Electric Auto Association

CURRENT EVENTS

May-June 2001 Promoting the use of electric vehicles since 1967 Vol. 33 No. 5&6

PUSHING EVs BEYOND THE BATTERY RANGE

By JB Straubel, copywrite 2001

As anyone involved with EVs [Electric Vehicles] knows, RANGE is the one central problem (combined with slow re-charge times.) EVs will have ranges between 25-110 miles (homebuilt to optimized production.) Recharge times can be as low as 1-3 hours with high capacity chargers. These factors still do not allow long-distance freeway travel on the occasions when it is needed.

The idea of the pusher trailer and/or generator trailer is to give the normal EV long-range capability with fast fuel stops without permanently installing an IC hybrid system in the vehicle. This saves the weight, and mess, of having the IC [Internal Combustion] engine with you (in the EV) for the 80+% of driving that is done within the EV's normal range. For long-range operation, the IC engine will take over the entire load and battery drain will cease or slowly reverse.

The "normal" approach to hybrid trailers (if there is one) is to have an IC engine driving a generator that sends electricity forward to the EV to supply the energy needed for highway cruising.

Generator benefits:

- ❖ Energy can be stored in the batteries when IC output is greater than needed.
- ❖ The IC load is very level as the generator output can be nearly constant.
- ❖ No transmission is needed.
- ❖ Standard trailer dynamics apply.

However, this approach suffers from the inherent problem that the energy is transformed from mechanical (at the IC shaft) into electrical and then back to mechanical (at the EV motor.) The energy will in the best case go through the generator, EV motor controller, and EV motor. In the worst case it will also cycle in and out of the batteries. All of these conversions deal a serious blow to the best efficiency possible. For a typical EV system you will need between 1/2 and 2/3 of the IC horsepower to simply push the car as you will to generate enough electricity to drive it.

Pusher Benefits:

- ❖ Fewer energy conversions (Chemical > Thermal > Mechanical).
- ❖ Less IC horsepower needed.
- ❖ Potentially lighter than a generator trailer (smaller generator, less fuel, less IC hp).
- ❖ EV system does not need to be sized for continuous use.
- ❖ Cheaper (no generator, more standard automotive parts).

The hybrid trailer in general only makes sense for long distance freeway travel (roughly greater than 50 miles.) The trailer efficiency will fall at slower speeds since the IC output must be cycled through the batteries or throttled back in the case of the pusher. In addition, urban driving raises the obvious problem of parking with the trailer in congested areas.

Control: One difficult problem with the pusher trailer is how to control the throttle and transmission remotely. I have chosen to keep all control electrical so that there is only a simple electrical connector to the EV.

With the second-generation trailer, the automatic transmission takes care of shifting. The trailer lights (brake, running and turn signals), are linked to the car's lights. The throttle is controlled by a large hobby RC-type servomotor. There is a microcontroller on the trailer that takes an input signal from a 5k potentiometer in the EV and then sends the proper command to the throttle servo.

Operation: This second-generation hybrid

Continued on page 4.

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PHOTO CREDIT - COVER STORY

JB Straubel, from his website.

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CE Topics to Povide Coverage

In a better effort to cover the many facits of EVs and provide a more balanced coverage of East Coast/Midwest/West Coast activities, the CE endeavors to expand coverage in these areas:

1. Editorial (perspective from the Editor and/or CE staff)

2. National EAA news - Description of focus of EAA and Chapters; Mission Statement.

3. Local EAA Chapters - Listing for contacts, locations and meeting schedules; Calendar of events; possible rotating focus on what's happening in various parts of the country and world.

4. Related EV Groups and Resources - List of other EV groups (like EV1 User Group, etc); List of websites and resources available online; both general and manufacturer specific.

5. Education - Description of what is happening at grade school and college levels to education and promote EV acceptance, usage and development; special features.

6. Industry - News and press releases for specific EV developments; Reviews of new vehicles and products; Lawsuites and recalls.

7. Legislation - CARB resolution; East Coast legistation; Tax and other financial incentives; Diamond Lane, free charging stations and other benifits.

8. Technology - Battery developments; Infastructure planning.

9. Manufacturers - Who's producing what and availability; Benifits and limitations.

10. Conversions - How to find out what's been converted (EValbum); Resources to convert yourself or hire; Benifits and limitations of conversion.

11. Performance - Speed envelope; Range envelope.

Travel Perspectives, non-US EVs

American EVer's need to maintain perspective on the impact and influence of the automobile on a global scale.

My family traveled recently to Italy for a long-overdo vacation. While in the lovely city of Florence, we noticed how the Italians are using EVs for their scale of needs.

Within the urban center of Florence, most people get around by powered scooters, or mopeds. Several manufacturers have produced EV-scooters that provide a pleasantly quiet alternative to the noisy, smelly vehicle-of-the-day. Several public charging stations were found where 220V is the standard currency.

Small 3- and 4-wheel service vehicles appeared with battery propulsion. And the Italians are integrating both natural gas and battery EV buses into their public transportation sector.

All in all, it was delightful to see EVs in cities and countries where noise, smell and fumes far exceed the standards of US living. And because of the tight spaces and shorter distances, small vehicles like EV-scooters provide a great solution.

So, next time you travel, take a look and a listen to what others are doing to improve the transportation environment.

Ed Thorpe, CE Publication Committee
Spare the air everyday, drive Electric.

Letter to the Editor:

I have not seen this section in your publication, but I just have some comments about GM from the recent newsletter.

Conflicting Stories from GM
Current EVents Vol. 33 # 3&4 page 14:

The second article mentions that CA should not force automakers to sell electric cars to consumers who don't want them, while the first article says all rebuilt EVs are already been spoken for before being released. To me, that means the demand is higher than the supply and more people want EVs. If GM had a warehouse full of EVI, EVII, then I can understand their statement. Same for the Honda EV Plus. I believe the EV Plus was also sold out before released, stating that consumers want more EVs.

My opinion is even if the EVI and EVII were in a warehouse, that would not matter as GM is not building the vehicles that consumers want. I see the EVI & II as Sci-Fi toys, whereas the EV Plus is a usable get around town family vehicle. I am waiting for the mandate to come into effect so that I can buy an electric vehicle. I owned one in 1978 and tried to purchase the EV Plus when it came available, but I spoke up too late. I would prefer a simpler connection like an electric dryer cord than the fancy $2000 inductive system. There are ways to avoid sparks and human contact to the electricity with a dryer plug. My '78 vehicle had both the dryer plug for 220 and a regular plug for 110 and that technology was quite sufficient.

I hope CARB's attorneys are smart enough to ask simple questions such as:

"Of the vehicles that you built, how many remain on sales lots waiting to be sold?"

"How long did the EVs sit on the lot waiting to be sold versus your gasoline models?"

"So you have not sold any. Did you consider that consumers might want to purchase them?"

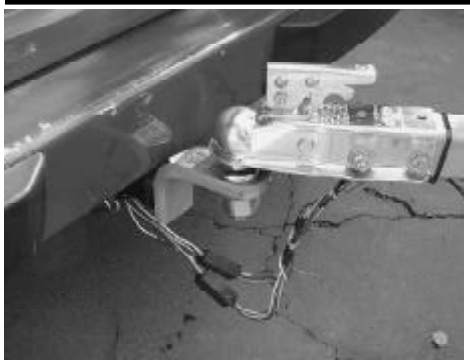
"You only built a sporty 2 seater, do you think there are consumers out there that would want a family sedan?"

"What would be the cost reduction to building 30,000/year versus 300/year?"

"Honda built a car for 4. They were sold (leased) before they made it to the dealer's lots. How do you explain your statement that consumers don't want electric vehicles?"

"If I went to a dealer today and asked about purchasing an electric vehicle, what models could I select from?"

Tom Holmes



trailer is very easy to "drive." All of the controls have been integrated into the dashboard of the EV so there are no dangling wires, etc. Since the trailer has an automatic transmission, it is left in the "drive" position always. The interlock that normally prevents starting the engine in drive has been removed. When towing the trailer without the engine on, the automatic transmission (AT) clutch is disengaged and the IC engine does not spin. The wheels turn freely (with only a slight extra drag from the AT.) Towing the trailer for long distances with the engine off is "not advised" since the AT does not have proper lubrication. But long distances are defined as 10-30 miles in the service manual (in between engine starts.) And, since the EV probably can't even tow the trailer 30 miles in between charges, this isn't a large concern. It just isn't possible (and doesn't make sense) to tow the trailer long distances without turning it on.

In the EV there is an ignition on/off switch and an engine start button. There is also a small, 5k potentiometer that controls the throttle on the engine. This could be wired directly into the 5k pot that is on the gas pedal running to the EV controller, but I opted for totally separate controls during initial testing.

Driving the EV/trailer combination is a piece of cake. The AT shifts as needed and you simply control the desired throttle level. It's also fun to simply turn the engine off when the traffic slows down or stops in rush hour and creep along silently with the electric drive.

Dynamics: Despite the facts that I shortened the trailer of the Gen-2 pusher by two feet and added more IC horsepower and much more pushing force with the ability of the AT to downshift...I have still found it basically impossible to get into a condition of oversteer. (This is where the car would want to turn into the direction of the turn if you take your hand off the wheel; normally if you release the wheel a vehicle will straighten itself out of a turn) Even in relatively tight turns with the trailer at nearly full power, the car wants to straighten itself out. The shortened trailer also drafts behind the EV much better further improving the mpg.

The hybrid trailer makes it completely possible to get by without a dedicated IC car at all. This allows the normal EV to meet 100% of your driving needs without sacrificing zero-emission city driving and grid rechargability (as all production hybrids today do.)

Things to add: IC engine cruise control (built in throttle actuator), Auxiliary high-voltage alternator on the IC (1000-2000 watts) to keep batteries charged (and to allow for greater electric use during hill climbing and hard acceleration).

Performance Specs:

- ❖ Top Speed: ~80 mph (flat ground, gasoline only).
- ❖ Top Speed: >100 mph with electric and gasoline use.
- ❖ Cruise Speed: 65-70 mph.
- ❖ Engine: 1800 cc '81 Volkswagen Rabbit, water-cooled, fuel-injected, gasoline engine.
- ❖ Transmission: '81 Rabbit stock automatic.
- ❖ Efficiency: 30 mpg (EV with trailer net at 65+ mph).
- ❖ Range: >300 miles (13 gallon capacity tank).
- ❖ Emissions: Catalytic converter, and fuel vapor recovery system.

JB Straubel is a graduate student in engineering at Stanford University. He is from Madison, Wisconsin and has been in California for about six years going to school. His favorite pastime is building "stuff", with biking, hiking, flying, camping, road trips, high power model rocketry, and school all as close seconds in competition for his time. His "technical" interests are just about anything involving high-power electricity or energy conversion. He is particularly interested in renewable energy generation, energy storage, electric vehicles, electric motors, fuel cells, and power electronics, to name a few.

Why an electric car?

Building an electric car is a wonderful challenge and combination of many things that I enjoy working on. Power Electronics, Batteries, Electric Motors, and Microcontrollers all come together. While the range is short (30-40 miles) the performance is quite good with a high-voltage battery system and a high-current motor controller.

The main challenge of this project has been building a motor controller from scratch. The controller is capable 240 Volts and 1200 Amps (motor or battery) that's 288 kilowatts! The batteries and clutch are really the limiting elements in the car right now, not the controller.

In addition to the general fun of building this project it is also fun to drive with quick acceleration. My commute from Midtown Palo Alto to Stanford is only about 5 miles and the round-trip is easily within range

while still driving the car like a Porsche. And let's not forget the standard EV benefits of being relatively quiet, emission-free, and rechargeable in the garage. Our house is now also purchasing 100% green energy from the Palo Alto Municipal Utility (for a 3 cent/kwh premium) so the car is truly a zero emission vehicle being recharged by some mix of wind, small hydro, and geothermal energy.

Project Details

The Motor Controller:

Features: Programmable current limit 100-1200 motor amps, automatic over-temperature current limit cut-back, water-cooled copper heat sink, low-loss IGBT modules, and "smooth-start" current limit reduction.

Processor: Microchip PIC 16F877 These are awesome microcontrollers running at 5 MIPS and 20MHz with 8kb of onboard program FLASH memory. They also have two onboard 10-bit PWM generators, eight 10-bit ADC converter channels, and a serial communication generator.

Power Components: IGBT Modules, six 500 Amp 600 Volt modules used (International Rectifier, GA500TD60U), Fast recovery diode modules, four 560 amp modules (International Rectifier HFA280NJ60C), Filter capacitors, six 450 volt 1000uF high ripple current, low ESR, screw-terminal caps (Mallory CGH102T450V3L), Heat sink, custom built water-cooled copper cold plate, isolated DC current transducer from LEM international.

Coolant System: The water cooling system uses a small 12V DC pump for circulation through a small plastic reservoir and an oil-cooler radiator. These radiators can be found at just about any auto parts store and are a good size. The pump is made by ShurFlo (model number 2088-423-344). It circulates around 2.8 gpm with a quiet 3-chamber diaphragm pump and permanent magnet motor. The current draw is between 2-3 amps. West Marine sells a wide variety of these pumps at competitive prices.

The Motors:

Two, 8" Advanced DC motors belted together and driven in series by the motor controller. One motor has a custom coupler that was machined to mate with the flywheel/clutch pressure plate. This motor is directly in line with the driveshaft running back to the transmission. On the outside of the coupler is a synchronous belt sprocket. This allows power to be transferred from a motor mounted above, through a Gates PolyChain GT belt, into the same coupler and clutch.

The Batteries:

Twenty 12V, deep-cycle Optima "yellow-top's" (D750S) for a total system voltage of 240 and a total pack weight of about 850 pounds. Peak power (at 9 kw per battery) ~180 kw.

Battery Mounting:

6 batteries in front of the motors roughly where the radiator used to be in front. 4 batteries on the floor behind the passenger and driver seats (well bolted down...).

10 batteries in the back where the gas-tank, muffler, and spare tire used to be. All of the battery racks are made out of 1"x1" (1/8" thick wall) mild steel angle pieces. Everything was put together in the garage with a small MIG welder. 3/8" all-thread clamps down all of the batteries except those behind the seats, there 7/16" rod was used...just in case.

Other Components:

DC-DC Converter: A custom modified Power-One power supply. This allows for an input of 240VDC with a continuous DC output of 40 amps at between 11-14 volts (adjustable). There were no commercial DC-DC converters available that took an input voltage this high. The converter is used to keep a small sealed lead acid battery topped off for load surges.

Performance:

- Top Speed: 104 mph.
- 0-60 mph: 8.7 sec.
- 1/4 mile: 17.2 sec.
- Battery Capacity: 65Ahrs, 240 volts (~ 15 kW*hrs).
- Controller Current Limit: 800 amps (motor or battery), Capable of 1200...but clutch slips.
- Charger: Onboard 6.5 kW, 240/208/120 volts (custom design).

CONVERSION WORKSHOP, STEP 4
REMOVING THE GAS OR DIESEL ENGINE

By Michael P. Brown, copywrite 2001

As promised in my last article, we are going to discuss the removal of the gas or diesel engine and the supporting fuel, exhaust, and cooling systems. However, before we grab a wrench and head for the car, there are some things we need to talk about.

Books You Need

The first things are books. There are two books that you should have before you raise the hood to start the conversion. One of them is the factory service manual for your donor car or truck. These manuals are published by the manufacturer itself, or by an authorized publisher like the Robert Bentley Publishing Company. They should be available at the parts department of the dealership for your make of car or truck.

