

PRESEZ

I will cover our negotiations with Delco in my column this month. The FVEAA was contacted by Delco on February 10 thru John Stockberger, inquiring about interest in converting a new Saturn station wagon. The project would require installation of a drive system developed for the Impact in the vehicle. The proposed battery would be an Ovonic nickel-metal hydride (NIMH) unit.

I assembled twelve FVEAA members likely to be involved in the project to determine if the invitation should be pursued. The unanimous view was to send a response to Delco. This was faxed to Delco on 2/13.

The project was discussed at the FVEAA meeting on Feb. 21. Due to the then confidential nature of the project the membership approved the response and directed that the Newsletter omit information about the negotiation.

This was followed by a March 16 visit by three DELCO representatives with the FVEAA members involved in the initial response. Project requirements were defined and a general approach was discussed. On March 27, a preliminary proposal was faxed to Delco outlining the work plan.

Follow up telephone calls inquiring about project status were made in April. I was informed on April 24 that the project was cancelled by DELCO.

This would have been a good project for the FVEAA. Since it has been cancelled, we now are free to continue our cooperative construction project that has been on hold during the negotiation period.

Ken

APRIL 21 MEETING MINUTES

The meeting at the College of DuPage was called to order at 7:40 PM by President Woods. Twenty four members and two guests attended. Minutes of the March meeting were approved as published. Treasurer Corel stated the savings account balance was \$ 2186.70 and the checking balance was \$ 2985.30, \$ 1900 of the latter is project money.

During the introduction of persons attending, the following converted vehicles were reported; 1950 Studebaker, Audi, Citicars (2), 79 Horizon, Mazda RX-7, Fiat, Rabbit, an a Mechanix Illustrated Town Car.

President Woods has agreed the FVEAA will be at the Geneva Earth Day anniversary celebration tomorrow on Island Park. Shafer's RX-7 will be on display.

Members were requested to contact auto dealers with a copy of the Ken Woods letter included in the April Newsletter and search for a car to be used in the Project.

An alternate proposal by Member Shafer to finance the Project was discussed. It was the consensus that the DELCO Project and the COOP Project could not be done at the same time. A motion to reject the DELCO project was defeated. A motion to proceed with the alternate funding was proposed and withdrawn after considerable discussion.

A motion was approved to ask members in the May Newsletter to participate in the COOP thru participation shares. The June decision date remains unchanged.

The meeting was adjourned at 10:13.

Dave Aarvold

RECENT EV ARTICLES

France plugs into electric cars with rebates - Tribune 4/1/95 (From Reuters) - The French government offered to make up the difference between the cost of an EV and a conventional car to encourage sales of the environmentally friendly cars. A \$ 1027 government payment and another \$ 2054 from the national utility . France leads in European EV development with more than 20 cities and towns now involved in trial programs.

Electrifying development for Ford trucks - Tribune 4/15/95. Ford will begin to provide gliders (vehicles without an engine, transmission & fuel system) for their Ranger series of trucks. These will be sold to converters qualified by Ford, who will install the electrical components and sell the cars. The glider cost will be substantially less than a Ranger that is ready for the road. A Ford spokesman said this program is in addition to other EV plans.

Chrysler to sign battery deal - USA Today 4/6/95 & Rockford Register Star 4/9/95. Chrysler announced a \$ 7.5-million contract with Electrosources to use the Horizon battery in an electric minivan that Chrysler will sell in California in 1998. The Horizon battery has about one-third more power per pound of battery weight than present batteries.

Electric cars missing practical spark - The Columbus Dispatch 4/15/95. Three years from now the California "2%" mandate kicks in and carmakers are scrambling. Lead acid battery energy storage limitations and EV costs are the principal barriers to widespread EV acceptance. Millions of dollars in R&D is being spent but so far results have been disappointing according to a spokesman for the International Association of Auto Manufacturers.

Big 3 electrics racing toward 1998 deadline - Aurora Courier News 4/7/95. (From NY Times) GM appears to be ahead of rivals Ford and Chrysler in the contest to sell EVs in California in 98. Their IMPACT, a purpose-designed EV that uses lead-acid batteries that store 17 kwh of energy has achieved impressive performance results. The sodium-sulfur batteries in Ford's ECOSTAR vans are much too expensive for a consumer product. Chrysler has been testing an electric conversion of a standard minivan that has excruciatingly slow acceleration. If you can't wait for an EV from Detroit, you can buy one from small companies such as Solelectria that converts cars, or you have the option of yanking the engine of an old car and converting it yourself. There are at least 14 companies that sell conversion kits.

