kwh per mile of travel, the range of the converted car is expected to be about (10)(1.26)/0.5 = 25 miles. It will probably be considerably less than this because current during acceleration will be 6 times above rated. Available energy is reduced under these circumstances but the range will be adequate for the author's urban driving.

The next paper in this series will calculate the steady-state power required to move the vehicle at a constant speed.

W H Shafer
3/2/1991

Transportation

THE ELECTRIC CAR

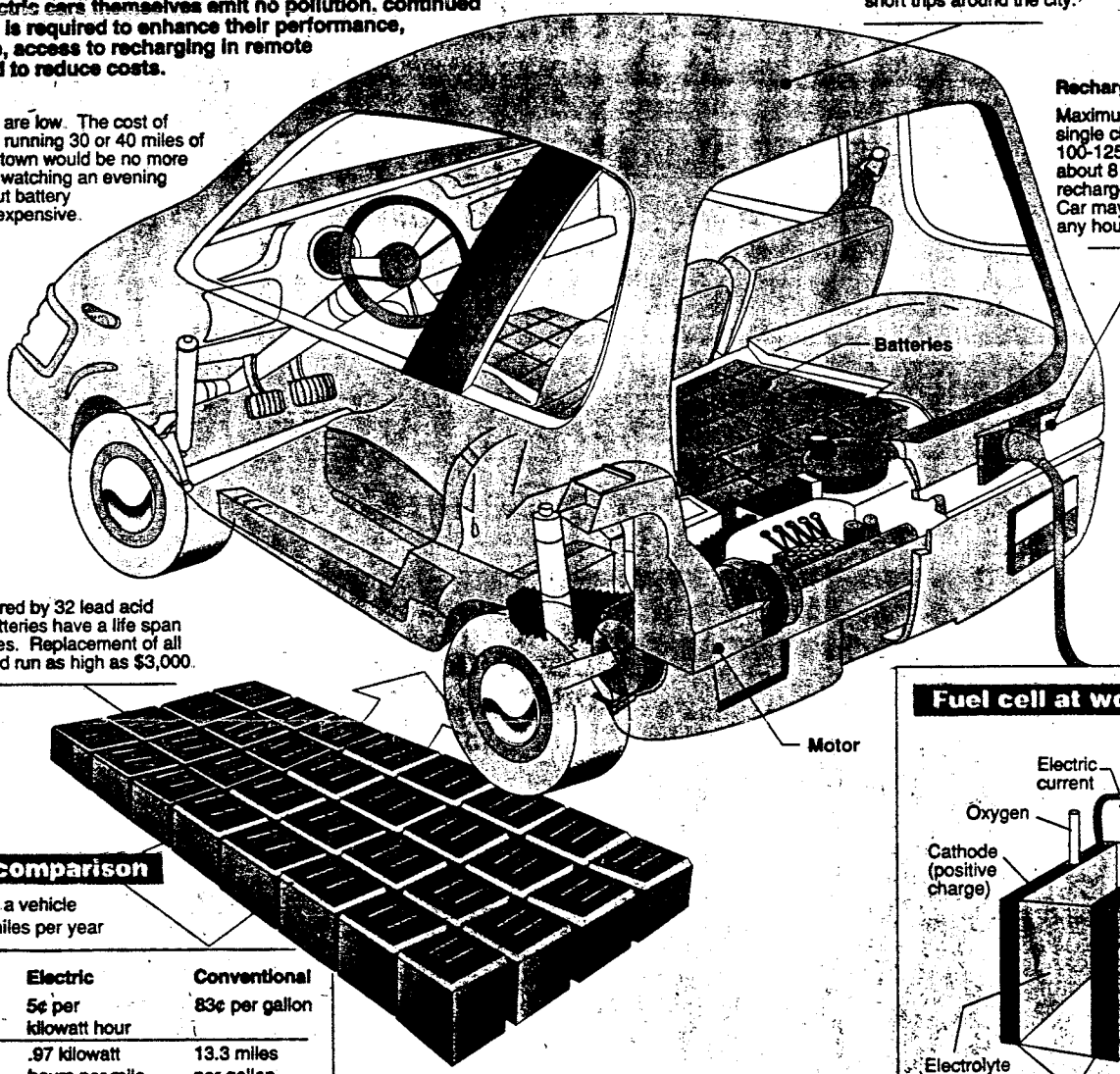
Charge and go

Although electric cars themselves emit no pollution, continued development is required to enhance their performance, driving range, access to recharging in remote locations and to reduce costs.

