The Role of EVs in Saving fuel:

STEPS study on PEV global potentials to 2030

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Project background

• UC Davis has been funded by FIA Foundation and ITS STEPS Program for this project
• Research team: Lew Fulton, Tom Turrentine, Gil Tal, Aria Berliner
• This project will use market analysis and diffusion theory to develop a new approach to projecting PEV sales around the world, and create a low and high scenario through 2030
• Will work with the IEA to estimate overall energy use/GHG impacts of these PEV scenarios
• Report by Autumn 2015
By 2050 the world will need to shift to selling mainly near-zero emissions vehicles (plug-ins, or PEVs)

Figure 13.18  Global portfolio of technologies for passenger LDVs

Key point  In the Improve case, electric, PHEV and FCEVs together account for nearly three-quarters of new vehicle sales in 2050.

Source: IEA, Energy Technology Perspectives (2012)
There exist many global PEV sales projections – mostly from an earlier time of exuberance...

IEA EV Outlook, 2013

20 million on the road by 2020
ICE dominance through 2030 even with remarkable PEV sales growth (global LDV sales over 5-year periods)

Source: ETP 2012, adjusted. Note: this aligns with the IEA 2DS Scenario except with only 5 million PEV sales 2015-2020 instead of 20 million.
UC Davis PH&EV Center Analysis: We are very early in a potential PEV transition

- Registered PEVs in the world will reach 1 million this year (Sept?)
  - .1% of 1 billion vehicles
- Annual world market about 300,000 in 2014
  - Should exceed 400,000 for 2015
  - About .5 % of 88 million vehicles per year in 2015
- Sales are concentrated in a few “beachheads” with strong incentives- West Coast US, Northern Europe, Japan & China.
  - California has about 9-10% of world PEVs sales, 2-3% of all vehicle sales

2014 World EV/BEV Sales

- Asia 2014, 85,019, 28%
- Europe 2014, 100,060, 33%
- USA 2014, 119,701, 39%
## Top 10 World Sales leaders 1\textsuperscript{st} Qtr 2015
(from EVBlogspot - Ponce)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Model</th>
<th>Type</th>
<th>March</th>
<th>YTD</th>
<th>Availability US</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nissan Leaf</td>
<td>BEV</td>
<td>6,484</td>
<td>13,437</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Tesla S</td>
<td>BEV</td>
<td>6,626</td>
<td>10,030</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Mitsubishi Outlander</td>
<td>PHEV</td>
<td>5,196</td>
<td>9,849</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>BYD Qin</td>
<td>BEV</td>
<td>2,476</td>
<td>6,319</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>BMW i3</td>
<td>BEV &amp; BEV/X</td>
<td>2,012</td>
<td>5,277</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>VW e-Golf</td>
<td>BEV</td>
<td>1,299</td>
<td>3,661</td>
<td>2015</td>
</tr>
<tr>
<td>7</td>
<td>Renault Zoe</td>
<td>BEV</td>
<td>1,349</td>
<td>3,053</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Chevy Volt / Ampera</td>
<td>PHEV</td>
<td>749</td>
<td>2,139</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>Toyota Prius Plug in</td>
<td>PHEV</td>
<td>719</td>
<td>2,081</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>VW Golf GTE</td>
<td>PHEV</td>
<td>442</td>
<td>2,003</td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>Total all models world</td>
<td></td>
<td>42,135</td>
<td>89,599</td>
<td></td>
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</table>
Five sectors of PEV transition process

1. ZEV & PEV Policy: goals, regulations & incentives
2. Research, development: demonstration & deployment
3. Infrastructure rollout & grid integration
4. PEV rollout & retail sector development
5. Early PEV users

Diffusion processes

Global Vehicle market
Tom Turrentine sees 3 stages of PEV technology roll-out, much like we had for hybrids.

- **First generation:** vehicles, buyers & infrastructure (2010)
- **Second generation:** batteries, rollout, expansion, buyers & infrastructure (2015)
- **Third generation:** vehicles, buyers & grid integration (2025)

2020:
- Early core market: 6-15% of market
- Early market followers: 3-5% of market

2015:
- Early market: 1-2%
Our research idea...