GM's Saturn division may soon plug into electric cars - Daily Herald 3/18/95. GM officials say the automaker is studying the possibility of adding an electric car to Saturn's line up by 1998. It would be based on the GM Impact. Industry experts note that Saturn's ability to bring young import owners back into the GM fold makes it the logical choice to sell EVs. The IMPACT selling price about \$ 10-15,000 above a conventional car is likely to be a turn off however.

Europe on the (EV) move - Sun-Times 4/2/95. Peugeot, the French car manufacturer, has unveiled the TULIP, a 2-seat EV with a 43 mph top speed in Stockholm, Sweden. No release date or price information is available.

RECENT EV ARTICLES - CONTINUED

EV America announces its 1995 test program - Press release 3/17/95. Beginning August 1 this year, EV manufacturers will be invited to provide 30 vehicles for 30 days of testing and a Phoenix proving ground facility. A copy of the vehicle specifications can be obtained by calling Jean Kenney at (202) 508-5600. EV America is a consortium of twelve electric power utilities that is managed jointly by the industry trade and research groups.

Electric Vehicle Association of the Americas (EVAA) benchmarks number of EVs - Press release 3/27/95. There are between 2078 and 2369 highway capable electric cars produced by original equipment manufacturers, major converters, and hobbyists. Cars from the Big 3 account for 190, conversion companies have produced 906, and the estimate of self-built cars is 695. Electric buses number 63, with another 56 in development. Pre-1990 cars are estimated at 515, assuming a 10% survival rate. The EVAA is a national, nonprofit membership organization working to advance the commercialization of EVs. It serves as a centralized source of EV information.

Flywheel of Fortune, Discover Magazine June 95, Page 55. The Chrysler Patriot that uses a flywheel spinning at 60,000 rpm to provide acceleration power for an electric racing car was awarded the magazine's top 1994 recognition in the automotive & transportation category. The car develops 500 HP and weighs 1700 pounds. Chrysler commissioned SatCon to develop the flywheel that will withstand road vibration and delivers more three times the punch of the designer's Yamaha XK-650 motorcycle.

Gearing Up for Electric Cars, Issues in Science & Technology, Winter 94-95. Author Daniel Sperling in this article makes a compelling case for decisive government action to encourage EV development. Automakers require better coordination of present regulations and some kind of shield from the risks to them that are likely to be a result of this desirable technology innovation.

FROM OTHER EV NEWSLETTERS

EEVC (The Eastern Group) in the April issue reported on a model EV competition in which 27 cars participated. In the speed event, the cars raced from one end of a basketball court to the centerline (42 feet). The winner did it in 2.35 seconds. In the bowling event, the cars were placed six feet from the starting line and tried to strike 2-liter soft drink bottles. The members will again display their electric cars on July 30 (the 100th anniversary of organized auto racing) at the Pocono Raceway. The 1912 Baker is being prepared for this summer's cross-country drive. The car presently has a single-charge range of 50 miles on a set of 12 golf car batteries. DC-DC converters with a 12 volt output, 165 watts are available from Conversion Devices, 15 Jonathon Drive, Brockton MA 02401, Phone (508) 559-0880.

FROM OTHER EV NEWSLETTERS - continued

GLEAN (The Great Lakes Association) April issue has 36 pages full of useful information. Particularly interesting is the article about the General Accounting Office report on federal EV policies is entitled "Electric Vehicles: Likely Consequences of the U.S. and Other Nations' Programs & Policies". There are a number of EV programs, the largest - a \$ 262-million Advanced Battery Consortium R&D effort. The report recommends development of a comprehensive approach rather than the present fragmentation. The report notes that foreign manufacturers that are presently testing a wide variety of electric cars will be the most likely to offer low-cost, performance-tested cars. The IRS proposes to exclude tax credits for EV conversions of used cars on the basis they do not meet the "Original Use" requirements of the legislation. There is a description of Unique Mobility-Pininfarina development of the new ETHOS 3. The extruded aluminum frame accounts for only 198 pounds of the 2315 pound curb weight. The 4-passenger car uses a 72 hp DC motor and 12 advanced lead-acid batteries @ 12 volts (144-volt system). Initial cost is expected to be less than \$ 40,000.

