

# **SOLAR 2007**

## **8<sup>th</sup> Annual Emerging Transportation Plenary**

**Moderator**

**Steve Heckerth**

**Chair Renewable Fuels and Transportation Division**

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# Renewable Fuels and Sustainable Transportation Division

## Mission

- Support the widespread development and use of clean renewable fuels.
- Lobby for improved fuel efficiency and emissions standards.
- Support the rapid transition to zero emission renewable technologies.
- Promote sustainable community planning to reduce fossil fuel dependence.

### Fuel Efficiency and Climate Change

Vehicle Type	\$ Gas 25 Mi. /Day	kWh 25 Mi. /Day	\$/year 25 Mi. /Day	Gal/yr 25 Mi. /Day	Tons of CO2/Yr Tailpipe	*+ Tons of Upstream CO2/Year
10 MPG Gas	8.75	100	\$3200	915	10.5	13.7
20 MPG Gas	4.37	50	\$1600	460	5.3	6.8
30 MPG Gas	2.93	34	\$1050	305	3.5	4.5
40 MPG HEV	2.20	25	\$800	230	2.6	3.4
50 MPG HEV	1.75	20	\$640	180	2.1	2.8
Plug-in HEV 25 Mile range	0	8	\$140	0	0	1.2
Battery EV	0	5	\$100	0	0	.7
Ultra light EV	0	1	\$20	0	0	.14

### Mobility *without* Pollution

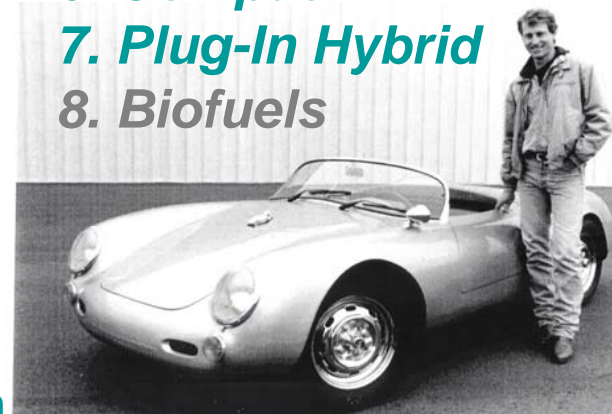
1. Consolidate Trips
2. Walk or Bike
3. Pedal Electric
4. Electric Rail
5. Ultra-light EV
6. Compact EV
7. Plug-In Hybrid
8. Biofuels

Assumptions: \$3.50/gal, \$.05/kWh nighttime rate, 40kWh/gal, 23#sCO2/gal

To join the **RFST Division** go to [www.ases.org](http://www.ases.org)

RFST Chair: Steve Heckerth, [steve@renewables.com](mailto:steve@renewables.com)

Heckerth pictured with one of the Electric Porsche Spyders he built in the early '90s



# 97% of US Vehicles are Fueled by Oil

## Renewables Forever

terawatt hours YEAR

### Direct Solar Radiation

350,000,000

Wind	200,000
Ocean Thermal	100,000
Biofuel	50,000
Hydroelectric	30,000
Geothermal	10,000
Tidal/Wave	5,000

