Saturday, May 11th
through
Friday, May 17th

The 1996
NESEA American Tour de Sol
Chronicles

Mike Bianchi and John Helwig

New York City
to
Washington DC

via
Lambertville, NJ
Boyertown, PA
Pottstown, PA
Chesapeake City, MD
Annapolis, MD

<u>Reconstructed</u>

This is a reconstruction of the original book
that suffers from some lost formatting information.

As a result, the page numbers do not match the original printing,
the page layout is single column instead of the original two column,
and the Index has been removed since it could not be reconstructed easily.

But all the words and pictures are here
so the story told is still the same.

Mike Bianchi
July 2015

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Front Cover, left-to-right, top-to-bottom**:**

'Hopper EV'
On display in Boyertown PA
The 'Ottawa Orange IV' Team
'KA-1000' finishing the race in Washington DC

2nd Printing

The 1996 NESEA American Tour de Sol was the eighth, and the fourth that I attended. Before and during the event I interviewed as many of the teams as I could and typed up those interviews into articles which were then made available on the Internet at NESEA's World Wide Web site:

`http://www.crest.org/nesea`

(When last I looked, the 1995 American Tour de Sol reports were still available at `http://nesea.nrel.gov`.)

This is a slightly edited version of those articles. I have removed redundant material, fixed a few factual errors, and repaired grammatical and spelling mistakes.

My personal comments, as opposed to what was written from the interviews, are often interjected ((enclosed in double parentheses)).

My intent here is to help tell the stories of the people and organizations who choose to participate in the NESEA American Tour de Sol. The event is organized by the Northeast Sustainable Energy Association (abbreviated as NESEA, and pronounced "NES-ee", as in the Loch Ness monster). It promotes the idea of electric vehicles as examples of transportation which are more benign to the environment and more sustainable than what we are using today. I focus mostly on the technology, because that is what interests me most, and the human stories of the people involved. (If you are looking for the drama of racing, who is in the lead and who is catching up to who, I'm afraid you will be disappointed.)

John Helwig provided the photographs and digitized them. John, and his wife Kazumi, were responsible for the starting line up of each day's run.

While John and I have attempted to be thorough, we know we are not complete. Not every team was interviewed and not every vehicle is represented by a picture. Our apologies to those we missed.

It is our hope you will find the story of the NESEA Tour interesting and informative.

Mike Bianchi
August 1996

Report 1: The Schedule

Here is the schedule for the American Tour de Sol (taken from the NESEA Tour web page.) If you get to the race and see a overweight, balding, 40 something bearded guy, come by and say hello!

Mike Bianchi

FRIDAY MAY 10 NEW YORK CITY - SOUTH STREET SEAPORT MARKETPLACE
10AM - 5PM Public Vehicle Display and Sustainable Expo

SATURDAY MAY 11 NEW YORK CITY - SOUTH STREET SEAPORT MARKETPLACE
10AM - 5PM Public Vehicle Display and Sustainable Expo
10AM - 5PM Vehicle Technical Inspections, open to the public, Water Street

SUNDAY MAY 12 NYC TO NJ - SEAPORT TO LAMBERTVILLE:
South Street Seaport to Jersey City via Holland Tunnel and 1&9W. Follow 510 thru Newark and Elizabeth. Follow 27S to Lambertville via Rosselle, Rahway, Colonia, Woodbridge, Edison, Metuchen, New Brunswick, Franklin Park, Kendall Park, Blawenders, Woodsville, and Hopewell. (65.4 miles)
10AM - 2PM Public Vehicle Display and Sustainable Expo
1:30PM - 2PM Starting Ceremonies
2:00PM - 5PM Drive New York City to Lambertville, NJ

MONDAY MAY 13 NJ TO PA - LAMBERTVILLE to BOYERTOWN MUSEUM:

Follow 220W into Pennsylvania thru New Hope and Buckingham to 313W thru Fountainville, Dublin and Quakertown to 663 thru Milford, Pennsberg, Layfield and New Hanover to 73W thru Gilbertsville to Boyertown. Boyertown to Owen J. Roberts School via 562S thru Colebrooksdale, Upper Pottsgrove, Pottstown, E Coventry, Bucktown and West Vincent. (67.5 required miles plus extra laps)

8AM - 10:30AM Display, Restart, and Drive Lambertville to Boyertown (51.3 miles)
11:30AM - 6:00PM Public Vehicle Display - Boyertown Museum of Historic Vehicles
12:30AM - 5:30PM Extra Laps (31 miles on route 100 or 7.1 miles on secondary roads)
6:00PM - 7:00PM Closing Ceremony and Drive to Owen J. Roberts MS (16.2 miles)

TUESDAY MAY 14 PA TO MD - POTTSTOWN TO CHESAPEAKE CITY:
Route 23S from Owen J. Roberts School thru Bucktown, Coventryville, Knauertown, Warwick and Elverton to 82S thru Conestoga, Loag, Brandywine, Brandamore, Coatesville, S. Coatesville, Ercildoun and Doe Run to 841S thru Springdell, Chatham, W. Grove, Lewisville into Maryland, thru Fairhill to rt 213S, Elkton and Chesapeake City. (63.6 required miles plus extra laps)

8AM - 10AM Public Vehicle Display - Owen J. Roberts M.S., Pottstown., PA
10AM 11:30AM Drive Owen J. Roberts MS, PA to Chesapeake City, MD
11:30AM - 6:30PM NESEA American Tour de Sol Display - Chesapeake City, MD
12:30 -6:30PM Extra Laps (66 miles on highway, or 8.6 on secondary road)

WEDNESDAY MAY 15 MD - CHESAPEAKE CITY TO SANDY POINT STATE PARK:
Chesapeake City 213S thru Cayots, Cecilton, Georgetown and Galena to 313S thru Massey, Millington and Unicorn to 300S thru Dudley Corners back to 213S thru Church Hill, Starkey Corner and Centreville to 18W thru Queenstown, Grasonville and Chester to 50W and the Chesapeake Bay Bridge to Sandy Point State Park. (71.4 required miles plus Autocross event)

8AM - 9AM NESEA American Tour de Sol display - Chesapeake City, MD
9AM - 10:30AM Restart Ceremonies. Drive to Sandy Pt State Park, Annapolis,
10:30AM - 6:30PM NESEA American Tour de Sol Display - Sandy Point State Park
12 NOON Welcoming Ceremony Media Event - Sandy Point State Park
12:30AM - 6:00PM Autocross Event & Acceleration Tests - Sandy Point State Park

THURSDAY MAY 16 ANNAPOLIS TO THE MALL, WASHINGTON, DC:
Rte. 213W from Sandy Point State Park thru Annapolis, Riva and Stewart Corner to 214W thru Davidsonville, Hall, Kolbes Corner, and Largo into Washington, DC. (43 required miles- these miles, though required, do not contribute to Tour Miles.)

8AM - 9AM Display and Restart - Sandy Point State Park
10:00AM - 11:45AM Drive to Washington, DC
10:30AM - 12NOON Jr. Solar Sprints - on the Mall at 3rd Street
10:30AM - 6PM ARPA Technology Fair open to the public - on the Mall
12NOON - 1PM NESEA American Tour de Sol FINISH LINE & Media Event

FRIDAY MAY 17 WASHINGTON, DC - ON THE MALL AT 3RD STREET
9:30AM - 1PM NESEA American Tour de Sol display - on the Mall

Report 2: Entrants list

The following is taken from the list of entrants found in the press kit.

Some of the abbreviations you'll see below are:

Adv PbA advanced lead acid
APbA advanced lead acid
BECO Boston Edison Company
CNG compressed natural gas
GPU General Public Utilities Companies
ICE Internal Combustion Engine
JCP&L Jersey Central Power and Light
LPG liquid petroleum gas
NAVC Northeast Alternative Vehicle Consortium

NHTI New Hampshire Technical Institute
NiMH nickel metal hydride
NiCad nickel cadmium
NiMH nickel metal hydride
PbA lead acid
PETC Pennsylvania Electric Transportation Council
US DOE United States Department of Energy

--- NAVC PRODUCTION CATEGORY ---

Team Name	**Vehicle Name (Vehicle Number)**
Home Town	**Vehicle Type (Battery Mfg, Chemistry)**
Allegheny Power System, Inc	Ford Ecostar (17)
Greensburg, PA	Ford Ecostar (Sodium Sulfur)
Connecticut EV/NAVC	Solectria / Horizon (50)
Windsor, CT	95 Solectria Force (Electrosource, PbA)
EVermont / NAVC	Nordic Challenger (7)
Waterbury, VT	1994 Solectria Force (Sonnenschein, PbA)
JCP&L	Solectria Force (15)
Morristown, NJ	Solectria Force (Interstate, PbA)
Met-Ed Penelec/JCP&L/GPU	Chrysler TEVan (14)
Reading, PA	Chrysler TEVan (NiCad)
NAVC	Solectria E-10 (62)
Boston, MA	1994 Chevy S-10 (GNB, PbA)
Solectria Corporation	Solectria Force NMH (4)
Wilmington, MA	Solectria Force NMH (Ovonic, NiMH)
STAPPA / NAVC	Solectria E-10 (34)
Boston, MA	1994 Chevy S-10 (GNB, PbA)
Technik & Design	Twike (12)
Germany	purpose-built tricycle (Panasonic, NiCad)

--- US DOE COMMUTER CATEGORY ---

Team Name	**Vehicle Name (Vehicle Number)**
Home Town	**Vehicle Type (Battery Mfg, Chemistry)**
Alternative Energy	Regenerative Braking (45)
Glastonbury, CT	1978 Jet Industries Electrivan (Trojan, PbA)
Boston Univ. SEV Team	B-U-LLET (24)
Boston, MA	Purpose-Built Commuter (Saft, NiCad)
Bridgewater Solar Works	Solar Bus (33)
Bridgewater, CT	1969 VW Bus/Solar (Trojan, PbA)
CSERT - NVCTC	Kineticar (35)

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Waterbury, CT — Chevy S-10 w/Solar (Trojan, PbA)

EV Moore - CEVA — Sparky (39)
Richmond, VA — 1986 Mercury Lynx (Trojan, PbA)

FMRHS - Solar Racing Team — George the Geo (57)
Landon, NH — 1991 Geo Metro (Trojan, PbA)

Greenwich H.S. Solar Flair — Roadrunner (54)
Greenwich, CT — 1979 Mazda RX-7 (Trojan, PbA)

Genesis Team — Genesis I (66)
Saginaw, MI — Dodge D-50 pick-up (Trojan, PbA)

NAVC / BECO / Solectria — Solectria Sunrise (63)
Wilmington, MA — Pre-production Prototype (Ovonic, NiMH)

Neocon / NYSEG — OHM Ranger (88)
West Babylon, NY — 1994 Ford Ranger (Electrosource, Adv PbA)

NHTI Electric Car Team — Sungo (72)
Concord, NH — Purpose Built (Electrosource, Adv PbA)

North Hunterdon High School — Lectric Lion (82)
North Hunterdon, NJ — 1989 Chevy S-10 (Trojan, PbA)

Parkland High School — Lightning Volt (74)
Orefield, PA — Chevy S-10 (Trojan, PbA)

PETC — Utility EV (46)
Allentown, PA — Pre-Production Prototype (Electrosource, APbA)

Polytech Chargers — KA1000 (43)
Farmingdale, NY — Purpose Built w/Honda body (Deka, PbA)

RMAVTS — Golden Gear Racing — Golden Gear Special (42)
Reading, PA — 1987 Fiero GT (Deka, PbA)

Rocky Hill High School — SolarSaurus (44)
Rocky Hill, CT — 1982 Dodge Rampage (Trojan, PbA)

Shadow Mtn. Electric Matadors — Porsche 914 Electric Bull (32)
Phoenix, AZ — ‘73 Porsche (Trojan, PbA)

Solar Electric Spyder Juice — Spyder Juice (31)
Tallahassee, FL — Pre-Production Prototype (GNB, PbA)

Taylor-Dunn — Electruck (47)
Anaheim, CA — Modified Production Electruck (Trojan, PbA)

Wallingford AC, Inc — trans2-AC
Margate, FL — Modified Production trans2-AC (Power, PbA)

Wattsmen Electric Hare (65)
Falmouth, ME 1984 VW Rabbit (US Battery, PbA)

Wooster's Charge Sparky 2 (38)
Danbury, CT 1972 Saab (Trojan, PbA)

--- SOLAR COMMUTER CATEGORY ---
Team Name Vehicle Name (Vehicle Number)
Home Town Vehicle Type (Battery Mfg, Chemistry)

CONVAL Solar Car Team Sol Survivor IV (83)
Dublin, NH Purpose-Built Solar Sedan
(Powersonic, PbA)

Longhorn Solar Racing Team Texas Native Sun (36)
Austin, TX Purpose Built Solar Commuter
(Trojan, PbA)

Newburgh Free Academy Sol Machine (58)
Newburgh, NY Purpose Built Solar (Concord, PbA)

Riverside School Helios the Heron (93)
Lyndonville, VT Purpose Built Solar (Deka, PbA)

Villanova Univ. EV Team Commuter Car (75)
Villanova, PA Purpose Built w/1969 VW frame
(Trojan, PbA)

--- CHRYSLER HYBRID CATEGORY ---
Team Name Vehicle Name (Vehicle Number)
Home Town Vehicle Type (Battery Mfg, Chemistry/Fuel)

Cornell HEV Maelstrom (3)
Ithaca, NY Hybrid Purpose Built (East Penn, PbA/CNG)

HEV Team of Virginia Tech VT Ani mul SL (81)
Blacksburg, VA HybriLumina (Hawker, PbA/LPG)

Hopper EV Hopper EV (94)
Concord, NH Hybrid Purpose-Built
(Optima, PbA/bio-Diesel)

Mount Everett Project e- Project e- (96)
Sheffield, MA Hybrid Chevy S-10 (US Battery, PbA/LPG)

Penn State SAE Electric Lion (48)
University Park, PA Hybrid Ford Escort (Exide, PbA/Methanol)

Team Hyperion Hyperion (26)
Boston, MA Hybrid Saturn (Optima, PbA/Ethanol)

Univ. of FL HEV Society HEV U Florida (19)
Gainsville, FL Hybrid Neon (Saft, NiCad/CNG)

University of Tennessee Hy Potential IV (21)
Knoxville, TN Hybrid Neon (Alexander, NiMH/CNG)

UTEP Miners HI!BRID (29)
El Paso, TX Hybrid Neon (Interstate, PbA/CNG)

Western Washington Univ Viking 25 (25)
Bellingham, WA Hybrid Neon (Saft, NiCad/CNG)

Western Washington Univ Viking 23 (23)
Bellingham, WA Hybrid Purpose-Built w/Solar
Saft, NiCad/CNG)

--- OPEN CATEGORY ---
Team Name Vehicle Name (Vehicle Number)
Home Town Vehicle Type (Battery Mfg, Chemistry)

Cato-Meridian HS Tech Team Sunpacer (92)
Cato, NY One-person purpose-built (Deka, PbA)

CTC NEastAdvVehTecCtr Electrobike (52)
Westboro, MA Electric Bicycle (NiCad)

Tech Prep Ottawa Orange IV (37)
Grand Rapids, MI One-Person Purpose Built Solar (PbA)

Union College Proteus 1 (64)
Schenectady, NY One-Person Purpose Built Solar (PbA)

And, yes, there is an entrant named "Lectric Lion" and one named "Electric Lion". And there is a "Sparky" and a "Sparky 2".

I suggest those of you following the NESEA Tour print out this sheet and keep it handy. "You cannot tell one entrant from another without a program!"

Report 3: Facts and Figures

The day dawned misty and cold at New York City's South Street Seaport, and the smell of fish was everywhere as the early-morning wholesale selling and buying of seafood was wrapping up at 8:30 in the morning. The NESEA volunteers were arriving, finding places to park, getting organized and unpacking the vans full of banners, books, walkie-talkies, press kits, race programs, and what-not.

Before long the fish people were gone and the EVs started arriving. About noon the weather turned suddenly spring-like and, as the afternoon wore on, it got warmer and sunnier. Buses of school kids of all ages arrived and they quickly surrounded the various vehicles, asking thousands of questions.

Just to tease you with what is coming, before I left I saw and had interviews with:

- A General Motors production engineer who is working on the EV1 (the car that got away — it will not be here — wherein lies a story).
- Half-a-dozen hybrid car teams.
- A micro-van with > BIG < super capacitors as part of the drive system.
- A sexy, tire-smoking sports car.
- Two cars named "Sparky".
- A solar VW microbus.
- A purpose-built aluminum-and-composite pickup truck.
- A 2-passenger car built by > elementary < school students.

So stay tuned. But first some facts and figures ...

Part of the press kit for the ‘‘Northeast Sustainable Energy Association (NESEA) American Tour de Sol US Road Rally Championship for Electric Vehicles’’ is a list of facts and figures that show some interesting things, I think.

There are 51 vehicles registered for the race; 50 from 15 states and 1 from Germany:

MA 8	FL 3	VT 2
CT 8	TN 1	NH 4
NY 6	MI 1	CA 1
NJ 2	TX 1	WA 2
PA 6	AZ 1	VA 2

There are more Production and pre-production prototypes than ever before:
9 in the NAVC Production Category:
- Ford Ecostar (#17)
- Chrysler TEVan (#14)
- 4 Solectria Force sedans (#50, 7, 15, 4)
- 2 Solectria E-10 pickup trucks (#62, 34)
- TWIKE 3-wheel 2-passenger from Technik & Design, Germany (#12)

3 pre-production prototypes in the USDOE Commuter Category:
- Solectria Sunrise (#63)
- Utility EV, by PA Electric Transportation Council (#46)
- Spyder Juice, by Simpler Solar Systems (#31)

2 modified production in the USDOE Commuter Category:
- Taylor-Dunn Truck (#47), extra batteries for extended range
- trans-2 (#2), modified with an AC motor and controller

Other statistics:

			------Battery Type------			
Category	Sedan	Van/Truck	PbA	Adv PbA	Advanced	TOTAL
Production	6	3	4	1	4	9
Commuter	13	10	18	3	2	23
Solar	5	-	5	-	-	5
Hybrid EV	9	2	7	-	4	11
Open	3+bike	-	3	-	1	4
TOTALS	36	15	37	4	11	51

PbA == Lead Acid
Adv PbA == Advanced Lead Acid

Advanced Battery Types:

2	Ovonic Nickel Metal Hydride (NMH)
1	Alexander Nickel Metal Hydride
7	Saft Nickel Cadmium (NiCd)
1	Panasonic Nickel Cadmium
1	ABB Sodium Sulfur (NaS)

Fuels used in the Hybrid EVs:

6	Compressed Natural Gas (CNG)
1	Ethanol
1	Methanol
1	bio-Diesel
2	Liquid Petroleum Gas (LPG)

Who built the vehicles:

15	corporations	30% _

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 10  universities        20%   |
  2  colleges             4%   |
  4  technical schools    8%   |
 13  high schools        26%   | 58% student built
  1  elementary school    2%  _|
  7  individuals/clubs   14%
```

There are more purpose-built vehicles this year:

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 18  purpose-built
 33  conversions
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Figure 1 — This Chrysler 'TEVan' is based on a Dodge Caravan. It carries about 60 kiloWatt-hours of NiCad batteries to drive a GE shunt-wound motor.

Report 4: Team Profile - 'KA1000'

Polytechnic University of Farmingdale NY, on Long Island, is back with their 'KA1000' entry (number 43). Originally built in 1979-80 by Karl Acker (hence the "KA") this metallic blue conversion of a Honda Civic was originally based on plans published in a 1977 issue of *Mechanix Illustrated* magazine. As part of the conversion the car got a "nose-job" which gave it a unique appearance and presumably cut down on aerodynamic drag. The nose also holds 6 extra batteries. It began life as an aircraft starter motor and 12 6-Volt batteries and was used by Karl as a commuter car. In 1982 it was donated to a technical school as a security vehicle, but it fell into disuse.

In 1993, Polytechnic acquired the car and students spent a year improving it. It was given a new motor and controller, 14 new batteries, and new paint. It was entered in the 1994 NESEA Tour, but they didn't finish building the car in time. However a new academic year, new students to replace the graduating team members, new ideas, new sponsors, and a lot of work yielded a car that in January 1995 was used as a daily commuter, was running errands and was collecting data.

Figure 2 — The 'KA1000' has a long and checkered history leading to the NESEA Tour. It started as a Honda Civic, but the "nose job" changes its appearance and adds room for batteries.

They entered and passed inspection for the 1995 NESEA Tour, coming in 3rd in the qualifying slalom and were 7th, out of 22, from the pole at the start. The first 2 days went smoothly and they were in 2nd place for efficiency in the Discovery Channel Commuter Class. But their charger was not replacing the energy used each day and so by the third day they ran out of charge along the route. The final day was cursed when the charger popped a circuit breaker over night and the car could not run. They did get a full charge in time for the autocross race in Portland Maine on the day after the NESEA Tour finished, and every team member got to drive the car that Saturday.

For the 1996 NESEA Tour, 'KA1000' returns with 16 batteries and HYDROCAP catalytic battery caps to preserve the electrolyte levels in the batteries. A BADICHEQ charge management system records data and brings each battery block to peak charge during each charging cycle, thus eliminating the need to do an "equalizing" overcharge every so often. They have also lowered the car's weight by removing extraneous equipment and changing to lighter structures. It sports new wheels and Goodyear low rolling resistance tires, and an added DC-to-DC converter. A larger solar panel on the roof powers the radio. ((The NESEA Tour rules require that every vehicle have a solar panel that provides power for some useful purpose. It's a way of promoting the idea of sustainable energy use. "Sustainable" is, after all, NESEA's middle name.))

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Motor:              Advanced DC 8 inch
Controller:         Curtis PMC 1221
Batteries:          16 Trojan T-145
                    flooded lead-acid, 96 Volts
DC/DC Converter:    Curtis PMC
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I spoke with:
Peter Voltz, faculty advisor, EE department
Karl Acker, original builder of KA1000
Mark Strong, former student, driver in 1995 NESEA Tour
Dan Murphy, junior, driver in 1995
Dick LaRosa, retired (read "downsized") engineer
Ted Trask, junior, team member
Coby Lichter, freshman, team member
The team has about 10 consistent contributors.

Mark always loved cars and was amazed how much he has come to love EVs. He hopes to work in the field, maybe even starting his own company. After last year's NESEA Tour he purchased a Honda Prelude which he has donated to the school and hopes to work it up into another EV for next year's NESEA Tour. So far it is stripped of the ICE components. Last year, while "breaking in" the new 'KA1000' batteries Mark enjoyed the notice he and the car got around town.

Peter says, "What impresses me is how student enthusiasm has grown over the last year. They do it as a totally extra curricular activity, on top of their normal course load, without receiving any academic credit. They do all the planning, design and work and I don't have to do anything." The team meets once per week for 2 hours and then works on the car at odd moments during the week. It is an small, enthusiastic, tight group that works real well together. The existence of the 'KA1000' program has caused the university library to acquire EV related books and start an EV section.

Karl is the driving force for the original project. During last year's race his camper, "The True Value 1000", was a tools and parts resource for many teams. "Most people don't realize how much work goes into the NESEA Tour. It is a week-long car show." The schedule is very demanding and people find themselves worn out by the time the cars are plugged in for the night.

Dan is a sophomore who was asked by a professor to research regenerative braking. Unfortunately, they haven't been able to add regen to the car because they didn't have the money to get a new controller; maybe next year it will be on the Prelude.

Dick is a professional engineer with a long term interest in conservation. His background was microwaves and surface acoustic waves, but now he is learning power electronics and helping to ensure that the electrical aspects of the car are safe.

Ted heard about the project through the IEEE chapter on campus and thinks "EVs are cool" but is finding it hard to put as much time into the project as he would like. He plans to be at the technical testing sessions in New York City.

This is only Coby's 2nd semester on the project, but he is learning as much as he can. His interest in environmental engineering led him to the group, and his knowledge of gasoline cars was useful while stripping the gasoline components from the Prelude in preparation for next year.

Report 5: Team Profile - 'HEVy GATOR'

The University of Florida team is in the Chrysler Hybrid Electric Category with a bright red Hybrid Neon named 'HEVy GATOR'. The team is made up of a faculty advisor and 25 students divided into sub-teams working on Battery, Controls, Drive Train, Heating, Ventilating and Air Conditioning (HVAC), IC Engine, and an Executive Board covering Finance, Solicitations, Public Relations, and Safety. This car also competed in the 1995 Hybrid Electric Vehicle Challenge where it finished 4th overall. This is the 2nd year of the project and the teams are mostly new folks drawn from the sophomore, junior and senior classes, plus one member from a nearby community college.

Brian Skeldon (`skeldon@eel.ufl.edu`) provided me with a pointer to their web page, `http://www.eel.ufl.edu/~skeldon/HEV`, from which this report is derived.

Figure 3 — 'HEVy-GATOR' from the University of Florida in Gainsville is a series hybrid electric. Although the engine is still in the front, an electric motor now drives the rear wheels.

I also spoke via telephone with Dr. Gary Matthew, the faculty advisor, and Brian Skeldon who is working on his BSEE.

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Vehicle:
      1995 Dodge Neon
 Powertrain: (series hybrid)
      Electric Motor is the primary mover
      APU provides charging capability to battery system
 Electric Motor:
      Unique Mobility SR218/4.5G, 180 Vdc brushless DC motor 43hp,
      106 hp peak (32 kW, 79kW peak)
      Capable of Regenerative braking, Water/Ethylene Glycol cooled
 Power Amplifier:
      Unique Mobility CA-18/300
      180 Vdc nominal input, Three phase pulse width modulated
      output to motor
 Batteries:
      Saft Aerospace battery Nickel Cadmium (Ni-Cd) Cells
      Nominal 1.2 Vdc, 35 AH capacity, 3.3 lbs each
      150 cells Provide 180 Vdc Nominal Peak Voltage
      Total pack: 6,300 Watt-hours, 495 pounds
 Auxiliary Power Unit (APU):
      Kawasaki, 617cc (45ci) stationary industrial engine
      V-Twin, 4 stroke, 15 hp output running on Compressed Natural
      Gas (CNG)
 Fuel System:
      36 Liters Compressed Natural Gas, operating pressure 3600 psi
 Alternator:
      Fisher Electric, Three Phase output - 18kW @3200rpm,
      Rectified output charges battery system
 DC-DC Converter:
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      Power source
      Converts 180 Vdc to 12 Vdc, Maximum capacity 900 W (75A @ 12
      Vdc)
 Performance:
      Top Speed - 65 mph, Range - 150 to 200 miles (expected)
```

Drive Train

The drivetrain consists of a three phase brushless DC motor coupled to an independent differential. The torsion bar mounts and shocks were redesigned to compensate for the extra weight of the vehicle. The CV-joints were replaced with double-yoke split-shafts to increase reliability. Coil-over shocks increase the capacity of the original suspension. The current setup allows adjustment of camber, toe-in, and ride height.

Controls

The controls group supplies voltage and current specifications for the desired equipment throughout the car. Each component requires power that must be included in the overall energy budget and control plan. For example, the amplifier circuit requires a high-current relay so the driver is not in direct contact with high-level currents while turning the key. Meanwhile, the key switch is also controlling the 12-volt supply to the accessories in the car.

Other control specifications consist of:

- Supplying 180 volts for the Heating and Air Conditioning group (HVAC) to drive their compressor.
- Supplying 300 amps to the amplifier to drive the electric motor.
- Supplying power to start the Internal Combustion Engine (ICE) in order to drive the 18-kiloWatt generator.
- Writing software (in C language) for the microprocessor so it can monitor several car operating parameters, including:
  - Battery voltage and current levels
  - Vehicle direction and speed
  - Amplifier and motor temperature

The microprocessor also performs some drive related functions, such as limiting the regen braking energy when the batteries are fully charged.

Internal Combustion Engine (ICE)

The IC group designs and implements the IC Engine, exhaust system, and thermal battery.

What is a "thermal battery"? It is a heat accumulator used to keep the catalytic converter warm. That way the converter can "scrub" the exhaust gases even when the engine is started cold.

The main objective is to increase the power output of the engine (which powers a generator to charge the batteries) from 12kW to 15kW while maintaining very low emissions.

Heating, Ventilating and Air Conditioning (HVAC)

This group removed the original heating and air conditioning equipment and replaced them with a full functioning heating, ventilating, and air conditioning system which employs a motor driven heat pump using environmentally safe R134a to provide efficient heating and cooling with zero emissions.

The vehicle is unusual in that although it is based on a Neon, which is a front wheel drive car, the electric motor now drives the rear wheels! The CNG engine and generator are in the front under the hood, and the motor and amplifier are in the trunk. A radiator for cooling the controller is below the rear bumper.

Report 6: Team Profile - 'Hopper EV'

I've been to 3 previous American Tour de Sol's, and at each of those Tom Hopper has brought a version of his 'Hopper EV' along. This one-person designed- from-the-ground-up personal project has transmogrified year to year and I cannot wait to see what Tom has done this year.

In 1993 it had bicycle-handle steering and thin bicycle-like spoked wheels under a dull gray body. To get in, Tom had to climb through the window which was not easy as he is a big man and the window was small. In 1994 the suspension was "real", the throttle control and regenerative brake control were on the > steering wheel <, and the body tilted forward so anyone could get in easily. In 1995 it sported foot controls for throttle and brake, and a new AC induction transmissionless drive system.