Operating costs are low. The cost of recharging after running 30 or 40 miles of errands around town would be no more than the cost of watching an evening of television. But battery replacement is expensive.

Town car
Two-seater electric car would be well-suited for short trips around the city.

Recharging
Maximum distance on a single charge is about 100-125 miles. It takes about 8 hours to completely recharge the batteries. Car may be charged out of any household 110-volt socket.



Batteries
Vehicle powered by 32 lead acid batteries. Batteries have a life span of 25,000 miles. Replacement of all batteries could run as high as $3,000.

Vehicle comparison

1987 figures for a vehicle driven 11,000 miles per year

Factor	Electric	Conventional
Average fuel costs	5¢ per kilowatt hour	83¢ per gallon
Fuel usage	.97 kilowatt hours per mile	13.3 miles per gallon
Fuel cost per mile	5.2¢	6.2¢
Maintenance labor	3.2 hours per 1,000 miles	1.5 hours per 1,000 miles
Parts cost	$30 per 1,000 miles	$38.60 per 1,000 miles

Chicago Tribune/Paige Braddock, Dennis Odom and Don Sena
Sources: Argonne National Laboratory, Electric Vehicle Development Corporation, GM and The Random House Encyclopedia

Fuel cell at work

The fuel cell produces electrical energy from the electrochemical reaction of hydrogen-based fuels and oxygen to form water and electrons.

Electric cars moving apace

But solving one problem generates another

By Jim Mateja
Auto writer

You turn the key and there's no sound. The term "whisper quiet" takes on new meaning.

You step on the accelerator and the vehicle moves forward, again without making any noise, and better yet, without emitting any harmful pollutants into the atmosphere for you, your children or even your grandchildren to inhale.

You head to work without having to stop on the way for a tank of gasoline. The $10 bill stays nestled in your pocket or purse, not in the register of the local petroleum dealer.

How heavenly it will be when this dream becomes reality. Or will it become a nightmare?

Some swear that battery-powered cars, trucks, vans and utility vehicles not only will resolve this nation's dependence on foreign oil, but will clean up the very air we breathe. Battery-powered cars don't need gasoline, and batteries don't emit gunk into the atmosphere, so it would be difficult to criticize these aspects of an electric car.

On the other hand, some swear battery-powered cars may not be utopia, and that they'll present a new set of problems.

For example, you turn on the key and there's no sound. Whisper quiet. That's because it's 30 degrees below zero and, while gasoline works at those temperatures, batteries take the day off.

Okay, it's July 1, not Jan. 1, so the car does start. You step on the accelerator only to find the pack of 32 batteries resting under the floorboard doesn't provide the same kick as 200 horses in your 24-valve gas-powered V-6. There's a slight hesitation between the time the foot presses the pedal and the batteries come to life.

Again, no problem. You can live with slightly less performance. After all, racing is for kids.

Besides, stick your head out the window and inhale deeply; the lack of noxious exhaust fumes makes the slight delay in leaving the light worth it.

On the way to work you pass the gas station. A smile fills your face. You arrive at the office, do your work and head home. Halfway there the batteries become abnormally quiet—as does everything else in the car, because the 32 batteries have discharged. You've driven 100 miles already this week, your maximum range limit, and you're not home yet.

The batteries now require an 8- to 10-hour recharging. You have to find a 110-volt electrical outlet so you can pull the extension cord from the trunk and plug into a socket. If you thought lugging a one-gallon gas can to the filling station was an annoyance, think of the fun you'll have knocking on a stranger's door and asking: "Mind if I plug in overnight?"

