Accelerating Worldwide Plug-in Electric Vehicle Market Development: 5 Policy Interventions

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Outline

1. Introduction to the PH&EV Center
2. Introduction to the International EV Policy Council
3. 5 Policy Interventions
4. Summary
Introduction to the PH&EV Center
Institute of Transportation Studies

- STEPS
- PH&EV Center
- 3Revolutions/Future Mobility
- NCST
- Energy Institute
- Policy Institute for Energy, Environment, and the Economy
PH&EV Center

Researchers
Dr. Gil Tal, PEV Markets, Travel Behavior
Dr. Tom Turrentine, World Market, supply and demand
Dr. Ken Kurani, Consumer Studies
Dr. Alan Jenn, PEV Regulations and Market Models
Dr. Angela Sanguinetti, Energy Feedback Systems
Dr. Scott Hardman, Global Policy, Consumer adoption
Dr. Jaehyun Lee, GIS and travel data analysis
Dr. Debapriya Chakraborty, Transportation economics
Dr. Yan Xing, China Center and PH&EV Center
Dr. Chris Nitta, Professor of Computer Science
Dr. Aria Berliner, New Mobility

Program Manager
Dahlia Garas

5 Research Staff, programmers, visiting scholars

10 Graduate Students

12 Undergraduate Students

280+ publications, 42 papers in 2017, 17+ under review
PH&EV Center Data Collection

We use multiple data sources to research the EV market in California and USA

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Details</th>
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<tbody>
<tr>
<td>Questionnaire Surveys</td>
<td>• Questionnaires with 30,000 PEV owners</td>
</tr>
<tr>
<td></td>
<td>• Non-EV buyer surveys with 25,000 car buyers in US</td>
</tr>
<tr>
<td>On road data collection</td>
<td>• OBD data on 600+ vehicles</td>
</tr>
<tr>
<td></td>
<td>• GPS data on 54,000 PEVs from OEMs</td>
</tr>
<tr>
<td>Infrastructure Data</td>
<td>• 9,000,000 Level 2 charging events</td>
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<tr>
<td></td>
<td>• 3,400,000 DC fast charging events</td>
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<td></td>
<td>• Vehicle Reported Charging Events</td>
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<tr>
<td>Registration Data</td>
<td>• 48,000,000 vehicles in 3 states</td>
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<tr>
<td></td>
<td>• 14,000,000 Households vehicle ownership</td>
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Introduction to the International EV Policy Council
International EV Policy Council

• 25 researchers, at 15 Institutions, in 13 Countries
  • Australia, Belgium, Canada, China, France, Germany, Netherlands, Norway, Portugal, South Korea, Sweden, UK, and USA
Workshops

- Sweden- April 2016
- Montreal- June 2016
- Shanghai- August 2016
- Washington DC- January 2017
- London- June 2017
- Stuttgart- October 2017
- Washington D.C- January 2018
- Oslo- May 2018
- Future workshops:
  - Kobe- October 2018
  - Washington D.C- January 2018
  - Lyon- May 2018
  - California- October 2018
Policy Brief Review Process
5 Policy Interventions
Scope of Policy Briefs

Plug-in Electric Vehicles (PEVs), including:

• Battery Electric Vehicles (BEVs)
• Plug-in Hybrid Electric Vehicles (PHEVs)
• Not Hybrid Electric Vehicles
5 Policy Interventions

• Consumer Engagement
• Purchase Incentives
• Reoccurring and Indirect Incentives
• Infrastructure
• Regulatory Mechanisms (NEV and ZEV)
Consumer Engagement
Why is Educating Consumers Important?

Consumers won’t buy EVs if they are not knowledgeable about them and the benefits of them.