AVEA (The Aussies) in the April issue noted that Toyota has built an electric hybrid bus that has a 1300 cc gasoline engine. Pollution costs in LA are estimated at \$17,000 by the Union of Concerned Scientists in their report "Benefits of Electric Vehicles". The Japanese Yahata Technical Institute reported a pulse charger improved efficiency by 18%.

EVAOSC (The Southern CA Association) -April issue reported that the March 30 Clean Air Road Rally in LA attracted 44 vehicles, half were EVs and 13 were hybrids. The issue also includes a technical application article on Curtis controllers. A presentation on hybrid vehicles was a feature of their March meeting.

MICHIGAN ELECTRATHON on June 30 will feature at least 30 participants from Michigan High Schools. This is likely to be the biggest event so far. (See EVents). The April issue also has inspection requirements for competition.

THE MAINE SUN - Spring 95 issue reports on the Tour De Sol which will conclude in Portland

VEVA (The Vancouver Bunch) April Newsletter featured an article on an electric bus being developed by Vancouver-based Ballard Power Systems. The vehicle uses 120 kw of fuel cells. Their 1995 Electrathon on June 5th has attracted sponsorship from 9 companies and several individuals. The issue also contains a report of SunDay in Daytona on April 1st. Two Triumph conversions, a Fiero, an Electric Spyder (fiberglass kit car), a 1900-vintage Milburn, a Festiva, a S-10 pickup using an IMPACT drive system, and a "SunDriver" were entered.

WORLD ELECTRIC TRANSPORTATION - Clarence Ellers Newsletter for April observes that pre- WW-II cars got 14-20 miles per gallon, and had about the same emissions as present cars equipped with the latest controls and built for midjets. He argues auto makers have spent millions to clean up emissions with very little results. Clarence will host an "EV Weekend" in Yachats Oregon, a two-day EV workshop (cost \$ 50).

EVents

1995 American Tour de Sol, May 20-29. Waterbury CT to Portland ME. Twenty three vehicles have been entered. For information call NESEA at (413) 774-6051.

Electric Transit Vehicle Conference & Expo, May 21-24 Chattanooga TN. This is the first national conference covering electric transit vehicles. For information, call Valerie Powell, ETVI at (614) 622-3884, FAX (614) 622-0744

EV Road Race Supervised by SCCA, May 27. Grattan Track near Grand Rapid MI. For information call Paul Zellar at (616) 887-2744.

Michigan High School Electrathon Competition, June 10. Michigan Ideal Speedway, south of Lansing, MI. Thirty Michigan High Schools have entered cars, making it the largest such event so far. For Information, call Paul Zellar at (616) 887-2444, FAX (616) 887-7755.

1995 Hybrid Vehicle Challenge, June 5-13 in Auburn Hills, MI, Thirty nine colleges are entered in the third annual competition sponsored by Chrysler, DOE, National Labs, SAE, and the Canadian Natural Resources Council. Colleges were provided new vehicles that have been adapted for the event. Competition will evaluate emissions, range, acceleration, efficiency, design review, and consumer acceptability. The Neon Class has 12 entrants that also includes an air conditioning evaluation. Other classes include Escorts and Saturns. For information call Bob Larsen at Argonne National Laboratory (708) 252-6594.

Sunrayce 95 starts June 20 in Indianapolis and finishes in Golden Co on June 29. This is a biennial renewal of the original event in Australia that was won by the GM Sunraycer. This year's event is an intercollegiate competition for solar powered cars sponsored by DOE. The race route will include a stopover in Illinois. For information call Sunrayce 95 Headquarters at the National Renewable Energy Lab at (303) 384-NREL. FAX (303) 384-6490

Cleveland Electric Formula Classic, June 21-22 at Burke Lakefront Airport. For information call Kevon Markell at (216) 447-3552.

Alternative Fuels Conference & Expo June 28-30 in Milwaukee, WI. This is the fourth annual event that considers such items as EVs, biofuels, CNG, methanol, propane, LNG, and hydrogen. For information call Bridges Public Relations and Marketing, 1-800-447-5088.