Consumers today generally keep vehicles five to six years before trading in. With an electric car, the life expectancy of lead acid batteries is estimated at 25,000 miles—considerably less the more you charge/discharge the system. The heavier your foot, the shorter life you can expect. Ballpark estimates of having to replace 32 batteries at one time run about $3,000.

General Motors Corp., Ford Motor Co., and Chrysler Corp. have battery-powered prototype vans undergoing testing, and GM also has a car. General Motors, if not the furthest along in battery-car development, at least is the most vocal about what it's doing. GM has said it will sell a two-seater battery-powered car called the Impact, and it has a five-passenger van under development called the HX-3.

Where GM stops short is in giving a timetable for the Impact's sale.

The production-date estimates range anywhere between 1993 and 1998, but GM President Lloyd Reuss is firm in not being pinned down.

"We aren't saying for competitive reasons, because

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Battery limits still biggest bump in ro...

By Jon Van

Technology to develop an efficient electric car has become a question of developing high-energy, high-power batteries that are lightweight and not extremely expensive.

The work to produce an electrical propulsion system and computer controls to coordinate it largely has been accomplished, but the question of batteries is still open, say experts in the field.

Because of California's pending antipollution standards, automakers no doubt will have to bring out electric cars that use batteries made with heavy metal components that have a driving range of 100 miles or so and may need replacement every year or so.

Soon, however, batteries will be available that will go 150 to 250 miles before needing a recharge, and will last for three to four years, experts predict.

By early in the next century, lightweight batteries with electrolytes made of plastic should be available, as well as fuel cells that essentially are batteries with fuel tanks that will need refueling, like today's gasoline-powered cars, but won't need recharging.

Argonne National Laboratory in Du Page County is doing its own research into electric-car technology and is coordinating much of the federal effort in this area for the Department of Energy, Argonne's parent agency. Kevin M. Myles, Argonne's manager of the electrochemical technology program, is optimistic about the future of electric cars.

The first electric cars to be marketed may use an advanced version of the lead acid batteries now used to start automobiles, Myles said. But the battery requirements for an electric car are vastly different than

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Electric

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a year ago, right after we said we were going to build the Impact, the Japanese suddenly started a tremen- dous effort on their own to develop electric cars," he told us in a recent interview.

GM in the early '80s announced it had come up with a zinc-nickel oxide battery to power cars, but neither the battery nor a car to house it ever materialized. Cheap gas prices, ready availability of the fuel and no Persian Gulf war have been cited as reasons the GM battery car never was built.

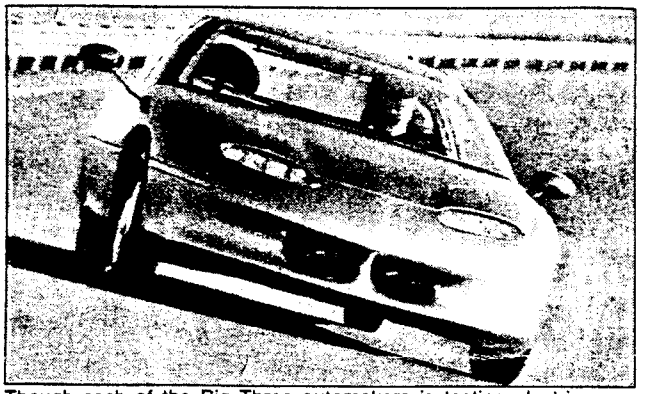
Some fear GM again may promote battery cars only to drop development as gas prices drop and the cost of finding long-life batteries escalates.

Reuss insists a battery car will materialize this time.

"With the call for lower emissions now, the time is here for a battery-powered electric car. There's a market for it. The only question is how big the market will be," Reuss said.

Impact and the HX-3 are powered by a pack of 32 lead acid batteries. The HX-3 is a hybrid, going a step further than Impact by also having a one-liter, three-cylinder gasoline engine that recharges the batteries as you drive.

Lead acid batteries aren't state of the art, as evidenced by the limited cruising range before the need to recharge. It will take new technologies to improve speed, range and overall life.



Though each of the Big Three automakers is testing electric-powered vehicles, GM's Impact is likely to be the first to hit the road.