But never one to leave well enough alone, Tom and co-team member Craig Cushing have added a 2-wheel trailer that turns it into a Diesel fueled hybrid. Quoting Tom, "The specs tell a good deal of the story."

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Vehicle         Vehicle + Trailer
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Length	114 in	180 in
Width	44 in	
Wheelbase	72 3/4 in	
Weight	1100 lbs	1370 lbs
Frame	Aluminum; box-section tube and sheet, welded, epoxy glued, riveted	
Body	Fiberglass/closed-cell sandwich; hydraulically counterbalanced for entrance and egress	
Solar Array	Solectria monocrystalline, 100 Watts, permanently roof mounted	
Battery	Twelve 12-Volt Optima "Yellow Top" spiral core lead acid in series; 144 Volts; 7700 Wh @ C/5	
Motor	Solectria AC GT20 induction	
Controller	Solectria UMoC system	
Drive	Gates toothed belts (primary and secondary)	
Suspension	Three-wheel independent; coil-over-shock front, swingarm rear	
Wheels	Lightweight aluminum alloy	
Tires	145/75R-13 Michelin Rainforce MX4 (front); 175/50R-13 Yokohama 72V (rear)	
Brakes	Three-wheel hydraulic; split system	
Charger	Solectria 1 kW; onboard	
Instruments	kiloWatt-hour; speedometer; odometer; trip; total distance	
Hybrid Internal	Combustion System	
System Format	Series	
Packaging	Two-wheel trailer; steel frame, honeycomb Nomex FRP body	
Engine	Kubota 479 cc 2-cylinder Diesel; 11 hp max, 6 hp nominal; meets 1996 EPA/DOT air pollution standards	
Fuel	Bio-Diesel if available; 6-gallon tank	
Generator	3.5 kW charger output continuous; direct-to-battery connection	

Figure 4 — 'Hopper EV' arrives in New York City after having driven all the way from Concord, New Hampshire, on soybean oil. Tom Hopper thinks he could get as much as 100 miles per gallon with this bio-Diesel fuel.

What the specs don't tell you is that Tom is a professor of Architectural Technology and Craig is a professor of English at New Hampshire Technical Institute in Concord. They are also advisors to the NHTI's Electric Car Team, which is bringing their 'Sungo' ((more on that in a future posting)). "We're both in our sixth decade, and we both retain what I hope is a youthful enthusiasm for everything we do," writes Tom.

"I derive great satisfaction in working with alternative energy, from my stand-alone home which is totally off-the-grid, to wind-powered watercraft, to human-powered vehicles, to my solar-electric vehicle projects over the years. I'm convinced that leadership (and thus teaching) is also a product of example - 'do what I do'. That's a big part of my motivation in solar-electric vehicle development, coupled with a desire to do a small part in making a cleaner natural environment."

Report 7: Team Profile - 'Solectria Sunrise'

((The following is based on an interview with Karl Thidemann, Director of Marketing of Solectria.))

The ‘Solectria Sunrise’ returns to the NESEA Tour for its second year, having won the Commuter Category last year and taken home the Range Trophy with 238 miles per charge. Naturally they hope to do even better this year. Superficially, the ‘Sunrise’ is a lightweight, full size, four passenger electric sedan, with interior space comparable to a Ford Taurus. The amenities include air conditioning, AM/FM stereo radio ((and I think I saw a CD player last year)), power brakes, dual air bags, and cruise control.

But in detail, it is unlike any production car on the road today. It has almost no metal in the body or frame. The monocoque structure is a single piece of advanced composite materials (laced with carbon and glass fibers) designed to be both light and strong. How strong? Last November it was subjected to a standard frontal crash test and Solectria is enthused by the results. ((I saw a video of the crash and it was quite impressive. If you think plastic cars > have < to shatter when in a collision, think again. The passenger compartment not only held together, but it kept its shape and nothing came in. The windshield didn’t even crack! All the energy was taken up in the front "crumple zones".)) The goal is to preserve the normal safety requirements or even improve them over conventional cars. The main reason for the composite material construction is to make the car lighter and give it advanced aerodynamics, thus it takes less energy to move down the road. The low weight and low drag mean that > any < battery pack will deliver double the range it would give in most other conversions.

Once again the ‘Sunrise’ features a Nickel-Metal Hydride battery pack, the ability to recharge rapidly or use a standard low power overnight charger, and a battery thermal management system for cold-weather operation.

The ‘Sunrise’ is not a converted anything. It was designed from the ground up for mass production and so they are paying close attention to issues that will make it cost effective to build. They also want to make sure that all the manufacturing processes are "green" and environmentally responsible.

The funds for the ‘Sunrise’ project were provided by NAVC (the Northeast Alternative Vehicle Consortium), by ARPA (Advanced Research Projects Agency) through NAVC, the Boston Edison company, and several automotive and advanced materials related companies.

Figure 5 — The ‘Solectria Sunrise’ begins it record breaking run which will ultimately take it 373 miles on a single charge.

Will it be for sale, you ask? Karl says that the target date for sales is 1998. Before that they expect to have a small batch, limited production run. ((Last year James Worden, CEO of Solectria, was saying that if they could get the production up to 20,000 cars per year, they could probably sell them for $20,000.))

Report 8: Team Profile - ‘Hyperion’

‘Hyperion’ is an entry of the Wentworth Institute of Technology in the Chrysler Hybrid Category. Wentworth is a co-op engineering and technology school in Boston MA which tries to give its students both the hands-on learning and the book learning needed to compete in today’s industries.

Shawn Newell is the faculty advisor to Team Hyperion and he tries to ensure that the experiences help them "see the equations at work". The group is currently about 16 students, 10 of which will actually get to go to race and, like the car, they are a hybrid. Academically, they include the disciplines of industrial design, civil engineering, mechanical engineering, electrical engineering, electro-mechanical engineering, and computer engineering. They are also an international group, with members from all over the Unites States, Kuwait, Iran, Iraq, and China. In addition to exercising their engineering skills, the students learn the human skills and teamwork needed to work effectively with the other disciplines, personality styles and

cultures. Although they don't receive any academic credit for their work, Newell says the students become "addicted to seeing the direct fruits of their labor. Their level of commitment to the project is remarkable." As the race deadline approaches every spare minute and late nights go into getting ready. It seems someone always winds up sleeping in the lab. But they love it, "they keep coming back for more," say Newell.

Figure 6 – 'Hyperion' is a parallel hybrid, constructed from a Saturn SL2. It now burns E-85, a mixture of 85% Ethanol and 15% gasoline and the exhaust smells a bit like moonshine.

The black and gold (school colors) 'Hyperion' is a rework of a Saturn 1991 SL2 4-door sedan. While it still has the original body, it has a totally new front-wheel drive train. The fueled engine is a 3-cylinder from a Geo Metro (donated by Solectria) reworked to provide 89-to-100 horsepower burning E-85 (a mixture of 15% gasoline and 85% ethanol) with a 12.5-to-1 compression ratio. The engine is connected through a clutch to two 28-horsepower AC induction motors in tandem. The pair of motors are then connected through a second clutch and transmission to the front wheels. With this arrangement the car can run in 3 modes: as a Alternative Fueled Vehicle (AFV), a parallel Hybrid Electric Vehicle (HEV), and as a Zero Emission Vehicle (ZEV). When in the HEV and ZEV modes the electric power comes from twelve Optima 12-Volt lead-acid batteries which can provide 8 kiloWatt-hours of energy. Either one or both electric motors can be engaged. When in ZEV mode, the car has a range of about 55 miles.

While the car has regenerative braking, technical problems, which probably won't be resolved in time for the race, keep the car from charging the batteries while under way or idling. A plug-in charger is still needed to charge the batteries.

In the creature-comforts department, the car sports a custom interior and a "killer sound system," including 4 100-Watt amplifiers driving Bose speakers.

The car was started 3 years ago and has raced in the 1994 and 1995 Hybrid Electric Challenges, finishing 8th in its class both years.

Projects like this involve more than just the engineering challenges; the business and finance issues must also be addressed. "We are still raising money so we can go to the race," Newell told me. The students have raised most of the funding by creating formal funding proposals to sponsors, whose names and logos give 'Hyperion' that race car look.

Report 9: Team Profile - 'Viking 23' and 'Viking 25'

Western Washington University, in Bellingham WA, about 1.5 hours from Seattle, entered the only hybrid in the 1993 NESEA Tour, 'Viking 21'. It was a "practice car", with a steel tube frame, fiberglass body, and a parallel drive train. The front wheels were electric and the rear wheels were driven by an internal combustion engine (ICE) running on propane ((if I recall correctly)).

WWU returns to the NESEA Tour with two vehicles, both entered in the Chrysler Hybrid Category. The cars are among the latest (they're up to number 26) in a series of experimental vehicles built under a program started by Dr. Michael Seal, director of the Vehicle Research Institute of WWU. I spoke with Gavin Campbell, a faculty advisor for both cars, and Dan Greenberg, a student and team captain on 'Viking 25'.

'Viking 23' (number 23) is a blue, 2 passenger car designed and built from the ground up. It is constructed with an all carbon-fiber and composite chassis and body. The race team consists of 5 people.

The rear wheels are driven by a water cooled Honda 900 racing motorcycle engine with 4-cylinders, dual overhead cam, and a 6 speed transmission. In the NESEA Tour, the ICE will run on compressed natural gas (CNG) but the car has two fuel tanks, one for CNG and the other for gasoline. They expect they can get 500 miles on CNG and 360 miles on gas.

The front wheels are driven by a tandem pair of air cooled, brushless DC electric motors from Unique Mobility, rated at 10 horsepower each at 4400 rpm. The motors connect to the front wheels through a 4-speed transmission and differential off a Honda 4-TRAX all terrain vehicle. There is the ability to apply regenerative braking, controlled by the brake pedal.

The battery pack is 120 Volts worth of SAFT nickel-cadmium (NiCd) cells carrying 4.6 kiloWatt-hours of energy.

The tires are Goodyear Invicta GAs on the rear and Firestones on the front. (They couldn't get Invictas in the correct size for the front.)

The charger, made by Xantrex in Vancouver British Columbia, can deliver 3 kiloWatts from a 208 Vac, 3 phase circuit.

The entire body, including the area that normally would be the rear window, is covered with 760 Watts worth of silicon solar cells. The driver's rear view is provided by a television camera and monitor.

I imagine the vehicle is a bit tricky to handle, since both the front and rear drive systems are under the driver's manual control. On the left side of the steering wheel are the ICE controls, including a rocker switch that selects between gasoline and CNG. On the right side are the electric vehicle controls. There is only one shifter, but it has two gates (shifting patterns), ICE and electric, side-by-side. One clutch pedal activates both front and rear clutches.

So how would you drive such a thing? In purely ICE or Electric Vehicle (EV) mode, it would be pretty straight forward, although in EV mode you would probably just use 2nd and 4th gears. But in hybrid mode, it's a bit different and you have to be experienced. For example, let's say you want to accelerate hard. "To start with," Campbell said, "you would just put the EV side in 4th gear. It will just give you a steady boost during acceleration." Then you would just shift up through the 6 speeds on the ICE side. They expect this will let them get from zero to 100 mph in 1/4 mile.

As you can see the driver must be totally aware of what is going on in two drive systems. Eventually the two systems will be placed under computer controls, possibly before NESEA Tour starts.

Figure 7 — 'Viking 23' opened up. The CNG tank strapped behind the rear wheels is made entirely of composite materials.

'Viking 25' (number 25) is a red conversion of a Dodge Neon. It was entered in the 1995 Hybrid Electric Vehicle challenge and won the award for best Consumer Acceptability, meaning it came closest to being a car anyone could just jump in and drive away. It also won 1st place for range. The current team is 6 people, and specific efforts on the car can be used for independent study credit.

'Viking 25' is still a 5 passenger vehicle with stock interior. Like its stable mate, it runs on CNG and electricity. But the drive system is very different.

The ICE is a stock 2.4 liter, 16 valve engine, running the stock 9.8- to-1 compression ratio, and a stock power control module (PCM). To accommodate the different fuel, the injectors have been changed to Siemens natural gas injectors, and customized circuits on things like the oxygen sensor and throttle position sensor "fool" the PCM so that the injectors are fired appropriately for CNG. Also, the PCM learns as it runs, trimming the algorithm that pulses the injectors. The result should be that the car adjusts automatically for peak fuel performance.

On the EV side, the 5-speed transmission's input shaft was extended to accept the contribution of a 43 horsepower Unique Mobility brushless DC motor. It in turn is controlled by a custom built "bunch of MOSFETs" (Dan Greenberg's term).

The battery is made up of 144 SAFT NiCd cells (that's a lot of connections!) providing 180 Volts. The charger is a 1000 Watt unit from Xantrex.

An air conditioner pump is attached, through a clutch, to the shaft on the back of DC motor.

Figure 8 – 'Viking 25', a parallel hybrid that uses CNG as its fuel, was so clean that it met the California Ultra-Low Emission Vehicle (ULEV) standard.

The driver has the choice to select ICE, Zero Emission Vehicle (pure electric), or Hybrid Electric Vehicle (both) operation. There is also the choice of having regenerative braking or not.

The only tricky bit of driving is when up- or down-shifting. Because the electric motor is tied to the transmission input shaft, there is more inertia, and the mechanical synchronizers within the transmission have a hard time making the input shaft slow down or speed up to match the speed of the gear you are shifting into. As a temporary fix, there is a rocker switch mounted on top of the gear shift lever to speed up or slow down the motor to help the synchronizers find a match.

Of course, they want to replace the rocker switch with some smart circuits that will automatically do the gear speed matching. If successful, this electronic solution could eliminate need for mechanical synchronizers. This approach could be also be useful in large trucks.

To demonstrate the practical potential of hybrid vehicles, Dan Greenberg told me they intend to drive 'Viking 25' all the way home after the race.

Report 10: Team Profile - 'Texas Native Sun II'

Katherine Duval heads the corporate team and is the public relations maven for the 'Texas Native Sun II' (number 36) from the University of Texas in Austin. It will be racing in the Solar Commuter Category. These notes are based on a conversation between her and Jack Groh.

Built from the ground up, at first glance the 'Texas Native Sun II' looks like a normal economy car, with its rounded front and full size windshield. It measures 1.2 meters high by 4.4 meters long by 1.8 meters wide. Closer inspection reveals that it is a one person vehicle with solar panels on top, sides and hood. It is painted white with navy solar cells.

Katherine is a petroleum engineer who got interested while building the carbon fiber body. Since she had some free time and to stay with project, she now handles the PR. The team, a student organization known as the Longhorn Solar Race Car Team, has existed for about 18 months and currently has 17 active members, although up to sixty have been involved in the design and construction. Some have graduated and others have moved on; you know how it is. The membership is all undergraduates, predominantly from the engineering disciplines, although there is one geologist, and a business major. They work on campus in the basement of the science building.

The faculty adviser to the project is electrical engineering professor Dr. Gary Hallock. Before him, the project was advised by Dr Fred Gilliam, now at University of Tennessee at Knoxville. As it turns out, Dr Gilliam will be accompanying the team to the Tour de Sol, since Dr Hallock cannot be there.

The project is funded by corporate donations. Dow Chemical, the Project Management Institute, Autodesk, National Instruments, the City of Austin, the Lower Colorado River Authority, Motorola, and the Schleicher Group (a systems control firm) are the major contributors. They figure the car will cost $500,000 from design through construction and they are still raising money.

It will have its debut at the NESEA Tour and then will race in the Winston Solar Cup Challenge in Dallas later this summer. Next year they expect to be in the Sunrayce and maybe go to Australia for the World Solar Challenge.

I got the car's specifications from Chet Krushefski, BSEE student of the class of 1996, who serves as project manager.

The chassis is a space frame of welded 6061-T6 aluminum tubing weighing just 48 pounds. It is designed to withstand an impact of 5 Gs and a rollover acceleration of 3 Gs. The front suspensions are unequal length, double wishbone arms, with the coil over the damper (shock absorber). The rear suspensions are trailing arm, also with coil-over-damper.

The body is made from 3/8 inch balsa inside a sandwich of 0.02 inch carbon fiber vinylester, shaped to a prototype mold using a SCRIMP vacuum process ((and no, I don't know what SCRIMP means)).

'Texas Native Sun II' will weigh about 900 pounds with driver and batteries. Chet says they have calculated the range to be between 120 and 150 miles per charge, with a top speed well above 60 mph; it should be able to do 75-80 mph.

Figure 9 —'Texas Native Sun II' and team at South Street Seaport in New York City. The solar cells can collect up to a kiloWatt of sun-generated electricity.

The motor is the result of 2 years of research and development. It is a custom-built in-hub DC brushless PM motor on the right rear wheel. There are 6 magnets on the rotor, and of course it has to be designed especially thin to take a reasonable tire. Hub-motors present some special problems as they can raise the unsprung weight of the wheel and they are subject to severe shock. This design uses some possibly patentable techniques to deal with those issues, so Chet wasn't willing to describe it further. The team figures it will deliver about 5 horsepower (peak) at between 60 and 96 Volts (they hadn't decided on final configuration when we spoke).

The controller is also a custom-built unit, using Motorola MOSFETs driven by the MC33035 controller chip. They plan to have regenerative braking, but that might not be ready in time for the Tour de Sol.

Since this car is racing in the Solar Commuter Category, the solar cells are very important. They are using terrestrial grade silicon solar cells totaling about 1000 Watts, and the peak power tracker (which keeps the solar cells at the best voltage and current for maximum energy collection) is from Solectria.

The batteries are Trojan flooded 12-Volt blocks, totaling between 60 and 96 Volts (again, not finalized at the time of this interview). At 60 Volts they would hold 5.7 kiloWatt-hours of energy.

There will be a charger, as backup for cloudy days, but which one is not yet determined.

Report 11: Team Profile - 'Electruck'

Rick Doran is from Taylor-Dunn, of Anaheim CA. He is here with the `Electruck' (number 47), a small commercial 4-wheel EV, that typically only runs between 18 to 25 miles per hour, used for in-town deliveries, at airports, or on industrial campuses. They are also big in Mexico City where they have over 1200 vehicles. They are popular there because the streets are so narrow. Big trucks supply neighborhood depots and then little trucks make the local runs, "delivering cookies, potato chips, pharmaceuticals, and Coca- Cola," Rick says.

The front has a two-seat cab with a relatively high bed to the rear that is normally configured as a micro pickup truck or, with a cap, a micro delivery van. I guess the overall length to be about 14 feet, and the width to be about 6.

Figure 10 – Electric delivery trucks make a lot of sense in urban areas. There are over 1200 'Electrucks' in Mexico City where exhaust pollution is a big problem.

For the race they modified it to do 35 mph and put a second battery string in to give it the range needed for the race; the longest leg is 71.4 miles. They expect to get over 100 miles per charge.

Batteries	12 Trojan T-145s, 72 Volts, 2 strings in parallel
Motor	GE shunt, direct drive
Controller	GE

Report 12: Team Profile - 'HI!BRID'

((One of the joys of this job is to read a well-written paper, either about a team or a technical explanation of a car. This report is based on the paper "The UTEP Hybrid Neon Conversion Entry into the 1995 HEV Challenge" by Juan Aguirre, Benjamin Gonzalez, Debbie Marquardt, Billy Olson, Anthony Perez, Ernesto Ramirez and Simon Vega.))

The 'HI!BRID' (number 29) is entered by the UTEP (University of Texas at El Paso) Miners. Originally built for the 1995 HEV Challenge, it is a conversion of a Chrysler Neon to a series hybrid. The electric half is based on a 100 kiloWatt AC induction motor and controller from AC Propulsion, and the fueled half is a 1- liter, 3-cylinder 1991 Geo Metro engine modified to run on Compressed Natural Gas (CNG). The project was sponsored by the El Paso Sun Metro transit authority as a response to the poor air quality of the region. Sun Metro already has half of its bus fleet running on natural gas, and the project is considering using the components of this car in a later demonstration bus.

A series hybrid uses fuel to run an engine, which in turn runs a generator, which charges batteries. The energy in the batteries is then used to run the electric motor that pushes the car down the road. (A parallel hybrid has both the engine and the motor directly connected to the wheels.) The UTEP Miners decided that a series drive train had the best chance to achieve low emissions.

Before they even started the Neon conversion, they decided to first convert a golf cart from pure electric to hybrid operation. That exercise taught them about the problems of interfacing electrical systems that have different reference grounds.

They also built a mock up of the Neon's engine compartment and attempted to place cardboard versions of both the engine and motor in it. That proved to them that the engine would have to go in the back.

Finally, they did detailed vibration measurements on the Geo engine to help them design the engine mounts for the rear.

The electric side is an AC-100 motor and controller pair that weighs 77 pounds. They are driven by anywhere between 240 and 400 Volts dc. Because the motor delivers a flat 110 foot-pounds of torque from zero to 5000 rpm, they decided to just use one gear ratio between it and the wheels optimized for 55 mph. They modified the stock transaxle by removing all the

internal pieces associated with the 1st, 3rd, 4th, 5th, and reverse gears, locking the 2nd gear so that it is always engaged, and removing the shifting forks and linkages. When they attached the motor to the transaxle, they included a phenolic insulator to separate the motor's ground from the chassis ground.

The batteries are 28 Concord PVC-1234s which deliver 11.1 kiloWatt- hours of energy at 336 Volts. In pure Electric Vehicle (EV) mode, the car should do 120 miles at 30 mph.

The AC-100 controller has recharging circuits built in, both for regenerative braking and plug-in charging from between 110 Vac to 240 Vac. The batteries can be recharged from a 50% depth-of-discharge in 1 hour!

A special circuit attached to each of the batteries automatically equalizes the charging. Once a battery reaches 14 Volts a small amount of current is shunted around it by this circuit. The charge cycle is stopped when the batteries reach 14.4 Volts. The same circuit provides the driver with block-by-block indications of when 14.4 Volts and 11.1 Volts ("full discharge") are reached.

To accommodate the batteries, the CNG tank and the engine, the car had its original floor pan, from the dash board to the rear bumper, removed. Extensive structural modifications provided support for the batteries and the fuel tank, bracing of the body, seat belt attachments, and a new floor that is 2 inches lower than the stock floor. Stiffer column springs recovered the 1/2 inch clearance loss in all that.

The Geo engine in the rear was not new (budgets, don't you know), so they coated the valves, pistons, and combustion chamber with a ceramic to help achieve a higher compression and to cut down on heat loss.

The engine drives a Fisher Technology Inc. 3-phase alternator, externally rectified, rated at 18 kiloWatts.

To keep the alternator speed at 3000 rpm, a universal aftermarket cruise control, sensing the speed of the flywheel, manages the throttle.

The car switches between Hybrid Electric Vehicle (HEV) and Zero Emission Vehicle (ZEV) modes automatically, although the driver can force it manually to be one or the other. Fully charged and fueled, the car starts out in ZEV mode running only on the batteries. When the voltage of the battery pack reaches a minimum level, selected by the driver, the CNG engine is started, generating electricity to both run the car and charge the batteries. Once the batteries reach a higher voltage the engine is shut down.

The whole operation is under the control of a Motorola 68H11 8-bit microprocessor, without an operating system, running a custom built control program that fits in 32 kilobytes. It monitors various HEV and ZEV functions and provides the driver with information via light emitting diodes and vacuum fluorescent displays.

For creature comforts, the car has a 1850 Watt resistance heater and the stock air conditioner compressor is driven by a 5 horsepower, 240 Volt, single-phase AC induction motor driven by a home-made DC-to-AC inverter.

Report 13: Team Profile - 'Roadrunner'

In past NESEA Tours, Greenwich CT High School's Solar Flair Team ran a VW Rabbit conversion (called 'Solar Flair') with the roof lowered 6 inches. This year they have a red 1979 Mazda RX-7 they are calling 'Roadrunner' (number 54). I spoke with Mark Smith, Christian Anderson, and Raphael Llamas.

I've heard of several people dreaming of converting an RX-7, but this is the first time I've seen one done. The guys said it was quite a challenge finding places for all the batteries. They had to cut out the floor of the trunk and fabricate the battery boxes to fit and still keep the body strength. They got it running a week or two ago. They expect the aerodynamic lines will help their efficiency and they know the sexy lines will turn more heads than the Rabbit.

They > drove < the car to the display on Friday, and expected to drive it home that evening and back on Saturday again. Then they'll charge. On the way down they had a brake problem, but a garage helped by fixing the right-rear brake cylinder.

Batteries	20 Trojan T-145, 120 Volts 1 12-Volt accessory battery
Motor	Advanced DC, 60 HP
Controller	Curtis 1221B
Solar Panel	65 Watt, charges accessory battery or 4 of traction batteries
Range	120 - 150 miles

The old Rabbit is going on to another phase of its life; it's now being converted to a hybrid.

They also have a project building a solar car. They have finished the two sides of the frame of the car, which next need to be welded together. They expect it to be ready for next year's NESEA Tour.

Figure 11 — The ‘Roadrunner’ hails from Greenwich Connecticut High School. The team that demonstrated a “never say die” attitude when luck wasn't with them.

Report 14: Team Profile - ‘Sparky’

I spoke with Jim Robb and Ernie Moore of the Central Virginia Electric Auto Association (CEVA), two of the members of "Team EV Moore".

The base vehicle is a 1986 Mercury Lynx converted in 1994 by Mark Laidlow, Paula Laroure and Ernie Moore, all of Richmond VA. The conversion is based on a kit from Solar Car Company in Melbourne FL, with some other parts, including the transmission adapter, from KTA in California. It sports 20 Trojan T-125 6-Volt batteries, a 28 hp Advanced DC motor and they say they expect between 70 and 90 miles/charge. "The conversion itself was relatively easy," says Ernie. "The hardest part was figuring out where to put all the batteries. We ended up with 12 under the hatchback and 8 under the hood."

Ernie is a nuclear engineer and has always been interested in tinkering with things and alternatively powered vehicles. When he saw a newspaper article about the CEVA where Jim was interviewed, he joined the club and within 3 months was starting his own project. About 4 months and $7,000 later the car was done. It now has 13,000 miles as an electric. Ernie averages 200 miles per week commuting to work and back.

This is not the first event ‘Sparky’ has entered. In 1995 they went to the "Sunday Challenge" in Daytona Beach FL and won the Commuter Category.

Figure 12 – 'Sparky' is a personal project built with the help of the Central Virginia Electric Auto Association (CEVA). It is Ernie Moore's daily commuting car, covering about 200 miles every week.

Report 15: Team Profile - 'Sparky 2'

Immediately after interviewing the people with 'Sparky' (number 39) from Virginia, I ran into Christen Johansen with 'Sparky 2' (number 38) from New York City. 'Sparky 2' is run by a team known as "Wooster's Charge" from the Wooster School in Danbury CT. They were also in the 1995 NESEA Tour when we went from Waterbury CT to Portland ME. Christen was a member of the Wooster Class of '68, and so he loans the car to them for the race. Why '2' you ask? Because their race application form arrived later than that for the Virginia team.

The vehicle is a conversion of a 1972 Saab 96, picked because of "my family's need for commuter transportation and fond memories of my first car. The conversion ... to electric power was a practical means to [avoid] maintaining a twenty-five-year-old engine." Originally it had a 96 Volt battery pack. That was extended to 120 Volts in 1995 to get the additional range needed for the race (at the expensive of the back seat), and this year a new Curtis PMC 1231C controller increases the power and efficiency. An Advanced DC FB1-4001A motor connects to the Saab 4 speed manual transmission ((with the free wheeling position; remember that?)). It weighs in at 3080 pounds.

I'm discovering that the EV world is highly interconnected. At one time Christen had planned to carry the extra batteries needed to go from 96 to 120 Volts in a trailer that would roll behind the car. "The more I thought about it and that shifting weight in the back, the less attractive that idea became to me. I decided to put the extra batteries on board. However, I sold that trailer to Fred Whitridge of the Blue Sky Club ((who entered his converted VW Cabrolet in the 1995 NESEA Tour)) and that's what he ran last year. He did OK with that, but we came in just one ahead of him. Maybe that was the difference." Christen still thinks he is better off keeping everything on board and keeping the added weight low and between the wheels.

Figure 13 — Sparky 2' is a personal project of Christen Johanson raced by his alma mater, the Wooster School in Danbury CT.

Report 16: The 'EV1' almost shows up, but ...

This is a story about the one that got away. Would you believe that a GM 'EV1' was in New York City, for an appearance on the "Today" show (which didn't happen), and here it is the first day of the NESEA Tour. What could be more logical than to display it here?! But we have not seen it.

The 'EV1' that was in New York is one of the first production units. It is being used as a training vehicle for the Saturn service departments.

But I ran into the next best thing, I think. Donald Lasell (pronounced LA sell) is a Senior Project Engineer in the Exterior Body Systems area of GM Advanced Technology Vehicles, Troy MI. An 'EV1' lapel pin caught my eye and we talked Friday morning before the race vehicles started to arrive.

Donald was originally from Vermont, and was involved with the 1994 Tour, when his son's high school team entered the solar racing vehicle known as the 'Patriot'.

Donald was also involved with the manufacturablity studies for GM's 'Impact' prototype. Now he is a "release engineer", directly responsible for the hood, deck lid, and roof, and several other fiberglass reinforced parts. He is about to join the project engineering team supporting the production of the 'EV1'.

