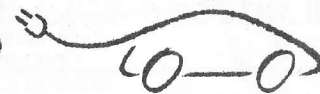


CURRENT EVENTS



March/April 1993

Promoting the Use of Electric Vehicles Since 1967

Vol. XXV No.2

EV "Supercharger"



150 KW Minit Charger

Chrysler Corporation and Norvik Technology Inc. announced a joint agreement for development of a fast, energy-efficient and smart electric vehicle battery charging system they hope will give future electric vehicle customers the refueling speed, safety and convenience of today's gas-powered vehicles.

The Chrysler/Norvik Smart Charging System, a major electric technology breakthrough unveiled to media at the 1993 Greater Los Angeles Auto Show, allows quick charging of any battery, can be used every time a charge is needed, and actually extends the life of the battery.

"This month Chrysler took two critical steps in making electric vehicles a viable part of this country's transportation system," said Francois Castaing, Chrysler vice president - Vehicle Engineering. "We began production of the first of 50 Dodge Caravan Electric minivans, which are the first Federal safety-certified electric

vehicles in the country, and today we are announcing a technological innovation that to improving the electric vehicle infrastructure with the Chrysler/Norvik Smart Charging System."

The Chrysler/Norvik Smart Charging System is not the first battery quick-charging system to be introduced, but may be the smartest and most user friendly for both the customer and the batteries. And as part of their agreement, Chrysler and Norvik are working to make the system even easier to use and more widely available by moving the systems' smart functions into future electric vehicles through the proprietary Battery Energy Management System (BEMS).

What makes the Chrysler/Norvik Smart Charging System station smart is its ability to instantly determine the chemical or physical makeup of a battery and quickly and efficiently charge it without producing a battery-damaging overcharge.

Specific elements of the Chrysler/Norvik Smart Charging Station include:

- Fast, smart and easy to operate.
- Can be used with any battery. System has already been tested on lead-acid, nickel-iron, nickel-cadmium and nickel-metal hydride battery technologies.
- Can be used to quick charge every time. Other "brute force" charging systems are designed to be used only 5-10 percent of the time with regular slow or overnight charging used the majority of the time.

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EVs, Rubber and the Road

by Paul Brasch

What can be done to increase the range of your typical electric vehicle? Everybody says we need better batteries. Of course, better batteries will always help, but when you have seen demonstrated and proven cars with good performance using present day batteries, why not work with what we have? One can always bemoan the present batteries and wait for something better. Or you can forge ahead and try to get the most out of available technology.

After batteries, the next most commonly thought of area of concern is the efficiency of the motor. I believe that this is misplaced. Typical motors used today are 88-92 % efficient and even the old aircraft starting/generators used way back in the '70s were 75-85 % efficient. Don't think that this means that the old aircraft motors compare

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Editor's Corner

EVs' Final Frontier (or Hurdle)

What are the impediments to widespread use of electric vehicles? Let's look at this in detail.

Electric cars are not like gasoline cars. This is both good and bad. We know the good features and the bad perceptions. I say perceptions because although there are technical problems with EVs, most of the problems are misperceptions by the public.

Let's compare the perceptions to the technical reality. The long time misperception that electric cars cannot be more than glorified golf-carts has been proven to be totally false by the designed-from-the-ground-up Impact and the high-powered Honda conversion by AC Propulsion, as well as the 90+ mph Porsche 914 conversion done by Ron Rasmussen. (And read what FMC is doing in the Symposium story in this issue.)

Everyone agrees that range per charge is a handicap for electric cars. People think that they need a magic battery that will give them 400-500 miles per charge. And they want it to be cost-effective at the same time. Is this reasonable? Not when the proven statistics show that the average of all personal travel is less than 25 miles per day per vehicle and that 54 % of daily travel is less than 5 miles. The typical conversion car gives a 45-75 mile range per charge with the better ones yielding more than 100 miles. The best have given 232 miles and 450 miles.

This range perception problem exists due to the perceived time needed to recharge. The present recharge time on a 120 VAC outlet is 8-12 hours. I liken this to filling up your gas tank using a straw. It is Absurd, but it is fine and dandy for overnight charging (you sleep 8 hrs anyway). Charge time drops to 4-5 hours if you have a true 240 volt charger that can charge at a 2-4 kilowatt rate.

Now, suppose that you could recharge in about the same time it takes to refill with gasoline? Suddenly the range between recharges becomes almost non-important. If you can drive 75-150 miles and then stop for 10-20 minutes and then drive the same distance again, then there is NO difference between that and a gasoline car except that you can go twice the distance before stopping. Big deal. After 3 hours of driving, most people need to stop for a stretch break or to visit the lavatory.

Fast charge equipment is not for home use, but it would be financially advantageous at a service station (remember when they actually gave service?) to provide this service. They could charge you \$10-20, (a similar price for a tank of gas) for approximately \$1 worth of electricity. This would be fair, as you would only pay this rate on a long trip and usually would recharge at home at night for the utility cost of about \$1.

I talked at length to Mr. Nor, the inventor of the this new fast charging system. He sent me over 40 pages of presentations and reports given to various international battery seminars. The technique has been used to quick-charge video cameras for some years. I read about it and I am convinced that it is real. (See front page story.)

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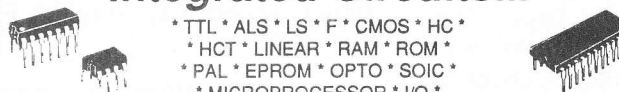
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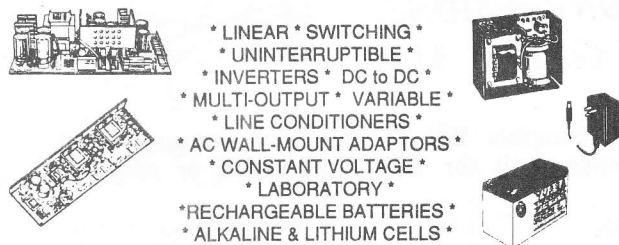
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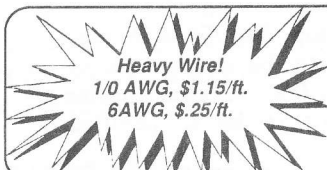
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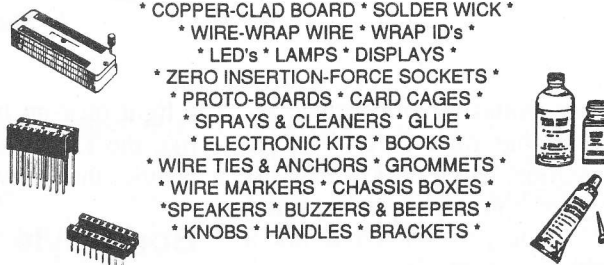


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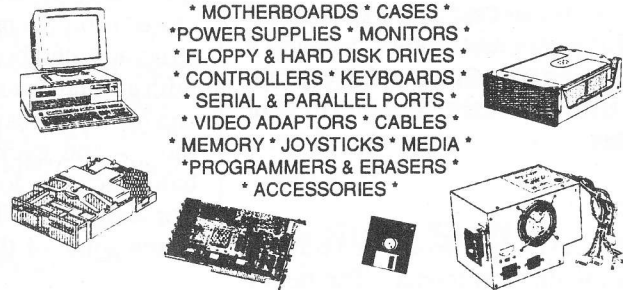
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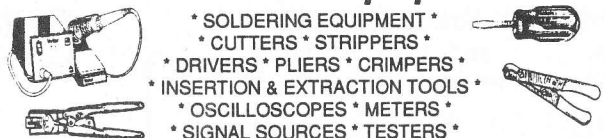
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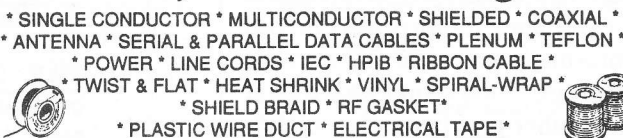
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Choosing a Conversion Car

by Shari Prange

In your fantasies, you cruise silently down the road in an electric dream machine. Not a puff of exhaust comes from the tailpipe — what tailpipe? The only reason to pull into a gas station is to check tire pressure and wash the windshield. Tune-ups and oil changes are fading memories. But now you want to turn your fantasy into a reality, and your first task is choosing a car for this metamorphosis. Making a wise choice at this first crucial step will insure that your reality lives up to your fantasies.

Size

Obviously, you won't be converting a Lincoln Continental. The heavy cars that get poor gas mileage will also be poor performers as electric. Look for a car that's under 2500 lbs curb weight, if possible. Two thousand lbs. or less would be ideal, and 3,000 would be marginally acceptable in a low-speed special application. Although you'll be removing the engine and miscellaneous other parts, you'll be adding a half-ton of batteries. The conversion will probably gain 600-800 lbs. from its original weight.

To check curb weight on a potential donor car, go to the library and look up *Road & Track* for the year that the car was built. There will probably be a detailed report with all the relevant specs. *Consumer Reports* also carries such information. On the other end of the spectrum, some wonderfully light cars have other problems. One is limited space for batteries. Even a very light car needs a minimum of 72 volts (12 batteries) to be marginally street-safe, and 96 volts (16 batteries) is recommended. Another potential problem is the added weight. A very tiny, very light car won't have the suspension to accept the added battery weight.

The ideal size is a Rabbit, Civic, Sentra, Escort, or something similar, or

a light pick-up truck. Beware of cars like the Fiero that are actually much heavier than they look.

Body style

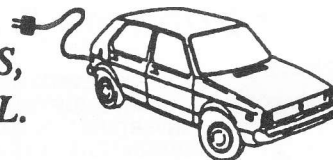
Look for accessible battery space. Hatchbacks are probably the best choice. Remember that batteries can be sunk into the body, as long as they are enclosed in proper racks, don't cut through structural members, and don't interfere with ground clearance. This means you can have your batteries and a backseat, too — and even cargo space in the hatchback, on top of the battery box. For weight distribution, you will want to put some of the batteries under the

hood, so look that area over with an eye toward any odd protrusions into the engine bay, or a low profile nose that reduces vertical clearance.

