Electric Transportation Program Update

Presented By Felix Oduyemi

Electric Transportation Department

6/26/08

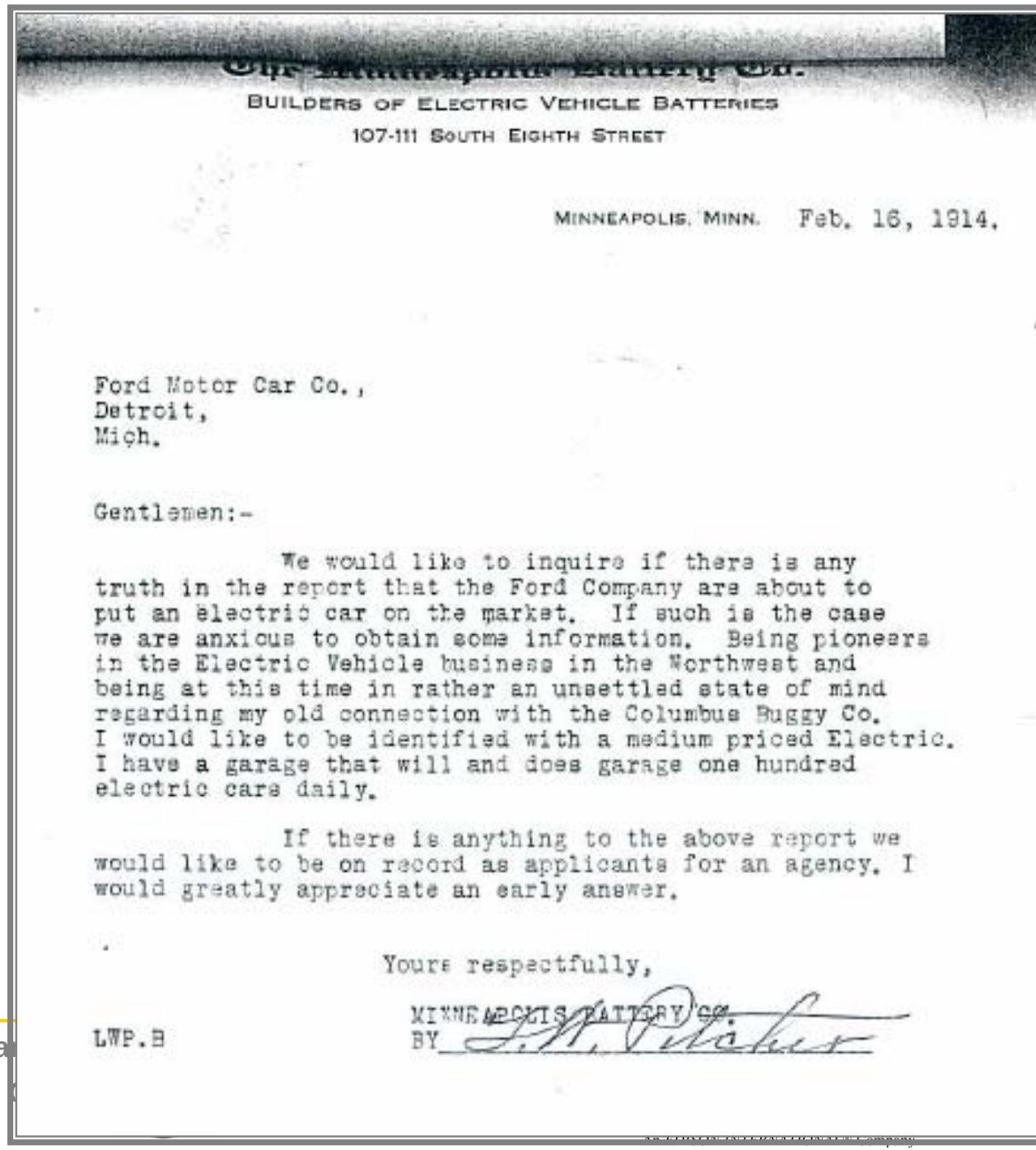
SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

Electric Transportation Overview

- Electric Vehicle Technology – Then and Now
- Trends in Transportation – A Perfect Storm
- Near Term Electric-Drive Technologies
- PHEV Demonstration Programs
- Challenges to PHEV Commercialization
- EV Batteries as Home Energy Storage System
- Bio-fuels and Hydrogen Vehicles
- SCE's EV Technical Center

Electrification of vehicles: not a new idea …..

