

# Electric Vehicle Charging Infrastructure Usage Observed in Large-scale Charging Infrastructure Demonstrations

John Smart

Smart Grid Interoperability Panel / V2G Subgroup  
Webinar

Idaho Falls, Idaho

March 2014

[www.inl.gov](http://www.inl.gov)



# *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 Development
  - 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

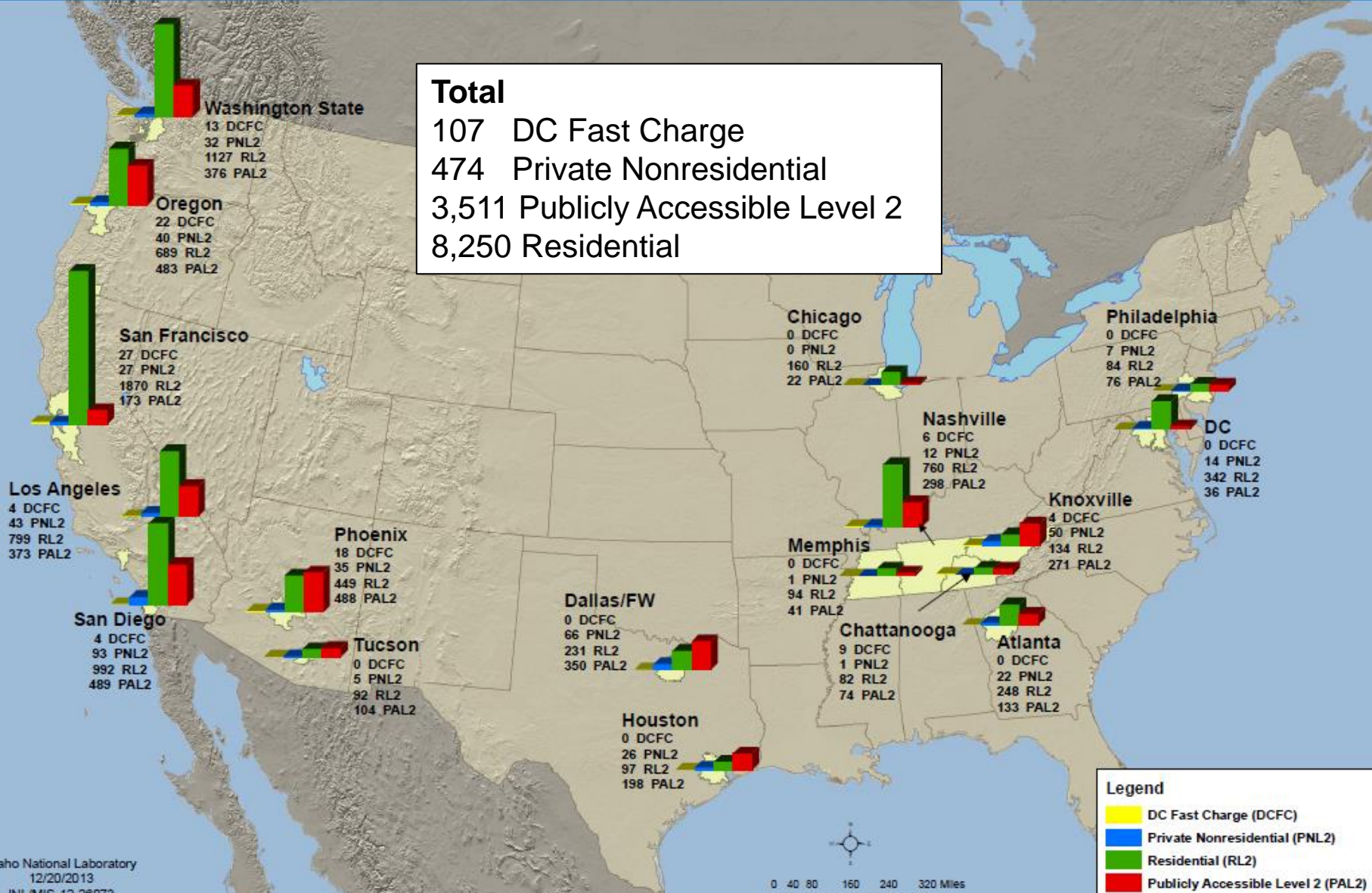
- Deploy 4,600+ residential and public AC level 2 charging units in 11 US regions
- Study customer usage of residential and public infrastructure
- INL data collection May 2011 – Dec 2013



# Infrastructure Deployment in The EV Project

Blink Charging Units Reporting Data in The EV Project through September 2013

**Total**  
 107 DC Fast Charge  
 474 Private Nonresidential  
 3,511 Publicly Accessible Level 2  
 8,250 Residential



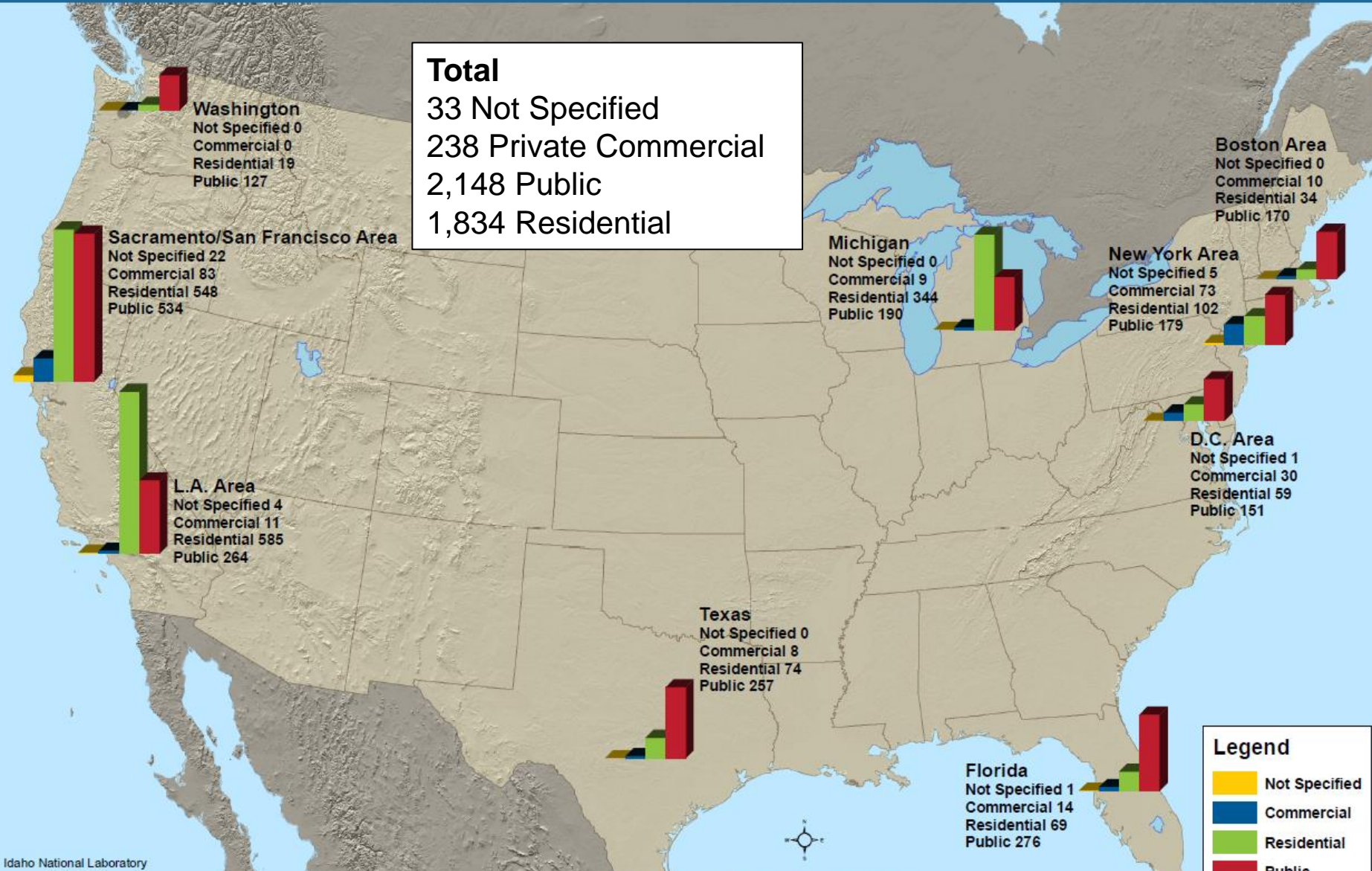
**Legend**

- DC Fast Charge (DCFC)
- Private Nonresidential (PNL2)
- Residential (RL2)
- Publicly Accessible Level 2 (PAL2)



# Infrastructure Deployment in ChargePoint America (all units are AC level 2)

## ChargePoint America Charging Units By Type - Through September 2013



# Outline

## Questions to answer

- What are the key differences in charging station use between regions?
- Which stations are used most frequently, and which least frequently?
- How are drivers using the stations?
  