If the service manual is unavailable for your car or truck, or unaffordable (the factory manual for the 914 Porsche is $350 and consists of three volumes), look for the service manuals published by the Haynes company. These are the only aftermarket service manuals that have enough detail to keep you from getting into trouble.

One of the reasons you want the manual is for the detailed instructions on how to do things like pulling the engine, replacing the suspension parts, and replacing the brake pads and shoes. Another item found in the service manual is the tightening torques for the various fasteners you removed during the disassembly phase, which you now have to put back to complete the conversion.

Perhaps the most important reason for having the manual is the detailed wiring diagrams. I use these diagrams to identify electrical components I don't recognize, find wires that can be reused in the conversion, and to help plan where to interface the existing electrical system with the new EV propulsion system. Handy Hint: the newer the car or truck, the more electronics it will have on board, and the more important the service manual.

The second book you need is a project or conversion notebook. What goes into this book? It is the place to record the measurements made before the conversion was started. Changes made to the vehicle during the conversion go there. The wiring diagrams for the high voltage propulsion system, and for the low voltage interface with the car's original electrical system are drawn there. Handy Hint: buy a set of colored pencils that match the colors of the wires you are using, and use these to draw your wiring diagrams.

I cannot overstress the importance of the conversion or project notebook. It can help you organize the conversion as you are doing it. It becomes the service manual for the EV, which will save you much time and wasted effort when you are trying to troubleshoot a problem in the coming weeks, months, or years. When the time comes to sell the EV, its value will be higher if it has complete documentation. In my years in the EV business, the lack of documentation has been the weakest part of the conversion process, both on the part of the hobbyist and commercial converter.

Tools For Heavy Lifting

Another thing we need to discuss before getting greasy is equipment for lifting and supporting the car and heavy components. The first piece of lifting equipment is an automotive style floor jack. This is a piece of equipment you should purchase because it will be used frequently during the conversion, and will be handy to have when servicing your EV.

It is important to buy the right jack. You do not want one of the little plastic-wheeled jacks with a sheet metal frame. Since it is going to be asked to safely lift a car or truck that is carrying 1,000 to 1,200 pounds of batteries once the conversion is completed, you need a real jack. By "real", I mean a jack with a steel plate frame, steel wheels on wide axles that have at least 20 inches between the axles. The jack should be rated for an honest 3-ton capacity.

The jack stands you use to support the vehicle once you have lifted it should be equally heavy duty. Use stands made of welded steel plate or cast steel frames with a capacity that matches or exceeds that of the jack. Buy these, too. Use the factory service manual to locate the proper places to support the car or truck without damaging the body or chassis.

The other piece of lifting equipment you need is the engine hoist or "cherry picker", as they are sometimes known. These devices are the safest and easiest way to remove the old engine and install the new electric motor. The engine hoist should be used with a moveable engine sling between the hoist and the engine to allow the engine to be tilted as it is lifted out to clear any obstructions in the engine compartment. You can rent these tools rather than buying them, as you will only need them twice during the conversion process.

Weights . . .

Now's the time to get hands-on. If the donor vehicle is still drivable, take it to a public scale and weigh it. Start by driving the front wheels of the car or truck onto the scale, and record this weight in your conversion notebook. Next, weigh it with all four wheels on the scale, and record the weight. Finally, weigh it with just the rear wheels on the scale, and record the weight.

These weights will help you determine how much you need to beef up the suspension to handle the additional weight of the batteries. On the way home, stop by a detail shop that does engine steam cleaning and have the engine compartment cleaned. Having it cleaned now could save you a lot of rag and solvent cleaning by hand later. Handy Hint: use this trip to run as much of the gas out of the tank as possible and still get home. We'll talk more about this later.

If your donor vehicle is not drivable, you might try to find a local auto racer who has a set of portable scales and could be hired to come to your location and weigh the car or truck for you.

And Measures

The next measurements take place in the space where you will be doing the conversion. Before you remove any parts or jack the car up and put it on the jack stands, you must measure the ride height. Do this at each wheel. This is done by running a steel tape measure vertically from the floor, through the center of the wheel, and up to the bottom of the wheel arch. Record this measurement in the conversion notebook.

These measurements will be different front-to-rear because of the different shaped wheel arches, and will vary a small amount from side to side. If the side-to-side measurements on the same axle are more than 2 inches different, you might check for frame damage, or bent or worn suspension parts.

The main purpose of taking these measurements is to have an original ride height to compare to after the conversion is finished. With the differences between the before and after measurements, and the axle weights taken earlier, you have a place to start when the time comes to modify the suspension to accommodate the extra weight of the batteries.

Next comes the first mechanical act of the conversion process: removing the hood. However, before you remove those four bolts that hold the hood on, use a scribe or marking pen to mark the location of the hinges on the hood. This simple act will make it much easier to install the hood in its original position when the conversion is finished. Correct hood alignment is critical to secure hood latch operation. Remove the hood and store it where it won't be damaged while it is off.

With the hood removed, the time has come to take some more measurements. When we install the electric motor/transmission assembly in the car and start to design the motor mount, we want them in the same place as the original engine and transmission. If the location of the new components is not the same as the original factory part's location, problems with the gearshift linkage, universal joints, or constant velocity (CV) joints on the front wheel drive cars could result.

To avoid these problems, we take a measurement up from the top surface of the transmission where it meets the engine to a point on the firewall. This point could be a seam on the firewall or a mark you put there for this measurement. Make sure that it's a permanent mark that won't come off easily. This method works best on front engine/rear wheel drive cars and trucks.

For the front engine/front wheel drive cars, with the engines that go from side to side in the engine bay, lay a flat bar of metal or wood from one fender to the other, above the centerline of the engine. Mark the bar's location on the fenders for future reference. Then measure straight down from the bar to the same place on the top of the transmission discussed above. Record the distance in your conversion notebook.

Next take a look at the throttle linkage or cable at the carburetor or fuel injection airbox. Measure how far the cable or linkage moves from the "full off" to the "full on" position. Make the same measurement under the dash at the gas pedal, and note any pedal stops at the full open end of the pedal travel. Having these distances in your conversion notebook will be a big help when you hook up the pot box and try to get "full on".

Keep This, Scrap That

Now you can start taking things apart. Read through the section of the service manual on removing the engine, then start to follow it through the sequence of operations. This is probably a good time to set aside two places in your work area to store things during the time you are doing the conversion. One place should be for parts that you know you won't use in the conversion, like the aircleaner, starter motor, and radiator.

The other storage area is for parts that you know you are going to reuse: the transmission, drive axles or drive shaft, and the original rubber engine mounts. Another item for the reuse area is any bracket that held a part (which is no longer needed) to the chassis of the vehicle. Any existing bracket that can be modified and used to mount a conversion component will save you the hours of design and fabrication time necessary to build your own bracket.

All fasteners should be saved in plastic bags that are labeled with the location they were taken from. The location of use is important because two bolts may be identical in diameter, length, and thread pitch but have a different grade of strength. Installing the wrong grade bolt in a high stress area could cause that bolt to fail. Saving and labeling the fasteners is also important because all the imported cars and some of the domestic cars and trucks use metric fasteners. Very few local hardware stores carry a large assortment of metric fasteners.

Label Your Wires

The first thing most service manuals tell you to do is disconnect the battery and remove it from the car. This is where you start disconnecting wires, so let's talk about labeling wires. Wires attached to the engine should be removed at the engine, using the connector that did the connecting. Cutting the wire to remove it should only be done as a last resort.

Immediately after you remove a wire, label it by folding a piece of duct tape over the wire and sticking it to itself. Write the name of the part it attached to, such as "oil pressure switch", on the duct tape with a permanent ink marking pen. On the newer cars and trucks, multiple wire connectors are used on some of the components, but the labeling procedure is the same.

Why all this labeling? As I said earlier, some of the engine compartment wires can be reused in the conversion as part of the interface between the EV parts and the vehicle's existing 12-volt system. Even if the wire isn't reused, you need to know what it used to be attached to. This will be important when you trace the wire on the factory manual wiring diagram, to determine if leaving it disconnected will cause you any problems.

The unused wires should be folded back over the wireloom and taped in place, with special care taken to keep bare connectors from touching each other. I do not recommend cutting into the wireloom and removing unused wires. I have seen real disasters created with a few snips of the wire cutters.

A Draining Experience

When you have disconnected all the wires and removed all the small parts that you can with the car or truck on the ground, it is time to jack it up, put it on stand, and start working underneath the vehicle. The first thing to do from underneath is drain the fluids from the cooling system, engine, transmission or transaxle, fuel tank, and rear axle if you have a rear wheel drive car or truck.

The cooling system is drained because you won't be reusing it, and in most cases the radiator has to be removed to get the engine out. Do not leave the used coolant in open containers, and mop up spills at once. Most coolants have a sweet taste and smell that make them attractive to dogs, cats, and small children for whom they are a deadly poison. Seal it in a plastic jug and recycle it.

You drain the engine oil mostly to keep from making a mess. If you have sold the engine, the new owner will want to put new oil in it after it has been installed, and if it's drained, there is no danger of an oil spill during handling. If you are going to recycle it, the recycle yard will want it drained when they get it. It's easier to drain the oil from an engine when it is still in the vehicle, so drain it, jug it, and recycle it.

Drain the transmission or transaxle oil, first of all, to prevent a mess while it is sitting out of the car or truck waiting to be reinstalled. No matter where you put it, somebody will come along, tip it on its side, and most of the oil will leak out of the vent or out of the axle shaft hole. The most important reason to drain the old oil is so you can refill it with a low friction lubricant to increase your range. This is also the reason to drain the rear axle on a rear wheel drive vehicle. So drain it, jug it, and recycle it.

All we have left is the fuel tank, and if you were lucky, you took care of most of the remaining fuel on the trip to get your axle weights. If the car or truck has a dead engine, things could get messy. Brown's First Law of Conversions states that any donor car with a dead engine will have a fuel tank that is more than half full. Draining a fuel tank on a modern car or truck is not an easy task, because most fuel tanks don't have drains. You have to use the outlet fuel line that goes to the engine and a bucket to drain it.

If the vehicle is fuel injected and has an in-tank fuel pump that stops the flow out of the tank, there will be a fuel return line that can be used as a drain. Be sure and have enough buckets to hold the contents of a full tank, and a suitable fuel container to store it in. I once got seven gallons of diesel fuel out of a ten-gallon tank into a can, with another two gallons on the floor.

Out With the Old

The service manual will tell you to disconnect the fuel and exhaust systems at this point, but since they will not be needed, you might as well completely remove them now. Be sure to label and save all brackets and fasteners.

The engines and transmissions of most modern cars and trucks are meant to be removed as a unit. Sometimes I talk to a customer about sending me their transmission so I can make an adapter pattern from it, and they tell me that it is not possible because they are going to leave the transmission in the vehicle. The reason most people give is that they don't want to remove the drive axles and CV joints. Removing the drive axles is a little more work, but nowhere near as much as fighting the engine out of a cramped engine compartment while dealing with a transmission hanging loosely from one mount and the drive axles. Read the service manual, follow the directions, and save yourself a lot of pain.

By now, after following the instructions in the service manual, the big moment has arrived. The engine and transmission are sitting in the vehicle, held in place by a few engine and transmission mount nuts and bolts.

Wheel the engine hoist into position and hookup the engine sling. In most cases, the attachment points for the sling are the lifting points the factory used to handle the engine during the assembly of the car or truck. When everything is hooked up, give the hoist jack a couple of pumps to take the slack out of the sling and the weight of the engine/transmission assembly off the mounts.

Next, carefully remove the nuts and bolts holding the engine and transmission to the mounts. Be careful when removing mounts that are bolted to the chassis and are supporting the engine or transmission on those bolts. Sometimes when these bolts are removed, the assembly will shift on the remaining mounts or the engine sling, and may fall a few inches very quickly. If your vehicle has a mount like this, it would be a good idea to support the assembly at this point from below with a jack. With the jack in place, remove the bolts, and then lower the assembly slowly with the jack.

With the engine and transmission loose from all the mounts, start raising the hoist and guiding the assembly out of the engine compartment.

Once the engine/transmission assembly is out of the vehicle, remove the transmission from the engine. Remove and save the clutch assembly, including the bolts that hold it to the flywheel. Measure the distance from the rearmost surface of the engine (where it mates to the transmission) to the rearmost flat surface of the flywheel. Write this measurement, which I call the "magic distance", in your conversion notebook. If your adaptor supplier does not already have a pattern for you transmission, he will need this number.

Then remove the flywheel and the bolts that hold it to the crankshaft, and the dowels that hold the transmission and engine in alignment. All these parts will be used in the conversion.

In the next installment of the Conversion Workshop, we will talk a little about what necessary cleanup is remaining, adapters and adapter installation, attaching the motor and adapter to the transmission, and installing this three-piece assembly in the car or truck.

Michael Brown is chronicaling the various stages of the ICE to EV conversion process. This is the 4th thus far in the series. As founder of Electro Automotive, he has many years of hands-on professional experience in the automotive industry, working with both ordinary family cars and race cars.

Trouble in NEDRA-land?

by John Wayland, copywrite 2001

There isn't trouble in NEDRA-land [NEDRA stands for National Electric Drag Racing Association]. NEDRA-land is just fine, thank you. Yes, some racers who based their vehicles on the Bolder and JC batteries are in trouble right now, as these batteries that looked 'oh-so-good' at first, have turned out to be 'oh-so-problematic'. The JC Inspira prototypes when new were awesome and made it possible to shatter old records and establish new ones, for sure.

Rod Wilde's Maniac Mazda ran an 11.2 best ET, a fantastic run, using brand new JC batteries, but as the batteries fell apart, the times fell slower. Dennis Berube' has run an amazing 8.801 seconds using Inspiras, but now is seeing slower times as well. Adding to the state of things, is the fact that these batteries are currently unavailable. Bill Dube's KillaCycle has had tremendous success with the Bolder cells, but the company is now in tough times and these batteries, too, may soon not be available any more.

There are options that have always been here. It does take sponsorship to get batteries that are 'special' in some way, but hey, that's how it has always been. I was the first EVer to use Optimas in a drag car, long before they became commonplace. I worked hard to garner early sponsorship. Rod was the first to get and use Inspiras. He worked hard to garner early sponsorship.

