

What codes, standards, & regulations are needed for conversions?

EV2010VE

**Vancouver, BC, Canada
September 16, 2010**

**Ron Gremban, Technical Lead
The California Cars Initiative
rgremban@calcars.org**

**For updated PDF of presentations:
www.calcars.org/downloads**



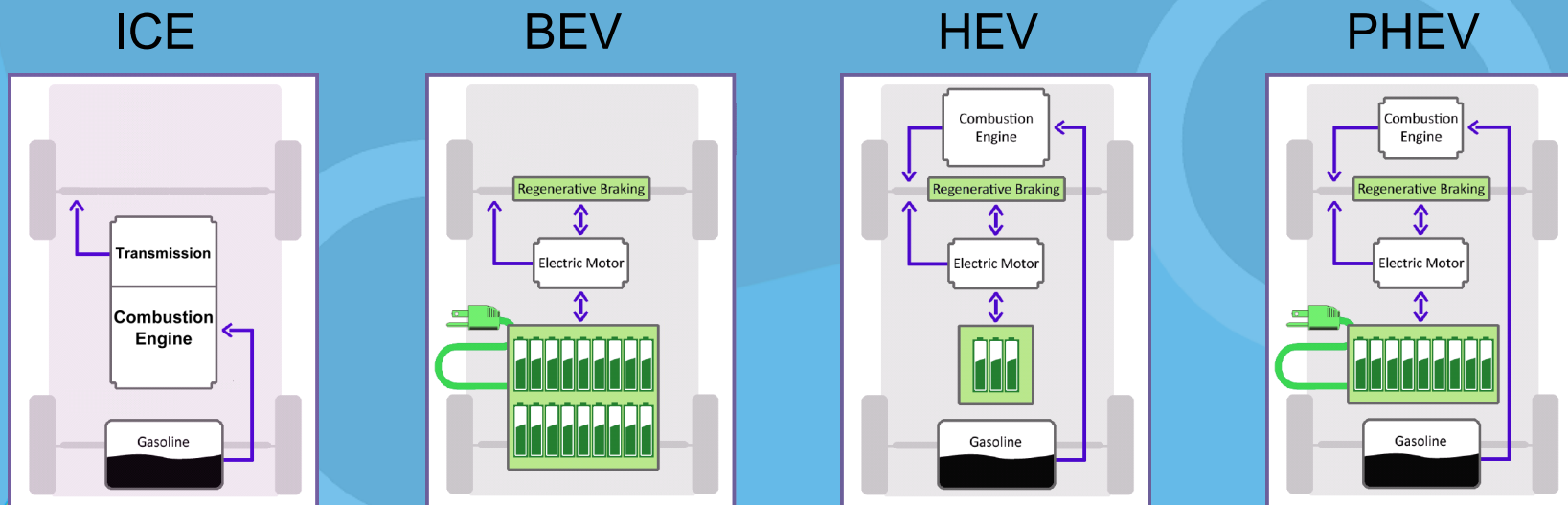
CalCars
THE CALIFORNIA
CARS INITIATIVE

www.calcars.org • info@calcars.org • PO Box 61045 • Palo Alto, CA 94306



What Plug-in Conversions Are There?

- ICE->BEV (Internal combustion engine to battery electric)
- HEV->PHEV (hybrid to plug-in hybrid)
- ICE->PHEV/EREV (... to plug-in hybrid/extended-range EV)
 - Drivetrain modification (usually parallel)
 - Drivetrain replacement (usually series aka EREV)



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Reasons for the 'Big Fix' Strategy of Mass-produced ICE->PEV Conversions

- It would be too energy intensive to retire existing vehicles fast enough to accelerate reductions by many years
 - Worldwide new-vehicle production capacity would have to double to accelerate by a decade
 - **Manufacturing new vehicles** (even with recycled materials) **adds the following 'embedded energy'** to lifetime energy consumption:
 - Today's **ICEVs**: ~15% on top of lifetime fuel consumption
 - **Efficient BEVs**: **up to 80%** on top of lifetime fuel consumption! (PHEVs are in between)

