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

John Smart, Jim Francfort

Grid Interaction Tech Team meeting

Mar 26, 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:

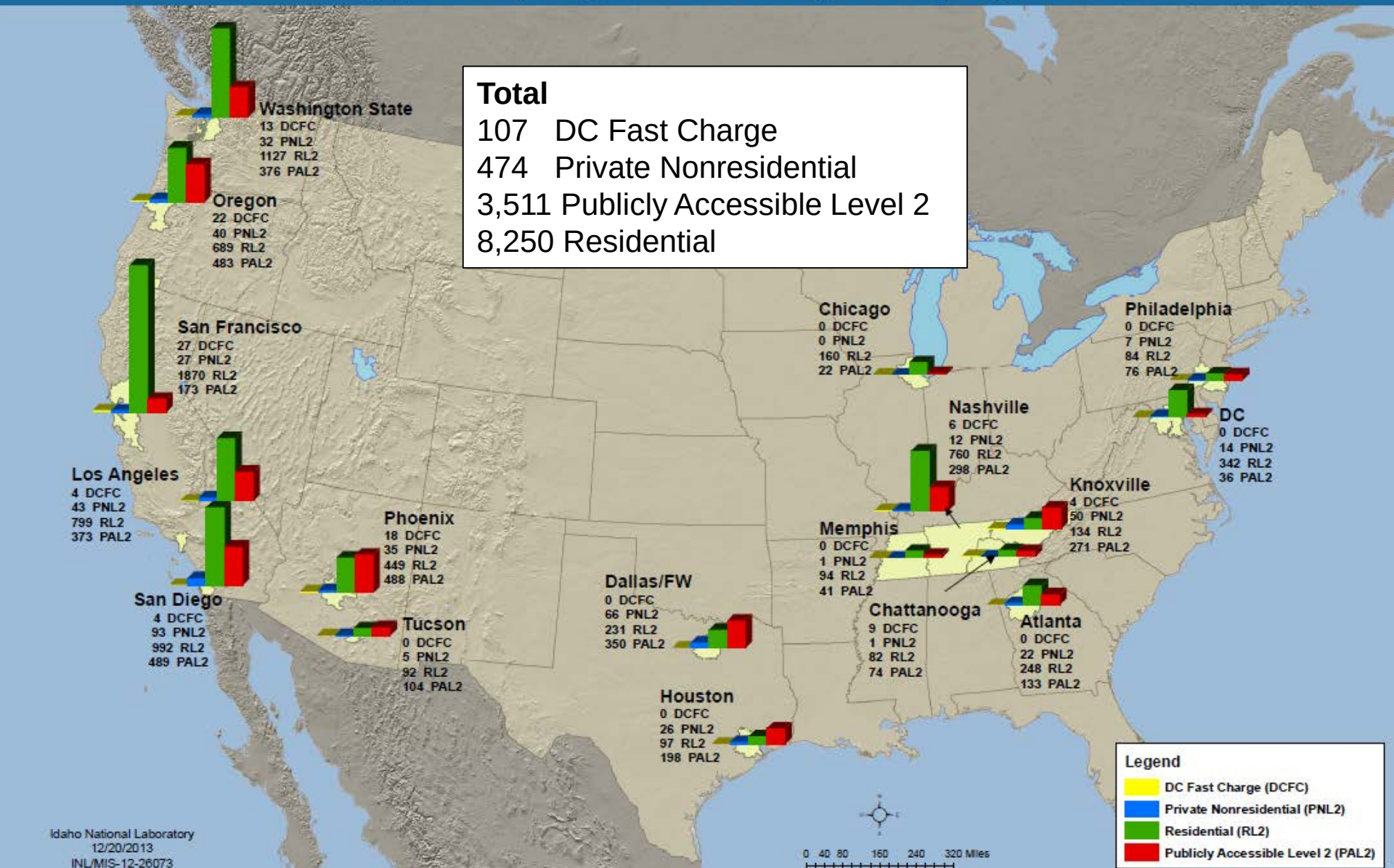
ChargePoint America

- 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

Idaho National Laboratory

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



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

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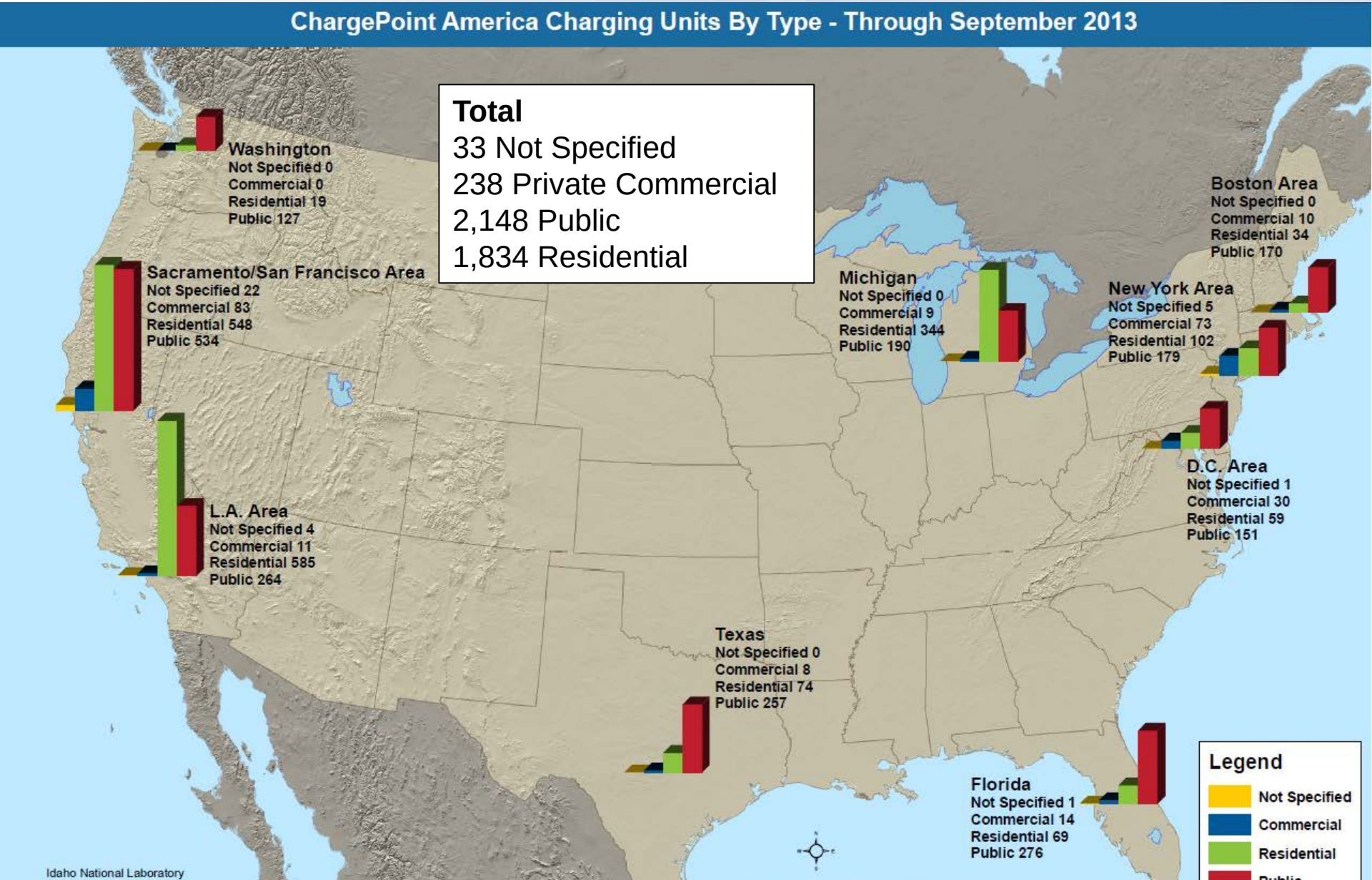


Outline

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 public and workplace charging stations?