The 'EV1' body structure is made of aluminum stampings, foldings and extrusions, assembled in Lansing MI using a process called "weld-bond" that was developed by Alcan. This space frame has the fenders and quarter panel attached to it. These elements are made of reinforced-rim reaction injection molded urethane. The whole point of using aluminum and composites is to get a strong yet light body structure. Don says that technique is exceptionally effective at reducing the weight. The 'EV1' weighs a little under 3000 pounds, including the 1300 pound pack of 26 lead-acid batteries.

Don spoke about the satisfaction of seeing the results of the crash testing program. They spent a lot of time figuring out how to make the energy absorbing features of the frame and body, and it was quite comforting to see things crush and fold where they were supposed to. Now the design is into three life-cycles of durability testing where they slam the doors, trunk and hood repeatedly. One lifecycle for a door is 65,000 slams. One body just came off a shake-stand that simulated 300,000 miles of shake, rattle and roll. Another was drowned in water. Another was tested with a simulated catastrophic battery failure which evolves hydrogen.

The 'Impact' PrEView fleet of 50 cars has accumulated 700,000 miles of use, and the couple-of-dozen 'EV1' models in proving-ground testing have accumulated about 200,000 miles.

We talked for about 20 minutes about all sorts of details of the car, but Don's final thought was, "It is the most impressive car I've ever been involved with. (Although I'm prejudiced.) I think the time is coming when we will all be driving electric cars and I'm fortunate to be in one of the programs that will make it happen."

Report 17: Team Profile - 'Nordic Challenger'

Harold Garabedian is with the car carrying the Vermont license plate "EV-7", also known as the 'Nordic Challenger' (number 7), racing in the Production Category. This 1994 Solectria Force was in last year's NESEA Tour and took NESEA's Efficiency Award in the Production Category and also Best Sedan using Lead-Acid Batteries. When not winning races, it is in daily use in Vermont and now has accumulated about 20,000 miles. Their handout shows a picture of the car charging at a solar array in Middlesex VT.

It is one of the EVermont demonstration program cars. "It is given to people to use the way they drive cars. It's not dedicated to any [particular type of use]. It's been a commuter; it's been traveling; it's been everywhere." They currently have 18 vehicles in the program, evaluating how EVs work in Vermont's cold climate and hilly terrain. They put data loggers in the cars and have shown that 12,000 miles a year uses about as much electricity as a home refrigerator.

The batteries are the original 12 Sonnenschein gelled electrolyte lead-acid batteries (manufactured under license in the US by East Penn Manufacturing, Lyons PA). They have required no maintenance so far. This car has been through Vermont winters. It has seen 20- to 30-below-zero weather, goes through slush and ice very well, and has driven up and down Mount Mansfield. A thermal management system keeps the batteries warm, and "an onboard, fuel-fired heater is for the depths of winter."

I found the heater particularly interesting. It is installed in front of the rear battery box, where the back seat might have been at one time, and looks like a DustBuster for the BatMobile. It's a black cylinder about a foot long and 7 inches in diameter. Cabin air is drawn at one end, heated using kerosene, and then directed through a flexible pipe to the front of the car and into the usual driver controls. I was a bit concerned that the exhaust of the heater just went into the passenger compartment, but Harold said that 3 gallons of kerosene would last one Vermont winter season, which implies a very modest burn rate. ((I guess it's like having a gas stove in a house.)) The unit is made by a company called Espar.

EVermont has a newsletter, "The Electric Voice". For a copy, write

The Electric Voice
EVermont
103 South Main Street, #3 South
Waterbury VT 05671-0402

Figure 14 — The 'Nordick Challenger' is a 1994 Solectria Force that has seen 20,000 miles of Vermont summers and winters. A fuel-burning heater keeps the passengers warm in the sub-zero weather on only 3 gallons of kerosene a winter.

Report 18: Team Profile - 'Project e–'

Mr. Everett High School of Sheffield MA returns with their 'Project e–' pickup truck. In 1994, 'Project e–' was a pure EV that came in 9th in the American Commuter Category. For the 1995 NESEA Tour it was converted to a propane- fueled Hybrid EV. It took first place in the Hybrid Category and the NESEA trophy for Best Overall Hybrid. Asked why they were

coming back to the NESEA Tour, they said, "We feel that we are a part of a large group of others trying to make the next generation of automobiles better for the environment, and consume less energy than the cars of today." I'd say the evidence of last year's performance supports that.

The team consists of:

Paul O'Brien	Tech. Ed. Dept. Head, Mt. Everett
Arthur Batacchi	community member
Stan Dupont	community member
Bob Fedell	student, Mt. Everett
Jake Dupont	student, Mt. Everett
Jason Cross	student, Mt. Everett
B. J. Law	student, Mt. Everett
Robert Martin	student, Mt. Everett

Schools take on such projects to provide hands-on learning experiences, and nature has a way of supplying them. A few weeks ago, a battery in the front of the truck had exploded while no one was around. "It taught us all to be more safety conscious and to definitely wear safety glasses when in the shop at all times."

When asked what they wanted from their participation in the NESEA Tour, they said, "We want people to remember that we helped to make vehicles that use less energy and that are safer for the environment."

Figure 15 – 'Project e–' was the only hybrid-electric vehicle entered by a high school team. It won the *Best Overall Hybrid, 2 person* prize.

They chose a pickup truck because of the safety factors of having a strong frame on which to hang the heavy batteries, because the batteries were outside the passenger compartment, and because the school district could use the truck as a maintenance vehicle. Originally a pure EV in 1994, in 1995 they converted it to series hybrid operation running on propane. Last year they won the Hybrid Category, but the competition is much stiffer this year, with 11 Hybrid entrants. Still the students I spoke to are confident they can "take the category" again.

I spoke with Robert Martin, Jason Cross, and B. J. Law, students who helped out on the truck. Robert removed the original inside door panels and replaced them with lighter plastic, to help reduce the truck weight. They also replaced the 3-year old batteries with a new set of 20 6-Volt US Battery blocks. Jason told me that they tuned the regulator to use less propane and B. J. said they had replaced the controller with a newer Curtis model.

Last year they got about 9 miles per kiloWatt-hour (kWh). Their tests this year show them getting 13 miles/kWh, a big improvement. In hybrid operation they are hoping for 200 to 300 miles range.

Base Vehicle	1985 Chevy S-10 pickup truck
Transmission	4 speed, 4:56 rear end change
Steering	converted from power to manual
Motor	28 HP DC brushed motor
Engine	Kohler propane 22 HP (12 kW output)
Alternator	Fisher 3 phase (12 kW, 120 Volts, 92 Amps)

Solar Panel	three 50 Watt panels in series
Regen Braking	30 Amp alternator with electric clutch
Charge Time	6-8 hours for full charge
Range	300+ miles
Top Speed	70 miles/hour

More info at 413-299-8734.

Report 19: Other Vehicles - 'RAV4-EV'

Frank Fontana is Consolidate Edison of New York's Manager of Alternative Fuels. He was displaying a Toyota 'RAV4-EV' that they got just about 3 weeks ago and they are evaluating as a company vehicle. The car looks like a scaled down sports utility vehicle, with 3-doors and 4-seats. The back two seats can be folded down to make room for more cargo. When the back seats are up, there is only a small amount of room for cargo between them and the rear door. The car is quite high, over 5 feet, so you sit relatively high up.

Under the hood is very clean and neat. A long radiator for the heat pump sits low, behind the front bumper, leaning forward. Two fans force air through it. A second, tiny (about 9 inches square) radiator with fan is for the coolant from the electronics box which dominates the center of the "engine" area.

The regen braking is controlled both with the accelerator pedal and the brake pedal. When you take your foot off the accelerator pedal you get regen braking comparable to compression braking in a gas car. Then the first portion of brake pedal travel adds more regen braking. The "shifter" (even though there is no transmission) has a "heavy regen" position which adds considerably to the regenerative braking effect.

There are two recharge ports on the passenger side front fender, each behind its own "gas cap" door. One is for normal charge and the other is for quick charge. (My impression is that normal charge uses an on-board charger and quick charge uses an external charger. The normal had what appeared to be a normal male AC plug (or maybe it was a 220 Vac plug), while the quick had a pair of round female sockets.)

There is a State of Charge meter that looks very much like a gas tank gauge in the instrument cluster.

Dimensions	145.5 in long, 66.7 in wide, 63.4 in high 86.6 wheelbase, 57.9 front tread, 57.3 rear tread
Motor	Permanent Magnet, air cooled, 20 kW (26.8 hp) continuous, 45 kW (60.3 hp) peak
Battery	valve regulate lead-acid, 12-Volt, 60 Ah (@ 3 hr rate), 24 blocks, 288 V, 17.3 kWh
or	
	valve regulated nickel-metal hydride 12-Volt, 90 Ah (@ 5 hr rate) 24 blocks, 288 V, 25.9 kWh
HVAC	Heat pump (for air), plus electrically heated seats, plus electrically heated windshield (defrosting)

ConEd also has been involved with EVs for some time and also have Solectria Forces, Chrysler TEVan, and Ford Ecostars.

Figure 16 — Toyota's 'RAV4-EV' has two charging plugs. One is for an external fast charger capable of delivering high current. The other is to provide AC current for the on-board opportunity charger.

Report 20: Other Vehicles - 'Sewanhaka Central High'

At the South Street Seaport display for the NESEA Tour, there are vehicles on display that are not in the race. One of those is a restored and converted Chevy S-10 pickup from Sewanhaka (sea WAN e ka) Central High School District in Floral Park NY. I spoke with Myron Rock, Director of Occupational and Continuing Education, Bill Ragona of the faculty and students Joe Simon, Joseph Loeven, Mike Sowinski. The truck was a 3-year project for the technical education school. The body was saved from the crusher and the students did a complete body and chassis restoration first, which took a year. The second year went into modifying the chassis to accept the batteries and installing the EV system components. Battery support frames were welded into the chassis under the truck bed which was hinged to allow easy access. ((The welding job is very clean and professional looking.)) The electric system components are from Bob Batson's Electric Vehicles of America and are typical of his systems. 20 Trojan T-145s that make up the 120 Volt system that power a Curtis 1221B controller which drives a Advanced DC 9 inch 120 Volt motor. The electronics are all contained in a removable box. All the cables in to and out of the box are connectorized to make isolation and removal easy. They added a large vacuum booster from a police car which provides the extra braking power for the added weight. A professional paint job was donated by a former student.

Joe and Joseph were new on the truck team this year, but Mike was there in the very beginning, when he was in 10th grade. Now he graduates with the entire experience of the restoration and conversion in his resume. He plans to work a year and then go on to either Ohio Auto Diesel or Universal Technical Institute (UTI).

Report 21: Snippets and observations

I ran into Dan Greenberg, team captain of the 'Viking 25' (number 25), a hybrid conversion of a Dodge Neon that uses Compressed Natural Gas (CNG) as its fuel. He was explaining the advantages and disadvantages of CNG (which is compressed methane) to a visitor, and made an important point, I think, about the current infrastructure for alternative fuels. At the moment there are only about 1,100 CNG stations in the United States, run by about 25 companies, so you have to plan your trips and stops. For example, Western Washington U. is in Bellingham WA. They drive up to White Rock, British Columbia, about 40 miles north of the campus. In Canada, CNG is much more available.

((This reminds me of the late 1960s, when I owned my first Diesel- fueled car. Every truck stop had Diesel, but they were not always along-the- way. To this day, I carry 5 gallons with me, though I haven't needed it in years. Old dogs and all that.))

At one point they had a tank of CNG and compressor on campus, but it was not built correctly. One day they unplugged after a fill-up and squirted compressor oil all over the car. Some oil also got into the tank. Those non- methane hydrocarbons gave them really bad emissions. Dan says, "Compressor technology and maintenance is very expensive, which is one of the limitations to CNG stations. That will have to be overcome in the future."

But when it is done right, CNG gives a very clean, fuel economic vehicle. "I believe we passed the ULEV (Ultra Low Emission Vehicle) standards. The methane is CH4 (one carbon and 4 hydrogen atoms), a very simple molecule that breaks up very readily."

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Eric Wong is a mechanical engineering major with the 'HEVy GATOR' (number 19), listed as 'HEV U Florida' in the official lists. He was responsible for the heating and air conditioning on the car, which is provided by a heat pump. Unlike a regular car, where the air conditioning compressor is connected to the engine with a clutch, here the heat pump compressor is driven by a Fisher electric motor.

Inside the trunk lid I found the signatures of team members; Eric's was accompanied by the slogan "The Wong Way or No Way". Other slogans included "$3 Bill", "The Lawnmower Man", "Troll 1", "The Funk", "Oh My God, Oh My God, Oh My God", "Disco Joe/Sidetrack". ((Ever since the Apple Computer folks signed the inside mold of the Macintosh case ...))

Figure 17 – Finding room for all the pieces of a hybrid conversion can be a bit of a challenge. Here the tank for the compressed gas used as a fuel takes up much of the trunk space. The horizontal slot on top of the tank is for a MagnaCharge padel.

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Janet Sapadin is the Pollution Prevention Coordinator for the Environmental Protection Agency (EPA) Region 2, which serves New York, New Jersey, Puerto Rico, and the US Virgin Islands. EPA Region 2 funded the NESEA Tour through two different programs; the Environmental Education Program, to develop materials for student visitors to the race, and the Pollution Prevent Program. They have a booth that is part of the display area.

Janet's program funds efforts to prevent pollution generation. The whole idea is to avoid creating the pollution at the source, so that it does not have to be cleaned up or even recycled. They also publish a newsletter on various EPA sponsored pollution prevention efforts. To get on the mailing list, or to apply for a pollution prevention grant, write:

Janet Sapadin
US EPA Region 2
290 Broadway, 26th floor
New York City NY 10007-1866

US EPA Region 2 has a home page at:
`http://www.epa.gov/Region2`

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Cruising Equipment Corp's "E-Meter" is in evidence just about everywhere since this is the way the US Department of Energy (DOE) plans to collect in-vehicle energy use data from the race. It's a bit more than 2 inches round, and has the ability to display Volts, Amps, Amp-hours and time remaining. An RS-232 option can deliver, at 9600 Baud in ASCII, second-by-second readings of:

time since last Amp-hour reset
kiloWatt-hours
Amps
Volts
Amp-hours
Peukert Amp-hours
Peukert Amps
time remaining

Connect it to your laptop PC or a Cruising Equipment Memory Module and you get data coming out your ears!

For more info, call 206-782-8100.

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I ran into Nick Karditsas of Ovonic Battery Company (aka Ovonics) who is accompanying the Solectria team. Solectria's 'Sunrise' has Ovonic Nickel Metal Hydride (NiMH) batteries, same as last year, and they have a 'Force NMH' sedan which is also running NiMH.

The 'Force NMH' will be carrying 23 kiloWatt-hours on board, in a 200 Volt string of 15 modules. The energy density of the modules is 70 Watt-hours per kilogram ((which calculates to about 330 kg (728 lb) of battery)) and they expect to get 600 cycles from the battery pack.

Nick said that the batteries now are available, although they are very expensive because they are still in pilot production. But they are working with GM Ovonic to bring the price down. They think they can get to $200 per kiloWatt-hour.

And things are getting better. There are modules in early development delivering over 80 Watt-hours per kilogram (that includes packaging). Along with improved energy density, they are also making improvements in lifecycle, and cost reduction.

Report 22: Team Profile - 'Spyder Juice'

Among the US DOE Commuter Category entrants we find 'Spyder Juice' (number 31), a pre-production prototype of a car Al Simpler intends to market. They finished building it in 1995 and took it to the "Sunday Challenger" in Daytona Beach FL, and won two First Place prizes and set new track records. Next stop was Phoenix for the EV 500 where they took 2nd place in the under-300 Volts drag race and 2nd place in the 40 km, and 3rd in the 80 km. Al says, "It has never been beaten by a street legal car, and it is street legal. It is also SCCA qualified." 'Spyder Juice' is featured in an article in *Kit Car Illustrated*'s June issue, out now.

The car is a bright yellow two-place sports car, set very low to the ground, custom built with a tubular frame and fiberglass body. It is configured for racing with a roll bar, impact bars, padding, and 6-point seat belts. ((It looks fast just standing still.)) It weighs 2700 pounds.

The batteries are from GNB. Because the batteries use sealed, absorbed electrolyte technology, some of them can be, and are, mounted sideways, with their terminals on the side. They add up to 216 Volts and 18 kiloWatt-hours. The controller is a custom-made unit that can handle 120 kiloWatts, drawing up to 600 Amps from the pack and deliver as much as 800 Amps to the motor.

The gear box is a Volkswagen transaxle, flipped upside down, mounted with an SHO clutch to a DC, 8-brush, high torque motor, a prototype from Advanced DC Motors. There are 4 forward gears, although they almost never use first.

They intend to build a coupe; information on that will be available soon.

More info: Solar Systems of Tallahassee FL, Inc. 904-5-SOLAR-5

Figure 18 – 'Spyder Juice' as it was qualifying for the race. It is bright yellow.

Report 23: Nancy Hazard - Race Director

The American Tour de Sol is one of NESEA's two big electric vehicle events; the other is the Sustainable Transportation and Solar & Electric Vehicles conference in the fall. Nancy Hazard is responsible for making both these events happen.

The NESEA Tour is a bigger undertaking because of all the logistics of lining up people, places and organizations to handle all the things that have to happen at each of the seven stops we will make this year. It helps to have significant sponsors.

"This year we have four Title Sponsors: the US Department of Energy (US DOE) through Argonne National Labs, Chrysler Corporation, the Northeast Alternative Vehicle Consortium (NAVC), and Goodyear Tire & Rubber Company. This kind of partnership indicates the growing interest in the electric vehicle industry. I see this as evidence that EVs are 'taking off'," Nancy says.

"This year we have 30% industry built vehicles, and 60% student built vehicles, both up from past NESEA Tours. The number of entries built by individuals has gone down.

"We are also seeing 18 purpose-built vehicles this year, which I think is more than we have ever seen before.

"Two modified production vehicles are particularly interesting. One is the 'trans2' which represents an important niche market; off-road vehicles. That company is just taking off. They started production last October and now have over 800 orders. They've modified a 'trans2' so it can do the long, cross country legs of the NESEA Tour, and are also going to be exhibiting. And the Taylor-Dunn vehicle is also modified to make it through the race."

Nancy also pointed out the huge representation of hybrid vehicles. "We have 11 hybrids this year, up from 3 last year. And we are seeing many different fuels."

The rules for the Solar Commuter Category are totally reworked from the solar categories of the past. Before there was a huge penalty for charging from the electric grid, to the point that some teams figured it was better to trailer over some legs of the race if they didn't get enough sun. "Now the rules expect that teams will charge from the grid, but the scoring will favor those with higher fractions of their energy coming from the sun."

Three different groups are giving NESEA money to research and development studies this year; US DOE, NAVC, and the Electric Vehicle Research Network (EVRN) which is a part of the Electric Power Research Institute (EPRI).

The EVRN sponsored study will be looking at power quality issues associated with chargers that are of interest to the electric power companies. These include things like induced line noise, harmonics, and power factor, all of which effect the ability to deliver electricity from the power plant to the ultimate user without loss or interference.

The US DOE study is focused on vehicle efficiency, collected from instruments installed on the cars. The NAVC study complements the US DOE study by looking at the power inputs to the individual chargers. Between the DOE and NAVC studies, they should be able to determine efficiencies of the chargers, the batteries, and the vehicles overall.

All this information together will help to determine the winners of the NESEA Energy Challenge, where the prize is for "the vehicles that use the least amount of energy to travel down the road." The calculation provides an equivalent-miles-per-gallon comparison with today's fueled vehicles.

Report 24: Team Profile - 'Twike'

Again this year we have an example of a human assisted electric powered vehicle ((or is that an electric assisted human powered vehicle? I can never remember)). Last year it was a special racing vehicle ridden by a professional bicycle racer. This year it is the 'Twike' (number 12) racing in the Production Category. Wolfgang Moscheid of Rosenthal Germany explained the "twin bike" to me.

The 'Twike' was first designed for the "Innovative Vehicle Design Competition" during the Expo '86 in Vancouver, Canada. The vehicle brought to the race is the prototype of a series of vehicles which they will build and sell when they have 200 orders. (See below.)

The idea is a two-passenger recumbent tricycle, 1-front wheel, 2-rear, with a pair of pedals for each passenger plus an electric drive system.

The body is a low, wide, molded "tub" of "Luran S" made by BASF ((which appears to be an ABS plastic)), with a high rear and a wide, clear windshield. When closed, the result appears to be quiet aerodynamic. The tub is on an aluminum space frame for rigidity and strength.

The pedals connect to a 5-speed hub and coaster brake, thus pedaling backwards applies the rear brake. The left hand passenger has a handle to his or her left which includes the parking brake and the front hand-brake. It has a 7 meter turning circle. Both rear wheels are driven, through a differential, by both the pedals and the electric drive.

The passengers sit side-by-side, with a steering tiller sticking up between them. Either passenger can steer and operate the buttons on the end of the tiller. A pair of buttons control acceleration and deceleration, with the deceleration performing regenerative braking. Also between the passengers, on another stalk coming up from the floor, is an instrument panel with an speedometer, controls for windshield defrosting, windshield wiper, turn signals, head lights or running lights, and horn.

Figure 19 – 'Twike', the twin bike from Germany, attracted a lot of attention. Many people were allowed to drive and pedal it, and found they could adjust to doing both quite easily.

The electric power system uses a combined charger/controller that manages a battery of 218 cells totaling 336 Volts offered in either a 2 kWh or 3 kWh pack. (The vehicle they are racing has 5 parallel strings.) The batteries are NiCads used in electric screwdrivers and other hand tools. The power is delivered to a 5 kW AC induction motor. They expect they can get about 62 miles of range on the batteries.

The system can be run on just people-power, just electric, or both. They expect that most people will provide about 10% of the power from pedaling and the rest will be electric.

All 3 wheels have independent suspension with shock absorbers. The brakes are hydraulic drum rear, mechanical drum front, and regenerative (aka "recuperation) braking from the electric motor.

The vehicle is for sale, if they can get enough orders, and the price on the flyer is listed at sFr 21,000, including batteries.

For more information contact:

Möscheid Automotive
Solartechnikbüro
Felgasse 6
35119 Rosenthal
Germany
phone: 0049 6458 388
fax: 0049 6458 1388

Report 25: Team Profile - 'Helios the Heron III'

When I was in elementary school, a couple of friends and I built "Bolts", a robot made out of Erector set parts, cardboard boxes, a speaker and a tape recorder. We thought is was neat (the word "cool" hadn't been invented yet) and we got our picture in the local paper. Maybe that's why I have a special place in my heart for the kids from Riverside School in Lyndonville VT and their 'Helios the Heron' series of vehicles. 'Helios the Heron III' (number 93) is a rework of 'Helios the Heron II' which was in the 1995 NESEA Tour. I spoke with Nina Berryman (6th grade), Andra Hibbert (7th grade), Daniel Wilson (6th grade), Karen Budde (English, Latin, Physical Education teacher/driver), and Topher Waring (Science, Shop teacher).

'Helios the Heron III' is a much more mature car than either of it's predecessors. HHI never ran at all. HHII had a personal best of 16 miles and placed 4th (ie last) in it's division. HHIII already has 145 miles on it! The outside shell is new, made from Kevlar, fiberglass and plywood. There are eight 12-Volt batteries, plus a another accessory battery charged by the

100 Watts of previously owned (read "used") solar panels. The car frame, the solar panels, dash board and mirrors are from last year's car. The seats, made from plastic school chairs, are new. There are two new doors, made of plywood and Styrofoam. Topher emphasizes that the materials have to be things the kids can handle.

There are now two seats in the car. For the first time the kids will actually get to sit in the car while it is moving. Karen Budde will drive and one of the children will act as navigator.

A wire loop on the outside of the car pulls an emergency disconnect inside the car that disables the drive system.

Above the windshield on the roof is a 2-inch tall, silver painted wood carving of the school mascot, the Heron, made by one of the team members last year, a Russian exchange student named Vesilli Germoloe. A larger, hand- painted version of their Heron-on-wheels logo graces the noise of the car, again done by one of the students.

The entire class of 46 kids, grades 5 through 8, worked on the car. 11 kids are on the A team, here with the car from Friday to Tuesday. They then swap with Team B which will finish the race.

Specifications (taken from their flyer, written by student Colin Browne):

Battery	9 Deka Dominator Jell Cells
Motor	General Electric 20 hp traction motor, 6000 rpm
Drive	Chain drive of rear wheel
Top Speed	60 mph ((but I'd never want to see it try))
Chassis	Ford Festiva front end, aluminum and plywood frame held together with rivets, industrial glue, and duct tape.
Body	light-weight aircraft foam and fiberglass

Figure 20 — 'Helios the Heron III' was built by 5th, 6th, 7th and 8th graders, not one of them legal to drive it. Still the kids were among the most enthusiastic participants in the NESEA Tour and also among the most popular.

The flyer also speaks of some of the challenges:

Getting globs of industrial glue off one's hands.
A brake pedal that beeped the horn.
Rapid fire turn signals that made no distinction between left and right.
Headlights that only turned on when they felt like it.

Report 26: Team Profile - 'Regenerative Braking'

William Glickman, of Alternative Energy in Glastonbury CT, has been doing EVs since (what seems) forever. I first met him at the 1993 NESEA Tour when he entered his 'Lightning Bug' VW conversion. This year he has a Subaru microvan he calls 'Regenerative Braking' (number 45).

He told me he has > big < capacitors in his car. "They're super capacitors! They are 9 inches in diameter, 12 inches long, 48 pounds each, rated at 28 Volts DC, and each one is > 85 Farads <!" What you might call lightning in a can. "If they were fully charged I could probably accelerate the vehicle from zero to 30 miles per hour."

The vehicle itself is labeled as an Electra Van. It is one of the (legendary) Jet Industry conversions done in Austin TX, which was sold to electric companies in the 1970s. Bill bought his from an old electrical engineer who is retired. It was a basket case. All it had was a motor. The tires were shot, the clutch was bad, the wheel bearings needed changing, the brakes were leaking, it didn't have a mirror or controller or batteries. Bill re-did the whole thing.

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Batteries       108 Volts, EV137s (made by Trojan, sold by Douglas)
Motor           27 hp GE shunt wound
Controller      Curtis PMC (about 20 years old)
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But where did those capacitors come from? "While talking to a professor at University of California at Davis I mentioned that I would like to try capacitors. Well, he knows this guy in Rhode Island who is into capacitors. So I call him up, tell him what I knew, and what I was interested in, and he says 'We got capacitors. You want to try them?'"

They've been in the vehicle for about a month, but as of Friday they were not hooked up. "Tonight I get to hook them up," Bill says. When they are connected, the capacitors will be in series. The most positive and negative ends will be connected in parallel with the batteries, isolated by diodes and relays. They will connected into the batteries using a 3-step foot pedal. "Step 1 energizes the shunt field and the main relay, so the car is driven by the main battery pack. The second step shuts off the main contactor, isolating the batteries from the capacitors, and turns on the other relay circuit to connect the capacitors for regenerative braking. And the third step changes the relays around so I get power out of the capacitors to the motor through the controller." The capacitors have a rated charge or discharge rate of up to 1400 Amps and are supposed to be 90% efficient.

I'm glad I don't have to try to drive this thing; I left my extra leg at home. There on the floor under the steering wheel is (right-to-left):

an accelerator pedal
a brake pedal
a clutch pedal
and an orange industrial pedal (such as you might see on a shop machine).

Bill does not have an extra leg either, but he is used to this. His old green Ford van conversion used this same foot pedal, to control regen braking. So he is used to this dance step.

"I also made a flywheel system," says Bill, "but I ran out of room and weight." (Preview of next year?)

Report 27: More Snippets

Tom Hopper ((the man I want to be when I grow up)) is here with his bio-Diesel auxiliary power trailer. He > drove < his Hopper EV plus trailer hybrid to New York City from Concord, New Hampshire. "It was great fun. It was raining cats and dogs when we left and I would have probably given a lot of money for a real good defroster. The windshield is Lexan, which has an affinity for moisture that doesn't quit." He plans to replace the glazing with glass and get a good defroster someday soon.

He has been using the "pure" EV all this fall going to school (the New Hampshire Technical Institute, where he teaches) every day, rain or shine. He used the data collected from those trips, which included turnpikes doing 70 mph and country roads doing 40. His average speed was 35 mph, his average power consumption was 3.5 kW. He then designed the engine to give 3.5 kW at its "sweet spot", which is at 2550 rpm. "It gives me energy so I can drive at 40 mph, steady state." The engine is manually controlled from the driver's position.

Tom hopes to demonstrate that his 5 gallon tank can give him a 500 mile range. In fact he hopes to drive it back to Concord from Washington DC. "I have no trailer, but I have confidence. I'll stay on the blue roads; more scenic."

Since last year the motor has been changed from a Solectria GU motor to a GT, "which has more torque, and the gear ratio has been changed so I have more torque off the line and less high end speed," to pull the 300 pound trailer.

And the exhaust smells like a restaurant. 10 to 20% of the fuel is used Fry-o-lator oil. Yet he gets 127,000 BTUs per gallon out of it, and that is what Diesel fuel is.

Finally, Tom has added a stereo radio/cassette, "mainly for entertainment for everybody else." And because he is a kid at heart, which is why he is still here.

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I met Scott Isgar of Staten Island at the 1994 American Tour de Sol, when we went from New York City to Philadelphia. That year he entered his 'Solar Deliver', a converted VW Vanagon with a large solar panel on the roof, and did very well. He is not in the race this year, but came to the New York City display to show off to his neighbors. The batteries in 'Solar Deliver' were about 24 hours old.