- Quantitative results
- Qualitative observations

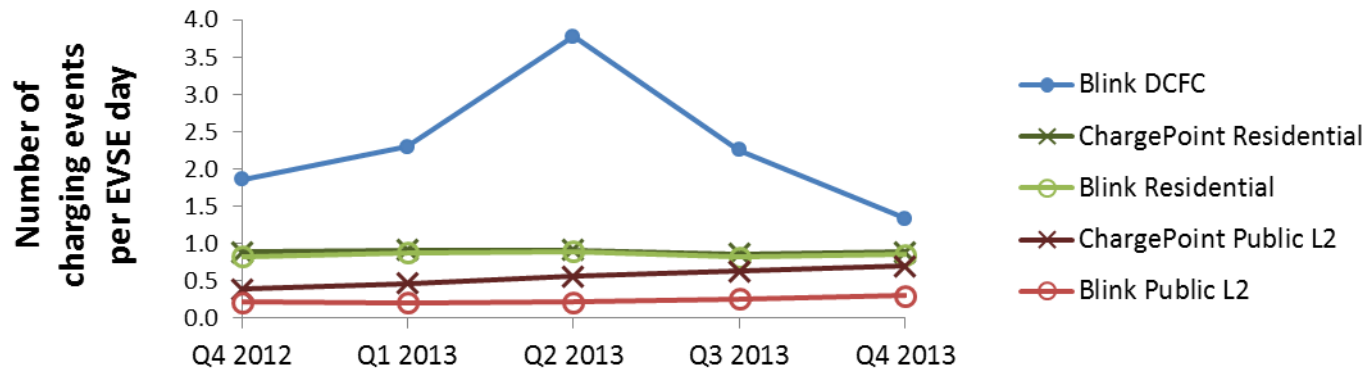
## ***Measures of “Goodness”***

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

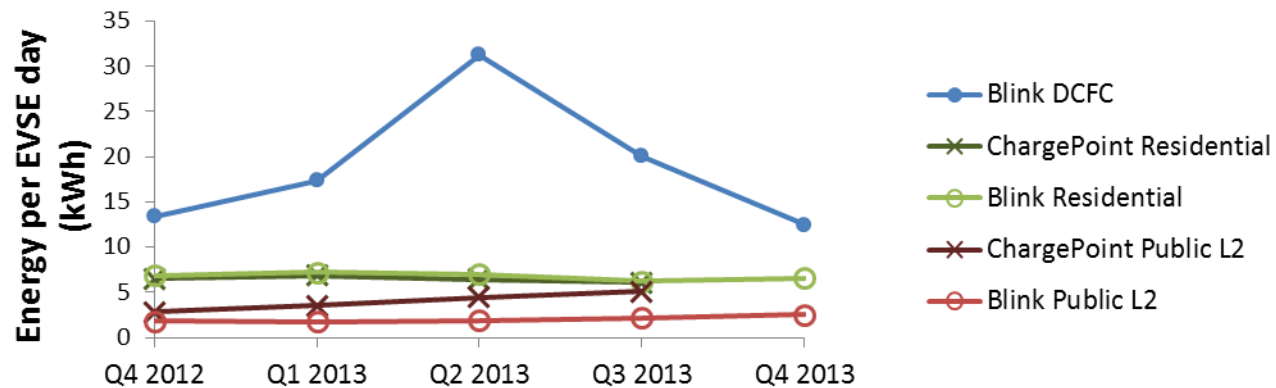
- Charging frequency: number of charge events per day or week
- Charging time: hours connected
- Charging energy: kWh consumed / EV miles provided
- Parking time: time spent in parking space / in store
- Charging site host may want electric vehicle supply equipment (EVSE) for other reasons, such as image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

# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

### Charging Frequency by EVSE Type



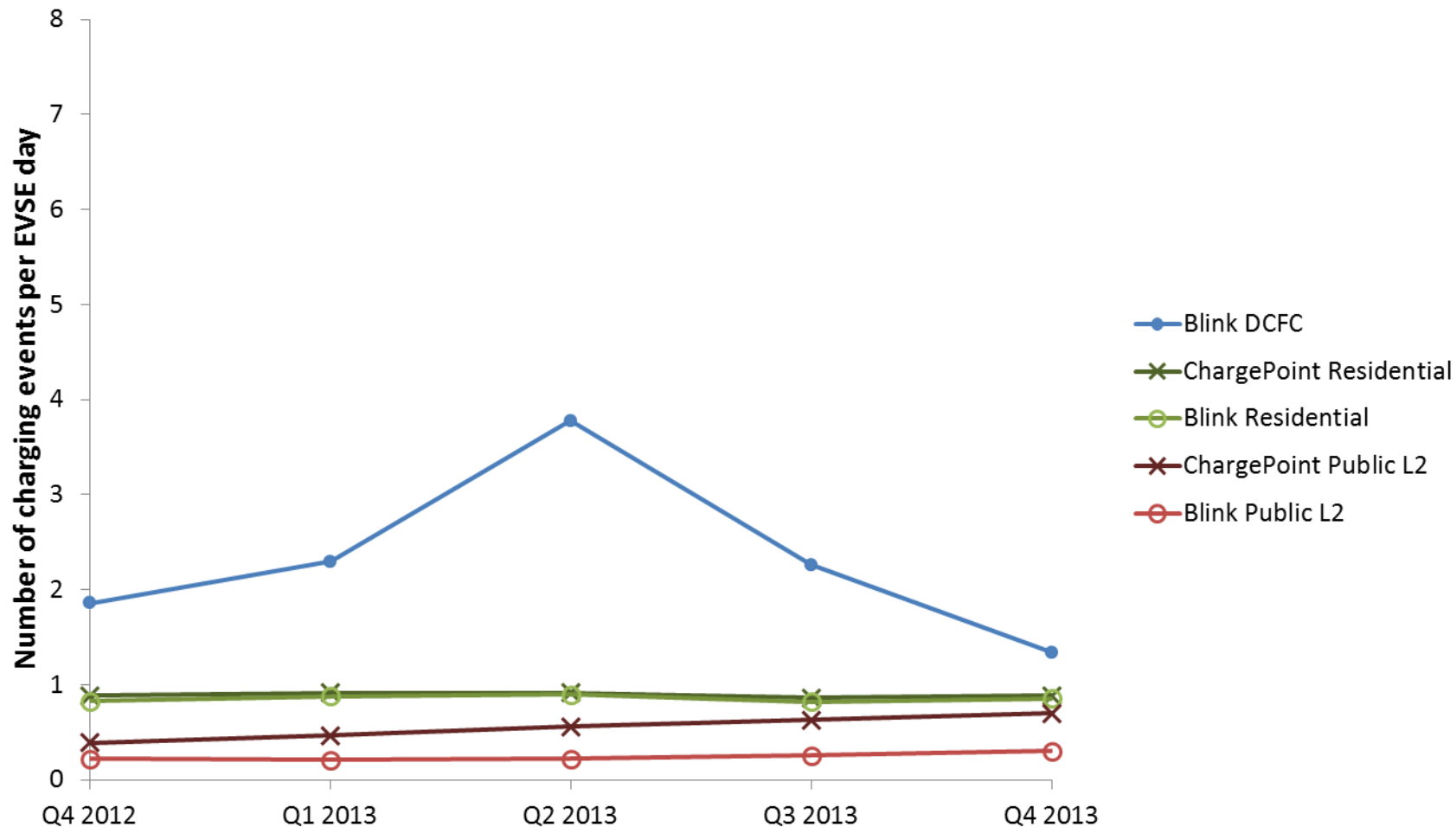
### Charging Energy by EVSE Type





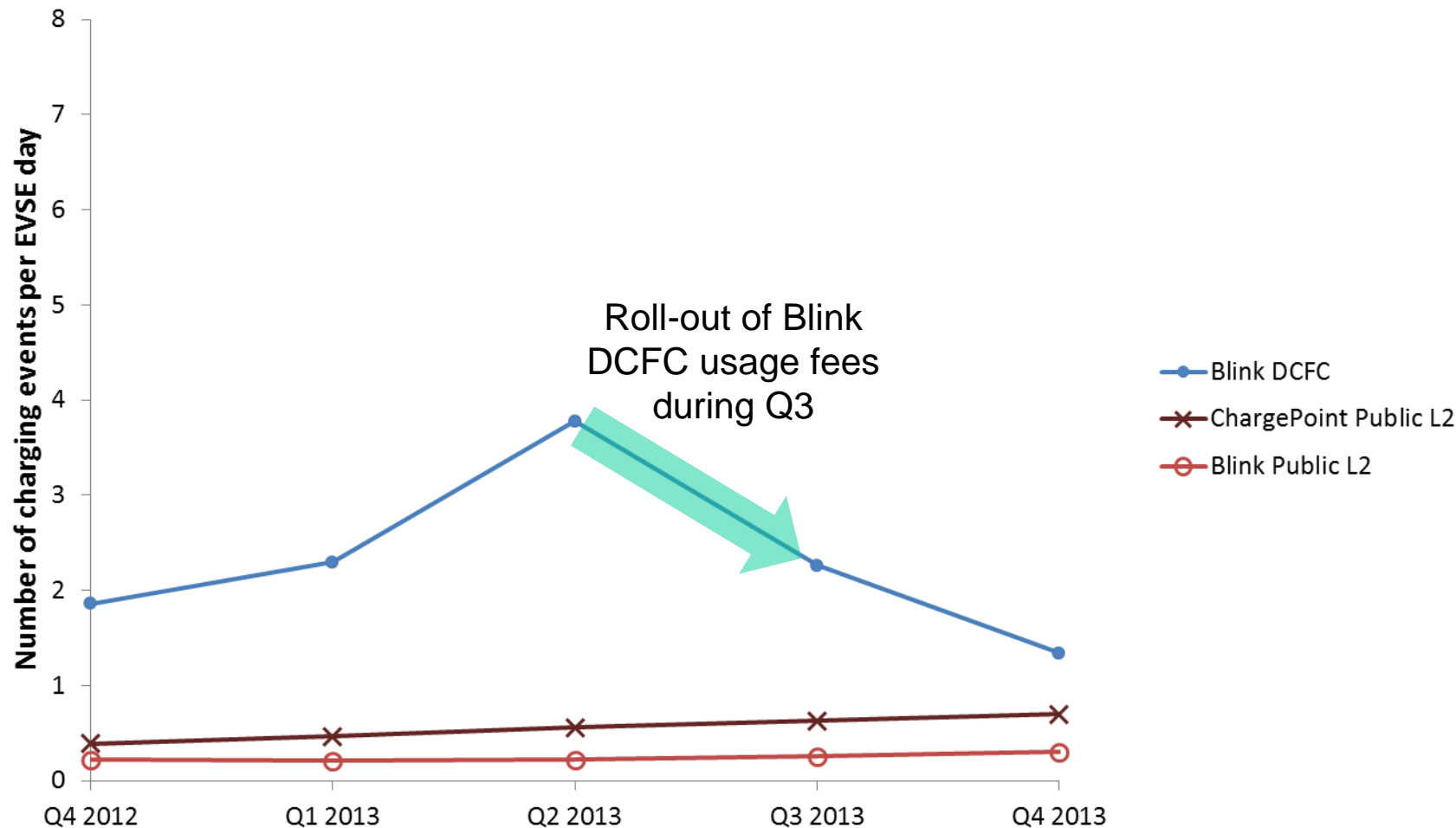
# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type