## Energy Stored in the Earth

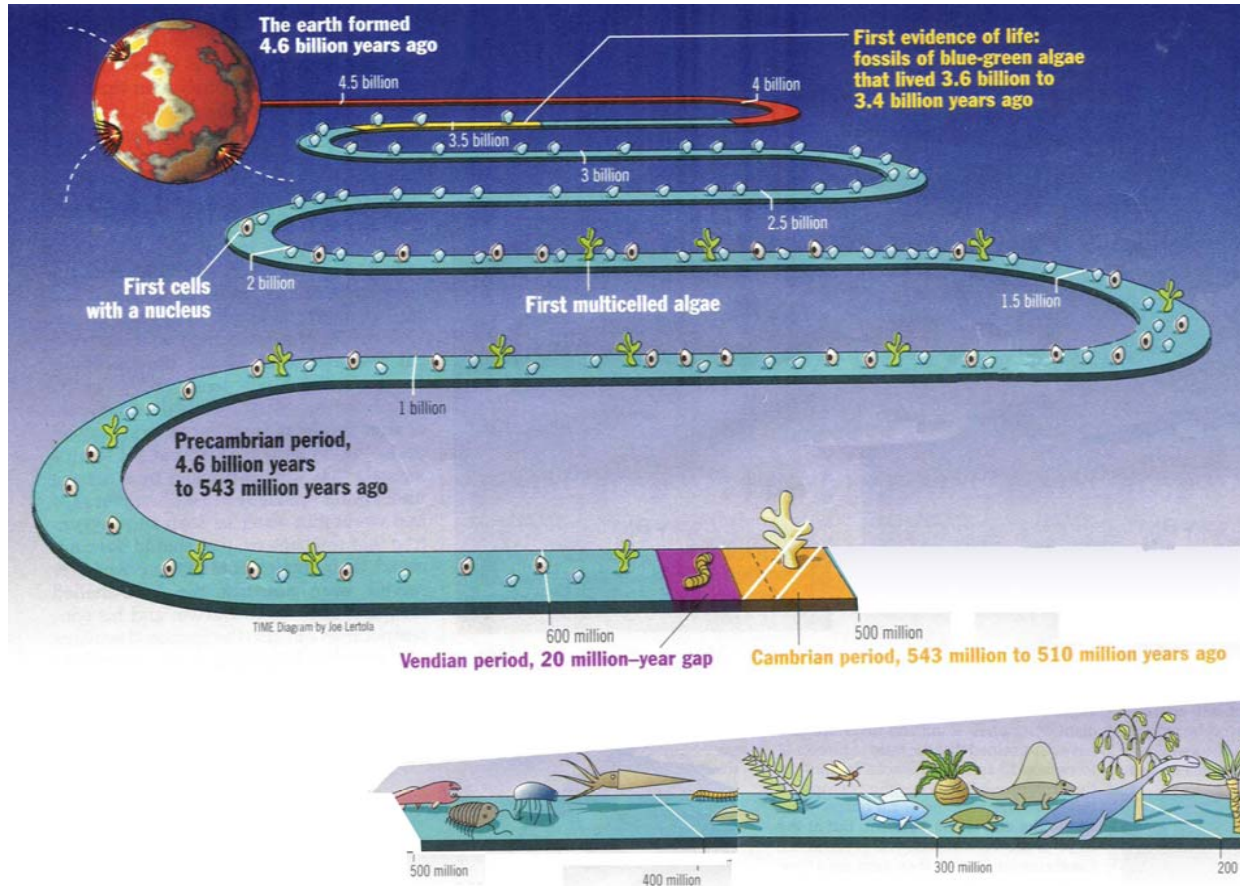
terawatt hours TOTAL

(Use it once and it's gone)

Coal	6,000,000
Natural Gas (US Peak 2004)	1,500,000
Uranium 235 (US Peak 2008)	1,500,000
<u>Oil</u> (US Peak 1970, World Peak 2010)	<u>1,000,000</u>
Tar Sands	800,000

World stored energy consumption = 70,000 terawatt hours/year

# Sun to Wheel Efficiency



It took 3.5 billion years and rare geologic events to sequester hydro carbons and build up O<sub>2</sub> in the atmosphere

$$3.5 \times 10^9 \text{ Years} \times 3.5 \times 10^8 \text{ TWh/year Solar Energy} = 1 \times 10^6 \text{ TWh Oil Total}$$

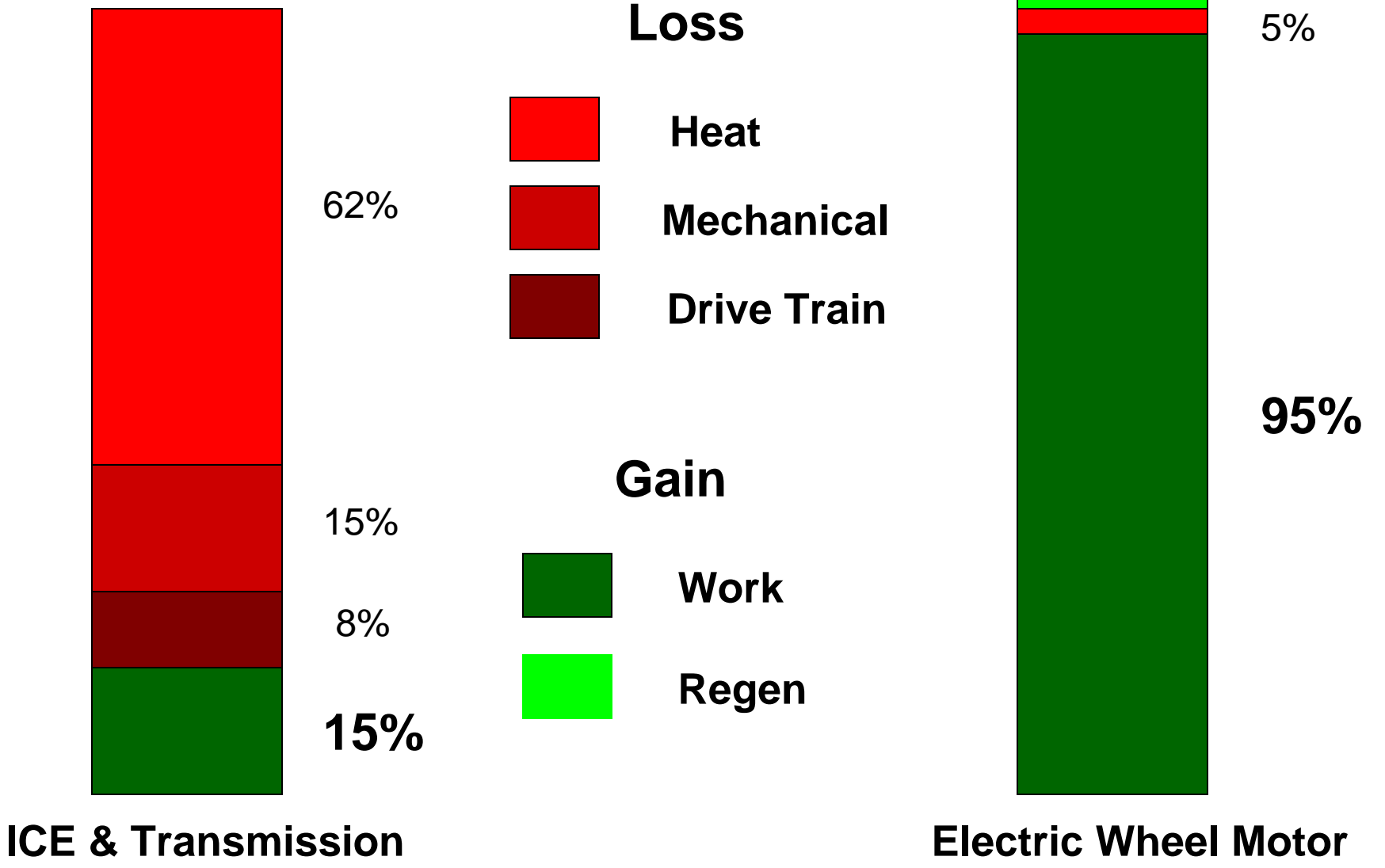
$$1.2 \times 10^{12} \text{ TWh Solar Energy} = 1 \text{ TWh Oil Energy}$$