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

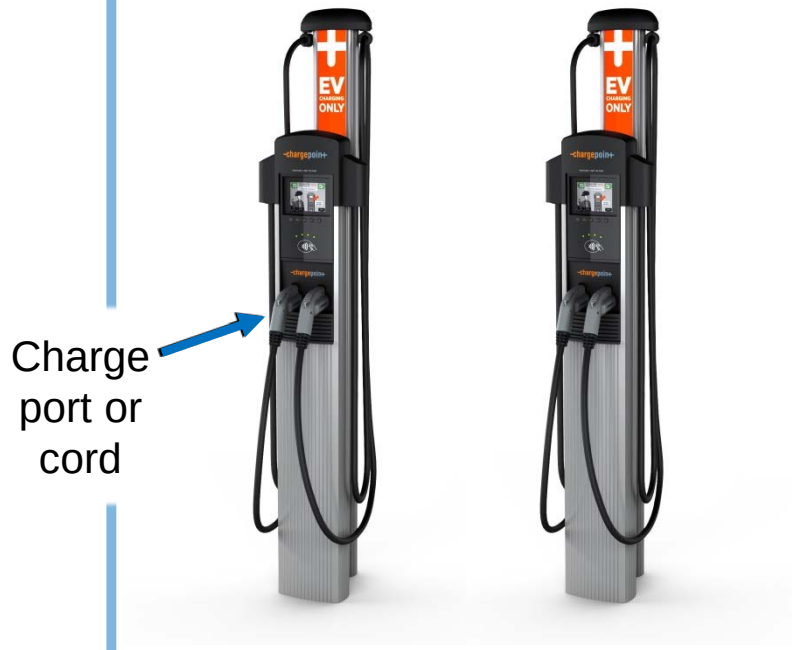
Dual-port DC fast charge EVSE unit or charging station

Single-port AC Level 2 EVSE unit or charging station

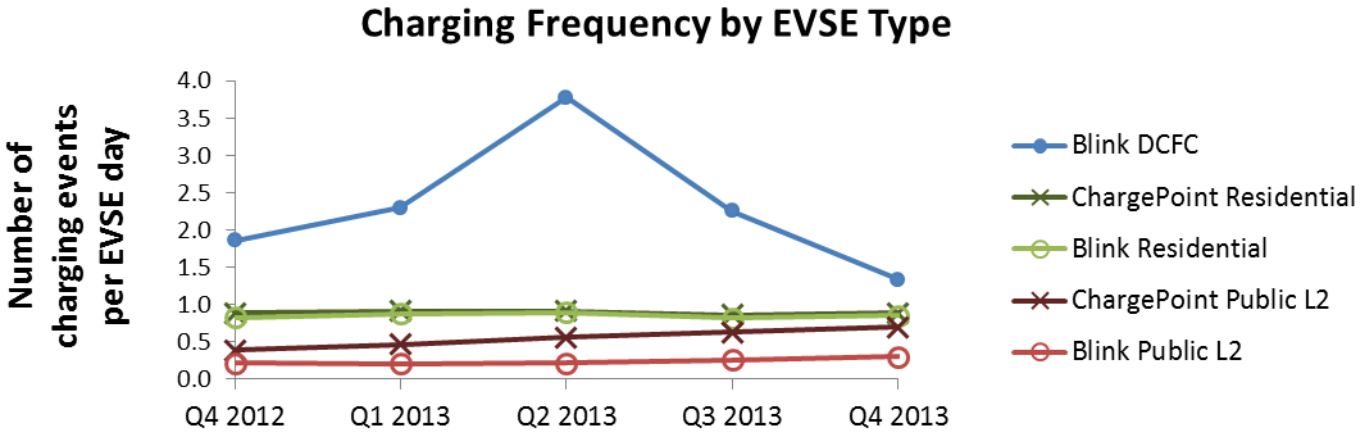
Charging site

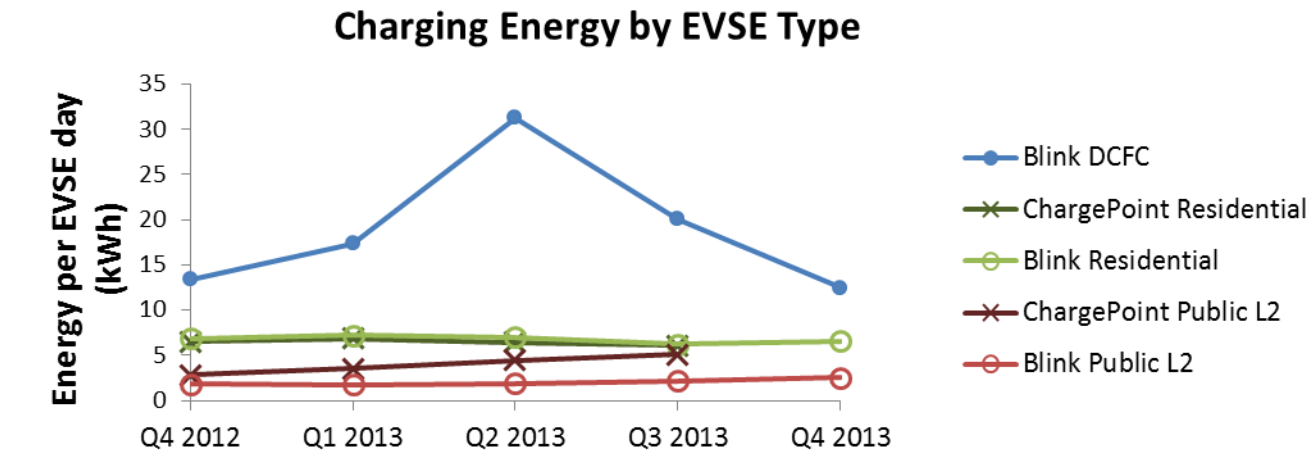
Dual-port AC Level 2 EVSE unit or charging station

Dual-port AC Level 2 EVSE unit or charging station



Usage Frequency of Public Level 2 EVSE and DC Fast Chargers





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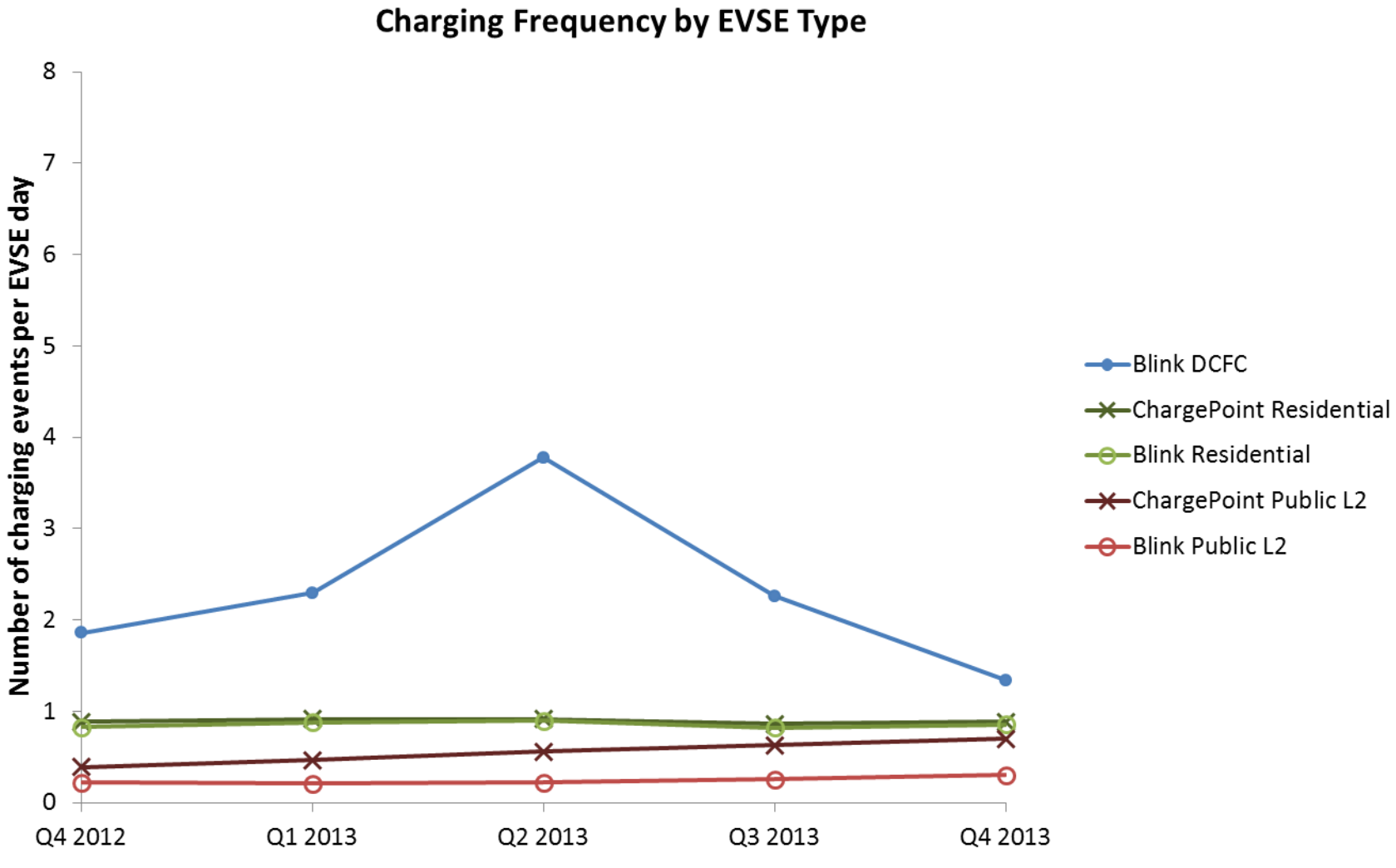

