

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

John Smart, Jim Francfort

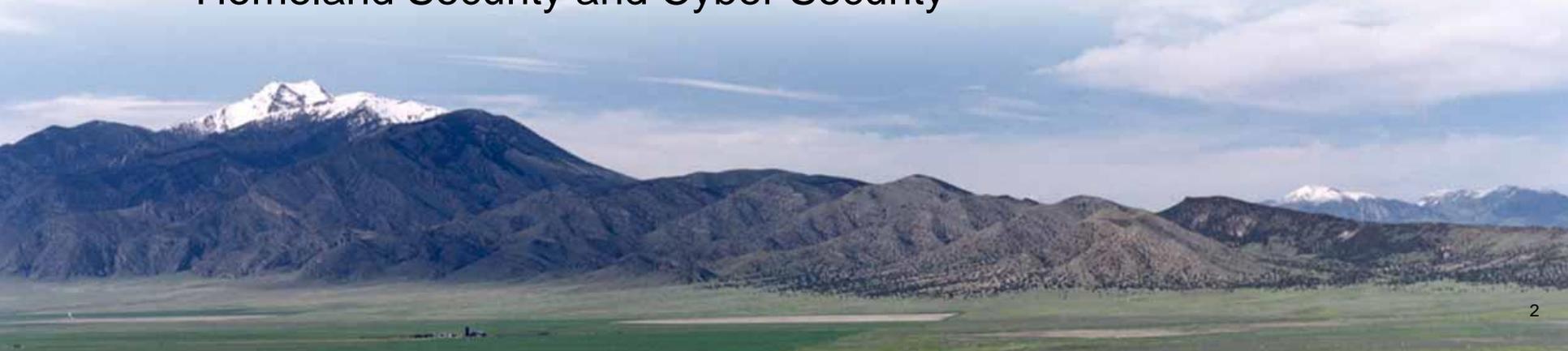
Grid Interaction Tech Team meeting
May 7, 2014

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 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

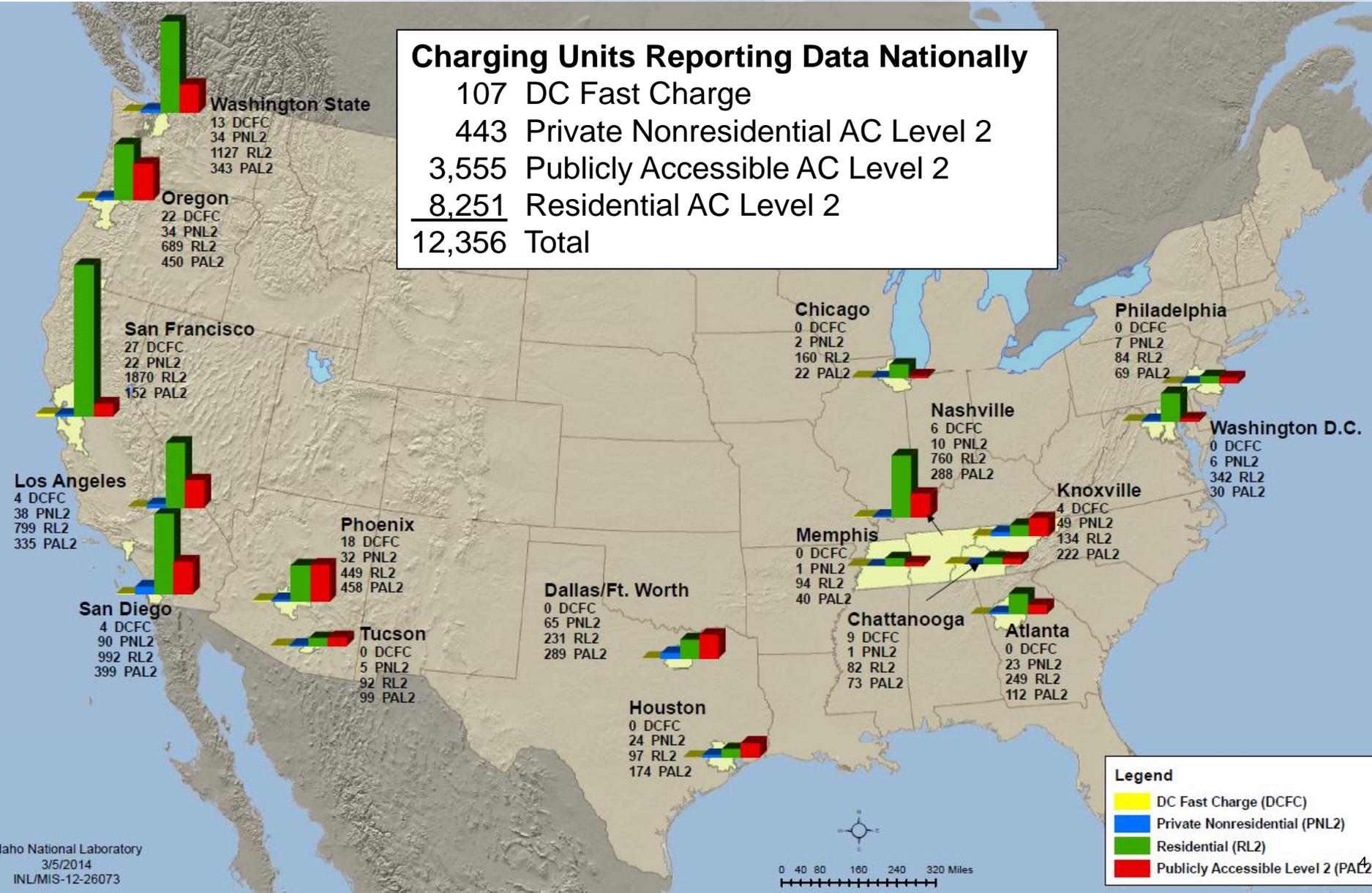
- Deploy 4,700+ residential and public AC level 2 charging units in 11 US regions
- Study customer usage of residential and public infrastructure
- INL data collection May 2011 – Dec 2013



