Electric Vehicle Charging Infrastructure Usage Observed in Large-scale Charging Infrastructure Demonstrations – ARB

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Plug-in Electric Vehicle Infrastructure Information Gathering Meeting
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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 Battery Testing
  – Homeland Security and Cyber Security
INL is a primary partner in two national electric vehicle (EV) 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:
- Not Specified
- Private Nonresidential
- Residential
- Publicly Accessible
Outline

• How has public AC level 2 EVSE and DC fast charger (DCFC) usage changed over time?
  – What was the impact of implementing payment for use of DCFC

• Did Leaf driving behavior change as public infrastructure usage changed?
  – Electric vehicle miles traveled (eVMT)
  – Time at DCFCs

• Which stations are used most frequently?
  – Free vs. fee by venue
  – Mix of charging at home/workplace/other locations
**Public EVSE Usage Fees**

**Blink usage fees**

- Public AC Level 2 fees started Jul – Aug 2012
  - Varies from $1.00 to $2.00 *per hour connected*
  - 16% of sites were still free as of Dec 31, 2013 (per local site host discretion)

- DC Fast Charger fees started Jul 2013
  - $5 for Blink member / $8 for non-member *per session*

**ChargePoint usage fees**

- Vary by site (per local site host discretion)
- Many are free
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

**Charging Frequency by EVSE Type**

- **Blink DCFC**
- **ChargePoint Residential**
- **Blink Residential**
- **ChargePoint Public L2**
- **Blink Public L2**

**Charging Energy by EVSE Type**

- **Blink DCFC**
- **ChargePoint Residential**
- **Blink Residential**
- **ChargePoint Public L2**
- **Blink Public L2**
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type

Number of charging events per EVSE day

- Blink DCFC
- ChargePoint Residential
- Blink Residential
- ChargePoint Public L2
- Blink Public L2

Q4 2012 - Q4 2013
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type

Roll-out of Blink DCFC usage fees during Q3

Number of charging events per EVSE day

Q4 2012 | Q1 2013 | Q2 2013 | Q3 2013 | Q4 2013

- Blink DCFC
- ChargePoint Public L2
- Blink Public L2
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers by Region

Charging Frequency by EVSE Type and Region

- Blink DCFC
- ChargePoint Public L2
- Blink Public L2

Number of charging events per EVSE day

Q4 2012 | Q1 2013 | Q2 2013 | Q3 2013 | Q4 2013
Usage Frequency of Individual DC Fast Chargers

Monthly Average Number of Charging Events per Day for Each DCFC

Usage of most DCFCs dropped when payment started

DCFCs with sustained high usage:
- Workplace
- Small Retail Tacoma - I5
- Workplace
- Parking lot Seattle downtown
- Fred Meyer North Seattle
- Workplace
Total Energy Consumption at Blink Stations in San Francisco

Energy Consumed by Public Level 2 EVSE and DCFC in San Francisco Region by Month

- **Energy Consumed by Blink DCFC**
- **Energy Consumed by Blink Public Level 2 EVSE**
- **Number of Blink DCFC**
- **Number of Blink Public Level 2 EVSE**
Total Energy Consumption at Blink and ChargePoint Stations in San Francisco

Energy Consumed by Public Level 2 EVSE and DCFC in San Francisco Region by Month

- Energy Consumed by Blink DCFC
- Energy Consumed by Blink Public Level 2 EVSE
- Energy Consumed by ChargePoint Public Level 2 EVSE
- Number of Blink DCFC
- Number of Blink Public Level 2 EVSE
- Number of ChargePoint Public Level 2 EVSE
Leaf eVMT in San Francisco

San Francisco EV Project Leaf eVMT vs. Blink DCFC Usage in San Francisco

Aggregate eVMT does not appear to be tied to DCFC usage
Energy per Charging Event Over Time

- DCFC events were longer after the introduction of payment
- Flat fee per session may prompt an “all-you-can eat” mentality
Top 10 Most Highly Used Free Public Level 2 Blink EVSE Sites by Venue

- **Workplace**: Longest bar indicating the highest usage.
- **Transportation Hub**: Moderate usage.
- **Retail**: Low usage.
- **Public Municipal**: Moderate usage.
- **Parking Lots/Garages**: Low usage.
- **Multi-Family**: Very low usage.
- **Medical**: Very low usage.
- **Leisure Destination**: Very low usage.
- **Hotels**: Low usage.
- **Fleet**: Moderate usage.
- **Education**: Low usage.