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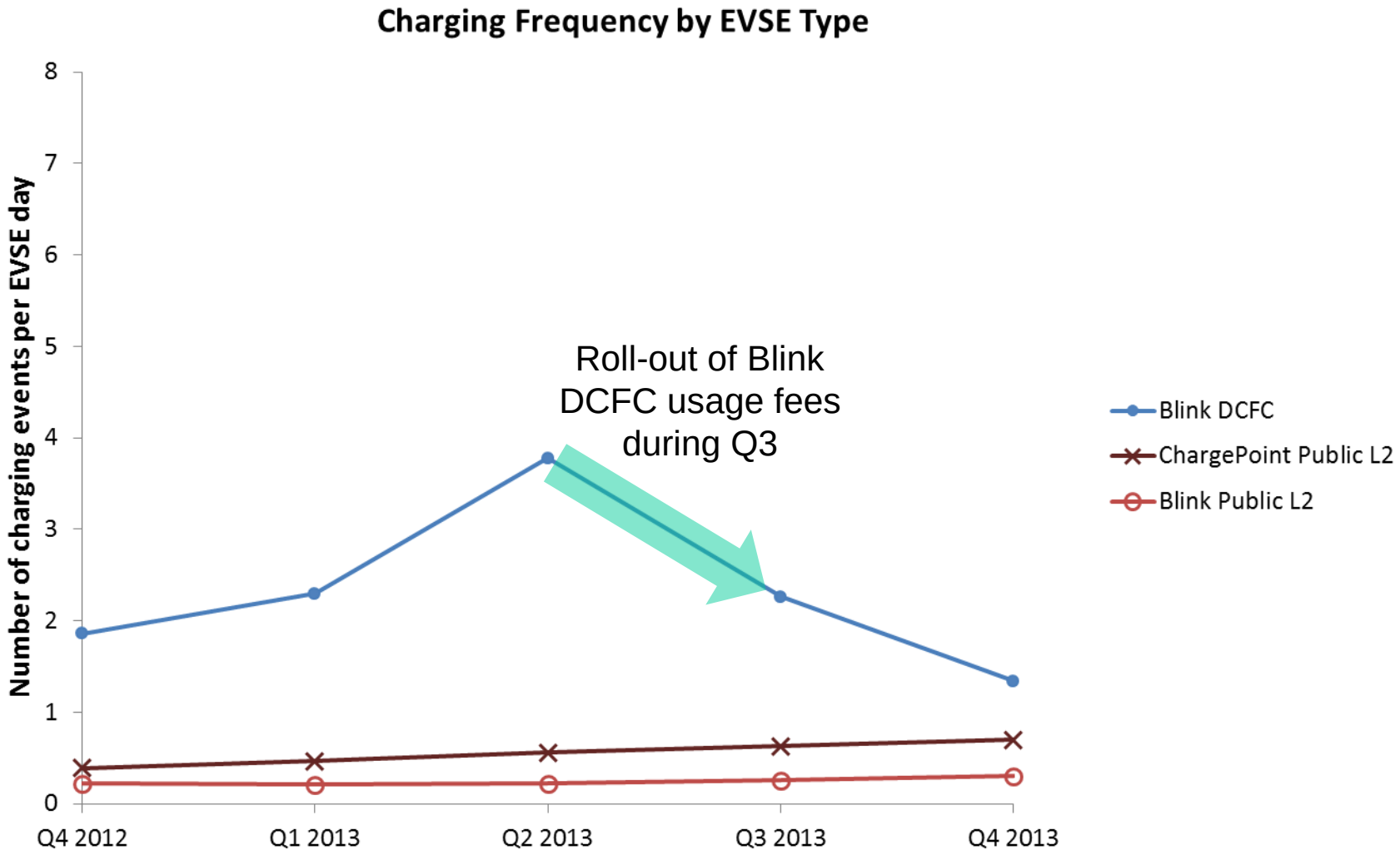

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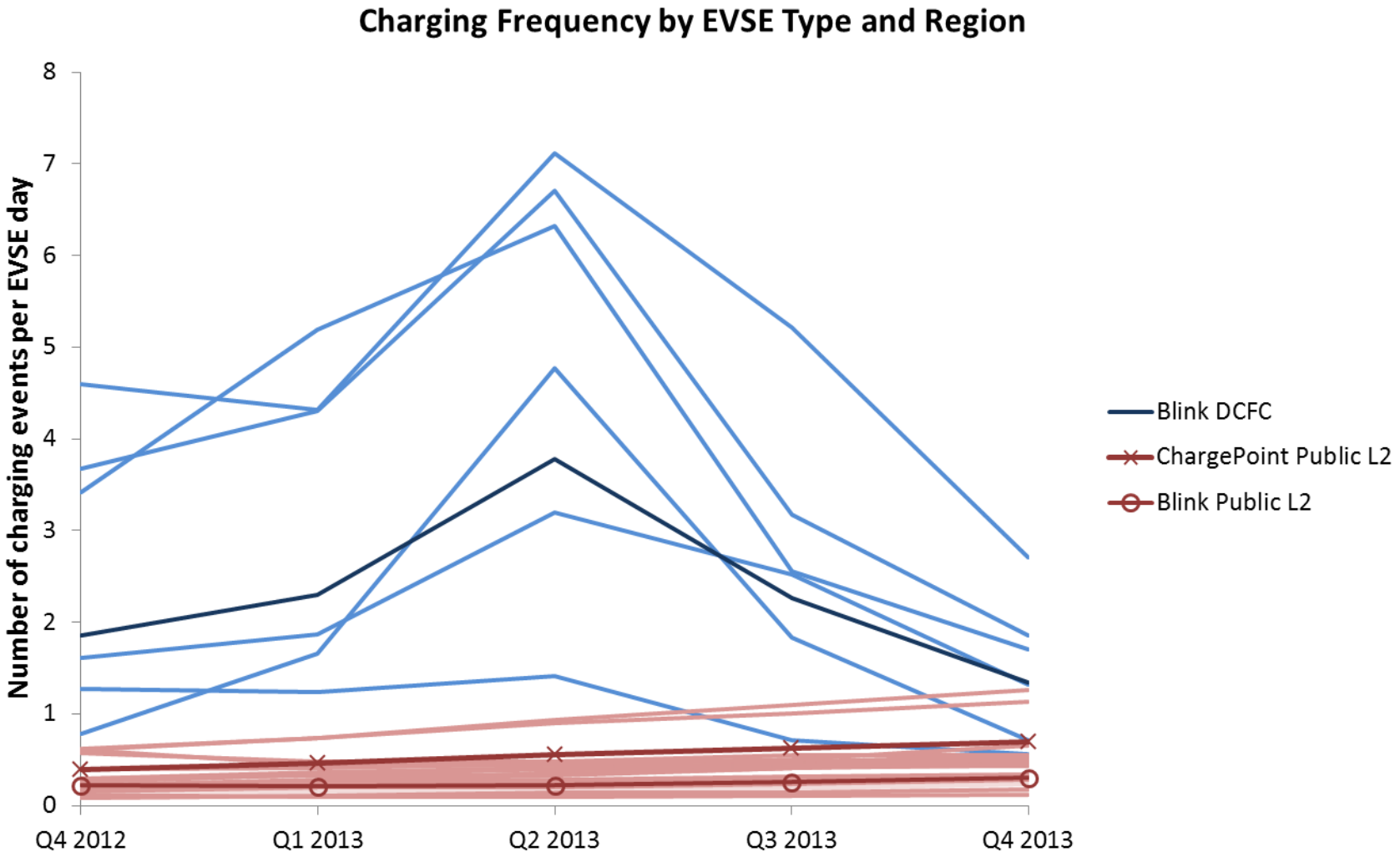

