California State Legislative Briefing: Plug-in Electric Vehicles
19 March 2014

Union of Concerned Scientists Legislative Briefing on Electric Vehicles in California
Sacramento, CA

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University of California, Los Angeles

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Outline

• Plug-in electric vehicles (PEVs):
  – What exists is possible: Current PEVs
  – “Managing EV Expectations”: Market status
  – Impact: Electric miles

• Charging infrastructure

• Electricity as a fuel
UCLA Luskin Center Activities Overview

- **PEV market dynamics**
  - Market blog
  - New-car-buyer survey
  - ZEV Sales Factors
  - Rebate design alternatives

- **Regional PEV readiness planning**
  - Won state best-practices, American Planning Association award

- **Charging-station analysis**
  - Workplace & Multi-unit-dwelling station financial viability and fueling costs
  - Utilization
  - Station siting

- **Emerging opportunities**: Mobile Electricity & Battery secondary use and V2G

- **Transportation Electrification Curriculum Roadmap**
“Electric Vehicles”

- **Plug-in EVs (PEVs)** — i.e., electric-fuel vehicles — comprise both plug-in-hybrid EVs and all-battery EVs

- Many common components under the hood, but different products for the consumer with distinct policy implications...

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**Plug-in-hybrid EVs (PHEVs)**

*Plug It in or Fill It Up*

Plug-in hybrid electric vehicles have an internal combustion engine and electric motor. These vehicles are powered by an alternative fuel or a conventional fuel, such as gasoline, and a battery, which you can plug in to charge.

**All-battery EVs (BEVs)**

*No More Gasoline*

All-electric vehicles are plugged in to charge the battery, which stores the electricity that powers the electric motor.

http://www.afdc.energy.gov/vehicles/electric.html
## Plug-in-hybrid EVs (1 of 3, in order of release)

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>MSRP</th>
<th>Fuel economy* (gas–electric)</th>
<th>Range* (electric, total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM Chevy Volt</td>
<td>$34,185</td>
<td>37–98 mpg&lt;sub&gt;e&lt;/sub&gt;</td>
<td>38 e-mi 380 mi total</td>
</tr>
<tr>
<td>Toyota Prius Plug-in</td>
<td>$29,990</td>
<td>50–95 mpg&lt;sub&gt;e&lt;/sub&gt;</td>
<td>11 e-mi 540 mi total</td>
</tr>
<tr>
<td>Ford C-Max Energi</td>
<td>$32,950</td>
<td>43–100 mpg&lt;sub&gt;e&lt;/sub&gt;</td>
<td>21 e-mi 620 mi total</td>
</tr>
<tr>
<td>Honda Accord Plug-in</td>
<td>$39,780</td>
<td>46–115 mpg&lt;sub&gt;e&lt;/sub&gt;</td>
<td>13 e-mi 570 mi total</td>
</tr>
<tr>
<td>Ford Fusion Energi</td>
<td>$34,700</td>
<td>43–100 mpg&lt;sub&gt;e&lt;/sub&gt;</td>
<td>21 e-mi 620 mi total</td>
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*EPA rating

(photos and MSRP from OEM websites 2/14)
## Plug-in-hybrid EVs

(2 of 3, in order of release)

<table>
<thead>
<tr>
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<th>Fuel economy (gas–electric)</th>
<th>Range (electric, total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porsche Panamera S E-Hybrid</td>
<td>$99,000</td>
<td>~30–72 mpg_e</td>
<td>20 e-mi (NEDC) &gt;220 mi total</td>
</tr>
<tr>
<td>GM Cadillac ELR</td>
<td>$75,000</td>
<td>33–82 mpg_e*</td>
<td>37 e-mi* 340 total*</td>
</tr>
<tr>
<td>Hyundai Sonata Plug-in Hybrid</td>
<td>TBD 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Outlander P-HEV</td>
<td>TBD 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercedes S 500 Plug-in Hybrid</td>
<td>TBD 2014</td>
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## Plug-in-hybrid EVs  (3 of 3, in order of release)