**Average number of charging events per site per week**
Top 10 Most Highly Used For-Cost Public Level 2 Blink EVSE Sites by Venue

- Workplace
- Transportation Hub
- Retail
- Public Municipal
- Parking Lots/Garages
- Multi-Family
- Medical
- Leisure Destination
- Hotels
- Fleet
- Education

Average number of charging events per site per week
Top 10 Most Highly Used For-Cost / Free Public Level 2 Blink EVSE Sites by Venue

Average number of charging events per site per week
Top 10 Most Highly Used **For-Cost** Blink DCFC Sites by Venue

- Workplace
- Transportation Hub
- Retail
- Public Municipal
- Parking Lots/Garages
- Multi-Family
- Medical
- Leisure Destination
- Hotels
- Fleet
- Education

**Average number of charging events per site per week**
Charging Location Preference – Nissan Leaf

707 Nissan Leafs with Access to Workplace Charging, 2012 – 2013

Overall Charging Frequency by Location (to scale)

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

Careful!
How important is this 3% to individual drivers’ mobility needs?

How does cost to use workplace charging influence this behavior?
Charging Location Preference – Chevy Volt

96 Chevrolet Volts with Access to Workplace Charging, 2013

Overall Charging Frequency by Location (to scale)

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

How does cost to use workplace charging influence this behavior?
Travel Extents of EV Project Leafs Based in CA

Feb 2011

INL Idaho National Laboratory
05/01/2014
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Additional Information

Publications coming soon:
• Leaf vs. Volt eVMT
• Leaf away-from-home infrastructure usage vs. eVMT
• Usage of public EVSE at different venue types
• Workplace charging case studies and driver behavior
• PEV travel on the OR/WA I5 corridor
• EVSE installation costs
• and more

• For all EV Project and ChargePoint America publications, visit
  avt.inl.gov/evproject.shtml
  avt.inl.gov/chargepoint.shtml

INL’s funding for this work comes from DOE’s Vehicle Technologies Office
Smart Boys Like EV Charging Infrastructure

(Now if only Dad would buy them an EV…)

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Additional Information
Measures of “Goodness”

There are numerous ways to assess how “good” public charging sites are:

• Charging frequency: number of charge events per day or week
• Charging time: hours connected
• Charging energy: kWh consumed / EV miles provided
• Parking time: time spent in parking space / in store
• Charging site host may want electric vehicle supply equipment (EVSE) for other reasons, such as image or cool factor
• etc.
**Terminology**

- **Charging site**
- **Charge port or cord**
- **Dual-port DC fast charge EVSE unit or charging station**
- **Single-port AC Level 2 EVSE unit or charging station**
- **Dual-port AC Level 2 EVSE unit or charging station**
- **Dual-port AC Level 2 EVSE unit or charging station**
Charging Site Location Considerations

• EVSE installations with respect to Americans with Disabilities Act (ADA) requirements are not consistent

  “Charger is between 2 handicap spaces. To charge and not get ticketed you need to park behind the charger in any of 3 spaces closest to the elevator / entrance in non EV dedicated spots. Good Luck.”
  – Comment from plugshare.com user

• Parking lot or garage may have
  – limited hours of operation
  – parking fees
  – restricted access
Charging Site Location Considerations

- Parking spaces in front of charging units may not always be accessible
  - Construction
  - Non-electric vehicle in parking spot ("you’ve been ICE’d")
  - Electric vehicles in parking spots but not charging

Fred Meyer in Seattle, WA

Photos from plugshare.com
Charging Site Location Considerations

• Charging unit maintenance and reliability is a big factor

“Both sides [of the DC fast charger] and level 2 not working. Had no electrics left. AAA couldn't send out the EV rescue truck because according to them they didn't have a tech trained to use it on hand. I ended up towing my car home. Not a good night.”

– Comment from plugshare.com user