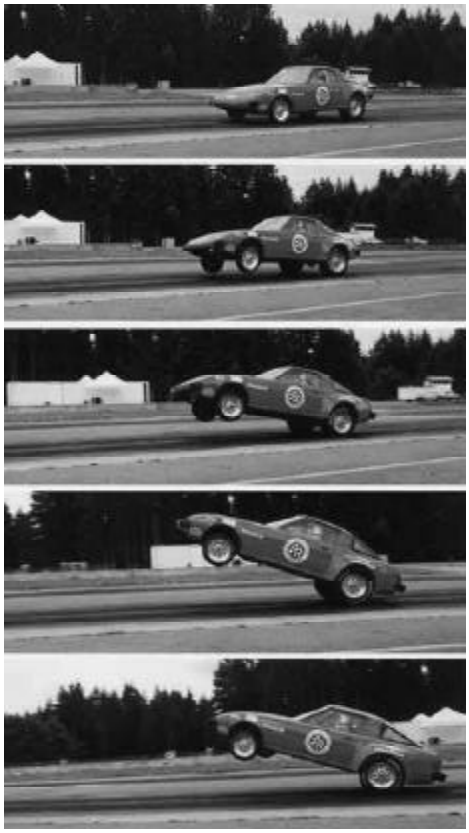
The use of Hawker and other generic lead-acids will not set us back significantly. While I had a problem at the Las Vegas drags in blowing up another Hawker, it was my own fault for not setting Godzilla's input current limit back to a reasonable level of 700-750 amps, as I have done in the past. I had set the limit higher in hopes of squeezing a last bit of performance out of my aging Hawker pack, and when I replaced them with this current healthy pack, I never reset that limit. As any EVer worth his salt knows, amps times volts equals watts, plain and simple. The 336v pack of Hawkers dipped way down to 168v at 800 amps, and under the heating-up conditions that 800 amps creates, the intercell connectors of these batteries work toward a meltdown and an eventual rupture of the intercell strap, causing instant hydrogen ignition....'BANG!!!!' With the current limit backed down to say, 700 amps, the pack has way less voltage sag, so it's again, amps times volts equals watts. I'm pretty confident that at this slightly lower (and safer) current level, the pack's risen voltage will make up for the lower current levels.

I believe that using the set of Hawkers as I am, I can extinguish any 1998, 1999, or 2000 EV record for a street legal EV, and intend on proving this is the upcoming Import drags here in Portland.

I only had two runs at Las Vegas. The first one was terrible (they all can't be terrific) with a tire smoking launch that reduced my 60 ft. time to more than 3 seconds and with 40+ degree batteries that pooped out before the end of the run. On the positive side of things, Rich got the chance to blow away White Zombie....wasn't that fun, Rich?

The second and last run was with slightly warmed up batteries that were still too cold, but they had way more power in them than on the first run. I got a strong launch that brought the nose up a bit, and the car pulled hard....then, I shifted from series to parallel, and the car continued to pull very hard. To me, it felt very much like a mid to low 13 second run. As everyone now knows, I blew a battery about 150 feet short of the traps, coasted across the finish line, and in spite of this, turned a respectable 14.3! Had the battery not failed, it would have been an easy 13.5 or so, for just the second run. In EV drag racing while using lead acid batteries, as the day goes on and as the batteries heat up, the times get quicker and quicker. Rich of all people, knows how this goes, having previously driven the Zombie to a world record best of 13.18. There's little doubt in my mind, that had things been different that night last weekend....warmer weather, better track conditions, proper current limits being adhered to, etc., that the Zombie would have dipped into the 12's....this is a far cry from 1998 levels.

If Dennis, Rod, and others give up and go back to the same Hawker batteries they had previously used, and if they did no other changes to the vehicles, their times would be back to 1998 levels. However, other things could be done to improve times. Yes,



better batteries are great, and I am also looking at new options, but let's not be so quick with the 'back to 1998 levels' proclamations.

EV racing will not take a big hit. In fact, maybe while the rest of we more established racers are reconfiguring and tracking down new battery types and new sponsors, others can step up using Hawkers, Optimas, and other fine lead acid batteries and have fun while establishing new records?

I agree that to keep pushing ahead, we do need to look at other battery types, super caps, etc. I have plans that I am quite pumped up about. But until I make them happen, I will continue to use my good 'ol Hawkers, continue to set new records for my race class, and continue to keep a positive attitude about our pioneering effort to show the world what EVs can do. There's no trouble at all in NEDRA-land, only a period of readjustment and experimentation...that sounds mighty exciting to me!

See Ya.....John Wayland
NEDRA president

http://www.nedra.com/

by Lee A. Hart

Topic: Battery performance – manufacturer claims vs. real-life experiences.

Roger Stockton wrote:
"When a user achieved performance approaching that claimed by the manufacturer, it makes more sense [to me] that this be taken as evidence that the batteries are *capable* of delivering the rated performance when treated well. It also makes sense [to me] that how this user treated the batteries be carefully noted as an example of at least one way to avoid murdering this particular type/model of battery."

TechMan response:
Good points. There are lots of variables; some that you can control, and some you can't.

When manufacturers test batteries, they use an industry standard test method. For example, the BCI [Battery Council International] test method discharges a 12v battery with a 25 amp load to 80% DOD [Depth of Discharge], recharges, and repeats until the battery delivers less than 80% of its original capacity. If the manufacturer knows such a test will produce unfavorable results, the battery is also tested some other non-standard way to produce better numbers for marketing. Thus the 50% DOD test for Optimas.

In the lab, everything is controlled; time, temperature, current, etc. They finish the test as quickly as possible so calendar age doesn't affect the results. The data for any weak batteries are ignored (they aren't "typical"). Unscrupulous vendors deliberately handpick the test samples to insure better results. Thus, battery manufacturers' test results are about as optimistic as you're going to get.

The main hope for improving life over manufacturers' tests is by smarter charging. Battery manufacturers use very conservative charging algorithms, in part because that is what is specified for BCI tests, but also because they only want to make sure the battery lives out its warranty. Undercharging kills batteries quickly; overcharging degrades them over time, so they err on the side of overcharging.

In the real world, we have poor control over the discharge current, depth of discharge, temperature, etc. Thus the results are always worse than lab tests. The REAL question is, "How much worse?"

Careless users, uncontrolled chargers, excessive DOD, excessive currents, and poor EV instrumentation that gives the driver no idea what is happening, all lead to battricide. The batteries die from abuse long before their laboratory cycle life.

For maximum EV battery life, here's what needs to be done (and isn't in most EVs):

- Very well controlled charging, that compensates for battery temperature and battery life, and only equalizes as necessary
- Some form of battery balancing, to keep them all at the same state of charge
- Instrumentation that a) indicates what is going on, b) warns you of problems, and c) shuts down the system if things get too far out
- Batteries in insulated boxes, with a means to prevent excessively high or low temperatures

for flooded batteries, some means to insure proper maintenance (watering, cleaning, checking terminals, etc.)

Even if all these things are fixed, there are uncontrollable variables that will always shorten real-world life compared to lab tests. Temperature, age, and manufacturing differences between batteries are uncontrolled. Discharge currents are dictated by traffic conditions. You might try to consistently limit depth of discharge, but occasionally miscalculate, and have to run them down excessively before you can get to a charging outlet.

In my case, I murdered my first few sets of batteries from the usual causes; poor chargers, excessive discharge currents, excessive depth of discharge, etc. As I learned, life improved. The last set of Sam's Club 6v golf cart batteries lasted me 6 years in my ComutaVan. However, I had an excellent Lester dv/dt charger (turned down to prevent overcharging), Cruising Equipment AmpHour meter, kept the car in a heated garage, and the batteries were in insulated boxes. I used it for daily commuting to work, 5 miles each way, at speeds under 40 mph so battery current rarely exceeded 250 amps. Depth of discharge was rarely more than 50%.

Even so, I had one battery failure around 3 years (replaced), and capacity was down to about 50% at the end. Total mileage was 12,900 and I paid $500 for the 13 batteries, which is 3.88 cents per mile.

Because of my short trips, an ICE might get 20 mpg in this service (at best). At $1.25 per gallon, it would have cost 6.25 cents per mile for gasoline. [At the current rate of $2.00 per gallon, it now is 10 cents per mile for gasoline.]

Topic: Recharging rates and affect on battery life

Teoman Naskali wrote:
"Is it better to slowly charge a battery?"

TechMan response:
It depends on the type of battery, and the circumstances. Let us talk about lead-acid, because that is what 99% of EVs use.

For lead-acid, it is important not to have too high a voltage per cell. Below 2.37 volts per cell, you can charge as fast as you want – even 100's of amps are OK. Essentially 100% of the current goes into charging. At these charging voltages, there is no difference between fast or slow charging.

When the voltage exceeds 2.37 volts per cell, some of the charging current begins to go to other reactions that produce gassing and heating. When the voltage exceeds 2.5 volts per cell, essentially all of the charging current is going into gassing and heating. These reactions are generally bad for the battery.

Thus, most chargers run high current until the battery reaches about 2.37 volts per cell (to minimize recharging time). This will get the battery about 80% recharged. They then hold the voltage constant for a period of time to finish charging. This causes the charging current to get lower and lower.

Chargers do go above 2.37 volts per cell for various reasons. It equalizes a multi-cell

battery (overcharges some cells to insure that the lowest cells will still reach full charge). It causes gassing, which helps stir the electrolyte.

Topic: Performance of cable interconnections.

Rich Weiss wrote:
"I read a treatise on connections that stated soldering a joint resulted in an additional "interface" to the voltage, and actually raised the resistance over crimped connections."

TechMan response:
This could be true if you have a poor mechanical joint, and use the solder as a filler. For example, if you poked a wire into a terminal and *didn't* crimp it, and used solder to fill the space between wire and terminal.

For a correctly made soldered connection, you first crimp or otherwise connect the wire and terminal so they are mechanically tight. THEN solder it. Properly done, the contact resistance is essentially zero; the bulk resistance of the terminal and wire will dominate.

The usual problem is that people compare poorly made soldered connections and/or poorly-made crimped connections, and draw erroneous conclusions. Soldering requires skill. Crimping requires expensive tools. Skimp on these, and you get bad joints.

That's not to say it is impossible for amateurs to make good soldered joints, or for cheap tools to make good crimps. What usually happens is that the quality of the joints varies. An expert with good tools can make 10 out of 10 joints perfect. An amateur with cheap tools might get 8 out of 10 joints perfect. So, you have to test every joint at high current, to insure adequate "quality control" to prevent failures.

Thus a hammer crimper can produce good results; but it can also produce bad crimps. A soldered joint might look good, but be bad. You have to check!

Topic: What should our expectation and responsibilities be for maximum battery pack life.

Damon Henry wrote:
"What are the different factors involved in the life of lead acid battery packs? ... I am looking through For Sale cars and seeing battery packs that are not lasting even 10k miles. Is this bad design, or typical?"

TechMan response:
Let's anthropomorphize a bit, and consider lead-acid batteries as alive, like the family dog.

1. They need exercise; it's good for them. You get the longest life when they are worked to about 50% of their capacity at moderate loads. After they have been loafing for weeks, you will notice a distinct improvement just from giving them moderate exercise.

2. But don't work 'em till they drop! If you drive an EV until it barely moves, the batteries are having a near-death experience! This is outright battricide, and a leading cause of early death.

3. They need to be fed regularly (charged). Feed as soon as possible after a workout; they don't like to sit around starving after use. Batteries left sitting for days in an undercharged state develop a condition called sulfation.

4. Don't overfeed, or they get fat and have cumulative health problems and so die early. Chronic overcharging is a major cause of early death.

5. Don't underfeed, or they can starve to death. Chronic underfeeding also leads to a weak sickly battery and an early death.

6. Batteries can sit unused for months (hibernate) without needing to be fed. You don't need to put them on a trickle charger; just be sure to feed them occasionally so they stay near full charge.

7. They need fresh, clean water occasionally. Sealed batteries have a built-in watering system, but flooded batteries do not. Be sure to check water levels, and fill with distilled water as needed (dirty water poisons them!)

8. They need to be kept at reasonable temperatures, that you would find comfortable. Not too hot, and not too cold. Lead-acid batteries are "cold-blooded", so the lower the temperature, the slower they get. Likewise, they can't "sweat", so high temperatures cook 'em to death.

9. Batteries can't talk. They won't whine when they're hungry, or cry when you hurt them. You have to check their state of health with instruments, like voltmeters ammeters and hydrometers.

10. There are different "breeds" of batteries, each with its own good and bad points. Slow plodding workhorse floodeds, but are long lived. Racehorse AGMs [Absorbed Gas Mat, also known as gell cell or sealed] that are fast and powerful, but short lived. Using the wrong breed of battery for the application, or having unrealistic expectations leads to disappointing results.

11. And some is just the "luck of the draw". For no obvious reason, identical batteries in the same vehicle will have some die young, and some seem to live forever.

The usual reason you see used EVs that say "needs batteries" is because the previous owner treated the batteries cruelly. Whether by ignorance or by laziness, some or all of the above guidelines were violated. But batteries are replaceable, and it usually means you can get the EV "cheap".

But such problems can be cured. A little detective work to fix the problems, and then some tender loving care will go a long way toward getting the longest life possible on the next set of batteries.

Tech Talk is compiled from various topics and questions fielded by Lee Hart which are sent in through the EV Discussion List. This will be featured as an on-going column in CE.

World's Largest Assemblage to Date of Fuel Cell Electric Vehicles

By Don McGrath and Bob Wing, copywrite 2000

At a ceremony attended by more than 400, the doors to the newly constructed California Fuel Cell Partnership headquarters facility, located in West Sacramento, California, were opened on November 1, 2000. The new 55,000 square-foot facility includes hydrogen fueling station, offices, work bays for partnership members, and a public gallery with educational exhibits, fuel cell models, and an interactive kiosk.

The facility will house more than 50 fuel cell vehicles that will be tested on California's diverse roadways in real world driving conditions. Twenty fuel cell buses will also be demonstrated in regular transit operations.

The California Fuel Cell Partnership was formed in April 1999. The Partnership is intended to promote development and public acceptance of Fuel Cell Vehicles (FCVs) over the next four years.

Many of the participating partners and associates gave brief presentations before the exhibits opened. Ride and drive opportunities were provided later. For the first time in history seven fuel cell cars were gathered together at one time for this event. Three fuel cell buses were also demonstrated.

This was by far the most exciting of any EV show exhibits to date, surpassing the excellent exhibits at EVS-12 at Disneyland, California and EVS-14 at Orlando, Florida. These fuel cell vehicles provide us with a look at the future of ultra low pollution transportation.

Inaugural Ceremonies

The inaugural ceremonies were MC'd by Alan Lloyd, Chairman of the state of California Air Resources Board, who introduced the Partner members. Partner members as of today include automakers DaimlerChrysler, Ford, General Motors, Honda, Hyundai, Nissan, Toyota and Volkswagen; energy providers BP, Shell, and Texaco; fuel cell companies Ballard Power Systems and International Fuel Cells (IFC); and state and national agencies concerned with clean transportation.

John Wallace, executive director of Ford's TH!NK group and Chairman of the Partnership Steering Committee, was then asked to introduce the Associate Partners assisting in certain specialties that include hydrogen gas suppliers Air Products and Chemicals, Inc., and Praxair; Methanex, a methanol fuel supplier; and bus transit companies AC Transit, operating in the San Francisco Bay area, and Sunline Transit Agency, Palm Springs, CA.

Following the introductory talks, a hydrogen fueling demonstration was given, using a Honda's new FCX-V3. After the fueling demonstration, visitors were treated to a parade of prototype - Fuel Cell Vehicles (FCVs). These prototypes included the Ford P2000, the Ford Focus FCV, the Honda

FCX-V3, Volkswagen's Bora HyMotion, the DaimlerChrysler NECAR 4, the Nissan FCV, and Hyundai's Santa Fe FCEV. Parked nearby were three FCBs (Fuel Cell Busses) - two XCELLSIS-powered buses, one being tested by Sunline and the other owned by the Federal Transportation Administration, and a bus by Daimler Benz.

Hydrogen Storage

The West Sacramento hydrogen fueling station is modeled after similar facilities in Dearborn, MI and Nabern, Germany. Liquid hydrogen is delivered by truck and stored in a 4,500-gallon tank. At present, it provides gaseous hydrogen at two pressures, 3,600 psi and 5,000 psi. The dispensers look like a gas station hose, one size filler nozzle for cars at the lower pressure and another set for busses. Fueling of fuel cell vehicles is quick and automated, taking just four minutes. Methanol distribution is expected on-site later. If there is a need for delivery of liquid hydrogen in the future, the capability can be easily added.