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<tr>
<td>Volvo V60 PHEV</td>
<td>TBD in 2014</td>
<td>TBD in 2014</td>
<td></td>
</tr>
<tr>
<td>VW Golf twinDRIVE</td>
<td>TBD in 2014</td>
<td>TBD in 2014</td>
<td></td>
</tr>
<tr>
<td>Audi A4 e-quattro</td>
<td>TBD in 2014</td>
<td>TBD in 2014</td>
<td></td>
</tr>
<tr>
<td>Audi A3 e-tron</td>
<td>TBD in 2014</td>
<td>TBD in 2014</td>
<td></td>
</tr>
<tr>
<td>BMW i8</td>
<td>TBD in 2015</td>
<td>TBD in 2015</td>
<td></td>
</tr>
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### All-battery EVs (1 of 3, in order of release)

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<tr>
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<tbody>
<tr>
<td>Nissan LEAF</td>
<td>$28,800</td>
<td>116 mpg_e</td>
<td>75 e-mi</td>
</tr>
<tr>
<td>smart electric</td>
<td>$25,000</td>
<td>107 mpg_e</td>
<td>68 e-mi</td>
</tr>
<tr>
<td>Mitsubishi i</td>
<td>$29,125</td>
<td>112 mpg_e</td>
<td>62 e-mi</td>
</tr>
<tr>
<td>Ford Focus Electric</td>
<td>$35,170</td>
<td>105 mpg_e</td>
<td>76 e-mi</td>
</tr>
<tr>
<td>Tesla Model S</td>
<td>$71,070</td>
<td>95 mpg_e</td>
<td>208 e-mi</td>
</tr>
</tbody>
</table>

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(photos and MSRP from OEM websites 2/14)
All-battery EVs (2 of 3, in order of release)

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<tr>
<td>Honda Fit EV</td>
<td>$36,625</td>
<td>118 mpg_e</td>
<td>82 e-mi</td>
</tr>
<tr>
<td>Toyota RAV4EV (Tesla inside)</td>
<td>$49,800</td>
<td>78 mpg_e</td>
<td>103 e-mi</td>
</tr>
<tr>
<td>Chevy Spark EV</td>
<td>$26,685</td>
<td>118 mpg_e</td>
<td>82 e-mi</td>
</tr>
<tr>
<td>Fiat 500e</td>
<td>$31,800</td>
<td>116 mpg_e</td>
<td>87 e-mi</td>
</tr>
<tr>
<td>BMW i3</td>
<td>TBD in 2014</td>
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(photos and MSRP$s from OEM websites 2/14)
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<td>Mercedes B-Class Electric</td>
<td>TBD in 2014</td>
<td></td>
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</tr>
<tr>
<td>Tesla Model X</td>
<td>TBD in 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VW e-Golf</td>
<td>TBD in 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kia Soul EV</td>
<td>TBD in 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infinity LE</td>
<td>TBD in 2014</td>
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</table>
Plug-in Electric Vehicle Prices (Base MSRP) and Incentives
(Feb. 2014, in order of increasing discounted price)

- U.S. tax credit
- CA CVRP
- Discounted price
Managing EV Expectations

How are PEVs doing?
U.S. Plug-in Electric Vehicle Sales Trends & Analysis
Dec 2010 — Feb 2014

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18-Mar-14

http://luskin.ucla.edu/blogs/brettwilliams
Where are we with plug-in electric vehicles (PEVs)?