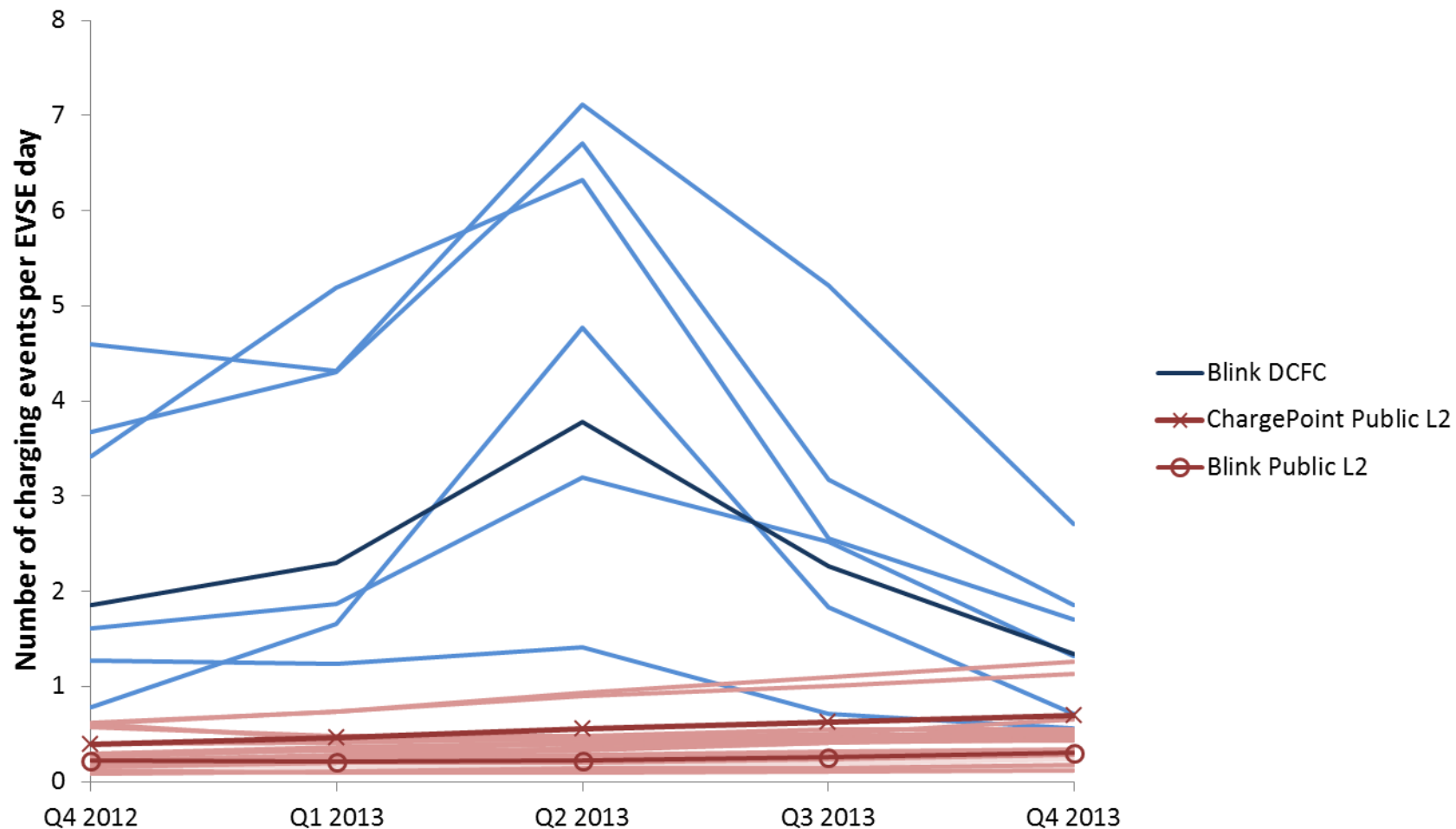
# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

## Charging Frequency by EVSE Type



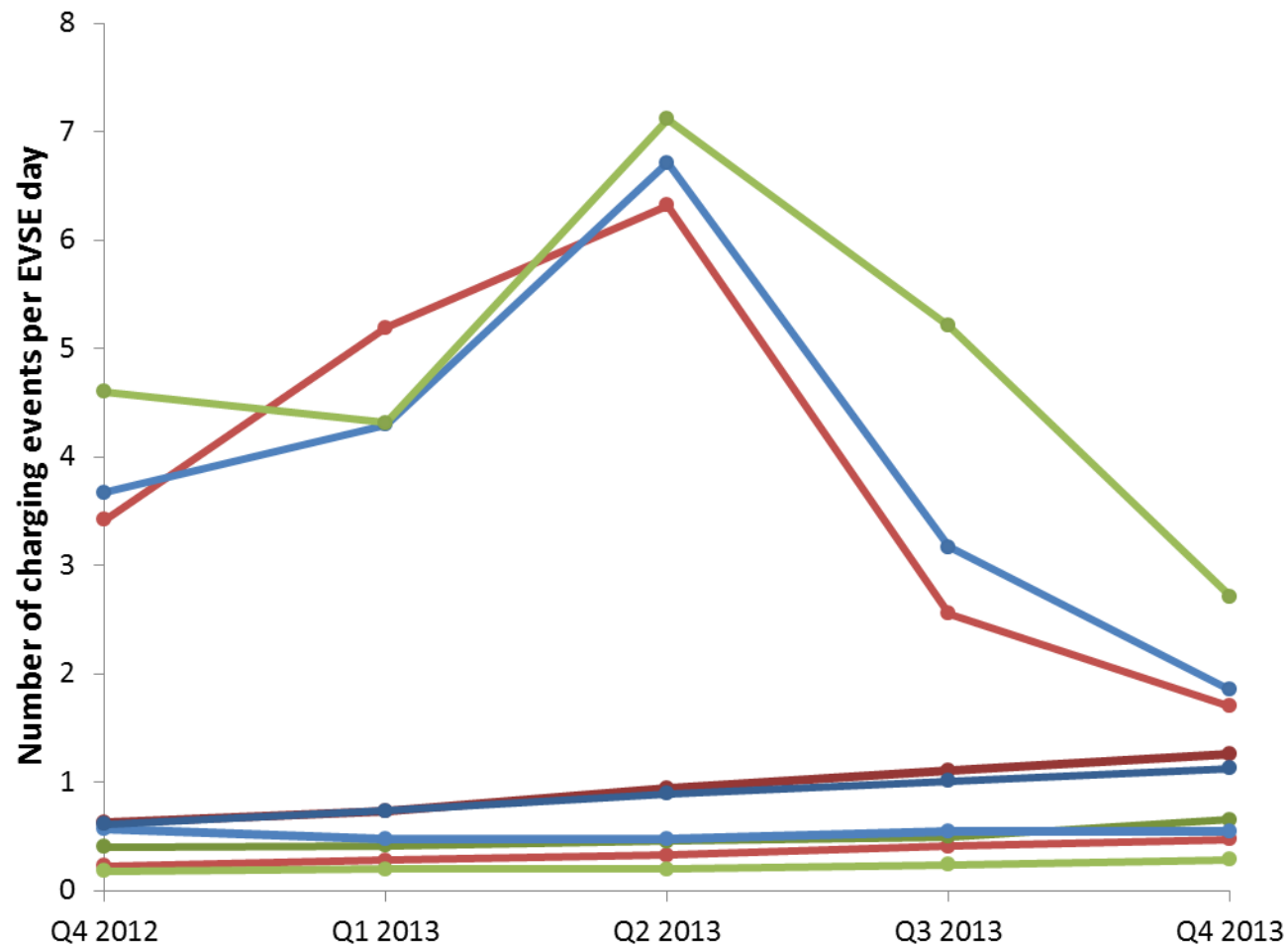
# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

## Charging Frequency by EVSE Type and Region



# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

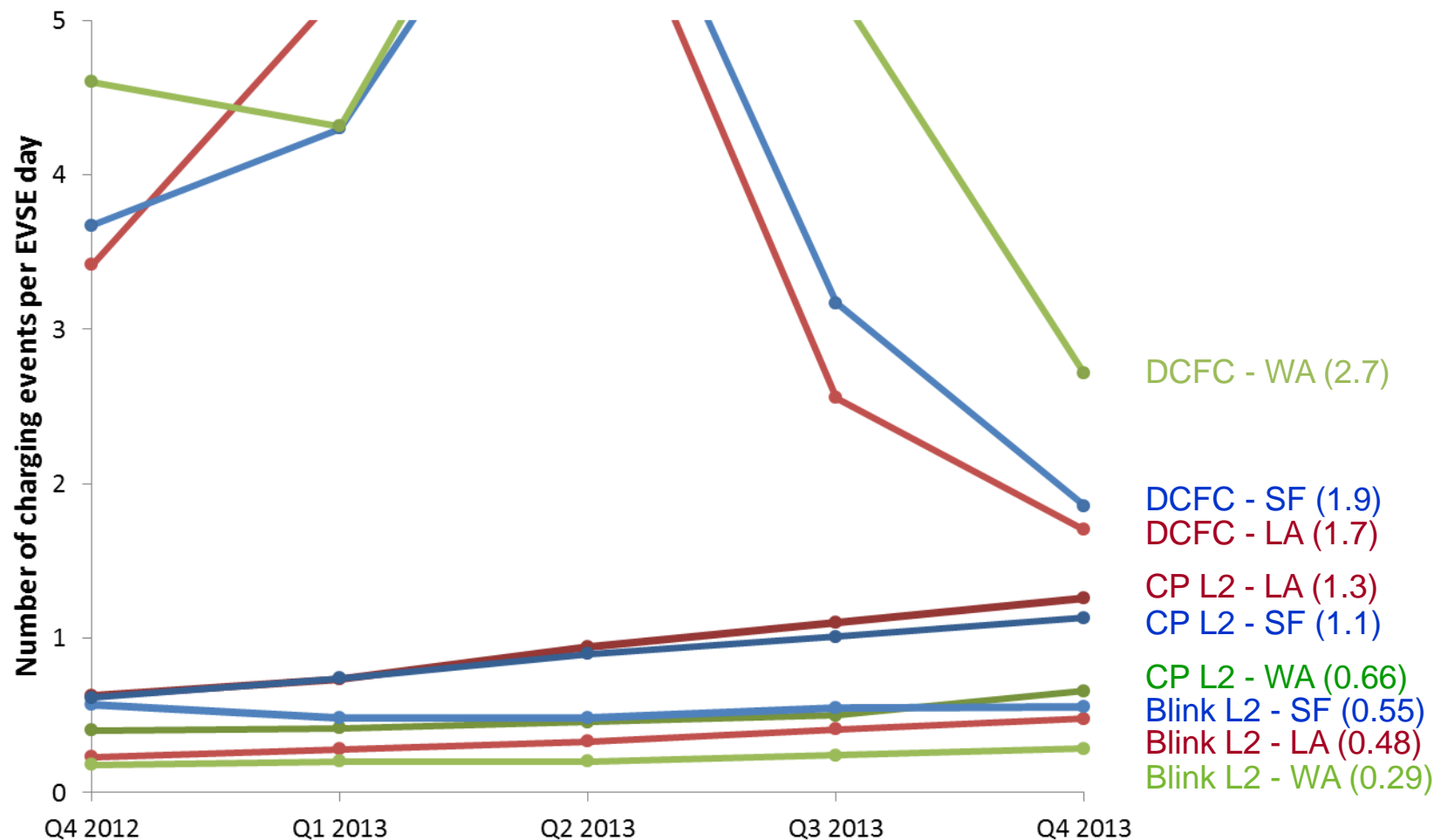
Charging Frequency by EVSE Type and Region - SF, LA, WA