What about kit cars? Kit cars have the advantage of being very light, since the bodies are fiberglass. They also offer lots of opportunities for modification, since you have to build the car from scratch anyway. On the down side, they are expensive and time consuming to build, so you'd better *really* love that car. Some kits are very sporty and don't have much battery room. Battery access is also crucial. Finally,

(Continued on next Page)

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(Continued from previous Page)

be sure you're dealing with an established reputable kit company that will still be there if you need them next year.

Age

The rule of thumb here is to look for a car that is less than ten years old, and the newer the better. There are many reasons for this. Obviously the newer car will be in better condition. It makes no sense to invest a lot of time and money converting a clunker. The newer car will also offer better crash protection and aerodynamics, since much progress has been made in these areas in the past decade. Finally, availability of parts is poorer after ten years, and drops significantly after fifteen years for many cars.

Condition

The ideal donor car has a good body and interior, sound transmission, but a dead engine. For this reason, the diesel VW Rabbit is an excellent choice. Watch for ads that say "Good body, needs engine". Also, talk to independent garages that specialize in the kind of car you want, or local junkyards, and tell them to watch for a good candidate for you. Specialty mechanics may be able to recommend a model of car with a tendency to blow engines.

If you get a donor that runs, you can recoup some of your investment by selling the engine. This is easier to do while it's still in the car and running. Be sure the buyer knows you will be keeping some of the parts, like the clutch and flywheel assembly.

Make and Model

In general terms, it is harder to find a suitable American donor than it is to find a foreign one. That is because American manufacturers have only recently become interested in producing small aerodynamic cars, and those are often American in name more than con-

tent. Japanese cars seem especially suitable.

Stay away from orphan makes and models. Yes, Aunt Tilly will give you her old Nash for free, or your brother-in-law will donate his Yugo, but where will you find brake cylinders when you need them? Stick to a manufacturer that has a good dealer presence in your area, and a model that was very popular and highly produced. If there are a lot of them still on the roads, someone will be selling parts for them, and there will be used parts available in the boneyards.

Transmission & Drive Axle

Conversions can be front wheel drive or rear wheel drive. Having the engine and the driving wheels at the same end of the car makes packaging easier, but isn't essential. Four-wheel drive is not a practical option at this time.

Automatic transmissions are also not realistic. For one thing, there are energy losses that an electric car can ill afford. For another, an automatic transmission depends on a continuously idling motor to provide fluid pressure. Without it, there is a serious lag in acceleration from a full stop. If you cause the electric motor to idle like a gas engine, you are wasting energy and defeating the efficiency of an electric. If you add a separate fluid pump, that adds one more component and level of complexity to the system. Finally, electric motors have a different torque profile, and want shift points that are different from those of a combustion engine.

Options

In general, a stripper version of a car is preferable to the luxury version. Air conditioning eats almost as much horsepower as it takes to move the car

down the road. Power steering is another energy-eater. Also, if the car really needs power steering, perhaps you should look at the curb weight again. Luxury models usually have more sound deadening material, which is unnecessary weight in an electric.

Power brakes, on the other hand, are easily accommodated with a vacuum pump, and highly recommended, due to the added weight of the batteries. Power windows and stereos don't use enough energy to hurt anything. Enjoy

The Right Stuff

There are three parts to a good electric vehicle: a good chassis, the right components, and a well-designed and carefully executed installation. Just because a particular car is readily available or cheap does not mean it's suitable, and a poor chassis will give you a poor EV. Making the right choice at the beginning will give you a good start toward getting your electric dream out of your fantasies and onto the road.

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Upcoming

- Solar Electric 500 report
- More CALSTART car details
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- And more . . .

EVs, Rubber and the Road

(Continued from Page 1)

with today's Advanced D.C. motors, Prestolite or G.E. motors. Today's motors are very rugged and reliably give 30-70 horsepower for acceleration.

So what are the areas where you can make improvements? Some are the almost obvious things such as making sure that the brakes do not drag. Also front end alignment is very important. Toe-in should be set to zero. Wheel bearings should be in good condition as well as the brakes themselves.

Also the gear oil in the manual transmission should be removed and flushed 2 or 3 times with kerosene for example, and replaced with a good lightweight synthetic such as Power Up or Red Line, or use ATF (automatic transmission fluid). You do not need the original 90 weight gear oil. It is not needed when there is no hot engine attached to the transmission.

Now what can this do to your range? Well, a bad front alignment can cost you maybe 15% or more in range, and changing the transmission oil might help 3%. Dragging brakes can be horrendous to the range. Assuming that these obvious details are attended to, you are ready for the biggest item to help your range.

Low rolling resistance tires can make a greater improvement to your range than anything other than an obvious fault such as the above-mentioned

brakes and alignment. I have had people tell me that low rolling resistance tires will only help on the flat, but tires cause a car to always be "climbing" the flat spot on the tire where it touches the road. As an example, Scott Cornell said that with his old tires on his '68 Karmann Ghia, which he ran at 40 psi,



Several examples of Goodyear's tire efforts.

it took all four fingers on each hand to move his car in his garage on a flat concrete floor. After he installed Goodyear "low rollers" for the Phoenix 500 race, he found that he could move his car using just one finger on each hand. A very significant difference.

Using these tires, the difference in a gasoline car can be a 4% improvement over a standard tire. Not much, you say? True, but a gas car throws away 85-90% of the energy in the gasoline as heat and exhaust gases. An electric is just the opposite. Instead of an 85-90% energy loss, you have 12-15% loss in an electric. So if an electric is about 6 times more efficient than a gas car, and a gas car can get 4% improvement by using Goodyear low rollers, then this should translate into a mid 20's percentage improvement in range.

I felt that this was correct logic, but I wanted to verify this with a true world expert. So I called and talked to Mr. Bill Egan — Goodyear's chief tire design engineer. This man can be found at the various racetracks in the US whenever a race is on. He has been at each Solar and Electric 500 race at Phoenix, and who knows how many regular race car races, suffice it to say, he KNOWS his business.

I discussed my theory with him and he agreed that in an electric car, the range improvement over a

standard tire should be in the mid 20% of range. Nothing else can make such a big improvement to a well-prepared car.



Now let's read what Goodyear has to say about rolling resistance and tire design.

(Continued on next Page)

EVs, Rubber and the Road

(Continued from previous Page)

Rolling resistance is power loss caused by the flexing of the materials in a tire. As a tire rolls through the contact patch on the roadway, the elements alternately store and release energy like a spring being compressed and released, said Bill Egan, Goodyear chief of tire design. As in other mechanical systems, not all energy is recoverable. Some energy is lost and ultimately results in tire friction or rolling resistance.

A tire's hysteresis, Egan said, creates rolling resistance. Hysteresis refers to the energy absorptive qualities of the tire. If a tire absorbs most of the stressing and straining forces generated as it moves down the road, rolling resistance will be high: if the tire deflects most of the energy, resistance will be low.

A tire's running surface is flattened by the load on a wheel, resulting in a footprint — the contact "patch" where the tire touches the road. The tire is deformed at the footprint and pressed into a flat surface contact area. This forced deformation of the tire material and friction of the tread elements on the roadway cause rolling resistance, he said.

To create a tire with less roll resistance, Goodyear engineers reduce the stress and strain within the tire by selecting lightweight materials and a rubber that doesn't absorb much heat.

"We design tires with reduced hysteresis," Egan said. "By considering tire profile, shape and construction, rubber compounds, tread design and tire inflation pressures, engineers can reduce sharply a tire's rolling resistance."

Various parts of a tire use different amounts of energy to perform their functions. The crown area — the tread, belts and shoulder — accounts for 75 percent of rolling resistance; the

sidewall and bead make up the balance, he said.

The importance of tire construction to rolling resistance helps explain why radial tires are more fuel-efficient than bias-ply, Egan said.

The casing of a bias-ply tire is made up of two or more fabric layers that cross each diagonally. Under load, the rolling and flexing action causes an inward and outward deformation at the footprint, which pulls and compresses stresses along the cords. The tire must undergo inner distortion not only in the tread area, but in the sidewall as well. Radial tires have fabric cords that run in a radial direction, across the tire's circumferential center line from bead to bead. This reduces the amount of inner deformation in the shoulder and sidewall, resulting in lower rolling resistance, he said.

Until the federal government mandated Corporate Average Fuel Economy requirements for the automakers, tire rolling resistance was of little concern. In time, Egan said, tires became primary targets for improved fuel economy — as important as tuning the engine. After all, each tire contributed 11 pounds of rolling resistance.

Today's production-car rolling resistance has been pared to about 9 pounds per tire. In 1992, Goodyear rolled to a new dimension with 18-inch prototype tires that generated only 2.5 to 3 pounds each at highway speeds on General Motors' Ultralite high gas-mileage car.

To soften the ride of this tire, we developed a new profile," Egan said. "A narrower rim width with a rounder sidewall gives the tire more shock absorption."

To make the tire roll more freely, low rolling resistance tread compound was molded into smaller tread ele-

ments that flexed easily — and with less friction — when it touched the road, he added.

"How a tire touches the road, with a good footprint geometry, is key to overall tire performance," Egan said.

In late 1991, Goodyear introduced the industry's first fuel efficient replacement passenger tire, the Invicta GFE. The linear relationship between vehicle fuel consumption and tire rolling resistance was figured into tire development. For passenger cars, a 5 to 7 percent reduction in rolling resistance produces 1 percent less fuel usage, he said. Researchers documented a 20 percent improvement in the Invicta GFE's rolling resistance over any of its other aftermarket tires for a 4 percent reduction in gasoline usage and related tailpipe emissions.

Actually, Goodyear's first venture into engineering "low rollers" for electric vehicles proved that the company wasn't just spinning its wheels, Egan said. In 1990, Goodyear 14 inch concept tires cut rolling resistance by 55 percent from conventional highway tires on General Motors' Impact electric car.

Lightweight materials and construction clipped this tire's resistance coefficient to 0.0048, about half that of ordinary tires, he said. The tires were also noticeably quiet, a feature required in an electric car with its low-noise drivetrain.

Also, in 1991, one result of tire customizing by Goodyear was the investigation of new standards with the Tire and Rim Association of America, for tires to be used on electric cars. Proposed E-metric tires, which operate at higher inflation pressure and reduced loads, are expected to be expanded to standard vehicles in the future to further improve fuel efficiency, Egan said.