Infrastructure Deployment in The EV Project through December 2013

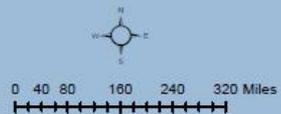
Charging Units Reporting Data Nationally

- 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**

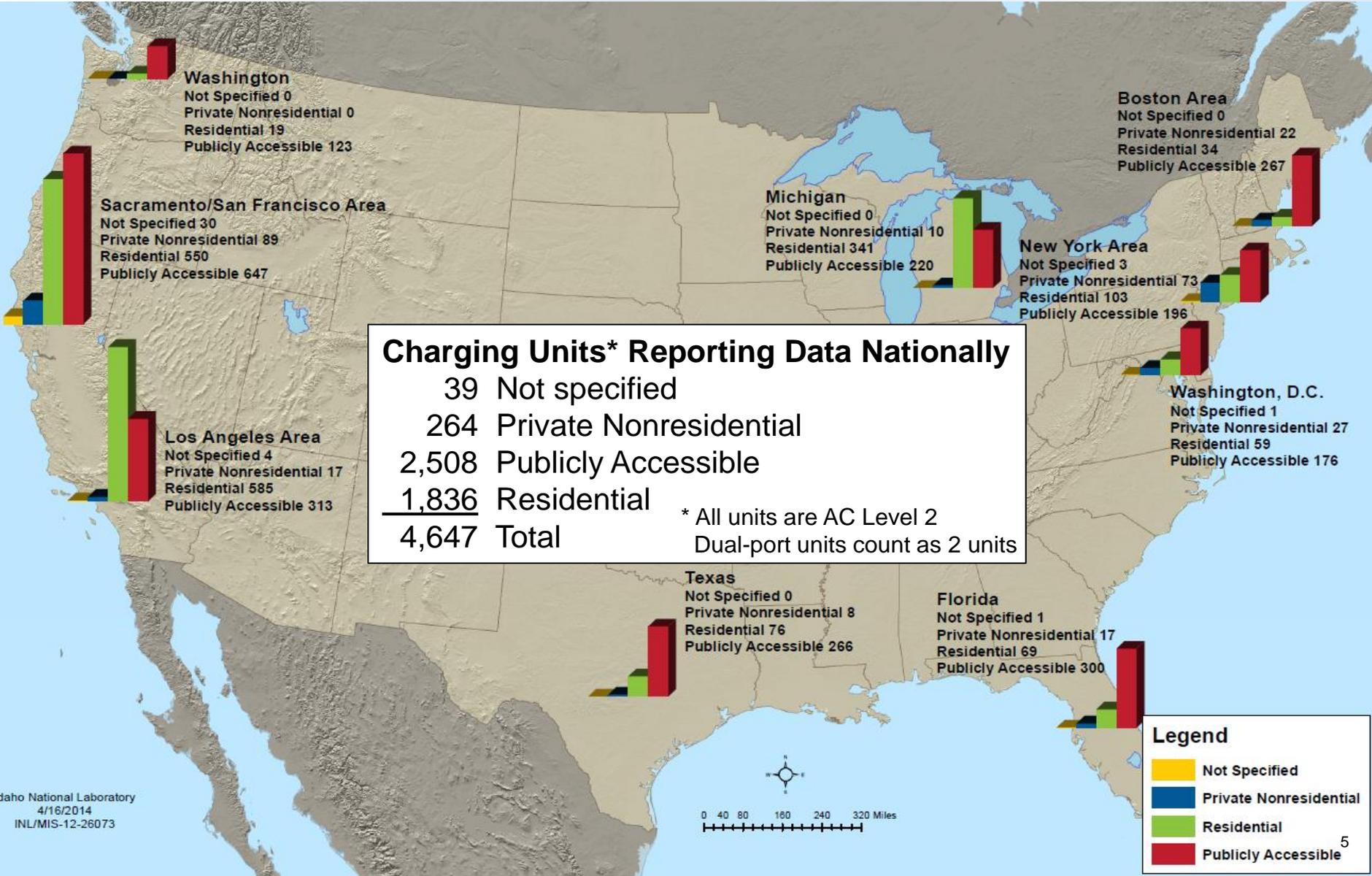


Legend

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



Infrastructure Deployment in ChargePoint America through December 2013

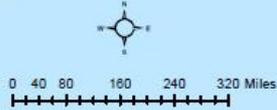


Charging Units* Reporting Data Nationally	
39	Not specified
264	Private Nonresidential
2,508	Publicly Accessible
1,836	Residential
4,647	Total

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

Legend

- Not Specified
- Private Nonresidential
- Residential
- Publicly Accessible



Outline

- How much are public AC level 2 EVSE and DC fast chargers used?
- What was the impact of implementing payment for use of DCFC
- Which stations are used most 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

Charge port or cord



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

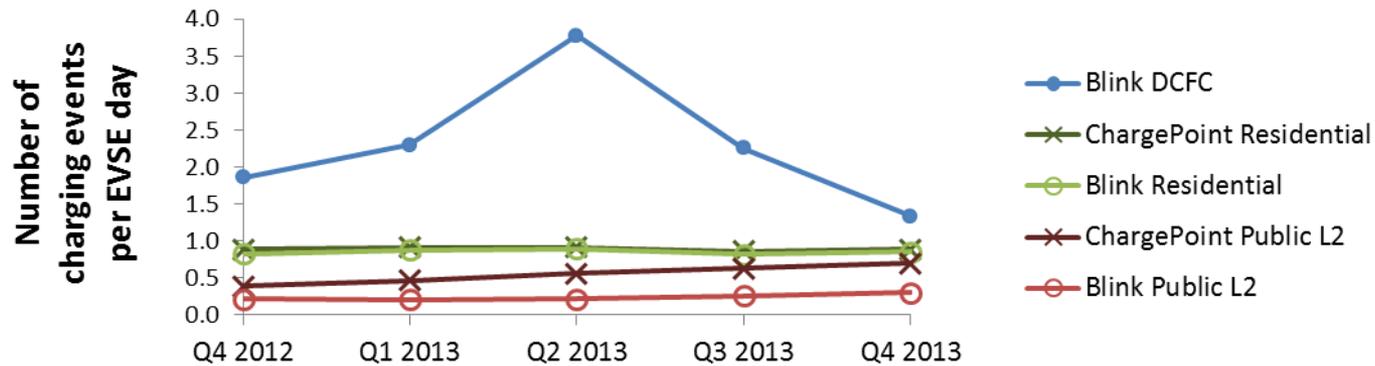
Dual-port AC
Level 2 EVSE
unit or
charging
station