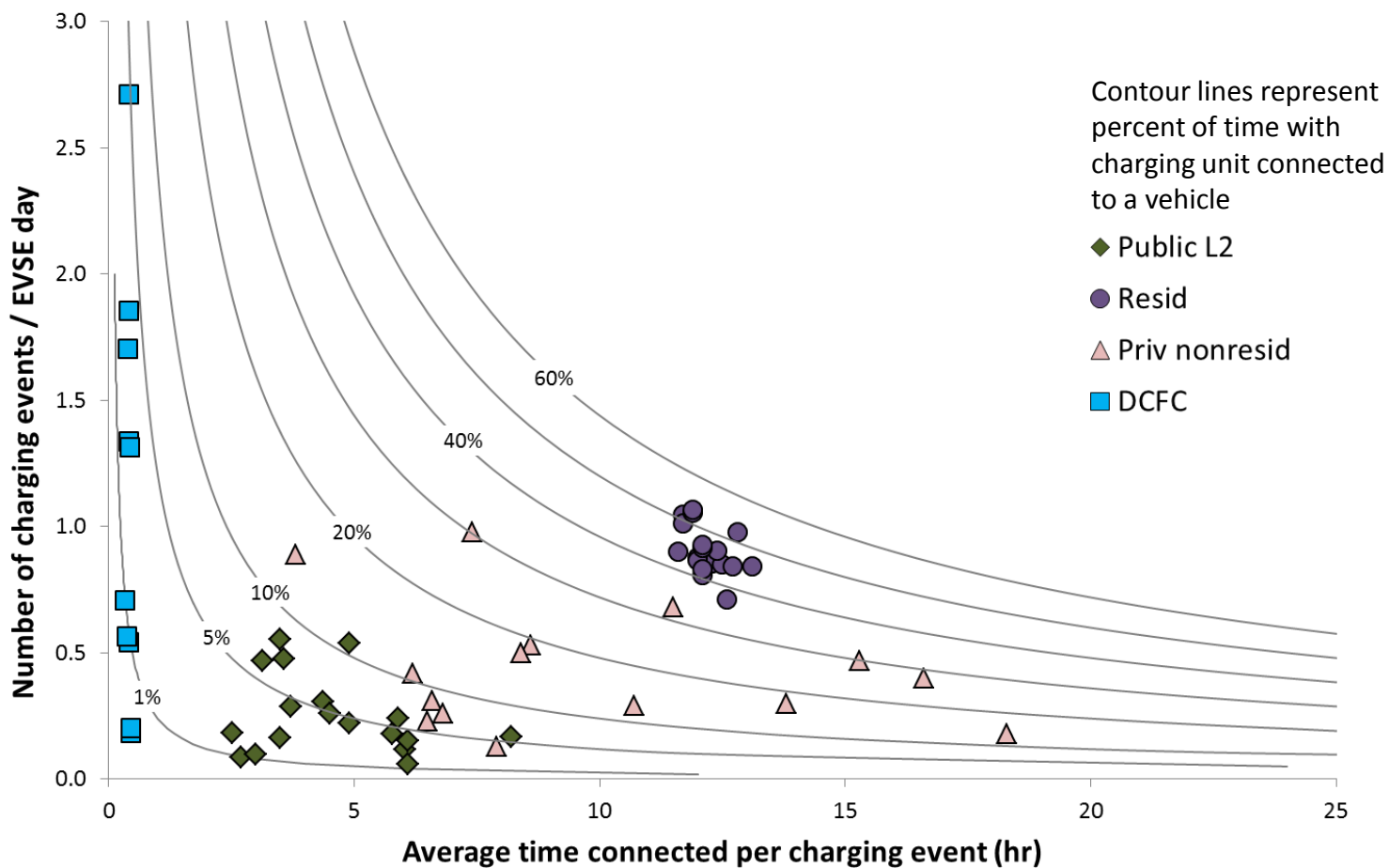
# Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type and Region - SF, LA, WA