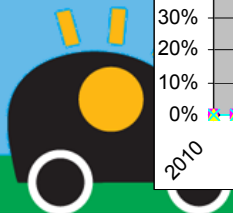
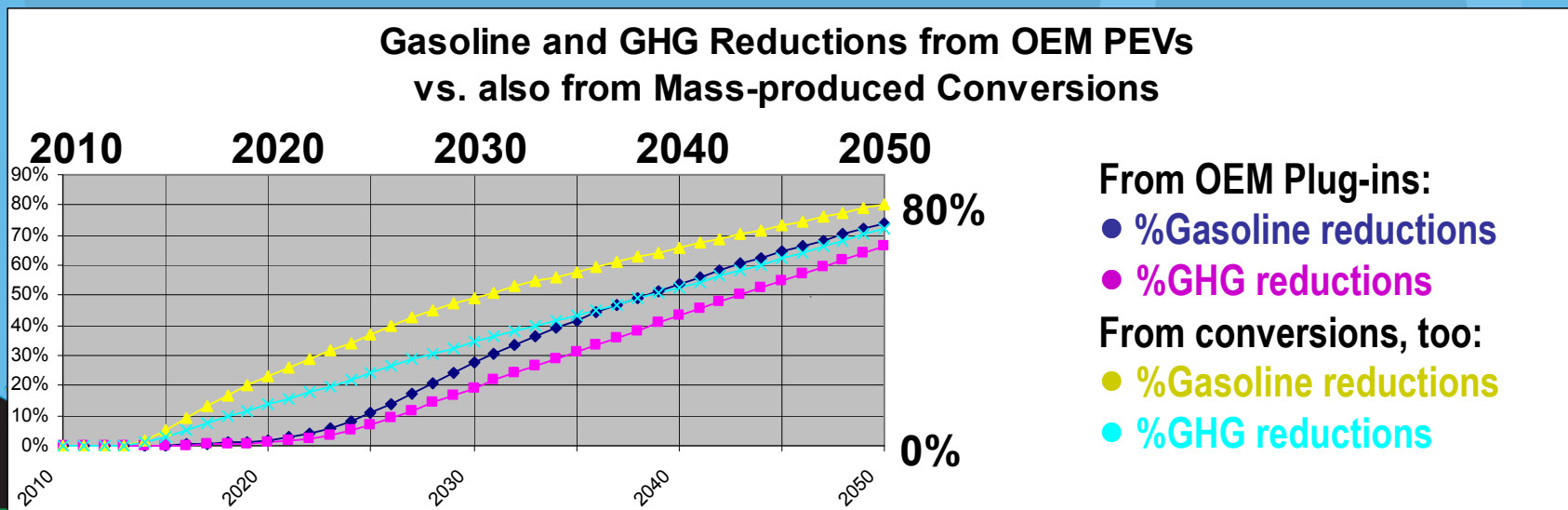
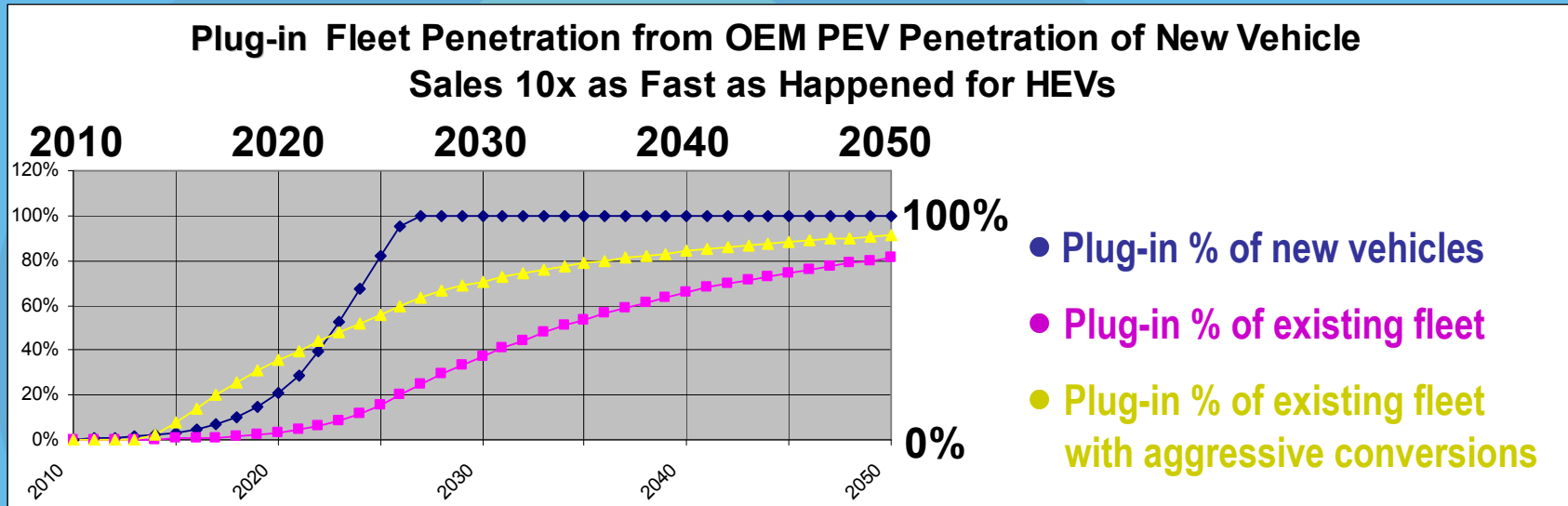


