EV Feasibility Project Basics

• Feasibility and Implications of Electric Vehicle (EV) Deployment and Infrastructure Development
  ▪ Lead Office: FHWA Office of Natural Environment

• Project Team:
Motivation for Research

• Existing highway infrastructure and funding is designed around conventionally fueled vehicles.

• Widespread adoption of EV technologies could have major implications on both of these areas.

• FHWA needs to understand whether future changes in the vehicle fleet have implications for its mission and programs.
Progress to Date

- Completed **literature review** to gather information from academic journals and other publically available sources related to EVs and their deployment.
- Undertook **interviews with industry and government experts** that were flagged as key information holders and reviewed suggested internal agency documents.
- Held **EV Forum** with attendance from ~50 practitioners in the energy, highway, and vehicle sectors to solicit expert input to the technical aspects of the project.
- Developed variables and dependent parameters for the **EV deployment scenarios**.
- Undertook scenario **analysis**, investigating the implications of the EV deployment scenarios on FHWA’s mission and other potential impacts.
- Developed four **case studies** of EV deployment: California Bay Area and Monterey Bay Area; North Carolina Greater Charlotte Region; Oregon I-5 Metro Areas; Texas Greater Houston Area.
- Developed a draft **Final Report**.
- Undertaking **outreach** to key stakeholders at relevant conferences and events.
General Scenario Analysis
Methodology

Numbers of PEVs
BEV to PEV ratio
Average range of BEVs

Average mileage driven for each category
Numbers of each PEV in each vehicle category
Average electric charge per mile for each category

Electricity consumed by PEV fleet for each scenario-year combination

Average volume of gasoline displaced for each kWh of electricity used for each category

Loss of income to Highway Trust Fund

Key

- Data specified in the scenario definitions
- Assumed characteristic
- Calculated implications

Electricity consumed by PEV fleet for each scenario-year combination (from above)
Average characteristics of charging events
Percentage home, Interstate highway and other public charging

The number of charging events & the number of chargers required for
- Interstate highway charging,
- and other public charging

Average characteristics of charging events
## EV Feasibility Project: Deployment Scenario Assumptions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>PEV uptake</th>
<th>BEV/PEV ratio</th>
<th>Average BEV Range</th>
<th>Charging away from home in 2050 (on interstate highways)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>EIA AEO 2013</td>
<td>EIA AEO 2013</td>
<td>EIA AEO 2013 (100 miles)</td>
<td>5.0% (1.0%)</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Value for Scenario 1 multiplied by ~3</td>
<td>EIA AEO 2013</td>
<td>100 miles</td>
<td>5.0% (1.0%)</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Value for Scenario 1 multiplied ~6</td>
<td>Around 25%</td>
<td>150 miles</td>
<td>5.0% (2.0%)</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Scenario 3</td>
<td>Scenario 3</td>
<td>Scenario 3</td>
<td>30.0% (15.0%)</td>
</tr>
<tr>
<td>Scenario 5</td>
<td>“Medium” PEV growth</td>
<td>Scenario 3</td>
<td>150 miles</td>
<td>5.0% 2.0%</td>
</tr>
<tr>
<td>Scenario 6</td>
<td>“Medium” PEV growth</td>
<td>~60% by 2040</td>
<td>180 miles</td>
<td>20.0% (3.0%)</td>
</tr>
<tr>
<td>Scenario 7</td>
<td>“Medium” growth from EPRI + 40%</td>
<td>Scenario 6</td>
<td>180 miles</td>
<td>20.0% (5.0%)</td>
</tr>
<tr>
<td>Scenario 8</td>
<td>“High” PEV growth</td>
<td>Scenario 6</td>
<td>220 miles</td>
<td>30.0% (15.0%)</td>
</tr>
</tbody>
</table>
PEV Deployment Scenarios – Vehicle Numbers

- Scenario 1: Based on AEO 2013 reference case
- Scenarios 2, 3 (& 4): PEV numbers developed for this research between Scenarios 1 and 5
- Scenarios 5 (& 6): Based on EPRI “Medium” PEV growth projections
- Scenario 7: PEV numbers developed for this research between Scenarios 5 and 8
- Scenario 8: Based on EPRI “High” PEV growth projections
BEV and PHEV & REEV Counts by Scenario-year Combination

- Millions of vehicles
- PHEV & REEV
- BEV
- Scenario 1
- Scenario 2
- Scenarios 3 and 4
- Scenario 5
- Scenario 6
- Scenario 7
- Scenario 8

Years:
- 2020
- 2030
- 2040
- 2050
## PEV Categorization

<table>
<thead>
<tr>
<th>Types of PEV - passenger cars</th>
<th>Types of PEV - light trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEV 100-mile range</td>
<td>BEV 100-mile range</td>
</tr>
<tr>
<td>BEV 200-mile range</td>
<td>BEV 200-mile range</td>
</tr>
<tr>
<td>BEV 300-mile range</td>
<td>PHEV 10-mile range</td>
</tr>
<tr>
<td>PHEV 10-mile range</td>
<td>PHEV 40-mile range</td>
</tr>
<tr>
<td>PHEV 40-mile range</td>
<td></td>
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<tr>
<td>PHEV 100-mile range</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing percentage of different PEV types across different years and scenarios]
Scenario Analysis

