The Dynamics of Plug-in Electric Vehicles in the Secondary Market

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Sponsored by the California Air Resources Board
Population and Sampling

- Used PEVs in DMV records: ~14000
- Invitations letters: 4700
- Address problem: 183
- Started: 913  Response rate: 20%
- Purchased used: 732  Used owners response rate: 17%
- Purchased from lease: 52
- Finished usable: 602  Completion rate: 82% of all invitations: 13%

Model Year:
- Nissan Leaf: 33%
- Chevrolet Volt: 28%
- Toyota Prius Plug-in: 15%
- Tesla Model S: 7%
- Ford C-Max Energi: 4%
- Ford Fusion Energi: 4%
- Toyota RAV4 EV: 4%
- Ford Focus Electric: 2%
- BMW i3: 1%
- Mitsubishi i-MiEV: 1%
- Tesla Roadster: 1%
- Other: 2%
We only use households with some experience, our data is “old”
Completion Time and Drop Rates

Number of Completes per 5 Minute time interval

Last Page for Responses
Who Sells Used PEVs?
7% of HH purchased 2+ cars, which is 35% of the new cars. 27% purchased 1 car or 65% of the new car purchases. 66% of the households did not purchase a new car in the last 5 years.
Used PEV Pricing
2012 LEAF Sold in 2015: The Seller Perspective

Residual Value 47.1%
2012 LEAF Sold in 2015: The Buyer Perspective

Residual Value: 55.0%

- Nissan Leaf, 2011: $34,990
- Nissan Leaf, 2012: $36,882
- Nissan Leaf, 2013: $33,488
- Nissan Leaf, 2014: $32,226
- Nissan Leaf, 2015: $32,030

Priced paid New

MSRP

Paid Price Minus Incentives

Purchased Used on 2013

Purchased Used on 2014

Purchased Used on 2015

$12,508

$22,779
2012 Volt Sold in 2015: The OEM Perspective

Residual Value 48.3%
2012 Volt Sold in 2015: The Seller Perspective

Residual Value 55.9%
2012 Volt Sold in 2015: The Buyer Perspective

Residual Value 68.7%
The Price of New Volt Dropped When the first Used Car came out of Lease

- Chevrolet Volt, 2011
- Chevrolet Volt, 2012
- Chevrolet Volt, 2013
- Chevrolet Volt, 2014
- Chevrolet Volt, 2015
# Residual Value is Between 34% and 99%

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Nissan Leaf, 2011</td>
<td>$33,572</td>
<td>$34,990</td>
<td>$26,815</td>
<td>$15,497</td>
<td>$11,463</td>
<td>$22,779</td>
<td>34%</td>
<td>43%</td>
<td>50%</td>
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<tr>
<td>Nissan Leaf, 2012</td>
<td>$36,882</td>
<td>$35,852</td>
<td>$26,564</td>
<td>$12,508</td>
<td>$22,779</td>
<td>34%</td>
<td>47%</td>
<td>55%</td>
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<tr>
<td>Nissan Leaf, 2013</td>
<td>$31,517</td>
<td>$33,488</td>
<td>$24,380</td>
<td>$13,912</td>
<td>$22,779</td>
<td>44%</td>
<td>57%</td>
<td>61%</td>
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<tr>
<td>Tesla Model S, 2013</td>
<td>$87,217</td>
<td>$96,732</td>
<td>$87,974</td>
<td>$67,338</td>
<td>$105,998</td>
<td>77%</td>
<td>77%</td>
<td>64%</td>
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<tr>
<td>Ford Fusion Energy, 2013</td>
<td>$39,235</td>
<td>$41,140</td>
<td>$35,936</td>
<td>$25,288</td>
<td>$36,214</td>
<td>64%</td>
<td>70%</td>
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<tr>
<td>Chevrolet Volt, 2012</td>
<td>$39,145</td>
<td>$41,140</td>
<td>$33,798</td>
<td>$24,672</td>
<td>$27,488</td>
<td>53%</td>
<td>62%</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Chevrolet Volt, 2013</td>
<td>$39,174</td>
<td>$41,000</td>
<td>$32,855</td>
<td>$24,672</td>
<td>$27,488</td>
<td>53%</td>
<td>64%</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Ford C-Max Energy, 2013</td>
<td>$31,665</td>
<td>$35,014</td>
<td>$29,664</td>
<td>$22,875</td>
<td>$29,900</td>
<td>72%</td>
<td>77%</td>
<td>77%</td>
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<tr>
<td>Toyota Prius Plug-in, 2012</td>
<td>$38,195</td>
<td>$36,211</td>
<td>$32,273</td>
<td>$24,823</td>
<td>$27,951</td>
<td>60%</td>
<td>71%</td>
<td>82%</td>
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<tr>
<td>Toyota Prius Plug-in, 2013</td>
<td>$38,704</td>
<td>$34,259</td>
<td>$30,394</td>
<td>$24,412</td>
<td>$27,951</td>
<td>63%</td>
<td>80%</td>
<td>87%</td>
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<tr>
<td>Toyota Prius Plug-in, 2014</td>
<td>$34,307</td>
<td>$31,726</td>
<td>$27,759</td>
<td>$27,525</td>
<td>$27,951</td>
<td>80%</td>
<td>99%</td>
<td>98%</td>
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Odometer Reading at Purchase
Used PEV price is, as in any car, correlated positively with the MSRP and negatively with time on the road and mileage