Reasons for the 'Big Fix' Strategy of Mass-produced ICE->PEV Conversions (cont'd)

- At any stage in an existing vehicle's life:
 - A replacement Plug-in vehicle would need to be twice as fuel efficient to save as much as the manufacturing energy lost by crushing its predecessor early.
 - After only 9000 mi, energy savings ensue from converting a vehicle into a Plug-in vehicle
- Rapid conversion of many of the 100M light, medium, and heavy-duty ICE vehicles in the U.S. into BEVs and PHEVs **can accelerate overall oil consumption and GHG reductions by up to a decade!**
- To save that decade without expending even more manufacturing energy, we must fix millions of the 900M (250M in the U.S.) existing vehicles, plus those ICE vehicles still being produced



The Goal: Mass-produced Conversions Can Accelerate Oil & GHG Reductions by up to a Decade!



What are the concerns?

- **Safety**

- Shock (meet existing SAE, NEMA, etc, standards)
- Fire (SAE is developing cell and battery pack safety standards)
- Drivability (brakes and power reliable and not erratic)
- Crash (pre-conversion crashworthiness not compromised)



What are the concerns? (cont'd)

- **Emissions not increased
(not a concern for conversions to BEVs)**
 - Initial
 - Lifetime
- **Customer Value**
 - Meet specs
 - Warranty



CalCars

THE CALIFORNIA CARS INITIATIVE

And yet: First conversion prototypes validate the technology

- Prototypes provide a vision of a future.
- Several startups apply **current technologies** in innovative ways, turning gas-guzzlers into EVs; for PHEVs, adding to instead of replacing the existing drivetrain.
- Public **tax incentives** will help attract new players.
- Other companies, large integrators, develop more designs.
- Business models based on technologies and incentives.
- **Partnerships with OEMs**: Qualified Vehicle Modifiers (QVM) or licensing, **bring new revenue streams to OEMs and dealers.**
- Attract investors and, we hope, one or more serial entrepreneurs to develop global business opportunity.



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Therefore, Progressive Regulations

- Encourage innovation while minimizing public risk
- Allow experimentation & funding through low-volume sales before requiring major financing
- The recently-approved California Air Resources Board certification standards for HEV->PHEV conversions provide a prototype
- Proposal:
 - Stage 1: a simple permit for 1-3 experimental prototypes
 - Must eventually be certified or returned to OEM status before sale



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

ICE->PHEV via wheel motor addition

Example: Started small with a game-changing concept



Poulsen Hybrid, LLC



poulenhybrid.com Shelton, CT

\$8,600 suggested retail price (before tax incentives) for complete Poulsen Hybrid System installed with 4.5 kWh Lithium-ion batteries, wheel motors and brackets.