GM Chairman Robert Stempel said the automaker had two choices: To wait until a higher-power, longer-range battery is developed, or to go ahead and use lead acid batteries now to get an electric car on the road, then replace those batteries in the future.

"With the concern over emissions, we decided it would be best to get the car on the road, so we decided to go ahead with lead acid for now," Stempel said.

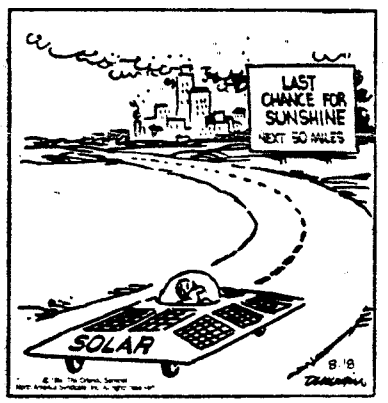
California is motivating the development of battery-powered vehicles. The state is requiring that 2 percent of an automaker's vehicles sold there by 1998, and 10 percent by 2003, have zero emissions. There are rumblings that California's standards will be adopted nationwide.

With lead acid batteries, the Impact has about a 100- to 125-mile range before needing a full recharge; the HX-3 would go 200 to perhaps 300 miles.

Another hybrid that would run on batteries or gasoline would be the next step in GM's development. You'd use batteries in congested urban driving where pollution is a problem, and the gas engine in less-populated rural areas or on expressways to conserve battery life.

But, according to Reuss, the HX-3 would cost more to produce than the battery-power-only Impact, and a vehicle that allowed either battery or gas power would

Continued on page 10



Electric

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cost even more than the HX-3.

"It's a matter of how much you want to spend," he said.

To cut costs associated with battery development, the Big Three automakers earlier this month formed the U.S. Advanced Battery Consortium to develop battery technology in cooperation with the U.S. Department of Energy and utility companies.

The group won't develop electric-powered vehicles, but will work to develop longer-range and longer-life batteries.

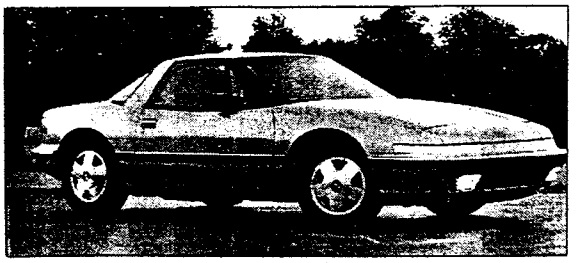
GM picks plant to make electric car

By Jim Mateja
Auto writer

General Motors moved a step closer to producing its first battery-powered electric car Monday by designating its Reatta Craft Centre in Lansing, Mich., as the car's future assembly site.

The two-seater Buick Reatta coupe and convertible that had been built at the Lansing facility since 1988 will be discontinued at the end of the 1991 model run to make room for the electric vehicle, officials said. Sales of the $30,000 coupe and $36,000 convertible have never lived up to expectations.

GM won't say when it plans to start production of a zero-emissions battery car or when it will start converting the plant to electric vehicles, other than "as soon as practicable."



Production of Buick's Reatta is to give way to an electric car.

"We've said all along that we aren't going to help our competitors by talking about such future product plans, and we'll continue that posture," said GM president Lloyd Reuss in a statement. "But if anyone still wonders if we're serious about producing an electric car, our announcement today should put an end to such doubts."

"GM could announce a production date on its electric car if it wanted to without worrying about what the competition does, but it's learned its lesson the hard way about talking too much too soon," said independent Detroit analyst Arvid Jouppi.

"Remember what happened with Saturn and all the hoopla from GM about that car before it came out—projections that were far too optimistic," he said. "There's strong support for an electric car at the highest levels at GM; they just don't want to be so public about a car this time."

Thomas O'Grady, who runs his own automotive research and consulting firm, echoed Jouppi.

"They don't want another Saturn scenario," O'Grady said. GM had promised that the Saturn would be totally new and be produced at the rate of 500,000 cars the first year to squash the Japanese small-car competition. Instead, Saturn looks like a Chevy GEO Storm in its coupe version and an Olds Cutlass Supreme in the sedan version, and its sales forecast was scaled back 50 percent even before the car was produced. "They don't want to be embarrassed again.