- In the early 1900's more than 27 companies were building electric cars
- In 1914, Henry Ford and Thomas Edison experimented with an electric car using by Edison Batteries
- In 1915 the Ward Motor Vehicle Company offered an electric wagon for $875 on an 1yr installment plan for the vehicle and a $10.50/month rental fee for the Edison Storage battery



The Minneapolis Battery Co.

BUILDERS OF ELECTRIC VEHICLE BATTERIES

107-111 SOUTH EIGHTH STREET

MINNEAPOLIS, MINN. Feb. 16, 1914.

Ford Motor Car Co.,
Detroit,
Mich.

Gentlemen:-

We would like to inquire if there is any truth in the report that the Ford Company are about to put an electric car on the market. If such is the case we are anxious to obtain some information. Being pioneers in the Electric Vehicle business in the Northwest and being at this time in rather an unsettled state of mind regarding my old connection with the Columbus Buggy Co. I would like to be identified with a medium priced Electric. I have a garage that will and does garage one hundred electric cars daily.

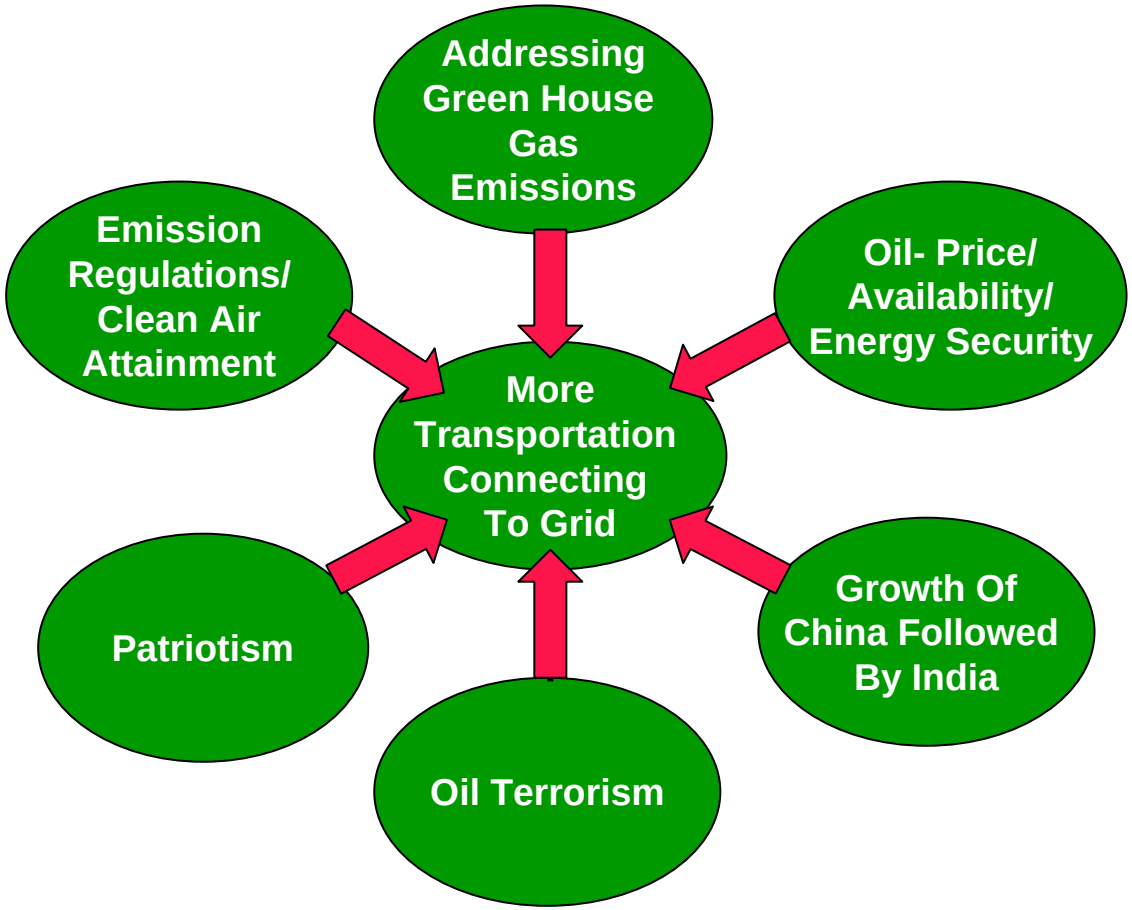
If there is anything to the above report we would like to be on record as applicants for an agency. I would greatly appreciate an early answer.

