Electric Auto Association

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Silicon Valley Chapter President

Electric Auto Association

www.eaasv.org

Electric Auto Association's Purpose

- To act as a **source of information** for the membership, other organizations and the public, on the current state of electric vehicle technology worldwide.
- To **encourage experimentation** in the building of electric vehicles, particularly to improve energy and resource efficiency, reduce emissions and improve vehicle safety.
- To **promote and organize public exhibits of electric vehicles** built by members and others for the purpose of informing the public on the progress of electric vehicle technology and conducting public opinion polls.
- To use all media, such as newsletters, web sites, information packages, and other paper and electronic media designed to **inform the public and promote the cause of electric vehicles**.

About the Electric Auto Association

- Founded in 1967 in San Jose
- About 2,000 members in USA, Canada, Europe
- 50 Regional Chapters and two affiliates
  - CalCars.org
  - PlugInAmerica.com
- Members get monthly Current EVents magazine
- Website: www.ElectricAuto.org (www.eaaev.org)

Electric Auto Association EVents

- Annual Electric Car Rally and Show, etc.
- Annual EV Conversion Workshop
- Monthly Meetings
- Special Interest Groups and websites
  - PHEV SIG (www.eaa-phev.org)
  - www.Evfinder.com , www.EValbum.com, EV Trading Post
- Public Outreach
  - Guest Speakers, public appearances, displays
  - Radio & Video Interviews, Press Releases, Flyers

Recent & Upcoming EAASV EVents

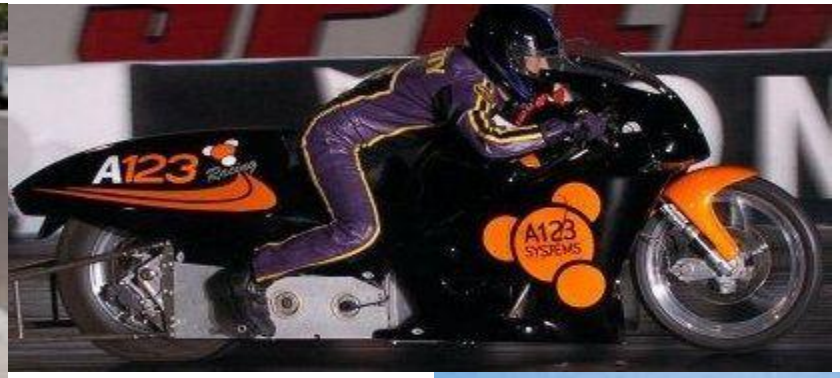
- Spring in Guadalupe Gardens, April 25, 2009
- Belmont Earth Day – April 25th, 2009
- PARC Earth Day – May 6, 2009
- EAASV Monthly Meeting – Palo Alto – May 23
- 37th Annual EV Rally & Show – Aug. 29, 2009
- Annual EV Conversion Workshop – Aug. 30
- Cupertino Fall Festival, Sept. 19 – 20, 2009

Recent Guest Speakers at EAASV

- Louis Palmer – Solar Taxi World Tour
- Jorge Brown – Tango EV demo
- Bill Dube – KillaCycle – world's quickest
- Tom Gage – AC Propulsion eBox
- JB Straubel – Tesla Roadster
- Richard Hatfield – Lightning Lithium Motorcycle

Photos of Guest Speaker's EVs











Typical EV limitations for PbA cells

- Range: 30 – 40 miles (PbA)
  - (How far do you drive each day?)
- Typical Top Speed: 55 – 80 MPH (PbA)
- Typical Charge times: 6 – 8 hrs (120 VAC)
  - Charge time: 3 – 4 hours (240 VAC)
- Typical Battery Life: 2 – 4 years (PbA)
- Excessive Weight (> 1,000 lbs.)

Advantage of Li-Ion Batteries

- Range: 40 – 300 miles (Li-Ion)
  - (May not need to charge each day – or V2G)
- Typical Top Speed: 55 – 80 MPH (Li-Ion)
- Typical Charge times: 6 – 8 hrs (120 VAC)
  - Charge time: 3 – 4 hours (240 VAC)
- Typical Battery Life: 2 – 15 years (Li-Ion)
- Reasonable Weight (< 600 lbs.)

Li-Ion Battery challenges

- High up front cost (life cycle cost OK)
- Thermal runaway issue with some chemistries
- Risk of Cell damage due to:
  - Overcharging
  - Undercharging
- Calendar life issue with some chemistries
- Battery Management System availability
- Packaging issues – polymer cells, 18650. etc

Can I charge my car with solar?