The eight deployment scenarios analyzed for their potential impacts:

- Public charging infrastructure needed
  - how many? where?
- Number of types of charging events
  - Private, public, Interstate; fast vs slow charge
- Fuel savings/displacement
- Fuel tax revenues
Decrease in annual vol. of gasoline consumed by the U.S. light vehicle fleet due to PEVs

<table>
<thead>
<tr>
<th>Scenario 1 predictions (lower bound) for gasoline displaced by US PEV fleet (millions gallons)</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>414</td>
<td>816</td>
<td>1,524</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 8 predictions (upper bound) for gasoline displaced by US PEV fleet (millions gallons)</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,249</td>
<td>7,007</td>
<td>18,029</td>
<td>27,189</td>
<td></td>
</tr>
</tbody>
</table>

% of US gasoline consumption displaced (see Note 1) | 2020 | 2030 | 2040 | 2050 |
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09–0.99%</td>
<td>0.37–6.27%</td>
<td>0.75–16.57%</td>
<td><strong>1.40–25.00%</strong></td>
<td></td>
</tr>
</tbody>
</table>

PEVs as % light vehicle fleet | 2020 | 2030 | 2040 | 2050 |
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.38–3.34%</td>
<td>1.31–19.05%</td>
<td>2.23–38.78%</td>
<td><strong>3.31–49.67%</strong></td>
<td></td>
</tr>
</tbody>
</table>
Reduction in annual federal fuel tax revenue caused by electric PEV travel by scenario (billion dollars)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sc 1 Baseline</td>
<td>0.002</td>
<td>0.023</td>
<td>0.104</td>
<td>0.186</td>
<td>0.317</td>
</tr>
<tr>
<td>Sc 2 Modest additional growth</td>
<td>0.002</td>
<td>0.079</td>
<td>0.312</td>
<td>0.603</td>
<td>0.966</td>
</tr>
<tr>
<td>Sc 3 Larger additional growth</td>
<td>0.002</td>
<td>0.107</td>
<td>0.611</td>
<td>1.269</td>
<td>2.193</td>
</tr>
<tr>
<td>Sc 4 Larger growth &amp; Interstate highway charging</td>
<td>0.002</td>
<td>0.107</td>
<td>0.611</td>
<td>1.269</td>
<td>2.193</td>
</tr>
<tr>
<td>Sc 5 Based on EPRI medium growth</td>
<td>0.002</td>
<td>0.122</td>
<td>0.927</td>
<td>1.932</td>
<td>3.474</td>
</tr>
<tr>
<td>Sc 6 Based on EPRI medium growth and extended range</td>
<td>0.002</td>
<td>0.128</td>
<td>0.951</td>
<td>1.954</td>
<td>3.250</td>
</tr>
<tr>
<td>Sc 7 Larger growth than Sc 6</td>
<td>0.002</td>
<td>0.192</td>
<td>1.332</td>
<td>2.820</td>
<td>4.170</td>
</tr>
<tr>
<td>Sc 8 Based on EPRI high growth, extended range &amp; highway charging</td>
<td>0.002</td>
<td>0.260</td>
<td>1.755</td>
<td>4.108</td>
<td>5.657</td>
</tr>
</tbody>
</table>
The reduction in revenue relative to a constant 2012 level of ICE fuel efficiency

Slide 13

- ICE Improvement
- EV Scenario 8
- EV Scenario 5
- EV Scenario 1
• Implications for FHWA & DOTs
  • Policy and Legal
    ➢ HOV lane policy
      - Policies exist (and could be expanded) to encourage uptake of PEVs to use HOV lanes - implications for signage and law enforcement
    ➢ MAP-21 and EV charging infrastructure:
      - Clarifies that infrastructure may not be placed in Interstate Rest Areas
      - Creates opportunities for federal financing at fringe or corridor parking facilities (off of the Interstate ROW) with STP funds or other locations with CMAQ funds
      - Implications for location and type of charging infrastructure

- Safety, emergency services, and incident response
  - First responder training needed nationally (ongoing NHTSA and DOE work)
  - ADA standards for charging stations need to be considered
  - Vehicle quietness concern for pedestrians (at low speeds only)
  - Debate about likelihood of EV drivers getting stranded on the side of the road
  - (~1.1% of incidents for “out of gas”)
EV Feasibility Project:
Early Conclusions and Implications

• Implications for FHWA & DOTs
  • HTF Impacts
    - Will have impact on HTF, but not as much as CAFÉ
    - Replacing lost revenue with charging income
      ➢ Vehicle tax
      ➢ Road user fee
      ➢ Other?

• Potential Climate Benefits of PEVs
  - Tailpipe emissions – no GHG or criteria air pollutants
  - Depends on how electricity is being generated
    ➢ Coal
    ➢ Natural gas
    ➢ Nuclear
    ➢ Hydro
For More Information

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Final report should be available on FHWA’s web site Summer 2014