Charge
port or
cord

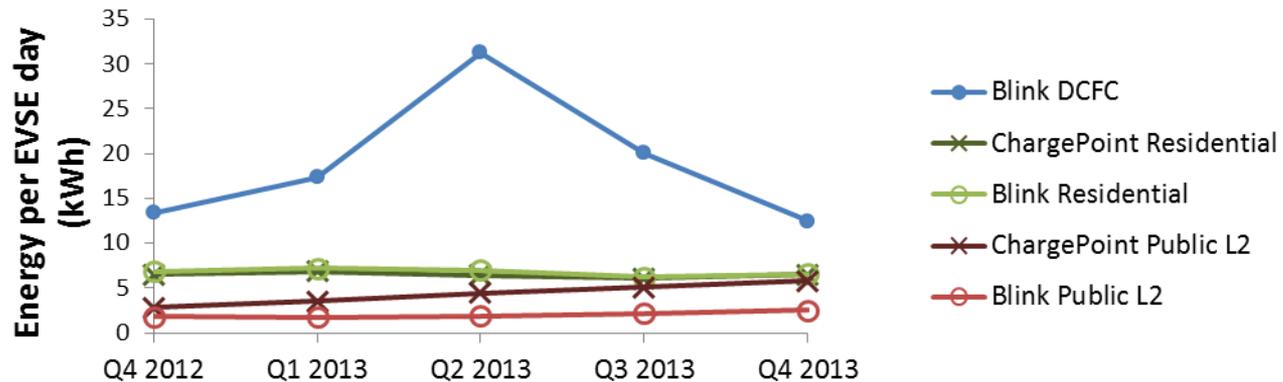


Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type

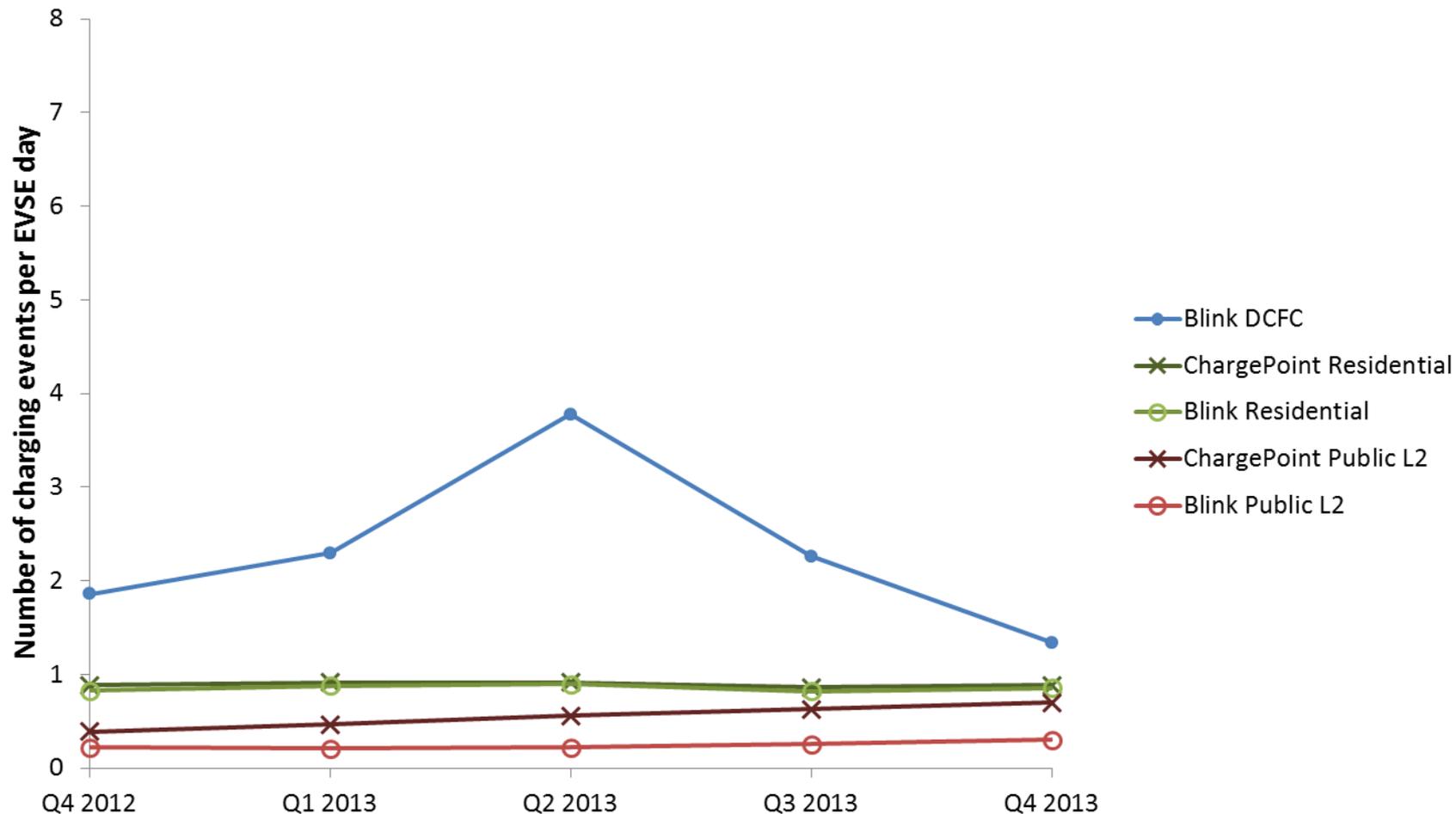