- Conversions for the most popular compact cars & SUVs.
- 20-30 mile battery assisted range matches 70% of US daily commutes.
- Four-hour local installation.
- Business model scales to convert tens of thousands/year.
- Creates green authorized installer jobs in communities everywhere.



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Progressive Regulation Proposal (Stage 2)

- **Stage 2: Initial certification to gather customer experience, via sales to 50-100**
 - **Require paper design validation, including:**
 - **Safety (meets known industry standards)**
 - **Emissions (why no increase is expected)**
 - **Continued OBDII error handling system operation**
 - **Require electronic data logging and record keeping**
 - **Allow documented changes and field upgrades that are unlikely to worsen concerns**
 - **Require warranty of minimum emissions and drivability**



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

ICE->BEV or PHEV via replacement

Example: Ready for next stage in Canada



Rapid Electric Vehicle Technologies, Inc.

rapidelectricvehicles.com
Vancouver British Columbia

- Developing partnerships with Canadian dealers.
- All-electric and PHEVs starting with Ford trucks and SUVs.
- Contracts pending with public and private fleets.
- Seeking investment funding.



REV 300ACX
Pure Electric

[Vehicle Details](#)

Max Speed: 100mph / 160 kmh
Range: Up to 200 km's
Acceleration: 0-100 <7 seconds
Charge time: 3.5 hrs at 240V

The image shows a white REV 300ACX SUV parked on a reflective surface at night. The background features a city skyline with illuminated buildings. The car has a distinctive black and white logo on the front grille and 'REV' branding on the front bumper. Below the car image, there is a text box with the model name 'REV 300ACX', the label 'Pure Electric', and a 'Vehicle Details' button. To the right of the car image, technical specifications are listed: Max Speed: 100mph / 160 kmh, Range: Up to 200 km's, Acceleration: 0-100 <7 seconds, and Charge time: 3.5 hrs at 240V.

CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Progressive Regulation Proposal (Stage 3)

- **Stage 3: Medium volume certification, to 1000 units sold**
 - Require new conversion emissions testing to new-vehicle specs
 - Require crash finite element analysis
 - Require paper and some test validation of OBDII error handling system changes
 - Require electronic data logging and record keeping
 - Require emissions and drivability warranty extended to OEM warranty endpoint
 - Only minor changes and field upgrades allowed without change certification



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

ICE->EREV via replacement

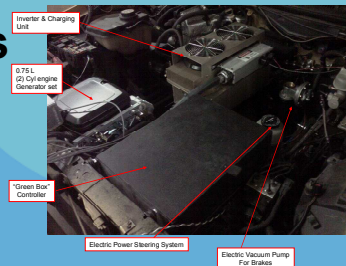
Example: Working on funding to quickly produce thousands



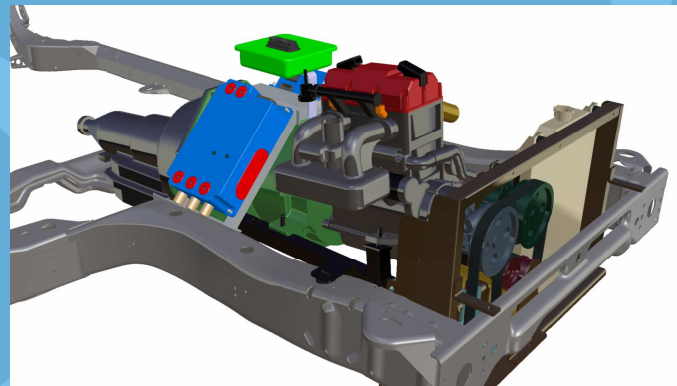
ALTe, LLC

- Staffed by auto industry and Tesla alumni
- Modular approach for vehicles from 2,000 lb to 16,000 lb
- Delivers 80% - 200% fuel economy improvement
- Customers/contracts/ 100 dealer nationwide network
- Aim: 90,000 powertrains annually starting Q1 2011
- Applied for DoE ATVM Loan & seeking \$5 M equity investment