• PHEV remains on average a 10.3% higher value compared to the MSRP than BEVs

• PEVs with HOV access sticker receive $1,430 more than PEVs without an HOV sticker.

Table 3: Parameter Estimates for price paid when purchasing used PEV

| Term                          | Estimate  | Std Error | t Ratio | Prob>|t| |
|-------------------------------|-----------|-----------|---------|------|
| Intercept                     | 6091.0037 | 2070.067  | 2.94    | 0.0034*|
| PEV Type [electric]           | -1958.399 | 241.1654  | -8.12   | <.0001*|
| PEV age when purchased (years)| -2950.497 | 249.7977  | -11.81  | <.0001*|
| HOV Sticker [No]              | -715.6517 | 252.7792  | -2.83   | 0.0048*|
| Miles when purchased          | -0.101106 | 0.016713  | -6.05   | <.0001*|
| Price paid when new           | 0.6887149 | 0.049827  | 13.82   | <.0001*|

Summary of Fit

- RSquare: 0.602079
- RSquare Adj: 0.598208
- Mean of Response: 4642.141
- Observations (or Sum Wgts): 520

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>1.6759e+10</td>
<td>3.3519e+9</td>
<td>155.5426</td>
<td>&lt;.0001*</td>
</tr>
<tr>
<td>Error</td>
<td>514</td>
<td>1.1076e+10</td>
<td>21549476</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>519</td>
<td>2.7836e+10</td>
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<td></td>
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</tbody>
</table>

Lack of Fit

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack Of Fit</td>
<td>472</td>
<td>1.0422e+10</td>
<td>22080574</td>
<td>1.4172</td>
<td>Prob &gt; F</td>
</tr>
<tr>
<td>Pure Error</td>
<td>42</td>
<td>654400057</td>
<td>15580954</td>
<td>0.0819</td>
<td>Max RSq</td>
</tr>
<tr>
<td>Total Error</td>
<td>514</td>
<td>1.1076e+10</td>
<td></td>
<td>0.9765</td>
<td></td>
</tr>
</tbody>
</table>
Who Purchases Used PEVs?
Household Income of New and Used Buyers

- $50,000
- $100,000
- $150,000
- $200,000
- $250,000
- $300,000
- $350,000
- $400,000

- BMW i3
- Chevrolet Volt
- Ford C-Max Energi
- Ford Focus Electric
- Ford Fusion Energi
- Mitsubishi i-MiEV
- Nissan Leaf
- Tesla Model S
- Toyota Prius Plug-in
- Toyota RAV4 EV

Used | New
Household Income of New and Used Buyers: By Model Year
Household Income of New and Used Buyers:
By Purchase Year
Knowledge and Motivations
Household Fleet

**Household Fleet**

- **One PEV**: 41%
- **2 PEVs with no ICE**: 4%
- **2 PEVs With ICEs**: 4%
- **One PEV and one ICE**: 39%
- **One PEV and 2+ ICEs**: 12%

**New and Used Cars in the HH Fleet**

- **12% of the HH**: Used only
- **49%**: Mix
- **63%**: Used only

**Number of Vehicles in the HH**

- **1**: Used only
- **2**: Mix
- **3+**: Used only
Which of the following statements best describes your interest in acquiring a Plug-in Electric Vehicle (PEV) when you started your search for your {mainpev}? 