Charging Energy by EVSE Type



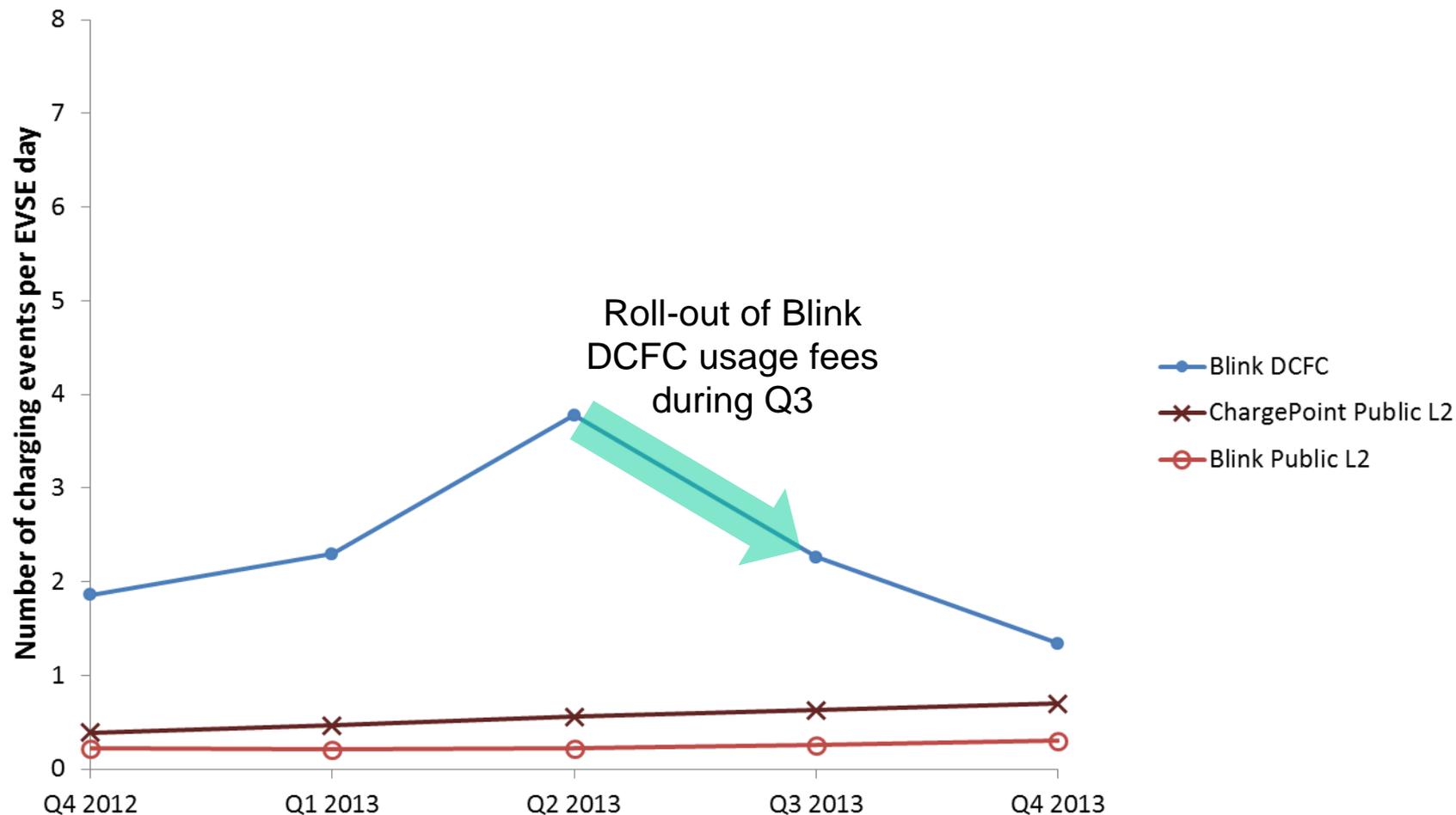
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type