Continued on page 14.

HUMOR - THE MAN WHO NEVER RECHARGED

by Lee Hart

Let me tell you all a story 'bout a man named Charlie
And his fight with the EPA
He kissed his wife good-bye, and left for work one morning
And he ain't come home to this day

Oh, he never recharged, no he never recharged
And they say he's still at large (oh, poor Charlie)
He may drive forever on the streets of Seattle
He's the man who never recharged

Now Charlie had a car, one of 10 Most Wanted
On a list by the EPA
Well, they caught him and they fined him, and when that didn't stop him
They towed Charlie's car away
Refrain

Well, he swore they'd never get him again for pollutin'
So he bought an electric car
It went pretty fast along the streets of Seattle
But it just didn't get him that far
Refrain

He was following one 'o them electrified buses
When a thought entered into his brain
So he rigged a couple poles goin' out thru the sunroof
And his life's never been the same
Refrain

Now he flies up the hills and down the streets of Seattle
His EV's got an infinite range
And he never has to think about the cost of his driving
With no batteries to charge or change
Refrain

Charlie is a grinning, but his poor wife is moaning,
"Oh what's to become of me."
He's never gonna stop because Charlie's such a miser
He'll never quit if driving it is free
Refrain

There's wires everywhere along the streets of Seattle
But there's one place they just don't roam
So we're passing the hat to get the trolley lines extended
To route poor Charlie back home
Refrain (from doing this :-)

My sincere apologies to the Kingston Trio, for this terrible parody of their "?? Street Protest Song" (I think it was called).

Seattle WA has an extensive system of electrified buses with overhead wires for power. When I worked out there, I took these buses to work, or drove an electric car (borrowed from Eric Sundin and the folks at EVsNW).

John Wayland came up for a visit from Portland OR, and we were riding around in one of Eric's EVs with a sunroof. John was driving it flat out, racing up and down the hills, and I was complaining that we'd run out of juice before we reached our destination. "No problem," he replied. "Just reach up and connect to those overhead wires!" The idea for this poem was born.

Exhibits and Ride and Drive

1. The Honda FCX-V3 is a truly fine piece of engineering. It is based upon the EV+ platform. With regen braking power pumped into a Honda-developed ultra capacitor, it is quiet, has very peppy acceleration, and has very adequate room in both front and back seats. Instrumentation is similar to that of the EV+ but is totally new, designed for FCV operation. Honda's 3rd generation FCX has a 10-second start-time, compared to 10 minutes for previous models. The fuel is pure hydrogen stored at 3600 psi in a 100-liter composite carbon fiber tank. The FCX-V3 has a 60 kW motor, weighs 1750 Kg (3850 lbs.) with a range of 110 miles.

2. The Ford four-door Focus FCV is based on the Focus gas car and labeled as being powered by TH!NK to highlight the company's environmental brand. The heart of the car's drive train is a Ballard Mark 900 fuel cell stack. This model has a 67 kW motor capable of speeds up to 75 mph but no regeneration. In the Ford work bay there were several other Th!nk models, a smaller two passenger for local street use at under 35 mph and a golf cart type with roof but no doors for use in gated communities. Ford has set up a new assembly plant for alternative fueled vehicles at Carlsbad, Calif., north of San Diego. Th!nk models will be assembled there. Ford, along with DaimlerChrysler, is a major investor in Ballard and part of joint ventures with the two of them for marketing both fuel cell power plants (XCELLIS) and electric drive trains (Ecostar}.

3. The Ford P2000 fuel-cell passenger car is a 4 door sedan with a curb weight of 3340 lbs., 100 mile range, Ballard Mark 700 Series fuel cell, and a 67 kW motor with peak efficiency of 91%. The Ford P2000 was driven in the Ride and Drive. The P2000 is a first generation vehicle, superseded by the Focus FCV. Acceleration was only fair, and

there was a lot of noise from the air compressor used to inject air into the fuel cell. Based upon the specifications, the Focus FCV should be a significant improvement, but unfortunately there was no time to test drive it.

4. The Hyundai FCEV had its first public showing at West Sacramento and is a light-

weight aluminum chassis based on the gas Santa Fe SUV. It uses International Fuels FCs which produce 75 kW of power and is built on an aluminum chassis, with a 65 kW motor. It is equipped with a 5000-psi storage tank enabling the vehicle to go more than 100 miles on one fueling. Electric drive train, motor and control unit are from Enova systems of Torrance CA. Top speed is 77 mph, range 100 miles and weight 3,572 lbs., acceleration 0-60 mph 13.4 sec, and starting time 10 seconds.

5. The DaimlerChrysler NECAR 4 was test-driven. It is quite small, roomy enough for two adults in the front seat but the back seat is only large enough for children. Acceleration was adequate. An unusual feature was the regenerative braking system, which was used to heat water, presumably for passenger cabin heating.

6. The DaimlerChrysler NECAR 5 (new electric car), also called the California NECAR, is based on the Mercedes-Benz A-class and was especially built for the California Fuel Cell partnership showing. It has a 50 kW electric drive system, and a Ballard Mark 900 Stack with an output of 75 kW. The stack weighs only about 2/3 of the NECAR 4 unit and takes up only half as much space. As a result the entire passenger and luggage compartment can now be used to full capacity. Top speed is 90 mph, and the operating range is about 120 miles.

7. The GM Opel fuel cell car is GM's sev-

enth generation model. It was developed in Germany and the US and it is based on an Opel Zafira 5-seat passenger van which is half the size of GM's previous model and 25% smaller that its nearest competitor.

This Opel was used as the pace car at the 2000 Olympic marathon in Sydney, Australia last summer. Costs are reduced as the fuel cell requires only half the platinum previously used. A commercial version is at least 4 or 5 years away. This car model is half the size of GM's previous model and 15% smaller than it's newest competitor. Reporter

Bob Wing can attest to that! He had trouble getting his six-foot frame through the door and into the seat. In fact all of the models in the ride and drive were a tough fit for headroom. The Zafira has a range of 250 miles per fill-up of liquid hydrogen and an 87 mph top speed.

8. The Nissan Xtera FCV was shown to EVS-17 in Montreal several weeks ago. No other information is available, as Nissan has not responded to our request for a media kit.

9. There was a mock up of VW Bora Hymotion but neither author saw it.

Panel Discussion

In the afternoon, Mr. Wallace chaired a panel of 22 experts from automobile companies, energy companies, fuel cell manufacturers, and government. All agreed that many obstacles must be overcome, including lack of infrastructure, high cost, and short vehicle range. The partnership is still in a pre-competitive phase and a cooperative effort is essential. The panel members said that the path to a hydrogen economy is not clear; the general public's first exposure to fuel cells will not likely be FCEVs. It's considered much more likely that the first consumer-oriented products will be auxiliary power units and portable power supplies; panel members believe consumers will not buy FCEVs because of low emissions.

An example given is the failure of battery EVs to create a market. It is felt that consumers will only buy FCEVs if and when it is economically advantageous to do so.

Several speakers felt that fuel cells had a great future in distributed power, particularly in areas where there is no well-established or extensive power grid. As for vehicles, the first applications will be for public transportation (e.g., buses) and for fleets. The most often quoted date for introduction of fuel cells is 2004.

Don McGrath can be reached at <vinter@napanet.net> and Bob Wing at <bwing@svn.com>. Article was first written up for the VEVA News (Vancouver Electric Vehicle Association in British Columbia, Canada) in December 2000.

For more information about Fuel Cell development, see the California Fuel Cell Partnership website located at www.drivingthefuture.org . Overview of each manufacturer's vehicle is describedat http://www.fuelcellpartnership.org/vehicles.html.

By Roderick Wilde, copywrite 2001

Hi All, I had meant to get to this quite some time ago but as many of you know when you leave the office for more than a week without access, your E-mail and other affairs get very backed up. Well my life is just about back to as normal as it ever gets for me ;-)

In my last update we were in the town on San Ramon and I had found a cyber cafe to send a post from. There are a few things I would like to mention that I had omitted due to haste. The ceremony at the Town Square in front of the grand Catholic Church was much more elaborate than I had mentioned. Ricardo Garron the director of Entebbe, the (Fundacion Costa Rica para el Desarolla Sostenible), of which APVE is a division of, gave a speech and then the introductions as usual. He has been with us since the beginning riding his personal electric scooter that he normally uses around his ranch. This gentleman with the constant warm smile and sparkling eyes held a high level ministry in the last administration. After the speeches from the local government officials we were treated to dancing by a teenage dance troupe from a local school. The dance told the story of the brutality of the Spanish invaders. One of the dancers represented Columbus. They definitely have a different opinion of him than many Americans. It's so enlightening to go to another culture and get a glimpse of how they picture the world through their eyes. At the end of the entertainment we were all individually introduced to the crowds of onlookers. From there we went to the City Hall for a light lunch. After lunch everyone was loaded on to buses to be taken up high into the hills to check into their cabins at the Villa Blanca. This private resort on 2,000 acres is located in the Los Angeles Cloud Forest and is owned by former President Rodrigo Lazaro Odin. I had stayed behind to write my second update at the cyber cafe and was given directions as to where to meet everyone back in town for dinner.

I arrived at the dinner location at the church hall a little before the buses pulled up. We were treated to a great dinner with music and dancing. The women dancers wore long full dresses similar in style to what women square dancers wear in the US only more colorful. After the entertainment we had a speech given both in Spanish and English by our host for the night, Rodrigo Lazaro Odin, who had some rather scathing remarks concerning our current president's not signing the Kyoto Accord. I'm sure we can recover from whatever damage Bush does to the environment within the next twenty or thirty years after he leaves office. This is just my own opinion on the subject. I will refrain from further political comments during the rest of this report. At dinner I met Jose Ross who does consulting to the CNFL in their electric vehicle program. The CNFL as you may recall from my earlier post is the major distributor of electricity in the country. He knew of Wilde Evolutions and appeared to be quite surprised to meet me as he had planned on contacting me via E-mail later in the week. He invited me to come to CNFL in San Jose after the rally and check out their vehicles. As I may have mentioned earlier, they had three entrees in the Rally, A transit bus from AVS (Alternative Vehicle Systems) in Chatanooga Tennesee, and two Solectria vehicles, an S-10 and a mini pickup. I will tell more on my experience with the bus later.

After dinner we loaded on the buses and were driven to our home for the evening in the cloud forest. It was getting near dusk as we headed up the winding road that led us to pasture lands with Brahman cattle. The fences are quite unique. Since vegetation grows rapidly with the combination of moisture and heat they have found an inexpensive replacement for fence posts. They plant trees along the edge of the road close together in a line and then wait a relatively short time and then attach the barb wire. If you aren't in a big hurry this works great and these people do not seem to be in a big hurry. As a side note, an old movie favorite of mine is "The Bishops Wife" circa 1947 with David Niven, Loretta Young and Cary Grant. Cary Grant, who plays an angel and Loretta Young, the Bishops wife are taking a ride in a Taxi. The taxi driver, whose name is Sylvester, says to them: "Do you folks happen to know what the main trouble with this country is? Grant: "Oh, I've heard several versions of that! Young: Do you know, Sylvester? " Well I think I do. The main trouble is there are too many people who don't know where they are going and they wanna get there too fast. Take you two, you I call you unusual. Grant: Thank you! You're very perceptive. Syvester: "First place you know your destination, but you're not in a hurry to get there. You want to enjoy some scenery en route, and you're not reluctant to spend an extra four bits for a day tour with Mother Nature." This movie reminds me of one of those old sayings that remind you that you should stop and snort the roses now and then. Now back to your regularly scheduled program. We arrived in the dark and went into the main building lobby to check in and get my key to my cabin. Lighted steps lead through the mist filled air down the somewhat steep hillside to my home for the evening. I had a cabin all to myself. It was nicely done with natural woods and it had a small fireplace, which I lit up. It wasn't that cold but the fire helped me to dry my hair after my shower. I had a great nights sleep, but a student from UC Riverside who ended up sharing a cabin with my former room mate from the Hotel Palacio didn't get a bit of sleep. I can sleep anywhere anytime and was never bothered by this guy snoring. That morning he had the new nickname of Diesel Don. Last names withheld to protect the guilty. We had a great breakfast with all the usuals that includes rice and beans, eggs and toast and lots of fresh fruit.

We headed back down the mountain to San Ramon after breakfast and met at the charging area. From there we headed out and up and up with only a few downs. Our charging stop for the day was at Esparaza. The CNFL had already arrived earlier with their bucket boom to drop a line from a power pole to set up a charging station. This was along side the road with a wide pull off area appropriately near the entrance to a gasoline filling station. There were reporters and a cameraman from a motor sports TV program there to capture the historic event. After the vehicles were charged we headed out. I decided to ride on the AVS bus on this next leg of the journey. This portion of the trip was mostly downhill through windy, steep mountain grades. I was paying attention to the amp hour meter as we made our decent. When I boarded we were only down about nine amp hours but as we dropped in elevation so did the amp hours due to the regenerative braking. As I was later to discover, this was the buses second excursion to Puntarenas. It had traveled there previously for the dedication of a new deep-wa-

ter pier that enabled Cruise Ships to dock. When we dropped to about five amp hours the driver pulled to the side of the road. As I got off the bus I immediately realized the reason for the unexpected pull over. Smoke was pouring from the front brakes. At first I didn't understand this as I knew the bus had regenerative braking. They had put a full charge over night on the bus at San Ramon. Leaving San Ramon and heading uphill had not used enough energy to account for all the downhills. When the batteries are near full the control logic in the motor speed controller reduced the amount of regen braking to prevent over charging the batteries. This meant relying on the front brakes to do most of the work on slowing the rapid decent of this multi-ton vehicle carrying two tons of batteries. Luckily we had a very bright driver who realized the situation and pulled over to let the brakes cool otherwise I may not have been here to write this. Our next stop was for a great lunch at Mirador Enis. From there I decided to not push my luck so I grabbed a ride on one of the other buses. I should have stayed on the bus as this final leg was when the Vice President of the country, Elizabeth Odio, chose to ride. I was later to be introduced to her.

Puntarenas lies at the end of a long narrow peninsula that heads due west from the mainland. The northern shore is somewhat parallel to the continental landmass. If seen from a map it reminds you of a lion's tail with the shorthaired part being the long narrow drive out to the city with water on both sides. Puntarenas is built on the end of the tail where it widens out to closely resemble the shape of the bristles of a Japanese calligraphy brush. As we arrived at our final destination the rally was far from over. Throngs of interested onlookers once again met us. We had more speeches in Spanish, of course, with introductions by or own Ricardo Garron. He gave a speech as he has at all the stops and then introduced the mayor and later the acting President of the country, Elizabeth Odio, who is also the Minister of Energy and the Environment. In Costa Rica the Vice President of the country takes over when the President is out of the country. The Vice President also chooses a Ministry to head similar to our cabinet positions here in the U.S.