• Awareness: consumers know PEVs, incentives, charging stations etc. exist
• Knowledge: consumers know what an EV is and the pros and cons
• Decision: consumers consider if they would purchase the vehicle

Awareness

Knowledge

Decision

Purchase
Consumer Engagement is Lagging Behind the Market

**US Annual PEV Sales**

- **2010**
- **2011**
- **2012**
- **2013**
- **2014**
- **2015**
- **2016**
- **2017**
- **2018 (July)**

**Key Events**

- **2014**
- **2018**

**EV Volumes 2018**

- Already own a PEV
- Actively shopped for an electric vehicle
- Gathered some information, but not really serious yet
- The idea has occurred, but no real steps taken
- Have not considered—but maybe some day we will
- Have not—and would not—consider buying a PEV

Kurani 2017, Hardman 2018
A Holistic Approach to Engagement is Needed

- Awareness
  - Traditional Media (Marketing Campaigns)
- Knowledge
  - PEV Ride and Drives & PEV Experience Centers
- Decision
  - Dealer education
- Purchase
Financial Purchase Incentives
Four Different Types of Financial Incentives

**Tax Credit (e.g USA)**
- Incentive amount: $7,500
- You pay: $32,687 out of pocket

**Rebate (e.g CA)**
- Incentive amount: $2,500
- You pay: $32,687 out of pocket

**Grant (e.g UK)**
- Incentive amount: $6,000
- You pay: $26,675 out of pocket

**Tax Waiver (e.g prev. WA)**
- Incentive amount: 6.5% MSRP ($1995)
- You pay: $30,680 out of pocket

*MSRP: $30,680 + $1995 tax*
Incentives are Increasing in Importance Over Time

- Q: *If the federal tax credit were not available how would this impact your decision to buy your PEV?*
- “No change” means they will still buy their PEV.

<table>
<thead>
<tr>
<th>Year (2010-2016)</th>
<th>Probability</th>
<th>Change in purchase decision</th>
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<tbody>
<tr>
<td>Chevrolet Volt</td>
<td><img src="Chevrolet_Volt.png" alt="Graph" /></td>
<td><img src="Chevrolet_Volt.png" alt="Graph" /></td>
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<tr>
<td>Model S</td>
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<td><img src="Model_S.png" alt="Graph" /></td>
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<tr>
<td>Nissan Leaf</td>
<td><img src="Nissan_Leaf.png" alt="Graph" /></td>
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<tr>
<td>Prius Plug-in</td>
<td><img src="Prius_Plug-in.png" alt="Graph" /></td>
<td><img src="Prius_Plug-in.png" alt="Graph" /></td>
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</tbody>
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Change in purchase decision:
- **No change**
- **Another plug-in vehicle**
- **A non plug-in vehicle**
- **Not to buy/lease a vehicle at all**
- **Don't know**

Jenn, Hardman, Lee, & Tai 2018
Financial Purchase Incentives- Recommendations

• Incentives more important for later adopters than early adopters.
  • Should not be removed too early in the market.
• Closer they are received to the point of purchase the more effective they can be.
• Incentives should be lower for PHEVs with short driving ranges (higher for BEVs and PHEVs with long ranges).
• Incentives are less important for buyers of high-end/luxury PEVs or for persons of high income.
Reoccurring/ non-financial incentives
Reoccurring/ non-financial incentives

- HOV, bus, or transit lane access
- Parking incentives (free, discounted, preferential locations)
- Toll waivers/discounts
- Restricted zone fee waivers /discounts
- Annual vehicle tax/fee exemptions
Reoccurring Incentive Impact Differs Between Regions

• Importance of incentives depends on local conditions, consumer preferences, regulations in place etc.