Electricore Formula Lightning Race, August 17 in Indianapolis. For information call Jim Hunnicutt at Electricore (317) 278-1673.

S/EV 95, November 13-15 Boston, MA. This is the seventh annual symposium that will discuss electric car developments. For information call NESEA at (413) 774-6051, FAX (413) 774-6053

THE COOPERATIVE CONSTRUCTION PROJECT (CCP)

Although it may not seem like it, we have made a lot of progress on this venture. For four months it has been on hold while we responded to the DELCO inquiry. We plan to proceed with the CCP now that the DELCO project has been terminated. A number of members have taken the letter about a car to convert to several auto dealers with promising results. Dealers receive cars in trade that have little value to them that are either sent to an auto auction or junked. They are apparently willing to consider selling or giving a suitable conversion car to the FVEAA. One dealer even offered to sell the converted car. We ask that a member who has not contacted a dealer to use the letter on the last page of the April Newsletter and see what interest it may produce. At least it will let the dealer know about the FVEAA. One dealer I talked with said, "Electric cars would put me out of business". I responded that someone will be selling electric cars and that an established dealer would be a logical choice.

Members and friends have provided or pledged over \$ 2000 for project participation shares. This is enough to get the project started, but insufficient for completion. Members attending the April meeting directed that another solicitation for participation shares appear in the May Newsletter. Response to the survey made when the CCP was being considered last October indicated 90% of the persons responding to the questionnaire would be willing to buy a \$ 100 participation share. (See minutes of the 11/18/94 Meeting in the December Newsletter).

We need the help of additional members for the funds needed to authorize CCP. If you will inform others of the FVEAA and its programs, it will expand our membership base and provide additional support. Every new member means additional support for the FVEAA and the CCP.

I believe we can have another EV on the road in 1995 - with your help.

Bob Munroe
CCP Manager

This article on Page 129 of the Nov. 7, 1994 issue of *Electronic Design* was furnished by a FVEAA member. It is interesting, informative, and reproduced in its entirety.

BOB'S MAILBOX

Dear Bob:

Re: Your Electric Car Stuff column in the August 8 Issue.

From 1978 to 1986, I was involved in the "Electric Adventure," the U.S. Dept. of Energy's program to put Electric vehicles on the road and develop test data and experience in a real-world driving environment. For eight years, under contracts with the U.S. Dept. of Energy, my joint-venture partner (a new car dealer in Dallas) and I leased Electric cars to individuals and businesses in the Dallas, Texas area.

All of these cars were internal combustion engine (ICE) cars before conversion to Electric vehicles (EVs). They were, therefore, not the most optimum platforms to evaluate the limits of EV technology. They tended to be heavier than they needed to be because of all-steel construction, and extra bracing was needed to keep the U.S. Dept. of Transportation happy.

In all, we had about 20 cars on the road, including Ford Escorts, Ford full-size sedans, Pontiac compact sedans, Dodge Omnis, and even a Mercedes Benz 190. The performance of these cars was certainly adequate for any type of driving mission within the obvious limits imposed by battery capacity. Some typical characteristics of these cars is listed below:

- Top Speed—At least 70 mph (the MB 190 would do 80 mph).
- Range on Full Charge—45 to 55 miles (in the city or at highway speeds).
- Batteries Used—Lead-acid, 6-V, golf-cart batteries in a series string.
- Acceleration—Brisk up to 20 mph, about 0.1 G after that.
- Efficiency—0.3 kWh/mile dc, and 0.5-1 kWh/mile ac (from the power line).
- Battery Life—More than 10,000 miles until the range fell to 65%.
- Battery Replacement Cost—About the same as now, approximately \$1000.

Safety Features:

- Every car had a manual electronic disconnect "knife switch" attached to a cable and handle under the dash, similar to the hood release, but red. All were fitted with fuses as well. A traffic accident did occur, but you should have seen the other guy! The extra steel and mass of the EV kept it intact and drivable, not so with the ICE it hit.

- The batteries were housed in steel boxes with lids snapped down tight, both under the hood and in or under the trunk. Forced-air ventilation kept hydrogen at a low level. A sensor warned of ventilation failure.

- Ground-fault circuit interrupters were in each car to disconnect the 240 V ac if as much as 1 mA of ground fault current occurred. The high-voltage battery (120 V) was not connected to the chassis of the vehicle. The 12-V system was, as usual, connected with the negative to chassis.