(Continued on next Page)

EVs, Rubber and the Road

(Continued from Page 5)

Present passenger P-metric tires operate at 35 or 44 psi maximum. The proposed E-metric standards will be 65 psi.

In 1991, when Goodyear introduced their replacement market fuel-efficient tire, the Invicta GFE steel-belted radial, it incorporated rolling resistance technology gained over the years. Goodyear's chemical compounding and testing procedures documented a 20 percent reduction in rolling resistance — over any of its other aftermarket tire lines. Priced only slightly higher than its most popular passenger tire lines, the GFE steel belted radial could give EV motorists at least a 15% to 20% range increase.

"As the world moves from a dependence on oil to environmentally friendly types of transportation, it's exciting to know that Goodyear is the leading partner in this transition by engineering fuel-efficient tires."

Ernie Holden, president of the Solar and Electric Racing Association, said "Our objective in the Solar and Electric 500 race is to promote the safety and performance of electric vehicles, and Goodyear's state-of-the-science know-how in this field will help us do that."



Now how do you get these Invicta GFE tires? They are being test-marketed in 3 cities in the US — Seattle, Kansas City and Boston. Mr. Egan said that any Goodyear tire dealer can special order these tires for you, but he needs the order number (tire part number). For this you may have to call Akron, Ohio to get the number for the size tires you need.

There are a few sizes of 13" tires in the GLR original equipment model that are available nationwide. These GLR tires are the exact same as the GFE replacement tires, but come on the Honda VX/CX car models. Also, GL tires are available in many sizes, but are not as good as the GFE/GLR tires.

Why are these great tires not being sold nationwide? The folks in the marketing department don't think that people are interested in these tires, so they are only selling them in the 3 test market cities. The response to the GFE tires was not what they expected, but they did very little advertising about them. They heavily promoted several other tires that they introduced in '91, such as the Aquatread, and lo and behold there was a great response for them.

Here is a great opportunity for the entire EAA membership to have a real effect on EV performance. Buy those tires and write to Goodyear at Akron to ask for them to be sold nationwide.

I expect that if all our membership wrote to them, that we would have an effect on Goodyear, as they only need to be shown that there is interest among their customers. —Pb

The address is:

**Goodyear Marketing Department
1144 East Market St.
Akron, Ohio 44316**

EV Assoc. of San Diego

The Electric Vehicle Association of San Diego (EVAOSD) was founded on March 5, 1991 by a small core group of people interested in electric vehicles (EVs) as viable alternative transportation. EVAOSD is affiliated with and has adopted the Charter Statement of the Electric Auto Association (EAA) which was established in 1967 and has over 25 chapters throughout the United States.

EVOSD activities include monthly meetings, at which a variety of speakers, discussions, electric vehicle displays, hands-on demonstrations, and alternative transportation videos are featured.

EVAOSD meetings are held the first Tuesday of each month at Eldyne, Inc. (local sponsor), 9775 Clairemont Mesa Blvd. (one block east of I-15) at 7 PM. Average attendance is about 25 people. Two newsletters are available and optional: the monthly local EVAOSD newsletter and the bimonthly EAA newsletter.

If you have something you'd like to share with fellow electric vehicle enthusiasts, would care to speak at a meeting, or would like more information, call Ron Larrea at (619) 443-3017.

SAFETY ELECTRIC VEHICLE HEATER

The RUSSCO Safety Electric Vehicle Heaters heat and circulate coolant through the original equipment heater, replacing the source of heated coolant supplied by the internal combustion engine. The heating system provides temperature control, fan speed, heat and defrost selection for heating, defogging, and ventilation. Model H-15 is suitable for temperatures above freezing. Model H-20 is suitable for temperatures below freezing and is recommended for systems under 120 volts. Heaters are supplied with hose, insulation, clamps, fittings, wiring, mounting hardware and easy-to-follow instructions. RUSSCO Heaters are warranted for one year.

SPECIFICATIONS

- 96-120 Volt input
- H-15, 1.5 KW, 12.5 A, 5120 BTU/H
- H-20, 2.0 KW, 16.7 A, 6830 BTU/H
- Coolant temp. rise, H-15, 1/2°F/sec
- Air temp. rise, H-15, 70°F
- Size 4" D x 8 1/2" H x 16" L
- Weight - 6 1/4 lb

SAFETY FEATURES

- Double fused
- Triple shut off
- Thermally protected
- Coolant loss protection
- "Heater On" dash indicator light
- No exposed high voltage
- High voltage warning label

CALL or WRITE FOR DETAILS

RUSSCO

ELECTRO-MECHANICAL ENGINEERING
PO BOX 3761, SANTA ROSA, CA (707) 542-4151



GM Shying Back from EVs?

by Clare Bell

General Motors has announced that it has scrapped plans to mass-produce its two-seater Impact electric car in '93. However, the Detroit automaker will build up to 50 prototypes this year and will also join with Chrysler and Ford in a cooperative effort to develop commercially viable EVs.

GM killed planned mass-production of its Impact electric car because of a company decision that a two-seat car was a mistake. Arguing the venture was too risky, John Dabels, director of market development, pointed out that a four-seater would have been a safer bet, and that GM will wait until it can produce four-passenger "vanlike" vehicles late in the decade.

Concern about markets and the need for financial belt-tightening are pushing the scale-back. Kenneth R. Baker, manager of GM Electric Vehicles, stated in a 12/11/92 press release, that "The uncertainty and rapidly changing technology makes major capital investment at this time high risk."

"We continue to be encouraged by the public's interest in EV's," Baker added, "but there is a high degree of

uncertainty in the electric vehicle market. Customers don't know how EV's will stack up against their personal transportation needs and manufacturers don't know how customers will react to the unique capabilities of EVs."

More confident earlier in the year, GM balked during talks among the Big Three on a research-sharing venture because it felt it was ahead of the other two carmakers. Apparently GM has re-evaluated its position.

Ford will deliver 100 of its Ecostar trucks to utility companies next year and Chrysler has an order for 50 of its electric TE vans to several utility groups across the nation. Chrysler announced that production will soon begin at a minivan plant in Windsor, Ontario.

Chrysler, Ford and GM, under the auspices of the U.S. Council for Automotive Research (USCAR), have signed an agreement to investigate cooperation in the design, development and possible manufacturing of electric vehicle components.

According to Baker, GM believes joint development among domestic manufacturers will help accelerate com-

mercialization of electric vehicles, "We believe a cooperative approach to EV development is essential," he said. "It has the potential to be a win for customers, industry and the country."

GM's 50 EV prototypes will be loaned, leased or sold to utilities, local governments and others who will be able to provide technical feedback and information about performance capabilities and user requirements. Baker said, "The company also will pursue two-way learning between individual potential retail customers and GM, using its Impact demonstration vehicles to show consumers what's possible and gain feedback on user requirements."

Frank Schweibold, GM director of finance, stated that if the Impact two-seater prototypes gain acceptance as commuter cars, mass-market production may proceed.

[General Motor's press release, 12/11/92 and EIN excerpts from TORONTO GLOBE & MAIL:12/14 and AUTOMOTIVE NEWS:12/21]

EAA at First Int'l Environmental Expo

The First International Environmental Exposition is coming to San Jose on the weekend of March 27-28. The Expo, two days of environmental awareness and enjoyment, will be held at the Red Lion Conference Center. EAA has been invited to participate in the event. EAA members will have an exhibit table, as well as electric cars for display. If you are an EV owner and want to show your car, contact Anna Cornell, East Bay Chapter President, tel. (510) 685-7580.

Ed Begley Jr., an EV advocate and owner is among the scheduled

guest speakers. Come out and support a fellow EV'er at the conference by bringing your car.

The Exposition will feature live presentations and debates led by major media figures and keynote speeches by politicians. Among the issues to be addressed are pollution, global warming, rainforests, endangered species (with a special emphasis on whales and dolphins), reforestation and energy conservation. Other attractions include displays of environmental art, films and thought-provoking exhibits.

Live entertainment will include "GreenAid", a musical concert to ben-

efit the environment, produced in Association with Bill Graham Presents. The Expo is sponsored in part by PG&E. Participating organizations include Greepeace, Earth Island Institute, The Dolphin Project, The Wilderness Society, Union of Concerned Scientists and others. A portion of the proceeds will be donated to organizations bettering the condition of our planet.

Call (415) 927-0649 or 1-800-364-1634 to register. Early registration price is \$15 for general admission. Banquet attendance and admission to "GreenAid" are extra.

1992 EAA Symposium, Part II

by Clare Bell and Paul Brasch

Benny Jay, president of Electrosorce, reported on his company's advanced lead-acid "Horizon Battery". Electrosorce's target is a cell that has double the energy density per unit weight as the present lead-acid design. Jay worked for Tracor Corp., then went to Electrosorce when it spun off from Tracor in 1987. Tracor's work with composite metal and fiberglass materials led to the development of a new lighter-weight material suitable for batteries.

At Tracor, Jay helped develop a co-extrusion process that coated metallic aluminum or copper on a fiberglass core. When the process successfully produced a lead-coated fiberglass wire, Electrosorce formed the wire into grids. The company found that these lightweight grids could replace solid lead battery plates.

Electrosorce discovered that lead-coated fiberglass offered other advantages. The lead-acid cell has remained much the same since its invention in 1859 by Gaston Plante'. To give it the ideal characteristics for a battery, i.e. high specific power, high specific energy, long cycle life and low weight, the lead plates have to be as thin and closely stacked as possible without touching (if they touch, the cell is shorted and destroyed).

The standard lead-acid design presents additional problems. During battery use, lead in solution redeposits on the positive plate, creating sponginess, expansion and fracturing. This creates areas of electrical isolation in the plate, leading to eventual failure. Battery designers seek ways to reduce this positive plate breakdown.

To improve the poor dimensional stability of pure cast lead, battery manufacturers have alloyed it with other metals, notably antimony. These alloys improve the dimensional stability of battery plates at the cost of interfering with the lead-acid chemistry and

accelerating plate deterioration. Antimony leaches from positive to negative plates, disrupting the grain structure and causing intra-granular corrosion. Areas of electrical isolation increase and lead in solution is blocked from re-depositing, destroying the battery's capability to accept charge.