"But Saturn is only part of it," O'Grady said. "GM definitely will build an electric car, but they still aren't sure what all the

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Battery

Continued from page 1

for a gasoline-powered car, he noted.

Electric cars will run on batter- that regularly discharge almost of their energy before being recharged, Myles said. Today's lead acid car batteries can do that about four or five times before they need to be replaced.

Current technology can produce lead acid batteries that can discharge and recharge their energy about 250 times before needing replacement, Myles said, which is quite an improvement but still falls short of what is really needed.

Depending on driving patterns, such a battery could power a car for a year or two and then need replacement at a cost of $1,000 or more.

Several other battery types, such as nickel-iron, lithium-iron-sulfide and sodium-sulfur, may provide 1,000 or more charge-and-recharge cycles before needing replacement, said Myles. This will be much more popular with consumers, he predicted.

Another concern of battery developers is the amount of power a battery can deliver quickly so that a vehicle can accelerate smoothly. Some batteries in development that use sodium-nickel-chloride and bipolar lithium-iron-disulfide would provide as much acceleration as a Corvette delivers today, Myles said.

Also, this advanced class of batteries should have a range up to 200 miles before needing a recharge, as well as a charge-recharge life of 1,000 cycles or more.

Electric vehicles will need different care from internal combustion hicles, Myles noted. For one ng, most of the batteries under evelopment run at temperatures of about 300 degrees Fahrenheit. Even though a battery's own power should keep it warm enough to run for up to a month, people have to be mindful of the heat requirement.

"You can't just leave an electric vehicle parked out in the winter under a viaduct for weeks at a time and then come and expect it to start," said Myles.

The first electric vehicles may be used in fleets, Myles predicts.

"It isn't so difficult for someone running a fleet to get used to the care and feeding of electric vehicles," he said. "Also, it's nice for someone in business to put a sign on the side of his delivery truck that says 'This electric vehicle does not pollute.' So you may see more of these in fleets before your next-door neighbor buys one."

It is likely that some of the various metal batteries now being developed will be powering electric cars through the rest of this decade and early into the next century. But research also is under way on radically new power sources for electric vehicles that likely will become available sometime early in the next century.

Northwestern University's Duward Shriver, a chemistry professor who was awarded the 1990 Materials Research Society medal for his work with plastics that conduct charged particles, already is doing research with lightweight plastic batteries.

In these batteries, the charge flows through a plastic material between electrodes made of lithium and of compounds like titanium sulfide. Such batteries are small and low-powered at present, Shriver said. They might be fabricated right on a piece of silicon to provide a self-powered computer chip and find other small, low-power applications.

There are several obstacles to scaling up such batteries, Shriver said. They include managing the increased heat large batteries generate and designing materials to function in winter conditions.

"It's much easier to make a small, button-sized battery than a large, multicell battery," Shriver said. "The complexity of several cells in series is multiplied because if any one cell fails, the whole battery fails."

Still, Canadian researchers with Ontario's government-run hydroelectric system are researching plastic batteries large enough to run a vehicle. They have made impressive claims of success, although Shriver said the batteries have yet to be demonstrated in public and scientists in the field generally are skeptical.

Fuel cells provide another possibility for powering electric cars. Fuel cells are like batteries in that they use electro-chemical processes to produce a flow of electrical current between two electrodes.

Fuel cells, however, bring outside particles, often charged hydrogen ions, into the process from an outside source, much like gasoline from a tank provides a steady supply of fuel for an internal combustion engine. Thus fuel cells, unlike batteries, needn't be packed initially with all the chemicals needed to set up the flow of electricity.

Some high-performance, high-priced fuel cells already have been developed for specialized military uses, Argonne's Myles said. At least two fuel cells designed more for lower-cost consumer use also are being tested.

One is named for a unique component called the proton exchange membrane and has attracted the attention of General Motors Corp. The other, developed at Argonne, is called the monolithic solid oxide fuel cell.