After the speeches the participating vehicles were loaded on to trucks to be taken back to Limon to be shipped by freighter. The Japanese team made arrangements to leave their Citroen in the country. When the loading was complete we all headed upstairs in the building that is the headquarters for the Puntarenas Tourism Board. Here awaited our final feast of a whole roast pig and local seafood plus salads and specialties. We were also treated to live music from local entertainers. The dinner and festivities were followed by an awards ceremony. Since this was an officially timed event the team with the closest to the ideal time were the winners. Marc Kohler, whose team I was on came in third in the street division with my new friend Jose Ross in second driving a Solectria converted micro pick up owned by the CNFL. The CNFL also took first place with their Solectria S-10 conversion. There were also prizes for the "Slow Speed Vehicle" division, which we refer to up here as NEVs (neighborhood electric vehicles) and last but not least for the electric scooter division which I believe was won by a gentleman riding one of the Pizza Hut delivery scooters. In Costa Rica in San Jose it isn't just Pizza Hut that delivers, so do McDonalds and other fast food chains.After the awards we all exchanged E-mails and address information and people had their T-shirts signed by their fellow "competitors". I use that term loosely as it was more like the feeling of comradery than competition. Once we completed our goodbyes we were loaded on to buses for our return trip to the Hotel Palacio in San Jose and then departure the next day for most of the out of country participants. I stayed on for a few more days and spent time back in Peurto Viejo where it all began. On my last day in the country I went back to San Jose and met with the owners of AISA, a company that makes forklift batteries and also distributes other deep cycle batteries. They were one of the sponsors of the yellow sports car. Later we went to CNFL to meet Eduardo Brenes Mata, the head of the electric vehicle division that Jose Ross does consulting for. I got to see some of their other electric vehicles. Most of these were bicycles, scooters and small motorcycles although they do have a Solectria Geo Metro that didn't make the Rally due to waiting for parts for it's charger. I'm sure it would have done very well also as did the other Solectria vehicles.

On this whole trip we had been treated almost as royalty. The hospitality was overwhelming! As word gets out of this Rally I think it will become the premier EV Rally of the world. The simplest way I can describe it is a cross between the Paris to Dakar and Mardi Gras. There will only be so many applications accepted for next years Rally as logistically they can only handle so many entrants. If any of you out there are wishing to be involved in one of the ultimate EV adventures and plan on going next year you should get your registration in early. I wish to personally thank Ronald Gonzales, whose ear I bent almost to the point of breaking and the rest of the staff from the APVE for putting on an incredible rally. Also a big thank you to the government and people of Costa Rica for the feeling of being more than welcome. I'll see you all next year!

Roderick Wilde— roderick@Wilde-EVolutions.com

Rally del Tropico 2001:

Date	Start / End	Dist
03/28	Puerto Viejo / Limón	60 km
03/29	Limón / Siquirres *	51 km
03/29	Siquirres / EARTH *	27 km
03/29	EARTH / Guapiles	20 km
03/30	San José / INBio	35 km
03/31	INBio / Alajuela *	28 km
03/31	Alajuela / San Ramón	52 km
04/01	San Ramón / Esparza *	33 km
04/01	Esparza / Puntarenas	21 km

** recharging locations*

Kohler Controler Team
Electric Vehicle Category, 3rd place
EV3PO

Marc Kohler - Jared Michaels Downs - Blake Edward Dickinson - Thomas Rutledge - Rodereick Wilde

By Michael H. Bianchi, copywrite 2001

GREENFIELD, Mass — The Tour de Sol: The Great American Green Transportation Festival, showcased dozens of vehicles that can reduce greenhouse gas emissions and ease America's energy crisis. "The impressive quality of the Tour de Sol's winning vehicles shows that Americans don't have to sacrifice safety, performance, or comfort to get a car that's good for the environment," said Warren Leon, executive director of the Northeast Sustainable Energy Association (NESEA), organizer of the festival.

"We were able to collect the best set of vehicle data ever, so that we can compare conventional gasoline vehicles with these new advanced vehicles." Said Dr. Robert Wills, technical director.

Honda's Insight, pace car for the 300 mile rally that included festivals in six communities between Waterbury, CT to Boston, MA May 19-26, is an excellent example of the new generation of vehicles coming to market. With a fuel economy of 70 miles per gallon, its gas-electric hybrid engine emits 45% less carbon dioxide, the major cause of global warming. A Toyota Prius, a five-seat gas-electric hybrid, achieved 50 miles per gallon, a great improvement over comparably sized Toyota Corolla gasoline control vehicle that achieved 26 mpg over the same course. The electric vehicles showed even higher efficiencies. Five electric sedans traveled at greater than 110 equivalent miles per gallon, with a maximum of 130 MPGs for a Solectria Force.*

As for carbon dioxide emissions, the major source of global warming, the Toyota Corolla emitted, on average, 391 grams of carbon dioxide per mile, while the Toyota Prius emitted 215 grams per mile. The Honda Insight emitted 150 grams per mile, which was about the same as the best electric sedans, assuming the electricity was produced in the Northeast. Several electric scooters built by Personal Electric Transport of Hawaii, and brought to the event by China and Micronesia, emitted only 80 grams of carbon dioxide per mile.

"These are the kinds of solutions that will promote energy conservation and energy efficiency in meaningful and effective ways," said U.S. Secretary of Transportation, Norman Mineta, at the Tour de Sol finish line ceremonies. "I want to congratulate all the participants of the Tour de Sol for the important role you're playing in bringing these concepts within reach, and making green transportation a reality."

In addition to vehicles already on the market, the Tour de Sol showcased a broader range of green transportation options than ever before. Dozens of students and individuals brought vehicles that ran on electricity, or fuels such as ethanol, biodiesel, compressed natural gas, or propane. Many exhibitors including Honda, Ford, DaimlerChrysler, Toyota, Korea's Advanced Transportation Technologies, Personal Electric Transport, and Spincycle brought conventional and electric bicycles, new neighborhood vehicles, pre-production prototype fuel cell cars, or information on public transit and pedestrian issues. Others brought displays demonstrating solar energy, or food products produced with the environment in mind. Festival attendees were serenaded by music from the solar-powered stage.

Major sponsors of the 13th annual Tour de Sol included the U.S. Department of Energy (Title Sponsor) and American Honda Motor Company (Gold Sponsor).

Top finishers in this year's competition were:

Production Division
Hybrid Electric:
Honda Insight, a gas-electric hybrid (entered by Naoto Inoue)
Battery Electric:
Solectria Force (Ethel Walker School, Simsbury, CT)
One —Person Vehicle:
PET Caballito Motor Scooter (Team China, People's Republic of China)

Prototype Division
Hybrid-Electric:
"Aluminum Cow", a biodiesel-electric hybrid (U. of Wisconsin — Madison)
Ethanol Challenge:
Chevy Silverado (University of Waterloo, Ontario, Canada)
Battery Electric:
Solectria Super Force (Team New England)
Solar Electric:
Solar Black Bear (University of Maine)

One-Person Vehicle:
Best 2-wheeler:
Climate Cooler (Team Micronesia, Federated States of Micronesia)
Best Commuter:
Sunpacer (Cato-Meridian High School)

Other major sponsors included the Connecticut Department of Transportation, ENSCO, Inc., the Massachusetts Department of Environmental Protection, the New York State Department of Environmental Conservation, the New York State Energy Research and Development Authority, the Texaco Ovonic Battery Company, and the Waterbury Region Convention and Visitors Bureau.

Additional major sponsors included: Automotive Wire, DaimlerChrysler, the Electric Vehicle Association of the Americas, EOTC/Mass Highway, Ford Th!nk Mobility, KeySpan Energy Delivery, National Grid, the New York Power Authority, and the U.S. Environmental Protection Agency.

The Tour de Sol is organized by the Northeast Sustainable Energy Association (NESEA), the nation's leading regional association promoting awareness, understanding, and development of non-polluting, renewable energy technologies. Headquartered in Greenfield, Massachusetts, NESEA has worked successfully for more than a quarter century in the fields of transportation, building construction, and renewable energy. Further information on the competition, including a complete list of all vehicle scores and results, are available on the web at www.nesea.org or by calling NESEA at (413) 774-6051.

* The equivalent MPG of an electric vehicle is calculated by converting kilowatt-hours of charging energy to equivalent gallons of gasoline by dividing by the miles traveled.

The complete set of Tour de Sol Reports for 2001 can be found at: http://www.foveal.com/TdS_Report_2001.html

WEST COAST WING - BOOK REPORTS

by Bob Wing, copyright 2000

1. David A. Kirsch, The EV and the Burden of History.

In early August an EVL msg noted that Amazon.com had the paperback copy for $20 plus shipping. My copy arrived August 24th so I took to the beach and read straight through. I learned many new things about early electrics, especially the number of electric 'taxis' charging from a central station in 20 cities from a total of 125 in New York to 8 in Cambridge MA and Schenectady, NY in 1913. Being a native Californian I never knew before that Los Angeles and San Francisco had 30 and 24 each. This 290 pp. book is a good buy.

This is quite different from the material in his doctoral dissertation of 1996 but obviously draws on many of his earlier sources.

2. Tom Koppel, Powering the Future, The Ballard Fuel Cell and the Race to Change the World.

Tom sent me a review copy of this 274 page hard cover book, $27.95 USA published by John Wiley and Sons, Canada. The author first visited Ballard in 1989 to write an article for Financial Post Moneywise magazine and later spent 5 years writing the book. When Ballard learned he was writing a book 1988 he was no longer permitted to visit the Ballard plant or talk by phone with any employees. His book is quite detailed so he found sources to describe the 25 years leading to Canadian venture capital investment and successful commercial production of Ballard fuel cells.

I remember seeing the Ballard FC busses at both EVS-12 in Disneyland and EVS-14 at Disneyworld and some other shows in California

3. Jim Motavalli, Forward Drive, the Race to Build Clean Cars for the Future. US $25. Sierra Club Books

I first read an article on EVs by Jim in the Sierra Club magazine. I called the SC editorial staff and found Jim's email address and asked him what else he was working on. He phoned me and said he had spent the summer at Point Reyes Station writing his final draft, six miles from where I live, then he returned to Connecticut. He then sent me a draft of Forward Drive for my comments. He interviewed over 180 people from academia, government, research institutes, and corporations. It read something like Scott Cronk's book Building the E-Motive Industry who interviewed over 100, of the same people for his 1995 book published by SAE.

Motavalli's book spends considerable time on the US government corporate welfare supported Program for New Generation Vehicles, or hybrid EVs. Only US firms were permitted to be members. So Toyota and Honda had to find funding for their hybrids separately and beat the US to market.

I felt Jim should have spent more words discussing Fuel Cells for truly ultra-low emissions as I see hybrids as only interim solution to satisfy high volume sales, and not that "green".

Jim asked me to set up a book signing session in the village Pt. Reyes Station for him, population about 900. I explained most of us get our books from the Marin County Library and that he might sell one copy. So I set up a date for the December meeting of the Peninsula Chapter EAA, closer to more EVers. However I found out later Jim let his publicist go and he did not show as scheduled.

TOYOTA TO SUPPLY HYBRID ENGINES FOR FORD VEHICLES

Toyota Motor Corp., Japan's biggest automaker, will supply Ford Motor Co. with low-emission hybrid engines that use both gasoline and electricity. Toyota will supply between 10,000 to 20,000 hybrid systems annually to Ford for use in the U.S. company's Escape HEV sport-utility vehicle, the report said without citing sources.

Toyota was the first major automaker to market a gasoline- electric hybrid car when it introduced the Prius compact in Japan in November 1997 and in the U.S. last year. Honda Motor Co. began selling its Insight hybrid in Japan and the U.S. in late 1999. Sanyo Electric Co. will make batteries for the engines. Toyota is also in talks with General Motors Corp. over a similar supply agreement, the report said.

2001/05/07 Bloomberg

FORD WANTS CONSUMERS TO TH!NK

The world's No. 2 automaker announced its first TH!NK electric vehicles will be available this fall at Ford dealerships in selected markets nationwide, but mainly in California, Arizona and Florida.

The first TH!NK model to be sold will be the "neighbor". It's a golf cart-like vehicle equipped with a windshield, seat belts, lights, brake lights and meets government crash test criteria for low speed vehicles. Neighbor's top speed is just 25 mph, and can travel about 30 miles on a charge. With a snail's speed and limited range, TH!NK is not designed to replace the family car, but it is aimed primarily at residents of gated communities who might otherwise tool around the lightly traveled streets within their confines in golf carts.

Ford also is looking at TH!NK as a low-cost introduction to electric vehicles for other consumers as well. While exact pricing has yet to be set, the TH!NK neighbor will probably start at about $6,000. In 2002, Ford plans to sell the more substantial TH!NK city in the United States. Already on the market in Europe, the vehicle is a street-legal, two-seat, front-wheel drive vehicle with a top speed of 56 mph and a range of 53 miles. TH!NK city is equipped with driver's side air bags and seat belts.

2001/05/05 The Associated Press

GM TESTS FUEL CELL TECHNOLOGY OVER DISTANCE

The hydrogen fuel cell vehicle was soaring along the test track at General Motors Desert Proving Ground, creating its own electricity and using it to spin its own electric motor.

A small Opel Zafira minivan, its normal internal-combustion drivetrain extracted and replaced with the most exotic propulsion system anywhere, raced along the five-mile oval at about 80 mph, emitting nothing into the air more harmful than water vapor. Hydrogen power is the future, automotive engineers say, when we'll all be driving around in cars and trucks that perform as well as today's vehicles, only without the air pollution.

The endurance test of GM's international effort to develop a practical hydrogen fuel cell vehicle came to an untimely halt midmorning due to a mechanical failure unrelated to the new technology. An air compressor was replaced, and the minivan was back on the track by midafternoon, still attempting to become the first fuel cell vehicle to run 1,000 miles in 24 hours.

A 12-hour endurance record of 663 miles was already set, and the German engineers at the Gilbert proving ground had made their point: that hydrogen converted by a fuel cell into electricity can be a viable fuel source in the real world.

One stopgap measure being planned is to create vehicles with on- board fuel processors that would separate the hydrocarbons of gasoline to supply hydrogen for the fuel cells. This would still result in a 50 percent reduction in pollutants.

2001/05/05 Phoenix Newspapers

HYBRID SUV ADDS ENVIRONMENTAL RESPONSIBILITY TO MUSCLE

The Dodge PowerBox hybrid concept vehicle combines the brawny looks that have become synonymous with the Dodge brand, with an advanced powertrain that is gentle on the environment. The rugged sport-utility concept provides the performance of a powerful V-8 engine, but achieves 60 percent better fuel efficiency than a comparable SUV, with near zero emissions. The vehicle is powered by a combination of a supercharged V-6 engine that runs on clean compressed natural gas (CNG) and an electric motor that provides added power for acceleration and passing.

As a super ultra low-emission vehicle (SULEV), the PowerBox hybrid SUV has a range of more than 350 miles (563 km), triple the mileage of most CNG vehicles and even more than most conventional sedans. Compared with a conventional Dodge Durango, the PowerBox is projected to achieve 25 mpg (9 liters/100km) resulting in a 60 percent increase in fuel economy without sacrificing horsepower. Off the starting line the PowerBox charges forward from 0-60 mph (97 kph) in about seven seconds, providing performance more in line with a sports car than a utility vehicle.

PowerBox's hybrid powertrain draws power from two different sources. A supercharged 2.7-liter, V-6 engine with automatic transmission drives the rear wheels, while a Siemens Automotive electric motor provides additional power to the front wheels. The V-6 engine is fueled by CNG and generates 250 horsepower (187 kW) while the electric motor adds another 70 horsepower (52 kW). The electric motor assists the CNG engine during acceleration and recaptures energy normally lost during deceleration. The engine and electric motor are not coupled in any way, connecting only through the road, hence the name for the patented technology.