- Vehicle uses about 300 watt-hours per mile
- What's a watt-hour ? (1 volt x 1 amp x 1 hour)
- Typical Solar panels produce 75 to 200 watts
- A 10 mile drive requires 3,000 watt-hours
- 10 hours at 200 watts = 2,000 watt hours
- A day of charging for less than 10 min driving (not to mention the cost of the solar panels)

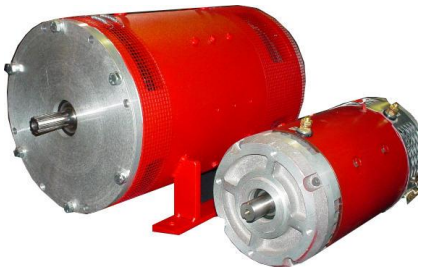
Energy Conversions

- 1 gallon of gasoline = 115,000 BTU = 33 kWh
- 144 Volts x 150 Amps x 1 hour = 21.6 kW
- If you go for 30 minutes you use ~10 kW
- Examples: RAV 4 EV has 288V @ 95 AH
  - RAV 4 EV battery: 26 kWH (range = 100 miles)
  - My EV1 electric car would store about the same energy as half a gallon of gasoline (range = 50 mi.)
  - RAV 4 EV uses NiMH, my EV1 used PbA

Electric Drive systems: AC or DC?

- AC more efficient and more expensive
- DC simpler and less expensive
- AC often has regenerative braking
- DC systems typically use half the voltage but twice the current (affects wire size)
- DC systems have lower RPM (more shifting of gears is required)

Motors

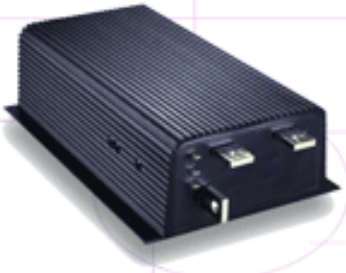


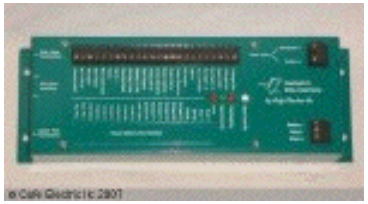


- DC Motors – 9 inch or more best for > 60 MPH
- AC Motors – 50kW or more recommended
- Can use two motors if needed
- Need to match motor and controller (inverter)
- Look at the EV Album to see what motors are used for the type of car you want to convert
  - www.evalbum.com (Search by Type/Make)

Motor Controllers and Inverters

- DC: 400 Amps to 2,000 Amps







- AC: matched to motor (20 kW to 150 kW)





Battery Tradeoffs

- Cost, Cycle Life, Capacity, Weight, Size
- Exotic: NiCad, NiMh, Li-Ion Cost: $12k - $20k
  - Protect your investment with BMS (Battery Management System)
- Lead Acid (PbA) – Deep Cycle, Cost: $2k - $6k
  - Flooded are very forgiving (no BMS)
  - Sealed types include AGM, Gel, FireFly (foam)
  - Voltage tradeoffs for 6V, 8V, 12V (weight vs. range)
  - EAA Discount at American Battery Company
    - Jim Ramos, Hayward, CA. - Call: 510-259-1150

Battery Chargers

- Conductive Chargers



- Inductive Chargers – see next slide
- DC-DC converters -

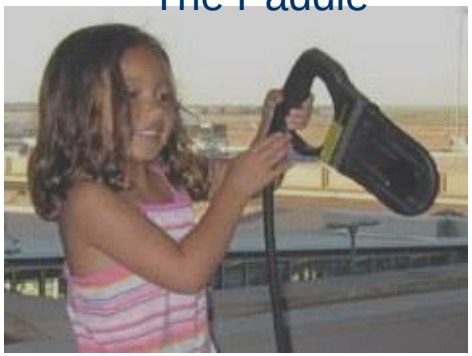


Inductive Chargers – (Paddle)

Solar Charging Station



The Paddle



Opportunity Charging at RV Park



Battery Monitoring System

PakTrakr

Now available for Lithium (LiFePo4) batteries!!

Also works great with AGM, Flooded PbA, Gel, and NiMh packs as well!

http://www.paktrakr.com

Detects individual battery problems *before* they destroy your entire pack.

" "The Attention Your Batteries Have Been Dying For"

Monitors up to 40 individual batteries in Electric Vehicles Automatically and continuously



PHEV



Available Now!!

