

Plug-In Hybrids: Best of Both Worlds

Reykjavik September 18, 2007

Driving Sustainability

Felix Kramer, Founder
The California Cars Initiative

info@calcars.org



CalCars

THE CALIFORNIA CARS INITIATIVE

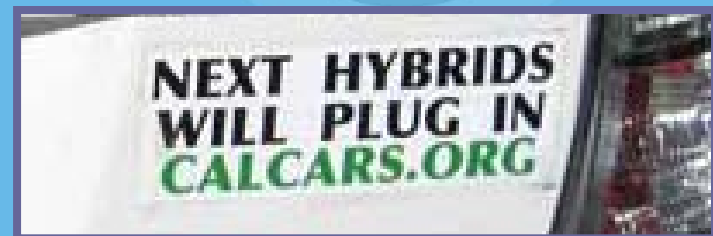
www.calcars.org

“Nonprofit Startup”: CalCars itself is a hybrid

Technology
(demos)

Advocacy
(buyers)

- Engineers
- Entrepreneurs
- Environmentalists
- Consumers/drivers
 - *Expanding the usual circle of decisionmakers*
 - *Communicating messages of hope*
 - *Approaching success!*



CalCars

THE CALIFORNIA CARS INITIATIVE






October 2003

www.calcars.org

Expanding driver choice: new cars/line extensions

Ford **BOLD MOVES**

MODELS

| | | | |
|--|--|---|--|
|  Escape XLT \$22,895* |  Escape Hybrid FWD \$26,215* |  Escape Hybrid 4WD \$27,820* |  Escape Plug-In Hybrid \$30,000+  |
|--|--|---|--|

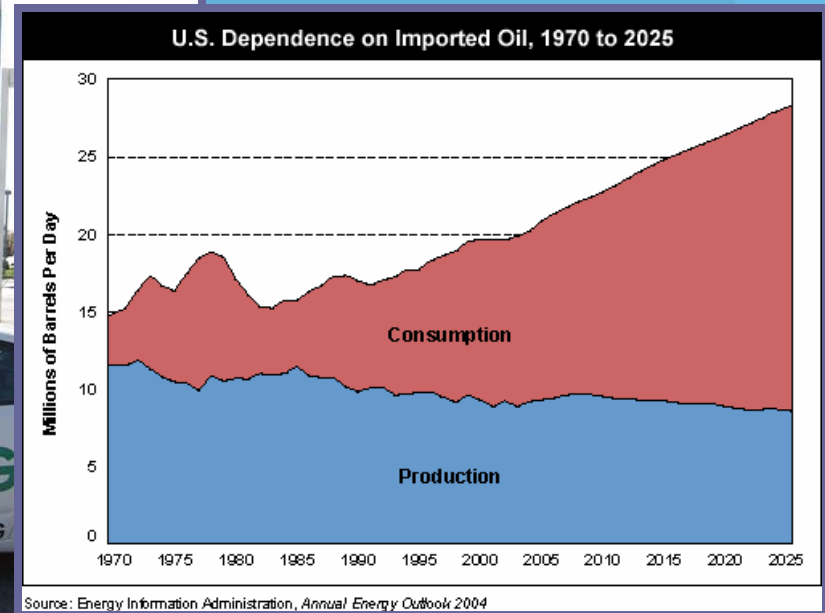
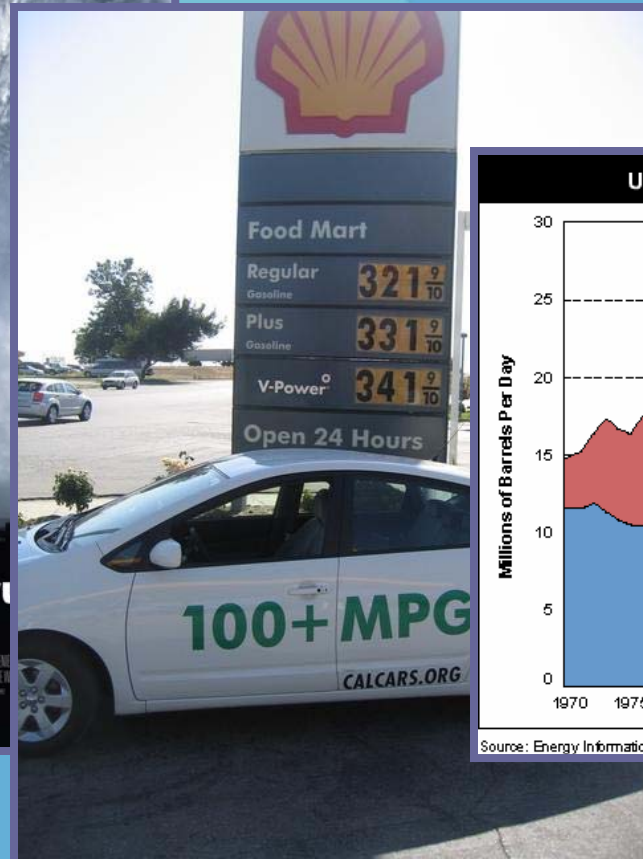


CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Cleaner, cheaper, domestic



CalCars
THE CALIFORNIA CARS INITIATIVE

Putting renewable electricity to best use

- Opportunity: for a world that hopes to have clean abundant energy, Iceland can show the roadmap
- Transmission ->battery->motor, 70-80% efficient
- Hydrogen from electrolysis->fuel cell, 20-27%; ICE, 7-9% (losses+CO₂ if reformulate natural gas)
- Worldwide, there's never "extra" green electricity to "waste" as long as coal can be displaced anywhere
- Even as range extender fuel, hydrogen will need to surpass cellulosic ethanol on a well-to-wheel basis
- Note: ethanol used at power station is more efficient than burned in an internal combustion engine



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Meeting the European Union's 120-130 CO₂ target

| ElectGrid Location | EV g/kWh | EV g/km | PHEV-32 gm/km | PHEV-96 gm/km | EV as % of ICE | EV as % of diesel | EV as % of HEV |
|--------------------|----------|---------|---------------|---------------|----------------|-------------------|----------------|
| Calif 2004 | 236 | 39 | 101 | 65 | 18% | 20% | 31% |
| U.S. 2004 | 615 | 103 | 120 | 110 | 48% | 53% | 81% |
| U.S. 2010 | 500 | 84 | 114 | 97 | 36% | 43% | 66% |
| U.S. 2050 | 375 | 63 | 108 | 82 | 29% | 32% | 50% |

- **Source-to-wheels CO₂ emissions for a Prius-sized passenger car**
 - 216 gm/km, gasoline @ 9.2 l/100km (26 mpg)
 - 194 gm/km, diesel @ 7.2 l/100km (33 mpg)
 - 127 gm/km, hybrid @ **5.4 l/100km (44 mpg)**
 - PHEV-20 (32 km EV range): **3.8 l/100km** at 30% EV -- with higher EV%, my PHEV-25 often gets
 - PHEV-60 (96 km EV range): **1.6 l/100km** at 70% EV 100+mpg (40km/liter or **<2.5 l/100km**)

*2010/2050 grid emission projections from 2007 EPRI/NRDC Study
EV/PHEV electric miles: 16.7 kWh/100km Analysis: CalCars Tech Lead Ron Gremban,
presentations at EEET-2007(see CalCars.org Downloads Page)*



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

November 2004: “open-source” PRIUS+ demo



The New York Times

Hybrid-Car Tinkerers Scoff at No-Plug-In Rule

By DANNY HAKIM

DETROIT, March 31—Ron Gremban and Felix Kramer have modified a Toyota Prius so it can be plugged into a wall outlet.

This does not make Toyota happy. The company has spent millions of dollars persuading people that hybrid electric cars like the Prius never need to be plugged in and work just like normal cars. So has Honda, which even ran a commercial that showed a guy wandering around his Civic hybrid fruitlessly searching for a plug.

But the idea of making hybrid cars that have the option of being plugged in is supported by a diverse group of interests, from neoconservatives who support greater fuel efficiency to utilities salivating at the chance to supplant oil with electricity. If you were able to plug a hybrid in overnight, you could potentially use a lot less gas by cruising for long stretches on battery power only. But unlike purely electric cars, which take hours to charge and need frequent recharging, you would not have to plug in if you did not want to.

“I’ve gotten anywhere from 65 to over 100 miles per gallon,” said Mr. Gremban, an engineer at CalCars, a small nonprofit

group based in Palo Alto, Calif. He gets 40 to 45 miles per gallon driving his normal Prius. And EnergyCS, a small company that has collaborated with CalCars, has modified another Prius with more sophisticated batteries; they claim their Prius gets up to 180 m.p.g. and can travel more than 30 miles on battery power.

“If you cover people’s daily commute, maybe they’ll go to the gas station once a month,” said Mr. Kramer, the founder of CalCars. “That’s the whole idea.”

Conventional hybrid electric cars already save gas. But if one looks at growth projections for oil consumption, hybrids will slow the growth rate of oil imports only marginally.

pending on... actually s... potentially... makers h... powered b...