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Thomas Faul was in the race last year with the 'Electra' from Skoda in Hungary. He's sold about a dozen of those cars in the US, and, if I heard him right, sold two while in New York City with us on display. He has been trailering an 'Electra' from stop to stop, showing it and giving people rides.

He now also is representing Wallingford AC Controls, which builds the ‘trans-2’ which was supposed to be in the race with a specially modified version capable of the long distances. It just was not ready in time; they hope to display it in Washington DC.

Report 28: Team Profile - ‘Hybrid Lumina’

Clarence Ellers of Electronic Transportation Design claims his ‘Hybrid Lumina’ (number 28) is the "only totally automatic hybrid electric vehicle in the world. Anyone can get in it and drive it in electric mode, ICE mode, and both, without any instructions. Under 35 mph it is a zero emissions electric vehicle, at 35 mph the gasoline engine kicks in, and when you want to pass someone or climb a hill you just push the throttle and you’ve got both. It has full time regenerative braking which means any time the front wheels are turning and not driving the car they are charging the battery. In addition there is a 150 Volt alternator on the gas engine, so if the batteries go dead you can park and charge them. And any time the engine is running you are also charging the batteries."

The base vehicle is a Chevy Lumina APV. The gasoline engine is in the rear and drives the rear wheels. The electric drive is in the front and drives the front wheels.

```
Batteries       144 Volts, 24 12-Volt blocks, 50 Ah each block,
                1 string of paired 12-Volt Optima Yellow Tops
Motor           GE 25 hp, shunt motor w/ regenerative braking
Controller      Curtis PMC P-series MOSFET
Engine          VW Fuel-injected, water cooled,
                engine and transmission (all but 1st gear removed),
                Chevy wheels adapted to the VW hubs.
Generator       Converted 24 V alternator
```

Figure 21 — The ‘Hybrid Lumina’ (also known as Challenger II) came all the way from Yachats Oregon to run in the NESEA Tour. It features a unique hybrid drive.

The control strategy is the basis of Clarence’s patents. "Basically when you get up to speed, a speed sensor closes a switch to activate a specially developed magnet torque converter which transmits torque depending on the amount of voltage you apply to it." His patent describes this as a ‘soft start’. At about 8 Volts the converter slips somewhat until the engine starts. Once the engine starts, the 12-Volt alternator on the engine builds the control voltage up to 14 Volts, at which point the torque converter is locked and the ICE is driving the rear wheels.

The Lumina has been running since about 1991. Clarence is looking for funding and wants to license his patent.

For more info:

Clarence Ellers
Electronic Transportation Design

PO Box 111
Yachats OR 97498
541-547-3506

Report 29: Team Profile - 'Lightning Volt'

I spoke with Pat Coyle, a senior, Mike Rinkunas, a sophomore, and Rich Fetcho, a junior, all of Parkland High School in Orefield PA. Their Chevy S-10 pickup conversion 'Lightning Volt' (number 74) is back for the third time.

Figure 22 – 'Lightning Volt' has been in the NESEA Tour for 3 years. It is a fine example of a conversion of a Chevy S-10 pickup truck to electric propulsion.

Range	80 miles
Max Speed	65 mph
Weight	4000 pounds
Solar Array	36 W Solarex polycrystalline
Motor	Advanced DC 9 inch
Controller	Curtis PWM 1221-B
Batteries	20 Trojan T-145, 120 Volts, 17.4 kWh
Regen Braking	alternator on the drive motor

The original truck was bought at auction and was pretty messed up. Pat's class first restored the body and chassis and then did the EV conversion.

For this year, Rich helped install new batteries and new Goodyear Conquest tires.

There are three drivers in the team, and this year they have been practicing to get all of them driving in a consistent manner. Where there are differences, they plan to have each driver on the legs where his or her strengths will help the most.

The regen braking is controlled through the brake pedal. When the regen is turned on, it is activated whenever the brake lights come on. The driver can increase the regen effect by down shifting to a lower gear, which drives the alternator faster and hence more current goes back into the battery.

Mike said this will be the last year for 'Lightning Volt' in the NESEA Tour. They plan to sell this truck and build another vehicle. They are considering an AC drive car, if they can get the funding.

Report 30: Team Profile - 'Team New England'

Olaf Bleck is here with his 1959 Berkeley racing as 'Team New England' (number 79). ((I think this car got in when another had to drop out, but I don't yet have the details.)) This car showed up for the last leg of the NESEA Tour last year, and also raced in the Autocross event in Portland ME immediately after the Tour was over. It is back with a brand-new interior; the old one was very, very shot.

Figure 23 — Team New England's '1959 Berkeley' is bright red and sporty as they come.

This is a tiny, little car, about 4 feet wide and about 10 feet long. It uses an older, 1990 Solectria AC induction motor system, salvaged when someone bought an upgrade for one of the earliest Solectria cars, and is powered by 13 of the Delphi EV batteries developed for the GM Impact/EV1 program. ((I am amazed that they all fit in and still have room for legs; Olaf is not short.)) There are 7 in the front and 6 in the "trunk". Olaf says, "they pack very nicely."

In addition to the new interior, they fixed up the chain drive between to motor and the differential. Last year they had trouble with the chain slipping off. There was also some wire repair, and "all the little details that take a long time to do, we got around to finally."

The car looks "hot"; bright red and petite, you might think it would go real fast. "Last year we had it up to 50, but it's 35 years old, made out of fiberglass, and not exactly the strongest car in the world." But this is not about smoking tires. "It is a nimble, little, cute car that looks neat."

I've been told that driving this car is like driving a video game; one pedal makes it go faster and the other makes it go slower. Because there is no transmission, you never have to unload the transmission so you can shift, which is an edge over transmissioned, and especially gasoline Autocross cars. And the regen baking is so powerful, you really don't need the mechanical brakes.

There is an Autocross event scheduled for when we get to Annapolis MD on Wednesday.

Report 31: Team Profile - 'Virginia Tech Ani mul SL'

'Virginia Tech Ani mul SL' is number 81 in the Chrysler Hybrid Category. The following is based on information from Randy Senger (rsenger@vt.edu), a mechanical engineering student and team manager of the Hybrid Electric Vehicle Team at Virginia Tech, Blacksburg Virginia.

The College of Engineering at Virginia Tech, and in particular, the Mechanical Engineering Department, supports a number of student involvement programs, including a hybrid car team, a Formula racing team, and an autonomous vehicle team. Of these, the Hybrid Electric Vehicle Team (HEVT) involves the most departments, faculty, and students from engineering and non- engineering majors.

The HEVT competed in the 1995 Hybrid Electric Vehicle (HEV) Challenge by converting a stock 1995 Dodge Neon into a hybrid electric vehicle in only nine months. Nearly 50 students working 6000 hours produced a car that finished fifth overall in its class, took second place in Design and received the awards for Best Safety and Best Sportsmanship. More information is available at

www.vt.edu:10021/org/hybridcar/

Figure 24 – Virginia Tech's 'Ani mul SL' packs a lot of hybrid EV technology into a deceptively simple looking package.

This year, the HEVT will be converting a 1996 Chevrolet Lumina, donated by General Motors, to race in the American Tour de Sol and the 1996 FutureCar Challenge. It is a Series Hybrid, where a fuel powered engine runs a generator that charges a battery, and the battery provides power to drive the electric motor which turns the wheels. In the VTech vehicle, named 'VT Ani mul SL' (Ani mul is Lumina backwards) there is a fixed gearing from the AC motor to the wheels, which means there is only one gear ratio. And when the car needs to back up, the AC motor is run backwards.

Specifications (As of 26 January 1996)

```
Engine:  1 liter Suzuki  (from a Geo Metro), 3 cylinder, 4 stroke
Peak Power rating:  41.0 kW  (55 hp)
modifications to the engine:  LPG Fuel, Engine Control Unit,
         operating at constant speed and load: approximately 19 kW
Fuel:     Propane, 15.8 Gallons (82 Liters)


Electric Motor Specifications:
Manufacturer:       General Electric
Model Number:       EV2000 prototype
Motor Type:         3 phase, AC induction
Rated Continuous Power:  60 kW (80 hp)  @ 3000 RPM
Peak Power:         85 kW (114 hp)      @ 5000 RPM
Maximum Torque:     195 N-M (143 ft-lb) @ 0 RPM
Maximum RPM:        15000 RPM
Rated Efficiency:   > 90%               @ All RPM
Weight:             86 kg (190 lbs)

Controller Specifications:
Manufacturer:        General Electric
Model Number:        EV2000 prototype
Controller Type:     IGBT Inverter
Input Voltage Range: 180 Low (V)     385 High (V)
Current Limit:       300 (amp)
Efficiency:          > 90%
Dimensions:          52 L x 42 W x 27 H (cm x cm x cm)
Weight:              13 kg

Battery Specifications:
Manufacturer:          Hawker Energy Corp.
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Model Number:          Genesis 26 A-h EP
Battery Type:          Valve-regulated, sealed Pb-A
Total Pack Weight:     300 kg
Number of Batteries:   28, 12 V each
Battery Pack Voltage:  336 V
Battery Pack Capacity: 28 amp-hr 9.4 kWh  for c/20 discharge.
                       22 amp-hr 7.4 kWh  for c/2 discharge.
 Cycle Life at a Depth of Discharge (DoD) of 80%:  350-500

 Battery Charger:
 Manufacturer:       Hughes
 Model Number:       Magne-Charge SCM
 Efficiency:         92% full power, claimed
 Charger shutoff mechanism: timed, voltage, and/or current cutoff
 Charger Input:      AC voltage      208-240 V
                     AC current 30 amp
 Charger Output:     DC voltage      432     V
                     DC current <20 amp
 Required Charge Time:     6 hrs from 80% DoD to full charge

 Series Generator Information:
 Manufacturer:       Fisher
 Model Number:       custom
 Generator Power Rating at Speed: 18 kW  Efficiency 95%  @ 2800 RPM
 Charging/Power Usage Strategy:  constant power,
                                 constant speed operation
                                 driven by battery SOC,
                                 with over-voltage limit

 Transmission:
 Manufacturer:       American Axle and Manufacturing
 Model Number:       from 4WD Chevrolet S-10 Blazer
                     front differential
 Year:               1983-9
 Number of Gears:    1
 Does it have a clutch?  No
 Axle ratio:         3.4:1
 Transmission gear ratio:  3.4 x 4.29

 Braking System:     electric vacuum pump with OEM braking system

 Hybrid Control Strategy:  APU (Auxiliary Power Unit,
                           i.e. engine+generator)
 APU on when battery SOC falls below 30%.
 APU off when battery SOC reaches 80%
          or bus voltage reaches 385 Vdc.

 Describe Hybrid Control Hardware (computers etc.):
        Motorola microcontroller 68HC11 controls APU start/stop,
        APU speed.
 Custom-built boost rectifier
        contains soft start, over voltage, over current,
        under voltage limits.

 Emissions Control Strategies:  Clean burning fuel (LPG),
        constant speed,
 constant power operation, closed-loop fuel control,
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        ignition with custom ECU tuning,
         exhaust catalyst formulated for LPG.

 Additional Instrumentation:
 Manufacturer:     Cruising Equipment
 Model:            kWHr+2
 Information monitored:  Bus voltage, current, kWhrs.
                         APU voltage, current, kWhrs.

 Additional Features or Information:  Power steering
       HVAC (heat, ventilation, air conditioning)
```

((Whew!))

At the New York City display, I spoke with Randy Senger, Greg Pettit, and Matt Merkle. After reviewing the specs and history (above) Randy felt that the experience of doing last year's Neon taught them a lot of "what not to do, more so than what to do. Our experience paid off in that we were able to put it together quickly. I think we did a very nice packaging job."

Report 32: Monday Snippets

I ran into the 'Helios the Heron III' folks, with one student wearing safety goggles and Playtex Living Gloves leaning into the rear section of the car. He was putting wire nuts on the ends of wires and taping them over with black electrical tape. The charger interferes with the driver's controls if left installed, so they disconnect it from the wiring each morning and seal up the dangling ends. At the end of the run they rewire the charger in.

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Rick Shanahan is a volunteer with the NESEA Tour who works for AeroVironment (of the Gossamer human-powered aircraft and GM Sunraycer fame). They have been doing electric vehicles and "in the process of building packs and cycling batteries, we basically built a cycler. Now we find people want the cycler, so we are now selling the technology that we had to develop so they can build the cycler." It is a 100 kW cycler, but different from every cycler I have ever heard of. Most cyclers have high power, very low ohm rating resistors to load down the batteries during discharge. "We actually put the current back into the electric power grid, and make the meter run backward." They also create very detailed reports during the tests, reporting numbers most people don't see, such as battery energy losses at many different charge/discharge rates and profiles. "For example we have found that when you hard-charge (with high current) a deeply discharged lead acid battery, it likes it better than when it is slowly charged." It accepts the charge better, faster, and also gives better cycle life.

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Goodyear Tire and Rubber Company is a title sponsor of the NESEA Tour this year, and along with a sizable display presence, they are providing additional logistical support. I spoke with Mike Sellers, who is providing tire and wheel services to race participants, Dave Russ, who is in Public Relations, and Petula Prudencia, an intern working the displays. Engineer Bill Egan is also here to give technical advice to the teams. They have a small tire shop in a van, so they can unmount, repair, remount and balance any team's tires that might require repair or changing.

Goodyear has several low-rolling-resistance tires on cars in the race (sometimes provided through sponsorships), including their Invicta GLR on cars and Conquest, originally developed for Chrysler minivans, on trucks. They also have a tire called the Momentum which is purpose-built for the EV market. These tires came about due to Big-3 interest in getting their CAFE (Corporate Average Fuel Efficiency) numbers down to acceptable ranges.

Low rolling resistance comes about through things like rubber and belting formulation, sidewall construction, and higher inflation pressures, all combined in the design. "Tires are composites of literally hundreds of parts and you can fine tune many of these in the design," says Dave.

Goodyear is also driving a Solectria Force as part of their fleet, for media and VIP drives.

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OK — Pop Quiz! What are the differences between methane, propane, Liquid Petroleum Gas (LPG) and Compressed Natural Gas (CNG)?

Pencils down!

LPG and propane are essentially the same, and CNG and methane are the same. LPG is about 97% propane, plus a few other distillates. CNG is lighter than air and LPG is heavier than air.

At the race, have six hybrids running on CNG, two on LPG, one on RFG (reformulated gasoline), one on E85 (85% ethanol, 15% gasoline) and one on bio-Diesel.

What do they smell like? E85 smells like Old Granddad (whiskey), LPG is cooking gas and doesn't smell much (to me), and bio-Diesel smells like cooking oil.

Report 33: Team Profile - 'Ottawa Orange IV'

This is the 4th year for a team from Ottawa Hills Technical Prep High School from Grand Rapids MI, this time with 'Ottawa Orange IV' (number 37). This "black beauty" is a rework of the frame from the last two years with a new, black plastic body that should improve the aerodynamics.

Figure 25 — 'Ottawa Orange IV' leaving Chesapeake City. The black body is a light, plastic faring over a box-tubing frame.

January Slater is a junior who worked on raising the money to pay for the trip to New York. She wrote letters and phoned and, apparently, they now have enough, "about 7 to 10 sponsors." There about 20 in the team, of which 8 students, plus 4 teachers, were able to come to the race.

Josh Ike helped both last year and this year. The car has a reconstructed frame, a new seat, and a 5-point harness. They changed it up to a 48 Volt system, and got a Monte Carlo kit-car body from a sponsor. The batteries are 8 12-Volt blocks in 2 parallel strings. There is a solar panel producing 800 Watts. Last year they got just about 70 miles. With the larger voltage they hope to go farther.

Ted Lovelady is the driver, and was also on the electrical team. Adding the extra batteries involved adding an extra supporting frame. The driver's seat is a deep, comfortable racing model with high sides that holds the driver firmly in position. A windowed hood covers the driver's position, but looks like it could get quite hot. Ted says that a pair of box fans under the dash provides enough air flow to help keep him cool and were a big improvement.

Report 34: More Snippets

Tom Hopper ((the man I want to be when I grow up)) is here with his bio-Diesel auxiliary power trailer. He > drove < his Hopper EV plus trailer hybrid to New York City from Concord, New Hampshire. "It was great fun. It was raining cats and dogs when we left and I would have probably given a lot of money for a real good defroster. The windshield is Lexan, which has an affinity for moisture that doesn't quit." He plans to replace the glazing with glass and get a good defroster someday soon.

He has been using the "pure" EV all this fall going to school (the New Hampshire Technical Institute, where he teaches) every day, rain or shine. He used the data collected from those trips, which included turnpikes doing 70 mph and country roads doing 40. His average speed was 35 mph, his average power consumption was 3.5 kW. He then designed the engine to give 3.5 kW at its "sweet spot", which is at 2550 rpm. "It gives me energy so I can drive at 40 mph, steady state." The engine is manually controlled from the driver's position.

Tom hopes to demonstrate that his 5 gallon tank can give him a 500 mile range. In fact he hopes to drive it back to Concord from Washington DC. "I have no trailer, but I have confidence. I'll stay on the blue roads; more scenic."

Since last year the motor has been changed from a Solectria GU motor to a GT, "which has more torque, and the gear ratio has been changed so I have more torque off the line and less high end speed," to pull the 300 pound trailer.

And the exhaust smells like a restaurant. 10 to 20% of the fuel is used Fry-o-lator oil. Yet he gets 127,000 BTUs per gallon out of it, and that is what Diesel fuel is.

Finally, Tom has added a stereo radio/cassette, "mainly for entertainment for everybody else." And because he is a kid at heart, which is why he is still here.

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He now also is representing Wallingford AC Controls, which builds the 'trans-2' which was supposed to be in the race with a specially modified version capable of the long distances. It just was not ready in time; they hope to display it in Washington DC.

Figure 26 — This 'Solectria Force' ran on Horizon advanced lead-acid batteries. It achieved 138 Watt-hours per mile. It was also awarded the *Best Sedan using Lead-Acid Batteries* prize.

42*	Golden Gear Special	RMAVTS - Golden Gear Racing
43*	KA1000	Polytech Chargers
44*	SolarSaurus	Rocky Hill High School
46*	Utility EV	PETC
57*	George the Geo	FMRHS - Solar Electric Racing
65*	Electric Hare	Wattsmen
66*	Genesis I	Genesis Team
63	Solectria Sunrise	NAVC / BECO / Solectria
72	Sungo	NHTI Electric Car Team
38	Sparky 2	Wooster's Charge
47	Electruck	Taylor-Dunn
88	OHM Ranger	Neocon / NYSEG
74	Lightning Volt	Parkland High School
79	54 Berkeley	Team New England
45	Regenerative Braking	Alternative Energy
82	Lectric Lion	North Hunterdon High School
54	Roadrunner	Greenwich High School Solar Flair