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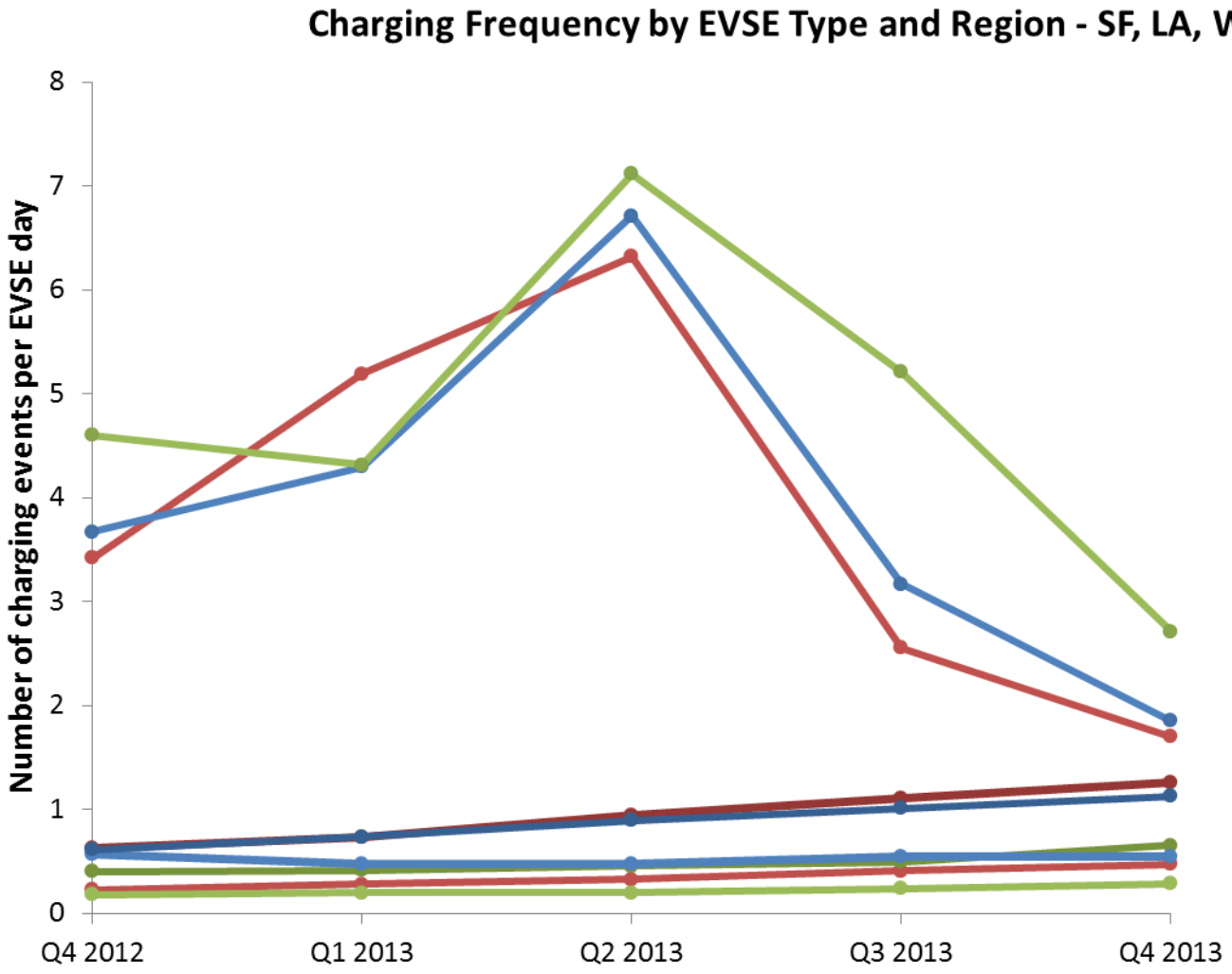
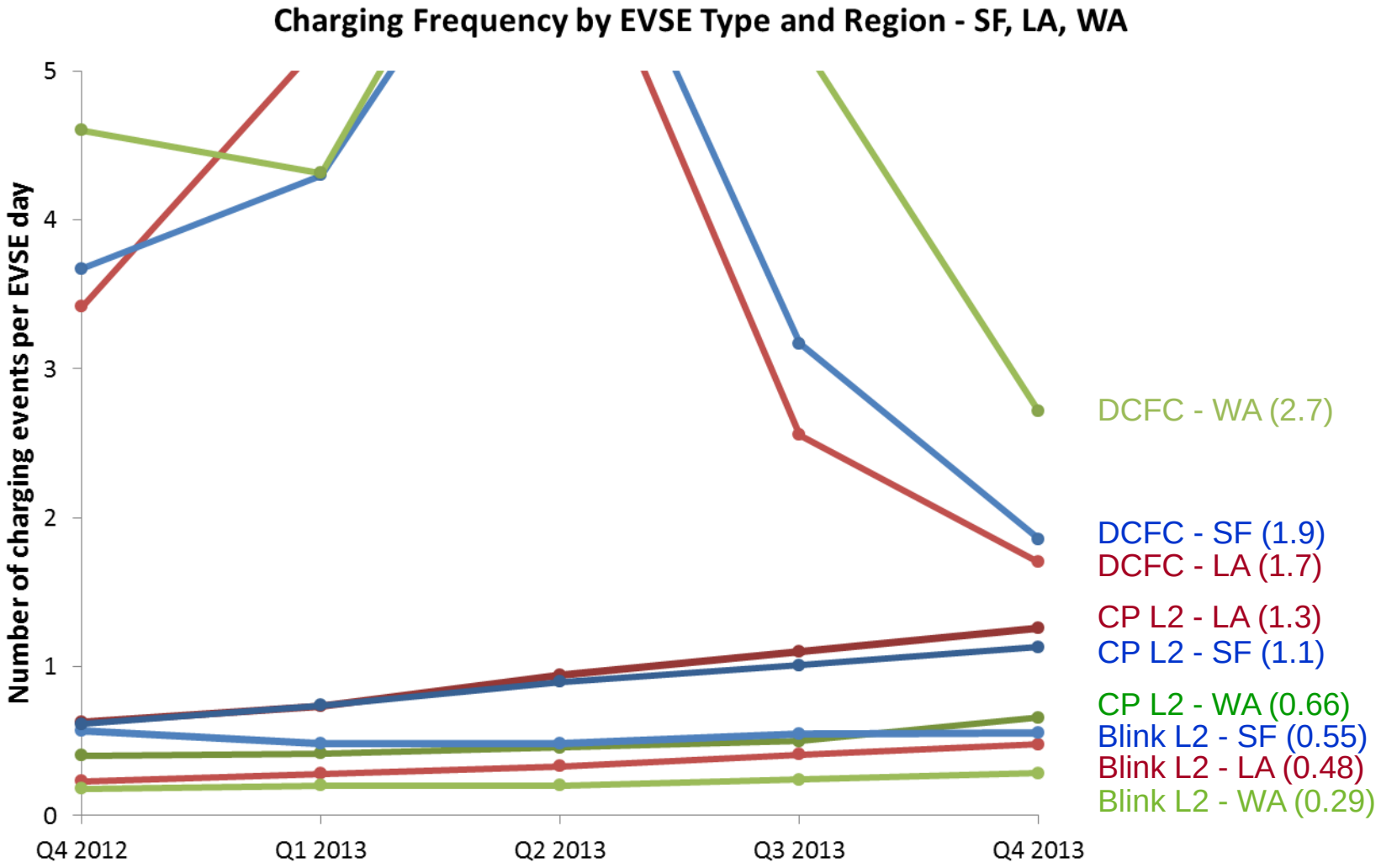
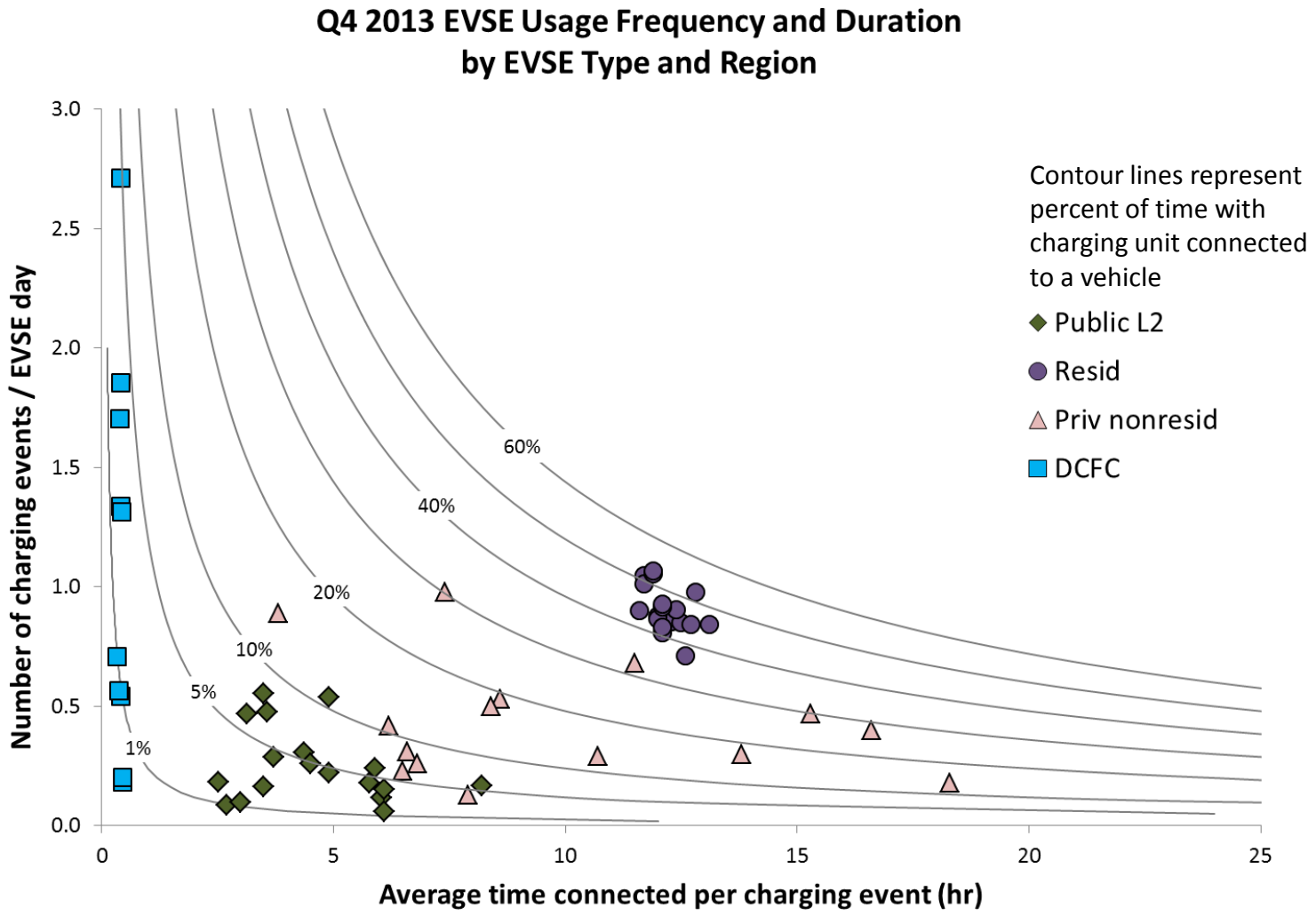