But fuel... reinventio... tion the na... nology to p... way from... brids say... is availab...

building them in garages.

“All of the relevant technology is at hand,” said Frank Gaffney, founder of the Center for Security Policy and an assistant defense secretary in the Reagan administration. His group was among a coalition of right-leaning organizations that released an energy plan this year promoting plug-ins as one way to increase fuel efficiency in light of the instability of the Middle East.

“If you’re thinking about this as an environmental issue first and foremost, you’re missing the point,” Mr. Gaffney said. Curbing dependence on... he added, “is a national emergency.”

However, says the plug-in for prime time.

“This is the next great... just isn’t,” said David... an executive engineer at... the electric utilities really... electricity and they want... the transportation sector... t expands their market... n agenda.”

plug-in hybrid is not just... of the garages of enthusi-



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Plug-in hybrids go to Washington 206



“ Amazing breakthrough... **”**



“ You pull in and you plug it right into the wall... **”**

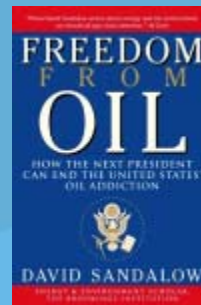
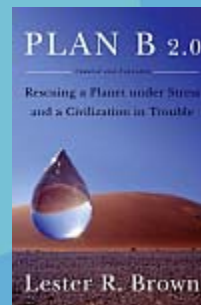
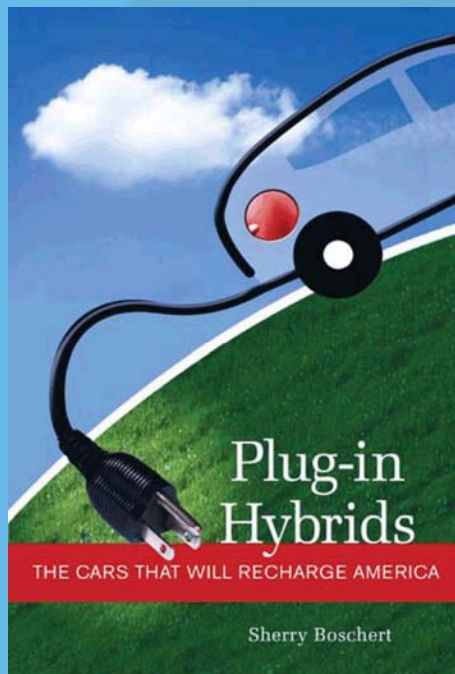


CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

2005-2007: 11 books with major focus on PHEVs



Order at www.calcars.org/books.html



CalCars
THE CALIFORNIA CARS INITIATIVE

www.calcars.org

PHEVs: Best of Both Worlds

“A coalition between the tree-huggers, the do-gooders, the sod-busters, the cheap hawks, and the evangelicals.” – former CIA Director James Woolsey

More @ CalCars Photos pages



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Unprecedented broad support & alliances

CONVERSION COMPANIES



SUPPLIERS & COMPONENT-MAKERS



JOBS & FACTORY CONVERSIONS

Editorial: Minnesota lays a bet on cars of the future



ENVIRONMENTALISTS & EV FANS



UTILITIES & FLEET BUYERS



NEO-CONS / GEO-GREENS



RechargeIT



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

**7 carmakers interested; race to be first; still no timetables
(CalCars "Carmakers" page tracks statements)**



"Maybe not first but best" – start with Plug-in HV



"Within 5-10 years" – Volvo may be sooner



**Daimler Sprinter PHEV;
Chrysler: new electric division**



*Saturn Vue possible 2009
Chevy Volt: mass production 2010 goal;
Opel Flextreme follows*

Interest from Nissan, Honda, Visionary Vehicles, Tesla



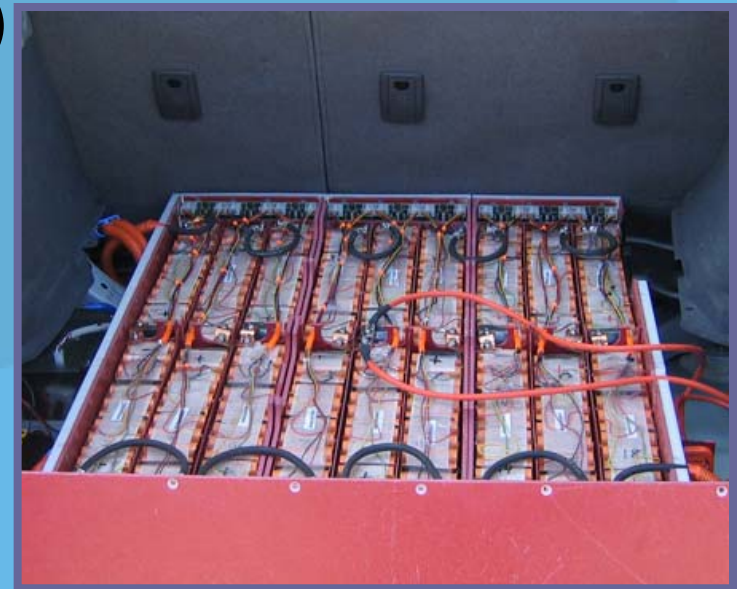
CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Automakers still holding out for perfect batteries