Report 35: May 13th Morning Race Summary

This report is based on the Race Summary handed out at the driver's meeting on Monday morning. It is the best information I have at that moment. There are several substitutions from previous lists.

```
 *  Tied for First Place in Category
 ** Tied for Second Place in Category
 X  Did not show up or maybe out of the race
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NAVC Production Category (in current standing order)

Number	Car	Team
4*	Solectria Force NMH	Solectria
7*	Nordic Challenger	EVermont/NAVC
34*	State Power	STAPPA/ALPA
50*	Solectria/Horizon	Connecticut EV/NAVC
17**	Ford Ecostar	Allegheny Power
15**	Solectria Force	JCP&L
14	Chrysler TEVan	Met-Ed Penelec/JCP&L/GPU

US DOE Commuter Category (in current standing order)

Number	Car	Team
12*	Twike	Technik & Design
31*	Spyder Juice	Solar Electric Spyder Juice
32*	Porsche 914 Electric	Bull Shadow Mountain Electric Matadors
33*	Solar Bus	Bridgewater Solar Works
35*	Kineticar	CSERT - NVCTC
39*	Sparky	EV Moore - CEVA

2X	Trans2-AC	Wallingford AC, Inc
24X	B-U-LLET	Boston University SEV Team

Solar Commuter Category (in current standing order)

Number	Car	Team
36	Texas Native Sun	Lonestar Solar Racing Team
83	Sol Survivor IV	CONVAL Solar Car Team
58	Sol Machine	Newburgh Free Academy
93	Helios the Heron III	Riverside School
75X	Commuter Car	Villanova Univ. EV Team

Chrysler Hybrid Category (in current standing order)

Number	Car	Team
26*	Hyperion	Team Hyperion
81*	VT Ani mul SL	HEV Team of Virginia Tech
94*	Hopper EV	Hopper EV
96*	Project e-	Mt Everett High School
84*	The Paradigm	Team Paradigm
28	Hybrid Lumina	Clarence Ellers
19	HEV U Florida	Univ of FL HEV Society
21	Hy Potential IV	University of Tennessee
23	Viking 23	Western Washington University
25	Viking 25	Western Washington University
48	Electric Lion	Penn State SAE

Open Category (in current standing order)

37	Ottawa Orange IV	Tech Prep
64	Proteus 1	Union College
52	Electrobike	CTC NEastAdvVehTecCtr
92	Sunpacer	Cato-Meridian HS Tech Team

Report 36: Team Profile - 'Electric Lion'

Figure 27 — The 'Electric Lion', a series hybrid from Penn State University, burns reformulated gasoline. It features separate electric motors driving each front wheel. Done properly, such an arrangement should make the car much easier to handle.

Duane Hobbs is from Penn State Society of Automotive Engineers, here with the 'Electric Lion' (number 48) in the Chrysler Hybrid Category.

Base Vehicle	1992 Ford Escort
Weight	3753 pounds
Top Speed	95 mph
Passengers	2
Engine	22 hp Kawasaki
Generator	Unique Mobility
Fuel	Reformulated Gasoline (RFG)
Motors	2 Solectria AC Induction (1 on each front wheel)
Controllers	Solectria, with regen braking
Batteries	Exide, 11,520 Wh
Range	40 miles ZEV, 200 miles HEV

Since there are two motors, each one independently driving a front wheel, the "differential" is a computer inside the glove box. A steering position sensor determines the amount of left or right turn the driver is requesting and then adjusts the power to the motors so the outside wheel will have more torque and turn faster as the car goes around the corner.

The independent motor control also allows the computer to determine exactly what each wheel is doing (as compared to what is desired) and the power to the wheel can be adjusted appropriately. The result is full time traction control, sort of like anti-lock brakes, but active all the time. This helped the car achieve superb times during the handling performance tests weaving around traffic cones.

A second computer controls when the engine is started or stopped, depending on battery voltage. Most the time the driver just drives the car. The driver can force the car into ZEV and ICE modes if required.

Report 37: Team Profile - 'Proteus 1'

I spoke with Terry Gilbert a mechanical engineering student at Union College in Schenectady NY. He showed me their 'Proteus 1' (number 64) racing in the Open Category.

Range	100 miles
Speed	60 mph
Weight	850 pounds
Wheels	2 front, 1 rear (cog-belt driven)
Dimensions	10'6" L x 4'6" W x 3'6" H
Passengers	1, 200 pounds
Design	purpose-built space frame, cromolley 4131 steel fiberglass & epoxy body
Batteries	60 Volt, 1200 Wh, lead-acid
Motor	Advanced DC
Controller	Curtis 1209-B

A team of two mechanical engineering students designed the car and three other students helped put it together in about 10 months. The body is shaped like a tear-drop, blunt-end forward, with the upper half of the front end serving as the windshield.

The springs in the suspension for the 2 front wheels are two stacks of 4 composite leaf springs. Teflon sheathing between each spring allows them to slide over each other as they flex. The company that manufactures them donated them to the car. (Last year we saw a similar idea made from a snow ski.)

The frame without the body has several hundred miles of testing, but the body was added just a couple of weeks ago. The NESEA Tour will be the first serious test of the entire vehicle.

Figure 28 – 'Proteus 1' is primarily a project of two Mechanical Engineering students at Union College in Schenectady NY.

Report 38: Team Profile - 'SolarSaurus'

Tony Guida and Eric Berner showed me the 'SolarSaurus' (number 44) from Rocky Hill High School in Rocky Hill CT. One glance told me this was a Bob Batson EV design.
Bob likes to lay out all the major electrical components, controllers, contactors, shunts, interconnects, etc. on a large piece of plywood or phenolic that sits high in the "engine" compartment. He lays out the color-coded wiring in a very neat, almost rectilinear manner that lets you read the circuit schematic diagram directly from the wiring. The result is a system that is easy to read and understand and, I dare say, cuts down on "where does this wire go-to/come-from" questions or mistakes. 'SolarSaurus' is just such a vehicle. A tyranosaurus logo is on the hood. (Rocky Hill has a state (national?) park with dinosaur tracks in the rocks.)

Base Vehicle	1982 Dodge Rampage
Battery	120 Volts, Trojan T145, lead acid, 22 kWh
Controller	Curtis PMC 1221-C
Motor	Advanced DC

Figure 29 – 'SolarSaurus' is a very professional conversion of a Dodge Rampage by the team from Rocky Hill CT High School.

Ben and Jerry's donated the truck. The team started working in November, ripping out all the gas parts and putting in all the EV stuff. The Rampage is a sporty pickup truck, and the battery box, made of ((what looked to me to be)) polypropylene, sits in the truck bed just behind the cab. The wiring here is again very neat and obvious.

This is one of the neatest conversion vehicles at any NESEA Tour I've attended. There are a few college students and adults who could learn a thing or two here.

Report 39: Team Profile - 'Solar Bus'

I spoke to Ed Witkin and Amelia Shrader-Witkin (his daughter, age 7) about 'Solar Bus' (number 33).

Base Vehicle	1969 VW Microbus
Solar Panel	480 Watts
Battery	120 Volts, Trojan T145, lead acid, 22 kWh
Controller	Curtis PMC
Motor	Advanced DC, regen alternator

"We are also Bob Batson groupies here," says Ed. The battery "tank" is mid- ships and serves also as the support for the middle bench seat.

Ed has been into solar energy for many years. He used to do "music in the mountains" near Atlanta. The generator was always too noisy and was always breaking down, and that's when he discovered the sun. When they moved to Connecticut, he built a solar house. Ed ran the solar powered sound system for the NESEA American Tour de Sol in 1991.

After the third engine burned out on the bus ... , well, you know the story. Now it is their every-day vehicle. The alternator used for regen braking is connected via an electric clutch to the tail shaft of the motor. It sends back 30 amps into the batteries. Ed got those parts from Solar Car Corporation in Florida.

Figure 30 – 'Solar Bus' raced as a family project. Ed Witkin's daughters and dog served as navigators during the Tour.

Report 40: Team Profile - 'Sungo'

I spoke with Randy Kezar, Spencer Allen and Scott Hall of New Hampshire Technical Institute who are with 'Sungo' (number 72) racing in the US DOE Commuter Category. 'Sungo' is back for its fifth year. Once again it has two motors separately driving the rear wheels with an electronic differential, on a welded aluminum frame and a composite molded body.

New for this year is a demonstration of an auxiliary battery system. Like the old VW bug and most motorcycles, where there is some undrainable fuel that could be gotten at in an emergency, this car has some undrainable energy held in reserve. In addition to the regular battery pack good for approximately 100 miles, there is a second "limp home" auxiliary pack good for about 10 miles. The main pack is made up of Electrosource Horizons holding 11 kWh and the auxiliary pack is made up of Deka Dominator gel-cells holding 1 kWh. Both packs are 120 Volts made up of 10 12-Volt modules.

Figure 31 – 'Sungo' improves each year. This time it featured Horizon batteries, a BADICHEQ battery management system, and a spare battery pack that is the moral equivalent of a spare can of fuel in the trunk.

The main pack is managed by a BADICHEQ battery charge controller which controls charge current to each of the modules. Most chargers only read the total string voltage when attempting to determine state-of-charge. One weak module in the string, or even a shorted cell, can cause the charger to overcharge the rest of the modules while trying to make up for the "missing" voltage of the weak module. This shortens the life of those remaining modules. BADICHEQ has a wire going to each of the module terminals and thus can read the voltage of each module. It also has a small, 20 Watt power supply and can add extra current to some of the modules that are lagging behind the others. Over several charge cycles, the lower voltage modules get the extra current they need to come up to full charge with the rest of the string. Modules with shorted cells are also easily identified. Which is exactly what happened in 'Sungo'; Spencer told me that they found a bad battery a week after they installed the system.

New in the safety department are a pair of side-impact bars made of 4130 cromolley steel inside the body to provide more of a cage around the passengers in case of a side collision or roll-over. These were Scott's senior project.

Report 41: More on 'Viking 23'

I spoke with Roseanne Gile, a vehicle design major, and Jeff Scott, a manufacturing engineering tech major, both from Western Washington University. 'Viking 23' (number 23) is a CNG fueled parallel hybrid capable of 30 miles as a ZEV (Zero Emission Vehicle), and 400 miles using its ICE (Internal Combustion Engine). The car is very similar to 'Viking 21' which was the only hybrid in the 1993 NESEA Tour and which served as a mule for 'Viking 23'.

What caught my eye is the car is basically two pieces; a 3/8 inch thick carbon fiber Nomex sandwich chassis topped by a body of essentially the same construction. Even the roll bars are composite construction. The chassis weighs 90 pounds. The body is a little less. Add all the batteries, motor, transmissions, engine and glass, etc. and it weighs about 2000.

The selection between modes is entirely manual, and there are separate gear boxes (which share a shift lever) for both electric and ICE operation. My first impression is that it would be helpful to have 4 legs and 3 hands, and Roseanne agreed it sometimes seemed that way. But Jeff made the point that the car is usually used in one mode or the other (ZEV or ICE). Driving in both can be done, but is tricky. Not surprisingly, their strategy is to run electric around town and ICE when on the highway legs.

The body is covered with satellite grade solar cells which convert 17% of the sun energy to electricity(!), but cost $18,000.

The car can also burn gasoline as its fuel, but that tank was removed for this competition. The engine has separate injection rails for CNG and gasoline.

Roseanne reminded me that they "are completely donation funded, so donations are appreciated."

Report 42: More on 'Hyperion'

I spoke with Shawn Newell, briefly. 'Hyperion' is a parallel hybrid, and is supposed to have a microcontroller controlling the switching between the ZEV, HEV, and ICE modes. The student responsible for the microcontroller is now at a co-op job and won't be back until September, when he will pick it up again.

The students are encouraged to document what they do in detail, since these projects last longer than the time individual students stay. If the designs and decisions are written down, then the knowledge can pass down through time to the next generation.

'Hyperion' burns E85 as its fuel, a mixture of 85% ethanol and 15% gasoline. Its exhaust has a distinct aroma because ethanol is a grain alcohol. It reminds me of Old Granddad. "The fuel is essentially moonshine, but the added gasoline means you cannot drink it."

Report 43: Team Profile - 'Porsche 914 Electric Bull'

The 'Porsche 914 Electric Bull' (number 32) is here from Shadow Mountain High School in Phoenix Arizona. I spoke with Michael Golden the team's faculty advisor. "This is a 1973 914. My students and I converted it about 3 years ago. Probably one of the best student projects we have ever done."

Top Speed	90 mph
Range	90 miles @ 45 mph
Weight	2900 pounds GVW
Transmission	stock 5 speed
Conversion time	1400 hours
Motor	Advanced DC
Controller	Curtis
Battery	20 Trojan, 120 Volts
Solar Array	5.1 W, 17.5 Volt at load
Charger	Lester outboard
Tires	Goodyear, Corsa GT

Figure 32 – The 'Porsche 914 Electric Bull' was built by a Phoenix Arizona high school team. They financed their trip east to the NESEA Tour by finding several generous sponsors.

7	Nordic Challenger	EVermont/NAVC
15	Solectria Force	JCP&L
12	Twike	Technik & Design
50	Solectria/Horizon	Connecticut EV/NAVC

It has taken first place awards at the APS in '95 and '96 (both in Range and Braking And Handling), the Disneyland Clean Air Road Rally '95, the Palm Springs Road Rally '95, and the SRP Pride Expo in '94 and '95 (Range EV).

This was a creation of the students (not a kit). The first car was a 4 door Chevette that was so successful that when they asked for a 914, the owner of Black Horse Motor Works(?) donated them one. "We've won almost every race we've been to so we are here to kick some Eastern butts!"

American West Airlines was the key to their getting out here. They donated the air travel for the team members. And Reliable Car Carriers donated transporting the car. (Clearly finding funding can be as important as building the car.)

More Info: 602 867-5359

Report 44: May 14th Morning Race Summary

This report is based on the Race Summary handed out at the driver's meeting on Tuesday morning. It is the best information I have at that moment.

* Tied for First Place in Category
*** Tied for Third Place in Category
**** Tied for Fourth Place in Category
X Did not show up or maybe out of the race
Y Dropped out of the race (my understanding)

NAVC Production Category (in current standing order)

Number	Car	Team
4	Solectria Force NMH	Solectria
17	Ford Ecostar	Allegheny Power
34	State Power	STAPPA/ALPA

14	Chrysler TE Van	Met-Ed Penelec/JCP&L/GPU

US DOE Commuter Category (in current standing order)

Number	Car	Team
63	Solectria Sunrise	NAVC / BECO / Solectria
72	Sungo	NHTI Electric Car Team
32	Porsche 914 Electric Bull	Shadow Mountain Electric Matadors
35***	Kineticar	CSERT - NVCTC
43***	KA1000	Polytech Chargers
39***	Sparky	EV Moore - CEVA
88***	OHM Ranger	Neocon / NYSEG
33****	Solar Bus	Bridgewater Solar Works
42****	Golden Gear Special	RMAVTS - Golden Gear Racing
66****	Genesis I	Genesis Team
65****	Electric Hare	Wattsmen
31****	Spyder Juice	Solar Electric Spyder Juice
44	SolarSaurus	Rocky Hill High School
38	Sparky 2	Wooster's Charge
47	Electruck	Taylor-Dunn
74	Lightning Volt	Parkland High School
57	George the Geo	FMRHS-Solar Electric Racing
46	Utility EV	PETC
54	Roadrunner	Greenwich High School Solar Flair
82	Lectric Lion	North Hunterdon High School
79	54 Berkeley	Team New England
45Y	Regenerative Braking	Alternative Energy
24X	B-U-LLET	Boston University SEV Team
2X	Trans2-AC	Wallingford AC, Inc

Solar Commuter Category (in current standing order)

Number	Car	Team
93	Helios the Heron III	Riverside School
36	Texas Native Sun	Lonestar Solar Racing Team
83	Sol Survivor IV	CONVAL Solar Car Team
58	Sol Machine	Newburgh Free Academy
75X	Commuter Car	Villanova Univ. EV Team

Chrysler Hybrid Category (in current standing order)

Number	Car	Team
94	Hopper EV	Tom Hopper
96	Project e-	Mt Everett High School
26	Hyperion	Team Hyperion, Wentworth IT
48	Electric Lion	Penn State SAE
23	Viking 23	Western Washington University
81	VT Ani mul SL	HEV Team of Virginia Tech
84	The Paradigm	Team Paradigm, U. of Wisconsin
28	Hybrid Lumina	Clarence Ellers
25	Viking 25	Western Washington University
19Y	HEV U Florida	Univ of FL HEV Society
21X	Hy Potential IV	University of Tennessee

Open Category (in current standing order)

52*	Electrobike	CTC NEastAdvVehTecCtr
92*	Sunpacer	Cato-Meridian HS Tech Team
64	Proteus 1	Union College
37	Ottawa Orange IV	Tech Prep

Report 45: Team Profile - 'Genesis I'

Brad Notter is with the 'Genesis I' (number 66) team, a perennial favorite, mostly because they come with lots of knowledge and spare parts and are willing to share both.

Figure 33 – 'Genesis I', Mark Parthe's daily commuting vehicle in Saginaw MI, might be named *Generous I*. Mark and Brad Notter helped many teams and the NESEA Tour staff during the race.

Base Vehicle	1989 Dodge D50
Batteries	Trojan T-145, 24.2 kWh, 120 Volts
Motor	Advanced DC Shunt
Controller	Curtis 1231C-8601
Chargers	onboard: Todd High Freq/SS
	offboard: Solar Car Corp. Ferro-Resonant
Solar Array	42 Watt Solarex Amorphous Crystal
Tires	Goodyear Conquest
Regen Braking	alternator tied to electric clutch on the motor
	tail shaft with twin V-belts

Last year the regen was only half-working, because of a fried alternator winding. Now they have the full regen. The batteries now have 230 cycles on them in 3 years of use. They had to replace 2 batteries after the winter (when the truck was in storage). "They were supposed to get 400 cycles on them, but we are not going to make it."

They also rebuilt the front suspension this year when it wouldn't hold an alignment.

Before the race even started they were performing their Good Samaritan duties for 2 teams. "We gave one team a forward gear so they could go. They have no reverse; we have to rewire their contactors."

Report 46: Team Profile - 'Golden Gear Special'

The 'Golden Gear Special' (number 42) is from Reading-Muhlenberg Vo-Tech in Reading PA and I spoke with Thomas Mohn, the faculty advisor.

Figure 34 — The 'Golden Gear Special' is another high school project, based on a Pontiac Fiero. It has particularly large batteries which brings its curb weight to 3600 pounds.

Base Vehicle	1987 Pontiac Fiero, Monocoque, ABS plastic body
Solar Panel	4.7 Watt, IPC Canada

Batteries	10 Deka 9C-12, lead-acid, 21.6 kWh, 120 Volts
Motor	Advanced DC FBI-4001, toothed belt drive to original transaxle
Controller	Curtis 1231-C
Charger	K&W BC20, transformerless, onboard

This car was in the 1994 NESEA Tour, but had difficulty with energy efficiency. It consumed about 1 kiloWatt-hour per mile and thus had difficulty getting to the end of each leg. They figured out what was wrong just in time to fix it for the last leg of the race. It turned out that one of the control leads to the controller was not crimped properly, but made enough of a contact for the car to run. This high-resistance contact, even though it was in a control lead, caused the controller to under power the motor and hence the poor power usage. Once they found that problem and corrected it, the car delivered about 5 miles per kiloWatt-hour.

The car this year has a slightly larger battery than before, so they are hoping for better mileage. The new batteries are a flooded cell design normally used in floor-scrubbers. Each module weighs 129 pounds each.

Report 47: Team Profile - 'Kineticar II'

New this year is 'Kineticar II' (number 35) from Naugatuck Valley Community Technical College in Waterbury CT. I spoke with Paul Mastrangeli, a business finance student, who is back for his 2nd year. Paul is responsible for the data collection taken from the Cruising Equipment E-Meter into his laptop computer through an RS-232 interface. Normally they could watch the data as they drive, but the battery on the laptop has not been lasting long enough to complete a leg, so they are instead downloading the data afterwards.

This is Naugatuck's 2nd vehicle. 'Kineticar' ran in all the NESEA Tours from 1992 through 1995. In 1995 it placed second among the student built vehicles and 4th overall in the American Commuter Category.

Figure 35 — 'Kineticar II' finishes the NESEA Tour on the Capital Mall.

Base Vehicle	1989 Chevy S-10
Weight	3600 pounds
Battery	20 6-Volt Trojan T-145, 120 Volts
Motor	Advanced DC 9 inch, 38 hp
Controller	Curtis PMC
Transmission	5-speed manual
Gauges	Motor RPM, Motor Current, kiloWatt-hours, MPH,

	Total Distance
Solar Array	25 Watts, United Solar Amorphous Cells

One distinguishing feature is that they replaced the truck hood with a clear plastic, with the solar cells mounted on it. You can both see them and some parts of the "engine" compartment without lifting the hood.

This year they have upgraded the controller to the 500 Amp Curtis controller, re-did the rear end, and improved the suspension.

More info: Don Narducci at 203-575-8090

Report 48: Team Profile - 'Lectric Lion'

We have two vehicles named "something Lion". The 'Electric Lion' is from Penn State.

But the 'Lectric Lion' (number 82) is from North Hunterdon High School in New Jersey. I spoke with Robert Zappulla and Daryl Sienicki, students on the team.

Base Vehicle	1989 Chevy S-10
Speed	60 mph
Range	50 miles
Battery	Trojan, 22 kWh
Solar Array	55 Watt Hoxan-Solec
Motor	Advanced DC 9 inch
Controller	Curtis 1231-C
Regen Braking	Motorola

Figure 36 – The 'Lectric Lion' was built by both North Hunterdon New Jersey High School students and night school students in about half a year.

"The conversion was performed by the high school students and a night class. All the parts were donated by local corporations; the truck itself was given by JCP&L. It took roughly half a school year," says Robert.

An alternator is connected to the motor shaft through a clutch. To activate the regen, you step on the brake until you hear a click. Then you press the accelerator pedal to activate the actual braking effect.

The truck was completed just a couple of weeks ago, so the NESEA Tour is its first long run.

Report 49: Notes from Lambertville, Sunday Night

Bill Glickman's 'Regenerative Braking' (45) suffered "lightning strikes" that burned out his controller. He only got about a 50% charge in NYC, so he made about 32 miles along the way to Lambertville NJ. While driving the vehicle to position it for charging he heard a "snap" and then someone saw smoke. When he took apart his controller ((which looked to be an older model, possibly using SCRs)), he found holes burned through the power transistor cans.

But he wasn't out of the race! Mark Parthe, of 'Genesis I' (66) lent Bill a Curtis controller, which Bill installed overnight in Lambertville. He hoped to start with us on Monday morning.

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Stacy Clifford told me that 'Texas Native Sun' (36) started OK in NYC but had some trouble with the motor which they hoped to have repaired by start time on Tuesday morning. This is the car's first race; they hope to be in at least one other this year.

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'Ottawa Orange IV' probably did not make any friends in New York City. A wire came loose that caused the car to stop in the middle of the Holland Tunnel. They repaired it and drove out. They made 54.8 miles before they ran out of battery.

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'Sunpacer' (92) almost made it to Lambertville. They ran out of juice 1.5 miles before the finish banner.

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'Helios the Heron III' (93) only traveled 1/2 mile in NYC, because they did not want to deal with the Holland Tunnel. Still it was a victory. It was the first time that any 'Helios' was able to drive under the banner with the start of the race.

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'Lightning Volt' (74) was done in by the NYC stop-and-go driving at the beginning and the steep hills before the finish banner. They missed the end by 4.7 miles. They also suspect the new batteries haven't been cycled enough.

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'1959 Berkeley' (79) got about 55 miles before running out of juice. Under-inflated tires and batteries that had been sitting all winter took the blame.

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'George the Geo' (57) made it all the way through from NYC to Lambertville. Their 2-string battery strategy apparently paid off.

Report 50: Monday's Efficiency Awards

The best efficiencies seen during the first day's run were:

Category	Vehicle	Energy Use
Open	'Sunpacer' (92)	150 Wh/mile
Commuter	'Sunrise' (63)	117 Wh/mile
Production	'EVermont' (7)	130 Wh/mile
comparison	Gasoline Neon	509 Wh/mile

That comparison Gasoline Neon is a rental car that is driving the same race course along with the rest of the pack. It is being measured so we can do some apples-to-apples comparisons of EVs and ICEs.

Report 51: Team Profile - 'Electric Hare'

Erica Pearl is a driver with the 'Electric Hare' from Falmouth High School in Falmouth Maine. It was the favorite with the folks in Portland ME last year.

Base Vehicle	1984 VW Rabbit
Batteries	20 Trojan T-145, 120 Volts
Motor	Advanced DC Series, 15 kW continuous, 30 kW peak
Controller	Curtis PMC 1221
Solar Array	52 W Solarex Crystalline

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Chargers        onboard: K&W transformerless
                offboard: Lester transformer/rectifier
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Figure 37 — The 'Electric Hare', based on Mike Brown's Voltsrabbit kit, was entered by the students at Falmouth Maine High School.

This year they got all new batteries and a new charger. They did very well on the leg from NYC to Lambertville NJ. "We had a lot more Volts left than we thought we would." Erica was also involved with putting the graphics on the car last year.

Paul Nicklas told me that the car was donated by one of last year's seniors; it had been rusting in his back yard. It was repainted by a local car dealership in Falmouth. They raised money by soliciting local businesses. Their physics teacher, Mr. Harick (sp?), was the leader who saw the project through. The basis of the conversion was the Voltsrabbit kit from Mike Brown's ElectroMotive.

Between races, the physics teacher drives it (since he put up a fair amount of the money) and loans it to team members, and it has appeared at events, such as being the first car across a new bridge.

Report 52: Team Profile - 'Sol Survivor IV'

'Sol Survivor IV' (number 83) was finished just before few days before the start of the race so the team was learning things as they went. I spoke with Mark Seeger, Ben Cheavers, Mat LeClair, Josh Huber, and Greg Perry.

Their energy consumption from NYC to Lambertville was higher than expected, so their controller refused to go any further when the battery voltage got too low. They were thrilled that they had no mechanical problems. They started the car about 3 months ago, so it is not quite the way it ultimately will be. For example it will get a windshield and doors.

To describe it; it is long thin "tub" that carries 2 people, one behind the other. A steel-tube frame is inside the tub and holds up the roof and provides attachment for the suspension elements. There are 4 wheels at the "corners" of the tub, and they will eventually be under farings. A rear solar panel "wing" is behind the rear passenger, and a small roof held up by 4 posts is above both passengers. Eventually glazing will surround them, but for now it is quite open to the elements.

Figure 38 – 'Sol Survivor IV' is the latest in a long line of cars entered in the NESEA Tour by the CONVAL High School team from Dublin NH.

Body	Steel Tube Frame, Fiberglass/Kevlar body
Batteries	12-Volt, Powersonic sealed lead-acid, 120 Volts, 8 kWh
Motor	Solectria AC induction, 28 HP
Controller	Solectria AC-300
Solar Panel	268 W, Solartex, Monocrystalline

'Sol Survivor III' climbed Mt. Washington, so someday they will make the attempt in SSIV; in June to be exact.

SSIII had outboard solar panels that, according to NESEA Tour rules could be used at stops as long as they were carried in the vehicle. SSIV should also get the same, but doesn't have them yet.

Report 53: Team Profile - 'George the Geo'

'George the Geo' (number 57) is from Fall Mountain Regional High School in Langdon NH. I spoke with Greg Bascom.

Figure 39 – 'George the Geo' has both its internal and trailer battery packs open for inspection. The pack in the trailer was used to let the larger internal pack "rest" a bit and recover some of its capacity. Switching back and forth proved quite effective in obtaining extra range. 'Sungo' (72) also used this strategy.

Base Vehicle	1991 Geo Metro hatchback
Solar Array	150 W Siemens, single cell, double crystal
Batteries	Trojan lead-acid
Motor	Advanced DC 9 inch
Controller	Curtis 500 Amp
Chargers	onboard: K&W transformerless
	offboard: Lester transformer

This car has two 120-Volt strings that the driver switches between manually. Thus when one string builds up surface charge they can let it rest while using the other. The result should be greater range without having to stop to let the batteries "rest".

One string is 10 12-Volt modules; 2 in the front of the car and 8 in the back. The second string is 20 6-Volt modules in a detachable trailer.

Report 54: Team Profile - 'Electrobike'

Chris Martin is the President of BAT 'Electrobike' (52) in Rome NY. The company is part of a "business incubation" center in Rome run by James Dunn. I spoke with both of them. BAT is the company we know from the west coast, both for "BAT Juice" and BAT electric vehicles.

Figure 40 – 'Electrobike' may not look special until you notice the large rear wheel hub motor and the batteries mounted on the frame between the wheels.

The bike is built on a Raleigh full suspension mountain bike frame. The add a very powerful 36 volt Heinzmann (of Germany) DC brushed hub motor to the rear wheel which then can drive the bike at about 20 mph without pedaling. A twist throttle on the handle, much like a motorcycle has, allows variable power settings. The batteries are 45 Volts of Nickel Cadmium totaling 1100 Wh.

The production bike is 60 pounds. In the race they had 2 22-pound battery packs, plus another 10 pound battery for emergency, plus 7.5 pounds for the motor, plus the weight of the bike. Having a full-suspension bike, with both wheels on springs and dampers, makes the weight of the motor and batteries transparent to the rider.

In the race, the rider pedals up to speed and then uses the electricity to cruise, or help going up hills.

The bike is for sale, $1,699.

Report 55: Bob Larsen, US DOE testing team

Bob Larsen is here with several colleagues from Argonne National Labs performing tests on the cars. Many (most?) of the cars were put on a dynomometer at the NYC Department of Environmental Protection Testing Lab in Brooklyn NY sometime during the week before the race started. I caught Bob who gave me some early impressions.

'Solectria Sunrise' (63) got 125 Watt-hours per mile on the dyno running the Federal Highway Driving Cycle (FHDC). For the New York Light Duty City Cycle and the Urban Driving Schedule, the 'Solectria Force NMH' (4) actually did better than the 'Sunrise'. "That may have something to do with the fact that the 'Sunrise' is so light and efficient that the dyno setting cannot go down low enough to accurately represent what is going on." They both got on the order of 200 Wh/m on a very challenging city cycle without much regen and lots of repeated, short acceleration.

The hybrids were also very interesting. One vehicle, 'Viking 25' (25) achieved California Ultra-Low Emission Vehicle (ULEV) standard, even without using the electric motor much. "Most of the hybrids are not getting quite the efficiency numbers we would have thought. It's probably because it is very challenging to get a control strategy that is sophisticated enough to blend two sources of power efficiently over a highly transient driving schedule."

Report 56: Team Profile - 'OHM Ranger'

The 'OHM Ranger' (number 88) is a Ford Ranger pickup truck converted by Neocon Technologies of West Babylon NY for NYSEG. I spoke with Dave Shemmans from Wavedriver Limited and Gus Sfakianos of Neocon.

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Base Vehicle    1994 Ford Ranger
Batteries       Electrosource Horizon, 324 Volts
Controller      Wavedriver AC
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Motor           Indramat AC Induction, 30 kW continuous, 50 kW peak
Chargers        onboard: Wavedriver, 10 kW Transformer/Rectifier
                offboard: Lockheed/Martin, 10 kW, Transformerless
                BADICHEQ battery management system
DC/DC Converter Wavedriver
Range           about 100 miles
Speed           65 mph
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The controller is made by Wavedriver, and is a combined drive and charging system (although it is only being used as a driving system in the 'OHM Ranger'). "Normally you can put 3-phase AC into this unit and it becomes a high-rate charger. Because 3-phase is not being used during the race, we are just using it as a motor controller. [It delivers] 250 Amps per phase, at 75 kiloWatts, which is just short of 100 horsepower." The unit can work at up to 700 Volts dc.

The motor is made in Germany by Indramat. "It is very, very efficient." The motor is mounted under the cabin, in what would normally be the space occupied by the rear of the transmission. The motor is tied directly to the drive shaft and is positioned for a balance that helps preserve good handling.

Both the controller and the motor are liquid cooled through a radiator, but some of the heat can be captured to heat the cab. "Liquid cooling also allows the motor and controller to be smaller."

A separate DC/DC converter capable of 80 Amps at 13.8 Volts is also made by Wavedriver. It is used to charge the auxiliary battery and provide power for the accessories, lights, etc.

Wavedriver provided the electronics and motor to Neocon who installed them in the Ranger. This is their first public exposure in the United States. "We also have customers that connect our unit to the electric power grid and use it to do power factor correction and harmonic compensation. Our unit lets you control the power factor. You can have a power factor of one, or compensate for other power factors that are not ideal."

When they drove the truck from West Babylon to New York City, they were getting about 250 to 300 Watt-hours per mile.

More info: +44 1763 260777; gregm@wavedriver.co.uk

Report 57: Junior Solar Sprints

Many of the NESEA Tour stops are accompanied with Junior Solar Sprint (JSS) races, where students build solar powered model race cars that run along a guide-wire. They are given kits that contain the solar panel and the motor, but the rest is up to them. 'The Sunchaser' was one such car, built by Tricia Pogovelski and Meggie Pogovelski, sisters from Denville NJ who were at South Hunterdon High School for a JSS event that was held after the big cars left. Tricia and Meggie were here with their science club, as were many others from schools all around Lambertville.

Figure 41 — Running on nothing but sunlight, the Junior Solar Sprint cars show the next generation how to create transportation that uses sustainable energy. A guide-wire steers the silent cars down the track while the crowd roars its encouragement.

Report 58: Team Profile - 'Solectria Force' (JCP&L)

P. J. O'Donnell from JCP&L was pleased with his new 'Solectria Force' (number 15) which they received a few weeks ago. It was second under the finish banner on the first day.

It is running Interstate flooded lead-acid batteries. Normally their Force uses Sonnenschein gel-cell batteries, which require no maintenance, but they are not as energetic as flooded cell batteries and would have a harder time making the longer legs of the race.

Report 59: Team Profile - 'Ford Ecostar'

Don Morchesky from Allegheny Power in Greensburg PA is with the 'Ford Ecostar' (number 17). It was first under the banner at the end of the first leg. He made a point of the fact that they are not here necessarily to win, but rather to show Ford's long commitment to EV development and the capabilities of the Sodium Sulfur battery technology.

Base Vehicle	1993 Ford (European delivery van)
Solar Array	Ford Glass, 32 cells
Batteries	ABB Sodium Sulfur, 30 kWh
Motor	GE AC Induction, 30 kW continuous, 56 kW peak
Controller	Ford
Charger	onboard: Ford, 5.7 kW
Tires	Firestone Concept EVT

The mission for Allegheny Power, when they took the lease program with Ford, was to use the EV for both public relations and testing. This Ecostar now has about 20,000 miles on it. It is used by meter readers day-in and day-out in between publicity events. It even has a few dents and dings to prove it. They added large windows in the payload area, at the request of the day-to-day users.

Ford has decided that they are not going to continue with the sodium sulfur batteries in their EVs, because of the problems associated with the high temperatures they require. In fact, Don said, they had a battery pack ''freeze'' on them because the control logic on the battery maintenance controller was made much less forgiving after some early problems with overheating cells. The result was that the slightest anomaly would cause the pack to head for freeze mode. Don said that last August they did have the first battery freeze, but they have had no problems with the one they got as a replacement. The frozen battery can be reconditioned, but that is an off- board operation.

Figure 42 — Based on a European delivery van, the Ford 'Ecostar' uses Sodium-Sulfur batteries capable of delivering well over 100 miles per charge.

Don did not know what the fate of their Ecostar would be. He felt it would make an ideal vehicle for his mission, even with a less energetic battery. (We agreed that engineers are often unable to understand the minds of marketers.)

Report 60: Monday Morning Snippets

Bits and pieces recorded Monday morning in Lambertville NJ.

'Proteus 1' (64) was only able to make 50 miles of the 63 mile leg, which was less than expected. They suspected that the drive belt to the rear wheel might be too tight and the front end might not be quite aligned.

And the stop and go traffic in NYC and Newark probably added up to 25 traffic lights, which also took a toll.

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Jim Mailin with 'Roadrunner' (54) told me that they broke down after only 5 miles. "The coil springs in the back, when the mechanic fixed them I guess he did them a little bit wrong, and somehow with the bouncing the drive shaft fell right out" and then pushed the rear end back and ripped off part of the suspension. They were going to try to get it repaired.

This is a double shame since they drove it from Greenwich CT to NYC for the race, demonstrating that it is a usable car.

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The 'Electrobike' (52) made it all the way through, but the team was a little bit concerned that it was at freezing last night and that might affect the charge they got. NiCad batteries are relatively temperature insensitive, but it was going to be a challenging course to Boyertown.

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Every year I've been at the race the team with 'Genesis I' (66), Mark Parthe and Brad Notter, have served above and beyond the call of duty and good sportsmanship by helping out other teams in trouble. (They are by no means the only helpful team; generosity is very evident here).

By Tuesday morning they had already helped "one guy with blown fuses and chargers, one school that just wasn't ready, and a lot of little miscellaneous stuff, but not near what it was last year. Even 'Helios' was working. They had a couple of bugs, but we got them fixed up."

'Genesis I' did not do as great as it did last year. The cold and the wind in the city affected the ability to take charge. They were able to drive under the finish banner, if slowly.

The age of the batteries is starting to show. Last year the pack delivered 24 kiloWatt-hours. This first day they saw 20.

Mark uses the truck every day to drive 22 miles back and forth to work, for shopping and for service calls. It is used all summer long until the snow falls.

Will there be a 'Genesis II' someday? "We've been thinking about it. 100 miles (per charge) is pretty good in a home-built, and I didn't loose it in the divorce. For now this is fine." Mark is waiting for the better batteries before he tackles another project.

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"Tails from the Charging Trailer"

Think about it. You have 49 electric cars that all want to be charged each night after running a minimum of 60 miles the previous day. Some want 120 Volts ac, others want 208 Vac, others want 220 V. When they first plug in, they all are sucking very hard on those extension cords. And if they have chargers with poor power factor (that is, with very inductive loads) or poor power quality (that is, non-sinusoidal current loads with lots of spikes and harmonics) the circuit breakers can get quite warm, or even hot. The 'Electrobike' (52) team actually had an infrared camera that let us look at the breakers and we could see the hot ones. ((I think I heard someone saying that one was running about 130 degrees F.))

Ron Lessard (le Sard) is one of the tenders of the charging trailer. He and his team must cable the electric panels on the trailer into a 400 Amp or larger, 3-phase circuit each afternoon, be ready to plug all the cars in about 7 pm, monitor the charging for problems (which often takes them until midnight or beyond), unplug the cars, disconnect the trailer, drive to the next site, and do it all again.

This is Ron's first NESEA Tour and Friday night in New York City he was completely by himself. Talk about your learning-under-fire exercise. Saturday night, Bob Goodrich came down from Waterbury CT (despite having had a heart attack 6 months ago and a more recent problem) to help out.

They are collecting data on power consumption and on current waveform harmonics. These will be written up in technical papers that will be presented at the NESEA Sustainable Transportation/Solar and Electric Vehicles Conference September 16-18, 1996, at Madison Square Garden, NYC. Contact NESEA for details.

Report 61: Monday Afternoon Snippets

From Boyertown PA:

'Helios the Heron III' (93) covered 39.1 miles under its own power on Monday, on the Lambertville NJ to Boyertown PA leg, a personal best. Last year its longest run was 16 miles.

To my surprise, they didn't run out of energy. The chain came off the wheel sprocket a couple of times. The idler doesn't have enough tension to keep the chain taught when the rear wheel bumps too much. They then had problems with not being able to accelerate. They may have blown their controller.

For the first time, the students of the Riverside School that built the car can actually ride in it during the race. They serve the roles of navigator and time keeper. Dan Wilson, a 6th grader, got the honor on Monday. "He was excellent at navigating. He had everything right where we were supposed to be," said Karen Budde, the teacher/driver.

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'Roadrunner' (54) looked very much out of it Sunday night, with a broken drive shaft and messed up rear end. They still looked like they might be out of the race this morning. But that was not the end of it.

Christian Anderson told me that by Monday morning they managed to get the parts they needed, get things pretty much back to normal and were able to drive the entire Lambertville to Boyertown leg. (The NESEA Tour rules allow for such cases. After they got things fixed, they recorded their start time, drove the course, got a finish time, and took a "not ready at post time" penalty.)

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Noah Williams with 'Ottawa Orange IV' (37) told me they started out good from Lambertville, ran fine most of the way, but ran out of juice. They stopped to solar charge and went a little further, but had to trailer it in at about 40 miles. "For what it is, I think it did pretty good. We are getting ready to change the gear ratio" to be more appropriate for the next leg.

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The driver's manual that NESEA provides includes an elevation chart showing feet Above Sea Level (ASL) along each leg's route. For example, Sunday we went from sea level to 400 feet ASL, with one 14 mile stretch rising about 300 feet. Monday took us from 400 feet, down to 100, up to 700 and back down to 400 ASL.

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Clarence Ellers' 'Hybrid Lumina' (28) was only able to make 5 miles of the leg on Tuesday. "I couldn't see any point to driving it only on gasoline and saying I drove 50 miles on 2 gallons of gas." Why not? Isn't that the point of a hybrid? "No. The point of a hybrid is to double the mileage and this vehicle can do it. But both systems have to be working."

So how come the vehicle didn't get charged? "I got there at 2 o'clock in the morning. One of my batteries blew up, it took a couple of hours to get that fixed. Then my chase car driver got lost," and took 5 hours to find the Lumina. Just why the battery failed is not clear but because the blocks are wired in parallel pairs the one failure took out its mate. It turns out the spare was already mounted in the vehicle and the substitution was simply a matter of moving wires.

"The sweep crew that comes to pick up the signs ((placed along the course to help direct the drivers)) came by and rescued me. They were so nice and so good at what they were doing."

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'Proteus 1' (64) did not make it all the way, due to a charging problem last night, but felt the performance of the car was pretty good. One of the team is rewiring the charger to load on more Amp-hours tonight. They did 40 out of 51 miles.

They found the car drove very nicely. "It is very stable for how small it is on the road. Our top speed today was 50 miles per hour and I felt comfortable at 50."

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'Electruck' (47) had no problem on Monday, but did have difficulty on Sunday and don't know why. They didn't run out of juice, but had some kind of glitch in the controller, possibly due to overheating. Today they ran with the cover off the controller box and did fine. The faring over the rear of the truck kept fingers at a safe distance.

Taylor-Dunn is providing the passenger cars for the 70 electric people movers that will be used in the Atlanta Olympics. Tug Manufacturing Company is making the tugs that pull them. (More on the tugs in a later report.)

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Ed Witkin's 'Solar Bus' (33) made it to the finish line again today. One of Ed's two kids rides in the passenger seat, but they have to also carry the dog with the smaller one to meet the weight requirement for two passengers. ((170 pounds each, as I recall.)) "This is definitely the farthest the bus has ever gone."

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'Electric Hare' (65) did very well at the beginning, but then "our 12-Volt battery seems to have some problem." While doing an extra lap the contactors wouldn't close. The problem seemed to be intermittent.

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'George the Geo' (57) didn't do as well has they hoped to do. "We got a bad charge today and we lost two lights ((I presume they mean on their state-of- charge meter)) on our trailer pack right off, but we got in two extra laps."

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'Golden Gear Special' (42) did well. "Today we used 12.3 kWh, and yesterday we used 16.5 and we had plenty left." They made good time from Lambertville, moving up through the pack and came in among the Production Category vehicles. "We have a lot of weight at 3600 pounds, but we seem to have the power that we need and the efficiency of the motors, and it seems to be working pretty decent," said Tom Mohn.

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'Sol Survivor IV' (83) made 46 miles out of the 51 mile leg. Other than that it did very well. But they got pulled over by the cops for obstructing traffic and also had a flat.

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I've observed that most everyone has a very positive attitude about the NESEA Tour. When I ask, "how did you do?" I often get, "very well," and then they tell me about their problems, how they intend to fix them, and how well they intend to do tomorrow. More detailed examples will be in later reports.

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Thomas Faul last year was running a Skoda 'Electra' in the race, and this year he is bringing one from site to site demonstrating it and giving rides. He is also selling them. He sold the one he is displaying in New York City on Sunday at the display and will deliver it right after the NESEA Tour.

Report 62: Team Profile - 'Sol Machine'

I spoke with Joseph Bonura, Mario DeMarco, and Mike Bayer of the Newburgh Free Academy's 'Sol Machine' (number 58) racing in the Solar Commuter Category. NFA is a public high school in Newburgh NY that started building the car about 3 years ago and finished about 4 months ago. This is their first race.

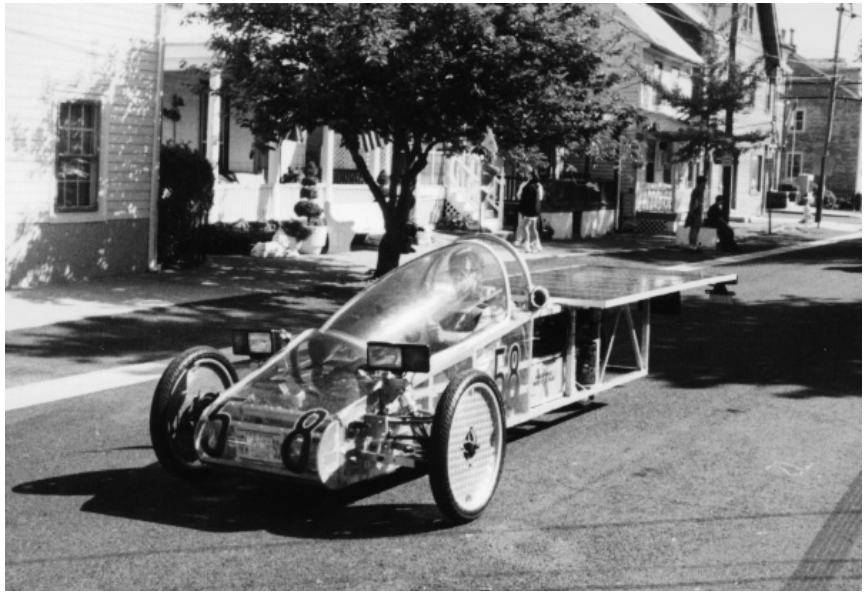

Figure 43 — The 'Sol Machine' has been a project at the Newbugh Free Academy for the past 3 years.

Base Vehicle	Purpose Built, aluminum and Lexan frame and body
Solar Array	840 W, Siemans/ARCO, Single Crystal, Solectria peak power tracker
Batteries	6 Concord, lead-acid, 1,764 Wh, 72 Volts
Motor	Advanced DC, 4 hp continuous, 11 hp peak
Controller	Curtis 1221-C
Charger	offboard: 3 West Marine, 120 V, high frequency

The car has rack-and-pinion steering tied to a front end off an All Terrain Vehicle (ATV). The rear end is off a Honda motorcycle. The frame is custom built, made from aluminum that the students welded.

They have an impressive data collection system that "measures acceleration, ground clearance, temperature, wind resistance and other parameters."

Each battery is charged separately by a smart charger; "we don't want to ruin them."

The first day they didn't get half the charge they needed, since "we had 40 Amp chargers and were plugged into 20 Amp lines. We didn't get half as far as we thought we would." The expected to do well on the 2nd day since the charging was all worked out.

Report 63: Bob Larsen on Efficiency

The US Department of Energy has Argonne National Labs measure the efficiency of many of the vehicles in the NESEA Tour.

On Tuesday morning I caught up with Bob Larsen of Argonne and we discussed what he was seeing in the testing data.

The first efficiency results from the hybrid vehicles is about what they expected but not as good as they hoped. For example, they saw the University of Wisconsin car, 'The Paradigm' (84), get about 250 Watt-hours per mile (Wh/m) combined electricity and fuel. It's a series hybrid running a relatively small engine on reformulated gasoline (RFG). "They ran about 5 or 6 hours without a hiccup on the dynomometer giving us complete city and highway, and all kinds of cycle results."

The gasoline control vehicle took a little over 300 Wh/m to travel the Tuesday course, which was more country roads but with some significant hills. The 'Sunrise' (63) and the 'Sunpacer' (92) were getting 110 to 115 Wh/m. It is very interesting that a high school team is turning in such impressive numbers, even though it isn't up to the same level of consumer acceptability as a production-grade car. That whole mind set of attention to detail and minimizing your losses where ever they are really pays off.

During the dyno testing in NYC the Western Washington University Neon, 'Viking 25' (25), achieved California Ultra-Low Emission Vehicle (ULEV) standards running Compressed Natural Gas (CNG) fuel in a parallel-hybrid configuration.

Also from the dyno testing, Bob remarked that "one result that sticks out in my mind is the comparison of the Neon gasoline control car (number 9), a hybrid, which I think was Wisconsin (84), and the 'Solectria Force NMH' (4) on the New York City driving cycle. This cycle simulates congested city driving with lots of idling and relatively low speeds, and so on. The gasoline Neon got less than 12 miles per gallon, even though it is a pretty efficient car. The best hybrid got approximately twice that at 22 to 23 miles per gallon, and the 'Force NMH' got the equivalent of 60 mpg. That is the kind of increase in efficiency that shows that in urban settings EVs make one whale of a lot of sense, and also the concerns of range are not as much of an issue."

Another group in Argonne's Center for Transportation Research did a modeling study that showed that if we could replace 12,000 vehicles in the center of Chicago, where the Argonne lab is, that would reduce the air pollution by an amount equal to the pollution output of all the industries within the city limits. "The point is that there is a highly disproportionate emissions benefit to replacing Internal Combustion Engine vehicles in cities with EVs. If we could work on electric or even hybrid buses (and other high emitters) that could give big, big benefits," Bob said.

I asked Bob why the hybrids do not get the 80 mpg equivalents that we read about in the theoretical papers. "Hybrids are hard. First, there is a lot of additional mass in the vehicle. Most have to carry around battery packs that, even in the small ones, are like 300 to 400 pounds. We often see 700 to 800 pounds and a couple are even 1000 or more. So that's everything an EV has, and then they also need an engine, generator and fuel system. There are not any really good small displacement engines for hybrids. Those we see here are industrial, or tractor, or Geo Metro engines that are not really designed for efficiency."

I also noted that the hybrids here have all picked an exotic fuel: CNG, Ethanol-85, Propane, or RFG. Why not just stick to gasoline which is widely available and burn it in an engine tuned to the teeth?

"We are to a large part responsible for that," Bob said. "We are pushing the schools to use alternative fuels as a way to turn the corner on oil dependency.

"You have to understand that these are mostly schools doing this, often as extra-curricular activities (with only occasional class credit). They are also trying to graduate, get a job, and keep their lives going. Really doing a very good calibration of an engine is an activity that takes thousands of person-hours of work," even for the car companies with sophisticated equipment and facilities. It just takes time to run things through all the variations of high and low throttle, high and low temperature, high and low altitude conditions, collect the data, change something, and then do it all again. "The schools have a hard time getting a power train to the same level of refinement," especially when they are trying something off the beaten track.

"And it is not at all obvious how to design a hybrid. Should it be a series or parallel hybrid? Should the electric motor only assist on acceleration? Should they provide the average power or peak power? And managing the energy flow through the vehicle is a sophisticated problem. One of our best schools is struggling with a control system that has 80 inputs." Does a car starting up a hill get the extra energy from the batteries? The engine driving the wheels? The engine driving the generator? A combination? "This is emerging technology. No one knows the best way. We are smarter than we were 3 or 4 years ago, but it is a mind-boggling type of exercise." And then there is a lot to be said for understandability, simplicity and elegance. The schools are discovering that each additional complexity makes it harder to get it to run right.

The DOE is also funding each of the Detroit Big-3 to go down a different path for hybrids, and the international companies are also trying lots of different things.

And the current technology presents a pretty high bar to clear. "The gasoline control Neon gets at least 30 mpg (highway) and weighs 2800 pounds. The hybrids are weighing 4000+ pounds and have to overcome that just to start."

We also have a couple of personal projects. Tom Hopper's 'Hopper EV' (94) runs on soybean oil and Clarence Ellers' 'Hybrid Lumina' (28) has a patented parallel design.

"Tom's strategy is provide the average power from the generator, so he can often avoid sending the power through the batteries and those losses. His hand operated throttle lets him do that, but it won't be the sort of thing that most people will want to deal with." Tom thinks he can make the entire route without refueling. They put a line on Tom's tank and will refuel him at the end of the race. Between that and the on-board data collection of energy taken from the battery pack, etc., they hope to get some idea of where the energy comes from and goes. "I don't think he'll get the 100 mpg he is claiming on the trailer, but I wouldn't be surprised he gets about 50, and if we could get every car to get 50 mpg we would be a hell of a lot better off than we are now."

There are some bio-Diesel demonstrations in Chicago right now. They are trying to break the oxides-of-nitrogen (NOx)/particulate (smoke) tradeoff that Diesel fueled engines currently force on us. Since Diesel engines are the backbone of much of our economy, bio-Diesel might be a way to make them clean and sustainable.

Bob knew less about Clarence's approach, but the goal of no driver input to the balance between ICE and EV operation is certainly what most people will want.

I asked about the Volvo hybrid that had a turbine engine that ran on Diesel fuel, and was said to deliver 50 to 60 mpg and yet was very clean.

"They claimed that they could meet ULEV emissions on that. One of the great advantages of a turbine or a Sterling is that they are an external combustion engine (ECE) and the burn is continuous." (ICEs run on a rapid series of explosions.) You can use an ECE in a series hybrid where the engine is decoupled from the road and does not have to respond to instantaneous power needs, where the energy losses and pollution generation are most severe. It can instead generate power to meet the average need.

"Corporations are asking themselves if it is a reasonable business decision to spend the millions of dollars to tool up for a whole new engine drive train." Turbines will probably have to use ceramic components to get high efficiency. They will be smoother and cleaner and compact, but it is a whole new technology with associated risks when you go into mass production.

People who depend on their vehicles, long-haul trucking for example, are very risk adverse, so something new not only has to save them fuel costs and be cleaner, but they have to be utterly reliable. And they want a short term pay back — and that just isn't there right now.

But that is the challenge. "We have to find a way to make it good for businesses and good for the environment and good for the economy. We starting with fleet vehicles like buses. We also have a program looking at putting a much smaller Diesel engine in a hybrid dump truck prototype."

"I see the types of vehicles in the next few Tour de Sol being somewhat different. I see more mass transit vehicles and more specialized vehicles. Maybe we'll see the very innovative, ultra-clean, hybrid taxicab that New York State is funding. Maybe we'll see a hybrid dump truck cruising the back roads of Pennsylvania."

(Coming to the Pottstown site I was following a tandem dump truck putting out a sizable Diesel cloud.)

As Bob concluded, "It may not be as glamorous as the 'Solectria Sunrise' but it all counts when it gets back to the well-head or forward to our lungs; either end."

Report 64: Solectria and Ford sets records (preliminary)

It's Tuesday evening at about 9 PM in Chesapeake MD. Today was the day for the cars which are going for range records to run the extra distances. As of this time, I have the following, unofficial records:

The 'Solectria Sunrise' has 32 kiloWatt-hours in a 252 Volt pack of Nickel Metal Hydride (NiMH) batteries. Tonight it demonstrated a range (again, unofficial) of 375 miles on a single charge.

The 'Solectria Force NMH', also running NiMH batteries, ran (unofficial) 244.2 miles per charge.

The 'Ford Ecostar' went (unofficial) 227 miles, which is its own best NESEA Tour record, on Sodium Sulfur batteries.

Report 65: Team Profile - 'The Paradigm'

The University of Wisconsin at Madison is here with their series hybrid EV called 'The Paradigm' (84), aka "The Electric Cow". I spoke with Ted Bohn who is the team captain.