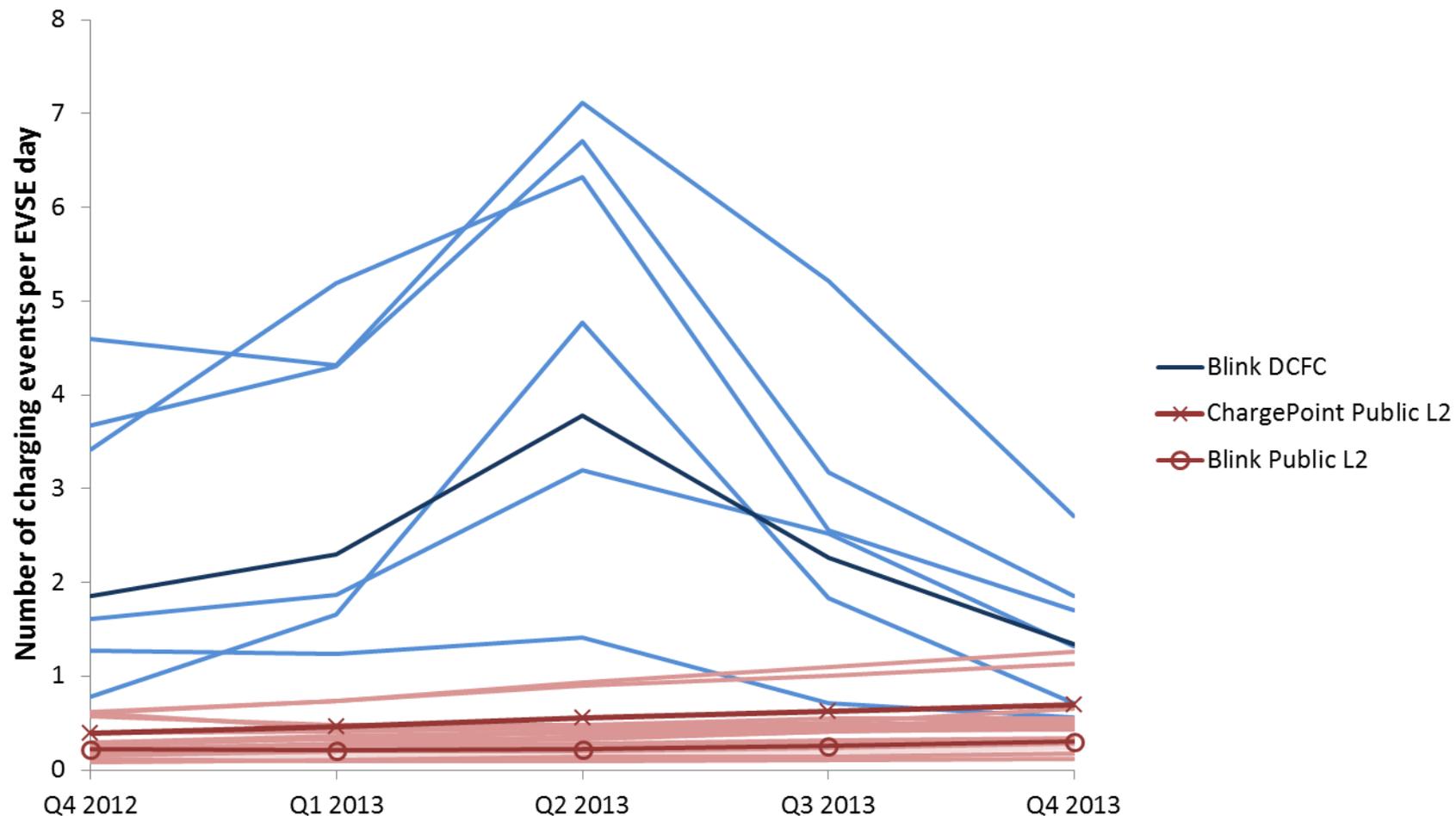
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type