Yours respectfully,

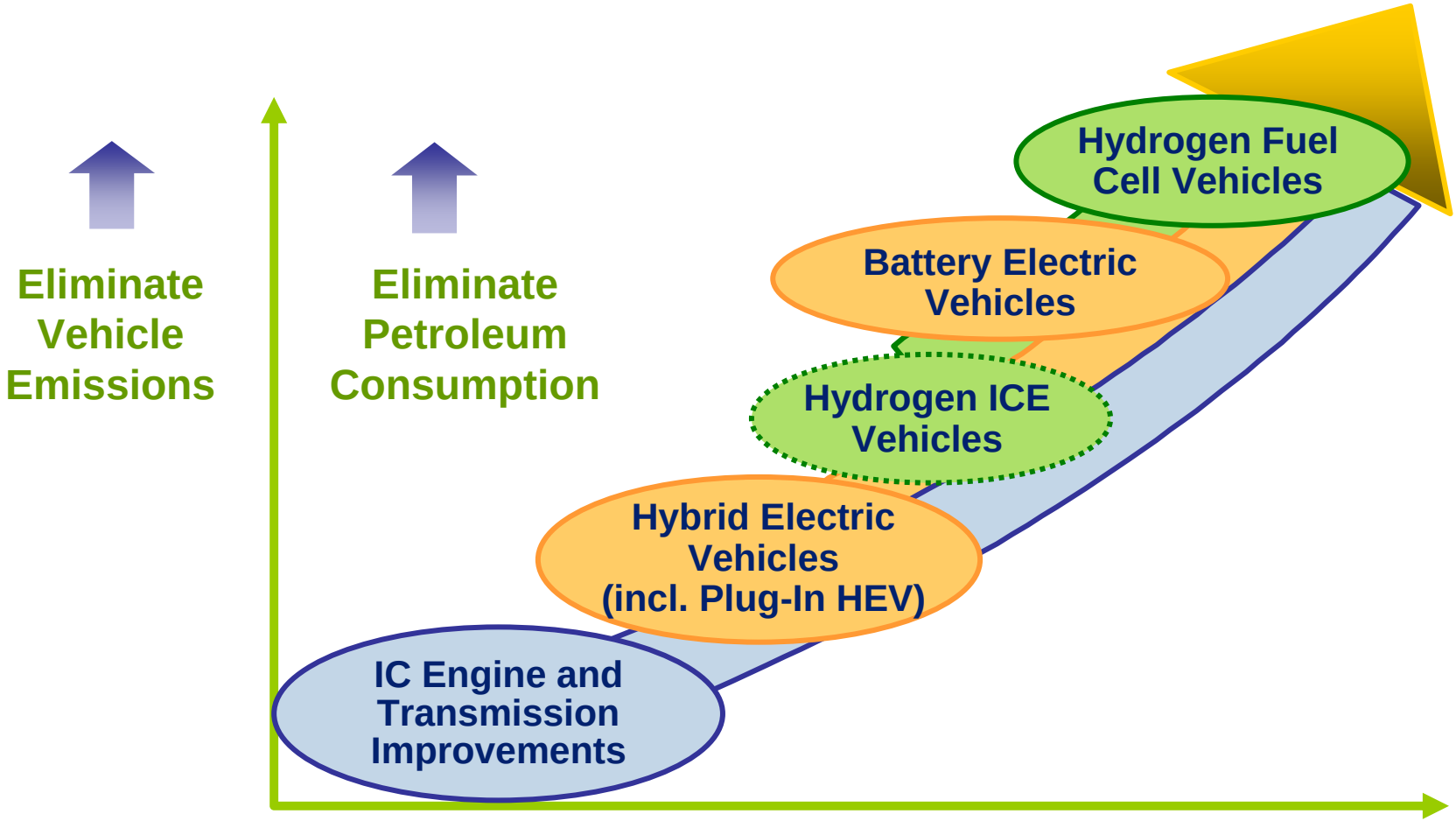
MINNEAPOLIS BATTERY CO.
BY L. W. Peterson

LWP.B

Trends In Transportation
A Perfect Storm?



Where's Technology and Energy Going?



