The Future of the Auto Industry: An OEM Perspective

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General Motors
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Plug-in Electric Vehicles (PEVs):
Includes PHEVs, EREVs and BEVs

- **PHEV**: Plug-in Hybrid Electric Vehicle
  - Chrysler Pacifica Hybrid
  - Prius Prime
  - Ford C-MAX Energi
  - Ford Fusion Energi

- **EREV**: Electric Vehicle with “Extended-Range”
  - Chevrolet Volt
  - Cadillac CT6

- **BEV**: Battery Electric Vehicle
  - Chevy Bolt EV
  - Nissan Leaf
  - Tesla S
  - BMW i3

- Mileage:
  - 10-30 EV miles
  - 40-60 EV miles
  - 80-250 EV miles
The Importance of 40 miles of Daily Electric Driving

Based on U.S. Department of Transportation 2003 Omnibus Household Survey

78% of customers commute 40 miles or less daily.

Why Target 40 Miles? 40 Miles Is the Key to Daily Driving
EV ADOPTION IS HERE TO STAY

- Innovators
- Early Adopters
- Early Majority
- Late Majority
- Laggards
# 1st to 2nd Generation EREV Improvements: Chevrolet Volt

<table>
<thead>
<tr>
<th>Metric</th>
<th>1st Gen Volt</th>
<th>2nd Gen Volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV Range (miles)</td>
<td>38</td>
<td>53</td>
</tr>
<tr>
<td>Total Range (EV+gas miles)</td>
<td>382</td>
<td>420</td>
</tr>
<tr>
<td>Fuel Economy (gas mpg)</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td>Battery (kWh)</td>
<td>16.5</td>
<td>18.4</td>
</tr>
<tr>
<td>Passenger Capacity</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>0 to 30</td>
<td>3.4 sec*</td>
<td>2.6 sec</td>
</tr>
<tr>
<td>0 to 60</td>
<td>9 sec</td>
<td>8.4 sec</td>
</tr>
<tr>
<td>Torque (ft-lb)</td>
<td>273</td>
<td>294</td>
</tr>
<tr>
<td>Charger (kW)</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>EV-only Trips</td>
<td>80%</td>
<td>90% (exp)</td>
</tr>
<tr>
<td>Miles between gas fill-ups</td>
<td>900</td>
<td>1000 (exp)</td>
</tr>
</tbody>
</table>

* Edmunds
## 1st to 2nd Generation BEV Improvements: Chevrolet Bolt EV

<table>
<thead>
<tr>
<th>Metric</th>
<th>1st Gen EV (Spark EV)</th>
<th>Metric</th>
<th>2nd Gen EV (Bolt EV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV Range</td>
<td>82 miles</td>
<td></td>
<td>238 miles</td>
</tr>
<tr>
<td>Battery</td>
<td>19 kWh</td>
<td></td>
<td>60 kWh</td>
</tr>
<tr>
<td>Passenger Capacity</td>
<td>4</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Passenger Volume</td>
<td>86.3 ft³</td>
<td></td>
<td>94.4 ft³</td>
</tr>
<tr>
<td>0 to 30</td>
<td>3 sec</td>
<td></td>
<td>&lt; 3</td>
</tr>
<tr>
<td>0 to 60</td>
<td>7.2 sec</td>
<td></td>
<td>&lt; 7</td>
</tr>
<tr>
<td>Charger</td>
<td>3.3 kW</td>
<td></td>
<td>7.2 kW</td>
</tr>
<tr>
<td>Availability</td>
<td>3 states</td>
<td></td>
<td>50 states</td>
</tr>
</tbody>
</table>
Bolt EVs at GM’s Lake Orion Assembly Plant (MI)
Year-over-Year Growth in the U.S. EV Market

- EV sales in the US have risen for 21 consecutive months.
- 38% EV sales growth in 2017 over 2016 (~89,285 vs. ~64,552)

U.S. Plug-In Car Sales (data through June 2017) – insideEVs.com
A Robust EV Market Benefits Everyone … at scale

• **Individual Benefits**
  – Quiet and exciting ride & handling
  – Fuel savings
  – Ability to “fill up” at home

• **Societal Benefits**
  – Economy (local spending, local jobs)
  – Environment (local air, climate)

• **Utility / Grid Benefits**
  – Load *growth* that’s “flexible”
  – Renewable energy integration
  – Downward pressure on rates

Scale Matters!
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  - Ability to “fill up” at home

- Societal Benefits
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  - Renewable energy integration
  - Downward pressure on rates