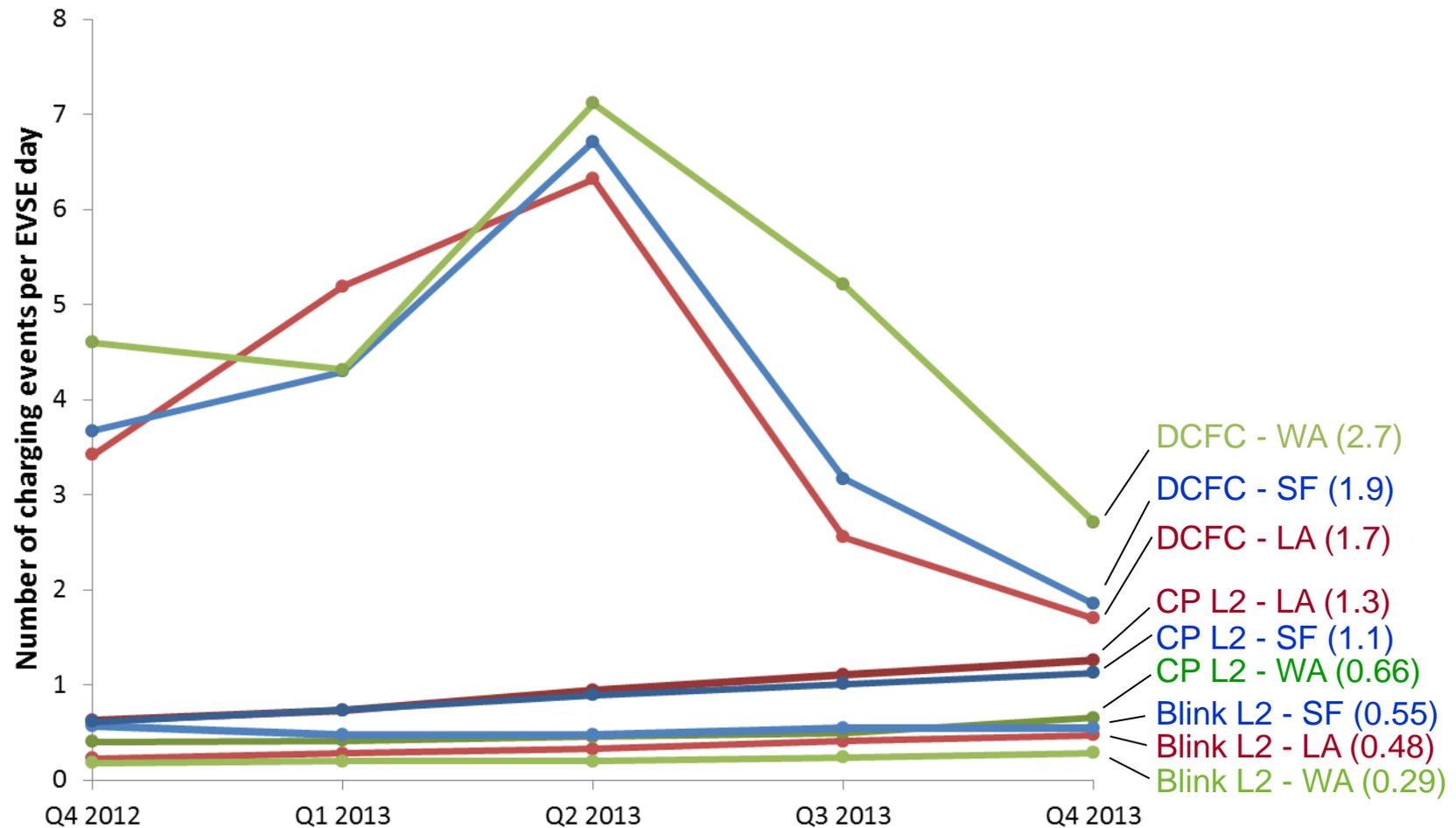
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type and Region