Petroleum *(Conventional & Alternative Sources)*

Bio Fuels *(E10, E85, Cellulosic Ethanol, Bio-diesel)*

Electricity *(Conventional & Alternative Sources)*

Hydrogen *(Conventional & Non-Carbon)*

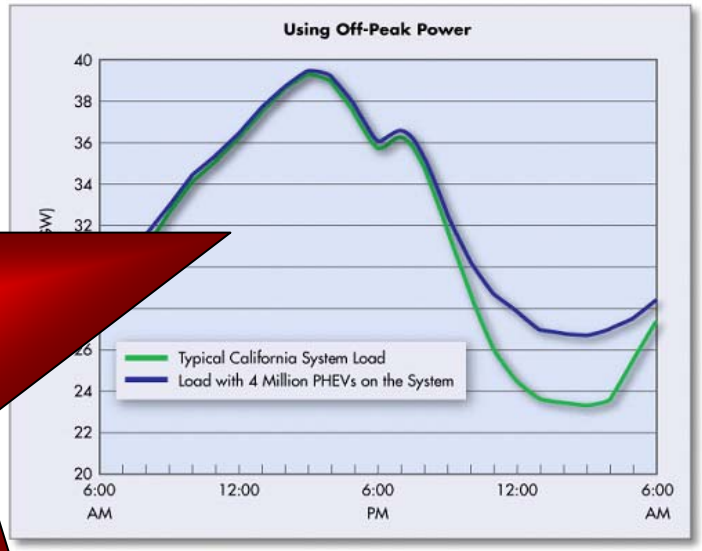
Transportation Energy Infrastructure

Delivering Enhanced Energy Efficiency and Energy Sustainability

…Why Plugging In Makes Sense

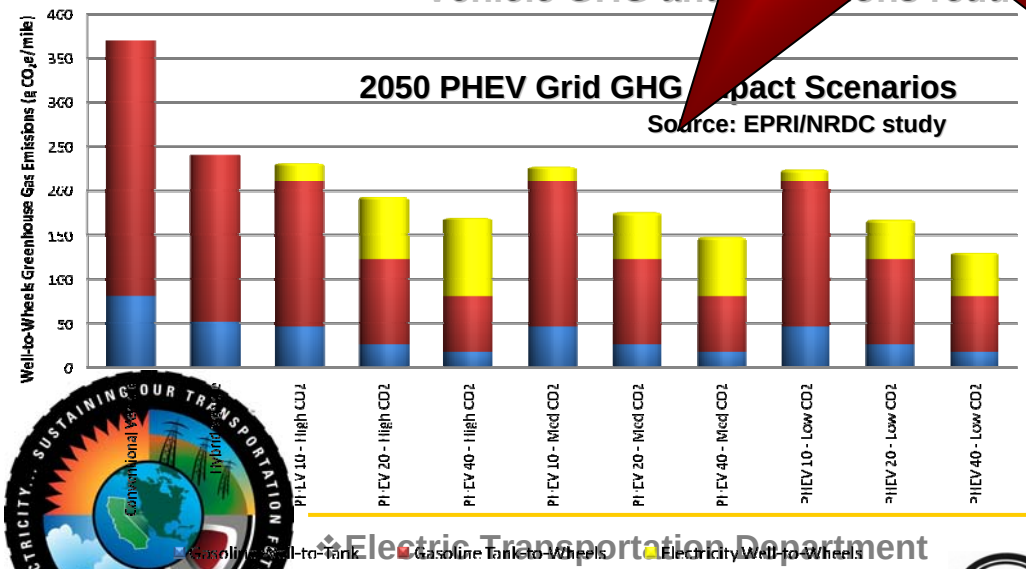
1 Electricity is 25-50% the cost of
A gallon of gasoline equivalent (gge)

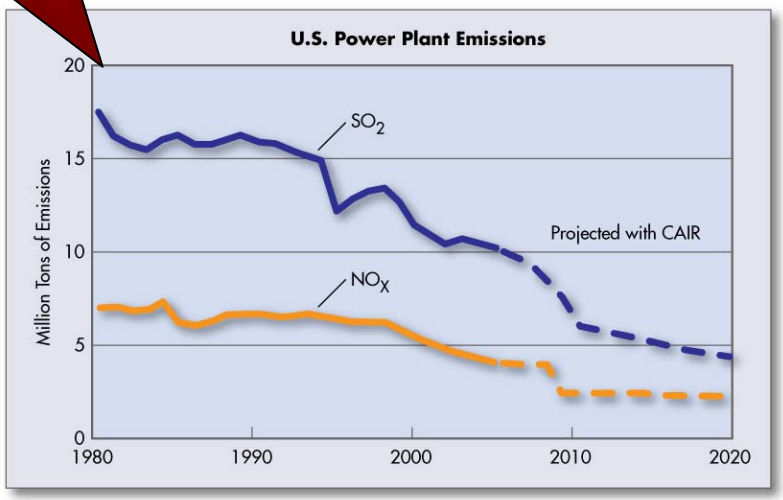
U S grid has significant excess capacity (off-peak) 3