```
Base Vehicle    1992 Ford Escort Wagon LX
Batteries       30 Johnson Controls UPS-1295,
                360 Volts, 6.5 kWh, 780 pounds
Motor           Baldor Electric, AC induction, 3-phase, 2-pole,
                200 Vac, air-cooled, 8000 rpm
                18.6 kW (25 hp) continuous, 74.6 kW
                18.7 (100 hp) peak
Controller      Indramat, 55.6 kW (75 hp), 202 Amps maximum
Engine          Kolher, 725 cc, V-Twin, OHV, air-cooled,
                port fuel injection, 18 kW (25 hp) @ 3600 rpm,
                Bosch closed-loop fuel injection,
                2 heated catalysts
Fuel            Reformulated Gasoline (RFG), 38 liters, 10 gallons
                (RFG: oxygenated gas with benzene, etc. removed)

Generator       Fisher permanent magnet AC alternator,
                390 Vac @ 3600 rpm, 15 kW
```

```
Transaxle       Single speed, 6.6:1, front wheel drive,
                Ford transmission stripped down to just 2nd gear
```

It was originally built in 1993 to run in the College Hybrid Challenge (CHC) run by Ford. It raced in the CHC in '93, '94 and '95. "It was built by undergraduates, about 50 per semester for the past 8 semesters, so a lot of students have gotten a lot of learning out of the vehicle." It has 4500 miles on it now, and on Monday it lost a coupler which wore out. (More on that story below.) The data sheet claims:

Top Speed	80 mph
0-40 mph	8 seconds
City Fuel Economy	50 mpg
Highway Fuel Economy	35 mpg
Range EV mode	30 miles
HEV mode	400 miles
Weight	3450 pounds
Component Cost	~$30,000

Figure 44 – 'The Paradigm' is a series hybrid from the University of Wisconsin. They picked up a couple of extra sponsors during the race, although not quite they way they wanted to.

It won the NESEA Tour Hybrid Vehicle Efficiency award on all 4 days it was given.

In the most efficient mode the engine/generator set sends power directly to the controller and motor, by-passing the batteries. The 15 kW output of the generator is enough to run the car down the highway at 55 to 60 mph.

In HEV mode, all power management is controlled by a computer that automatically starts the engine when battery voltage reaches a minimum, runs the engine at full power to recharge, and shuts off when the batteries are full. "It can be strange when driving through the city," Ted told me. "You might not hear anything while driving and then, while sitting at a stop light, the engine just roars! While in Manhattan, we were stopped and a guy shouts 'Hey buddy, your engine is idling a little high.' I said, 'Oh, I'm sorry,' and turned it off. Then the light changed and we drove away without making a sound. 'That is > so < cool!'"

Now for the story. On Monday they were driving down a hill and they hear knocka-knocka-knocka-ROAAAARRR! The ROAR was when the spline on the coupling from the motor to the transaxle tore out all the teeth. Olaf Bleck of Team New England happens to be nearby and says, "Think really hard before you put your car on the trailer. The penalties for trailering are pretty severe."

"Fortunately we didn't give up too soon," said Ted. Instead, some miracles happened.

Miracle number one: They were at the top of the hill when all this happened.

Miracle number two: At the bottom of the hill is Histands, a truck dealership of Doylestown PA. "Yes, you can borrow our cherry-picker to pull out your drive train." So they lend the team tools, rags and everything. "By the way I know someone at Zenco Machine Tool Company (also of Doylestown)." The manager of Zenco says, "All my guys are busy; I will do it personally." He likes the concept of the car so much that he makes the part personally; charges $130 for 4 hours of labor. We go to a Ford dealership, buy an Escort clutch, strip out the center coupler by drilling out the rivets, turn it down on a lathe, reassemble the transaxle to the motor, put the motor and transaxle back in the car, get it all lubed and adjusted, drove it down the highway and were back at the race by 9 pm.

On top of all that, the guy at Histands looked up the web pages for the Tour de Sol and Team Paradigm while the team was working on their car. Both Histands and Zenco instantly got sponsorship decals on the car.

More info: vehicle@cae.wisc.edu
http://www.engr.wisc.edu/~vehicle
608 265-3204

Report 66: Team Profile - 'Utility EV'

The `Utility EV' (number 46) is the Pennsylvania Electric Transportation Council's Utility Electric Vehicle, abbreviated PETC UEV. It is a ground-up design exercise that has been shown statically in the past, but now is in the race. I spoke with Ken Quinty, an old friend I first met at the 1993 NESEA Tour.

Figure 45 — The 'Utility EV' is a proof-of-concept project of the PETC. It is built almost entirely out of composite materials and so is very light and maneuverable.

It actually has been running for about a year and they have been evaluating what they should have done differently. And they are doing it. The next generation prototype is now being designed and built at a design studio in Michigan and by next year should be on the road.

Without the batteries, the `Utility EV' weighs about 1700 pounds, about 1000 pounds less than an S-10 pickup, after which it is modeled. The batteries add 1400 pounds, so it gets to be a bit more than a gasoline S-10. But the GM electric S-10 prototype weighs over 4000 pounds. The difference comes from the fact that the `Utility EV' has an aluminum frame for the motor and front-end suspension, and a molded fiberglass body. The batteries are carried in a tunnel, again made of composite materials, that runs down the center of the vehicle between the passenger and driver and below the load bed. The tunnel also has a thermal control system that keeps the batteries warm in winter while the truck is plugged in.

The vehicle was designed and built by Advanced Composite Products of Harrisburg PA. The goal of the first design exercise was to prove the concept of an electric utility vehicle that would be usable by companies like power utilities. The second generation will share the same goals, but won't share many of the original design elements. Issues of manufacturability will be far more important this time.

