EV Charging Infrastructure Usage in Large-scale Charging Infrastructure Demonstrations: Public Charging Station Case Studies for ARB

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Idaho National Laboratory

Plug-in Electric Vehicle Infrastructure Information Gathering Meeting
July 15, 2014
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
Infrastructure Deployment in The EV Project through December 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

- Which stations are used most frequently?
  - By region and EVSE make
  - By charging level and venue
- Determining hot spots using vehicle data
  - Bay Area examples
- I5 Corridor EVSE usage preview
Public EVSE Sites Exceeding Minimum Usage Threshold by Region and EVSE make

Min usage threshold is > 3 events per site per week
Distribution of Usage Frequency of Blink & ChargePoint Level 2 EVSE Sites by Venue

- Median site usage frequency
- Data from 9/1/2012 to 1/1/2014; includes all sites meeting minimum usage threshold

<table>
<thead>
<tr>
<th>Venue</th>
<th>Average number of charging events per site per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking Lots/Garages</td>
<td>9.4</td>
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<tr>
<td>Transportation Hub</td>
<td>9.3</td>
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<tr>
<td>Workplace</td>
<td>8.5</td>
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<tr>
<td>Public Municipal</td>
<td>7.6</td>
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<td>Leisure Destination</td>
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<td>Retail</td>
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<tr>
<td>Fleet</td>
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<tr>
<td>Non-profit</td>
<td>6.9</td>
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<tr>
<td>Hotels</td>
<td>6.6</td>
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<tr>
<td>Medical</td>
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<tr>
<td>Multi-Family</td>
<td>6.3</td>
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<tr>
<td>Education</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Distribution of Usage Frequency of Blink & ChargePoint Level 2 EVSE Sites by Venue
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Average number of charging events per site per week

- Parking Lots/Garages: 9.4
- Transportation Hub: 9.3
- Workplace: 8.3
- Public Municipal: 7.6
- Leisure Destination: 7.2
- Retail: 7.2
Distribution of Usage Frequency of Blink & ChargePoint Level 2 EVSE Sites by Venue
Blink & ChargePoint Level 2 Sites – Parking Lots and Garages

- 77.5 Downtown Palo Alto
- 73.4 Fifth & Mission Garage, San Francisco
- 70.6 Downtown Palo Alto
- 60.9 Downtown Redwood City
- 58.3 Parking Structure, Irvine CA
- 51.8 Parking Structure, Irvine CA
- 51.4 Parking garage, San Francisco CA
- 50.7 Sutter Stockton Garage, San Francisco CA
**Blink & ChargePoint Level 2 Sites – Transportation Hubs**

- **53.0** San Francisco Airport
- **39.3** Anaheim Canyon Metrolink
- **32.3** Oceanside Transit Center Metrolink train /light-rail/bus station park and ride
- **21.9** Oakland International Airport parking
- **17.0** San Francisco Airport
- **15.6** Expresso Airport Parking, San Leandro CA
- **15.2** San Francisco Airport
- **13.3** MBTA Alewife Station, Cambridge MA
- **10.9** Long Beach airport parking garage; all-electric vehicles can park free at Long Beach Airport.
Blink & ChargePoint Level 2 Sites – Public / Municipal

76.7  SCAQMD HQ building, Diamond Bar CA
52.8  City library, Dublin CA
50.0  City library, Redwood City CA
39.3  City hall, Huntington Beach CA
37.7  Civic center, Campbell CA
37.3  City hall, Hermosa Beach CA
35.1  SCAQMD HQ building, Diamond Bar CA
34.6  City hall, Orange CA

Average number of charging events per site per week
**Blink & ChargePoint Level 2 Sites – Leisure**

- **30.3** Rialto Sebastopol Cinemas, Sebastopol CA
- **25.7** La Cienega Tennis Center, Beverly Hills CA
- **23.9** Canal Park, Washington DC
- **20.8** Post Office Square Garage, Boston MA
- **18.2** Red Morton Community Center, Redwood City CA
- **14.4** San Diego Zoo
- **11.7** Balboa Park Air & Space Museum, Automotive Museum, gymnasium, Starlight theatre, etc.
**Blink & ChargePoint Level 2 Sites – Retail**