2001/01/04 PR Newswire

ELECTRIC BICYCLES OFFER A NEW OPTION

Sales of electric bikes provided a small spark of life last year to a struggling global bicycle industry. Bicycle production has shown little growth in the last five years, but sales of electric bikes in 2000 tripled over those in 1999. More than 1.1 million sold

last year, accounting for about 1 percent of global bicycle production. Commercially available only since 1993, electric bikes are proving popular among commuters in China and Europe, and among seniors in the United States, who use the vehicles primarily for recreation.

E-bikes, as they are sometimes called, allow riders to add more power to their pedaling by engaging an electric motor at the flip of a switch. On some models, the extra power is supplied steadily, while on others it is added only as the rider pedals. Unlike motorbikes-the heavier, usually gasoline powered vehicles that resemble small motorcycles-electric bikes are standard bicycles that, with the aid of an attached rechargeable battery-powered motor, can reach speeds of 15 to 20 miles per hour without pedaling. And as electric bikes are substituted for motorbikes or cars, they have the potential to make cities cleaner and quieter.

Electric bikes tend to be expensive compared to conventional bikes, ranging from about $500 to several thousand dollars, although they are more affordable than motorbikes. Seventy percent of e-bike sales last year were made in China, where they are now a common sight on city streets.

2001/05/01 World Watch 10

A Beastly Tale
by Tony Ascrizzi, copywrite 2001

There it sat, in the dark shadows, silently, forlorn and alone, The Beastie, with its beaten and weak batteries, suffering from controller failure, waiting...waiting. Now past its prime, the once powerful, majestic Beastie sat licking its wounded pride, wondering how it will survive its final days. Its glowing metallic crimson paint job and bodacious sound system, longing to be seen and heard, were waiting...waiting. No longer useful for long distance touring or towing its siblings to the playground, it thinks back, over the good times had with its master.

One day several years ago, a stranger came to visit the Wayland homestead. John, wanting to impress the visitor, woke up the Beastie. Fresh and beaming with energy, the Beastie clawed and ate up Portland's freeways, climbing mountains, eager to please its master and show off its greatness to the visitors. After enjoying several hours and many miles of touring the Portland area, it was time to return home. After silently backing into its shelter, the Beastie fed. It would feed for several more hours, before sleeping for the night. This was but one of the many adventures the Beastie enjoyed. For this was what the Beastie was built for, long distance touring, and to show others that an electric vehicle can be built at a reasonable cost and have more than ample range and performance for us mortals.

This was the Beastie's role in life. Now three years later, things are very different. Its master now needed to travel far far away, and for days at a time. And one day, a newcomer to the Wayland stable arrived. Sleek and trim, like a racehorse, it looked down its silver nose to where the Beastie sat, sneering at the large and heavy Beastie. This newcomer to the Wayland stable was Sniffer, a new Honda Insight. Able to charge its own batteries while traveling and only stopping briefly every 700 miles or so to take a quick drink from a hose, a hybrid had come to challenge the Beastie's place. Somewhat similar, yet very different, this new breed of vehicle was to become the steed of choice, but only reluctantly.

But what was to become of the Beastie? It could be sold, but the Beastie was still very near and dear to the master's heart. Its former master's widow would be heartbroken if it was sold. It could be put into retirement, but storage costs would be excessive and wasteful, so the Beastie sat, not knowing what or even where its place was in the Wayland stable. But the Beastie was remembered by that stranger, now friend, from three years ago. There was only one option. Under the cover of a moonless night, a deal was made to have the Beastie secretly taken far away, for who could love a Beastie more than John Wayland? Tony Ascrizzi!

So the Beastie fed one last time, gorging itself by sucking its last amps from the Ugly Box Charger, storing them for the long trip ahead. That night, a large ship arrived, equipped to transport the Beastie to a new home. A home where it will be healed and renewed, to travel the highways and byways, to once again be free to go where no EV has gone before! For 10 long days it remained tied down, unmovable while the ship crossed the Rockies, the Great Plains and the Appalachian Mountains. Now on the East Coast, the ship landed in Auburn, Massachusetts where the Beastie was released from its bindings. The key was turned and the Beastie was awakened in a new land, only 8 miles from where it will enjoy a new life. Although very sleepy from its long journey, the Beastie felt a renewed surge of power from within, got on the highway and headed to its new home in Worcester. It was here that its new owner tended to the minor wounds of transport, rejuvenated and replaced tired batteries, replaced the troublesome controller and brought the Beastie back to health. With range returning bit by bit with every new cycle on the batteries, the Beastie felt like it got a new life, for once again it was free to tour the open road as it was built to do.

For seven whole months, only a select few would know where the Beastie had gone. The time came, after the first week of spring had sprung, that the Beastie's whereabouts should become known. For now the Beastie resides in its new home, Worcester, Massachusetts. Having traveled many, many miles and survived its first New England winter, it now shares the driveway with the VoltzDragon and E.V. Rabbit. Lovingly cared for and enjoying scenic New England with new roads to travel, and mountains to climb, the Beastie has been upgraded. It is now fitted with a new DCP-1200 [DC Power Systems RAPTOR 1200] controller and some new batteries, its glowing paint job and bodacious sound system ready to announce its presence on the East Coast.

So now you know what happened to the Beastie: the secret is out and so is the Beastie. I look forward to a lifetime of enjoyment driving the magnificent Beastie! Thanks John!

P.S. But there is another..... But that is another story....

Tony Ascrizzi - Electric Vehicle Systems
http://ElectricVehicleSystems.com

A Collectable, Energy-demand-responsive Electric Bicycle, *The Charger*

By: Peddler T. Coaster

Alameda Island and the East Bay continue to live the EV industry dreams. Many EAA activities over five years have occurred at Calstart's Hangar 20 in concert with Calstart's East Bay EV Hatchery. Calstart's consolidation had lost many intrinsic benefits for membership. Technological entrepreneurialism lives here within historic reuse of our military facilities own transportation infrastructure's historic capabilities. From Alameda's historic red electric trains to Cybertran-hatching and now liquidation of the CHARGER bicycle excess inventory through General Resales' Mr. Bill Smith! Community meeting activist, military conversion entrepreneur and EAA member and benefactor, Mr. Smith is promoting and marketing the Charger Bicycle from here,

This Charger Bicycle's Impulse System™ drive train represents, according to Smith, an American technology milestone in electric bicycle design engineering. Acceleration through manual pedaling is an assimilated skill, mastered and experienced according to capability. Pedal-impulse assist is the more instinctive, quicker and more naturally learned power boosting technique [where the electric engine supplements the human pedaling action]. The CHARGER bicycle, our first true Pedelec, (i.e. required pedaling with electric assist) introduces the conceptual feature of "Pedal-Assisted Torque/Power Multiplication" of the riders physical effort. Here the electronic propulsion system adds proportional torque power to the seven-speed internal transmission hub in direct proportion to the amount of torque effort that the cyclist applies to the hub by pedaling. Chain tension on a chain idler wheel bends the torque sensing strain gauge to provide a variable-ratio signal to the computer. Four power pack button pressure switches through the computer's algorithm additionally control the ratio of added electric power assist over pedal power. The computer generates variable maximums of up to either ½ horsepower (up to 375 watts), ¼, 1/8 or 1/16 horsepower increases in direct-chain drive power to any and all of the seven internal-hub gears. Try to find a better method of maximizing your batteries utility!!

The Charger bicycle is a well-balanced and integrated design. Shimano Group components are top of the line.

This Olympic effort (faster, farther, stronger and higher in San Francisco's hills) paradigm of cycling was the brainchild of Paul McCready's AeroVironment group. Paul McCready and AeroVironment have a long history of technical breakthroughs and innovation. McCready designed the GM Impact which became the GM EV1, arguably the most advanced electric car today. McCready is also known for his work in aviation technology, developing everything from a solar powered electric spy plane to finally accomplishing the dream of human powered flight. With this type of pedigree it is no surprise that the Charger bicycle is so innovative. AeroVironment from the start set out to develop a bicycle that stood out from all others. They started out with a 24V system instead of a 12V system common until 1996. The quick-release power pack module is eloquently contained in an advanced bent-tubes "Kona" racing chrome-moly frame design. Chargeable on or off-board with built in 3 ½ hour charger, the 23 pound pack houses batteries, control and power circuitry. This drive train incorporates a double-chain drive, one chain for pedal power and one chain for electric power. The pedal power chain rides upon a strain gauge tensioner that signals the amount of pedaling effort being multiplied utilizing the desired torque-multiplication power setting ratio. By using a chain to direct-drive the rear wheel electrically the Charger bicycle gains significant efficiency over the roller to tire ("scrub") friction-drive systems and multiplies the tire life over these older styles.

When the time finally comes to open up the Chargers' power pack to replace batteries you will be struck by the sophistication of this bicycle's electronics. In addition to two 12 volt sealed lead acid batteries the removable power pack also houses two impressively populated circuit boards, one for power and one for logic. The Charger drive system is microprocessor control based to be energy-demand responsive to optimize battery energy utilization and life. Almost all of the sophisticated control electronics in the Charger is incorporated on two printed circuit boards soldered together above lead acid gel cells inside the power pack housing. The smaller board detects rider inputs via the pressure switch pads and provides status signals, such as battery charge, over temp, over speed, sensor errors, and low charge back to the LED's. A Microchip Technology PIC16C74 is used on the smaller board for embedded control. This reduced instruction set computer (RISC) is based on a Harvard architecture with pipelined execution and fetching of instructions so that one instruction (except jumps) is processed per clock cycle. This allows the system clock to run at only 4 MHz saving power and avoiding the need for a heat sink or fan to cool the control board. Microchip is currently producing 100 million micro controllers per year in their popular PIC series. The 8-bit CMOS version used in the Charger has RAM, ROM, an A/D converter, various timers, counters, ports, PWM modules, resets and modes. In addition to this 44 pin micro controller the control board also contains a DAL, comparators, voltage regulators, serial EEPROM, logic and other

discrete surface mount devices.

Signals at one edge of the control board are routed to and from one edge of the larger triangular power board through soldered right angle connectors. The power board contains various DIP Op-Amps, PWM controllers, optoisolators and discrete power components to provide 2-wire 0-24 volt DC motor power and battery recharging from a standard 120V AC outlet. Six of the largest discrete semiconductors in TO-220 packages are mounted along another edge of the power board and clamped to one side of the large extruded aluminum heat sink for cooling atop the power pack. Each time the power pack is installed a 24 pin Molex connector on the third side of the power board connects it to the bicycles component system. This connector allows the pack to be disconnected from the electric components that remain on the bicycle such as the motor, and speed and chain tension sensors.

In a nutshell, the transistorized speed controller is more advanced than many found in full size electric cars. The Charger's electronics are indeed state of the art and truly represent our current computer age.

With all this technology you would think this bicycle would not be inexpensive. This could have very well become the case, except for an important factor: enter General REsales. General REsales has come to life with the sole purpose of promoting the Charger bicycle. As an EAA member and Alameda resident Bill Smith decided to bring the Charger bicycle technology to our membership for expert technological feedback. General REsales saw an opportunity to make this bicycle available to EAA members at less than half its original price. Believing that the bicycle represents more than a consumer item as it has become a collector's item, General REsales has been making plans to enhance the bicycle. The plans include safety accessories and a battery pack trailer. The Necessary safety accessories, long under development, are going to be introduced to customers of this higher speed vehicle. A high-speed, high-energy battery pack trailer will increase range. Bill's long range view is to help create the infrastructure that will make it possible to keep Paul McCready's dream alive for many decades to come, and in doing so Bill also keeps alive the legacy of active EAA members maintaining a professional EV community in the East Bay.

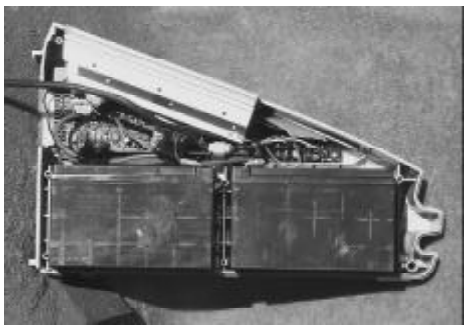
(For more information on the Charger bike or to contact Bill Smith you can call General REsales at: (510) 523-3205 or E-mail: billsmith1999@yahoo.com)

The Charger's power pack easily quick-disconnects from the frame triangle so you can carry it inside to be charged from the wall.

Charger's electric motor is chain driven through a Nexus Seven speed hub giving the bicycle effective surging power that friction drive systems can only dream of.

Shown are the bike's two circuit boards. The vertical one on the top is for power and the horizontal one on the bottom for logic.

The four power select buttons give you variable power multiplication of up to ½, equal, double or quadruple your effort up to 375W (1/2 horsepower). The fifth button is for "stop/clear".



A cutaway view showing the Charger's power pack with its heat sink, circuit boards and two 12V, 12 amp-hour lead acid gel cells that give Charger its 24 volt energy source.

EAA member and EV entrepreneur Bill Smith is seen smiling along side his computer controlled Charger electric bike.

by Jon Mauney, Triangle EAA, copywrite 2001

The Carolina EV Challenge is sponsored by the Carolina EV Coalition. Some of the major sponsor participants include North Carolina Department of Environment and Natural Resources, NC Department of Administration, Carolina Power & Light Co., Advanced Energy Corporation, Triangle Electric Auto Association, and Tarheel Sports Car Club.

Friday and Saturday, April 27-28, saw the culmination of the sixth annual Carolina EV Challenge, probably the best Challenge ever. Certainly it was the biggest ever, with 21 high schools traveling from 4 states (NC, SC, VA, FL) to participate in the final events, plus teams from four middle schools inaugurating our first Junior Solar Sprint.

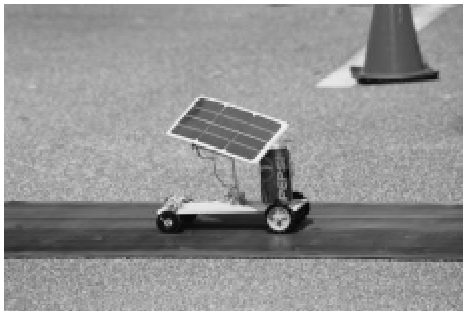
The Challenge competition comprises seven events, with trophies awarded in each event, plus an overall trophy for the best-combined score. For those events that involve the converted vehicles, there are three vehicle classes: Lightweight, Heavyweight, and Modified. Two of the events, School Initiative and Web Site Design, are completed in advance; the remainder occur during the two-day final event.

On Friday, the venue was Carolina Power and Light's (CP&L) Shearon Harris visitor center, and the events were Design judging, Troubleshooting, Oral Presentations, and Range. In the morning the EVs lined up for weigh-in, technical inspection, and judging. In the afternoon, they lined up for the range competition. In between, students took a break for pizza from the Dominos Pizza 18-wheeler. Throughout the day, teams took turns giving oral presentations and finding the faults on the new troubleshooting board.

Saturday the action moved to North Carolina State University's (NCSU) Solar House and McKimmon Center, with the Autocross competition in the big parking lot, Junior Solar Sprint in the small parking lot, displays in between, and the award ceremony indoors.