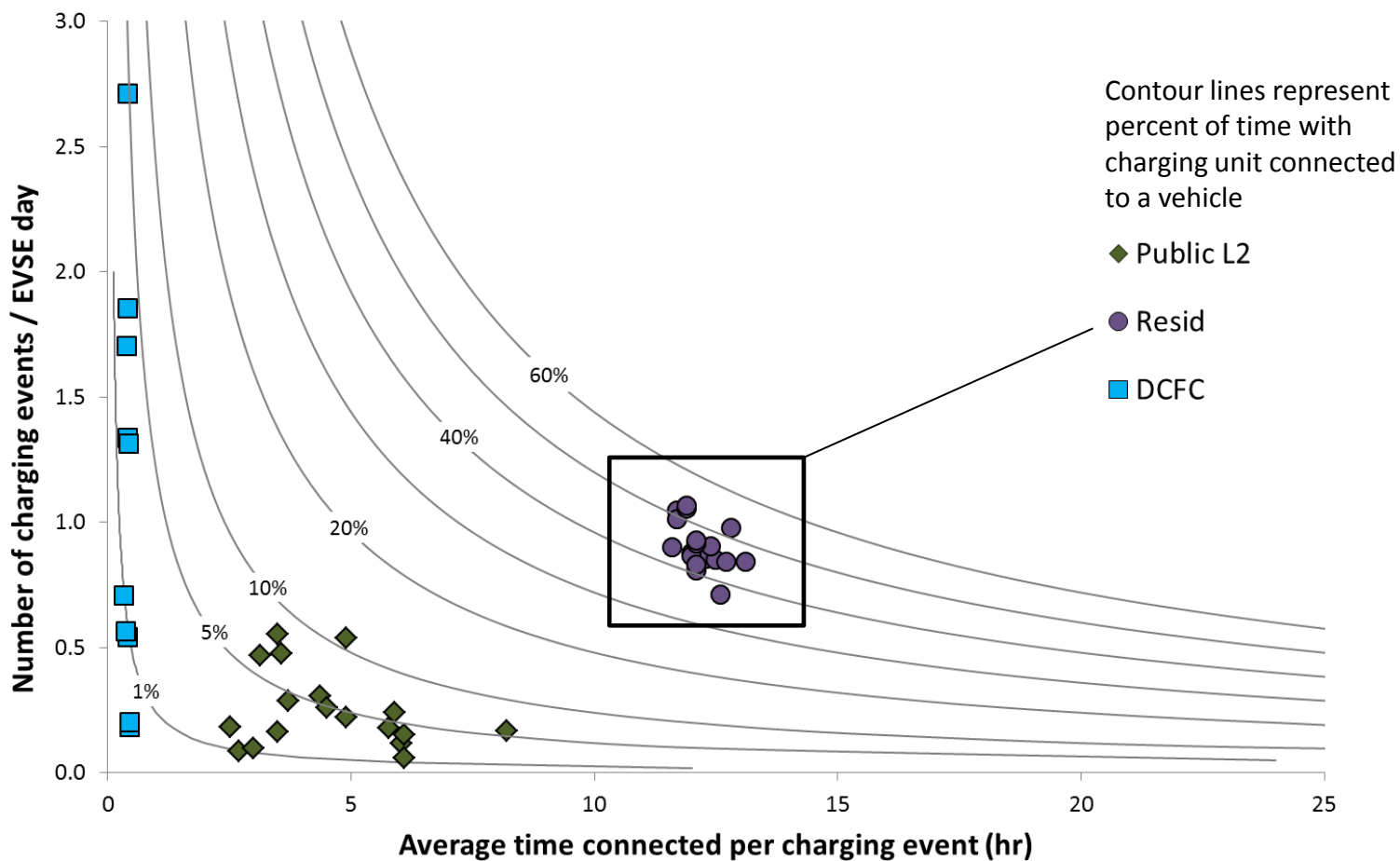
# Blink Charging Unit Usage

Q4 2013 EVSE Usage Frequency and Duration by EVSE Type and Region



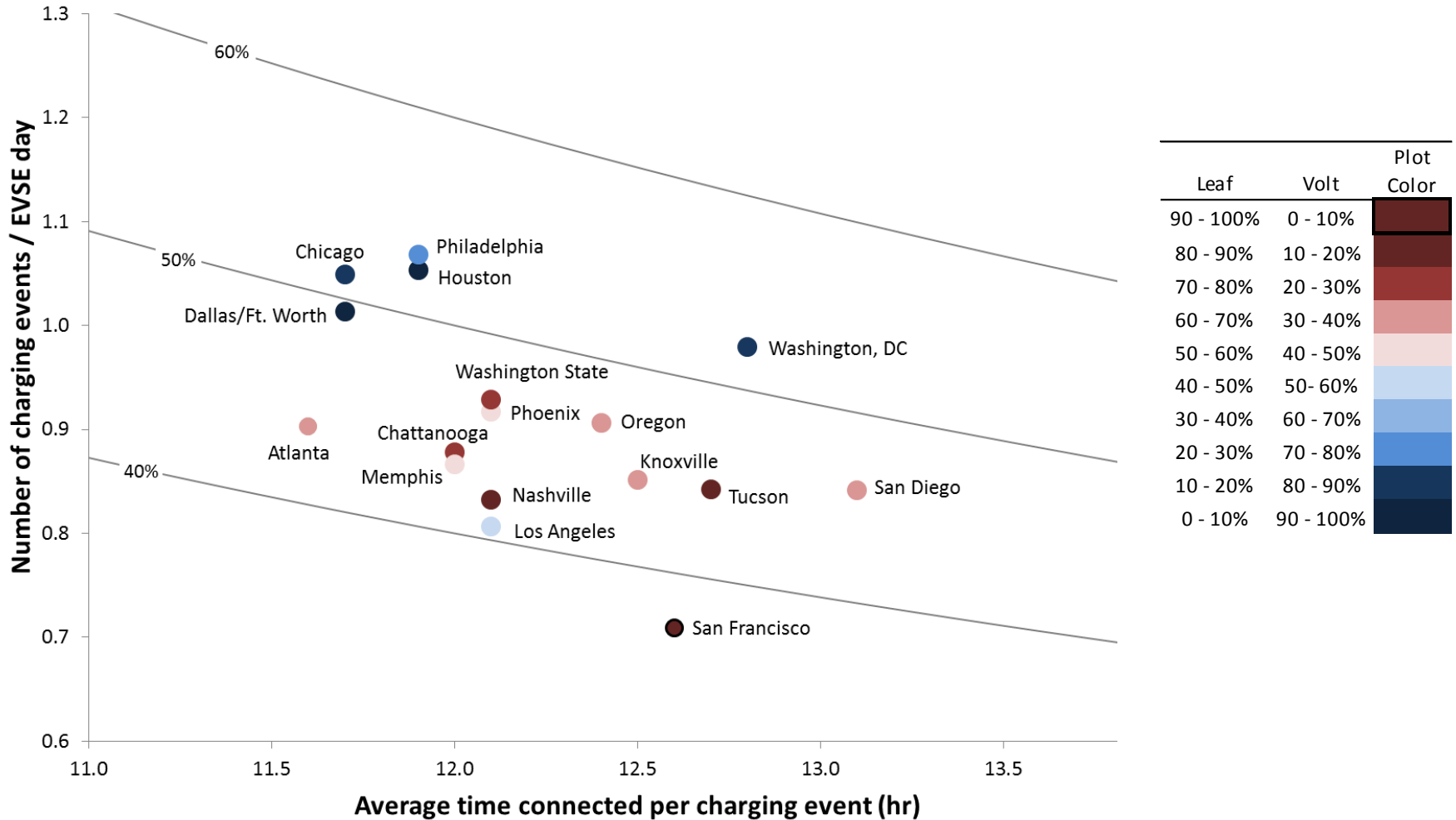
# Blink Charging Unit Usage

## Q4 2013 EVSE Usage Frequency and Duration by EVSE Type and Region



# Blink Residential EVSE Usage

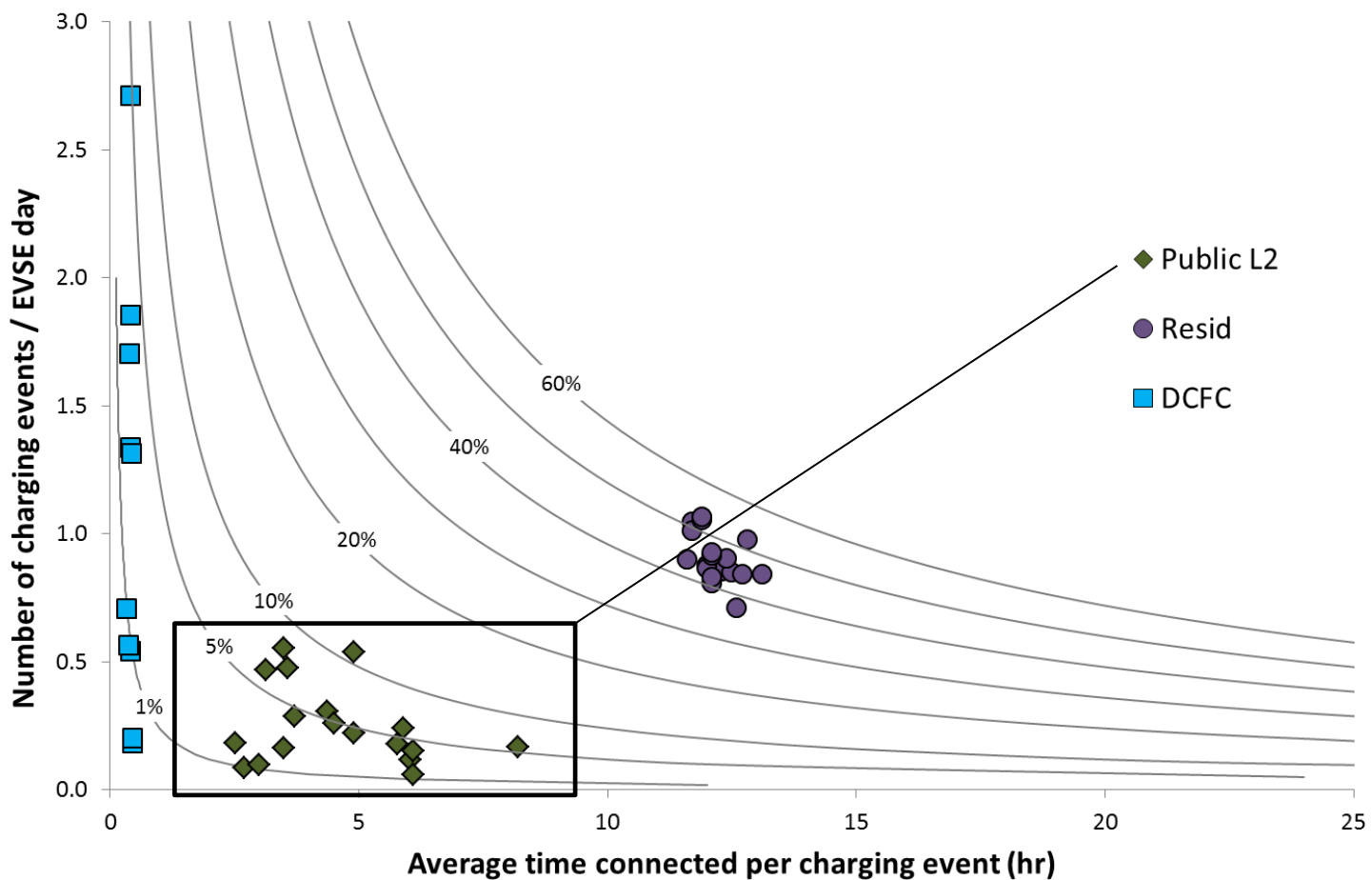
## Q4 2013 Residential EVSE Usage Frequency and Duration