- **40 mile range/life of vehicle/price-competitive**
- **NiMH:** Proven in hybrid, RAV4 EV (100K+ miles)
- **Lithium-Ion (50-75K+ miles)**
*“Good enough” for
Version 1.0 demo fleets*



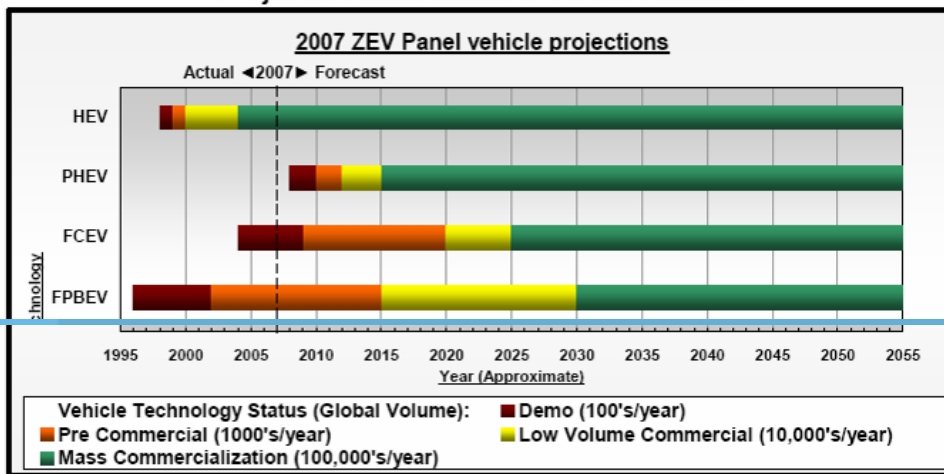
CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Disruptive forecasts: CARB & Alliance Bernstein

Projected Achievement of Global Volumes



Years to Achieve Penetration Rates

| Technology/Innovation | of US Auto Sales | | |
|-----------------------|------------------|-------|-------|
| | 20% | 50% | 80% |
| Airbags* | 3 yrs | 5 yrs | 7 yrs |
| Front-Wheel Drive | 6 | 9 | 13 |
| Fuel Injection | 5 | 9 | 13 |
| Multi-Valve Engine | 3 | 10 | 20 |
| Radial Tires | 3 | 4 | 4 |

Int'l Energy Agency: "Niche"
 Alliance-Bernstein: "Mainstay"
2015: HEVs 50% new car sales

2030 Hybrid/PHEV Share
 Vehicle Base: 0.7% vs. 72.0%
 New Vehicles: 1.0% vs. 85.0%

CA Air Resources Board: Staff Report, ZEV Technology Symposium, April 2007 (excerpt)

"The Emergence of Hybrid Vehicles" 50 pp. June 2006
(download at CalCars.org)



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

“Perfect” products start as “good enough”



Prius version 1.0 1997:
Japan only



v. 2.0 2001:
acceptable



v. 3.0 2003:
best-seller



Demo PHEVs 2004-07



Plug-in HV: pilot 2007-08



GM Impact 1990-1995



GM EV-1 1996/1999



AC Propulsion tZero 1997/2003



Tesla Roadster 2007: market success



Volt series PHEV 2010: GM hoping to build it



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Iceland's role in creating sustainable PHEVs

- Ideal test-bed:
island/commuter driving
- “Soft” buy order (hundreds)
- Buyer/seller incentives
- Promote “level playing field” for multiple energy solutions (“silver buckshot” not “silver bullet”)
- Internationally, connect domestic geothermal know-how, R&D on “enhanced geothermal” (EGS) and steps to electrify transportation



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

CalCars website as a resource

Today's presentation:

- At About/Downloads

Links at home page:

- News at News-Archive
- What Carmakers are Saying
- How to Get a Conversion



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org