While the high school cars and trucks were screaming through the autocross slalom course, the Triangle Electric Auto Association (TEAA) sold raffle tickets for a Zappy scooter and gave test rides in EVs: a Prizm, an S-10, and the brand new Dynasty "IT". Also on display were hybrid Toyotas and Hondas from the state's fleet, the State Capitol Police's electric S-10 (used every night on patrol), and controllers from ZAPI.

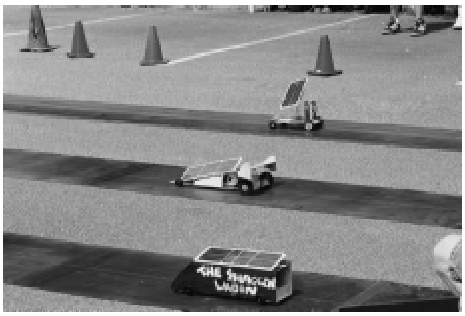
After the schools are finished with their competitive runs through the autocross, the course is traditionally turned over to the "open class" – EVs from the community at large, such as the pickups from CP&L and the State Capitol Police. This year, TEAA President Ken Dulaney drove the Dynasty "IT" neighborhood vehicle through the course, earning the car a third-place trophy in the open class, and first in the car's weight class.



New with the Challenge this year was the Junior Solar Sprint, our first move into the middle schools. In the Sprint, students are given a standard photovoltaic panel and electric motor, and they build a car using these components and their choice of gearing as the sole power train. The design must also incorporate a 12-ounce soft drink can, but beyond that, anything goes. One entry used stiff wire for the electrical connections and had no other chassis; another had a carved and painted eagle's head as a nose cone, while yet another used compact discs as the wheels.

The Junior Solar Sprint is run all over the country; for this pilot year for this event in North Carolina, four middle schools were invited to participate. The whole project was managed by the apparently inexhaustible efforts of Richard and Jayne Howard.

In case of inclement weather, the vehicle's solar panel can be replaced by a battery pack. Saturday morning started out cloudy, and it looked like the race would have to use batteries, but at the last minute the Sun came out and so we had true solar racing for the first year of the Sprint.



Winners in the individual events were:
Community Initiative Northern Vance High
Web Site Development Wake Forest-Rolesville
Troubleshooting Winston-Salem/Forsyth
Oral Presentation Northampton-East High
Vehicle Design Lightweight Southern Durham High
Vehicle Design Heavyweight Western Harnett High
Vehicle Design Modified West Carteret High
Range Lightweight Marion High (87 miles)
Range Heavyweight West Carteret High (75 miles)
Range Modified Hertford (80 miles)
Autocross Lightweight Northeast Guilford High
Autocross Heavyweight Lincoln County High
Autocross Modified Miramar High.

The overall winner, for the third year in a row, was Northern Vance High School. In fact, this year Northern Vance took both first and second places, with their car and their truck.

Interview with Rob Wills, Technical Director for the Tour de Sol:

14 years ago, when Rob Wills was a graduate student at Dartmouth College, he helped build and race a solar powered car in the Swiss Tour de Sol. The next year he led the group that founded the American Tour de Sol. He is still the Technical Director of the Tour de Sol, and 13 years on he still finds it invigorating.

"Three things excite me this year," he said. "One is the level of the production hybrids coming to market. They are clearly on a strong path because they reduce the world's reliance on gasoline." In spite of the engineering challenge of creating an efficient engine and transmission, and an efficient battery pack, motor and generator, and then making them work together effectively, these vehicles are delivering the increased mileage we need. And with energy prices suddenly spiking upwards, increased mileage is getting everyone's attention. "Hybrids are too complicated to meet our long term needs, but they are an important step along the way."

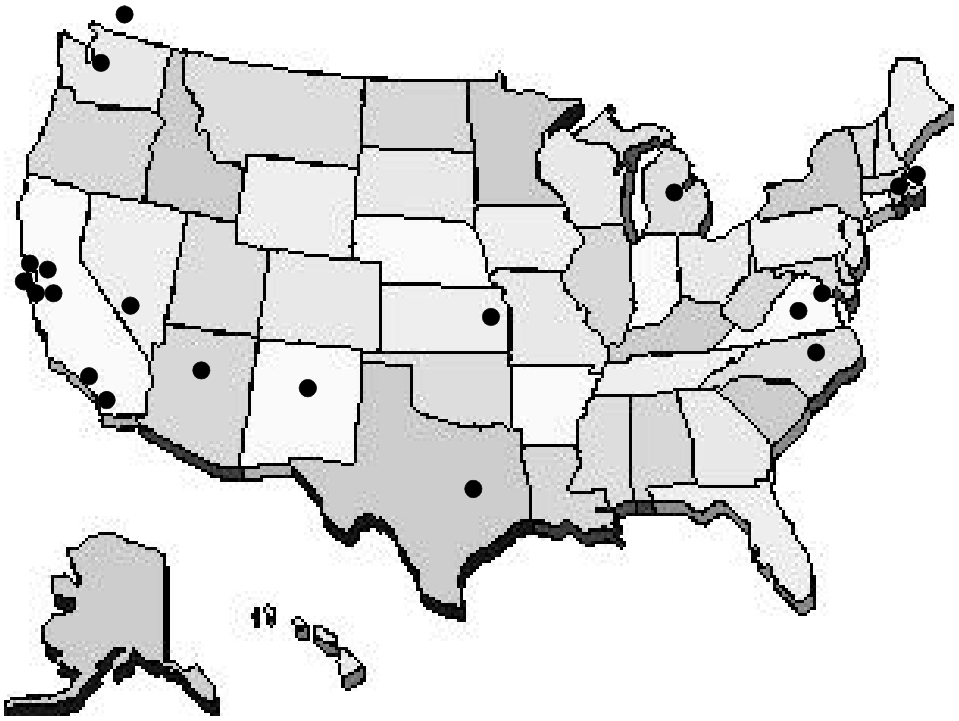
The second thing that Rob likes in this year's Tour de Sol is the increased presence of fuel cell powered vehicles. "Fuel cells are very interesting because the technology is pretty close. We should see production fuel cell vehicles in 5 years." Although only one fuel cell vehicle is competing, that one is demonstrating a very innovative hydrogen storage system. "I am very excited by the ``Genesis''. It shows hydrogen as an energy carrier as opposed to a fuel. Using hydrocarbon fuels to provide hydrogen still produces carbon-ladened exhaust." The cost and efficiency of a reformer that extracts hydrogen from gasoline or methanol is an issue for Rob. "In addition to the polluting exhaust, a fuel cell that runs at 50% efficiency coupled with a reformer at 50% gives the same performance as the hybrids using internal combustion engines. The "Genesis uses the sodium borohydride Millennium Cell system that only lets steam and water escape."

And finally Rob is still excited by his first love, solar powered vehicles. "I believe we will eventually see autonomous vehicles in the sunny climates, that can collect enough solar energy for commuting 40 miles." If we combine a vehicle capable of 100 Watt-hours per mile, cover it with flexible photo voltaic cells, and drive and park it in the sun I think it becomes mathematically possible and not that far away from practicality." In the mean time, he expects that people who get their hands on production electric vehicles like the Ford Th!ink or Corbin Sparrow will increase their range by covering the roof with solar cells.

"Every year at the Tour de Sol, I am so happy to see all the innovations that come from high schools, colleges, small companies and individuals. It is so exciting to see young scientists applying their enthusiasm to the multi-disciplinary problem of putting an advanced technology vehicle into this event. Not only do they have to solve problems in mechanics, electrics, electronics, power electronics, fluid dynamics and solar radiation, but also economics, environmental sciences, fund raising, team work, logistics, planning and management. In the real world there is never enough time to do any of those things completely right and most often there is a hard deadline. At the Tour de Sol the challenges are that they need a vehicle capable of driving on real streets, in real traffic and weather. The deadline is when the competition begins on Monday May 21st."

NATIONAL EAA HEADQUARTERS
Web Site: http://www.eaaev.org/
Contact: EAA-contact@excite.com
Phone: 1-510-864-0662
Mailing: 2 Smith Ct, Alameda, CA 94502-7786, USA

Chapter Count: 20



CANADA

VANCOUVER ELECTRIC VEHICLE ASSOCIATION
Web Site: http://www.veva.bc.ca/
Contact: Haakon MacCullum, 1-604-878-9500, hmaccallum@hotmail.com
Mailings: P.O. Box 3456, 349 W. Georgia St., Vancouver, BC V6B3Y4, Canada
Meetings: 3rd Wednesday/month 7:30 pm
Location: BC Transit Center cafeteria, off of Kitchener between Boundary and Gilmore, Burnaby, B.C.

UNITED STATES

ARIZONA

PHOENIX EAA
Web Site: http://geocities.com/phoenix_eaa/
Contact: Roy Thompson, Chapter President, 1-480-991-5075, dv8bug@aol.com
Contact: Sam DiMarco, 1-480-948-0719, voltek_2000@yahoo.com
Mailing: EAA Phoenix Chapter, PO Box 6465, Scottsdale, AZ 85258, USA
Meetings: 4th Saturday/month, 9:00 am
Location: Varies, see Web Site for details.

CALIFORNIA

EAST (SF) BAY EAA
Web Site: http://geocities.com/ebeaa/ http://www.geocities.com/MotorCity/1756/
Contact: Ed Thorpe, Chapter President, 1-510-864-0662, EAA-contact@excite.com
Mailing: 2 Smith Ct., Alameda, CA 94502-7786, USA
Meetings: 4th Saturday/month, 10:00 am (call for Nov/Dec).
Location: Alameda First Baptist Church, 1515 Santa Clara Ave, Alameda, CA

LOS ANGELES EAA
Contact: Irv Weiss, Chapter President, 1-818-841-5994
Mailing: 2034 North Brighton, Burbank, CA 91504, USA
Meetings: 1st Saturday, 10:00 am
Location: CA Tech, Winnet Lounge, Pasadena, CA

NORTH BAY EAA
Web Site: http://www.geocities.com/MotorCity/1757/
Contact: Chuck Hursch, 1-415-927-1046, chursch@yahoo.com
Mailing: 13 Skylark Dr., #13, Larkspur, CA 94939, USA
Meetings: 3rd Saturday/month 10 am
Location: Call for meeting details.

SAN FRANCISCO PENINSULA EAA
Web Site: http://www.geocities.com/MotorCity/1759/
Contact: Tony Kabage, Chapter President, 1-650-992-1834
Mailing: 356 East Moore Ave., Daly City, CA 94015-2039, USA
Meetings: 1st Saturday/month, 10 am
Location: San Bruno Public Library (downstairs), 701 West Angus St., San Bruno, CA

SAN DIEGO ELECTRIC VEHICLE ASSOCIATION
Web Site: http://home.att.net/~NCSDCA/EVAoSD/
Contact: Chris Jones, Chapter President, 1-619-6030
Mailing: 315 South Coast Highway 101, Suite U44, Encinitas, CA 92024, USA
Meetings: 4th Tuesday/month, 7:00 pm (except Dec.)
Location: San Diego Automotive Museum, NE door, 2nd flr conference, 2080 Pan American Plaza, San Diego, CA

SAN JOSE EAA
Web Site: http://geocities.com/sjeaa/
Contact: Mike Thompson, Chapter President, m.t.thompson@ieee.org
Contact: Roy Paulson, 1-408-269-7937
Mailing: 1592 Jacob Ave. San Jose, CA 95118, USA
Meetings: 2nd Saturday/month, 10:00 am (call to confirm)
Location: Reid-Hillview Airport, 2350 Cunningham Ave., San Jose, CA

SILICON VALLEY EAA
Web Site: http://eaasv.org/
Contact: Will Beckett, Chapter President, 1-650-494-6922, Will Beckett@email.com
Mailing: 4189 Baker Ave., Palo Alto, CA 94306, USA
Meetings: 3rd Saturday/month, 10:00 am
Location: Hewlett-Packard Co, Corporate World Headquarters, Lobby A Auditorium, 3000 Hanover St., Palo Alto, CA

MID AMERICA EAA
Web Site: http://maeaa.org
Contact: Mike Chancey, 1-816-822-8079, evtinker@hotmail.com
Contact: Don Buckshot, Chapter President
Mailing: 1700 E. 80th St., Kansas City, MO 64131, USA
Meetings: Call 1-877-377-0833 for current meeting info.

MASSACHUSETTS
NEW ENGLAND EAA
Web Site: http://people.ne.mediaone.net/bmatheny/home.htm
Contact: Tony Ascrizzi, Chapter President, 1-508-799-5650, tonyascrizzi@juno.com
Mailing: 34 Paine Street, Worcester, MA 01605, USA
Meetings: 2nd Saturday/month, 2 pm
Location: Call or email for meeting location.

PIONEER VALLEY EAA
Web Site: http://www.geocities.com/pveaa/
Contact: Karen Jones, Chapter President, k-jones@juno.com
Contact: Emlen Jones, Chapter Vice President, 1-413-549-6522
Mailing: P.O. Box 153, Amherst, MA 01004 USA
Meetings: 3rd Saturday/month, 2 pm (Jan-Nov)
Location: Call or email for meeting location.

MICHIGAN
DETROIT EAA
Web Site: http://geocities.com/detroit_eaa/
Contact: Lawrence Rose, larryrose11@yahoo.com
Mailing: 4301 King Fischer, Detroit, MI 77035, USA
Meetings: Email for meeting details.
Location: in Ferndale, MI.

NEVADA
LAS VEGAS EVA
Web Site: http://www.geocities.com/lveva/
Contact: William Kuehl, Chapter President, 1-702-645-2132, bill2k2000@yahoo.com
Mailing: 4504 W. Alexander Rd., N. Las Vegas, NV 89030, USA
Meetings: Call 1-702-642-4000 for time and location.

NEW MEXICO
ALBUQUERQUE EAA
Web Site: http://abqev.org/
Email: info@abqev.org
Contact: Neil Wicai, Chapter President, 1-505-899-7660, neilwicai@home.com
*Mailing:*19 Santa Maria, Corrales, NM 87048, USA
Meetings: 1st Tuesday/month, 7:00 pm
Location: Shoney's Restaurant, 6810 Menaul NE, Albuquerque, NM

NORTH CAROLINA
TRIANGLE EAA
Web Site: http://www.rtpnet.org/~teaa/
Contact: Ken Dulaney, Chapter President, 1-919-461-1241, teaa@rtpnet.org
Mailing: 202 Whitehall Way, Cary, NC 27511, USA
Meetings: 3rd Tuesday/month, 5:30 pm
Location: Varies, call for details.

TEXAS
HOUSTON EAA
Web Site: http://www.dataline.net/hceaa/
Contact: Dale Brooks, Chapter President, 1-713-218-6785,brooksdale@usa.net
Mailing: 8541 Hatton St, Houston, TX 77025, USA
Meetings: 3rd Thursday/month, 6:30 pm
Location: The Citizen Environmental Center, 2nd flr, rm 280, 3015 Richmond Houston, Texas

VIRGINIA
VIRGINIA ELECTRIC VEHICLE ASSOCIATION
Contact: Ernest Moore, Chapter President, 1-804-271-6411
Contact: Bob Oldham, 1-804-864-1455, bobtheham@igc.org
Mailing: 12276 Welling Hall Rd, Doswell, VA 23047, USA
Meetings: 3rd Wednesday/month, Call for details.
Location: Richmond Technical Center, Westwood Ave., Richmond, VA

WASHINGTON
SEATTLE ELECTRIC VEHICLE ASSOCIATION
Web Site: http://www.halcyon.com/slough/seva.html
Contact: Steven Lough, 1-206-524-1351, slough@halcyon.com
Mailing: 6021 32nd Ave. NE, Seattle, WA. 98115-7230, USA
Meetings: Call for details.