Made In The USA

Vehicle GHG and ons redu en grid-connected

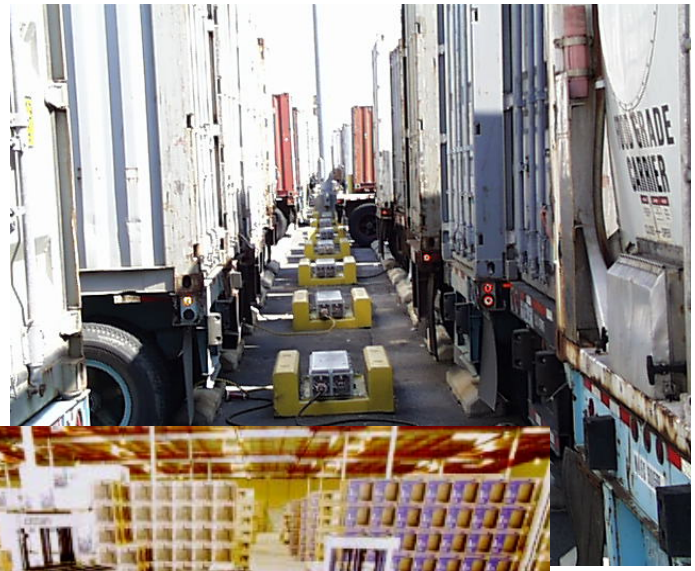




Top Five Near-Term Electric Technologies (TIAX Study)

Truck Stop Electrification

E-TRU



PHEVs

NREVs

Cold Ironing

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20 Years of SCE Plug-In Leadership

SCE operates the nation's largest fleet of Battery EVs (Toyota RAV4s) having traveled Over 14m EV miles- 13m since 1998!

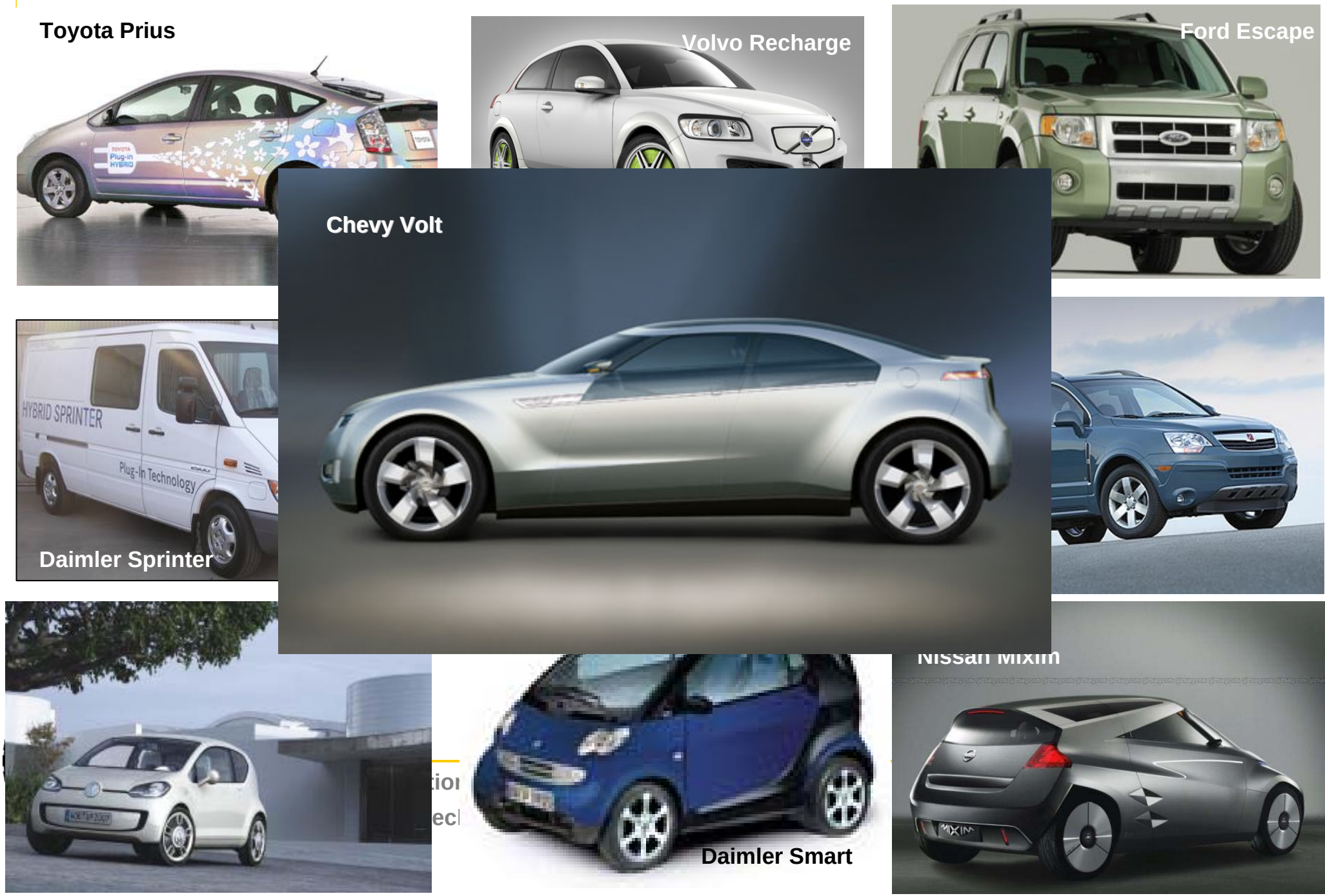
SCE and Chevron celebrate grand opening Of SCE's Hydrogen Energy Station. By year end SCE will operate up to 10 FCEVs