Cumulative U.S. sales
Light-duty U.S. PEVs sold and market share

Cumulative plug-in-vehicle sales by calendar year thru Feb'14

- 10,000  20,000  30,000  40,000  50,000  60,000

- 2010  2011  2012  2013  2014

market share (%)

- 4%  6%  13%  15%  25%  31%

Cadillac ELR
Panamera S E-Hybrid
500 Elettrica
Chevy Spark
Fusion Energi
Accord Plug-in
C-Max Energi
RAV4EV
Fit EV
Model S
Prius Plug-In
Focus Electric
i
smart electric drive
Chevy Volt
LEAF
by PEV type

Cumulative U.S. plug-in electric vehicles sold thru Feb'14

- All-battery EVs
- Plug-in-hybrid EVs
by PEV type, CA

Cumulative CA plug-in electric vehicles sold (data: CNCDA, Polk)

- All-battery EVs
- Plug-in-hybrid EVs
Cumulative CA plug-in electric vehicles sold (data: CNCDA, Polk)

by PEV type, CA

All-battery EVs
Plug-in-hybrid EVs

California rebates: ~52k thru 3/10/2014
Cumulative U.S. plug-in electric vehicles sold thru Feb'14

- **All-battery EVs**
- **Plug-in-hybrid EVs**

California rebates:
- 52% all-battery
- 47% plug-in-hybrid
Cumulative U.S. plug-in electric vehicles sold thru Feb'14

- All-battery EVs
- Plug-in-hybrid EVs

by PEV type

Cumulative U.S. plug-in electric vehicles sold thru Feb'14

Dec-10 Jun-11 Dec-11 Jun-12 Dec-12 Jun-13 Dec-13

0 2,000,000 4,000,000 6,000,000 8,000,000 10,000,000 12,000,000 14,000,000

bdw@ucla.edu
U.S. sales by calendar year from introduction of EV type

Number of vehicles

PEVs=BEVs+PHEVs ('10 thru '13)

Conventional hybrids ('99 thru '02)

# of calendar years from intro. of vehicle type (conventional hybrid or PEV)
PEV Impact
Does size matter?
Per-charge and per-day e-mile potential

(Williams 2013)

Cumulative electric-mile potential
of U.S. retail PEVs sold thru Sept. 2013

Electric miles

Vehicle capabilities

BEVs
PHEVs
Does size matter?
Per-charge and per-day e-mile potential

(Williams 2013)

Cumulative electric-mile potential of U.S. retail PEVs sold thru Sept 2013

Vehicle capabilities
Average daily driving (30mi cap)
Recharging Infrastructure

Charging Stations
California charge stations (~1,626 as of Feb’14)

Electricity production: Diverse, increasingly clean portfolio

- Diverse production portfolio
- Different solutions for different locations
- Existing CA grid mix positions plug-in vehicles for “80 in ‘50” emissions-reduction goal
- As approach 33% renewables, plug-in cars get cleaner as they age
Thank you for your attention!

Additional slides, references available...
Notes about these slides

- EV = electric-drive vehicle = conventional hybrids + PEVs + FCEVs
  - HEVs = hybrid EVs (aka “hybrids”) = conventional (all-gasoline) hybrids + PHEVs
  - PEVs = plug-in electric vehicles (aka “plug-ins”) = BEVs + PHEVs
    - PHEVs = plug-in hybrid EVs (aka “plug-in hybrids”)
    - BEVs = all-battery EVs (aka “all-electric”)
  - FCEVs = fuel-cell EVs
- Figure legend order usually reflects sequence of vehicle introduction.
- No single source used contained a complete and/or accurate list of sales data, so multiple sources were compiled by the National Renewable Energy Laboratory (gasoline-only hybrid data), CNCDA (California yearly totals), and UCLA Luskin Center (PEV data, most of which were compiled from monthly reports at hybridcars.com).
- Data for the Tesla Roadster, Cooper MINI-E, Th!nk City, Azure Transit Connect Electric, Fisker Karma, and Coda Sedan are usually not included.
- Tesla Model S sales are estimates and increasingly overestimate U.S. sales as the vehicle is marketed globally. Further, for simplification, it is assumed that all 2012 sales are the 85kWh model and 2013 and subsequent sales are the 60kWh model.