- I did not know PEVs existed: 1%
- I had no interest in a PEV: 3%
- I had some interest in a PEV: 11%
- I was only interested in a PEV, but considered multiple PEV make/models: 33%
- I was very interested in a PEV: 24%
- I was only interested in the specific PEV make/model I purchased: 28%
What did they look for?

• When comparing new cars to used cars, throughout your shopping experience for your \{mainpev\}, were you more likely to buy a new or used vehicle?
What did they look for?

When comparing conventional vehicles to plug-in vehicles, throughout your shopping experience for your {mainpev}, were you more likely to buy a conventional or plug-in vehicle?
No Potential Buyers Of New ICEs Who Bought Used PEVs
What about technical knowledge?

When buying your {mainpev} did you ask about the condition of its battery?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, I received a battery report from an independent tester</td>
<td>1.4%</td>
</tr>
<tr>
<td>Yes, I received a battery report from the dealer</td>
<td>13.3%</td>
</tr>
<tr>
<td>Yes, I looked at the dashboard display when the battery was fully charged</td>
<td>15.8%</td>
</tr>
<tr>
<td>Yes, I searched online or consulted other sources regarding the battery</td>
<td>17.9%</td>
</tr>
<tr>
<td>Yes, I asked the seller</td>
<td>27.6%</td>
</tr>
<tr>
<td>None of the above</td>
<td>1.5%</td>
</tr>
<tr>
<td>No, I did not ask</td>
<td>11.2%</td>
</tr>
<tr>
<td>No, the car is under warranty</td>
<td>41.8%</td>
</tr>
</tbody>
</table>
When buying or leasing a new {carmain}, or a similar new plug-in car you may (or may not) be eligible for different incentives that may reduce the price of the new vehicle in your area. When buying your vehicle were you aware of any of the "Federal Tax Credit"?

Federal Tax by Vehicle

- Total
- Tesla Model S
- Toyota RAV4 EV
- Ford C-Max Energi
- Ford Fusion Energi
- Toyota Prius Plug-in
- Chevrolet Volt
- Nissan Leaf

Federal Tax by Purchase Year

- 2015
- 2014
- 2013
Dealers are Not Helping

Share of "not aware of the federal tax credit"

- An online service (Like eBay or similar. I did not see the car before purchasing it.)
- A private owner
- Other
- A car dealership of the brand I purchased
- A used car dealership (including online)
Used PEV Usage
Used PEVs are driven more than New PEVs except LEAFs and RAV4
But they plug in less

Ford C-Max Energi
Ford Fusion Energi
Chevrolet Volt
Toyota Prius Plug-in

- In the last 30 days we drove the car as a hybrid car, we did not plug it in
- In the last 30 days we drove the car mostly as a hybrid car, we plugged in 1-4 times
- In the last 30 days we plugged in our car more than 4 times
What do we know about the secondary market so far

• Residual value is in the eye of the beholder as
  • Price of new PEVs dropped over time
  • Some buyers had the right knowledge to calculate actual cost
  • BEVs price dropped more than PHEVs
  • HOV access may be part of the story

• Second owners have lower income than first owners, but not by much.

• Most of the buyers were looking for a used PEV, very few start with a
different car in mind.

• Knowledge (awareness and education) is most likely the key for a strong
secondary market

• Used PEV buyers are more utilitarian than new PEV buyers as reflected by
their high driving need but they may be less committed to electric driving
not always plugging in their vehicle
What do we know that we don’t know

• Overall buyers of used PEVs purchased a vehicle that
  • They plan to buy
  • They learn about it in advance
  • Is relatively new with low mileage and in most cases under warranty
  • Is at a relatively low price

• This may not be the case when the PEV market will contain more older vehicles with high mileage and over the battery and powertrain warranty limit.
Thank you

Questions?

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