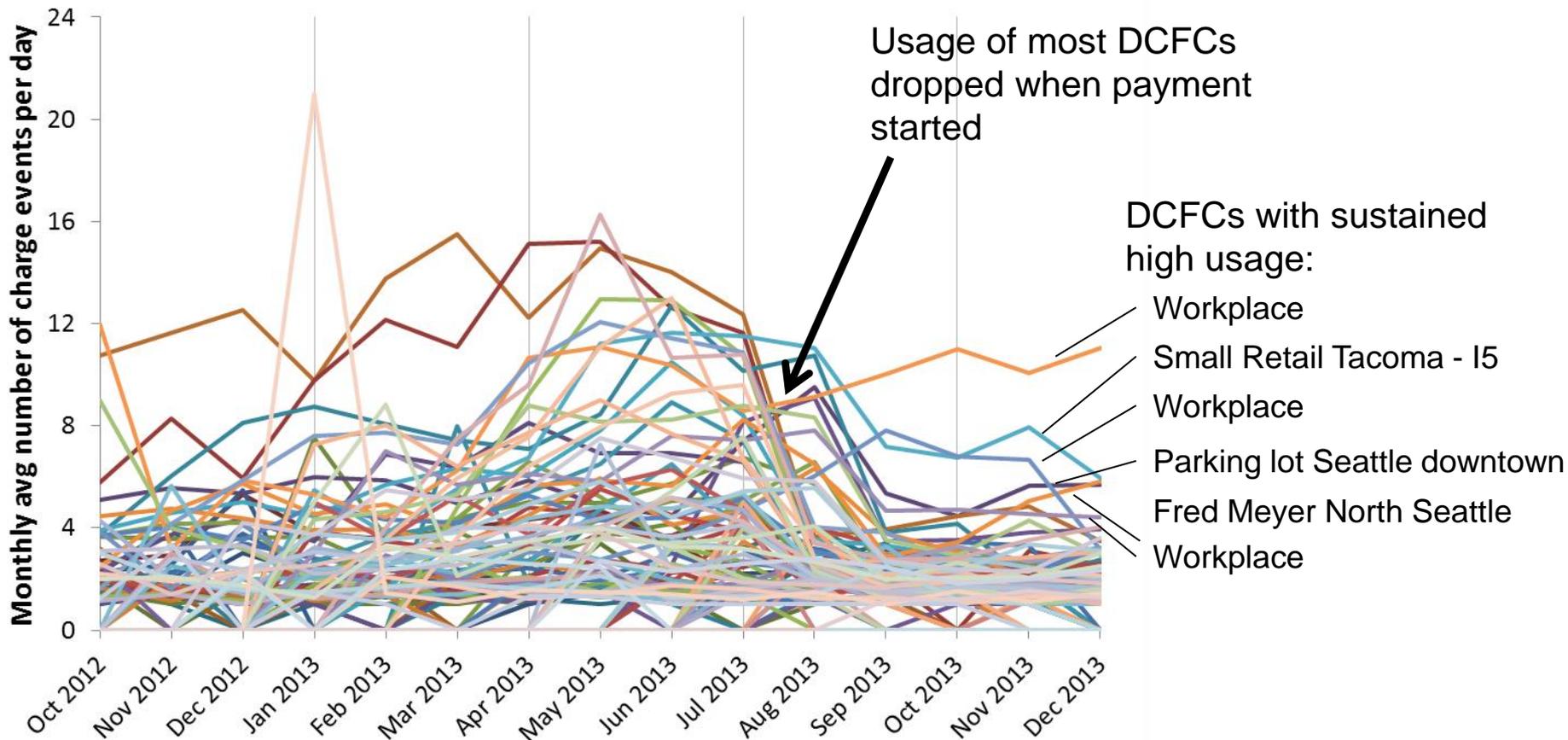
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