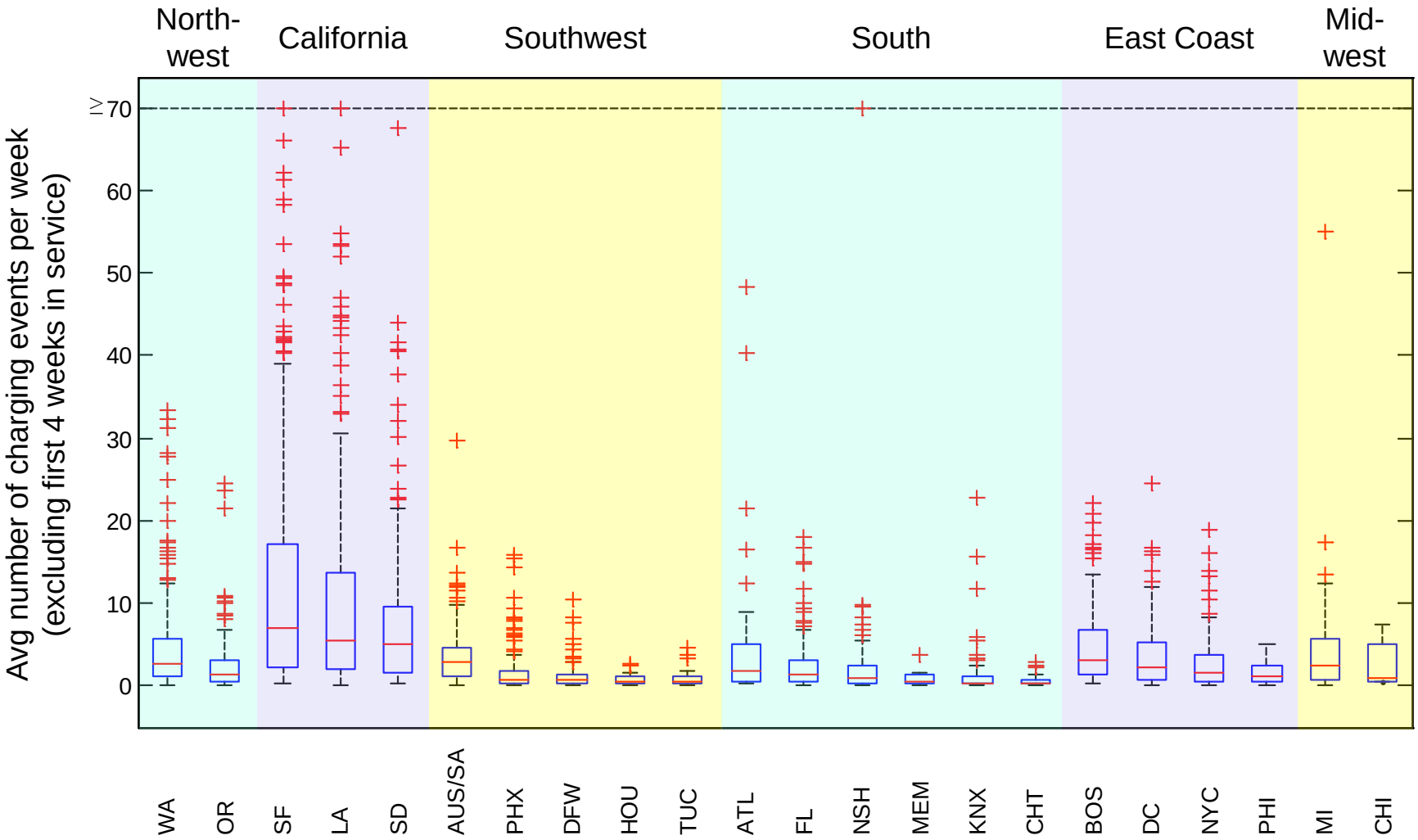
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers



Blink Charging Unit Usage



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

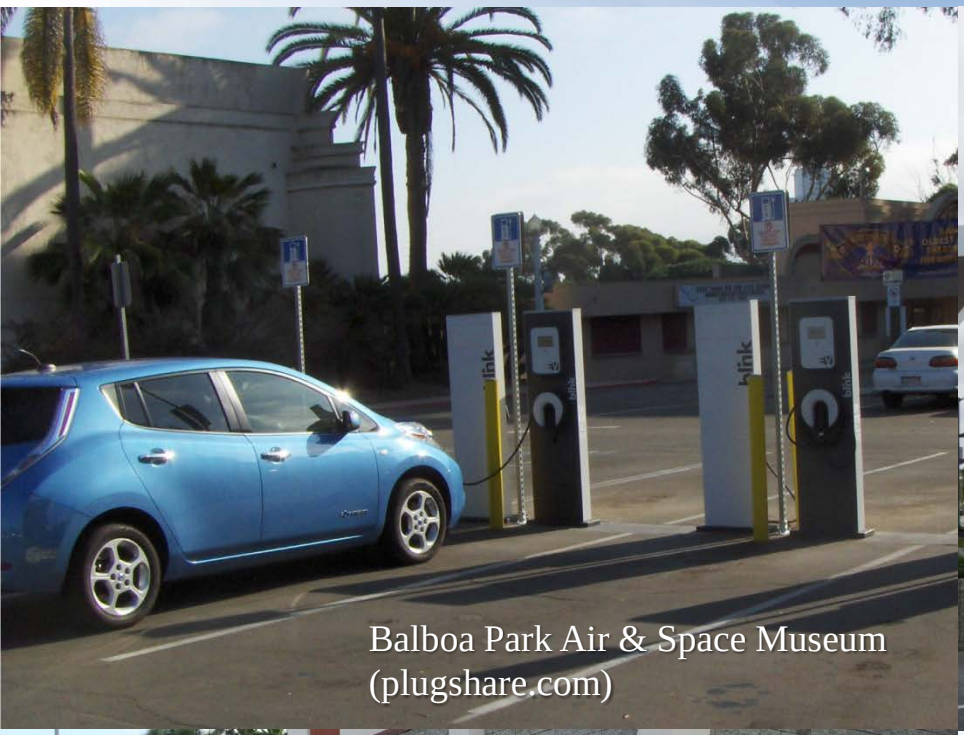
Date Range	1/1/2013 – 1/1/2014
Total Charging Events per Site	2500 - 6300
Average Number of Charging Events per Week per Site	60 -120
Sites by State	• 19 in California • 1 in Tennessee
Venues of the Top 20	• Parking Garage (8) • Business Office (5) • Public / Municipal (3) • Mall (2) • University (1) • Manufacturing plant (1)

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
    - Expected to park/charge for ~4 to 16 hrs
  - Restaurant or retail customer parking / charging
    - Expected to park/charge for 0.5 to 2+ hrs
  - Car sharing fleet vehicles
    - Expected to park/charge for 0.5 to 100+ hrs

Public Level 2 Charging Examples in San Diego

Idaho National Laboratory



Balboa Park Air & Space Museum
(plugshare.com)

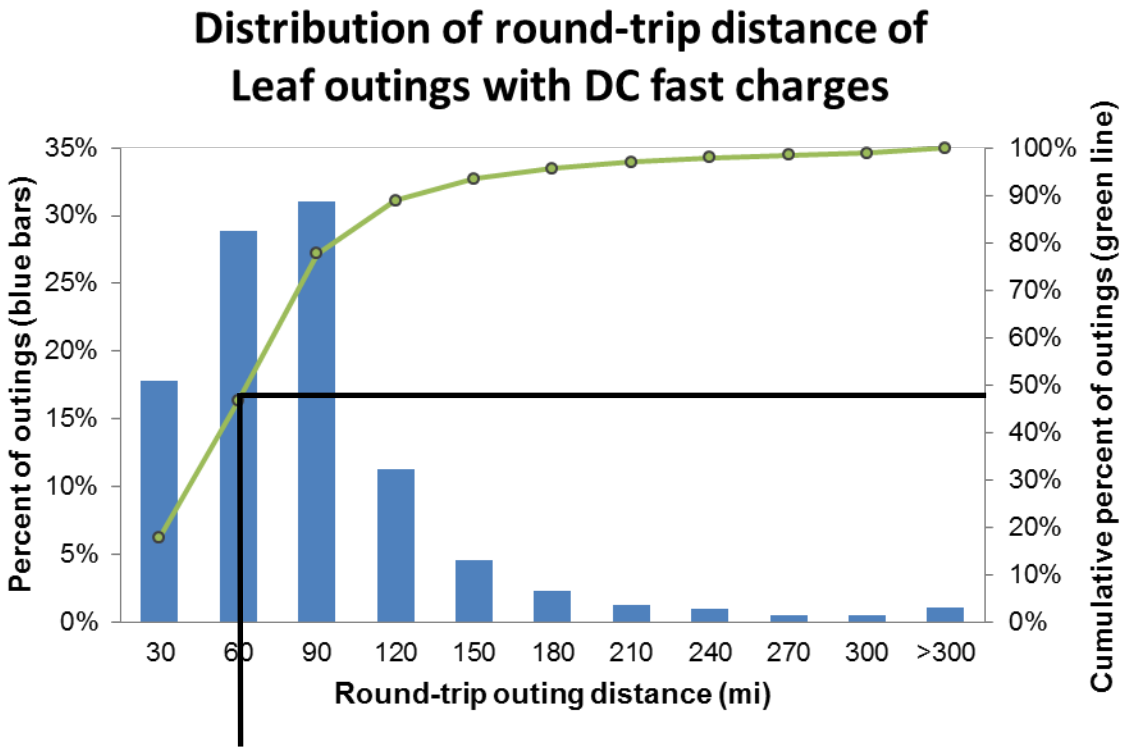
San Diego State University

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	• 11 in California • 7 in Washington • 2 in Oregon
Venues of the top 20	• Retail / Mall (6) • Business Office (5) •University (3) • Public / Municipal (2) • Auto Dealership (2) • Recreation / Museum (1) • Multi-Family (1)