```
Controller/Motor     Northrup/Gruman (formerly Westinghouse)
                     75 horsepower, AC induction motor
Batteries            Deka Dominator gelled electrolyte
```

	288 Vdc
Charger	On-board, 120 or 240 Vac input
Wheelbase	112 inches
Length	66 inches
Height	60 inches
Ground Clearance	8 inches
Payload	800 pounds
Top Speed	75 mph
Acceleration	0-60 mph in 15 seconds
Range	100 miles, 70 miles in winter
Energy Consumption	300 Watt-hours per mile
Vehicle Service Life	10 years minimum

Report 67: Disasters and Miracles, Snippets and Protest

From Tuesday night and Wednesday morning ...

Poor Bill Glickman. No sooner does he get his controller for 'Regenerative Braking' (45) replaced with a loaner from Mark Parthe of 'Genesis I' (66) than his brand new, $2000 motor fries. "I had it all connected up, so I try to run it in neutral. 25 Amps; looks good. So I try 50 Amps; looks good again. So I try 100 Amps and the motor blows up! I'm getting a good night's sleep and going home."

((I wonder if Bill was so sleepy after working on replacing his controller that he forgot the dangers of overreving a motor with a wound rotating armature. If rotating too fast, the centrifugal force causes the windings to expand and hit the stator, usually with spectacular and disastrous results.))

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"So 'Helios the Heron III' (93) is on a trailer, being towed to the airport to do a parent swap on Monday evening," Karen Budde is telling me. "We blow a tire on the trailer at 9 pm. It is one of those dinky little tires. So we go into Sears and the guy says, 'You got to be joking. Maybe, maybe you can find one someplace in town.' So we decide to drive on 3 wheels. But the Suburban that was towing the trailer and was sitting there with its flashers going has died! The battery is dead!

"We go to open the hood to jump start the Suburban and the hood latch goes PWONGG! and we cannot open the hood.

"So we call the parent who is at the airport on the cellular phone who says, 'Slap the hood.' We slap the hood and the hood pops open.

"So we get the Suburban started, and the tow truck shows up. He says, 'You don't really need me, but I know a guy who will help you. So he drives us down 422 to a General Tire Store at 9:30 at night. The guy comes over from his house, fixes our dinky little trailer tire, and slaps it on the trailer. We get to the airport at 10:30, exchange our parents (one is extremely happy to leave, the other wondering why he decided to come) go 1/4 mile the Oakland Lane Day School which offered to put us up for the night in their ready room.

"So we get 5 hours of sleep, get on the highway, fix the controller, and are on display. Another day for 'Helios the Heron'!"

Fix the controller? Yep, 'Helios the Heron' burnt out a controller again this year. And, as it turns out, Mark Parthe once again has one to loan because while Bill Glickman did fry his motor, the controller was OK. No sooner does Bill return it than 'Helios' needs it.

But this time they know why. They had been mounting their controllers on the plywood floor of the rear of the car. What's wrong with that? Plywood is an excellent thermal insulator and the controller was overheating. Now it is mounted vertically on an aluminum bracket which should radiate heat very well.

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Eva Mathews is a teacher/advisor to 'Ottawa Orange IV' (37) from Grand Rapids MI again this year. She made the observation her high school team has been very good this year. "They have been working with each other very well, and we had a really good day Tuesday. I'm very proud of them."

A couple of years ago, there was a dispute (over what I don't recall) and the teachers locked the kids in a trailer saying, "we don't care what the resolution is, but you all must agree to it." It was hot and stuffy in there, and they didn't come out quickly, but they did finally come to a unanimous decision. "Now it is part of our history," says Eva. "They know it > could < happen.

High school is a hard time for them. "They sometimes want to act like kids, but they know they have adult responsibilities, so they get confused at times. We try to give them a focus all year long. Focus on the job, and leave the egos and the attitudes in the pocket, and take care of the business.

"This is not like those trips where they take a note pad and listen to people talk. You are responsible for keeping a vehicle on the road and a team together. And it doesn't start at 7:40 am and end at 2:10 pm. It starts when it starts and ends when it is done."

Curtis VanWingen told me that they changed the gear ratio on 'Ottawa Orange IV' to a lower gear ratio because the rest of the route is much flatter and they hope this will improve their range. There have been a few minor adjustments, but no major-major breakdowns. When they stopped in the Holland Tunnel, the forward-and-reverse switch went out. "Now we don't go backwards."

I asked how the team was holding together. "We're just trying to stick together! When we first started we where, like, separate. As we are getting farther into it we are actually starting to work as a group instead of trying to be individuals."

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Again this year, the 'Ford Ecostar' has Frisbees to give out to kids. They are hugely popular.

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As I drove by from Pottstown PA to Chesapeake City MD I saw several groups of people and school classes sitting by the side of the road waiting for the electric cars to come by. One guy was sitting on the traffic circle. They were not quite sure if I was one of them (I wasn't) because I had the race logo on the side of my car.

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Tom Hopper, who I would never have described as "angry" or "emotional" in a negative sense, staged a protest on the Pottstown PA to Chesapeake City MD leg. 'Hopper EV' (94) was the first one under the finish banner, 10 minutes ahead of everyone else, even though he started back in the pack. He averaged 37.3 mph, well above the second place 34.1 mph.

What's going on here?

Well in years past, the NESEA Tour had a problem with contestants speeding. There was a speed component to the scoring, and so being first meant something tangible in the score. We heard protests from police when cars went through their towns too fast, or ran stop signs and traffic signals.

So the rules were changed to take high speed out of the scoring. Instead, people were expected to drive the posted speed limit and those who got in too early were penalized, as were those who got in too late. However if you arrived anywhere within your window of time, you got full credit for the leg.

But that raised other problems noted by several drivers. If you didn't drive with the traffic flow, which was almost always above the posted speed limit outside of towns, you were this car or truck, prominently labeled "Electric Vehicle", apparently having trouble keeping up with traffic. On top of that, the estimates of allotted time to drive a leg were based on earlier drives, often at different times of day and in different weather and traffic conditions. I suspect they may not always have been precise enough.

So Tom protested. "I'm not driving on eggs anymore," he said. I am driving like a normal person and staying with the traffic." He wanted to bring to the Race Jury's and rules makers' attention that the window system based on strict adherence to posted speed limits not only made us look bad, but created safety problems as annoyed people tried to pass cars under circumstances that did not really permit it. (Because much of the race is on country roads and not on major highways and interstates, we were often in hilly areas where there is no passing lane, no passing zone, and no shoulder. The slowest vehicle defines the speed for everyone behind. And if that is an EV ...)

"The public is not going to pay attention to EVs unless they out accelerate ICE cars at the stop sign, out distance them, and out last them," said Tom. "The most important thing that has happened in all the Tour de Sols happened on our trip from New York City to Lambertville. Mr. Larsen said we got a factor 4 times better (economy) in the city than on a gasoline production car. But that isn't what's going to sell it. Beating an ICE will sell it.

"I'm not going to drive my EV like an EV any more. I'm going to drive it like a normal car. I'm driving with the traffic, and staying right with them."

Tom's action, along with other similar driver comments, caused the Race Jury to reconsider the issue, and the early arrival limit was dropped. However, the Jury also decided to consider any unsafe action or unsportsmanlike conduct much more seriously and to extract stricter penalties.

I suspect the issue will be reconsidered in some detail before next year's event.

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Keith Smith, of MascoTech Special Vehicles of Detroit, has been at each display site with 3 Chrysler vehicles that draw considerable interest.

The first is a new Dodge Intrepid ESX concept vehicle. It's a series hybrid EV with a Diesel engine/generator set for charging the batteries. It has 100 hp electric motors at each rear wheel. It has an all aluminum body and chassis and is slated for production by the year 2000. The model is strictly a show car.

The second car here is the first prototype of the Plymouth Prowler, built in 1993, again with an all aluminum body and chassis, which will be for sale in January 1997.

The third is an Epic electric minivan. Eric did not know much about it since his company did not have anything to do with it.

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'HEVy GATOR' (19) (also listed as 'HEV U Florida' in the standings, is not racing but is still showing up at the site displays. They fried their controller. "About 28 MOSFETs blew on us. We don't understand why," said Shane Miller and Brian Skeldon. They were about 35 miles out of New York when it happened. They have tried to rebuild it several times but have not been successful.

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Alison MacClean, Mercedes Robins, and Julia Lewandoski told me that 'Helios the Heron III' (93) covered 37 miles from Pottstown to Chesapeake City, but is still loosing the chain because it is not completely in line. Monday they were in first place in their category, but Tuesday morning they are in second place.

Report 68: Snippets from Wednesday Morning

Wednesday took us from Chesapeake City MD to Sandy Point State Park outside Annapolis MD. These notes are from the morning before we left.

'Electrobike' (52) is doing fine. Not only are they making it through the 50 to 70 mile legs, but they even took some extra laps yesterday for some 18 extra miles.

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Mike Kocsmiersky has been managing the charging trailer data collection. "Everyone is monitored for the amount of power we are supplying. In addition, the Production cars are monitored for harmonics and we are reading their waveform." When a circuit breaker trips out, as sometimes happens, they measure their current on the line side. Many chargers have Amp meters that report current to the battery, but the AC load can be much higher. Another factor may also contribute to breakers tripping. With almost 50 cars drawing from banks of circuit breakers, each breaker is running up near its rating, especially early in the evening. So all the breakers in a very full panel are warm, and there is no place for the heat to go. So a charger that may work at home, because it is just under the limit for a cool breaker may pop a warm one. "When we see a popped breaker, we use an Fluke RMS AC Ammeter to see the true load." Then they try to help the cars solve the problem.

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Figure 46 — This 'Solectria Force NMH' went over 240 miles on a single charge of its Nickel Metal Hydride batteries. It also delivered the equivalent of 60 miles per gallon during an urban driving-cycle test.

Nick Karditsas of Ovonics told me that the 'Solectria Force NMH' (4) is running a battery data collection and management system that GM Ovonics had Solectria develop for that car. It monitors module voltages, pack voltage and current, records Amp-hours and Watt-hours. It also protects the battery by watching the pack in detail. "There are three stages of warning. If battery damage is imminent, the first step is lighting an LED on the dash. The second step is a buzzer that sounds. The third step is turning the controller off." This is part of Ovonics real-world testing getting ready to go to mass market.

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More miracles:

Jodie Cooke of 'Hyperion' (26) told me that they broke an axle. "We were at an intersection, going nice and easy and then pop." But they are not out of the race. "The other half of the team is at a machine shop now, and they are picking up another axle. It's a Geo Metro engine, so one spline is from Geo and the other spline is from Saturn and had to be custom machined. When we broke down this guy came up and pointed us to a machinist," and he spent last night getting things put back together. (Another instant sponsor!) (They were ready in time to start this leg!)

Jodie is an Electro-Mechanical Engineering major at Wentworth Institute of Technology. "I was originally going for mechanical engineering and want to go into the automotive industry, but since everything is switching over to electronics, I thought it would be in my best interest to switch to Electro- Mechanical and learn about both, and keep myself well rounded for the field. It is a new program, and only a few schools in the country offer it. I think it will keep me on the cutting edge." Just about everything today has a sensor and an actuator. "It looks good on your resume."

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I now understand how the 'Twike' (12) is driven.

On the tiller that steers the front wheel are two 2-step buttons. The top button is for acceleration and the bottom button is for deceleration. The first step, pressing the button down to its first stop, is a mild acceleration or deceleration, and the second step is more aggressive. The second step of deceleration is so strong it can be used instead of the brake, and, since it is regenerative braking, some power goes back into the batteries.

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Scott Hall told me that 'Sungo' (72) went 125 miles on a charge yesterday, on Horizon lead-acid batteries, a personal best. Scott felt that being able to go back and forth between the main and auxiliary battery packs gave the main pack a chance to rest and recover. "That thing worked!"

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Bill Simpson is the Market Development Manager for "Quin-T", your classic what-do-they-make? company. Its logo shows up on all the Solectria race vehicles, but it was a couple of years before I knew why. Quin-T makes electrical insulation sheets that go into the Solectria motors and controller transformers. "It is a high temperature material that stands the heat. It also has very good thermal conductivity to help conduct the heat out of the motor, controller, and transformers." Quin-T also supplies Advanced DC, GE, and Unique Mobility.

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'Spyder Juice' (31) has been having trouble getting a good charge. They kept popping the 20 Amp breaker they were assigned on the charging panel. Last night the electricians gave them a 30 Amp breaker and plug, and the proper cords were obtained, so this morning they have a good, full charge.

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'Texas Native Sun' (36) has a laptop computer that serves as the driver's instrument panel. They use National Instruments LabView software in the car. A Digital-to-Analog Converter (DAC) card in the PCMCIA port of the computer collects currents, voltages, temperatures and speed readings and presents them to the driver. A radio modem on the serial port sends the data back to the support van where the strategist there can study it all and then send recommendations to the driver, either via radio intercom or via the radio modem to a message window on the screen.

Report 69: May 15th Morning Race Summary

This report is based on the Race Summary handed out at the driver's meeting on Wednesday morning. It is the best information I have at that moment.

X Did not show up or maybe out of the race
Y Dropped out of the race (my understanding)
Z Dropped out of the race, but displaying vehicle at stops

NAVC Production Category (in current standing order)

Number	Car	Team
4	Solectria Force NMH	Solectria
17	Ford Ecostar	Allegheny Power
7	Nordic Challenger	EVermont/NAVC
50	Solectria/Horizon	Connecticut EV/NAVC
34	State Power	STAPPA/ALPA
15	Solectria Force	JCP&L
12	Twike	Technik & Design
14	Chrysler TE Van	Met-Ed Penelec/JCP&L/GPU

US DOE Commuter Category (in current standing order)

63	Solectria Sunrise	NAVC / BECO / Solectria

72	Sungo	NHTI Electric Car Team
32	Porsche 914 E. Bull	Shadow Mountain E. Matadors
39	Sparky	EV Moore - CEVA
88	OHM Ranger	Neocon / NYSEG
43	KA1000	Polytech Chargers
35	Kineticar	CSERT - NVCTC
42	Golden Gear Special	RMAVTS - Golden Gear Racing
44	SolarSaurus	Rocky Hill High School
38	Sparky 2	Wooster's Charge
65	Electric Hare	Wattsmen
66	Genesis I	Genesis Team
33	Solar Bus	Bridgewater Solar Works
57	George the Geo	FMRHS-Solar Electric Racing
46	Utility EV	PETC
74	Lightning Volt	Parkland High School
79	54 Berkeley	Team New England
31	Spyder Juice	Solar Electric Spyder Juice
47	Electruck	Taylor-Dunn
82	Lectric Lion	North Hunterdon High School
54	Roadrunner	Greenwich H S Solar Flair
45Y	Regenerative Braking	Alternative Energy
24X	B-U-LLET	Boston University SEV Team
2X	Trans2-AC	Wallingford AC, Inc

Solar Commuter Category (in current standing order)

83	Sol Survivor IV	CONVAL Solar Car Team
93	Helios the Heron III	Riverside School
36	Texas Native Sun	Lonestar Solar Racing Team
58	Sol Machine	Newburgh Free Academy
75X	Commuter Car	Villanova Univ. EV Team

Chrysler Hybrid Category (in current standing order)

96	Project e-	Mt Everett High School
94	Hopper EV	Tom Hopper
48	Electric Lion	Penn State SAE
23	Viking 23	Western Washington University
81	VT Ani mul SL	HEV Team of Virginia Tech
26	Hyperion	Team Hyperion, Wentworth IT
84	The Paradigm	Team Paradigm, U. Wisconsin
25	Viking 25	Western Washington U
28	Hybrid Lumina	Clarence Ellers
19Z	HEV U Florida	Univ of FL HEV Society
21X	Hy Potential IV	University of Tennessee

Open Category (in current standing order)

92	Sunpacer	Cato-Meridian HS Tech Team
64	Proteus 1	Union College
52	Electrobike	CTC NEastAdvVehTecCtr
37	Ottawa Orange IV	Tech Prep

Report 70: 'Impact' sounds, and 'Sunrise'

Figure 47 — The 'GM Impact' making a tight, tight turn during the Autocross event in Annapolis MD.

Wednesday afternoon at Sandy Point State Park, we had a GM 'Impact' on display giving rides-and-drives around the parking lot. There was a steady line, but I managed to get time off from announcing duties to do my turn around the parking lot. Driving the Impact has been described in considerably more detail by people who have gone much further, so I'm not going to say more than, "I liked it, a lot! It does what it does very well, and, yes, given half an opportunity, I would consider buying or leasing one."

I did notice one thing that I don't recall reading about, the pedestrian alarms. When in reverse there is a gentle, but quite audible BLIDI--BLET sound as a backup alarm, and, when you flash the head-lights with the turn-signal stalk, there is a faster BLIDI-BLIDI-BLET sound to warn folks in front of you. A very good idea, to my mind. We've had discussions about "What sound should an EV make when an EV makes sound?" and this strikes me as a very reasonable answer.

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James Worden, CEO of Solectria, was talking about the 'Sunrise' (63) setting its range record.

"The Tour de Sol is always a learning experience. We were hoping to beat 300 miles (per charge in the Sunrise). We knew we could do it but it depends on a lot of things. When we found out the extra lap course was on a highway, we thought would do less. It turned out that once the car got rolling, the efficiency went up so high it didn't matter. The combination of the light weight, the aerodynamics, and the drive train meant that it didn't matter so much that we were doing 55 mph on the highway." (The amount of time allotted for laps now has become a limiting factor.)

They drove the 'Sunrise' mostly in the Economy mode, which limits the battery current drawn. ((On my Solectria Force, Economy limits to 60 Amps, Normal to 120 Amps, Power to 200 Amps. I'm guessing the numbers are similar for the Sunrise, especially since the 'Sunrise' weighs 1972 pounds while the Force is 2390.))

"The Ovonics battery gave us great energy. But the real magic is combining that good energy in a light-weight battery, with a very light-weight car, with good aerodynamics, with an efficient suspension, with very efficient vehicle design, and a low loss drive train to achieve low Watt-hours per mile. Over 90% of the electrical input from the battery shows as mechanical output to the wheels over a wide torque and speed band."

There are four Sunrises. Two are operational vehicles and two are used for testing, crashing and such. When will we see production?

"The goal is that in about two years we'll start limited production. To go real with the Sunrise, we need a major automotive company, or automotive parts supplier, or another with a big vested interest in EVs to come in and work with and invest in the program. We are not seeking investment right now, but we are exploring these options and need to move forward quickly to make this happen."

The 'Sunrise' is running Solectria's Universal Motor Controller (aka the UMoC) which is aimed at lowering the cost of AC induction drive systems. "The price is lower, and, in fact, at 5,000 quantity we will sell the whole drive system, the motor, the gear box, and the controller, with the stuff in between, for under $3,000."

The Force Nickel Metal Hydride car is now on sale in two versions. "The 100 mile version is $65,000. It comes complete with a data acquisition system for collecting battery data. We have sold some of those and are building more of them.

"The slightly larger battery version, which we are calling the 150 mile version, is the one we raced here and that got 244 miles per charge. We are not selling it yet, but it will be released in the summer and will cost about $95,000."

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Joel Anstrom is with the 'Electric Lion' (48) and we were talking about how independent front wheel drive affected their performance in the autocross event. The power that goes to the separate motors that drive the left and right front wheel is determined by a computer that looks at where the steering wheel is pointing the car.

"We were running our efficiency tires which are high 70-series tires which means we lost a little bit of traction in the autocross.

"But the independent drive system did what it was supposed to do. Our driver said that was what was keeping him in control as he came in hard in the corners. With a motor on each wheel, he could get on the brakes as hard as possible, and the computer controls how much braking the motors generate, so they don't lock up.

"If you noticed when he was going around a hard corner, the inside wheel becomes lightly loaded," (due to the rolling of the car body towards the outside of the curve). "On a lot of cars, that inside wheel would spin which would loose almost all power to the driver train. But on our car the outside wheel is still being driven."

"We are going to go a step further. My PhD thesis is to do a full car model and apply some algorithms which would be like smart ABS (Antilock Braking System). The car will take your driving inputs and interpret them for the best handling possible." The goal is to have the car respond so intelligently and quickly that it gets average drivers out of bad situations before they realize they are getting into them.

Report 71: Autocross and Acceleration Test Results

On Day 4, Thursday at Sandy Point State Park near Annapolis MD we had an autocross event set up by the Washington Metropolitan Area Sports Car Clubs, (I hope I have that right) and acceleration tests run by the Argonne National Labs people. These are the results. "Cross" is the time in seconds to run the course, which consisted of a short acceleration run into a slalom, right turn, 3 off-set gates, a hard right turn, 1 1/2 revolutions around a skid-pad circle (counter clockwise), another hard right turn, and then a short run to a dead stop. Each team was given up to 4 attempts at the autocross, not necessarily with the same driver each time. (Driver skill and experience in autocross racing has a lot to do with the results.)

The first list is in autocross event order. The second is in acceleration test order.

DNF Did Not Finish; usually made errors driving the course.

Num	Name	Team	Cross	Accel
9	Neon Control car		35.763	11.158
31	Spyder Juice	Solar Electric Spyder Juice	36.270	11.002
84	The Paradigm	Team Paradigm	36.875	
46	Utility EV	PETC	37.426	11.302
	GM Impact	PrEView	37.559	
32	Porsche 914 E. Bull	Shadow Mountain Matadors	37.685	14.965
63	Solectria Sunrise	NAVC / BECO / Solectria	38.270	13.197
17	Ford Ecostar	Allegheny Power	38.371	12.785
72	Sungo	NHTI Electric Car Team	39.223	15.421
33	Solar Bus	Bridgewater Solar Works	39.395	16.403
4	Solectria Force NMH	Solectria	39.660	14.034
15	Solectria Force	JCP&L	39.884	14.709
48	Electric Lion	Penn State SAE	41.077	14.584
81	VT Ani mul SL	HEV Team of Virginia Tech	41.833	14.193
50	Solectria/Horizon	Connecticut EV/NAVC	41.899	15.694
26	Hyperion	Team Hyperion, Wentworth IT	41.955	15.211
23	Viking 23	Western Washington U.	42.042	13.053
25	Viking 25	Western Washington U.	42.100	11.331
65	Electric Hare	Wattsmen	42.216	17.136
54	Roadrunner	Greenwich HS Solar Flair	42.427	17.549
43	KA1000	Polytech Chargers	42.533	16.066
44	SolarSaurus	Rocky Hill High School	43.019	15.550
39	Sparky	EV Moore - CEVA	43.434	
34	State Power	STAPPA/ALPA	43.545	14.330
88	OHM Ranger	Neocon / NYSEG	43.725	16.537
94	Hopper EV	Tom Hopper	43.746	12.908

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83	Sol Survivor IV	CONVAL Solar Car Team	44.675	15.013
74	Lightning Volt	Parkland High School	45.278	17.821
82	Lectric Lion	North Hunterdon High School	45.938	18.545
35	Kineticar	CSERT - NVCTC	46.564	17.043
52	Electrobike	CTC NEastAdvVehTecCtr	47.000	
64	Proteus 1	Union College	47.002	15.816
12	Twike	Technik & Design	47.573	17.529
14	Chrysler TE Van	Met-Ed Penelec/JCP&L/GPU	48.897	17.004
79	54 Berkeley	Team New England	49.646	15.086
38	Sparky 2	Wooster's Charge	107.863	16.856
66	Genesis I	Genesis Team	121.000	17.517
93	Helios the Heron III	Riverside School	219.000	50.233
7	Nordic Challenger	EVermont/NAVC	DNF	15.677
57	George the Geo	FMRHS-Solar Electric Racing	DNF	18.323
96	Project e-	Mt Everett High School	DNF	16.407
92	Sunpacer	Cato-Meridian HS Tech Team		20.962

Num	Name	Team	Cross	Accel
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57	George the Geo	FMRHS-Solar Electric Racing	DNF	18.323
82	Lectric Lion	North Hunterdon High School	45.938	18.545
92	Sunpacer	Cato-Meridian HS Tech Team		20.962
93	Helios the Heron III	Riverside School	219.000	50.233

Report 72: Onward to the Capital Mall

'SolarSaurus' (44) was already in Annapolis before any of the racing cars arrived. Don Brown told me why they had trailered to Annapolis. "We had a charging problem on Tuesday night. We had drained our pack down so low going into Chesapeake City after doing extra laps that we kept tripping the 20 Amp breaker all night long. So we didn't get a full charge." There was nothing else wrong with the car.

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Eastern Senior High School's Marching Band showed up and put on a high-energy show (as is only appropriate).

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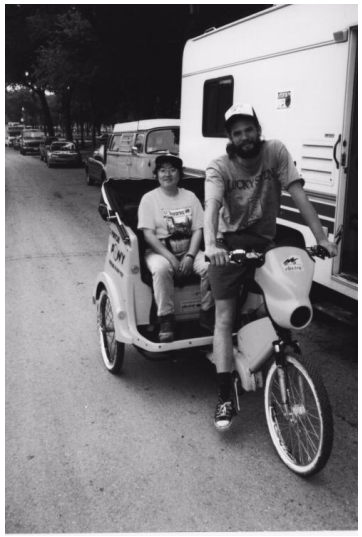

Glen Dobbs with the Center for Technology Commercialization/Northeast Advanced Vehicle Technology Center of Cheshire CT built an electric assisted Pony-Cab that can be pedaled and driven as an EV.

Figure 48 – Glen Dobbs, who also rode the 'Electrobike' during the NESEA Tour, gave people rides around the Capital Mall on this Pony-Cab.

Batteries	36 Volts
Motor	GE, 2 hp
Controller	Curtis

(I was in a hurry, so I didn't get much information from Glen, but I saw the vehicle later on. It is a 3-wheeler, with bicycle wheel and handle bars front and a two passenger seat over the rear wheels. The driver sits on a bicycle seat, and has pedals and hand controls. Glen was giving rides around the Mall.)

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Chris Nikpora and Ernie Bannister were on the Mall with what looked to be a fairly normal postal delivery vehicle, with sorting tray and right-hand drive, but, as you might guess, it was an electric. The conversion was one of six done by US Electricar. (The Postal Service has a dozen Ford Ecostars also.)

Base Vehicle	Postal Van
Batteries	~450 Volts(?), Genesis
Motor	Hughes, AC induction, transmissionless drive, 50 kW
Controller	Hughes Dolphin, with regenerative braking
Charger	Inductive, MagneCharge, plus 110 Vac emergency charge
Range	40 miles

The average postal route is about 8 miles, so that range is more than adequate.

One comment the drivers make about this truck is that it is much cooler in the summer because there is so little waste heat from the drive system. Winter heating is provided by a small electric water heater with a small pump that circulates the water to the cab radiator. There are plans to upgrade the heating system in the future.

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Georgia Power's Glen Mauldin was on the Mall with one of the 70 people-movers, a tug-and-three-trailers arrangement, that will be used in Atlanta for the Olympics. Jim Johnson designed the tug for Tug Manufacturing Company.

Base Vehicle	Airport cargo handling tug
Batteries	Deka, 30 kWh, 80 Volts, 3,300 pounds
Motors	2 Advanced DC, one on each rear wheel
Controller	Sevcon
Total Weight	7,000 pounds
Top Speed	17 mph
Pull weight	35,000 - 50,000 pounds
Grade	12%+

They anticipate that each trip will take about 1 hour around the Olympic village, and then they will swap battery packs. These batteries look nothing like the ones we've seen in cars. Each > cell < stands about 3 feet tall, and 40 make up a pack. The pack is a steel case holding all the cells. A crane lifts the pack up and out of the rear of the tug, a fresh one is lowered in, and connection is made with a large Anderson connector. The whole process should take 2 to 3 minutes.

"We really don't care how much the battery weighs," said Jim. "In fact the heavier the better. It saves us having to weld thick steel plates to the tractor to get traction."

Taylor-Dunn made the trailers for Georgia Power and GP put the system together. After the Olympics, there are plans to give the trains to the Park Service.

More Info: 770-422-7230

Report 73: Other Vehicles - Joint Tactical Electric Vehicle

Jeff Bradel of the Naval Surface Warfare Center/Marine Corp Programs Office, Dutch Steudler of Ron Millen Motorsports, and Catherine Anderson of AeroVironment were on the Mall with a series hybrid vehicle reminiscent of a jeep. Called a Joint Tactical Electric Vehicle (JTEV), it is the result of a design exercise funded by the US Marine Corp, US Army, and DARPA (Defense Advanced Research Projects Agency) to demonstrate an EV test bed built on commercially available technologies.

Base Vehicle	Custom built space frame, tube construction, adjustable ground clearance
Batteries	360 Volt, 5.5 kWh, lead-acid, gel-cells, in sealed box
Motors	2 30 kW continuous, 102 kW peak, AC induction motors
Engine	80 kW (107 hp) Diesel engine, Peugeot
Generator	60 kW alternator, Onan
Weight	4200 pounds
Payload	1500+ pounds
Height	62 inches
Width	65 inches
Length	169 inches
Ground clearance	10-15 inches, adjustability
Wheels	33 inches diameter, 10.5 inches wide, 15 inch rims
Top Speed	65 mph

Figure 49 — The US military is studying the possibility of using EVs because of their low noise, heat, and exhaust signatures. This Joint Tactical Electric Vehicle is the result of such a study. And yes, that is an *armored* hybrid EV personal carrier in the background.

Acceleration	0-30 mph: 3.5 sec 0-60 mph: 10 sec
Engine-on range	460 miles
EV range	10 miles
Fording depth	36 inches, salt water
Gradability	60%
Side Slope	40%
Approach angle	75 degrees
Departure angle	60 degrees

The JTEV is designed for deep insertion missions where it would be delivered by helicopter, travel in HEV mode until near the target area, switch to EV mode to lower its noise, thermal, and exhaust plume signatures, get in and out, switch back to HEV and be picked up.

The motors are integral with the front and rear differentials. The suspension has 18 inches of wheel travel which gives excellent off-road mobility. For comparison, the HUM-V (sp?) has only 9 inches.

The alternator actually replaces the flywheel on the engine, and acts as flywheel, alternator, and starter motor. The engine is down rated from 80 kW to 60 kW to allow them to run it at peak power full time. Catherine noted that, "the flexibility of a hybrid drive allowed us to make some unusual packaging decisions." For example, the shocks are laid over on their sides and tied to the suspension through sort-of bell crank arrangements. This let them have large wheel travels and adjustable height range and still have large cargo areas. And not having to tie the differentials to the engine with drive shafts also helps get those large travels. The center of gravity is also lower than in a normal 4-wheel drive.

The JTEV has significant on-board power for use by sensor suites or target acquisition equipment or high power communications equipment. It is more about stealth, speed and mobility than about heavy payloads. There is a plan to change to a 2-speed transmission which will give higher torque for quicker starts and even greater gradability. "The low gear will let it winch itself straight up," said Catherine. "The high gear will give us an even higher top speed. We are currently motor speed limited for top speed, not power limited."
The driver controls are simple. Pushbuttons select Park, Reverse, Neutral, or Drive. A single button selects HEV or EV mode. Regenerative braking is part of the system.