Engineering and mass producing Series PHEV and EV complete powertrain conversion kits and platforms



Gen 1 Series PHEV Powertrain in a running Ford Crown Victoria



Gen 2 Series PHEV Powertrain in a running rolling chassis



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Progressive Regulation Proposal (Stage 4)

- **Stage 4: High volume certification, above 1000 units**
 - Require actual crash testing
 - Require repair data on existing conversions
 - Require, from a representative sample of existing conversions:
 - Detailed electronically-logged lifetime data
 - Emissions re-testing data at specific periods



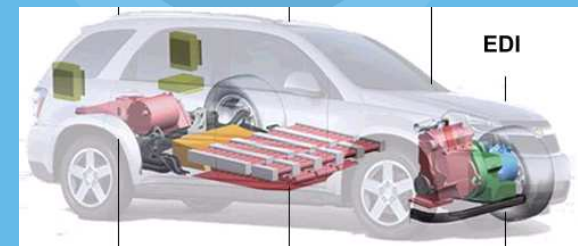
CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

The Low-hanging Fruit: Pickups, Vans, Larger Vehicles, and Those with Defined Drive Cycles

- They use **50% of transportation fuel**; generally have room for batteries
- Due to scale, **conversion cost is lowest per gallon** of fuel saved
- Vehicles with known, limited routes can become BEVs; others, PHEVs
- **Conversions can extend the life of vehicles** in good shape but with aging/gluttonous drivetrains
- **Conversions can be:**
 - Custom designed, tested, and **certified for each** of the most popular **vehicle models** like the F-150
 - Built in recently closed auto assembly plants, **using the projected glut of batteries** from new recently-stimulus-funded factories
 - Installed by local dealers and repair shops, **providing local jobs** across the country



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

CalCars: a resource for a broad new campaign

- Subscribe to [CalCars-News](#) & watch [ICE-conversions](#) Page

09/01/09: [Important Developments on Hybrid and Gas-Guzzler Conversions](#)

08/21/09: [Plug-Ins: Industry Developments and Media](#)

08/11/09: [The 21st Century Car Industry: Fixed in the USA](#)

03/27/09: [Our New Guzzler Video; Other Media; Apply for US Billions; GM Book; Correction](#)

01/21/09: [Our Testimony on Conversions Bolstered by 140+ Thoughtful Appeals](#)

11/12/08: [Multiple PHEV Conversion Solutions Gain Momentum](#)

10/03/08: [Should We Crush Gas-Guzzlers? Or Convert Them to Plug In? An Analysis](#)

09/20/08: [Another F-150 Conversion company](#) (Envia Rapid Electric Vehicles)

08/04/08: [Andy Grove's Ambitious Conversions Goals at Plug-In 2008](#)

- Print/distribute PDFs from Downloads Page
- And thanks for all you've done—and will do!



Donate!



CalCars

THE CALIFORNIA CARS INITIATIVE

www.calcars.org

Keep up with issues & emerging companies

- Subscribe to [CalCars-News](#) & watch [ICE-conversions](#) Page

Follow ICE Conversions news, photos; links to companies
calcars.org/ice-conversions.html

Download eight-page White Paper and analysis
calcars.org/scrap-or-retrofit.html

CalCars
THE CALIFORNIA CARS INITIATIVE — 100+ MPG Hybrids

POPULAR: [Convert Big Gas-Guzzlers to Plug In](#) | [Research Analysis: Scrap Or Retrofit Clunkers](#)

Plug-In Hybrids Use Cheaper, Cleaner, Domestic Energy

Quick Takes
[How to Get a PHEV](#)
[Where PHEV Conversions Are](#)

9/20/09 DRAFT: *The Big Fix: 16 Founding Points for the Campaign to Upgrade Gas Guzzlers*



Download flyer;
endorse campaign

Watch our video
calcars.org/audio-video.html
www.calcars.org