EV Project Nissan Leaf DC Fast Charger Usage



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

Charging Site Location Considerations

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

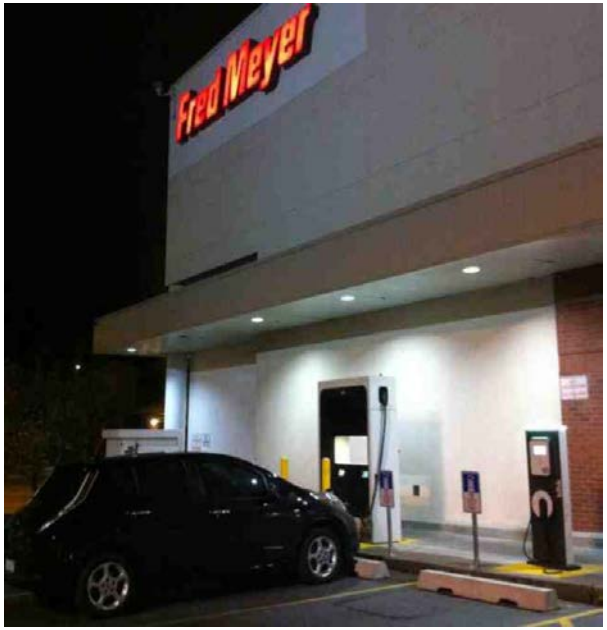
  "Charger is between 2 handicap spaces. To charge and not get ticketed you need to park behind the charger in any of 3 spaces closest to the elevator / entrance in non EV dedicated spots. Good Luck."

  – 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

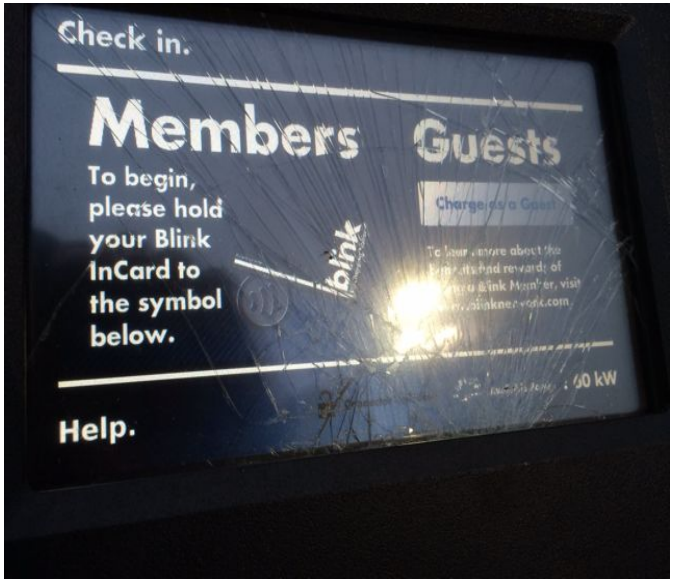
Photos from plugshare.com

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



Workplace Charging Examples

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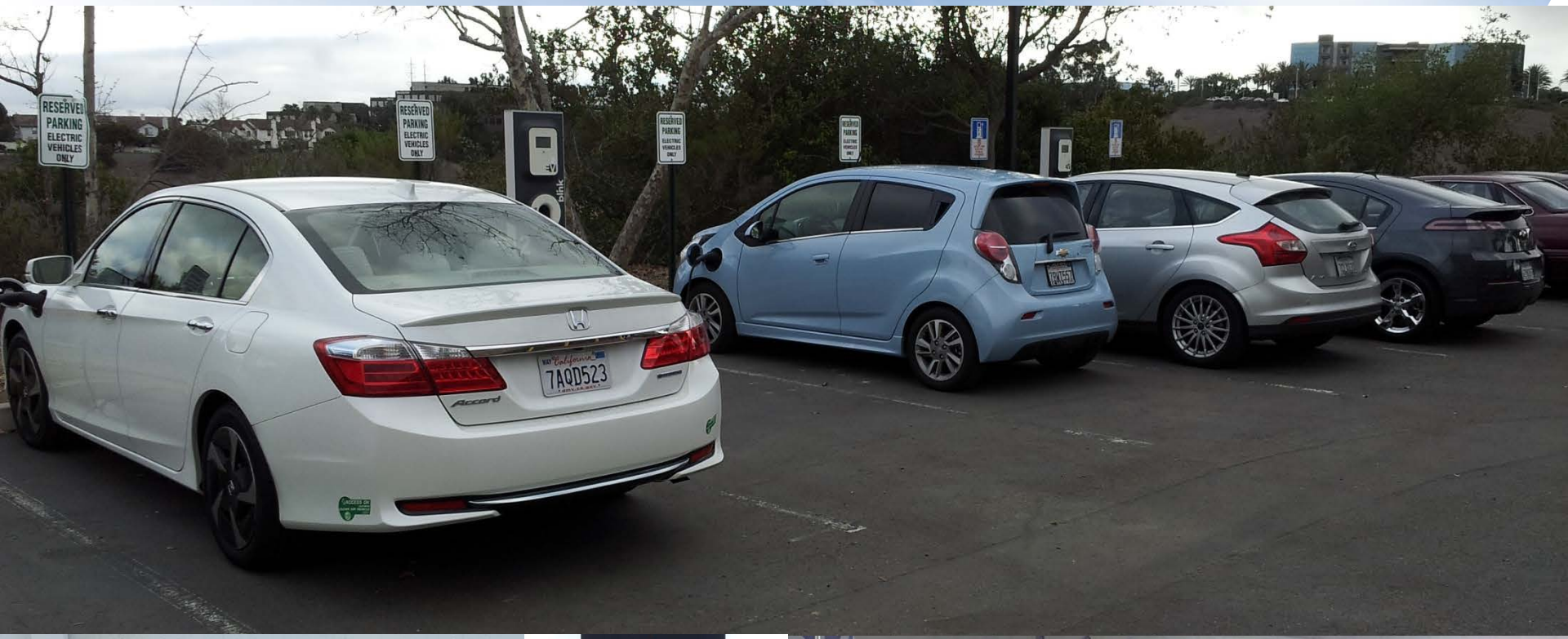