UC Irvine and Toyota announced a collaborative including SCE to evaluate the technology and system impacts of PHEVs

SCE is evaluating the nation's first PHEV fleet vans from DaimlerChrysler and has begun work on a PHEV medium duty utility bucket truck w/ Ford, EPRI and Eaton

SCE and Ford announced the first OEM led effort to evaluate the complete energy system impacts of fully certified PHEVs on the utility grid

Automaker Plug-in Programs



SCE Leadership- Ford/SCE Partnership

SCE and Ford announced the first OEM led effort to evaluate the complete energy system impacts of fully certified PHEVs on the utility grid

Ford PHEV projects

PHEVs represent a potential opportunity to reduce our petroleum consumption – closing the gap until more advanced technologies and renewable fuels become readily available

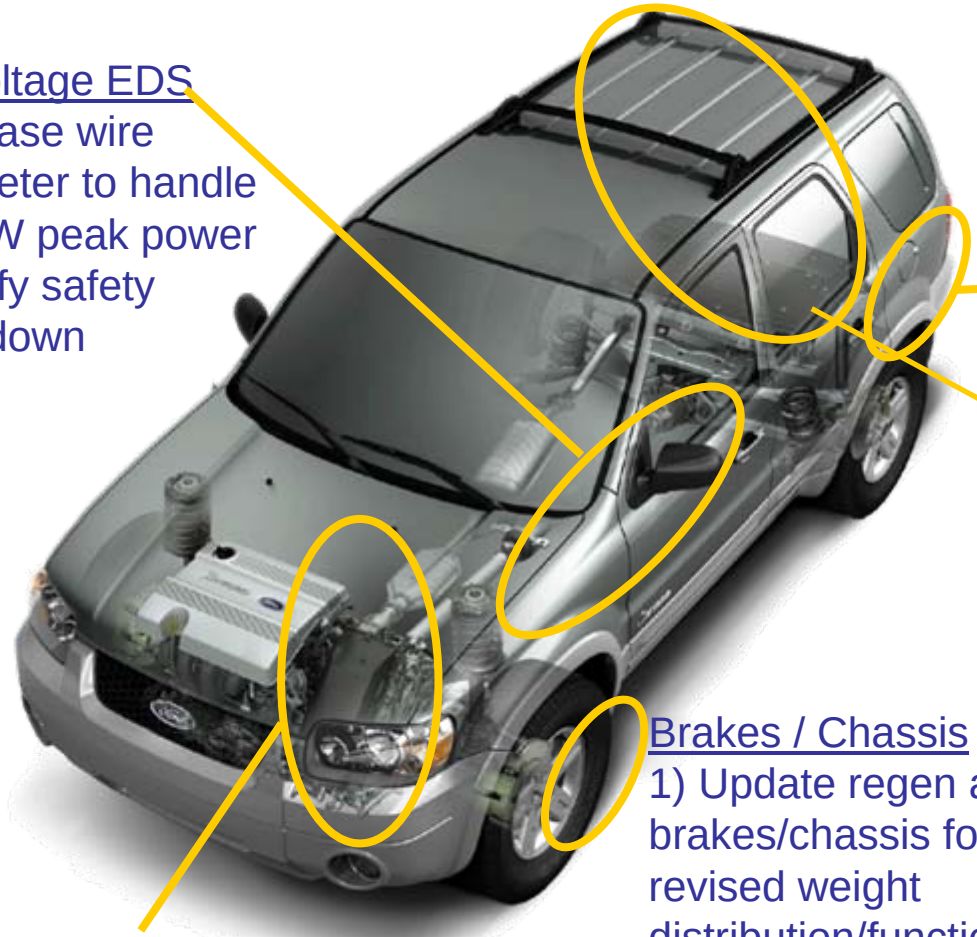
The Ford HySeries Drive

- Worlds first drivable fuel cell plug-in series hybrid vehicle
- Powered by a 336 volt lithium-ion battery pack
- All electric range of 25 miles; fuel cell provides additional 200 miles of gasoline free driving

The Ford Escape Plug-In Hybrid

- Plug-in Parallel Hybrid Electric Vehicle
- 30 miles Charge Depletion range
- High Capacity Lithium-Ion Battery

What goes into a PHEV?



High Voltage EDS
1) increase wire diameter to handle 60 kW peak power
2) Modify safety shutdown

110 V AC plug-in door

Rear Cargo Area
1) replace production high voltage battery with high energy Li-Ion battery
2) add battery charger
3) add gateway module for plug-in control
4) revise rear structure for added weight and safety performance
5) redesigned suspension for added weight

Brakes / Chassis
1) Update regen and brakes/chassis for revised weight distribution/function

Transaxle/Engine Compartment
1) modify transaxle oil lubrication/cooling circuit for extended engine-off durability