WASHINGTON D.C.
ELECTRIC VEHICLE ASSOCIATION OF WASHINGTON DC
Web Site: http://www.evadc.org
Contact: David Goldstein, Chapter President, goldie.ev1@juno.com
Meetings: 2nd or 3rd Tuesday/month, 7 pm
Location: National Institute of Health (NIH), Building 31-C, 6th Floor, Bethesda, MD.
Note: Please call Charlie Garlow 1-202-564-1088 to confirm attendence.

Listing updated, verified and current as of 4/15/01.

We encourage groups to become affiliated with the EAA by complying with the EAA Chapter Handbook. Copies may be requested via the Membership address.

Summary for EAA Chapter Requirements:

1) Each chapter must file a statement of affiliation with the EAA.

2) Each chapter must have at least two (2) elected officials who are currently paid EAA members - the President, Vice President, and/or Treasurer. Variations are acceptable; some groups have elected directors with no official title or duties.

3) Each chapter will hold a minimum of two (2) public meetings or other events/activities per year, for members and visitors to attend.

4) Each chapter will have a minimum of five (5) currently paid EAA members to be considered an official EAA chapter.

5) Each chapter agrees to abide by EAA organizational bylaws.

6) Each chapter agrees to abide by EAA organization's Code of Ethics.

7) Chapter identity (your unique chapter name) will include the EAA logo and/or the designation "EAA" or the words "Electric Auto Association".

May 2 - 5

Canadian Electric Vehicle Conference 2001, Kelowna, BC, Canada
Annual conference of the Canadian EVAC.
Contact: Tom Lewison, EVAC
Phone: 1-613-723-3127 *Fax:* 1-613-723-8275
E-mail: evac@evac.ca
Website: http://www.evac.ca

May 13-16

National Clean Cities Conference and Expo, Philadelphia Convention Center, Philadelphia, Pennsylvania, USA
Seventh annual meeting focusing on alternative fuel issues, transportation policy initiatives, and technology innovations to ease smog and improve air quality in urban areas. Hosted by the U.S. Department of Energy and the Greater Philadelphia Clean Cities Program.
Contact: NREL Conference Services, 1617 Cole Boulevard, MS 1623, Golden, CO 80401-3393
Phone: 1-800-224-8437
Website: http://ccities.doe.gov/conference.shtml

May 15 - 16

Grid-Connected Hybrids Conference, Davis, CA, USA
A conference at the Institute of Transportation at U of Calif, Davis. In 2003 the new California mandate permits up to 50% of ZEV requirement can be met with grid-connected, plug-in hybrids have all-electric range <20 miles.
Web Site: http://its.ucdavis.edu/events/

May 16-18

F-Cells Week 2001, Palm Springs, California, USA
A conference on the challenges facing the commercialization of fuel cells for automotive and stationary applications.
Contact: F-Cells Week 2001
Phone: 1-800-822-8684 or 1-973-256-0211
Fax: 1-973-256-0205
E-mail: fcells2001@iqpc.co.uk
Web Site: http://www.f-cellsnetwork.com

May 19-26

NESEA Tour de Sol, Boston, Massachusetts, USA
Thirteenth annual championship of electric and green vehicles will travel from Waterbury, Connecticut to Boston, Massachusetts over seven days, with festivals along the way in Albany, NY and Pittsfield, Greenfield, and Worcester, MA. Over 50 vehicles will compete and many more will be on display.
Contact: Nancy Hazard, NESEA
Phone: 413/774-6051 *Fax:* 413/774-6053
E-mail: nhazard@nesea.org
Web Site: http://www.nesea.org

June 2

Tanforan Friendship Rally, San Bruno, California, USA
San Francisco Peninsula EAA annual EVent for displaying EVs and educating the public.
Contact: Tonyh Kabage
Phone: 1-650-992-1834

June 2

Boyertown Historic Electric Vehicle Weekend, Boyertown, Pennsylvannia, USA
First annual EV Weekend sponsored by the Eastern Electric Vehicle Club of PA (EEVC).
Contact: Perry Oliver
E-mail: perryo@Cinnaminson.com

June 4 - 5

Electric: The Smart Solution, San Diego, California, USA
EPRI national conference focusing on new technologies in non-road electric vehicles.
Contact: Laura Ramos, EPRI
Phone: 650/855-7919
E-Mail: lramos@epri.org
Web Site: http://www.epri.com

June 4 - 7

ITS 2001, Miami Beach, Florida
Eleventh annual ITS America meeting and expo. EXHIBIT OPPORTUNITIES AVAILABLE
Contact: ITS America
Phone: 202/484-4847 *Fax:* 202/484-3483
Web Site: http://www.itsa.org

June 10 - 13

EnV2001, Southfield, Michigan
Annual conference and expo focusing on technology and global standardization of environmental vehicles and alternative fuels.
Contact: ESD
Phone: 1-800-659-2559
Web Site: http://www.esd.org

June 12 - 13

Vehicle Systems Integration In the Wired World, Brighton, England
International conference will focus on the technical research and engineering challenges facing the automotive product development sector from the current market drivers for the industry.
Contact: Corrine Paine, Ricardo
Fax: +44-(0)1926-614977
Web Site: http://www.ricardo.com/conference

June 17 - 20

Canadian Hydrogen Conference, Victoria, B.C., Canada
Eleventh annual conference will present the latest advances and issues in the science, technology, business and policy associated with the emerging hydrogen economy.
Contact: Canadian Hydrogen Council
Phone: 1-250-721-6295 *Fax:* 1-250-721-6323
E-mail: cha2001@iesvic.uvic.ca
Web Site: http://iesvic.uvic.ca/cha

June 20 - 22

Engine Expo 2001, Stuttgart, Germany
An international exhibition and conference dedicated to engine design, engine components, and engine manufacturing
Contact: Engine Expo 2001
Phone: +44 (0) 1306 743744 *Fax:* +44 (0) 1306 877411
E-mail: expo@ukintpress.com

June 23

East Coast NEDRA Drag Race, Mason-Dixon Dragway, Hagerstown, Maryland, USA
EVA/DC is organizing the Power of DC, an electric drag race which will be held at the Mason Dixon Dragway outside of Washington D.C.
Contact: Greg Pokorny
E-mail: grepok@bigfoot.com
WebSite: http://www.evadc.org/pdc/index.html

June 24 - 28

Air and Waste Management Conference, Orlando, Florida
Annual conference on environmental issues and solutions.
Contact: AWMA
Web Site: http://www.awma.org

July 15-25

American Solar Challenge, Chicago, Illinois to Los Angeles, California, USA
Teams from around the world will participate in this 2300 mile solar car race from Chicago to Los Angeles.
Website: http://formulasun.org/asc/

August 6 - 10

2001 Management Briefing Seminars, Traverse City, Michigan, USA
Annual management briefings on automotive industry and transportation issues sponsored by Environmental Research Institute of Michigan Center for Professional Development, University of Michigan College of Engineering
Contact: ERIM
Phone: 1-734-662-1287 x946 *Fax:* 1-734-662-5736

Website: http://www.erim.org

August 25

EBEAA EV Rally, Walnut Creek, California, USA
Fifth Annual EBEAA Annual Rally for distance and performance.
Phone: 1-925-685-7580

August 25

Woodburn Electric Car Drag Races,
Wodburn Dragstrip, Woodburn, Oregon, USA
Phone: 1-503-982-4461
Web Site: http://www.woodburndragstrip.com/

September 9 - 14

Hypothesis IV, Stralsund, Germany
Conference on theoretical and engineering solutions on hydrogen power. It will cover all aspects of technology developments and commercialization of hydrogen and fuel cells.
Contact: Fachhochschule Stralsund University
Phone: +49-3831-456-811/456-703 *Fax:* +49-3831-456-687
E-mail: hypothesis@fh-stralsund.de
Website: http://www.hypothesis.de

September 15

SVEAA Chapter Rally, Stanford, California, USA
Annual Silicon Valley EAA Rally, from 10 am to 4 pm, at the Stanford University Campus.
E-mail: Will Beckett@email.com

September 29

Sacramento Races, Sacramento Raceway, Sacramento, California, USA

October 1 - 4

SAE Automotive and Transportation Technology Congress and Expo (formerly ISATA), Barcelona, Spain
Conference to explore issues, products and ideas vital to the automotive and transportation technology industry.
Contact: ATT staff
Phone: +44-1372-720620 *Fax:* +44-1372-720101
E-mail: enquiries@attce.com
Web Site: http://www.attce.com

October 20 - 24

EVS-18, Berlin, Germany.
Eighteenth annual EVS, hosted by EVAA.
Contact: EVAA
Phone: 1-415-249-2690 *Fax:* 1-415-249-2699
E-mail: ev@evaa.org
Web Site: http://evs18.tu-berlin.de/

Sources for Existing EVs for Sale:

Silicon Valley Chapter EAA
http://home.pacbell.net/beckettw/forsale.htm#owned

Innevations
http://www.innevations.com/used-evs.html

Eco-Motion Electric Cars
http://www.halcyon.com/slough/contributions.html

Arcata Electric Car
http://www.tidepool.com/~ecar/list.html

EV Tradin' Post
http://members.nbci.com/evalbum/geobook.html

EVA/DC
http://www.evadc.org/forsale.html

Triangle EAA
http://www.rtpnet.org/~teaa/forsale.html

1979 four-door VW Rabbit for sale: converted by Electro Automotive for current customer in 1993, using the Voltsrabbit Kit. It has:

8" ADC motor
Curtis/PMC 1221 controller
Sevcon DC/DC converter
K&W onboard charger
Welded steel/powdercoated battery racks
Welded polypropylene battery box in hatchback (batteries under hood in open racks)
Power brake booster system
Custom springs, heavy duty shocks
16 US Battery 125 batteries, about 3 years old, still going strong
12V auxiliary battery is 1 1/2 years old

Car has 95,819 miles total, about 15,000 miles electric. Located in Oakland, CA, and has been regularly driven up a couple of good hills. Selling to reduce the household fleet from two cars to one. Asking $6,000 or best offer. (For reference, this kit currently sells for $7,950, without batteries.)

Contact Margaret Elizares at 510-562-2517. Has complete documentation on the car, including a faithful driving log.

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Electric Auto Association (EAA) Membership Application Form

Print and fill out this form, attach a check or money order in US funds only for $39 ($42 Canada) ($45 International) payable to 'Electric Auto Association'. You can fold this form as indicated and mail it with your payment enclosed. Do Not use staples. Use tape to attach your payment, and seal the form before you mail it.

New Member: ___ Renewal: ___ Country origin: _____ Date: _____

Name & *email: _____

Home & Work phone # _____

Street, City, State & ZIP: _____

Referred by:

I support the _____ EAA Chapter (*optional)

(fold back ward, this will protect your personal information, placing it on the inside)

The Electric Auto Association www.eaaev.org

'Providing free Electric Vehicle information to the public since 1967'

The Electric Auto Association (EAA) is a non-profit organization (eaaev.org 501c3) for the promotion of Electric Vehicle use in and by the public. Your membership is Tax Deductible and you will receive the informative monthly EAA publication, "Current EVents". All information and statistics in this application are for the exclusive use of the EAA and is not sold or given to any other organization or company. From your membership dues, a percentage goes to the EAA Chapter you support for public Electric Vehicle promotion activities like EVents, Rallies, Shows, and EV rides.

(fold the bottom half under. This will now be the front of the letter. Be sure to seal it with tape)

Return address

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1st Class Postage Here

Electric Auto Association
Membership, 4189 Baker Ave.
Palo Alto, CA 94306-3908 USA

EAA Merchandise

The **Electric Auto Association** (EAA) is a nonprofit organization for the promotion of public awareness of Electric Vehicle use as a viable transportation option. All minor sales proceeds are used to cover the costs of our nonprofit efforts in this cause. Please show your support with your purchases for better, cleaner, quieter, and lower maintenance transportation.

Product	Description	Comments	Item#	Price
Licence Plate Holder	Black plastic frame, white lettering on visible green.	Allow 6 weeks.	LICPH1	$ 10.00
Licence Plate Holder	For motorcycles. Black or chrome metal.		LICPH2	$ 14.00
Embroidered Patch	White, Sew-On.	Allow 3 weeks.	PATCH1	$ 6.50
Embroidered Patch	Green, Sew-On.		PATCH2	$ 6.50
Embrodered Hat	Adjustable fit.		CAP002	$ 9.50
"Electric Vehicle Parking Only" Sign	Metal sign, reflective white background with dark green lettering. Wall or pole mounting.	Like public no-parking sign quality.	PARK01	$ 25.00
EAA Key Chain	With LED light and "30 years 1967-1997".		KEY01	$ 2.50
Coffee Mug	Ceramic.		MUG03	$ 5.50
Insulated Car Coffee Mug	Plastic.		MUG02	$ 6.50
Embroidered Polo Shirt	Size: S,M,L,XL,XXL. Color: Forest, Teal, or Navy.	Allow 10 weeks.	SHIRT01	$ 30.00
EAA Jacket	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	JACKE1	$ 59.00
EAA Wind Breaker	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	WBREK1	$ 49.00
EAA Sweat Shirt	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	SWEAT1	$ 39.00
EAA ball-point pen	EAA ball-point pen with EAA.	Sold individually.	PEN01	$ 1.00
Car Window Shade	EAA Car Window Shade.		SS001	$ 8.00
Bumper Sticker #1	EAA Bumper Sticker.	Size: 10.5" x 3.75"	BS800	$ 2.00
Bumper Sticker #2	EAA Bumper Sticker "The Switch is on".	Size: 15" x 3.75"	BS002	$ 2.00
Decal	EAA Decal (The Switch is on).		DECAL	$ 1.00
	— EV Buyers Guides —			
2000	Electrifying Times Preview 2002.		BG2000	$ 5.95
1999	Electrifying Times	Not available.	BG1999	NA
1998	Electrifying Times Preview 2000.		BG1998	$ 5.95
1997	1997 EV Buyers Guide.		BG1997	$ 5.95
1996	1996 EV Buyers Guide.		BG1996	$ 5.95
1995	1995 EV Buyers Guide.		BG1995	$ 5.95
	— Literature —			
Convert-It	EV conversion Book		CONV01	$ 24.95
KTA Catalog	Electric Vehicle Kits & Component Parts		CATAL1	$ 5.00
Window Literature Holder	Light plastic.		WL002	$ 15.00
	— Special —			
AVCON to 14-50 Electrical Adapter Kit	Sheet metal box, 14-50 outlet (2 hots and a ground, no neutral), for 220 VAC chargers only.	Allow 6+ weeks delivery after payment deposited. Some assembly required.	ADAPT1	$200.00
EAA Membership	Fill out Membership for on opposite page	Include form w/ order.	EAAM01	$ 39.00
Shipping	US =10% / CANADA =15%, OTHER = 20% of the sub-total.	*Orders are restricted to the US, Mexico and Canada*	Subtotal Shipping	$_____ $_____
			Handling	$ 2.00
			TOTAL	$_____

To order, include your name, phone number, mailing/shipping address and payment by check or money order. Please specify quantity for each item and size/color for clothing.

Send orders to:

EAA Store, 5820 Herma St., San Jose, CA 95123-3410

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