Workplace Charging Case Studies

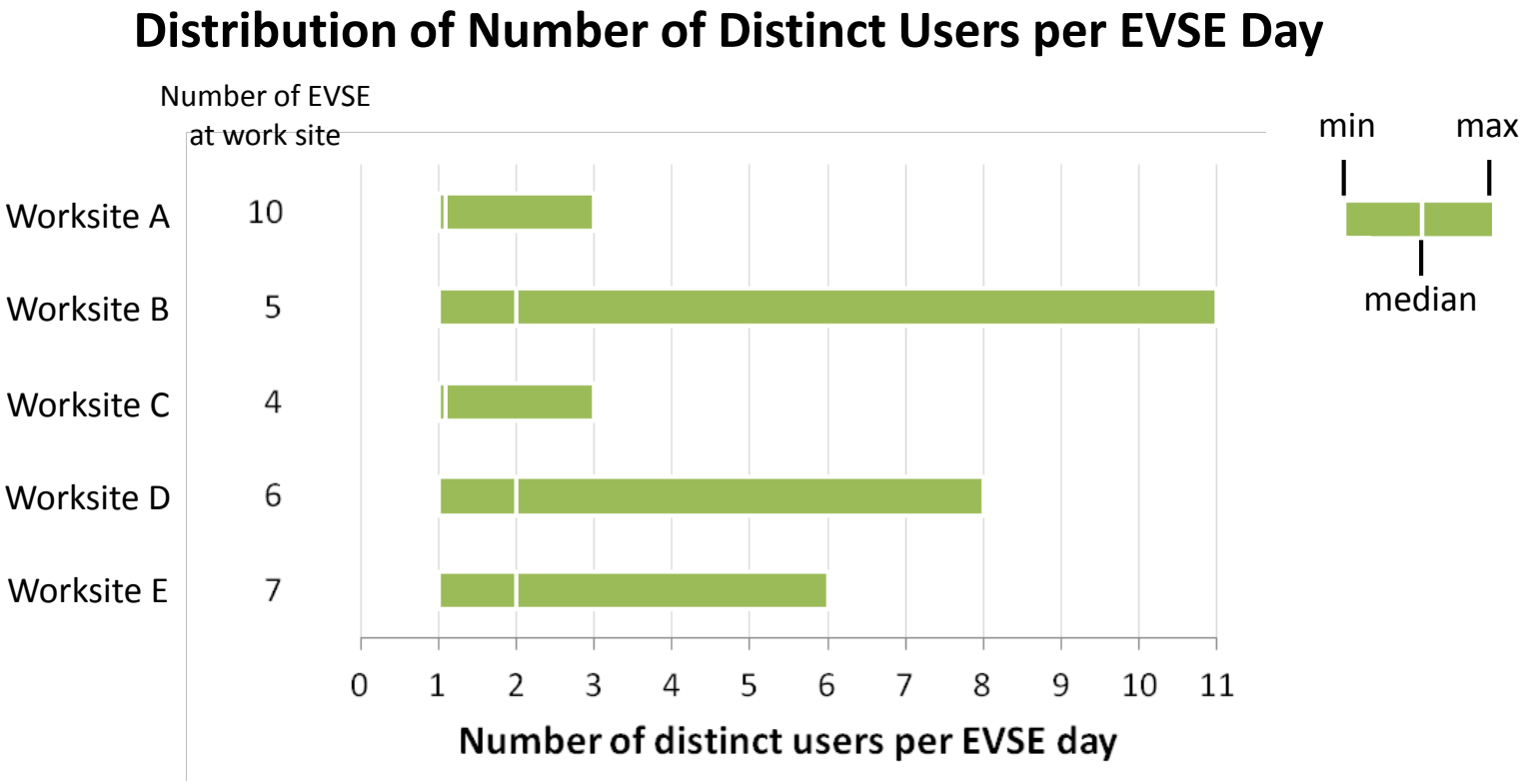
Workplace charging sites identified in two ways:

- Work sites where ChargePoint and Blink EVSE are installed
- Work sites where EV Project vehicles have charged
- Cross-referenced with AFDC database EVSE locations and descriptions

Workplace Charging Case Studies – Analysis of Workplace EVSE Data

Are drivers monopolizing workplace EVSE or do they move their vehicles during the day?

- 5 work sites with numerous ChargePoint or Blink level 2 EVSE were selected



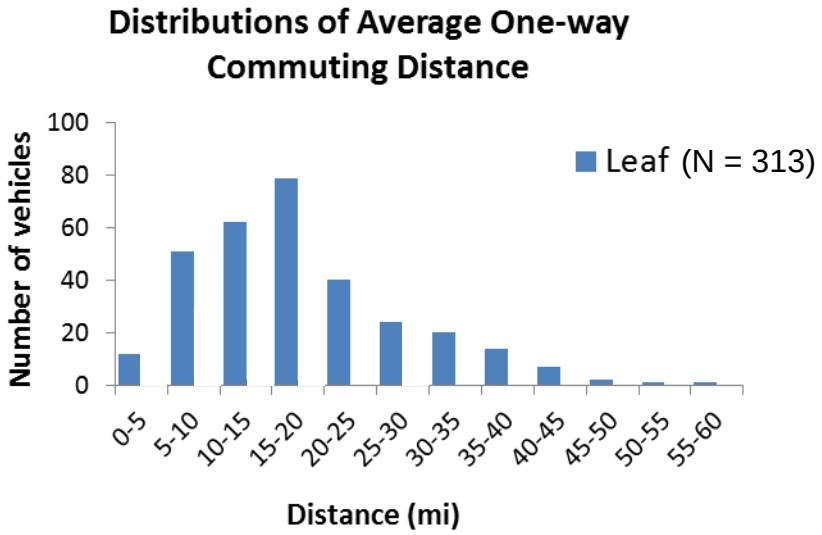
Workplace Charging Case Studies

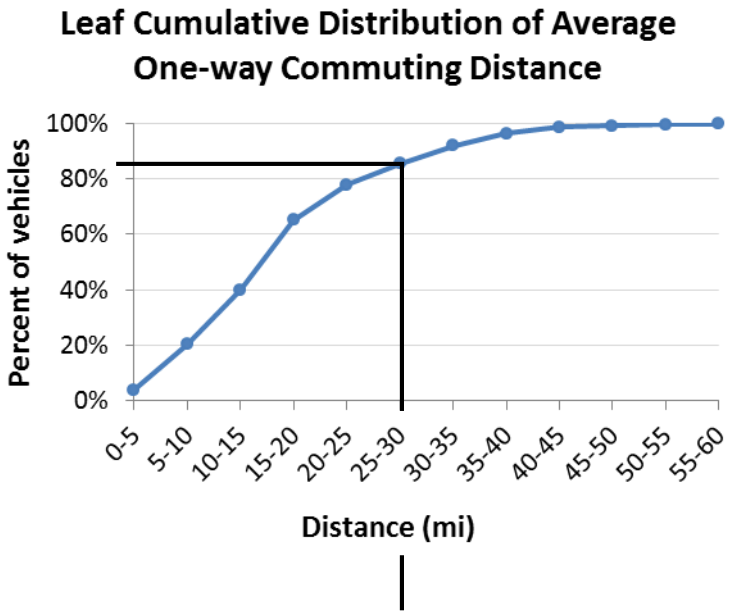
Summary of workplace charging work sites identified using ***vehicle data***

- 277 work sites with known EV charging for 140 companies
- Located in 11 metropolitan areas across the United States
- Wide variation between sites with respect to:
  - Size (from individual office buildings with small parking lots to large corporate complexes with multiple parking lots and garages)
  - Type and amount of charging equipment,
  - Number and make/model of vehicles that could potentially charge
  - Access (some sites are open to the general public; others are for employees only)
  - Cost (some sites exact fees for charging; others offer free charging)

Workplace Charging Case Studies – Commuting Distance

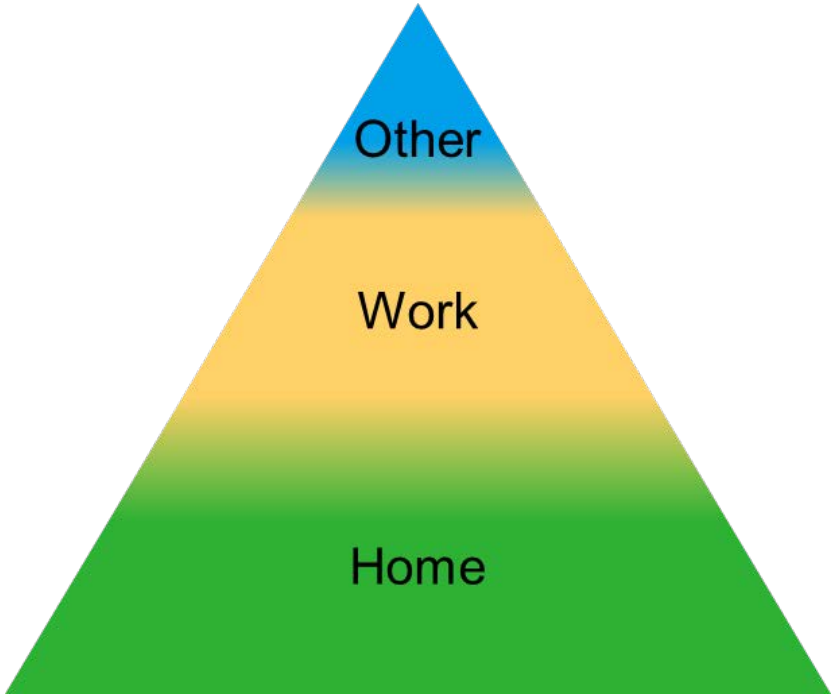
- Data from 313 Leafs which frequently parked at work sites with EV charging during Q2 2013





86% of EV Project Leafs parking at worksites identified average 30 miles or less between home and work

Workplace Charging Case Studies – Charging Location Preference



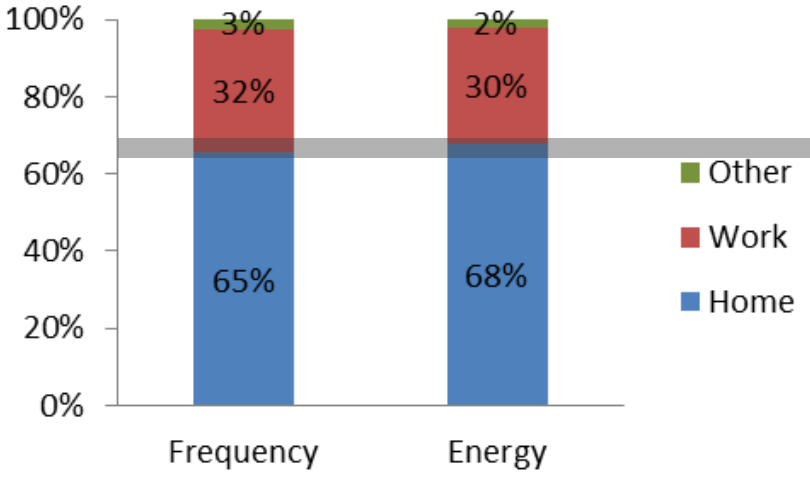
Charging Location Preference – Nissan Leaf

- 2012 – 2013 study period
- 707 EV Project Nissan Leafs frequently parked at worksites where PEVs are known to have charged
- 200,000+ total charging events
- How often did these drivers charge at home, work, and other locations?
- How does this compare to the location preference of the overall set EV Project Nissan Leaf drivers?

