Overview of Electric Vehicle Market Issues in the U.S.

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Contents

• Current status of plug-in electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) in the U.S. market
• U.S. regulatory landscape
• U.S. government incentives
• Market drivers
• Market barriers
• Conclusions
History of EVs in the U.S.

- EVs held at least 30% of the market in 1900
  - EVs disappeared as gasoline became more available and less expensive and gasoline vehicles improved in power, reliability, and cost.
- Small revival during energy crisis in 1970s
- Another revival after initial CA ZEV mandate in early 1990s
  - GM EV1
  - Toyota RAV4 EV
Current U.S. Market Status
EVs and PHEVs in U.S. Market

• Many new vehicle models entering market
  – 2011
    • Two major introductions: Nissan Leaf EV and Chevrolet Volt PHEV
    • Also Tesla Roadster, BMW ActiveE EV and Smart fortwo EV
  – 2012
    • Mitsubishi i EV, Ford Focus EV, Tesla Model S EV, Toyota Prius PHEV, and Fisker Karma PHEV
  – 2013
    • Honda Fit EV, Toyota RAV4 EV, Ford C-Max Energi PHEV, ...

• Total sales remain relatively small
  – 0.1% of overall sales in 2011, 0.2-0.3% of sales in 2012
U.S. Refueling Infrastructure

• Home charging
  – Nationwide, 50-60% of all U.S. households have garages
  – 61% of new vehicle buying households in California have access to an electrical outlet within 50 feet of parking location
  – Level 1 (120 v) systems can work for PHEVs
  – Level 2 (240 v) are best for EVs
    • GE WattStation sold to consumers for $1,000 plus installation

• Public charging stations
  – About 4500 public charging stations in U.S.
  – Mostly Level 2 (240 v) systems, a few Level 3 (480 v) systems
Utility Programs in U.S.

• Promoting consumer interest
  – Offering new pricing options
    • Lower rates for nighttime charging
    • Dedicated meters with lower rates for home charging
    • Fixed monthly price for unlimited EV charging at public stations
  – Free or reduced price Level 2 charging stations and home installation

• Evaluating potential impacts on electric grid
  – Distribution infrastructure (e.g., transformers)
  – “Smart charging” and vehicle-to-grid technology

• Operating EV/PHEV fleets for research purposes

• Collaborating with cities, local governments, and other stakeholders on plug-in vehicle readiness planning
Lifecycle GHG Emissions Performance
(Real world, based on EPA eGRID2012)

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<tbody>
<tr>
<td>2012 Cruze</td>
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<tr>
<td>2012 Leaf EV</td>
<td>Gas</td>
<td></td>
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<tr>
<td>2012 Volt PHEV</td>
<td>Gas/Elec.</td>
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GHG Emissions (grams CO2e/mile)

- Upstream Emissions
- Tailpipe Emissions
U.S. Regulatory Landscape
U.S. Health-Related Emissions Standards

• U.S. (EPA and the California Air Resources Board) was the global pioneer in reducing automotive health-related pollution in the 1970s and 1980s

• EPA “Tier 2” standards now in effect represent 98-99% reductions, relative to 1970, for hydrocarbons, carbon monoxide, and oxides of nitrogen emissions
  – Technologies such as fuel injection and on-board electronic controls have led to cars that are not only cleaner, but better performing and more reliable and durable as well

• EPA considering future “Tier 3” standards that could tighten both vehicle and fuel standards

• Unlikely to have major effect on future EV market
## U.S. National Program GHG/CAFE Standards
(www.epa.gov/otaq/climate/regulations.htm)

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<th>MY 2010 Baseline</th>
<th>MY 2016 Standards</th>
<th>MY 2025 Standards</th>
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<tbody>
<tr>
<td>GHG emissions</td>
<td>351 g/mi (218 g/km)</td>
<td>250 g/mi (155 g/km)</td>
<td>163 g/mi (101 g/km)</td>
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<tr>
<td>Fuel economy</td>
<td>25.3 mpg (9.3 L/100 km)</td>
<td>34.1 mpg (6.9 L/100 km)</td>
<td>49.6 mpg (4.7 L/100 km)</td>
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# U.S. National Program

## GHG Compliance Incentives for EV/PHEVs

<table>
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<tr>
<th>Timeframe</th>
<th>GHG Emissions Compliance Treatment for Grid Electricity</th>
<th>Compliance Multiplier</th>
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<tbody>
<tr>
<td>2012-2016</td>
<td>Below sales limit: 0 grams/mile Above sales limit: Net upstream</td>
<td>None</td>
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<tr>
<td>2017-2021</td>
<td>0 grams/mile</td>
<td>EV: 2.0 ... 1.5 PHEV: 1.6 ... 1.3</td>
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<tr>
<td>2022-2025</td>
<td>Below sales limit: 0 grams/mile Above sales limit: Net upstream</td>
<td>None</td>
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U.S. National Program
Net Upstream GHG Approach for EVs

• Measure vehicle electricity consumption over EPA city and highway test cycles in watt-hours/mile
• Divide value by 0.935 to reflect transmission losses to reflect electricity needed at the electric powerplant
• Multiply value by 0.534 grams/watt-hour to reflect EPA projection of overall electricity upstream GHG emissions (both powerplant and feedstock) associated with extra electricity demand for EVs/PHEVs in 2030
• Subtract the upstream GHG emissions of a gasoline vehicle with the same footprint meeting its CO₂ target
CAFE Treatment for EVs

• Based on “petroleum equivalency factor” per DOE regulations, reflecting that little or no oil is used in U.S. electricity generation

• CAFE rating = 82,049 Wh/gal divided by electricity consumption in Wh/mile over EPA tests
  – Nissan Leaf uses 238 Wh/mile, so CAFE = 347 miles/gallon
California ZEV Program
(www.arb.ca.gov)

• Originally established in 1990 to require a fraction of sales of advanced technology vehicles with zero or near-zero health-related emissions
  – Mostly met by ultra-low emissions gasoline and hybrid cars
  – Smaller number of EVs, often “Neighborhood EVs”

• Evolving to greater focus on vehicles that use fuels with “zero emission” tailpipe GHG emissions
  – Grid electricity and hydrogen

• Compliance based on credit system reflecting technology, EV range, hydrogen fuel cell storage pressure, etc.