Using direct solar energy is 1,200,000,000,000 X more efficient than using oil

# Biofuels?

- Using waste oil or biomass is great while it lasts but a fast food restaurant can only supply 2-3 vehicles and there are already many examples of food crop land being used to fill the tanks of SUVs. The cost of tortillas has quadrupled in Mexico in the last year because of the demand for corn to make ethanol. It takes 1000 gallons of water and more than a gallon equivalent of fossil fuel to produce one gallon of corn ethanol.
- Burning hundreds of square miles of virgin rain forest in Indonesia and Brazil to plant GMO mono-crops for biofuel production is destroying biodiversity.
- The overall efficiency of biofuels from Sun to Wheel is about 0.01–0.05 %.
- The overall efficiency of PVs charging EVs from Sun to Wheel is 3–20 %
- Solar-charged EVs are from 60 to 2,000 times more efficient than internal combustion vehicles burning biofuels - when efficiency is measured from Sun to Wheel.

# Drive Train Efficiency



# The Cost of Combustion

## Vehicle Type



**20 MPG Gas**



**PHEV/25/grid**



**EV/1kW PV \***

Liquid fuel used  
25 mi/day / 25 yrs

**11,500 gals**

**ZERO**

**ZERO**

Energy used 25 yrs

**460 MWh**

**70 MWh**

**45 MWh**

Fuel cost now / 25 yrs  
\$3.50/gal, \$0.07/kWh

**\$40,000**

**\$5,000**

**\$5,000**

Fuel cost over 25 yrs  
\$10.00/gal, \$0.20/kWh

**\$115,000**

**\$14,000**

**\$5,000**

Fuel cost/ month

**\$385**

**\$45**

**\$15**

Annual cost

**\$4,600**

**\$420**

**\$180**

CO<sub>2</sub> / 25 years

**320 tons**

**17 tons**

**trace**

Assumptions average next 25yrs : 40kWh/gal, \$10.00/gal, \$0.20/kWh, 28#s CO<sub>2</sub>/gal,  
.5#s CO<sub>2</sub>/kWh \* Current installed cost and performance in CA for PV

# 25 million cars in California 25 miles a day for 25 years

## Oil-combustion

At \$115,000/car X 25 M cars  
= \$2,875 billion for fuel  
+ CA share of oil wars  
\$10 B/yr = \$250 billion  
Cars not included  
= \$3,125 billion total  
  
+ 8 billion tons of CO<sub>2</sub>

## Solar-electric

At \$5,000/car X 25 M cars  
= \$125 billion total  
+ \$100,000 for everyone in  
California to spend on  
electric cars or whatever  
= \$3,125 billion total  
  
+ NO CO<sub>2</sub>

Assumptions average next 25yrs : 40kWh/gal, \$10.00/gal, \$0.20/kWh, 28#s CO<sub>2</sub>/gal,  
.5#s CO<sub>2</sub>/kWh \*Current installed cost and performance in CA for PV



# PLENARY SPEAKERS

1. **Paul Scott**, Plug-in America, Star in 'Who Killed the Electric Car'
2. **Sherry Boschert**, President, San Francisco Chapter of the Electric Auto Association, Author 'Plug-in Hybrids'
3. **Danilo J. Santini**, Senior Economist, Section Leader, Technology Analysis, Center for Transportation Research, Argonne National Laboratory
4. **Travis Bradford**, President, Prometheus Institute, Author 'Solar Revolution'
5. **Ron Swenson**, Cofounder *SolarQuest* and publisher of [www.OilCrisis.com](http://www.OilCrisis.com)

# Plug-in Hybrids



# Plug-In Hybrids