Electrosorce has found that lead-on-fiberglass plates offer a number of advantages. The composite essentially separates the demands on each material, allowing it to do what it does best. Instead of compromising lead's electrochemistry in order to get strength and stiffness, the battery designer relies on the fiberglass core. The coating can be chosen for optimizing electrochemical performance, keeping the fine grain structure and eliminating any interference with plate chemistry.

These grids can be positioned to closer tolerances than cast-lead plates, allowing denser geometry and thus more energy storage capacity per unit weight. Denser plate packaging reduces electrolyte volume, helping to lighten the battery.

The Horizon battery is packaged using a bipolar flat-plate design that minimizes the current path between

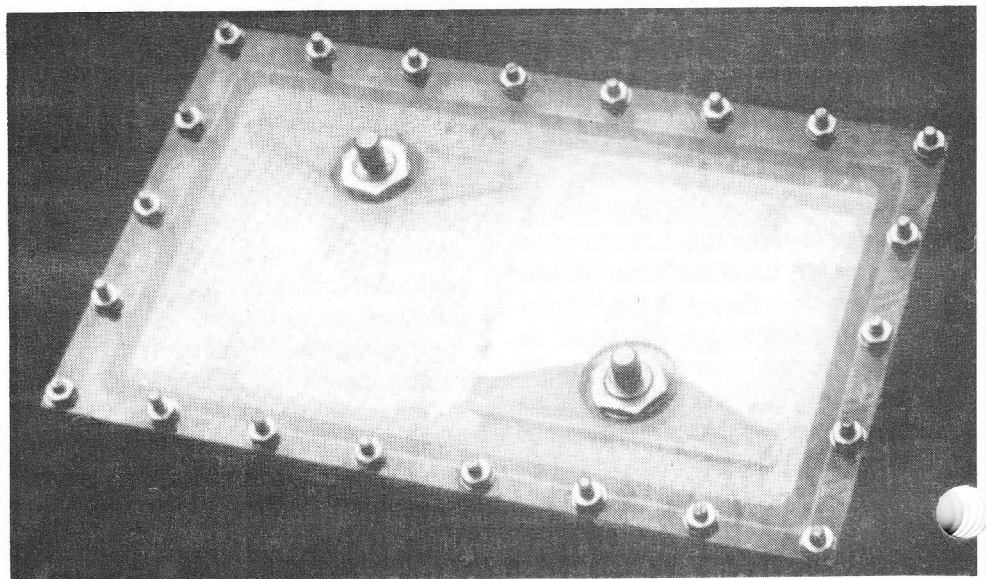
plates to keep down internal resistance. By combining the bipolar design with the advantages of the new composite grid material, Electrosorce has given new strength to lead-acid technology. Well over a year ago, the company hoped to eventually increase the energy storage capacity of a lead-acid battery from 12 W-hr./lb. to greater than 22.7 W-hr./lb. at the three-hour discharge rate. The current accomplishment is greater than 23 W-hr./lb.

Some time ago, the Idaho National Engineering Laboratory test data showed that the Electrosorce technology had 27% greater specific energy and 3.7 times higher specific power than the best production sealed lead acid batteries. An Electric Power Research Institute (EPRI) evaluation agreed with this conclusion.

Staying with lead-acid offers additional advantages. Lead is abundant as a planetary resource. The Horizon battery is expected to be as recyclable as the standard lead-acid cell, minimizing its effect on the environment.

The first Electrosorce product will be a U1 garden-tractor type battery,

(Continued on next Page)



An actual working "Horizon" battery.



EAA Symposium

(Continued from previous Page)

but the company is also eyeing the passenger car market. The Delco-Remy division of GM has estimated that the Electrosorce technology, if used in the electric Impact car and limited to 80 % depth of discharge, would provide a cumulative range of 80,000 miles. The current design appears to be capable of providing over 900 charge-discharge cycles with an average range between charges of 90 miles. It can also meet the heavy power demands of acceleration, since it can deliver and sustain 90 kW for 3 minutes.

The recharge time is also greatly improved, helping to get rid of a bugaboo that has hindered EVs. The 18.2 W-hr/lb. test pack for EPRI will be able to return 70% of capacity in 7 minutes.

— CB

The final speaker was John McGinnis of FMC in San Jose. They build the Bradley armored personnel carriers (APC). I believe it was more than 10 years ago that they started on an in-house project to design and build an electric APC. In the early days, the electronics to control the two 250 horsepower continuous /500 hp peak motors required the space of 4 four-drawer file cabinets. As power transistors improved, this gradually shrank to one drawer. In the last few years, with dramatic advances in power semiconductors, this has now dropped to half a breadbox in size.

The motors to drive the APC that they electrified (not a Bradley, but a precursor to it) are oil cooled and about 2 feet in diameter and about three feet long. This system can produce a mean tractive effort of 1.5. This means that there is the power to raise the about 40,000 lb. vehicle straight up in the air and have a 50% reserve.

FMC has shown this vehicle at the EAA Annual Rally in 1987 and again in 1991. They have video tapes showing it out-accelerating a standard pow-

ered APC. It blows the other's hatches off.

Due to the precise steering control that the electric drive allows, they were able to drive back to the trailer from between parked cars with ease at our 1987 Rally. Try this with a standard APC using slipping clutches instead of a simple steering wheel and we would have had some flat cars in the parking lot. The maneuverability of this vehicle has to be seen to be believed. Their video shows it jumping over hills and making right angle turns as if it were a go-kart. The driver definitely needs a seat belt.

A few years ago, they cut the blueprint dimensions down in size and built a 125 hp unit (250 hp peak). This motor produces 100 lb-feet of torque from 0 to 15,000 RPM. Imagine a 3 to 1 gear reduction on it. This would give 300 lb-ft from 0 to 5,000 RPM. It would power a bus, or truck, or race car very well, and all in a package about 13-14" cubed. Too much for a passenger car, really, they now are constructing an 80 hp unit for testing.

Their motor controller gives full regenerative braking as a normal fall-out of the design. John feels that in production it could cost less than \$1,000. In my estimation, a complete motor-controller system should be produceable for well below the approximately \$4-5,000 price of the only AC motor controller now for sale. All that is needed is full production for it to happen. But this is tough to achieve, as it is the old chicken and egg problem. Prove that there is the market for them and someone will build them. However their availability would help create that market.

FMC is presently working with NEVCOR, the privately funded spin-off of the EAA's Hybrid Vehicle project, to test the 80 hp unit in a hybrid conversion car. —Pb

BDM & Electrosorce

BDM International, Inc., and Electrosorce, Inc. formed a strategic alliance that will facilitate the manufacturing of advanced lead acid batteries to meet the requirements of electric vehicles that are already being mandated by state laws.

"The nation has faced two obstacles to the widespread use of electric vehicles," explained BDM president and CEO, Philip A. Odeen. "One was the development of a powerful, lightweight battery that can be recharged quickly and has a long operating life. The other was the technology to manufacture the battery once it was developed. The alliance we're announcing today will address and solve both of those problems."

Electrosorce (Austin) has designed and tested a high-performance lead acid battery — using woven lead mesh instead of heavy lead plates — that will help overcome the major impediments to public acceptance of electric cars, Odeen explained.

Advantages of Electrosorce's Horizon battery are that it can be recharged 50 percent in 8 minutes and 99 percent in half an hour and travel more than 100 miles between charges; can sustain more than 900 charge/discharge cycles, which according to independent tests, means the battery will last approximately 80,000 miles; has shown, in other testing, a significantly higher storage capacity to weight ratio than previous batteries and delivers more than **52 watt-hours per kilogram** specific energy; and can be manufactured for significantly less than other advanced batteries (such as nickel iron batteries).

BDM Technologies, Inc., a subsidiary of BDM International, Inc., will design and integrate the new manufacturing plants, which will be required to produce the batteries. "We have the technology to design and build the plants," said Odeen. Manufacturing will not be an impediment to the large-scale introduction of the new battery."

(BDM TECHNOLOGIES
RELEASE: 1/25)

News in Brief

Chrysler, Gm Race On Fast-Charge Methods

An auto industry source says that Chrysler's new quick-charge system can quick charge a battery pack in about 25 minutes. Developed by a Canadian company, the device will help encourage electric cars to hit the roads. It would also be mobile, allowing it to be used for roadside emergency assistance.

Meanwhile, Hughes Power Control Systems, now a GM subsidiary in Los Angeles, is said to have developed a battery charger that will recharge an electric car's power source in just 15 minutes [for the typical 5-9 mile trip]. Both companies expect to have prototypes ready for testing by the middle of 1993.

Both charging systems require 500 volts, and are too powerful for home use. But quick charge locations, perhaps within shopping areas, are on the drawing boards.

(UPI: 12/28)

200,000+ Jobs In Next 20 Years

Scott Sklar, executive director of the Solar Energy Industries Association, argues that renewables will create more jobs for American workers. His editorial, entitled, "Environmental Technology Could Boost US Growth," appeared in the November 6 Boston Globe. He says, "In May, three US industry groups released a study that showed that removing investment barriers in natural gas, energy efficiency, solar and other renewable technologies would create 200,000 to 400,000 jobs in the next 20 years. "Last year the Organization for Economic Cooperation and Development released a study

showing that over the next decade, a \$200 billion worldwide market will exist for environmental technologies, but the United States is not poised to capture this market even though we hold the technological lead.... The US lead is due to the same environmental laws, enacted over the last 20 years, that the Bush campaign has denigrated. "The question is whether we will let the opportunity slip by or leverage our pollution prevention and abatement industries as one of the key options for our country to create jobs in a sustainable way."