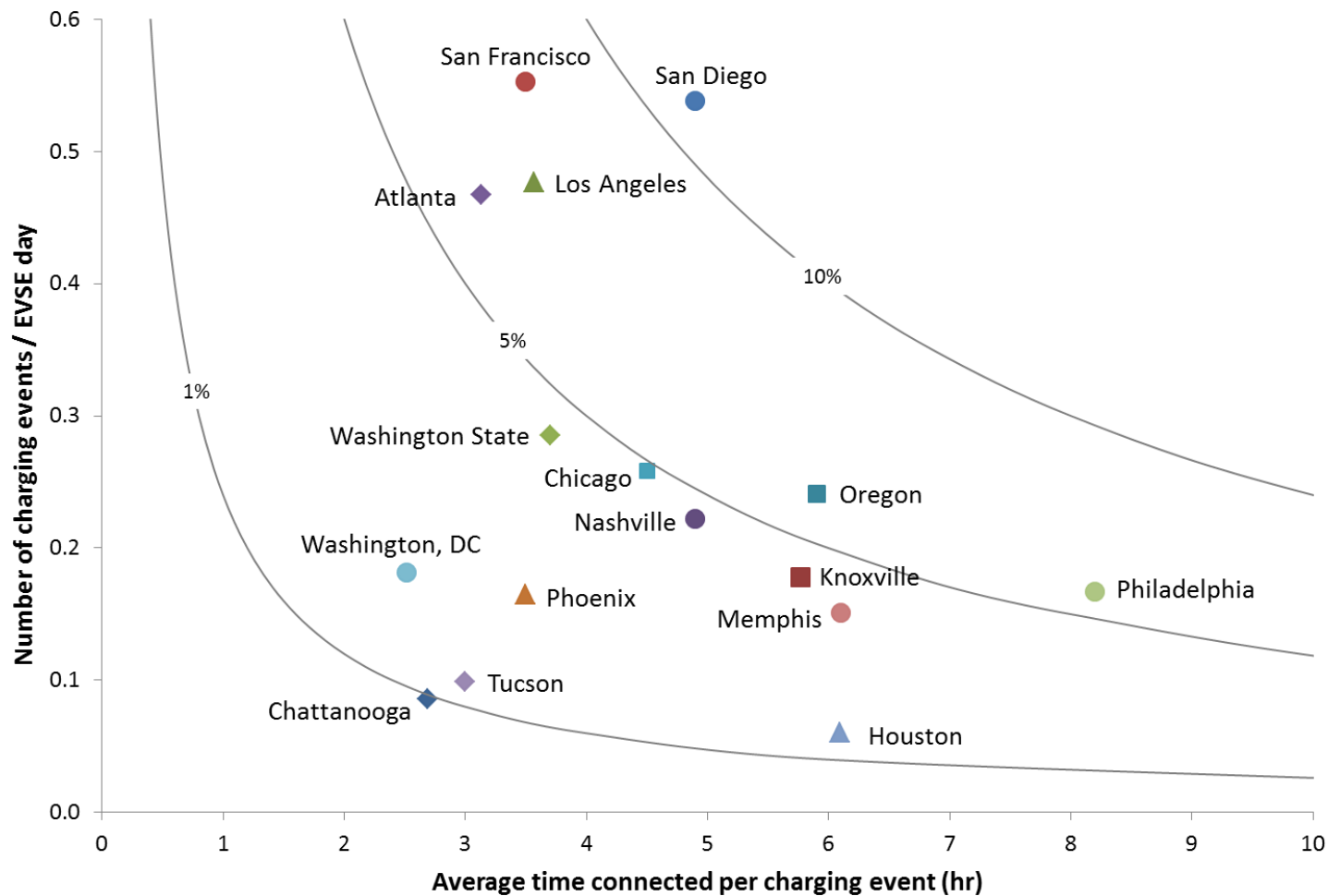
# Blink Charging Unit Usage

Q4 2013 EVSE Usage Frequency and Duration by EVSE Type and Region



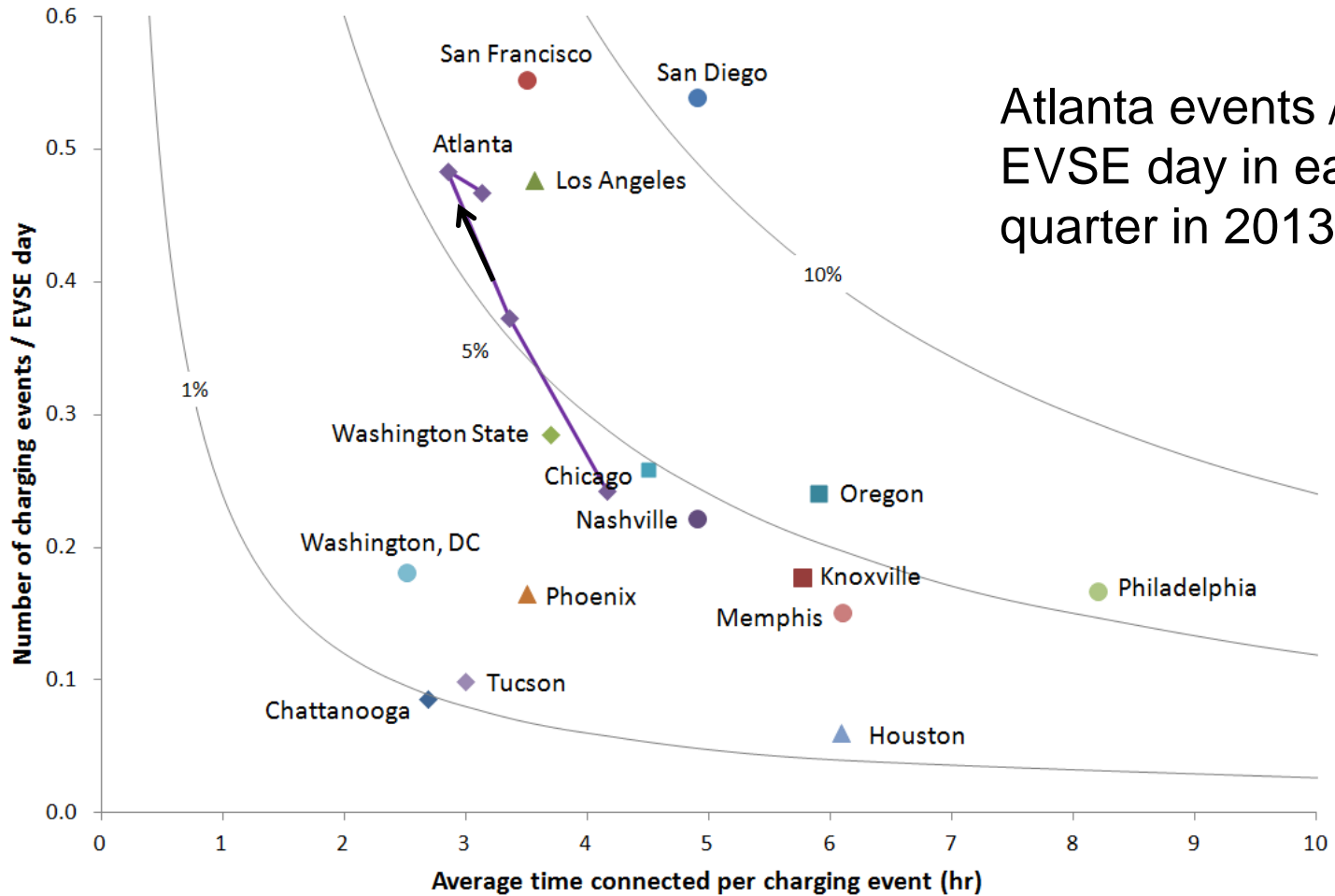
# Blink Public Level 2 EVSE Usage

## Q4 2013 Public Level 2 EVSE Usage Frequency and Duration



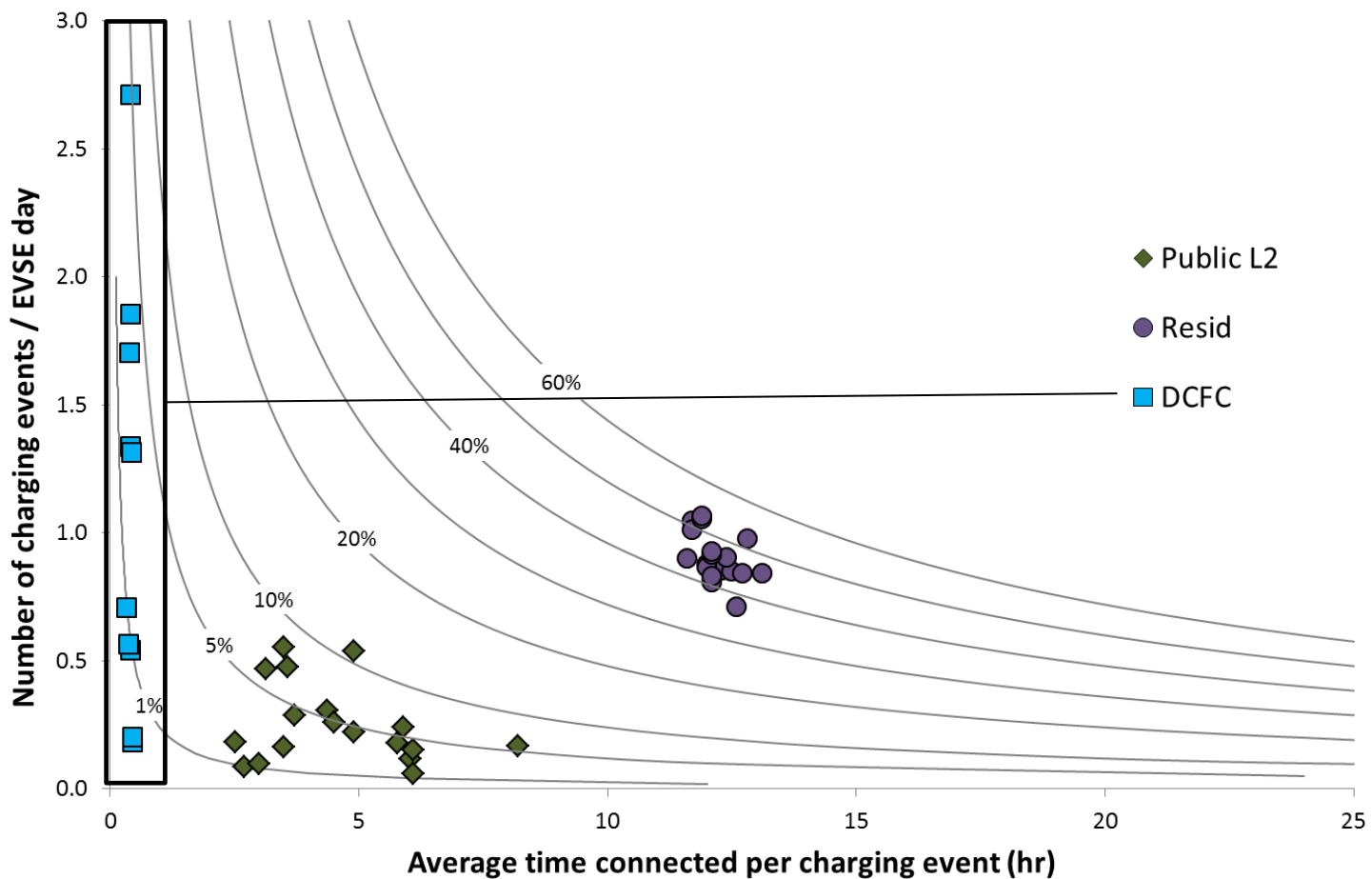
# Blink Public Level 2 EVSE Usage

Q4 2013 Public Level 2 EVSE Usage Frequency and Duration



# Blink Charging Unit Usage

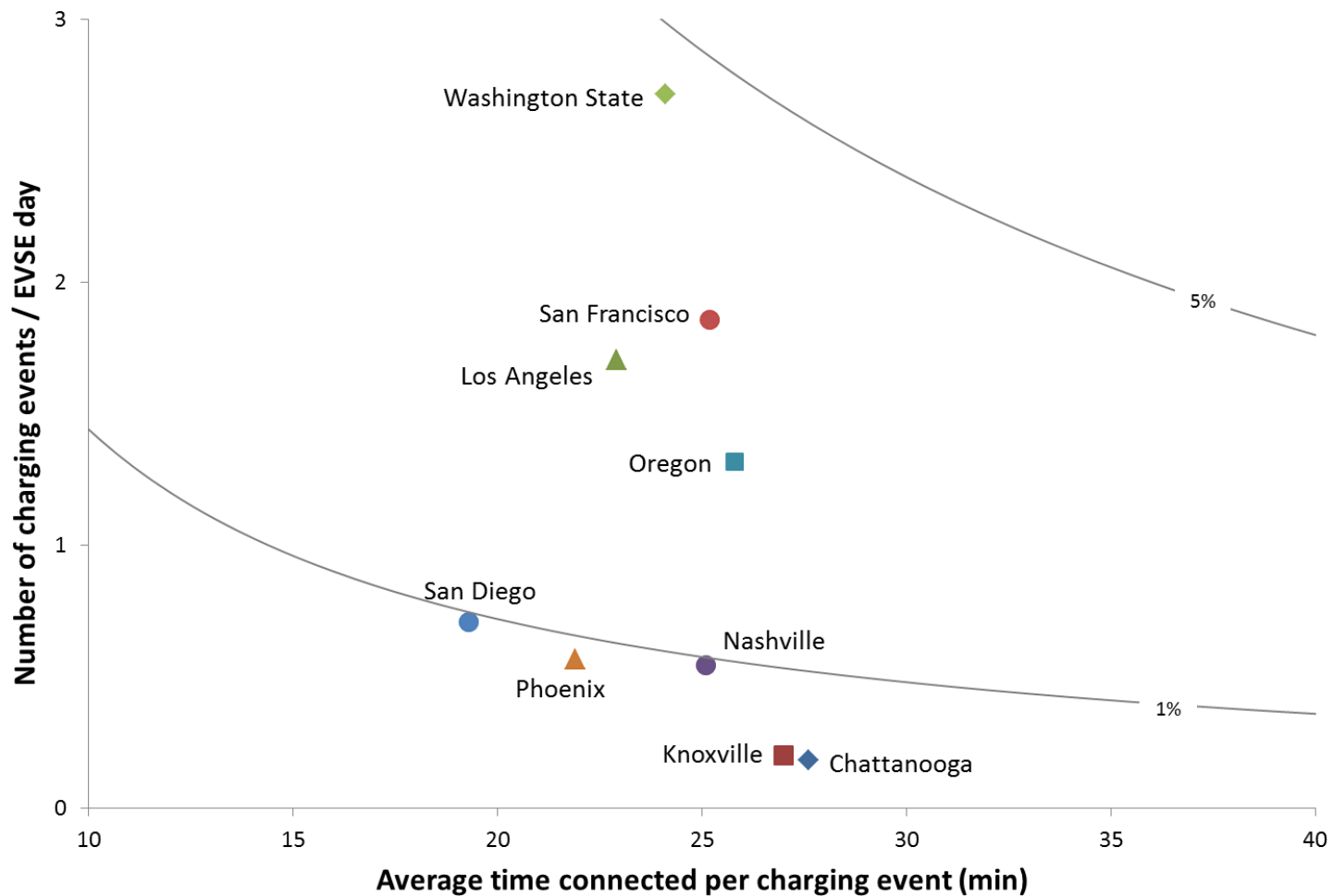
Q4 2013 EVSE Usage Frequency and Duration by EVSE Type and Region