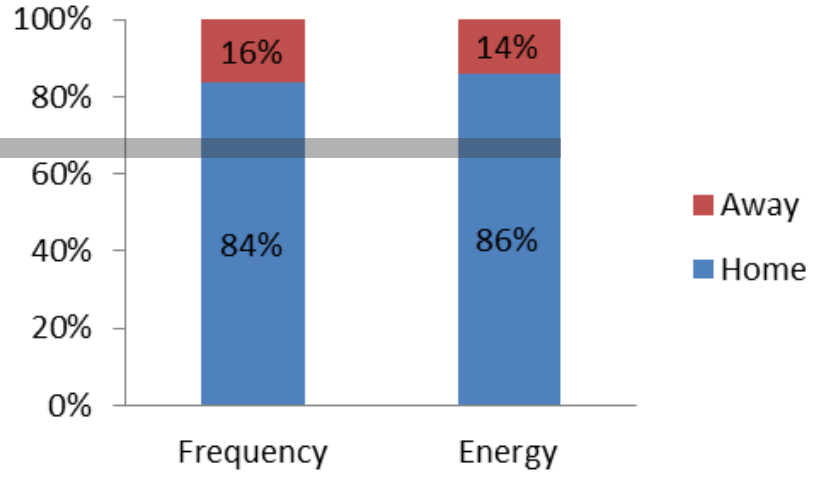
- Full paper entitled “Where do Nissan Leaf drivers in The EV Project charge when they have the opportunity to charge at work?” is available at avt.inl.gov/evproject.shtml under “Lessons Learned White Papers”

Charging Location Preference – Nissan Leaf

Group of Nissan Leafs with Access to Workplace Charging 2012 – 2013



Overall Set of EV Project Nissan Leafs 2012 – 2013



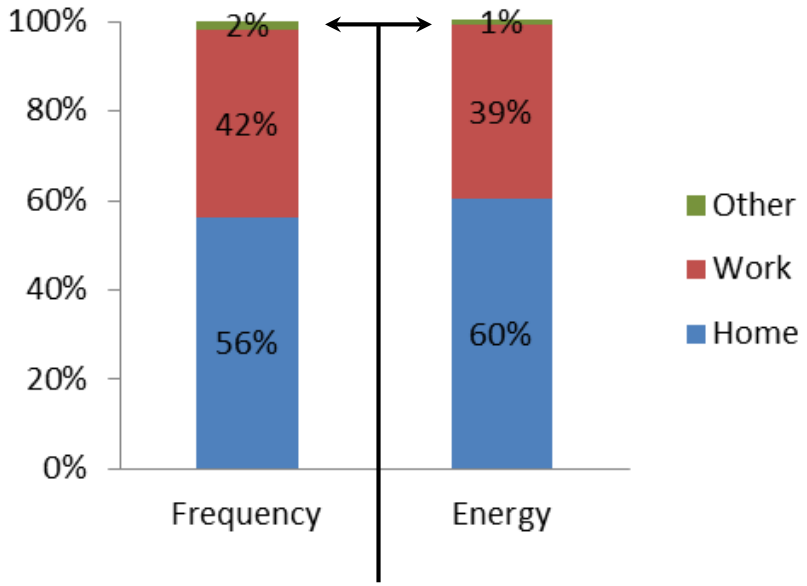
"Workplace vehicles" charged away from home more than twice as much as the overall project group

Most of that away-from-home charging was at work

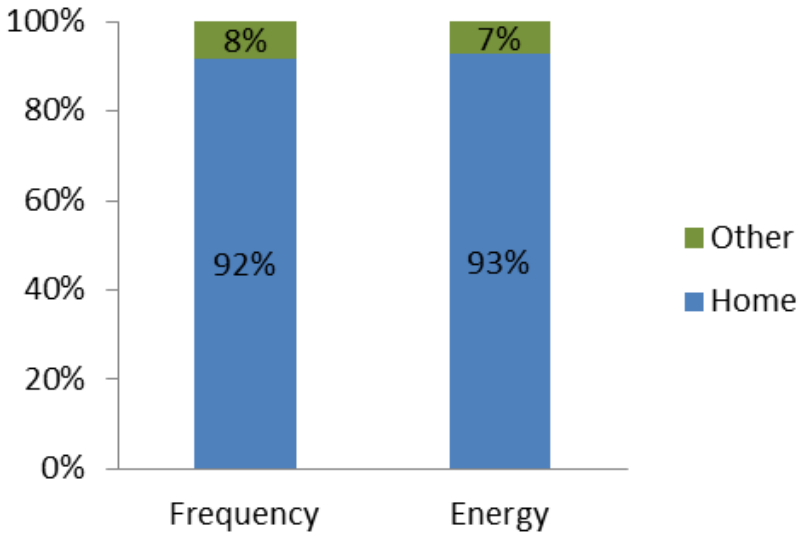
Charging Location Preference – Nissan Leaf

Group of Nissan Leafs with Access to Workplace Charging
2012 – 2013

Days When Vehicles Were Parked at Work



Days When Vehicles Were Not Parked at Work

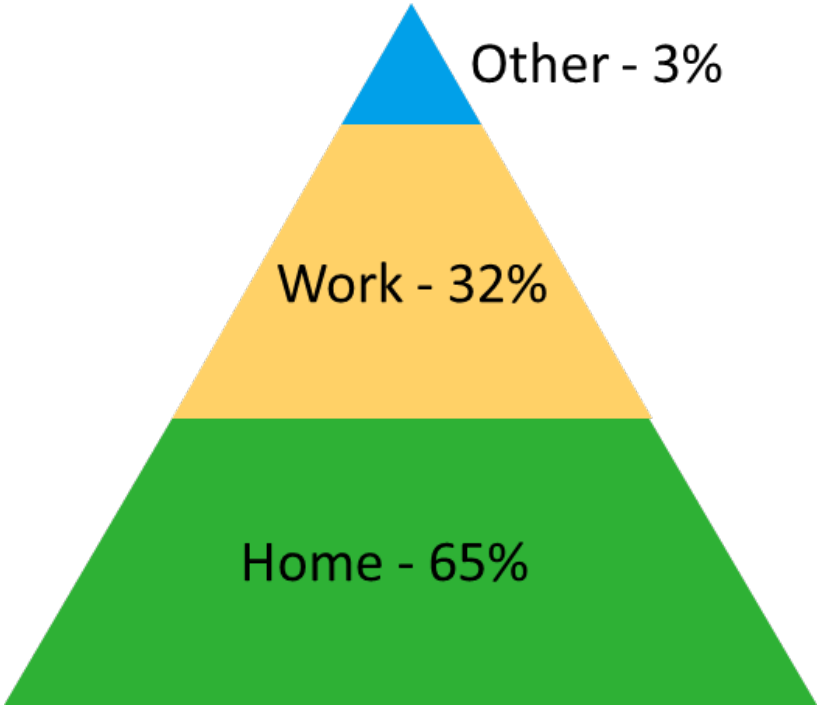


In aggregate, workplace vehicle drivers had little use for public infrastructure on days when they went to work

Charging Location Preference – Nissan Leaf

Group of Nissan Leafs with Access to Workplace Charging, 2012 – 2013

Overall Charging Frequency by Location (to scale)



Careful!

How important is this 3% to individual drivers' mobility needs?

How does cost to use workplace charging influence this behavior?

Conclusion

Questions to answer

- What are the key differences in charging station use between regions?
  - San Francisco, Los Angeles, Washington State lead the country in public EVSE use
  - San Diego public Level 2 use high because of Car2Go fleet charging
- Which stations are used most frequently, and which least frequently?
  - For level 2, parking garages and business office lots
  - For DCFC, retail/mall and business office lots
  - Resist urge to rush to conclusions on infrequently used sites
- How are drivers using the stations?
  - Multiple users per EVSE per day at workplaces
  - Multiple use cases for same charging site
  - Those with access to workplace charging use it
  - Cost matters by some measures, but more analysis needed
- 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:

- White papers on
  - Leaf L2 vs. DCFC usage
  - public charging venues
  - More from workplace charging case studies
  - 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

INL/MIS-14-31614

Additional Context

Number of public charging sites nationwide

- Blink: 1,793
- ChargePoint: 1,302

Blink usage fees

- Public Level 2 fees started Jul – Aug 2012
  - Varies from $1.00 to $2.00 / hr
  - 16% of sites are still free (per local site host discretion)
- DC Fast Charger (DCFC) fees started Jun – Aug 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