(BOSTON GLOBE: 11/6)

Funding To Consortium Improves Prospects For EV Batteries

New grants to members of the U.S. Advanced Battery Consortium (USABC) are improving the prospects for development of an advanced electric car battery. USABC, a consortium whose members include Chrysler, Ford, General Motors, and the Electric Power Research Institute, has set a goal to develop a cost competitive electric battery by the end of the decade. Among the recent grant awards are the following: \$42 million to W.R. Grace & Company and its partner Johnson Controls, and Saft America; \$18.8 million to Energy Conversion Device's subsidiary, Ovonic Battery Co.; and an additional \$12.2 million representing cooperative development and research funds to the Sandia and Argonne National Laboratories. Furthermore, General Motor's Delco Remy Division is awaiting approval by the Department of Energy for a contract for which they were selected. Initial funding for USABC came from a government-in-

dustry agreement to kick in \$260 million with the Department of Energy providing 50% and the USABC partners providing the other half. Beyond the cost competitive electric battery goal, the consortium's immediate goals include the following: double the electric vehicle's range, increase the potential number of passengers or amount of cargo, and improve the battery system's lifespan. In the cost competitiveness area, the consortium hopes to develop a battery costing \$150 per kWh with a 5 year lifespan. Currently, the most promising areas in battery development are the lithium-polymer electrolyte and lithium (metal)-sulfide battery technologies.

(CHEMICAL & ENGINEERING NEWS: 11/16)

—Ed. See *Electrosource* this issue.

Students Design Electric Cars

In Colorado, Arizona, and New Mexico, students are becoming involved in the design of electric cars. A Boulder, Colorado, resident, Michael Craven, won a \$5,000 scholarship for his design of a luxury car which runs on battery power. California's Art Center College of Design sponsored the competition.

In Arizona and New Mexico, high school students are gearing up for next March's third Solar and Electric 500 in Phoenix. They are involved in the construction of race cars in the competition and have been helped by contributions from GE and Arizona Public Service.

(AUTOMOTIVE NEWS: 11/9)

Pre-1983 Cars - Big Polluters

Following emissions tests, pre-1983 cars have been found to pollute 60

(Continued on next Page)

News in Brief

times more than newer cars. Although automanufacturers have made progress in reducing exhaust emissions from new cars, old cars remain a problem.

"Eighty-three percent of automobile pollution is created by cars built before 1983," said former head of General Motors Robert Stemple. Under the old clean air bill, car owners were required to spend only \$100 to bring their car up to standard. This bill has now been updated, and owners must now spend \$450. This mandate however, only applies to 1992 models and beyond.

A major problem has been to convince owners to turn in their cars. Due to the high cost to purchase and maintain a new car, many owners are reluctant to give up their old one. However, many auto executives feel the rise in gas taxes will be a large motivator.

In an attempt to get these old cars off the road, Unocal, an oil company, offered owners in the L.A. area \$700 for their cars. Illinois, Northern Virginia and Delaware are in the process of adopting similar programs.

(WASHINGTON TIMES: 11/20)

—Ed. *A better idea for the consumer is to recycle a smogger into a nice clean EV, and for much less money than a new car costs.*

Cafe Fines Don't Hurt

Auto manufacturers have paid more than \$233 million in fines for inadequate fuel-efficiency over the past several years, according to the National Highway Traffic Safety Administration. Although it is illegal for companies to fail to comply with federal standards for corporate average fuel economy (CAFE), many find that the

gains from their position in the market outweigh the cost of violations.

At present auto manufacturers must produce a fleet of passenger vehicles that average 27.5 miles per gallon or face a fine equal to \$5 for each tenth of a mile under the standard, multiplied by the number of cars sold in the United States that year. Models that fall below 22.5 mpg are assessed a gas-guzzler tax.

The top five out of fourteen manufacturers that have violated CAFE standards since the 1983 model year are as follows: Mercedes-Benz of North America Inc. accounted for almost half the fines, equalling \$102.5 million; BMW of North America Inc. came in a distant second with \$58.6 million; Jaguar Cars Inc. followed with \$40 million, Volvo Cars of North America had \$13.3M in fines; and Porsche Cars North America Inc. had \$7.9 million.

Most of the violators primarily market luxury cars or sports cars. Mercedes-Benz and BMW say they place a high value on safety features which often weigh down the cars and thereby decrease fuel-efficiency.

(WASHINGTON TIMES/CHICAGO TRIBUNE: 11/15)

—Ed. *And I believe in the Easter Bunny.*

Air Pollutants Should Be Viewed As Private Property

The following excerpts are from an editorial by Malcolm Wells, an architect specializing in underground designs. The editorial, entitled, "Pollution...or Property?" appeared in the September/October 1992 issue of *The Futurist*:

"It's obvious that nothing can be done about pollutants once they've been released into the air. And yet, we continue to talk of 'air pollution, as if the air...[is] somehow a partner in the crime. And air pollution is also blamed on the sunlight's action or on the lack of air movement, as if nature itself were partly at fault for our poisonous habits.

"...until we [come] to think of pollution as private property illegally dumped into the public domain [we'll] get nowhere. If a flowerpot fell on you from someone's upper-floor window, you'd want to know right away who was responsible. Who dumped that object into the air so that it caused you harm? But let someone dump tons of sulfurous smoke from a factory chimney, and we all say 'air pollution' and wait for the wind to blow it somewhere else...

"And what if we were similarly charged for all the property that belches from the tailpipes of our cars and our chimneys? At first we'd grumble, we'd try to produce fewer wastes, and we'd pay the fees until a lot of smart operators saw all the dollars in those wastes and sold us equipment or services that would drastically reduce the amount of private property (smoke, wastes) we were releasing into the environment.

"It's all a matter of economics. Put a high penalty on the dumping of private property into the public domain, and inventors will be coming out of the woodwork to cash in on the market created by the penalties.

"Making the polluters pay is a concept that's starting to catch on with regard to toxic wastes, but the idea that there is no right to dump any wastes

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News in Brief

into the air, water, or land is still up ahead of us somewhere."

(THE FUTURIST: SEPTEMBER/OCTOBER 1992)

Vehicle Air Pollution Costs Over \$9 B. A Year

Researchers have determined that the economic costs of air pollution from vehicles amounts to at least \$9 billion a year.

Although individual emissions from cars and trucks has been significantly reduced over the last 25 years with cleaner burning vehicles and fuels, this has been totally offset by the increase in the number of vehicles and in the amount of time the vehicles are driven.

At least two studies have been undertaken to determine the economic costs of these emissions. Mark French of the Federal Reserve System pegs this number at \$9 billion a year, considering the costs of lost labor and lost agriculture. This is a very conservative figure because French does not include the cost of the impact of a number of additional problems that are affected by carbon monoxide and other vehicle emissions including health problems, acid rain, and forest damage from ground-level ozone.

The second study conducted by the University of California at Davis determined the cost to range from \$10 to \$200 billion per year. In their study, researchers included all the possible variables — health effects, agriculture, early death, materials damage, etc. The figure ranges so dramatically because it is difficult to place a monetary value on life and health. However, the study does find at least \$10 billion in costs as its most conservative figure.

(SURFACE TRANSPORTATION POLICY PROJECT BULLETIN: 12/92)

Enviro Regs Good For Business

The following excerpts are from an editorial by Martin A. Brower, publisher of the Orange County Report. The editorial, entitled "Regulations Are a Blessing in Disguise to Business," appeared in the December 9 issue of the Los Angeles Times:

"...State, county, city and special-district regulations imposed on business are tough. But these regulations are here to stay, and will probably increase in number and strength as citizens become ever more concerned about their environment and the welfare of their families. "...The answer is that Southern California business leaders have to work with this region's strengths—just as the automobile industry is learning to live with safety regulations. Do automobile ads tell us that car manufacturers lost their hard-fought, years-long battle against passenger air bags? No. They boast that their cars feature not only driver-side air bags but passenger-side bags as well. "Competition from other states without our stiff regulations? Sure. There will always be companies that move to regions that lack regulatory controls—for now. Even Houston, long an example of how a city can survive without zoning regulations, is now instituting zoning controls.

"...Southern California's economic future can be better served by business leaders who proclaim the region's many strengths, rather than wasting their efforts in futile and counterproductive attempts to reduce regulations."

(LOS ANGELES TIMES: 12/9)

EVs 95% Cleaner Than Gas Cars, Says Letter

The following excerpts are from a letter to the editor by Charles Garlow, entitled, "Electric cars will help ease

energy and environmental woes." It appeared in the December 1 Washington Times:

"...The pollution from an electric car, including power-plant emissions, is less, on a mile-for-mile basis than gasoline cars by about 95 percent. This is because power plants do not pollute as much as your typical out-of-tune gasoline car.

"Some power plants have zero air emissions, such as hydroelectric, nuclear, wind or solar electric-generating stations. Some, such as natural-gas fired plants, have very low air emissions compared to gasoline engines. Others, such as coal-fired plants, may be somewhat dirtier, regarding sulfur dioxide and nitrogen dioxide (which contribute to acid rain), but they are much cleaner when it comes to real air pollutants of concern in America: smog and carbon monoxide."

(WASHINGTON TIMES: 12/1)

Ed: Thank you Mr. Garlow (an EAA member) for your response.

WHO/UN Says Mexico City Has World's Worst Air Pollution

Of all the major cities in the world, Mexico City has achieved the unpleasant distinction of possessing the most polluted air. A report published by the World Health Organization (WHO) and the UN Environment Programme looked at 20 "megacities" and identified London, New York and Tokyo as having the lowest pollution. Forty years ago, London's was the worst, and though its previous pollution levels have not yet been reached, some cities are approaching it, the report points out.

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News in Brief

In Mexico City, sulfur dioxide, carbon monoxide, lead, ozone and airborne dirt were nearly double WHO's recommended levels. The report, based on 15 years of research, identifies automobiles as the greatest cause of pollution in half the cities and warns that the number of cars—630 million today—could double within two to three decades.

In Bangkok, Beijing, Bombay, Cairo, Calcutta, Delhi, Jakarta, Karachi, Manila, Seoul and Shanghai, dirt is a serious problem while Cairo and Karachi also had high lead levels. Tokyo, Sao Paulo and Los Angeles have serious ozone problems, the report said.

Because the UN estimates that 47% of the world's population will be living in urban areas by the year 2000, both organizations recognize air pollution as a primary cause of health problems and death. Besides automobiles, the study identified pollution sources such as: domestic fires, large and small industry, and power plants. Ground-level ozone problems result from high levels of traffic and abundant sunshine.

(UPI: 12/2)

World Bank Helps Mexico

The World Bank has provided \$220 M in credit to Mexico to help finance a massive program to improve the air quality in Mexico City, which is considered to have the worst air contamination in the western hemisphere.