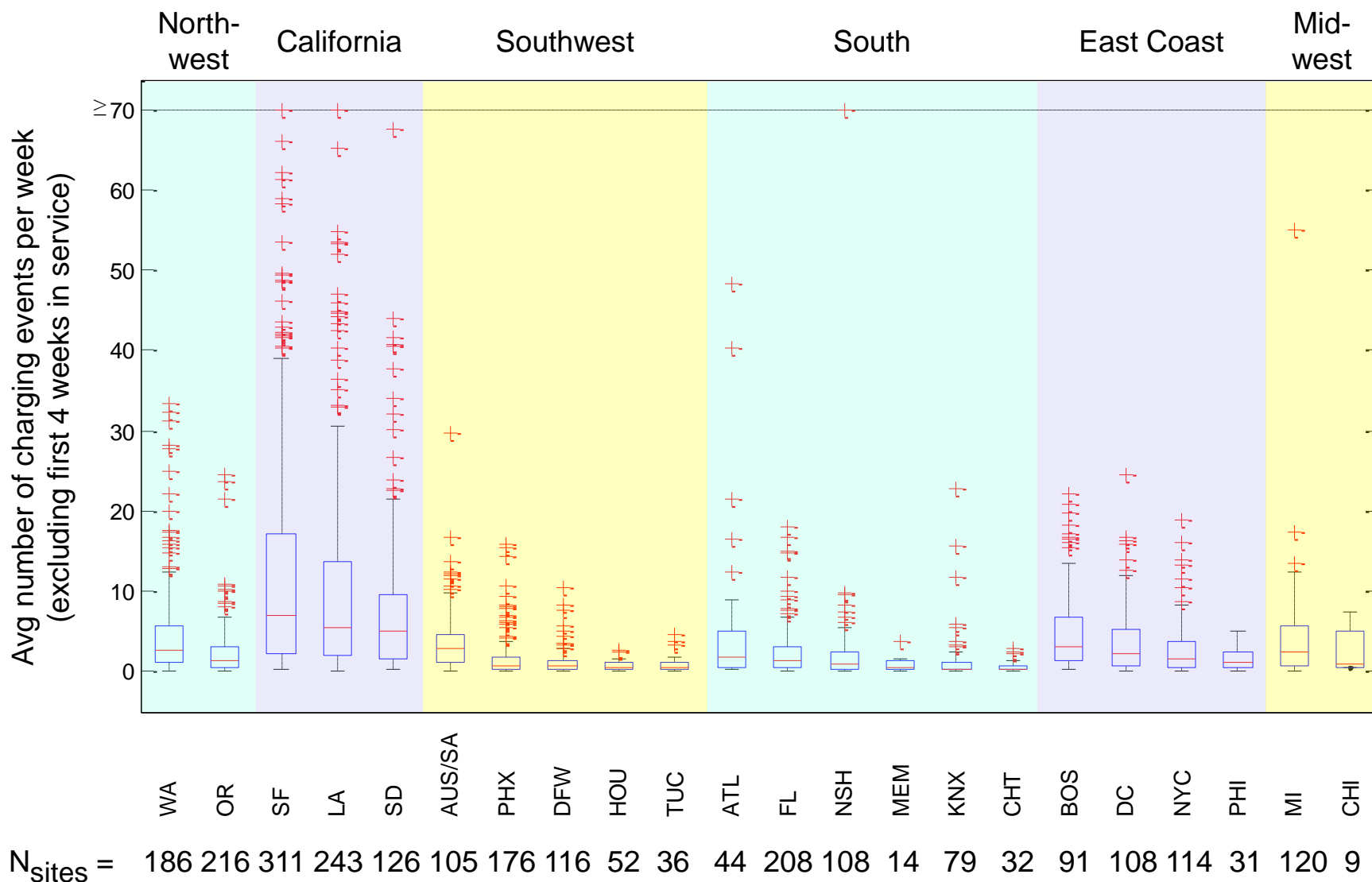


# Blink DC Fast Charger Usage

Q4 2013 DCFC Usage Frequency and Duration



# Distribution of Blink & ChargePoint Public Level 2 EVSE Usage Frequency by Region and Metropolitan Area in 2013



# Top 20 Most Frequently Used Public Level 2 Charging Sites

Date Range	1/1/2013 – 1/1/2014
Total Charging Events per Site	2500 - 6300
Average Number of Charging Events per Week per Site	60 -120
Sites by State	<ul style="list-style-type: none"> <li>• 19 in California</li> <li>• 1 in Tennessee</li> </ul>
Venues of the Top 20	<ul style="list-style-type: none"> <li>• Parking Garage (8)</li> <li>• Business Office (5)</li> <li>• Public / Municipal (3)</li> <li>• Mall (2)</li> <li>• University (1)</li> <li>• Manufacturing plant (1)</li> </ul>

## ***Multiple Cases at Same Public Charging Site***

- Public charging venue is not always clear indicator of how the charging units will be used
- Example: EVSE in public parking garage in urban center may serve multiple types of customers
  - Workplace parking / charging
    - 4 to 16 hrs
  - Restaurant or retail customer parking / charging
    - 0.5 to 2+ hrs
  - Car sharing fleet vehicles
    - 0.5 to 100+ hrs



# Public Level 2 Charging Examples in San Diego



Balboa Park Air & Space Museum  
(plugshare.com)



San Diego State University

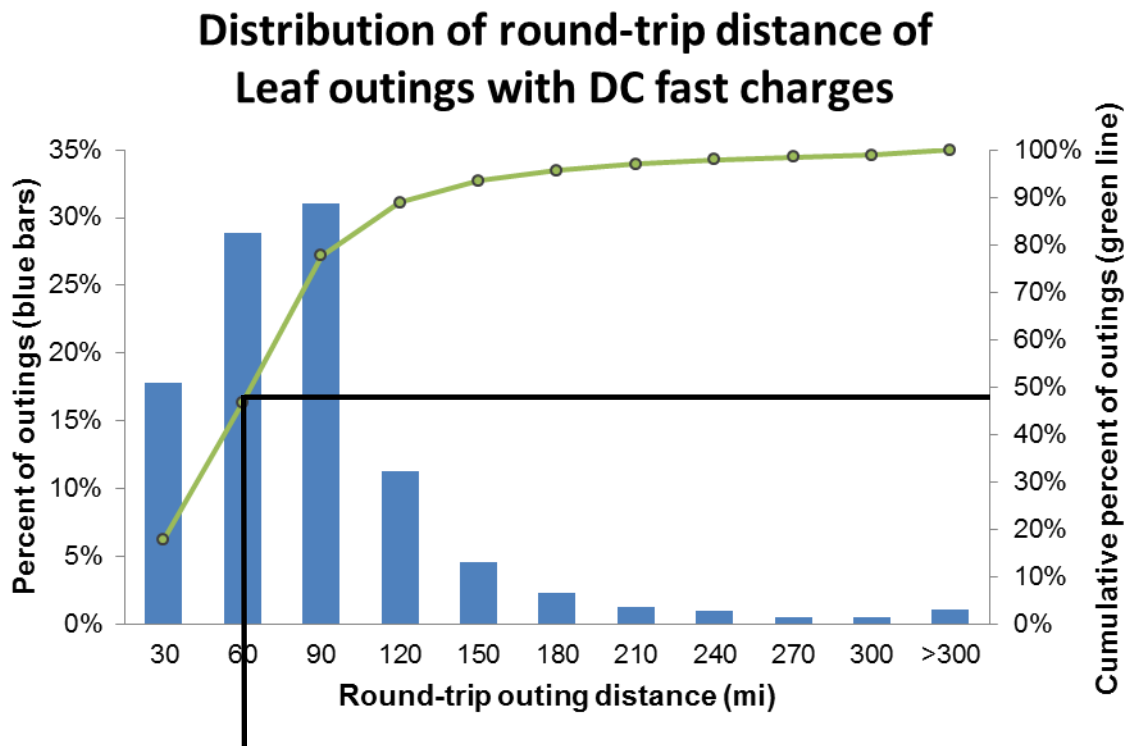


West Mission Valley Mall – Macy's

# Top 20 Most Frequently Used Public DC Fast Charging Sites

Range Of Use	1/1/2013 – 1/1/2014
Total Charging Events per Site	1400 - 3000
Average Number of Charging Events per Week per Site	23 - 52
Sites by State	<ul style="list-style-type: none"> <li>• 11 in California</li> <li>• 7 in Washington</li> <li>• 2 in Oregon</li> </ul>
Venues of the top 20	<ul style="list-style-type: none"> <li>• Business Office (5)</li> <li>• Retail / Mall (6)</li> <li>• University (3)</li> <li>• Public / Municipal (2)</li> <li>• Auto Dealership (2)</li> <li>• Recreation / Museum (1)</li> <li>• Multi-Family (1)</li> </ul>

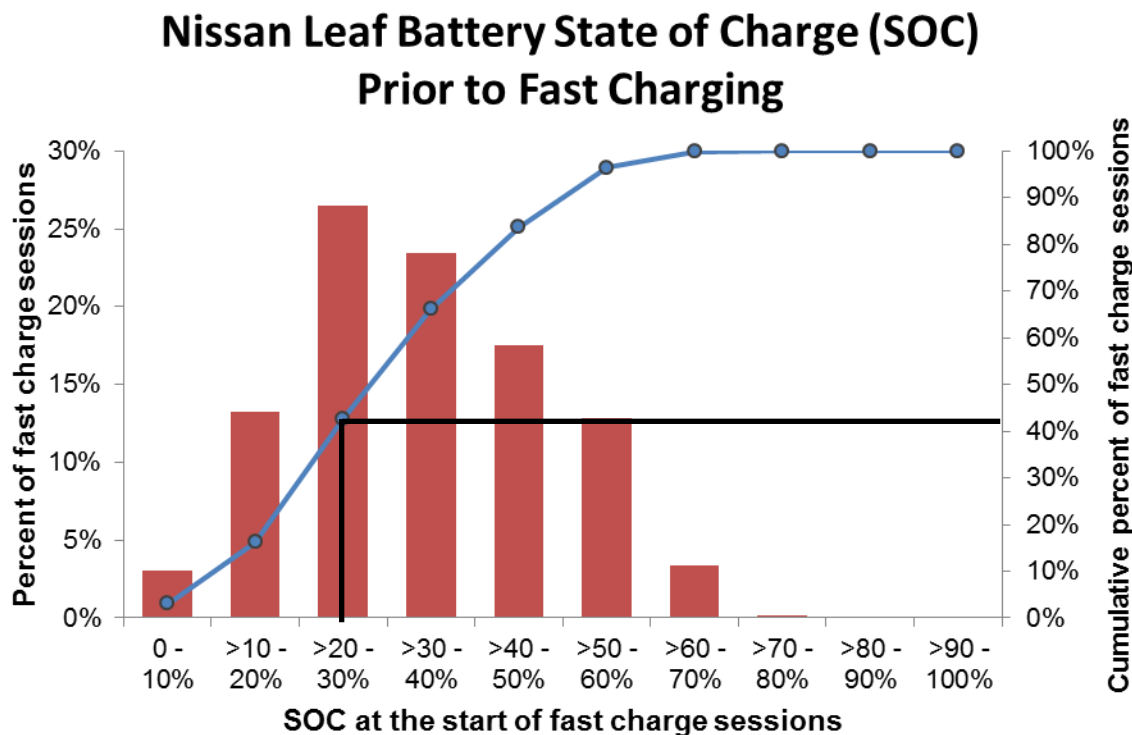
# EV Project Nissan Leaf DC Fast Charger Usage



