Workplace Lessons Learned through the Nation’s Largest PEV Charging Projects

DOE Workplace Charging Challenge Summit
Alexandria, VA

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Idaho National Laboratory

• 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
  – Fossil, Biomass, Wind, Geothermal and Hydropower Energy
  – Advanced Vehicles and Batteries
  – Homeland Security and Cyber Security
INL was a primary partner in two national electric vehicle charging infrastructure demonstrations

The EV Project

- Purpose is to build mature EV charging infrastructure in 17 US regions and 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
  - INL data collection Jan 2011 – Dec 2013

- Project partners:

ChargePoint America

- Deploy 4,700+ residential and public AC level 2 charging units in 11 US regions
- Study customer usage of residential and public infrastructure
- INL data collection May 2011 – Dec 2013
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
Infrastructure Deployment in ChargePoint America through December 2013

Charging Units* Reporting Data Nationally

- 39 Not specified
- 264 Private Nonresidential
- 2,508 Publicly Accessible
- 1,836 Residential
- 4,647 Total

* All units are AC Level 2
Dual-port units count as 2 units

Legend:
- Yellow: Not Specified
- Blue: Private Nonresidential
- Green: Residential
- Red: Publicly Accessible
Workplace Charging Analysis

- 250 work sites identified with workplace charging available
- 600+ Nissan Leafs and 100+ Chevrolet Volts in The EV Project who park at these sites
- 2012 – 2013
Workplace Charging Analysis

3 ways to look at data
1. Charging station usage at a work site
Workplace Charging Analysis

2. Parking and charging at a work site by vehicles reporting data
Workplace Charging Analysis

3. Vehicle driving and charging throughout the day
Where did PEV drivers with access to workplace charging choose to charge?

Nissan Leafs

Overall Charging Frequency by Location (to scale)

- Home - 65%
- Work - 32%
- Other - 3%

Percent of Charging Events by Location and Day

- Workdays:
  - Home: 56%
  - Work: 42%
  - Other: 2%

- Non-workdays:
  - Home: 92%

Legends:
- Other
- Work
- Home
Where did PEV drivers with access to workplace charging choose to charge?

Chevrolet Volts

Overall Charging Frequency by Location (to scale)

- Home - 57%
- Work - 39%
- Other - 4%

Percent of Charging Events by Location and Day

- Workdays:
  - Other: 2%
  - Work: 50%
  - Home: 48%

- Non-workdays:
  - Other: 11%
  - Work: 89%
How much did PEV drivers charge at work vs. home?

- Common assumption: If drivers have access to home and work charging, they will charge at home and “top off” at work.
How much did PEV drivers charge at work vs. home?

- 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 much did PEV drivers charge at work vs. home?

- Leaf drivers who did not need workplace charging on most days had varying behavior

![Pie chart showing battery charging behaviors]

- Fully charged at home and topped off at work on most days: 35%
- Partially charged at home and topped off at work on most days: 29%
- Only charged at work on most days: 29%
- Mixed: 17%

4% of drivers did not participate in the survey.
How many drivers needed to charged at work to complete their commutes?

• Assumption: if you need it, you need it; if you don’t, you don’t
• 14% of vehicles needed workplace charging to complete their daily driving 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%
Percent of vehicles needing to charge at work on at least 5% of days: 43%

86% Not Needed
57% Not Needed
Does workplace charging increase electric vehicle miles traveled?

Yes!

• 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

- % Days Not Charged
- % Days Charged

![Chart showing days with and without charging for different companies]
How often did drivers charge at work?

• ... and from vehicle to vehicle at the same site
What determines whether drivers will charge at work?

From 47 Leafs, 5 Volts at 6 worksites

Correlation to commute distance only on high end

Some correlation to free/cost

Ratio of vehicles to charging units, policy for use, and other factors also matter also – see paper
Which is better: AC Level 1, Level 2, or DC Fast Chargers

- Know your vehicles – charge power varies by vehicle
  - Toyota Prius Plug-in charges at only 2 kW
  - Thus far, only BEVs can use DCFC and connectors differ
- L2:
  - Can charge multiple vehicles per day
  - Provides option of managing load
- L1:
  - Employees can plug in and forget it
  - Cheaper equipment but probably same to install
  - Lower overall electricity demand
- DCFC:
  - Provides flexibility, good for “emergencies”
  - Expect visitors
  - Expensive (but do the math)
What policy should employers adopt to manage charging?

It depends on your goals!
For more information, visit

avt.inl.gov/evproject.shtml

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 (in review)

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