A 50 mm machine gun is mounted above the roll bar but is just for display and so is disabled.

Jeff wanted to emphasize that at this point the project is to test the feasibility of this technology in this type vehicle. It is not even a prototype. If this exercise proves promising, then future programs would work toward designing a real vehicle for actual use.

More info: Jeffrey Bradel, 301-227-4222, Fax -4389, bradel@oasys.dt.navy.

Report 74: Other Vehicles - 'trans-2'

Todd Ansbacher and Catherine Feer, from Wallingford AC, Inc., were on the Mall with a couple of 'trans-2' vehicles. These are two-seat, 4-wheel vehicles that look a lot like golf carts, but are not. The literature calls them "personal community vehicles" for the turf or street. It has a reduced power mode for off-road use, but can be taken out on the street where it gets up to 20 mph.

Batteries	4 12-Volt, Champion EVR, lead-acid, 48 Volts
Motor	GE series wound
Controller	Curtis
Charger	Saftnife (sp), 110 Vac
Range	30 miles

The aluminum space frame puts the heavy components down for a low center of gravity. The body panels and interior are made from composite materials. 4- wheel hydraulic brakes, seat-belts, high seat backs with headrests, safety glass windshield, head and tail lights and turn signals make it practical on the local road. There is also a radio and cup holders. List price is $6,995.
More info: 1-800-205-8222 (retailer and sales info)

Figure 50 — Although unable to run the race, these 'trans-2' vehicles gave rides all around the Capital Mall.

"Next year it will have an AC controller and motor in it which increase the power and range by 40%," said Catherine. A 4-page flyer promoting Wallingford AC Controls claims "AC Motor Controller System Performance at DC System Pricing!" It goes on to claim to have eliminated harmonics, overheating, and radio/TV interference commonly associated with inverters used to drive AC motors from DC power. The flyer implies that the system will be generally available.
More info: (954) 973-4350

Report 75: Other Vehicles - H-Power's Fuel Cell Bus

Jessie Herbert of Georgetown University is an intern working on testing a 40 foot long, hybrid, fuel cell powered, EV Bus. It was built by H-Power Corporation of Belleville NJ as a proof-of-concept vehicle. 150 gallons of methanol and water provides a range comparable to a Diesel bus.

Fuel Cell	Fuji Electric Co. of Japan Phosphoric Acid (electrolyte) Fuel Cell, 50 kW
Bus Chassis	Bus Manufacturing USA, Santa Barbara CA
Propulsion	Soleq Corp, Chicago IL
System Integration	Booz, Allen & Hamilton, Inc., McLean VA

There is a battery pack, but its primary purpose is load leveling, providing extra power for acceleration and hill climbing, and to take up the energy created by regenerative braking. The batteries are necessary in this bus, because the fuel cell cannot respond fast enough to changes in load. It can take 20 seconds to respond to an increase in load.

The ideal way to run a fuel cell is to provide pure hydrogen on the anode and pure oxygen on the cathode. The exhaust would be water and steam. Using hydrogen and air would not be a bad compromise, but either way you have to carry hydrogen, which is still a bit tricky. This bus uses a mix of methanol and water as the source of hydrogen, and in a step called "reforming", that involves a catalyst, the hydrogen is made available to the fuel cell and the left over carbon and oxygen combine to make carbon dioxide. Some carbon monoxide and oxides of nitrogen are also produced, but at levels 1/60th and 1/400th the level of Diesel engines.

This bus has only been used in testing and doesn't run a "mission". The next version will be a commercializable 40 foot vehicle. This version will have both a phosphoric acid fuel cell and a Proton Exchange Membrane (PEM) fuel cell, for comparing them, and both should be able to respond to load demand changes much better.

Report 76: Other Vehicles - Blue Bird's Bus

Curtis Pearson, Huntly(?) Dorsey and Ron Satchell from Northrup were on the Mall with a 34 foot long Blue Bird bus labeled 'EAGL' (Environmental Alternative for a Greater Lifestyle) ((everything has to have an acronym?)) that is on its way to Cedar Rapids, Iowa.

Base Vehicle	Blue Bird Transit Q Bus
Batteries	336 Volt, GNB, lead-acid, absorbed glass mat, 110 kWh
Motor	230 hp AC induction, single ratio reducer, 1.5 kWh/mile
Controller	Northrup Grumman, with regenerative braking
Heat/AC	Heat pump, plus Diesel fueled heater
Range	60 - 80 miles

The 'Q Bus' is designed as an EV from the ground up to seat 33 passengers, plus 20 standing, with 2 wheelchair positions and a wheelchair lift in the step well of the rear door. (Unlike some EV buses I've seen, this has a fairly high step up to the riders' seats.)

"The fueled heater is very low emission, so we can call this a Zero Emission Vehicle even with that running," said Curtis. ((Interesting definition of Zero, to my mind, but ...)). "It will keep the bus quite warm, even in the minus 25 degree temperatures they get in Cedar Rapids."

"We have some of these (Q Buses) going into Richmond, and to the Olympics where they will be operated by Georgia Power driving the 'Cultural Olympiad' event ring in downtown Atlanta." They are also getting a lot of interest in California, New York and Maryland.

The bus is not entirely quiet when standing still. ((Some of us are never satisfied.)) A motorized pump runs continuously to provide oil-cooling ((presumably for the motor and electronics)), and hydraulic pressure for the power steering and power brakes. ((To me, it sounded like a noisy fan. Certainly nothing to interfere with our conversation.))

The braking system is simpler and less expensive than on a normal bus. "Because we have hydraulic braking the braking system is less complex. Because we have regenerative braking, which does about 90% of the braking, we figure we can skip 3 or 4 brake (shoe) change cycles." The regenerative braking is entirely on the top portion of the brake pedal by connecting directly into the hydraulic lines. The regen is done in the dead-band before the brake shoes start to grab. With both brake and accelerator pedals up the bus coasts, "about a mile from 55 mph. We found it was more efficient to coast to a stop than to have the regen in the accelerator pedal."

"The operators love it because they can see the simplicity of the bus and pick out ways they are going to save money in operation.

"We are testing 3 or 4 different battery management systems to see which ones work best and provide the most value. Some are very expensive and some are very cheap. We are looking for the balance that provides the most value."

"These vehicles are for sale, so contact your Blue Bird dealer."

The first Blue Bird EV bus was a school bus that has sold well in California (at least 23). "The school bus drivers are telling us they love it because the whole bus is quieter since the kids are not yelling to be heard over the sound of the Diesel engine. The drivers love it because it is the quietest bus in operation, both in mechanical and human terms."

Report 77: Other Vehicles - Advanced Vehicle Systems' Bus

Brian Pannell, with the Allison Transmission division of General Motors, was on the Mall driving a low-floored shuttle bus built by Advanced Vehicle Systems (very similar to the CARTA EV buses in Chattanooga TN) "but we put in our own drive system." It is a series hybrid, running on Compressed Natural Gas (CNG).

Batteries	2 strings in parallel, 26 12-Volt Delphi, 312 Volt, gas recombinant valve regulated lead-acid
Motors	2 AC induction wheel motors based on the GM EV1, 30 kW continuous, 70 kW peak each
Controller	Delphi inverter
Weight	13,000 pounds
Generator Set	up to 30 kW, computer adjustable

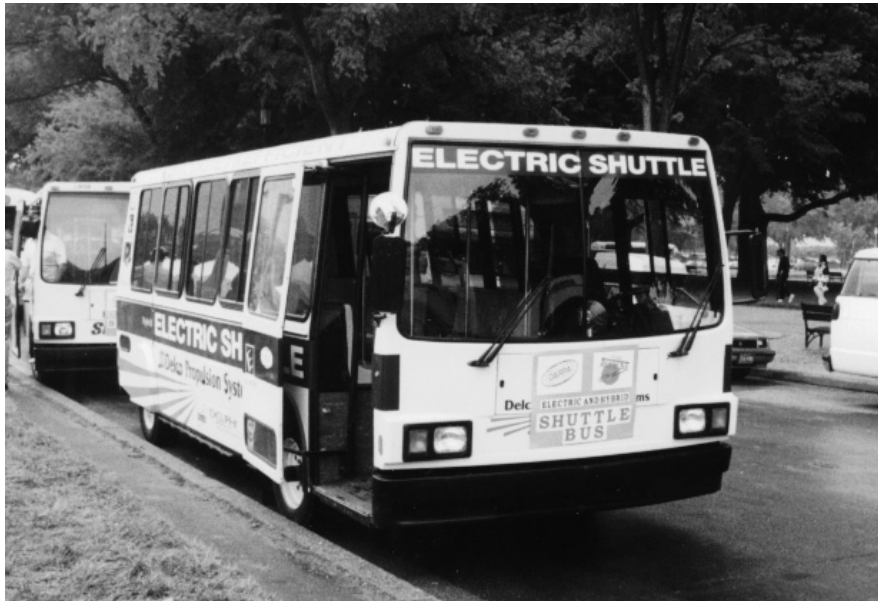

Figure 51 — This hybrid electric bus had just finished some intensive testing before it was sent to Washington DC to give demonstration rides. Its next stop was Chattanooga TN to join their dozen all-electric buses.

"This vehicle is a technology demonstrator, the first of three we built under a DARPA (Defense Advanced Research Projects Agency) grant. It has just finished a 5,000+ mile at the GM proving grounds in Milford MI and will be delivered to CARTA to join their fleet in service to get real-world experience." At the proving ground they were driving 250 miles per day with a couple of CNG refuelings.

"The batteries have a computer in each pack that monitors each individual cell's voltage, temperature, and condition and will protect the batteries from being abused," a variation on the system on the GM EV1. "It automatically manages the charge to keep the batteries from over charging and gassing, and protects against over discharging."

I have often heard that the problem with wheel motors is that they become part of the unsprung weight of the vehicle and that can create problems. Brian pointed out that having 2 rear wheel motors instead of an axle with differential raises the unsprung weight by very little.

Report 78: Other Vehicles - 'Number 51'

Ken Green and Ed Torrence from Phelps Career Senior High School (in Washington DC?) are with 'number 51', a car that showed up in Annapolis and drove with the pack down to the Capital Mall. "It was originally built for the EV Grand Prix race down in Richmond VA in 1994, and we have range limitations" and budgetary constraints that prevented them from running in the race from New York City. "It was converted according to the EV Grand Prix specs. We hope to make the NESEA Tour next year."

Base Vehicle	1983 VW Rabbit GTI
Batteries	8 Electrosource Horizon 12N95, 96 Volts
Motor	Advanced DC(?)
Controller	Curtis 1231C
Charger	? w/ BADICHEQ
Range	~50 miles

"This project was constructed at the IDEA (Integrated Design and Electronics Academy) at Phelps. The Wood Shop, the Paint Shop, the Automotive Shop, the Electronics, and the Communications programs all worked together. IDEA is a joint project between the Department of Defense, the Department of Education, and Phelps. The DoD has given us about 10 retired military people that work with the students in what becomes almost a family environment," Ken said. This project has proved very rewarding. "In the past three years it has been exciting to see the kids growing in confidence and maturity, especially taking them to Richmond, watching them develop teamwork and team spirit."

Report 79: Snippets from the Capital Mall

Bob Larsen of Argonne National Labs told me:

'The Paradigm' from University of Wisconsin at Madison got a hybrid range 52.3 miles per gallon on Wednesday (Chesapeake City to Annapolis) as compared to the gasoline Neon control car which got 38.4 mpg.

The best dynomometer fuel economy was the University of Tennessee at 31.3 mpg.

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I heard that several school teams will be getting additional sponsors next year. One of the team members from the 'Ottawa Orange IV' team said that Solectria was going to help them next year. "With George Kloster and Eva Mathews in there, that car is going to be a winner!"

I also heard that Solectria will be helping 'Helios the Heron' next year.

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Ken Quinty who drove the 'Utility EV' to impressive rankings in the autocross and acceleration runs (4th and 3rd places) said, "We could have won the acceleration very easily with a little reprogramming in the controller. And I just found out that the guy from Northrup Grumman who could have done that was there! If he had a laptop he could have done the whole thing in ten minutes! We could have beaten the Neon and 'Spyder Juice' very easily." OK, Ken. Show us next year! We'll be there.

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Figure 52 — The two people in Boston University's 'Silber Bullet' ride back-to-back, so as to keep the body narrow and aerodynamic.

Boston University's 'Silber Bullet', which was supposed to be in the NESEA Tour but wasn't ready to start, was on the Mall for the display. My first question was, "Why Silber?" I got answers from Naumann Sheikh (the treasurer for the team),and Gideon Coltof, and Bernard Andoh.

"It's named after our outgoing President of 25 years, John Silber."

And why weren't they at the starting line? "We had a number of difficulties that kept the car from being up to racing standards." They also didn't have a controller the day before the race, so that pretty much clinched it.

But it would have been very interesting to see this car in operation. It is shaped like a bullet and carries two people, but the passenger is behind the driver > facing backwards <! He or she has a large windshield ((so they can tell the driver, "you should have turned back there!" ;-))) and eventually will have a front-view mirror. "The driver is also the navigator. The passenger performs other functions," such as monitoring systems. The thinking was that the US DOE Commuter Category rules require two people on board, and this strategy was to put them in that category with a very stream-lined and competitive vehicle.

About 20 people worked about 6 months. With the exception of the motor, controller, batteries, calipers for the brakes and a few other things, "pretty much everything was designed and hand-made by the team." For example, the wheels are made from carbon-fiber composites.

Batteries	65 or 120 Volts, Nickel Cadmium, 20 kWh
Motor	Solectria, permanent magnet, 11 hp
Controller	Solectria
Top Speed	110-120 mph, estimated

The high stop speed is due in large part to the low coefficient of drag, which they calculate to be 0.065, "which is not physically impossible, but is a very good > theoretical < number to work with." ((I'm not quite sure how to take that. I suspect they don't quite believe it either.))

The car is number 24 and dedicated to Travais Roi, a Boston U hockey player who was paralyzed during his first game this year.

More info: http://engc.bu.edu/solarcar

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A large panel van with paintings of Air Force jets on the side was also on display. It is an electric mail delivery truck used at Hanscom Air Force Base near Boston. Ray Bagwell told me about it.

Batteries	54 6-Volt, GNB, 340 Volts
Motor	GE AC induction, 100 hp
Top Speed	50 mph
Range	50 miles per charge (estimated)
Weight	6 tons
Capacity	1 ton

It was built by Specialty Vehicles in California and they have had it in use for about a month. The walls of the cargo area looked to be made from fiberglass panels between steel supports. The cargo area was very tall and wide, I'd guess about 10 feet wide x 12 feet long x 6.5 feet tall.

Report 80: May 16th Evening Race Summary

This report is based on the Race Summary I received at the closing ceremonies on Friday afternoon. It is the best information I have at that moment and I believe it to be the final results. (I am skipping the results from Thursday morning; no time to type them up.)

I've also attached the Tour Miles and (Total Miles) numbers. (Total Miles) is the distance actually traveled. Tour Miles is (Total Miles) minus penalties for various reasons, including not being ready to start on time, moving and safety violations, failure to be on display at the appointed times, etc.

Tour Miles determine pole position day-to-day a the winner of each Category. Many other prizes are also awarded (more on them later).

X	Did not show up or maybe out of the race
Y	Dropped out of the race (my understanding)
Z	Dropped out of the race, but displaying vehicle at stops

NAVC Production Category (in final standing order)

Num	Car	Team	Tour Miles (Total Miles)
4	Solectria Force NMH	Solectria	604.7 (609.7)
17	Ford Ecostar	Allegheny Power	538.7 (543.7)
50	Solectria/Horizon	Connecticut EV/NAVC	388.6 (409.7)
34	State Power	STAPPA/ALPA-Solectria Force/NiCd	385.5 (391.4)
7	Nordic Challenger	EVermont/NAVC	383.3 (422.0)
15	Solectria Force	JCP&L-running Lead-acid	382.2 (387.2)
12	Twike	Technik & Design	316.7 (319.5)
14	Chrysler TE Van	Met-Ed Penelec/JCP&L/GPU	286.2

1996 NESEA American Tour de Sol Chronicles

				(322.7)

US DOE Commuter Category (in final standing order)

Num	Car	Team	Tour Miles	(Total Miles)
63	Solectria Sunrise	NAVC/BECO/Solectria	772.7	(810.5)
72	Sungo	NHTI Electric Car Team	384.6	(393.6)
57	George the Geo	FMRHS-Solar Electric Racing	382.3	(386.1)
32	Porsche 914 E. Bull	Shadow Mountain E. Matadors	378.6	(378.6)
88	OHM Ranger	Neocon/NYSEG	361.4	(361.4)
31	Spyder Juice	Solar Electric Spyder Juice	357.4	(362.5)
43	KA1000	Polytech Chargers	356.4	(361.4)
39	Sparky	EV Moore - CEVA	344.2	(344.2)
35	Kineticar	CSERT - NVCTC	342.3	(352.8)
42	Golden Gear Special	RMAVTS - Golden Gear Racing	336.7	(336.7)
38	Sparky 2	Wooster's Charge	335.5	(345.3)
65	Electric Hare	Wattsmen	331.7	(336.7)
66	Genesis I	Genesis Team	328.1	(328.1)
33	Solar Bus	Bridgewater Solar Works	324.1	(328.1)
46	Utility EV	PETC	296.9	(332.5)
74	Lightning Volt	Parkland High School	289.7	(324.7)
44	SolarSaurus	Rocky Hill High School	159.8	(265.3)
82	Lectric Lion	North Hunterdon High School	83.4	(241.1)
54	Roadrunner	Greenwich H. S. Solar Flair	20.8	(287.4)
79	59 Berkeley	Team New England	-1.1	(210.6)
47	Electruck	Taylor-Dunn	-7.5	(171.0)
45Y	Regenerative Braking	Alternative Energy	-230.7	(63.6)
24X	B-U-LLET	Boston Univ. SEV Team		
2X	Trans2-AC	Wallingford AC, Inc		

Solar Commuter Category (in final standing order)

Num	Car	Team	Tour Miles	(Total Miles)
83	Sol Survivor IV	CONVAL Solar Car Team	93.0	(248.2)

58	Sol Machine	Newburgh Free Academy	-135.9
			(149.0)
93	Helios the Heron III	Riverside School	-213.6
			(91.4)
36	Texas Native Sun	Lonestar Solar Racing Team	-313.1
			(38.9)
75X	Commuter Car	Villanova Univ. EV Team	

Chrysler Hybrid Category (in final standing order)

Num	Car	Team	Tour Miles (Total Miles)
94	Hopper EV	Tom Hopper	471.1
			(673.1)
96	Project e-	Mt Everett High School	470.9
			(505.3)
23	Viking 23	Western Washington Univ.	427.9
			(440.3)
48	Electric Lion	Penn State SAE	366.9
			(382.1)
81	VT Ani mul SL	HEV Team of Virginia Tech	288.4
			(318.4)
26	Hyperion	Team Hyperion, Wentworth I. of T.	251.8
			(304.1)
84	The Paradigm	Team Paradigm, Univ. of Wisconsin	240.3
			(340.9)
25	Viking 25	Western Washington Univ.	81.7
			(229.3)
28	Hybrid Lumina	Clarence Ellers	-248.3
			(71.3)
19Z	HEV U Florida	Univ of FL HEV Society	-274.9
			(78.0)
21Z	Hy Potential IV	Univ. of Tennessee	

Open Category (in final standing order)

Num	Car	Team	Tour Miles (Total Miles)
92	Sunpacer	Cato-Meridian HS Tech Team	257.8
			(322.7)
64	Proteus 1	Union College	83.8
			(262.6)
52	Electrobike	CTC NEastAdvVehTecCtr	81.8
			(276.5)
37	Ottawa Orange IV	Tech Prep	43.3

Tuesday:

NAVC Production Category	12	Twike	68	Wh/mile
US DOE Commuter Category	63	Sunrise	103	Wh/mile
Chrysler Hybrid Category	84	The Paradigm	387	Wh/mile
Open Category	92	Sunpacer	90	Wh/mile

Wednesday:

NAVC Production Category	12	Twike	68	Wh/mile
US DOE Commuter Category	63	Sunrise	89	Wh/mile
Chrysler Hybrid Category	84	The Paradigm	237	Wh/mile
Open Category	92	Sunpacer	80	Wh/mile

Report 81: Efficiency Awards

The daily efficiency awards went like this:

Monday:

NAVC Production Category	7	EVermont	130	Wh/mile
US DOE Commuter Category	63	Sunrise	120	Wh/mile
Chrysler Hybrid Category	84	The Paradigm	228	Wh/mile
Open Category	92	Sunpacer	154	Wh/mile

Thursday:			
NAVC Production Category	12 Twike	68	Wh/mile
US DOE Commuter Category	72 Sungo	113.6	Wh/mile
Chrysler Hybrid Category	84 The Paradigm	241	Wh/mile
Open Category	92 Sunpacer	81.8	Wh/mile

Overall 4 Day Efficiencies

NAVC Production Category (in final standing order)

Num	Car	Team	Overall Wh/mile
12	Twike	Technik & Design	66
7	Nordic Challenger	EVermont/NAVC	111
15	Solectria Force	JCP&L	122
50	Solectria/Horizon	Connecticut EV/NAVC	138
4	Solectria Force NMH	Solectria	165
14	Chrysler TE Van	Met-Ed Penelec/JCP&L/GPU	-
17	Ford Ecostar	Allegheny Power	-
34	State Power	STAPPA/ALPA	-

US DOE Commuter Category (in final standing order)

Num	Car	Team	Overall Wh/mile
72	Sungo	NHTI Electric Car Team	114
63	Solectria Sunrise	NAVC / BECO / Solectria	135
31	Spyder Juice	Solar Electric Spyder Juice	156
43	KA1000	Polytech Chargers	158
32	Porsche 914 E. Bulls	Shadow Mountain Electric Matadors	167
65	Electric Hare	Wattsmen	170
39	Sparky	EV Moore - CEVA	198
42	Golden Gear Special	RMAVTS - Golden Gear Racing	206
38	Sparky 2	Wooster's Charge	209
54	Roadrunner	Greenwich High School Solar Flair	214
46	Utility EV	PETC	226
88	OHM Ranger	Neocon / NYSEG	235
35	Kineticar	CSERT - NVCTC	255
66	Genesis I	Genesis Team	256
74	Lightning Volt	Parkland High School	258
33	Solar Bus	Bridgewater Solar Works	301
44	SolarSaurus	Rocky Hill High School	-
47	Electruck	Taylor-Dunn	-
57	George the Geo	FMRHS-Solar Electric Racing	-
79	54 Berkeley	Team New England	-
82	Lectric Lion	North Hunterdon High School	-

Solar Commuter Category (in final standing order)

Num	Car	Team	Overall Wh/mile
83	Sol Survivor IV	CONVAL Solar Car Team	104
36	Texas Native Sun	Lonestar Solar Racing Team	-
58	Sol Machine	Newburgh Free Academy	-
93	Helios the Heron III	Riverside School	-

Open Category (in final standing order)

Num	Car	Team	Overall Wh/mile
92	Sunpacer	Cato-Meridian HS Tech Team	82
37	Ottawa Orange IV	Tech Prep	-
52	Electrobike	CTC NEastAdvVehTecCtr	-
64	Proteus 1	Union College	-

Figure 53 — 'Sunpacer' from Cato-Meridian High School in New York turned in an impressive efficiency of 82 Watt-hours per mile, second only to the much lighter 'Twike'.

Report 82: Prizes at the Closing Ceremonies

These are awards that are given within each of the Categories.

Z Dropped out of the race, but displaying vehicle at stops

The NAVC presented the awards in the category it sponsored. Nancy Hazard presented the awards on behalf of Sheila Lynch of NAVC.

NAVC Production Category

Number	Car	Team
4	Solectria Force NMH	Solectria
	<> Best Sedan using Advanced Energy Systems	
	James Worden dedicated this prize to the memory of Craig Douglas of the University of Massachusetts at Lowell.	
	<> 1st Place, Range, using Advanced Energy Systems	
	<> Autocross Prize	
7	Nordic Challenger	EVermont/NAVC
	<> 3-way tie: 1st Place, Range, using Lead-Acid Batteries	
12	Twike	Technik & Design
	<> Best 3-wheeler	
15	Solectria Force	JCP&L
	<> 3-way tie: 1st Place, Range, using Lead-Acid Batteries	
17	Ford Ecostar	Allegheny Power
	<> Best Utility Vehicle using Advanced Energy Systems	
	<> Autocross Prize	

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 50     Solectria/Horizon       Connecticut EV/NAVC
        <> Best Sedan using Lead-Acid Batteries
        <> 3-way tie: 1st Place, Range, using Lead-Acid Batteries
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The US Department of Energy gave prizes in the category it sponsored. Richard Moore, a Department Director at DOE, presented the awards.

US DOE Commuter Category

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 Number Car                     Team
 31     Spyder Juice            Solar Electric Spyder Juice
        <> Autocross Prize

 32     Porsche 914 Electric Bull Shadow Mountain Electric Matadors
        <> 3rd Place, Student-built Vehicle
        <> 3-way tie: 1st Place, Range, Commuter Category

 35     Kineticar               CSERT - NVCTC
        <> 5th Place, Student-built Vehicle

 43     KA1000                  Polytech Chargers
        <> 4th Place, Student-built Vehicle

 46     Utility EV              PETC
        <> Autocross Prize

 57     George the Geo          FMRHS-Solar Electric Racing
        <> 2nd Place, Student-built Vehicle
        <> 3-way tie: 1st Place, Range, Commuter Category


 63     Solectria Sunrise       NAVC / BECO / Solectria
        <> Best Vehicle
        <> Best Sedan running on Advanced Energy Systems
        <> 1st Place, Range, using Advanced Energy Systems,
           US DOE Commuter Category

 72     Sungo                   NHTI Electric Car Team
        <> Best Sedan running Lead-Acid Batteries
        <> 1st Place, Student-built Vehicle
        <> 3-way tie: 1st Place, Range, Commuter Category

 88     OHM Ranger              Neocon / NYSEG
        <> Best Utility Vehicle running Lead-Acid Batteries
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Solar Commuter Category

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 Number Car                     Team
 83     Sol Survivor IV         CONVAL Solar Car Team
        <> 1st Place, Tour Miles
        <> Best Solar Fraction, 31%
        <> Autocross Prize
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Chrysler Corporation, as the sponsor of this category, created some of the special categories, such as those prizes for Neon conversions. Doug Teague (sp?) of Chrysler made the presentations.

Chrysler Hybrid Category

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 Number Car                     Team
 19Z    HEV U Florida           Univ of FL HEV Society
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<> 3rd Place Neon HEV

21Z Hy Potential IV — University of Tennessee
<> 2nd Place Neon HEV

23 Viking 23 — Western Washington University
<> 3rd Place, Tour Miles

25 Viking 25 — Western Washington University
<> Best Neon HEV
<> Best Neon HEV Range
<> Best Neon HEV Consumer Acceptability
<> Best Neon HEV Overall Design

26 Hyperion — Team Hyperion, Wentworth Inst. of Tech.
<> Best Customer Acceptability

48 Electric Lion — Penn State SAE
<> 4th Place, Tour Miles

81 VT Ani mul SL — HEV Team of Virginia Tech
<> 2nd Place, Tour Miles
<> Lowest HEV Emissions

84 The Paradigm — Team Paradigm, University of Wisconsin
<> Best Efficiency
<> 1st Place, Tour Miles
<> Best Energy Economy Overall
<> Autocross Prize

94 Hopper EV — Tom Hopper
<> Best Overall Hybrid, 1 person
<> 1st Place, Range, Hybrid Category

96 Project e- — Mt Everett High School
<> Best Overall Hybrid, 2 person
<> 5th Place, Tour Miles

Open Category

Number	Car	Team
52	Electrobike	CTC NEastAdvVehTecCtr

<> Best Overall Open Category, 2 wheels
<> Autocross Prize

92 Sunpacer — Cato-Meridian HS Tech Team
<> Best Overall Open Category, 3 or 4 wheels
<> 1st Place, Student-built Vehicle, 3 or 4 Wheels
<> 1st Place, Range, Open Category

Peter Barnes, representing the board of directors of the national Electric Automobile Association, presented the "1996 Keith Crock Award for Outstanding Achievement" to James Worden of Solectria.

A set of safety awards will be given at a future time.

Rob Wills announced several non-trophied prizes:

"The I-Couldn't-Have-Done-It-Without-You Award"
to 66 'Genesis I' for loaning parts, controllers, and expertise to the teams and even repairing the car of one of the support staff.

"The Powers-That-Be Education Award"
to 34 'State Power' for giving many VIP rides at the expense of race points.

"The Teaching the Next Generation of EV Enthusiasts Award"
to 93 'Helios the Heron III' for enthusiastic explanations given to children who came to the displays.

Report 83: A Reporter's Final Thoughts

Well, we've come to the end, folks, of over 40,000 words of what I hope have been informative and interesting reports about the 1996 NESEA American Tour de Sol.

I would like to add a few of my own observations and comments.

I go to the NESEA Tour because I am interested mostly in the technology of electric vehicles. It was the most important factor in my deciding what type of electric vehicle I got and how I got it. The American Tour de Sol is the one place where I could see EV technology "on the hoof" and in the environment I would be driving in, so it has served me well.

As some of you may have guessed, I am not all that concerned about who-came-in-first, although I do try to get accurate standings as the week progresses. For final race standings I refer you to NESEA, which has the last word on such things.

The NESEA Tour gives an excellent cross-section of EV activity in the United States. We naturally get more representation from the northeast; it is NESEA's first name, after all. But the fact that people from as far away as Germany, Washington state, Oregon, Arizona and Florida participated provides a wider view of how sustainable energy sources and efficient energy systems can be used for transportation. It is a view like no other I've seen.

The variety of technologies represented here grows each year. In 1996 we saw our largest number of hybrids ever, fueled by everything from reformulated gasoline, to compressed natural gas, to propane, to ethanol, to soybean oil. Some were series hybrid and some were parallel.

We had the most different advanced battery chemistries we have ever seen; Advanced Lead-Acid, Nickel Cadmium, Sodium-Sulfur, and Nickel Metal Hydride, and all but one in multiple vehicles.

We had DC drive systems and AC drive systems. We had an electrically assisted bicycle and an electrically assisted two-person tricycle. We had a race car and a minibus. We had homebuilts and commercial vehicles. We had more sophisticated computer controls and instrumentation than ever before.

We had corporations, universities, colleges, technical schools, high schools, an elementary school and just-plain-folks all enter successful vehicles.

We had three cars, 'OHM Ranger', 'Roadrunner' and 'Hopper EV', that drove from home to the race.

One car, 'Hopper EV', drove home, from Washington DC to Concord NH! To my mind, that is the > Most Significant Event of the Tour < . On top of that Tom Hopper and his team partner Craig Cushing were operating "without a net" (no trailer in case of a breakdown). I think this demonstrates to the world that EVs in general and Tom's hybrid EV in particular have crossed the line to practicality. (Western Washington U's 'Viking 25' was also supposed to drive home, and if they did and made it, they also get my MSE award with Oak Clusters for Range!)

I believe we had fewer breakdowns than in past years, and we saw several cases where "never say die" proved to be the right answer.

I sat on the Race Jury this year, and saw some of the behind-the-scenes discussions that go into trying to make the NESEA Tour safe, fair and fun. It showed me again how difficult it is to come up with the "right" answer in the real world and how "simple rules" can have unexpected consequences. (In the unsolicited advice department, let me suggest the next time you hear of some decision that "just doesn't make any sense", consider that people might be working real hard to come up with a safe and fair answer to a question that probably has more sides to it than you thought it might. I know I will.)

At the displays we had even more EVs of various stripes. We saw the Toyota RAV4-EV, the GM Impact, buses from H-Power, Blue Bird and Advanced Vehicle Systems, research military vehicles, and a Pedi-Cab human/EV hybrid.

And of course, records were set.

Solectria set range records of 244 miles per charge in the Production Category and 373 miles per charge in the Commuter Category, using "ordinary cars" running NiMH batteries. I think it is fair to say that the major thing standing between us and EVs with 200 and 300 mile ranges is manufacturing volume.

The 'Viking 25' CNG hybrid met California ULEV standards.

I suspect the 'Hopper EV' soybean oil hybrid got more than 50 mpg (I've not heard final numbers).

And finally, I think I can safely say that a good time was had by all.

Yes, there were long nights when chargers drew more current than anticipated and kept tripping circuit breakers. There were tense times when it was not clear if a vehicle was in or out of the race due to a problem.

But there was also wonderful team work and generosity, typified by the folks from 'Genesis I' who helped others with every thing from the right bolt to a complete controller or charger.

And everyone I spoke to said this was the smoothest NESEA Tour yet. That credit has to go to the people at the Northeast Sustainable Energy Association who have worked for well over two years to pull this off. It goes to the people who sponsored our stops and displays and provided everything from bathrooms and showers to meals and power and lodging. It goes to the dozens of volunteers both at single sites and who traveled with the race, who helped do whatever that needed doing; set up or take down banners and signs, direct traffic, sell T-shirts and books, park cars, conduct tours, keep times and records, and calculate results.

I have had fun. I hope you have too. If you live in the Northeast and would like to be part of this next year, contact and/or join NESEA. The current plan is to race in New England, according to Nancy Hazard, the race director.

And if you can think ahead to 1998, Nancy is planing on another New York to Washington DC event.

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And let me remind you that the other half of NESEA's electric vehicle program is the annual Sustainable Transportation and Solar & Electric Vehicle Conference. This year it is September 16-18, 1996, at Madison Square Garden, New York City. Each year the technical data from the NESEA Tour is reported in papers and sessions there.

For more information on the American Tour de Sol, visit the web page at
http://www.crest.org/clients/nesea/atds.html

Official American Tour de Sol information is available from the sponsor, the Northeast Sustainable Energy Association (NESEA) at 413-774-6051. All media inquiries should be addressed to ...

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Display at South Street Seaport in New York City

How does this 'Twike' thing work?

'Lectric Lizzy' from Champlain College was an entrant in the 1994 NESEA Tour. This year it came to the displays and offered rides.

Working on 'Helios the Heron III'.

John Helwig found the lack of a door on 'Lectric Lizzy' poses a bit of a challenge.

'Sungo'

The 1996
NESEA American Tour de Sol
Chronicles

Mike Bianchi and John Helwig

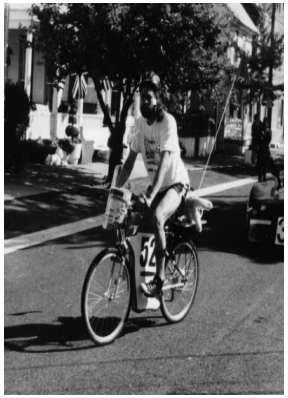
'Helios the Heron III'

From May 10th through May 17th of 1996, the NESEA American Tour de Sol Road Rally Championship for Electric Vehicles provided a showcase of energy efficient and environmentally benign cars, trucks and specialty vehicles.

During the course of the event, Mike Bianchi interviewed the participants and provided a running commentary to people around the world via the Internet. This book collects those reports along with John Helwig's photographs of the vehicles.

Join us on a fascinating journey as people look for ways to improve the environment without giving up the convenience of motorized transportation. Meet the elementary, junior high, senior high and college students, the people from American and European corporations, and the just-plain-folk who are inventing the future.

'Hyperion' starts the NESEA Tour in New York City



'Electrobike'

'Texas Native Sun II'

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