Fuel cells can run on a variety of fuels, including forms of alcohol such as ethanol and methanol. They produce some carbon dioxide and water as byproducts of operation, but no major pollutants.

"You'll see electric cars running on batteries in this decade and early in the next century," said Myles, "but I think that eventually fuel cells will be the power source for electric cars.

"They offer unlimited range, just like today's gasoline-powered cars, as well as the advantages of electrical-powered vehicles. They'll be tough to beat."

Electric

Continued from page 1

nuances will be, and until they do they aren't going to make any claims or set any dates they can't live up to."

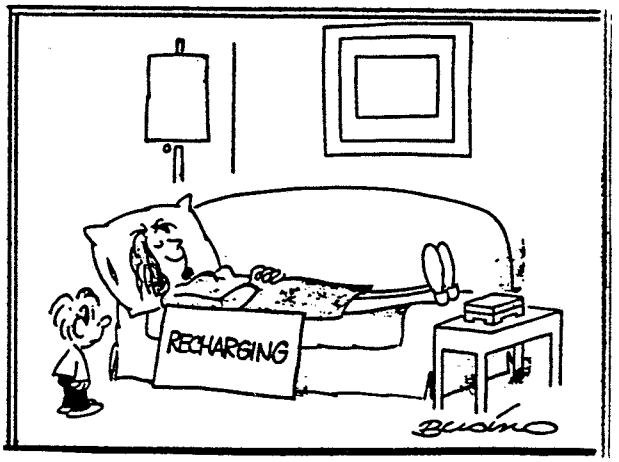
GM a year ago unveiled a two-seater electric concept car dubbed Impact and powered by a pack of 32 lead-acid batteries. That is the car to be produced, GM officials said Monday. But they said there has been no decision on what the name will be or if Impact will be used.

Reuss also wouldn't say which GM division would be in charge of building the first GM electric vehicle. Though the plant now builds the Buick Reatta, the facility is owned by GM's Cadillac division. GM spokesman John Hartnett said no decision has been made as to which GM division will manage the plant or whether a separate electric car division will be formed to build the vehicle. Reuss has said he favors a car carrying a generic nameplate and sold by a variety of GM divisions in order to provide owners with service and repair outlets throughout the U.S.

GM had been thought close to naming its Van Nuys, Calif., plant, which produces the Chevy Camaro and Pontiac Firebird, as the site for its first electric car. California emission laws mandate that automakers sell electric cars in that state starting in 1998, and GM already had said it would stop building Camaro and Firebird at Van Nuys, probably in 1994.

"Lansing was considered more suitable because of its central location to service all markets in the U.S. as well as to provide for exports overseas," Hartnett said.

The Reatta plant, which will be renamed as soon as Buick stops producing the car, originally had the capacity to build 20,000 to 25,000 vehicles annually. It didn't build that many combined in the 4 years the Reatta has been on the market. Buick sold 2,759 Reattas in 1988, 7,911 in 1989, 7,022 in 1990 and only 371 so far in 1991.



FOX VALLEY ELECTRIC AUTO ASSOCIATION MEMBERS WITH CARS FOR SALE

THESE FVEAA MEMBERS FVEAA HAVE ELECTRIC CARS THEY WISH TO SELL

MEMBERS NAME	PHONE #(708)	CAR	PRICE
Jack Cahill	629-3989	1974 Hornet	Free
Bob Kyp	469-8121	Pinto with 4-step voltage switching 48-volt system. With extra motor. Needs new batteries	$ 1000
Carl Swick	429-4955	1976 Chevette. New batteries & controller. 48 volt, 400 amp system Hybrid addition posssible.	2500
Everitt Harris	232-0344	1975 Honda Civic. New batteries, tires. 54 volt controller system. Hybrid addition possible.	3500
Bill Wilcox	634-4605 Area (815)	1980 Dodge Omni. 4-step 48-volt switching system. One year since conversion.	3500

Some of these cars offer an opportunity to get started with an electric car at a very modest cost. Some wish to sell because they want to do an improved conversion. In some cases, the price is what just the electrical components would cost today.