2) add oil to air heat exchanger to increase continuous operating capability of electric machines

Other Areas
1) Emissions - need revise strategy to meet PZEV w/extended engine off time
2) Climate control - need new approaches for heating vehicle and defrosting during extended engine off time

What will it take to Commercialize PHEV's?
New Business Paradigms Are Needed…

- Climate change and energy security are real
  - Vehicle, Fuel, and Utility Technology Solutions needed
    … for a new shared customer

- Potential vision of New Business Paradigms
  - Today: World of independent solutions
  - Opportunity: Convergence of technologies and industries
  - Future: Transportation and Utilities become interdependent

- Goal: Accelerate the production of PHEVs and V2H technologies acceptable to customers and profitable to automakers and utilities

- Key challenges to overcome:
  - Technical: battery, vehicle system interface, V2H enablers
  - Business case: customer/company affordability, new value streams, two or three independent industries

Final Thought- Batteries and Where We Make Them…Still A Concern!

Design Goals:

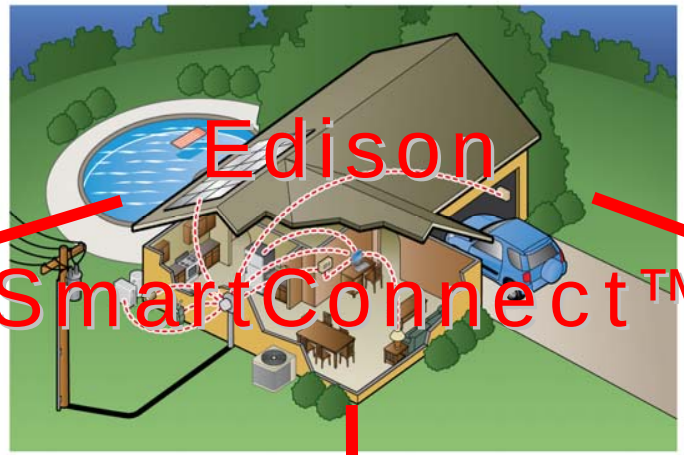
Safety, Calendar & Cycle Life, Energy & Power, Lower Cost, Recyclability

- **NiMH (Nickel Metal Hydride)**
  - Proven, mature, mass produced
  - Weight, energy density, materials and cost limitations
  - **SCE EVTC** PHEV Module testing- 2512 cycles/25 months = approx. 125,000 vehicle miles
- **Li-Ion (Li-Ion)**
  - Great promise
  - High energy/power density
  - Potentially lower material cost
  - Still challenges to overcome
  - **SCE EVTC** PHEV module testing- 3000 cycles/34 months = approx. 150,000 vehicle miles

SCE Near Term Focus With Auto Partners

Same battery pack in both mobile & stationary applications could create early volume driving down costs

