Learning from Experience Plug-In Vehicles, Usage and Infrastructure

New Orleans 2017

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PH&EV Center Data Collection

- 24,000 New car Buyers surveys
  - 2010-2017
  - 12 US states
  - Focus groups
  - Interviews

- 27,000 Electric car buyer surveys
  - 2010-2017
  - 12 US states, China, Germany
  - Used PEV buyers
  - Focus groups and Interviews

- PEV and ICE on road data collection
  - OBD data 264+ vehicles over a year
  - GPS data 54,000 vehicles over 2.5 years (4 OEMs)
  - 4,000 Vehicles second by second dataset for California

- US Infrastructure Charging data 2012-2017
  - 9,000,000 Level 2 charging events
  - 1,700,000 DC fast charging events
  - Vehicle reported charging events
EV Infrastructure planning toolbox: CEC Grant 2010-2014

Market Forecast Using Census Data

Work Charging Based on Market Scenario

EV Planning Toolbox

ArcGIS Interface Allows You To Make Your Own Scenarios

Fast Charging - Estimates Take into Account Existing Chargers
Second generation PHEVs: 20-40 miles range, SUV/Crossover type vehicles, more power mixed with short range European PHEVs

- **2017 Toyota Prius Prime**
- **2017 Chevrolet Volt**
- **2017 Audi A3 eTron**
- **2017 Volkswagen Passat GTE**
- **2017 Chrysler Pacifica**
Curve based on rollout of HEVs in Japan & California 1997-2015

1st generation policy, vehicles, “innovators” & infrastructure 200,000 PEVs

2nd generation batteries, vehicles, “followers” 500,000 PEVs

3rd generation: batteries, vehicles, “core market” 800,000 PEVS

4th generation 3 - 4 million???

California 2025 ZEV goal = 15% / 1.5 million BEVS, FCV & PHEVs

Main market 15-25%

Early core market: 6-15%

3-5% of market

1-2%

700 300 200 150 Lithium pack prices per kWh
Discussion Guide:
A simple purchase process model

Awareness → Knowledge → Consideration → Purchase
How different types of vehicles are fueled, percent correct

ICEV
HEV
PHEV
BEV

Jun-14 Nov-14 Feb-17 Jun-17
It takes two good reasons to buy a PEV and one flimsy excuse not to.

- PEV and ICEVs/HEV buyers are answering different questions
  - PEV buyers: “How do I get a PEV?”
  - ICEV/HEV buyers: “Why would I buy a PEV?”
    - Notably, they may not have considered this question until the interview
- ICEV/HEV buyers were either...
  1. Unaware: Simply don’t know PEVs are a possibility, or
  2. Unengaged: Have no impetus to solve even their first (imagined) problem with PEVs; no impetus to explore any other problems.
- PEV buyers are engaged
  - They have the impetus to solve one problem and move on to solve the next until they own a PEV
NEW CAR BUYERS: who is more likely to buy a PEV?

75% of the households did not purchase a new car in the last 3 years

- 21% bought 1 car = 72% of new car purchases
- 4% of HH purchased 2+ cars = 28% of new cars

- 4% of the households are responsible for almost one third of the market over the last 3 years 2010-2012
- Up to 15% of PEV buyers are on their second PEV
Overlapping Incentives

No Need of any Incentives
22%-50%

Monetary Incentives
25%-50%

Non monetary Incentives (HOV)
5%-20%

Public infrastructure
2%-8%
CHARGING
How often do they Charge

Charging event per week

- **Hyundai Sonata Plug-in Hybrid**: 7 events (L1: 5, L2: 2, DC Fast: 0)
- **FIAT 500e**: 6 events (L1: 4, L2: 2, DC Fast: 0)
- **Audi A3 Sportback e-tron**: 6 events (L1: 3, L2: 3, DC Fast: 0)
- **Toyota Prius Prime**: 6 events (L1: 3, L2: 3, DC Fast: 0)
- **Chevrolet Volt**: 6 events (L1: 3, L2: 3, DC Fast: 0)
- **Toyota Prius Plug-in**: 6 events (L1: 3, L2: 3, DC Fast: 0)
- **Volkswagen e-Golf**: 6 events (L1: 3, L2: 3, DC Fast: 0)
- **Nissan Leaf**: 5 events (L1: 3, L2: 2, DC Fast: 0)
- **Tesla Model X**: 5 events (L1: 3, L2: 2, DC Fast: 0)
- **Ford C-max energi**: 5 events (L1: 3, L2: 2, DC Fast: 0)
- **BMW i3**: 5 events (L1: 3, L2: 2, DC Fast: 0)
- **Tesla Model S**: 5 events (L1: 3, L2: 2, DC Fast: 0)
- **Chevrolet Bolt EV**: 4 events (L1: 2, L2: 2, DC Fast: 0)
Do they even plug in?

- Toyota Prius Plug-in
- Ford C-max energi
- Audi A3 Sportback e-tron
- Toyota Prius Prime
- Hyundai Sonata Plug-in
- Chevrolet Volt
- BMW i3

Legend:
- Hybrid
- PEV
Home Charging 2013-2017

2013 Survey
Nissan LEAF Level 2 home Charging  86%

2015 Survey
Nissan LEAF Level 2 home Charging  60%

2017 Survey
Nissan LEAF Level 2 home Charging  42%
Workplace Charging
Do they Have a Charger at work?
Is it congested?

- Not Congested: 56.6%
- 1 day per week: 13.6%
- 2 days per week: 11.2%
- 3 days per week: 7.1%
- 4 days per week: 3.3%
- Always: 8.2%
DC Fast Charging
Who is using DC Fast?

- **Nissan Leaf**: 33%
- **Tesla Model X**: 33%
- **Tesla Model S**: 31%
- **Volkswagen e-Golf**: 12%
- **Chevrolet Bolt EV**: 10%
- **BMW i3**: 10%

Options: No, Yes
Comparison of free-prepaid and paid charging for the BEV80 Nissan Leaf and the BEV200+ Chevrolet Bolt

Distance Home to Charger (mi)

- Nissan Leaf 24kWh Free-Prepaid Charging
  - 10-20 cents per min

- Nissan Leaf 24kWh Paid Charging
  - 10-20 cents per min

- Chevrolet Bolt Paid Charging
  - 10-20 cents per min
How often do they use DC fast?
PG&E Scenario 2025

- Home dominates in urban areas (10 AM peak)
- Work centers have work based demand (noon and 6pm peak)
- Corridors draw from far away (5-8 pm peak)

- Corridors are the most speculative. Depends on confidence of availability and increase in battery Size

Nobody goes there anymore. It's too crowded.

- If public charging is free we need about 60 chargers per 100 PEVs.

- If public charging is congested nobody goes there anymore.
  - Especially not those who need it in order to go back home.
  - The only one who can use it are does who can charge at home anyway.

- Paid public charging may reduce sales in the short term but increase sales overall by improving the usability of BEVs.
Electrifying Shared Mobility

- OEM Vehicle Lease
- Aggregator Drivers
- Shred mobility provider
- Charging Provider

DC Fast under utilize capacity
Conclusions

- Vehicle sales/availability
- Dependable infrastructure
- Home charging
- Education
- Awareness
- Price
- Incentives
Thank you