The total cost of the final project is estimated at \$1.09 B. The credits will be used partially to cover the cost of replacing older vehicles with others having improved emission control systems. The credits will also help accelerate the conversion of high-consumption gasoline and diesel vehicles into natural gas users.

(INTER-PRESS SERVICE: 12/16)

Ed: How about electrics?

National Energy Policy Act Of 1992 To Boost EVs

The most comprehensive energy-related legislation ever enacted, the National Energy Policy Act of 1992 will affect every energy market. The

following are the provisions of the Act that affect alternative fuel vehicles:

The Alternative Fuel Vehicle Provisions are found in Titles III, IV, and V. Title III affects fleets of at least 20 vehicles that are centrally fueled or capable of being centrally fueled within an urban area of 250,000 or more and all fleets of 50 or more vehicles (excluding vehicles held for lease to the general public, law enforcement and emergency vehicles, etc.)

The new law provides tax deductions for the purchase of "clean fuel vehicle property," defined as the engine, fuel storage, and delivery equipment, and exhaust gas handling equipment. After June 30, 1993, deductions are allowed up to \$2,000 for a light-duty vehicle up to 10,000 lbs.

Electric car buyers get an even bigger boost—a tax credit of 10% of the price, up to \$4,000 per vehicle. The qualified devices of dedicated AFVs qualify for the deduction on a full-cost basis. The law also allows a deduction of up to \$100,000 for the cost associated with equipment for the storage and dispensing of alternative fuels.

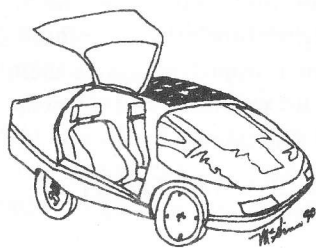
(ARIZONA DEPT. OF COMMERCE NEWS: 12/92)

Nissan Opens Two Quick-Charge Stations

Nissan Motor Company working with Tokyo Electric Power Company, Hokuto Denko Company, and Japan Storage Battery Company recently opened two speedy electric car recharging stations.

Located in Tokyo and Kanagawa Prefecture, the recharging stations can

(Continued on next Page)



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News in Brief

recharge a typical electric vehicle like the Nissan Sunny California car in 15 minutes to 80% capacity, as opposed to the typical overnight recharging time. The two stations will undergo a trial period lasting until March of 1994, according to Nissan officials.

(JAPAN TIMES WEEKLY: 12/14)

Li/Poly Battery Wins Big

Valence Technology has won a \$100 million contract from Motorola, Inc. for its high-tech battery. The battery holds great promise for electric vehicles (EVs) since it overcomes many problems of batteries currently being used in EVs. Conventional nickel-cadmium batteries are heavy, need frequent recharging, and contain highly

toxic cadmium. Unlike its counterparts, the Valence battery, which is composed of lithium and conductive polymers, is extremely light and has four times the lifespan of nickel-cadmium batteries without the toxicity. Although the Motorola contract is geared towards batteries for use in communication products, Valence is up for \$14.5 million in research money to design an EV battery.

The lithium/polymer battery is helping Valence Technology become a major player in the international race for environmentally friendly, rechargeable batteries. The Motorola contract "signals that Valence is at the forefront in developing technology that will tap into huge markets," according to Digby MacDonald who directs Penn State University's Center for Applied Materials Research. "It's good news for American industry in general. The technology is truly revolutionary," he added.

(WALL STREET JOURNAL: 12/9)

Citicar Maker To Re-Enter The Ev Market

Bob Beaumont, who manufactured the electric CitiCar in the 1970's, will re-enter the electric vehicle market with a new venture, Renaissance Cars, Inc. of Melbourne, Florida.

Renaissance will introduce the Tropica, an EV that can achieve 68 to 70 miles per hour and go 75 to 100 miles on a single charge.

Renaissance's Tropica will utilize 12 6-volt lead-acid batteries, weighs 1,700 to 1,800 pounds, and will cost less than \$10,000. The company has hired Management Advisory Group of Boston to help them raise \$2.75 million in venture capital for manufacturing.

The Tropica will be initially marketed in Florida.

Although Beaumont's CitiCar was ranked by Motor Trend as one of the worst cars in history, the CitiCar achieved sales of 2,250 in a year and a half. Designed for commuting in low speed areas, the CitiCar could only travel at speeds of up to 38 mph.

Beaumont says many of his CitiCars are still running. "We've had more CitiCar sightings than Elvis," he adds.

(AUTOMOTIVE NEWS: 12/14)

Ed: Only a 72 volt system? What a shame. See Oct/Nov editorial.

Wisconsin Gets Support For Renewables

Strong support for Wisconsin Governor Thompson's renewable energy development proposals was shown when the legislature's Joint Committee on Finance approved all of them under the \$3.4 million 1992 oil overcharge fund allocation.

(RENEWABLE QUARTERLY: WINTER 1993)

Another Aluminum Battery?

A model lightweight high-current battery based on an aluminum/iron-cyanide system may prove to be the

(Continued on next Page)

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News in Brief

basis for a good EV battery. Stuart Licht at Clark University in Worcester, Mass. reports in the 1992 Journal of the Electrochemical Society that aluminum/iron-cyanide generates more than two watts per square centimeter. This reaction is usually so energetic that chemists keep those two compounds apart, but Licht has found a way to tame it. By dissolving the cyanide compound in water, flowing it over aluminum and a porous nickel plate, and adding alkaline additives, he can configure the battery in such a way that the electrons transfer too fast for a chemical reaction to occur. By changing the solution's chemistry, Licht can enhance the oxidation of aluminum and the transfer of electrons. He is working on other similar combinations that may prove easier to recycle and handle.

(ADAPTED FROM SCIENCE NEWS, 1/93, BY CB)

EVs Spurred By New Standards

The Edison Electric Institute has released a report saying that by the year 2010, six million of a 190 million "light duty" vehicles — automobiles, light trucks and vans — could be electrically powered. Credit is given to environmental regulations pushing alternative fuels. Kathryn Callahan, Executive Director of the Electric Transportation Coalition, points to states where legislation requiring alternative fuels is a mainstay of clean air measures. California's low emission vehicle program is calling for 2% production and sale of electric vehicles by 1998; approximately 35,000 vehicles. By 2003 the percentage increases to 10%. A DOE report says existing plant capacity would support conversion of some

22% of vehicles expected to be on U.S. roads by 2000 — about 43 million light duty vehicles. Ms. Callahan, meanwhile, calls attention to facets of electric vehicle use that will directly affect power plant pollution: availability of battery charging facilities; benefits of night-time charging during off-peak hours; the sulfur dioxide credits a power plant possesses which determine how much it can emit; and smog-causing properties of battery charging combined with sunlight. However, Ms. Callahan says, if 22% of vehicles were converted to electricity it would also save a million barrels of oil per day; not an insignificant step toward U.S. energy security.

(OXY-FUEL NEWS: 11/16)

Multi-Billion Dollars In Clean Air

To hedge their bets, perhaps utility companies should think of going into the pollution control industry. Regulations cost them plenty, but those who produce pollution control devices stand to see the market grow as much as \$50-\$70 billion by the year 2000, according to a study prepared for the EPA by ICF Resources of Fairfax, Va., and Smith Barney of New York.

Most of the profits will accrue from the Clean Air Act's smog and air toxic control requirements, going to producers of mobile and stationary air pollution controls. Companies that produce and transport clean-burning or alternative fuels will also increase their bottom line, says the report.

The need for pollution control devices like scrubbers, incinerators and carbon adsorption devices, a response to Clean Air Act Title 1, will continue to increase by approximately \$8-\$11

billion by the year 2000. Mobile source requirements (Title 2) will see growth in diagnostic equipment and oxygenated and reformulated gasoline. Title 3, dealing with air toxics, will bring growth in equipment like baghouses, scrubbers and carbon absorbers, and changes in processes that will reduce emissions.

Title 4 of the Clean Air Act, addressing acid rain regulation, will call for scrubber technology advances, NOx control and continuous emissions monitoring (CEM) equipment. Other opportunities await providers of low sulfur coals and natural gas.

Stratospheric ozone control as covered by Title 6 will mean a need for more CFC recovery equipment and CFC substitute products.

The study is entitled "Business Opportunities of the New Clean Air Act: The Impact of the Clean Air Act of 1990 on the Air Pollution Control Industry."

(BUSINESS OPPORTUNITIES OF THE NEW CLEAN AIR ACT: 8/92)

Three European Studies Say Wind Energy's Cost Effective

Earlier and more discouraging studies of energy produced vis-a-vis cost to build are being regarded as old news by renewable energy boosters. Energy balance is leaning toward cost effectiveness even in the solar field where products are now performing better and beginning to pay back their manufacture cost within a few years.

A wind turbine, by contrast, can pay back its cost within a year say three independent studies, two Danish and one German. The findings of the three

(Continued on next Page)

News in Brief

have been pieced together in the November 16 issue of Wind Energy Weekly which also presents findings and citations in table form.

The German study examined wind turbines ranging from 10 kW to 3MW in size while the Danish studies focused on a "typical" windmill. All three studies concluded that utility-scale turbines placed where commercially usable wind exists can pay for themselves within a year. The cost breakdown is roughly two-thirds for the nacelle and rotor and a third for foundation and tower.

(WIND ENERGY WEEKLY: 11/16)

Long Beach Clean Air Transit Venture

Southern California Edison, the South Coast Air Quality Management District (SCAQMD), and Long Beach Transit inaugurated the Belmont Shore Electric Shuttle Bus which began its 3 to 9 p.m. daily operation last week in Long Beach. The 22-passenger electric shuttle bus, manufactured in Downey, California, is one of two shuttle buses leased by Southern California Edison. Edison will loan the first shuttle to Long Beach Transit for a six-month demonstration period, and the utility will analyze the vehicle performance and user satisfaction data. Funded by registration fees, the SCAQMD's goal is to have electric vehicles account for 16 percent of the vehicle miles traveled in the region by the year 2010. Diane Wittenberg, manager of electric transportation for Southern California Edison, said, "This shuttle bus will give Long Beach residents a chance to compare current diesel-powered vehicles to energy-efficient, non-polluting electric vehicles, which are 97 percent cleaner, even counting power plant emissions."