<table>
<thead>
<tr>
<th>Average Number of Charging Events per Site per Week</th>
<th>Site Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.1</td>
<td>Retail-Small (Becker Surfboards), Hermosa Beach CA</td>
</tr>
<tr>
<td>49.9</td>
<td>Mall (Bella Terra Shopping Ctr), Huntington Beach CA</td>
</tr>
<tr>
<td>45.5</td>
<td>Mall (Westfield Galleria Mall), Roseville CA</td>
</tr>
<tr>
<td>40.7</td>
<td>Mall (The Grove), Los Angeles CA</td>
</tr>
<tr>
<td>40.3</td>
<td>Mall (The Americana at Brand), Glendale CA</td>
</tr>
<tr>
<td>32.1</td>
<td>Mall (Stanford Shopping Center), Palo Alto CA</td>
</tr>
<tr>
<td>30.4</td>
<td>Mall, Beverly Hills CA</td>
</tr>
<tr>
<td>27.5</td>
<td>Mall (Fashion Valley Mall), San Diego CA</td>
</tr>
<tr>
<td>26.6</td>
<td>Retail-Small (Ralph’s grocery store), Marina Del Ray CA</td>
</tr>
<tr>
<td>23.4</td>
<td>Retail-Small (Mollie Stone's Market grocery store), Saulsalito CA</td>
</tr>
<tr>
<td>23.0</td>
<td>Retail-Big (Kohl's), Yorba Linda CA</td>
</tr>
<tr>
<td>22.8</td>
<td>Electric Lodge Performing Arts Center (dance and fitness center), Venice CA</td>
</tr>
</tbody>
</table>
Distribution of Usage Frequency of Blink DCFC Sites by Venue

8/1/2013 to 1/1/2014 (after Blink network fees were instituted)
Distribution of Usage Frequency of Blink DCFC Sites by Venue

Average number of charging events per site per week

- Public Municipal
- Parking Lots/Garages
- Workplace
- Hotels
- Education
- Multi-Family
- Retail

Values: 1.1, 1.2, 1.3
Distribution of Usage Frequency of Blink DCFC Sites by Venue
Distribution of Usage Frequency of Blink DCFC Sites by Venue

Average number of charging events per site per week

- Public Municipal: 15, 12.3, 9.1
- Parking Lots/Garages: 9.4, 9.3, 7.6
- Transportation Hub: 7.2
- Leisure Destination: 7.2

L2
Blink DCFC Sites – Public / Municipal

- 22.0 City hall, Hayward CA
- 16.6 South Coast AQMD HQ, Diamond Bar CA
- 12.5 Petaluma Visitors Center near 101, Petaluma CA
Blink DCFC Sites – Parking Lots and Garages

Average number of charging events per site per week

- 42.3 Downtown Seattle WA
- 29.2 Downtown Seattle WA
- 16.0 Downtown Los Angeles CA
- 12.3 Public Library, park, shopping center, Santa Clara CA
- 6.9 Public parking, Azusa CA
- 5.9 Downtown San Francisco CA
- 4.6 Business park, South San Francisco CA
Blink DCFC Sites – Retail

- 54.4 Tahoma Market on I5, Tacoma WA
- 35.0 Fred Meyer, Kirkland WA
- 30.4 Nissan dealership, Bellevue WA
- 23.1 Fred Meyer, Hillsboro OR
- 22.8 Fred Meyer, Seattle WA
- 22.6 Mall on I205, Happy Valley OR
- 20.9 Fred Meyer, Salem OR
- 19.1 Fred Meyer, Portland OR
- 16.5 Nissan dealership, Santa Rosa CA
- 16.4 Shopping center near I5, Wilsonville OR
- 16.0 United Markets (grocery store), San Rafael CA
- 12.7 Nissan dealership, Petaluma CA
Identifying Hot Spots Using Vehicle Data

• EV Project Leaf away-from-home parking location density in San Francisco Bay Area
• Cumulative through the end of 2013
Leaf Heat Map

- Low Density Parking
- High Density Parking

Sources: Esri, DeLorme, NAVTEQ US Inc, ARCAN, METI, N. TomTom
Blink DCFC usage on I-5 Corridor in OR & WA

Blink DC Fast Corridor EVSE
- < 3 events per week
- 3 -< 13 events per week
- 13 -< 23 events per week
- 23 -< 34 events per week
- 34 -< 44 events per week
- 44 -< 55 events per week
- The EV Project Territories
AeroVironment DCFCs near the I-5 Corridor in OR & WA

- AV DCFCs highlighted in yellow
- Other publicly available EVSE sites in blue and purple
Additional Information

Published since last meeting:

- Leaf vs. Volt eVMT
- Workplace charging case study: Facebook Offices, Menlo Park

Publications coming soon:

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

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
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

- Dual-port AC Level 2 EVSE unit or charging station
- Single-port AC Level 2 EVSE unit or charging station

Charging site

Dual-port AC Level 2 EVSE unit or charging station

Dual-port AC Level 2 EVSE unit or charging station
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
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