Data source: DOE’s INL EV Project Reports - https://avt.inl.gov/content/pubs-az#E
**CHARGING DETAILS**

**Level 1 - 120 volt**
- Up to 4 miles per hour of charge
- 120v charge cord comes standard
- Opportunity/top up charging

**Level 2 - 240 volt**
- Up to 25 miles per hour of charge
- AeroVironment 240 volt/32 amp
- Available via GM Accessories
- Public & workplace charging

**DC Fast Charge**
- Up to 90 miles in about 30 minutes of charge
- Public stations only
- Great for road trips; stop for lunch/coffee to recharge
### EV Awareness – 2 Key Findings

#### Electric Vehicle Finding 1: Perceptions

A lack of awareness, price and “range anxiety” represent the current main barriers to mainstream EV adoption (assuming vehicles were available)

<table>
<thead>
<tr>
<th>Perception</th>
<th>% of all respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t know or know very little, 60%</td>
<td></td>
</tr>
<tr>
<td>Know about but won’t buy, 27%</td>
<td></td>
</tr>
<tr>
<td>Own an EV, 3%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Importance</th>
<th>% of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of charging stations</td>
<td>45%</td>
</tr>
<tr>
<td>Too expensive</td>
<td>41%</td>
</tr>
<tr>
<td>Duration of Charge</td>
<td>35%</td>
</tr>
<tr>
<td>Dislike feel of EV</td>
<td>29%</td>
</tr>
<tr>
<td>Lack of noise</td>
<td>28%</td>
</tr>
<tr>
<td>Be eco-friendly</td>
<td>20%</td>
</tr>
<tr>
<td>Save money on gas</td>
<td>18%</td>
</tr>
<tr>
<td>EVs make less noise</td>
<td>15%</td>
</tr>
<tr>
<td>Experience auto tech innovation</td>
<td>13%</td>
</tr>
<tr>
<td>Like feel of EV</td>
<td>10%</td>
</tr>
</tbody>
</table>

#### 2 Key Findings:

- **60%** know little/nothing about EVs
- **Of the 27% that know something about EVs, 85% would not consider an EV because there is not enough EV infrastructure**

(Next reasons were expense and time-to-charge)

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**Source:** AVL&Co, Connected Car Survey, 2016, N = 2,562 respondents. Questions “knowledge,” “w/purchase,” “not purchase”
MAVEN CITY
Round-Trip Car Sharing

NUMBER OF CITIES
14 and counting

AVERAGE TRIPS
~14 Hours
~80 Miles

FAVORITE CARS
Chevrolet Volt
Chevrolet Tahoe

MAVEN HOME
Exclusive closed-community car-sharing

AVAILABLE IN
Residences in DC, San Francisco + growing.
(Multiple non-exclusive properties as well)

AVAILABLE TO
> 8,000 Residents and counting

MAVEN GIG
Solutions for the Gig Economy – Ridesharing, Delivery Services.
Short-term rental includes vehicle, maintenance, insurance.

AVAILABLE IN
11 Cities

MILES DRIVEN
143 Million
• Program designed, in part, to help new drivers and new riders get exposure to EVs
• Ride-sharing drivers typically do not have charging at home, so they must leverage public charging
• Building confidence through the infrastructure network (among other things) is critical for long-term success

GIG / BOLT EV MILEAGE
>1.4 million miles driven

GIG / BOLT EV CHARGING
Total DCFC Events >14,000
Total kWh >400,000

GIG / BOLT EV RIDERS
>140,000

Since Early Feb 2017
$14mil investment in Cruise Automation

Expanding 50-vehicle Bolt EV fleet of self-driving vehicles to 180

Operating in San Francisco, Scottsdale, AZ, and in the Detroit area
Largest existing auto-utility collaborative effort -- formed in 2007
Over 50 utility members and the Electric Power Research Institute (EPRI)
Focus areas: Aligned Messaging and Policy Priorities, Customer Outreach and Infrastructure, Vehicle-to-Grid Technology, New Business Opportunities
DC Fast-Charging: Major Gaps

U.S. : 1,156 SAE DCFC

Source: https://www.afdc.energy.gov/fuels/electricity_locations.html
DC Fast-Charging: Major Gaps

- **Michigan:** 13 SAE DCFC
- **Florida:** 55 SAE DCFC
- **Texas:** 54 SAE DCFC
DC Fast-Charging: Major Gaps

