REAL-WORLD CHARGING BEHAVIOR OF BATTERY ELECTRIC VEHICLE DRIVERS WITH ACCESS TO WORKPLACE CHARGING

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U.S. Department of Energy (DOE) federal laboratory
890 square mile site with 4,000 staff

Support DOE’s strategic goal

- Increase U.S. energy security and reduce the nation’s dependence on foreign oil

Multi-program DOE laboratory

- Nuclear Energy
- Renewables and Hybrid Energy Systems
- Advanced Vehicles, Batteries, Fuels, and Infrastructure
- Unmanned Aerial Systems and Autonomous Vehicles
- Cyber Security
The world’s largest EV infrastructure deployment project

Objectives:
• Build mature EV charging infrastructure in 17 US regions
• Study:
  – Infrastructure deployment process
  – Customer driving and charging behavior
  – Impact on electric grid
• 12,000+ AC level 2 charging units, 100+ DC fast chargers
• 8,000+ electric drive vehicles
• Project partners:
Charging Units Reporting Data Nationally

- 107 DC Fast Charge
- 443 Private Nonresidential AC Level 2
- 3,555 Publicly Accessible AC Level 2
- 8,251 Residential AC Level 2
- 12,356 Total
How Are Leaf and Volt Drivers Using Public Charging Infrastructure?

- PEV drivers who charge away from home tend to have 1 or 2 “favorite” charging locations
- For many drivers, a favorite charging location could be work
• 250 work sites identified with workplace charging available
• 700+ Nissan Leafs and ~100 Chevrolet Volts in The EV Project who park at these sites
• Data from 2012 - 2013
Where do Leaf and Volt drivers with access to workplace charging choose to charge? (Jan 2012 - Dec 2013)

**Nissan Leafs (707 Vehicles)**
- Home: 65%
- Work: 32%
- Other: 3%

**Chevrolet Volts (96 Vehicles)**
- Home: 57%
- Work: 39%
- Other: 4%

**Overall Charging Frequency by Location (to scale)**

**Percent of Charging Events by Location and Day**

- **Workdays**
  - Home: 92%
  - Work: 42%
  - Other: 56%

- **Non-workdays**
  - Home: 8%
  - Work: 8%
  - Other: 2%
How did Leaf drivers use workplace charging?

• Answer the question:
  – Are there drivers that need workplace charging?

• Address the common assumption:
  – If drivers have access to home and work charging, they will charge at home and “top off” at work
How did Leaf drivers use workplace charging?

- 14% of Leafs studied needed to charge at work in order to complete their daily commute on most days
- On these days, they charged at home and topped off at work as expected
How did Leaf drivers use workplace charging?

- Leaf drivers who did not need workplace charging on most days had varying behavior.
Assumption: if you need it, you need it; if you don’t, you don’t
- 14% of vehicles needed workplace charging on *most* days, but...
- 43% of vehicles needed workplace charging to complete their daily driving on *some* days

**Percent of vehicles needing to charge at work on at least 50% of days**

- 14% Needed
- 86% Not Needed

**Percent of vehicles needing to charge at work on at least 5% of days**

- 43% Needed
- 57% Not Needed
Does workplace charging increase electric vehicle miles traveled?

- On days when Leaf drivers needed to charge at work, workplace charging extended their range by an average of 15 miles.
- Round-trip commutes on these days averaged 73 miles.
- On days when drivers did not need workplace charging but used it, they averaged 12% more miles than on days when they did not charge at work.
How often did drivers charge at work?

• Assumption: if they can charge at work, they will
• A study of Leaf and Volt parking and charging at 6 work sites showed dramatic differences from site to site

Days With and Without Charging

[Bar chart showing percentage of days not charged (red) and charged (blue) for six companies (A to F).]
How often did drivers charge at work?

- Differences were also seen from vehicle to vehicle at the same site.
What determines whether drivers will charge at work?

From 47 Leafs, 5 Volts at 6 worksites
What determines whether drivers will charge at work?

Summary of Factors Influencing Workplace Charging Frequency

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<tr>
<th>Round-trip Commute Distance (mi)</th>
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<tr>
<td>100</td>
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<th>Company</th>
<th>% Days Not Charged</th>
<th>% Days Charged</th>
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<td>B</td>
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<td>C</td>
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<td>E</td>
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<td>F</td>
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<tr>
<th>Company</th>
<th>Round-trip commute distance</th>
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<td>A</td>
<td>Max vehicle avg</td>
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<tr>
<td>B</td>
<td>Overall average</td>
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<td>C</td>
<td>Min vehicle avg</td>
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Cost

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<th>Cost per hour</th>
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<td>Cost per hour</td>
<td>Cost per kWh</td>
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<td>Policy</td>
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<td>Move after charged (unenforced)</td>
<td>Move after charged (enforced)</td>
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<td>1.1</td>
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Lessons learned white papers related to workplace charging:

- Where do Nissan Leaf drivers in The EV Project charge when they have the opportunity to charge at work?
- Where do Chevrolet Volt Leaf drivers in The EV Project charge when they have the opportunity to charge at work?
- Workplace Charging Case Study: Charging Station Utilization at a Work Site with AC Level 1, AC Level 2, and DC Fast Charging Units
- Workplace Charging Behavior of EV Project Drivers at Six Work Sites (in review)
- Driving and Charging Behavior of Nissan Leaf Drivers in The EV Project With Access to Workplace Charging

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