(SOUTHERN CALIFORNIA EDISON RELEASE: 12/18)

TVA Hopes To Revisit Electric Vehicle Frontier

The Tennessee Valley Authority (TVA) hopes again to become a leading research center for electric vehicles. At one time, TVA was actively involved in electric car research, but plans were dropped in 1988. In making the decision, a TVA administrator cited both the high costs of the research and feelings that the research was beyond the parameters of TVA. However, the current TVA administrators brought the program back recently and hope that TVA will become the leader in development of electric transportation.

(AUTOMOTIVE NEWS: 11/30)

Push For Clean Locomotives

The Southern California Regional Rail Authority (SCRRA) has revealed its plan for achieving a clean locomotive fleet: 1) low-emission diesel/electric; 2) ultra-low emission liquid natural gas/electric and 3) zero-emission fuel cell or overhead contact (electric wire powered) engine technology.

Progress has been excellent in lowering NOx emissions says an SCRRA spokesperson, who says further improvements are on the way. One engine for change will be a locomotive designed and retrofitted by GM/EMD that will feature low-temperature aftercooling hardware that will help reduce NOx emissions a cumulative 40 percent overall vis-a-vis older commuter models.

(PROGRESSIVE RAILROADING: 9/92)

CA Law Requires Increases In AFVs

California's emission laws require a continual increase in alternative fuel vehicles to be represented in the Cali-

fornia market of 2 million new cars each year. Yearly deadlines are set with the AFV requirements, as follows:

1993: by the end of this year, at least 1000 AFVs, chiefly flexible-fuel vehicles, will be utilized in fleets and pilot programs. In addition to flexible-fuel vehicles, natural gas, propane, hydrogen and hybrid electric vehicles will also be utilized. An estimated additional 2,000 AFVs should be on the road by 1995.

1994: the emission standard on hydrocarbon emission limits of .126 grams per mile takes effect mandating that 10% of cars meet this standard. Cars meeting this standard are described as Transitional vehicles.

1996: the Transitional vehicle total is increased to 20%. Furthermore, pump gasoline reformulation rules take effect aimed at emission reductions of 30 to 40% and reductions of benzene compound associated cancer risk by 25%.

1997: the low emission vehicle regulations (.075 hydrocarbon gpm and 0.2 gpm nitrogen oxide) take effect which require these vehicles to represent 25% of new car sales. Furthermore, the ultra-low emission standards (0.4 hydrocarbon gpm, 0.2 nitrogen oxides gpm, and 1.7 gpm of carbon monoxide) take effect requiring these vehicles to represent 2% of new vehicle sales.

1998: the zero emission vehicle regulations (i.e. electric or hydrogen powered vehicles) take effect which require these vehicles to represent 2% of new car sales.

2000: the low emission vehicle regulations must be met by all new cars. Once this regulation takes effect

(Continued on next Page)

hydrocarbon emissions should decline by 28%, nitrogen oxides by 18%, and carbon monoxide by 8%.

2003: the California market for AFVs will be composed of low emission vehicles at 75%; ultra-low emission at 15%, and zero emission at 10%.

Only those car makers that produce less than 3,000 vehicles will be exempt from the zero-emission standards.

(LOS ANGELES TIMES: 1/3)

**Many of these stories are provided courtesy of Environmental Information Networks Alexandria, VA.*

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Board Meeting Highlights

By Clare Bell



Correction

A correction to the previous Board meeting minutes was requested by Stan Skokan. During that meeting, he had made a motion to stop all pay-outs until the Finance Committee met. This motion was passed by the Board with one dissenting vote.

Chairperson Palmer agreed that there had been an omission and moved that the last meeting's minutes be amended to show the vote. Skokan seconded and the motion passed. Last meeting's minutes will be corrected to show that the stop pay-outs motion was made and passed.

Skokan asked that important Board actions be reported in the newsletter.

Electrathon

Wing presented, in a letter, a motion to halt EAA sponsorship of Electrathon events unless 16-18 yearolds with driver's licences are prohibited from driving in the competition. Wing then made a motion to halt all EAA insurance coverage of Electrathons until the Board decides what to do. There was no second to the motion and it was dropped.

EAA budget

Stan Skokan presented a proposed percentage budget. After several modifications, the budget, with seven line items was submitted for approval.

Newsletter 49%
Rebates 12.5%
Administration
& Fundraising 10%
Chapter relations 10%
Deficit payoff 10%
Contingency 5%
Insurance 3.5%

Palmer then moved to accept the final version of Skokan's percentage budget. Skokan seconded. Motion passed with none opposed.

EAA Fellow Award

Bob Wing originated and administers the Fellows Award. He moved that 6 names on certificates be awarded to all nominated candidates and asked that the names be published in Current Events, along with a short bio for each, and the names of the members who nominated them.

Newell seconded the motion and a vote was taken. The motion passed. The award announcement, with pictures is planned for the next issue.



Letters to the Editor

Dear Paul,

My name is Faridodin "Fred" Lajvardi and I am an instructor at Carl Hayden Community High School in Phoenix, Arizona. I have just recently become a member of the E.A.A.. Last year I had students that were members.

In your Dec./Jan. issue, there is an article on the Solar Electric 500. It was a great article, however I have one gripe. There is no mention of the numerous high schools in this year's race and no mention also of the even more numerous schools in this year's race. Word has it that there are about 30 high school vehicles entered in the race. We have three vehicles that we are racing ourselves, and there are other schools that will have more than one entry as well. Last year Paradise Valley High School won the hybrid race, Marcos DeNinza was second and we were third. There was little or no coverage on the high school entries in the race. That was a crime! The future of the public acceptance of electric vehicles can be greatly influenced by the educating of today's youth and what better way than for the students to build and race their own cars. You mentioned your observation of the public's ignorance in the Editor's Corner. Well, here is one way to beat that ignorance.

I would like to point out everyone else's ignorance of what it takes for a high school to undertake such a challenge. The first and foremost is the funding problem. Most schools cannot even begin to afford such a project so the students and the teacher first have to be public relations people to go out and raise the money, either through some kind of fund-raising event or

soliciting sponsors. The next problem is the fact that the students have to work on the project as an extra-curricular activity. It is not possible to get any work accomplished in a forty minute period once a day, so weekends, holidays and after school are the only times that any significant work can be accomplished. Most businesses, of course, are off during those hours that the students can work on the car.

The sacrifice of the student's family to have their son or daughter gone from home at those times as well is another hardship that the students must endure. The instructor also has to make a sacrifice with their time as well. As you can see, this is a tremendous accomplishment, and really remarkable when you consider the incredible amount of paperwork that is involved with such a project as well as the red tape one must go through with the school's district office. If all this isn't enough to convince you of the intense dedication required by all the members of the team, you must take into account that this must all be done in a 6 month period from start to finish of this project.

With all this, I don't understand why the schools are almost never mentioned in any significant publication. Our vehicle had over 40 sponsors and about \$26,000 invested in the vehicle. We had computer monitorization that was transmitted via telephone modem through use of a cellular system. The data was displayed on a portable computer in the pit area. Fifteen elements of data were transmitted every second and were recorded for later playback. There was also a live television broadcast from the car, showing the driver's point of view.

I hope I've convinced you that there needs to be media coverage about all the high schools in the race. If not then the crime will continue and the public will go on being ignorant about electric vehicles.

One last thing I would like to mention is that sponsors want recognition for their sponsorship in the race and media coverage is how they are motivated to get involved in the project. It was more difficult this year to get sponsors because of the lack of publicity surrounding the high school entries. High school involvement can grow and be more productive if there was more coverage to attract more sponsors.

Thank you very much for your time and I hope that I don't sound like I'm crying for no reason, I'm just tired of watching the high schools being left in the dust. I may be wrong, but I think that there are few if any other high schools anywhere else in the nation working on electric vehicles at this level of dedication. It seems to me that Arizona is leading the way!! Check it out!!!!

Fredi Lajvardi
Electric Car Racing Team
Carl Hayden Community High School
3333 West Roosevelt
Phoenix, AZ 85009

Dear Fredi,

I am sorry that I have not been able to mention more about the high school involvement. Being only one person covering the race, I write about what I discover and thus I have to depend a lot on Ernie Holden's press notes.

I agree that what your team has been doing is every bit as impressive as what many so called "professionals" do and more than most. What private initiative and perserverence has accomplished in the EAA in the last 25 years and elsewhere, is more than the Big Three have done over many de-

(Continued on next Page)

More letters

(Continued from previous page)

cedes with millions of dollars. We (collectively) have been putting EVs on the road and using them on a regular basis.

The general media is biased against schools and individuals and high schools even more than universities. If you are not doing it for money, you are thought to be amateurs. But I know that it takes your enthusiasm, persistence and evangelism to change the world.

I am going to forward your letter and these comments to Ernie in the hope that the press notes will have more about yours and others efforts. However, I suggest that you do your own PR with your own press releases and inside stories of the facts behind the teams and cars.

All the best to you - Pb

We might consider this a good opportunity to start a column in Current EVents which covers high school EV activities. Current EVents needs people to send in stories and do columns on an on-going basis. Right now most of the magazine is being written by two people with occasional contributions from letters, press releases, news briefs and articles. Fredi, if any of your students are into journalism as well as EV's, ask them to cover what's happening on the Phoenix high school EV scene, or you or any of the other instructors. We want Current EVents to have something for all EV-ers all across the country and a column for the high school and college-ager's would be a good start. We'd love your coverage of your car at the upcoming March race. Send some press releases or an article.

— CB

Dear Paul,

I am a 71 year old, retired (but not entirely inactive), Catholic priest. I am working toward an electric car, which will be my only vehicle. I have reduced my driving from 12,000-13,000 miles a year to about 7,000, so I know what I save the environment will not be terri-

bly significant. (I know it all helps, but in terms of the total mess..!)

My thinking is this: Although I could live with a relatively simple car, I will try to get one that has most of the things people want — within "reason!" I want to sell the idea to others. Along with that, I was thinking of preparing a simple flyer that tells about the possibilities and virtues of EVs to hand out to inquirers. Then, this week, I received Current EVents and read your editorial and saw the mention of the brochure. Please send me a few for now and I will probably want "lots more" when (I'm not saying "if") I get my EV.