Accessories:

- Several cars had air conditioners that used about 1 kW to run when on. Since the vehicle motor used about 10 kW, the range was only reduced 10% or less—a small price to pay for comfort.

- All cars had heaters and defrosters. Some were gasoline-powered, some electric. Again, about 1 kW was required.

- All cars had power brakes, powered by a small electric motor vacuum pump.

- All had radios.
- Some had power steering, automatic transmissions (not really needed), electric windows, seat heaters (the greatest), etc.

In other words, anything you can hang onto an ICE you can hang onto an EV. The EV's motor consumes so much of the available energy, the other stuff doesn't matter much.

Some observations:

At first it seems different driving an EV. Then you realize one day that you've been driving around town in an

EV without giving it a second thought! I think that sums up the ease with which one adapts to EVs.

In my final report in 1985, I recommended a small ICE auxiliary power unit (APU) be installed in EVs to provide increased range and reliability. "Don't leave home without it." Eventually, fuel cells would replace the ICE APU, but the high-discharge-rate battery would still be needed for acceleration.

Batteries that have twice the energy of lead-acid have existed for at least 10 years, and they did consistently give 100-mile-plus ranges in these same cars. On a life-cycle cost basis, they are less expensive than lead-acid and would last over 100,000 miles. Edison invented them for electric cars 75 years ago—the nickel-iron battery. Some have been in use that long!

What about GM's Impact EV? They achieved a 125-mile range using lead-acid batteries. How did they do it? With a very lightweight chassis, low-rolling-friction tires (very high pressure), and a clean aerodynamic shape. Now, if you put in an Edison battery and an APU....

GEORGE H. THIESS

IZU Products

Lufkin, Texas

Your experiences with electric cars are quite encouraging. There's no doubt the CARS are adequate, it's just the BATTERIES that don't have enough range or life. Maybe nickel-iron will prevail. Flywheels may need more study, but I think they are "closing fast on the outside."

Still I don't favor 4000-lb. cars, whether ICE or EV. The real economy of EV will come at the 2000-lb. level. (If I took all the junk out of my Beetle, it might attain 2000 lbs.—RAP

Dear Bob:

First, I'd like to let you know that I have been enjoying your column in each and every issue of *Electronic Design*. In your September 5 column on Rendezvous Stuff, you asked about

FVEAA Members have indicated interest in the OVONIC Nickel Metal Hydride (NIMH) battery. An article on the battery appeared in the November, 1993 FVEAA Newsletter that was based on a presentation by Dr Ovshinsky at an IIT colloquium is reproduced again here. FVEAA member Steve Leisner obtained a press release from the company last month. A summary of material in that document is included. Further info appeared in the April, 1993 issue of Science, Page 176 and may be consulted for detailed technical information.

The Ovonic battery is similar to the Nickel-Iron battery developed by Thomas Edison and sometimes called the Edison cell. He initiated a battery investigation after finding lead-acid batteries unsatisfactory for his electric vehicle. At the time he observed, "There must be a better way (to store electricity), FIND IT!"

Both batteries use a potassium hydroxide (KOH) electrolyte. Instead of a nickel electrode, the NIMH battery uses an engineered, proprietary mixture of vanadium, titanium, zirconium, nickel, cobalt, iron, and chromium. Electrochemical activity of the NIMH battery is superior to the nickel of the Edison cell due to the metallurgical phase mixture of the component metals achieved during manufacture. Development has increased the number of mixed-phase active sites. The spectrum of bonding energies available at the variety of active sites improves battery energy storage and volumetric efficiencies. As with all electrochemical batteries, the challenge is to improve the utilization of active material and increase surface area available for reactions to take place.

The NIMH battery has a nominal voltage of 1.2 volts per cell. It stores hydrogen as a reaction product in the solid hydride phase. Because of this feature, the NIMH battery does not electrolyze water in the KOH electrolyte which causes the Edison battery to emit copious quantities of gas during operation - particularly charging. The NIMH battery is a sealed unit.

During charging the NiOH electrode is oxidized and the metal hydride electrode is reduced. There is no net change in electrolyte quantity or concentration over the charge-discharge cycle.

ECD has expended considerable research efforts to produce the NIMH electrodes using disordered materials to improve battery performance.