Michigan: 13 SAE DCFC

Florida: 55 SAE DCFC

Texas: 54 SAE DCFC

255 mi

282 mi

257 mi

239 mi

635 mi
## EV Infrastructure – Where, What, Why Guidance

<table>
<thead>
<tr>
<th></th>
<th>Home</th>
<th>Work</th>
<th>Public</th>
<th>Commercial</th>
<th>Commuting</th>
<th>Road Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single Family Home</td>
<td>Multi-Unit Dwelling</td>
<td>Workplace Charging</td>
<td>Short-dwell public</td>
<td>Mid-dwell public</td>
<td>Long-dwell public</td>
</tr>
<tr>
<td>Parking/Charging description</td>
<td>Overnight</td>
<td>Overnight</td>
<td>Work shift</td>
<td>1-2 hours</td>
<td>4-8 hours</td>
<td>1-X days</td>
</tr>
<tr>
<td>... e.g.</td>
<td>... condos, apartments</td>
<td>... retail</td>
<td>... parks, beaches</td>
<td>... airports</td>
<td>... airports</td>
<td>... airports</td>
</tr>
<tr>
<td>Near-term</td>
<td>L1 or L2 (L2 recom’d)</td>
<td>Neighborhood L2 and DC (50kW)</td>
<td>L1 or L2</td>
<td>L2</td>
<td>L2</td>
<td>L1 or L2</td>
</tr>
<tr>
<td>Long-term</td>
<td>L1 or L2 (L2 recom’d)</td>
<td>L1 or L2 at Multi-Unit Dwelling</td>
<td>L1 or L2</td>
<td>L2</td>
<td>L2</td>
<td>L1 or L2</td>
</tr>
<tr>
<td>Importance to Consumers</td>
<td>Where most charging is done</td>
<td>Need to grow EV market to these consumers</td>
<td>Where many consumers see EVs for the 1st time (EV Showcase) and most use charging after “home”</td>
<td>Nice perk (and retailers benefit from increased in-store dwell time)</td>
<td>Increases practicality of EVs (the number of places an EV can go)</td>
<td>Increases practicality of EVs (especially among early adopters/professionals)</td>
</tr>
</tbody>
</table>

- Note, Professional installation of L1, L2 and DC is always recommended
- Note, Future 150-350kW SAE fast-chargers will be backward compatible, allowing 50kW EVs to charge

Station redundancy is especially important
VW Settlement: Appendix C and D EV Infrastructure Opportunity

“Appendix C”
- National program ($2Bil) for EV infrastructure, EV awareness, and Green City (Sacramento)
- Cycle 1 (of 4) = 2,500 EV chargers at 450 sites
  - Highway Corridors (4-10 chargers/site); 38 states; 150kW or 350kW; 70-120 miles apart
  - 17 Metro/Urban Cities (workplace, MDU, retail, municipal lots/garages); L2, 50kW, 150kW

“Appendix D”
- 50-state program ($2.7-2.9Bil)
- Each state must “claim” the settlement
- Each state allowed to use max 15% for EV infrastructure
Where should Utilities engage?

1. Engage actively in home, workplace and DC fast-charging
   • Most charging at home, so this is a way to reach all consumers (including those in multi-dwelling units)
   • Workplace charging is key to growing EV awareness and corporate relationships are key to utilities
   • A visible strategy of DC fast-chargers tells a big story to consumers and grows EV adoption among fence-sitters

2. Ensure electricity is cheaper than gasoline (residential and commercial) – incl. demand charges

3. Engage actively in PEV outreach and education
   • Utilities are trusted 3rd parties and operate at a local level – key for building awareness

Utilities need to be active participants in growing the PEV market
   • This is a “learning” transition requiring hands-on experience to shape next steps
   • The PEV market will not escape “niche” unless utilities (and regulators) get involved
What will it take to Grow the PEV Market?

• Drive Consumer Demand!
  – Keep a Laser-like Focus on the Vehicle (don’t get distracted by other “metrics”)
  – Build Awareness through:
    • Promotional Campaigns (that really get to new car buyers)
    • Ride & Drives ("Butts-in-Seats")

• Install Charging Infrastructure at a faster pace (incl. role for utilities)
  – Address the “Perception” that there isn’t enough infrastructure
    • Public DC Corridors (SAE Combo)
    • Workplace Charging

• Affordability/Incentives
  – Help make these vehicles more affordable for mainstream consumers:
    • Through incentives, help make this an easy choice, until OEMs can get more cost out of the technology
    • Stay steady until we reach a meaningful tipping point
Thank you!