Prius+ PHEV Kits

10% Off for EAA Members

PbA (lead-acid) PHEV conversion based on Calcars' Open Source Prius+ Technology.

- Future proof! Upgrade to $LiFePO_4$ batteries when available.
- Reliable performance and durability.
- 10-15 miles All Electric Range.
- Provides access to spare tire.

Complete system includes batteries, battery box, charger, CanView, auxiliary display and wire harness.

Price: $6,095 plus shipping.

Save more, buy some components yourself, like batteries.

4th generation system shipped with latest CalCars Basic Control board. Also accepts new Spoofing Board. With it you can send CAN code to the car.

New Feature! Switch for EV operation up to 52 mph. It works great!

Installation not included. Instructions included. DIY friendly.

We are recruiting dealers!

Call or email anytime.

Regards, Robb Protheroe
Plug-In Supply Inc
707 849-2422

Plug-In Supply Inc
pluginsupply.com

www.pluginsupply.com

Nano Technology and EVs

- Examples of Nano Technology for energy storage:
- Altair Nano – Reno, Nevada
- A123 Systems - MIT
- Stanford University – Nano wires
- EE-Stor – Cedar Park, Texas

Altair Nano Lithium Batteries

- **Altairnano from Wikipedia, the free encyclopedia**
- **Altair Nanotechnologies** is a Reno, Nevada-based research company that develops nanotechnology-based solutions for energy storage and the life sciences. In particular, the company is well known for its "NanoSafe" lithium-ion battery technology that is used in battery-electric vehicles. The firm is publicly-traded on the Nasdaq

- AltairNano's primary product is the "NanoSafe" lithium ion battery. NanoSafe replaces the conventional anode with one made of a lithium titanate oxide formed into the spinel cubic structure. The titanate replaces the graphite anodes of normal batteries. NanoSafe is not the only battery to use nanostructured spinels, but other batteries, like those from A123 Systems generally replace the cathode rather than the anode.
- The primary advantage of the NanoSafe battery is that it can be charged very quickly. In testing a NanoSafe 35 kWh battery pack was charged in ten minutes.[1] Other advantages include longer life with up to 25,000 deep cycles, higher power density than other nanostructured cells, wider operating temperatures, and greater stability under electrical and mechanical stress (i.e. the cells cannot catch fire). On the other hand they have lower power density that the best conventional cells,100 versus 120 Wh/kg.[2] They are also more expensive to produce, US$2 per Wh, due to low manufacturing volumes.
- Dennis “Kilowatt” Berube set the National Hot Rod Association’s (NHRA) Super Pro class world speed record for electric dragsters driving an vehicle powered by NanoSafe battery packs. Berube's electric dragster, named the Current Eliminator V, accelerated to a speed of 153.6 mph at the Speedworld Motorplex drag strip on December 15, 2007 covering a quarter-mile in 8.10 seconds.[3]

A123 Systems Lithium Batteries

- **A123 Systems from Wikipedia, the free encyclopedia**
- **A123Systems** is one of the world's leading suppliers of high-power Lithium-Ion batteries. Founded in 2001, A123Systems' proprietary nanoscale electrode technology is built on initial developments from the Massachusetts Institute of Technology.
- The company has over 1200 employees and has grown to be the #1 volume producer of nanophosphate-based cells in the world.
- **Vehicles**
- A123Systems cells have garnered considerable interest in the automotive market due to their unique combination of power, safety and life. Several automakers and heavy duty vehicle manufacturers are developing vehicles using A123Systems cells.
- Killacycle, the worlds quickest EV capable of accelerating from 0-100km/h (0-60MPH) in less than 1 second.
- Chevrolet Volt
- Saturn Vue Green Line plug-in hybrid development program
- Daimler Commercial Buses of North America (Orion VII). The number one selling hybrid bus in the world. Currently operating in New York, San Francisco, Toronto, Dallas and other major cities.
- Venture Vehicles VentureOne
- Th!nk