California
HOV lane access is a primary motivation for 25-40% of buyers in SF and LA

Norway
Free tolls have large impact on 50% of PEV buyers
Reoccurring/ Non-financial Incentives- Recommendations

• Any intervention that makes PEV ownership easier, cheaper, or more convenient can be effective in promoting PEVs
• Incentives used will depend on location, saturation rate, consumer preferences, regulatory power of policymakers
• Incentives should also differentiate BEVs, long range PHEVs, and short range PHEVs
• Can be easier to implement compared to purchase incentives
Charging infrastructure development
Charging infrastructure development

Charging locations
• Home (while at home)
• Work (while at work)
• Public
• Corridor

Charging levels (North America)
• Level 1
• Level 2
• DC Fast
Public Charging enables more eVMT but is not a prerequisite for EV adoption the USA
Charging Infrastructure Development- Recommendations

- Home location chargers most important followed by work, then public
- Charge level needs to be optimized for specific use. Level 1 is fine for short trips and locations with long dwell times.
- Charging should not be free as this can increase congestion and reduce dependability
- Charging should be managed by pricing, location, charging speeds, and smart charging.
Regulatory Mechanisms
Regulatory Mechanisms

- Introduced in 1990
- Requires OEMs to sell “ZEVs” which includes PHEVs, BEVs, FCVs
- OEMs must obtain a certain number of credits by selling ZEVs

<table>
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<th>California ZEV Program</th>
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<td>Regulated OEMs</td>
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</table>
| Credits                | 7% in 2019  
                         | 9.5% in 2020 
                         | 7-12% by 2025 |
| Can credits be saved for future years? | Yes |
| Technological specificity | Certain portion of requirement must be pure ZEV (BEV or HFCV) |
| Credits per vehicle sold | 0.4 to 4 |
Sales of PEVs in ZEV & non ZEV States

• The ZEV mandate creates supply and sales in ZEV and non ZEV states.
Regulatory Mechanisms - Recommendations

- Regions without ZEV mandates may want to consider implementing such a regulation to similarly signal their intent to accelerate the transition.

- The impact of this could be:
  - Increased vehicle supply and number of vehicle models in state
  - Increase sales of PEVs

- PHEVs and BEVs should be credit base on performance (eVMT, range)

- ZEV works as part of an holistic approach together with purchase incentives and infrastructure development.
Summary
Top Five Key Takeaways

• Making vehicles, infrastructure, and incentives available is not enough to increase awareness and knowledge. A more proactive and widespread approach is needed.

• Financial incentives are more important when approaching main market. Their phase out needs to be carefully considered.

• Reoccurring incentives can have strong regional effects, but they may not be a long term solution (HOV/bus lanes congestion, loss of parking revenue etc.)

• Home location charging is the most frequently used and most influential in purchase decision and vehicle usage. Infrastructure is not a barrier for early market it is an enabler for main market

• The ZEV (and now NEV in China) has regional and international effects on PEV market. Though PEV market success can be archived without this (e.g Norway, Washington State).
Thanks

Acknowledgements

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Contributing Authors

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phev.ucdavis.edu/international-ev-policy-council-policy-briefs

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Plug-in Hybrid & Electric Vehicle Research Center
Additional slides
Removal of incentives
Removal of incentives

Georgia BEV Market Share
Federal Tax Incentive (US$7,500)

- Not at all Important: 6%
- Slightly Important: 6%
- Very Important: 16%
- Moderately Important: 26%
- Extremely Important: 45%

State Rebate (CVRP) (US$2,500)

- Not at all Important: 7%
- Slightly Important: 17%
- Very Important: 28%
- Moderately Important: 45%
- Extremely Important: 45%
A bar chart showing the percentage of respondents who will buy a PEV, Will buy an ICE, or I will not buy a new car for different models:

- **ALL (unweighted sample)**: 71.5%
- **TESLA MODEL S**: 86.1%
- **TOYOTA PRIUS PLUG-IN**: 84.7%
- **FORD FUSION ENERGI**: 82.3%
- **FORD C-MAX ENERGI**: 76.2%
- **CHEVROLET VOLT**: 59.7%
- **NISSAN LEAF**: 50.9%
ZEV Credits

- Toyota Prius Prime PHEV
- 2018 Nissan Leaf
- Chevrolet Bolt
- Tesla Model S (100kwh)

- PHEVs
- BEV (2018-)
- Unblended PHEV (2018-)
- Blended PHEV (2018-)
- 2009-2017 Credits