I recently called Mike Hackleman and Stan Skokan for information and advice. I am working with two men here. One is an electrical engineer who worked with Johnson Controls to develop a more efficient controller. The other is a man who has a business of restoring classic cars and he is eager to do a conversion. He wants to obtain a Saturn and has the word out to a number of auto salvage companies and I will shortly run ads in the Milwaukee Journal and the Chicago Tribune to try and obtain a "used/smashed running or not, Saturn."

I've met the Wisconsin chapter EAA contact person. I don't think he is an "evangelizer" and I think his name was not on the latest list. I would like to see an active local chapter and I would be willing to be active in it

A little over a year ago, I had a booklet published *Celebrating God's Good Earth in Prayer and Action*. God-willing, I would like to write another book; an over-all introduction to the environmental crisis. If all goes well, EVs will get more than passing mention! PEACE, Paul, all good things to you, to yours and to your work!

Sincerely yours in Christ,
Fr. Ed Eschweiler

—Ed. Thank you Father. You might contact our Advertisers for conversion books and mechanics training. Brochures are in the mail.

Supercharger

(Continued from Page 1)

- No overcharging and thus no loss of energy through heat results in a very energy efficient system. The current Chrysler/Norvik Smart Charging Station operates at a 95 percent or greater charge efficiency rate.

- Extends the life of the battery. By not overcharging, as is done with other quick charging systems and in regular overnight charging, the expected life of the battery is actually extended.

- Can be used in all weather conditions.

"The trick of the Smart Charging System is that it takes the diagnostics - the pulse of the battery - several times every second and then adjusts the charge current.," said Jiri K. Nor, Norvik vice president of Research and inventor of the Norvik technology. "It gives the battery as much current as it can take, not more, not less. So you have the fastest possible charge."

How fast, according to Nor, really depends on the battery.

"With the right combination of battery and charger and our charge control technology," he adds, "we can refuel electric cars as fast as we now pump gasoline."

Today, the Chrysler/Norvik Smart Charging station will provide a full charge (0-95 percent state of charge) in about 25 minutes when a common 480 volts AC is supplied from the utility grid to the station. The charging station then converts the voltage to a lower DC voltage (250 V) for the Dodge Caravan electric of today.

In future, the Smart Charging Station, without any change in voltage from the utility grid will run at higher DC voltage and charge the vehicle far faster as the battery system design is changed and as the smarts of the Smart Charger station are integrated into the vehicle as the BEMS (Battery Energy Management System). The end result, according to Chrysler and Norvik, is a full charge capability (0-95 percent in as little as 10 minutes.

Editorial

(Continued from Page 2)

Not only is there a profit incentive to sell the electricity, but the capital cost is small. Mr. Nor told me that a typical service station set-up to charge 8-10 cars at a time should cost less than \$50K for the equipment less any load-leveling battery energy storage costs. For the initial stations, load-leveling would not be needed, but as the concept grows, the utilities would want this and might even subsidize its installation.

So all of the misperceptions about EV's can be addressed by technology and the range becomes less and less important with fast charging. The final hurdle will just fade away and we can all drive EVs for all our needs.

Paul Brasch - editor.

SUNRAYCE '93

Solar powered vehicles will compete in a seven day, 1,000 mile race stretching from Texas to Minnesota entitled SUNRAYCE '93.

The winner of the race, which takes place June 20-26, will be the vehicle that travels the course in the least amount of cumulative time. Approximately 143 miles will be travelled each day during sunlight hours with all cars stopping each evening at the same location.

Qualifying events for SUNRAYCE '93 are as follows: April 9 at Indianapolis Motor Speedway; April 16 in Phoenix; and June 16 in Arlington, Texas.

Colleges and universities from across the country are fielding teams and cars for the race.

(PHOTOVOLTAIC
INSIDER'S REPORT: 12/92)

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FOR SALE: Cheap CHARGERS!!: 10 amp, transformer isolated, \$100/ea., 60-120 volt traction pack. Add \$20 for 12 volt isolated. Approx. 25 lbs each. Leave message (510) 525-3636.

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Calendar

March 1-5, 1993 Society of Automotive Engineers International Congress and Exhibition. Detroit, MI. Tel. (412) 776-7131.

March 5-7, Solar & Electric 500. Phoenix, Arizona. (602) 953-6672.

March 9, Alternative Fuel Vehicles - Meeting Air Quality Needs for the 90's Conference, Portland Marriot Hotel, Portland Oregon. Contact Oregon Dept. of Energy c/o State Management Association, (503) 378-7998. Presentations on EVs.

March 27-28, International Environmental Exposition at Red Lion Conference Center, San Jose, CA. Featuring speakers, displays, performers and vendors. For more information, call IEE '93 (415) 927-0649.

April 17, Earth Day at Stanford University. 9:00am-4:00pm. Electric vehicle demonstration and rides. For info, call Anna Cornell (510) 685-7580.

April 22, Earth Day - various local and national events.

April 22-28, Soltec '93 -ASES Annual Conference, Washington, D.C. Contact (303) 443-3130. Fax. (303) 443-3212. American Solar Energy Society.

April 24, Renewable Energy Fair Business Expo, Solar Hydro, Wind, Battery, EV workshops & Fair Arcata, CA (707) 822-3481.

April 30-May 1, E-DAY '93 Energy environment & everyone fair. EVs, solar, etc. Olean, New York rec. center 7-11pm EST. (716) 933-6175.

May 13-15, Clean Air Vehicle Conference, Expo and Grand Prix, Atlanta, GA (404) 237-1980.

May 23-29, Fifth American Tour de Sol, Solar & Electric Car Championship, Massachusetts, New Hampshire & Vermont. Contact NESEA, (413) 774-6051.

June 18-20, Fourth Annual Midwest Renewable Energy Fair, Amherst, Wisconsin. Box 249 116 Cross St. Amherst, WI 54406 (715) 824-5166.

June 25-27, Sunfest '93, 3 day energy expo, includes finale of SunRayce '93. Minnesota Zoo. (218) 546-5369.

October 22-23, S/EV 93 - NESEA 5th Solar and Electric Symposium, Car and Trade Show, including Transportation 2001. World Trade Center, Boston, MA. Contact Northeast Sustainable Energy Association, (413) 774-6051.

KTA Services has moved....

KTA Services will have a new address, effectively February 6, 1993. The new address and phone number:

KTA will be introducing some new products in 1993.

- ◆ The new K & W BC-25 onboard charger with dual input voltage/25 A, 96-216 V output.
- ◆ "The Phoenix"
- ◆ Distributive Charging Shunts
- ◆ A new high-output/low-noise vacuum system
- ◆ A new K & W amp-hr meter
- ◆ AC - 100 propulsion hardware
- ◆ A complete Eletrathon drive package and more

KTA Services Inc.

944 West 21st Street
Upland, CA 91786
Tel: (909) 949-7915
Fax: (909) 949-7916

**See back page for more info on KTA*

Advertising Rates

What do you sell? Are you looking for great new ways to promote it?

The Electric Auto Association (EAA) will help you tap into a wealth of opportunity through advertising in our newsletter, **CURRENT EVENTS**. Our membership extends worldwide and consists of members who share one common interest — electric transportation.

CURRENT EVENTS is renowned for the latest information on electric transportation. With an ad in **CURRENT EVENTS**, you will reach a target audience of members who understand the value and importance of your product.

Advertising Rates:

	1 issue	3 issues
Full Page	\$300	\$200 EA
1/2 Page	\$150	\$100 EA
1/4 Page	\$ 75	\$ 60 EA
Full Page	7.5" x 9.5"	
1/2 Page	7.5" x 4.9"	
1/4 Page	3.65" x 4.9"	

Ad rates are for black and white copy only. For each color, please add \$100 per fountain.

Deadline for camera-ready copy is due the 1st of the month. Please contact Susan Hollis, Advertising Manager at (408) 374-8605 for additional information.

Camera-ready copy and payment for the ad should be sent to:

Electric Auto Association
Attn: Advertising Mgr.
18297 Baylor Avenue
Saratoga, CA 95070

KTA SERVICES

944 W. 21ST STREET UPLAND CA 91786 909/949-7914

Established in 1984, KTA SERVICES caters to electric vehicle hobbyists and manufacturers by supplying EV components, publications, and design/consulting services. We are a complete supplier of EV components and certified kits....everything you need except for the batteries.

All components we recommend and sell have been selected with safety and reliability foremost in mind. All components have been proof-tested in electric vehicles. All components are new, competitively-priced, and come with full manufacturer's warranties. We proudly stock the following:

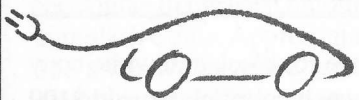
- ◆ Curtis-PMC Motor Controllers
- ◆ Advanced DC Series-Wound Motors
- ◆ Albright Engineering Contactors
- ◆ General Electric Circuit Breakers
- ◆ Bussman & Reliance Safety Fuses
- ◆ Sevcon DC-DC Converters
- ◆ K & W Engineering Onboard Chargers
- ◆ An ever-growing lineup of EV Publications
- ◆ 5 Kits Certified for California \$1000 Tax Credit & Sales Tax Exemption
- ◆ Curtis-PMC Throttle Pots
- ◆ Curtis Instruments Battery 'Fuel' Gauges
- ◆ KTA Services' Expanded-Scale Meters
- ◆ Deltec Meter Shunts
- ◆ EVCC Adapter Plates & Hubs
- ◆ Carol Ultra-flexible Welding Cable
- ◆ Thomas & Betts Welding Cable Lugs
- ◆ Battery Cables custom-made to spec.

You can purchase your components from us with the confidence of knowing that we specialize in user-friendly customerservice. With 10 years of EV experience and engineering expertise, we can answer just about any EV question you can come up with. Additionally, we offer engineering services:

- ◆ Complete System Quotations (free)
- ◆ Project Consulting/Engineering Design
- ◆ Project Overview w/Schematic & Recommendations
- ◆ Computer-based EV Performance Predictions

Call or write us with your EV needs!

For a COMPONENTS & PUBLICATIONS CATALOG, send \$5.00 (refundable)



Electric Auto Association

ELECTRIC AUTO ASSOCIATION

2710 St. Giles Lane, Mountain View, CA 94040

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