Stanford NanoWire Battery

- **Nanowire battery information from Wikipedia, the free encyclopedia**
- A **nanowire battery** is a lithium-ion battery invented by a team lead by Dr. Yi Cui at Stanford University in 2007. The team's invention consists of a stainless steel anode covered in silicon nanowires to replace the traditional graphite anode. Silicon, which stores ten times more lithium than graphite, allows a far greater energy density on the anode, thus reducing the mass of the battery. The high surface area further allows for fast charging and discharging.
- Traditional silicon anodes were researched and dismissed due to the tendency of silicon to crack and become useless as it swelled with lithium during operation. The nanowires, on the other hand, do not suffer from this flaw. According to Dr. Cui, the battery only reached 10x density on the first charge and leveled out at 8x density on subsequent charges. Since this is only an anode advancement, an equivalent cathode advancement would be needed to get the full energy storage density improvements; however, lightening the anode alone would, according to the team, lead to "several" times better energy density.
- Commercialization is expected to take approximately five years[1], with the batteries costing similar or less per watt hour than conventional lithium-ion. The next milestone, lifecycle testing, should be completed, and the team expects to get at least a thousand cycles out of the battery. These batteries could create revolutionary improvements in mobile electronics and electric vehicles.

EEStor UltraCapacitors

- **EEStor from Wikipedia, the free encyclopedia**
- **EEStor** is a company based in Cedar Park, Texas, United States that claims to have developed a superior type of capacitor for electricity storage, which EEStor calls 'Electrical Energy Storage Units' (EESU). The EEStor EESU is an integral part of the much anticipated ZENNergy_drive-train. Its CEO and president is Richard Weir, who is also a co-inventor named on their principal technology patent.[1]
- According to its patent, these units will use high-purity barium titanate coated with aluminum oxide and glass to achieve a level of capacitance claimed to be much higher than what is currently available in the market. The claimed energy density is 1.0 MJ/kg (existing commercial supercapacitors typically have an energy density of around 0.01 MJ/kg, while lithium ion batteries have an energy density of around 0.54–0.72 MJ/kg).[2]
- Based on these claims, a five-minute charge should give the capacitor sufficient energy to drive a small car 300 miles (480 km). However, standard household wiring is not capable of delivering the power required for this, so charging times this short would probably require purpose-built high capacity dispensing stations.[3] Overnight charging at home should still be practical,[4] as is using a second EESU for the home which could be charged overnight using cheap, off-peak electricity to then charge the EEStor unit in the car in 5-10 minutes on demand.[5] Also, according to Ian Clifford, a normal household outlet with 110 volt supply can fully charge the EEStor powered CityZENN in 4 hours for a 250 mile range and a normal household outlet with 220 volt supply can fully charge the EEStor powered CityZENN in 2 hours for a 250 mile range.[6]

Nano Technolgy for Solar Power

- Traditional Solar Cells have low efficiency
- SunPower has higher efficiency
- NanoSolar also has high efficiency and lower cost – see next slide



nanosolar San Jose, CA

Nano Technology for Energy Supply

At Nanosolar, we have taken the highest-performance and most durable photovoltaic thin-film semiconductor, called CIGS (for "Copper Indium Gallium Diselenide"), and innovated on all seven critical areas necessary to reach a breakthrough cost reduction in solar cells, panels, and systems.

As opposed to using slow and expensive high-vacuum based thin-film deposition, we developed a proprietary ink **(1)** to allow us to use much simpler and higher-yield printing **(2)** for depositing the solar cell's semiconductor.

We use a highly conductive yet low-cost foil as a substrate **(3)**, which allows us to avoid the need to separately deposit an expensive bottom electrode layer (as required for a non-conductive substrate such as glass).

The foil furthermore allows us to apply the superior economics of high-yield continuous roll-to-roll processing **(4)**,

achieve a lower-cost high-performance top electrode **(5)**,

assemble cells by individually matched electrical characteristics **(6)**, and

develop high-power high-current panels **(7)** with lower balance-of-system cost.

The result sets the standard for cost-efficient solar electricity.

SunPower – San Jose, CA

- **SunPower Corporation** designs and manufactures high-efficiency silicon solar cells and solar panels based on an all-back-contact solar cell invented at Stanford University. SunPower set the world record for practical scale Silicon solar cell efficiency, with an efficiency of 23.4% in May 2008.
- SunPower provided the solar cells for the NASA/AeroVironment Pathfinder-Plus, which then set an altitude record of 80,201 feet (24,445 m) for solar-powered and propeller-driven aircraft.

Putting it all together with V2G

- V2G = Vehicle to Grid Technology
- Uses EV Battery Storage for peak demand
- Charge at night – sell power during the day
- Energy Independence from petroleum
- AC Propulsion eBox has V2G built in



In Conclusion…

- Thank you.
- Web links:
- www.eaasv.org (order books from Amazon)
- www.EVfinder.com (classified page)
- EV Trading Post (link from EVfinder)
- www.EValbum.com
- www.EVchargerNews.com