How good is the battery? A comparison of battery parameters gives an idea:

Property	Lead-Acid		NIMH
	Available Today	Possible Development	
Specific Energy (Wh/kg)	35-45	80	80
Energy Density (Wh/liter)	70-90	135	215
Peak Power (Charged) (W/kg)	110	-	230
Power Density (W/liter)	150-200	250	470
Cycle life (80% discharge)	300-500	600	1000
Life (Years)	2-4	5	10
Recharge time- hours (From 80%)	6-8	6	1
Self discharge in 48 hrs	Data not available	>15%	<10%
Cost (\$/Kwh)	50	<150	200 *

* Projected for 10,000 units @ 40Kwh.

Also refer to this Fig from the paper which shown Argonne Lab test data that compares depth-of-discharge data for a number of EV battery types.

The battery operates between -30 C and + 70 C. It can be quick charged to 60% of capacity in 15 minutes. The demonstrated energy storage capacity is three times that of a conventional lead-acid battery. Compared to the 17 kwh stored in an IMPACT battery, the OVONIC unit is expected to give a single charge range of 250 miles. A spent battery can be recycled to reclaim metal content.

The cost of an OVONIC battery for a vehicle will initially be \$200/kwh, (\$4-5,000) for an expected 100,000 miles of travel.

GM an OVONIC announced a partnership agreement on March 9, 1994 for the further development, manufacture and commercialization of the NIMH battery for EVs.

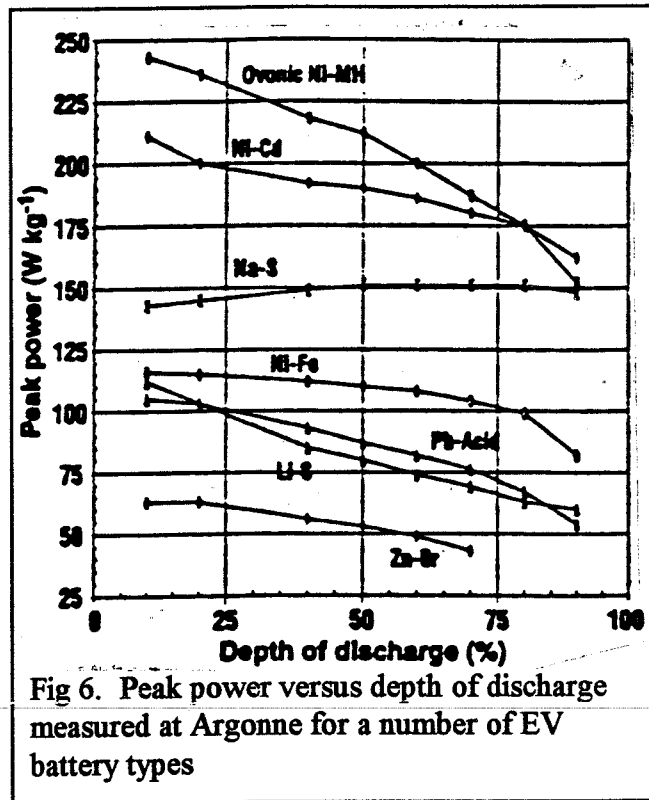


Fig 6. Peak power versus depth of discharge measured at Argonne for a number of EV battery types

Almost every FVEAA member with a converted EV would probably be interested in paying four times as much for an OVONIC battery that would extend the range of his car by almost three times, has a power capability twice that of the golf car unit he has, and would eliminate rewatering. The problems are cost and availability. The projected \$ 200/kwh is based on producing and selling 10,000 40 Kw units. The final cost may be higher; after all, expensive rare earth metals are used in making the plates.

Recharge time may be another problem. Our present chargers are supplied from readily available 15-amp, 120-volt ac supply circuits rated at 1.5 kw. It would require a 45kw supply to recharge a NIMH battery in one hour. This could be supplied by a 3-phase, 240-volt source, something that is not found in a typical residence. A 6kw power level that would recharge a 40Kw battery in 6.3 hours could be supplied by a 240-volt, 30-amp single phase circuit similar to an electric clothes drier supply. One might even interlock a drier and EV circuit to use the same supply circuit for either a drier or EV with a NIMH battery. The FVEAA addressed the question of recharging circuits in its 1994 Infrastructure Design Competition entry.