• Is not to “predict” or “forecast” the sales of PEVs, but explore what factors may matter in determining the trajectory, such as:
  – Consumer awareness, interest in different countries
  – Rate of new model appearance; manufacturer investments in new models/facilities and production ramp-up rates
  – The size and nature of different market segments in different countries, where PEVs are likely to appear, and how this may evolve
  – Diffusion rates of models across countries
  – Policy overlays – the PEV-relevant policies in major markets and their impacts on market development
• We will combine these concepts into a quantitative framework that allows us to project PEV sales to at least 2025, using a scenario approach
The role of market structure

- Plotting out vehicle sales by market segment/RPE to understand the distributions in different markets
- Can overlay PEV models onto this to see where they land
The role of market structure

US LDV Sales by segment, 2013
The role of market structure  US LDV Sales by price, 2013
The role of market structure US Segment C

Number of Registered Vehicles

- Less than $10.9k
- $11k-$14.9k
- $15k-$18.9k
- $19k to $22.9k
- $23k to $26.9k
- $27k to $30.9k
- $31k to $34.9k
- $35k to $38.9k
- $39k to $42.9k
- $43k to $46.9k
- $47k to $50.9k
- $51k to $54.9k
- $55k to $58.9k
- $59k to $62.9k
- $63k to $66.9k
- $67k to $70.9k
- $71k +

Categories:
- Other
- Hybrid
- Plug-in
Consumer behaviour

• Investigate awareness of PEVs in different countries, based on information available. Create an “awareness diffusion curve”, also called legitimation

• Relate potential demand to:
  – Number/percent of consumers aware of possibility of purchasing plug-ins; percent willing to consider
  – Number of models available by market segment and the sales of that segment
  – Price and attribute comparison of these models to average vehicles in this segment
  – The policy overlay – what incentives exist in this country that promote PEVs, improve awareness, et.
Manufacturer behaviour

• Snapshot of vehicle makes/models available in different countries today

• Look at sales per model, assume that future introductions occur when sales per model reach a certain level (and taking into account 3-5 year lead time)
  – Models will likely appear first in higher priced segments
  – Manufacturers will gear production toward largest markets and those with best policy/incentive structures

• Use a diffusion concept to model the rate of spread of models and vehicle production/availability across countries
Role of technology

• Consider “3 phases” of PEV introduction with 2015, 2020 being start of phase 2 and 3.
• Battery cost decline – function of cumulative sales
• Higher battery range – the arrival of 300 km EVs.
• More public charging stations, including fast charging or battery swapping
Role of policy

- For each country, estimate the impact of:
  - Vehicle purchase incentives
  - Other incentives (e.g. parking, HOV lanes)
  - Regulatory policies (fuel economy standards, sales restrictions)
  - Support for manufacturing/introduction of models
  - Development of recharging infrastructure
  - Education/awareness campaigns
Putting it together

• These elements will be linked together in an iterative way – the version of this model developed in 2015 will be simplified.

• We will project all LDV sales by market class in each country through 2025, the introduction and sales of new PEV models by class. This will reflect income and total LDV sales growth projections from the IEA.

• We hypothesize that our approach will tend to dampen sales projections, due to limiting factors:
  – Level and spread of awareness, interest in PEVs
  – Limited policy support in many countries
  – Manufacturer limits on investments, rates of new model introduction/roll out, availability by market/class
  – Diffusion rate limits to new markets, new countries
outputs

- Develop low and high scenarios for PEV projections by country, PEV type, through 2025/2030
- Feed this into IEA Mobility Model to generate impacts in terms of electricity use, other energy use, CO2 emissions across transport. Might use this model also to apply diffusion to other countries beyond the major markets we characterize in our main study
- Show the contribution of PEVs through 2025/2030, describe what factors will be most important, how changes in policy could change trajectory
My hypotheses about our coming results

- Is that limits on rate of introduction of new models, rates of production, and consumer awareness will severely slow the projected rate of plug-in adoption
  - Consider that hybrids have been “stuck” at a few percent per year in most countries for nearly 2 decades
- We will explore how policies can be used to speed factors like:
  - Consumer awareness / demand
  - Producer investments / diffusion
- We will try to identify “tipping points” where demand may take off (a la smartphones); this will most likely require widespread awareness, infrastructure, and better/cheaper vehicles
Thank you