• EPA currently reviewing “waiver” for 2018-2025 that could be met by, for example, 13% EV 100 and 4% PHEV
  – Or fewer fuel cell vehicles, or EVs with longer range
U.S. Fuel Economy & Environment Label

- Starting with model year 2013, all new passenger cars and trucks sold in the United States are required to have the revised fuel economy & environment label.
  - The label’s metrics and design enable consumers to compare across technologies (gas, diesel, EV, PHEV, FCV, CNG).

More information, including upstream GHG emissions estimates, are available on joint DOE-EPA website.
U.S. Government Incentives
U.S. DOE Funding to support EVs/PHEVs

• American Recovery and Reinvestment Act of 2009
  – $2 billion in grants for advanced battery manufacturing and recycling & electric drive component manufacturing
  – $400 million for transportation electrification program to install charging infrastructure and purchase EVs/PHEVs for demonstrations—The EV Project
    • 20+ cities
    • Over 8000 Evs and PHEVs
    • 14,000 Level 2 chargers and 300 Level 3 chargers
    • Data at http://avt.inl.gov/evproject.shtml

• Recent Research & Development programs
  – EV Everywhere Grand Challenge, announced March, 2012
    • Goal to enable US companies to develop an EV that is cost competitive with conventional vehicles (payback < 5 years) and has a range that meets average Americans’ needs by 2022
    • Working with industry, academia, state and local governments, and other stakeholders
  – $4 million to develop a wireless charging system for EVs, announced April 2012
  – $43 million for breakthrough energy storage technologies for electric vehicles and the grid
    • through the DOE’s Advanced Research Projects Agency-Energy, announced Aug 2012

• Advanced Technology Vehicles Manufacturing Loan Program
  – Loans help fund domestic manufacturing facilities for EVs and batteries (as well as other advanced technology vehicles)
  – $25 billion authorized, $8,4 billion spent so far
U.S. EV/PHEV Tax Credits

• Primary economic incentive to promote consumer interest in EVs/PHEVs

• Federal tax credit
  – $2500 credit for EV/PHEV with battery capacity of 4 kWh
  – Credit increases by $417 for every kWh in excess of 4 kWh
  – Maximum credit of $7500 for battery capacity of 16+ kWh
  – Credit begins to phase down after a manufacturer’s cumulative EV/PHEV sales reaches 200,000 units

• Some individual states also offer EV/PHEV tax credits
  – Highest credit is $5000 in Georgia
  – California state incentive ended June 30, 2012
HOV Lane Access in U.S.

• Primary non-economic incentive to promote consumer interest in EVs/PHEVs
• High-occupancy vehicle (HOV) lanes are normally restricted to vehicles carrying a certain minimum number of passengers to encourage car-pooling
• 11 states allow EV and PHEV drivers to use HOV lanes
  – Including California, New York, New Jersey, Florida, Illinois, Virginia, and Maryland
• In some areas, this can be a very powerful incentive
Fuel Road Taxes in U.S.

• U.S. fuel taxes
  – Federal: 18.4 cents per gallon
  – State: vary, but typically average about 30 cents per gallon

• Vehicles that use electricity generally pay no fuel taxes
  – One state, Washington state, has a $100 annual EV tax

• This yields an annual benefit of about $250 relative to a gasoline car that pays fuel taxes, or $2500 over a 10-year period
U.S. Market Drivers and Barriers for EVs
U.S. Market Drivers

• Direct benefits to vehicle owner
  – Fuel prices
    • Much lower
    • Much more predictable
  – Refueling
    • Can do so at home and avoid gasoline stations
  – Reduce personal oil use and carbon emissions
  – No tailpipe/noise may be perceived as more “elegant”

• Collective societal benefits
  – Large carbon savings, especially if electric grid is transformed to low-carbon feedstocks
  – Large oil savings can also reduce oil prices, reduce trade deficit, and keep more dollars in local economies
U. S. Market Barriers

- Much higher vehicle cost, due primarily to batteries
- Vehicle range
  - Lower
  - More variable due to climate and driving behavior
- Inconvenience and flexibility
  - Loss of peak vehicle utility
  - Longer refueling time
  - Greater need for household planning for vehicle use
- Lack of widespread public charging infrastructure
- Consumer reluctance to try very different car technology
- Cost and challenge of transforming electric grid to low-carbon feedstocks
Perspective

• EVs are a “bigger change” than any other alternative vehicle technology option for the U.S. market
• U.S. gov’t has done more to promote EV/PHEVs than other advanced technologies, but sales remain low so far
• It is impossible to predict whether EVs will be successful
  – Plausible that EVs will gain only a very small market share, e.g., as a second or third “city car” for high-income families
  – Plausible that EVs will become a mainstream competitor and the “technology of choice” for those consumers who want to nearly zero out their oil and carbon footprints
• Major determinants of future EV success in U.S.
  – Oil prices
  – Battery innovation and cost
  – Ability to transform U.S. electric grid to low-carbon feedstocks
  – Cultural attitudes toward oil and carbon
Thank You

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