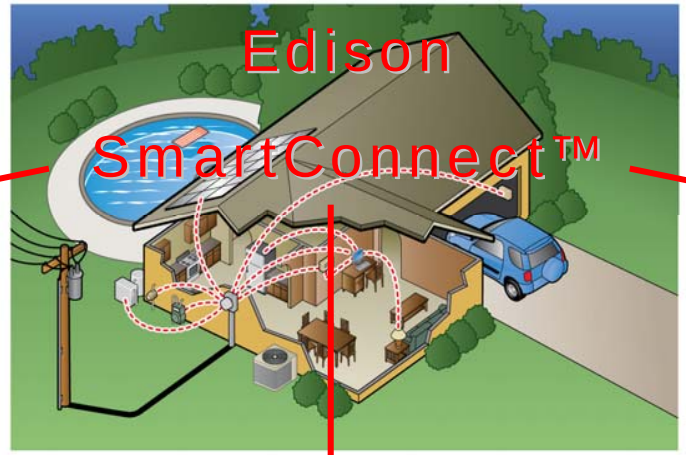
PHEV Bi-directional Connection
occasional emergency back-up
occasional peak shaving



PV with Home Energy Storage
reduced grid stress
addresses PV intermittency

Home Energy Storage
reduced grid stress
lower customer bill

SCE Leadership…Exploring New Battery Applications For The Home



PV with Home Energy Storage
- reduced grid stress
- increased grid efficiency
- addresses PV intermittency
- less PV + storage = low cost?
- community aggregation?
- future b[illegible]es?
- rate d[illegible]s/ policy?

CSI & LM?

PHEV Bi-directional Connection
- occasional emergency back-up
- occasional peak shaving
- LCFS impacts?
- connection & communication w/ HAN?
- rate d[illegible]tives/ policy?

RPS & LM/DR?

Home Energy Storage
- reduced grid stress
- increased grid efficiency
- lower [illegible]ll
- com[illegible]ion?
- futu[illegible]s?
- rate ba[illegible]cture?
- rate design incentives/ policy?

RPS & LM/DR?

Whatever The Alternatives… They Must Be Sustainable

12 percent of the world's maize is being used to produce biofuels (mainly ethanol) Source: Food & Agriculture Organization

Goldman Sachs predicts that land given over to biofuels is likely to rise from around 50 million hectares in 2007 to close to 120 million by 2015.

In the US, 14% of corn crop used to produce ethanol in 2006 — projecting 30% by 2010. This is also cutting into production of staples like soybeans, as farmers take advantage of generous subsidies and switch crops to corn for fuel.

Thousands of farmers and trade unionists protest against rising price of tortillas - partly caused by growing U.S. ethanol demand – Mexico City, Jan '07.

Absent new technologies — U.S., Canada and EU will require between 30 and 70% of their current crop area if they were to replace 10 percent of their transport fuel consumption with biofuels

"Peak Oil" is morphing into "Peak Food"

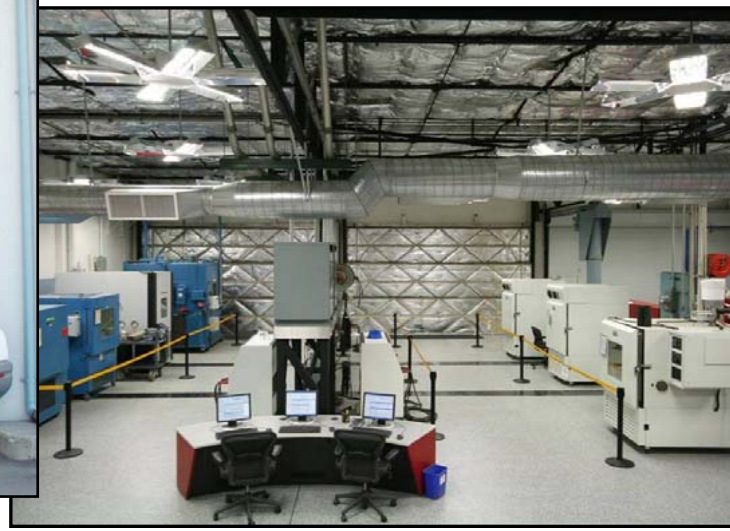
Hydrogen Activities

Rosemead Hydrogen Energy Station (DOE – Chevron)

Hydrogen Vehicle Maintenance Bay

Fuel Cell Testing Facility

SCE's Unique EV Technical Center



- ❑ 20 Years Of Leadership
- ❑ ISO certified
- ❑ 2 years of PHEV battery testing
- ❑ PHEV light and medium duty vehicle evaluation programs
- ❑ DOE, OEM, battery manufacturer collaboration programs