47% of fast charges were performed on round-trip outings of 60 miles or less



# EV Project Nissan Leaf DC Fast Charger Usage



Vehicles had 30% or lower SOC at the start of 42% of fast charges

# Charging Site Location Considerations

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

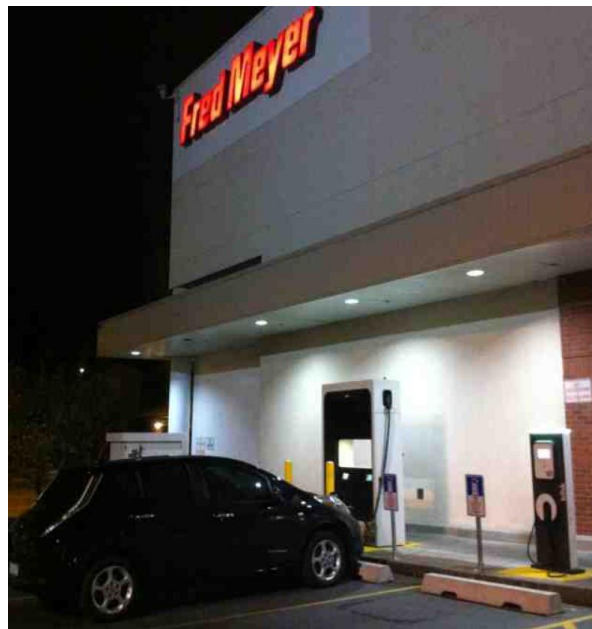
“Charger is between 2 handicap spaces. To charge and not get ticketed you need to park behind the charger in any of 3 spaces closest to the elevator / entrance in non EV dedicated spots. Good Luck.”  
 – Comment from plugshare.com user



- 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

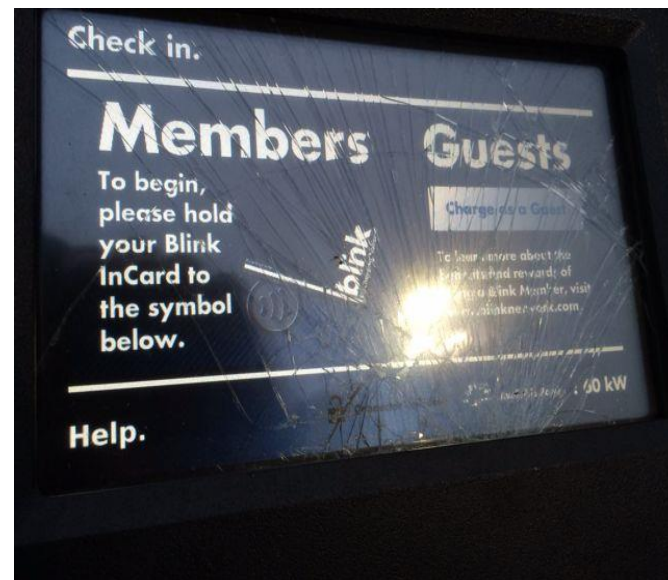
Photos from  
[plugshare.com](http://plugshare.com)

# 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 electricians 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

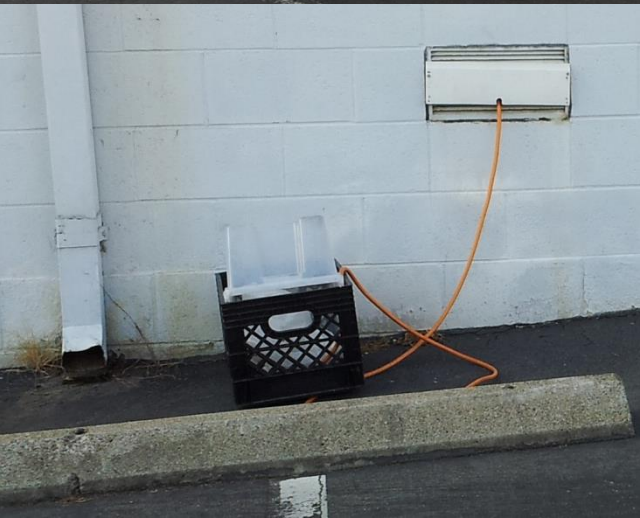




## ***Comments on Cost of DC Fast Charging***

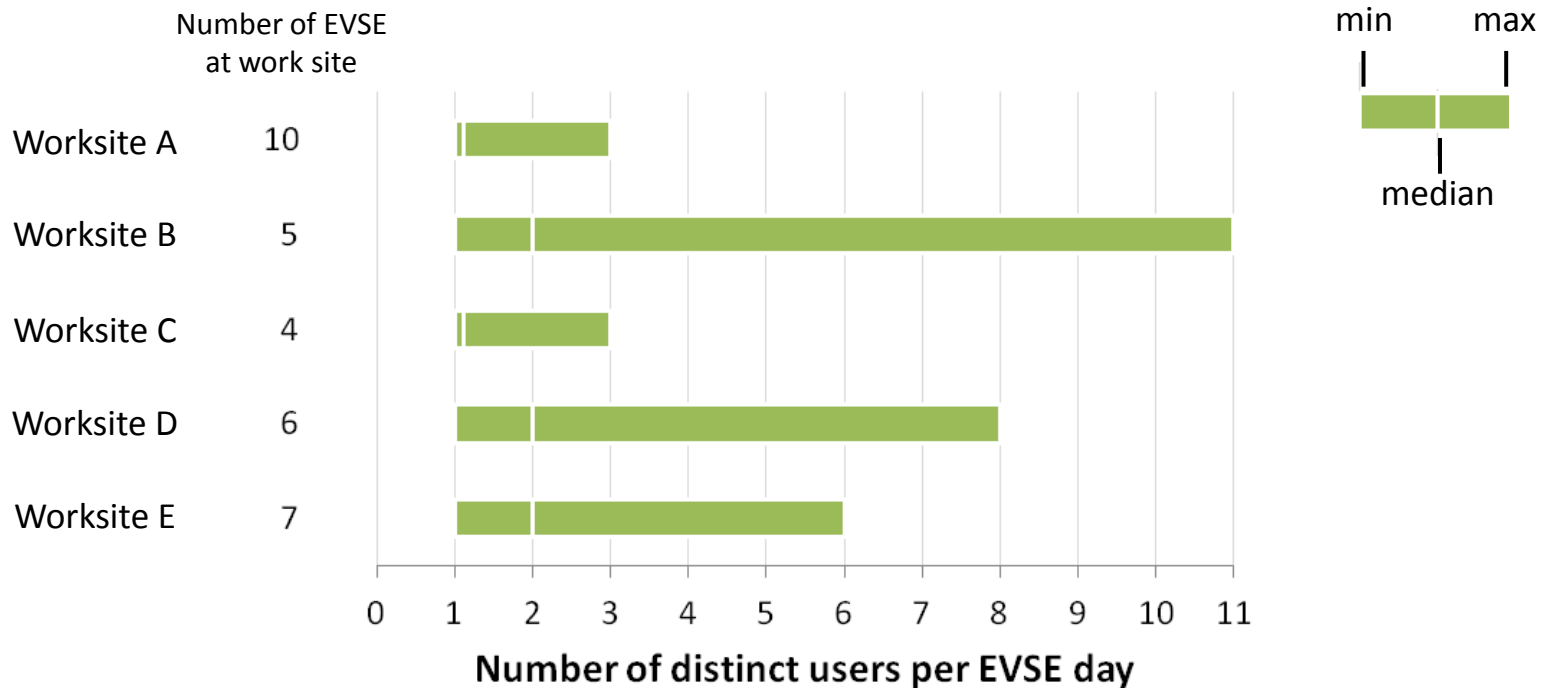
- “One of the DC fast chargers is now open and responsive. When I swiped card, it indicated a charge of \$5 would be levied, and since my car was nearly fully charged, I opted not to charge. The other DC fast charger and the Level 2 charger are still inaccessible.” – Comment from plugshare.com user
- “Did a quick charge on blink card, worked great. Was out if charge, so quickly charging up for \$5 was OK.” – Comment from plugshare.com user
- “The quick charger here is awesome! I can go into the Fred Meyer and have lunch and have my car fully charged by the time I'm done. This makes having an EV more practical as I had to commute to Redmond from Everett with an already low charge. Definitely worth \$5” – Comment from Plugshare.com user

# Workplace Charging Examples



# EVSE User Turnover at Work Sites

## Distribution of Number of Distinct Users per EVSE Day at 5 Worksites with Level 2 EVSE



# Conclusion

## Questions to answer

- What are the key differences in charging station use between regions?
  - San Francisco and Los Angeles areas lead the country in use
  - San Diego use high because of Car2Go Car Sharing vehicle charging
  - Atlanta stands out for increasing trend
- Which stations are used most frequently, and which least frequently?
  - Most frequently used sites identified
  - Workplace charging is popular for level 2 charging, as expected
  - Cannot rush to judgment on infrequently used sites
- How are drivers using the stations?
  - Multiple users per day at workplaces
  - Cost matters, but hard to say how much at this point
  - Multiple use cases for same charging site
- Factors that complicate public charging
  - ADA considerations
  - Parking spots can be “ICE’d”, blocked by construction, etc.
  - Parking lot/garage may have hours of operation, parking fees which impact usage of charging units

## ***Additional Information***

- Publications coming soon:
  - Leaf L2 vs. DCFC usage
  - public charging venues
  - workplace charging case studies
  - EVSE installation costs
  - and more
- For all EV Project publications, visit

[avt.inl.gov/evproject.shtml](http://avt.inl.gov/evproject.shtml)

INL's funding for this work comes from DOE's Vehicle Technologies Office