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



Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

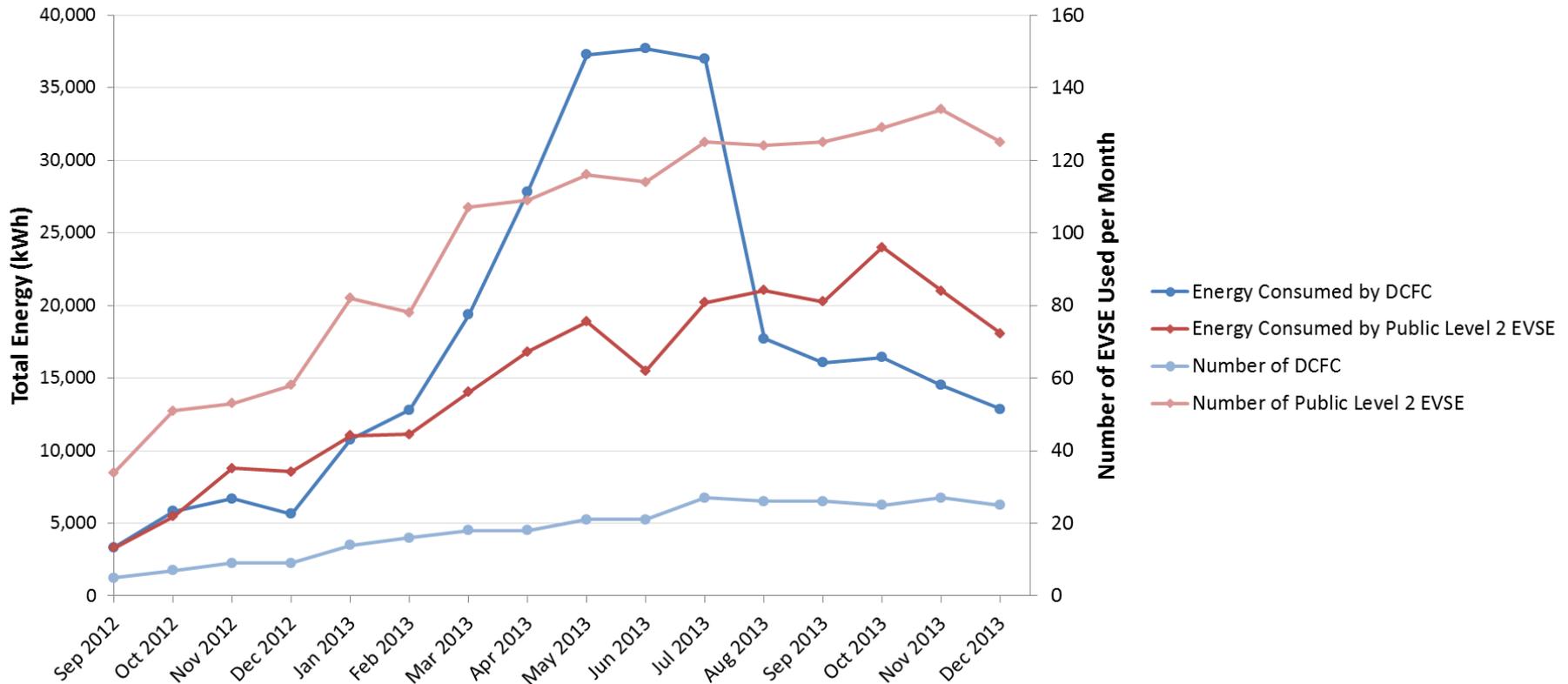
Monthly Average Number of Charging Events per Day for Each DCFC



Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

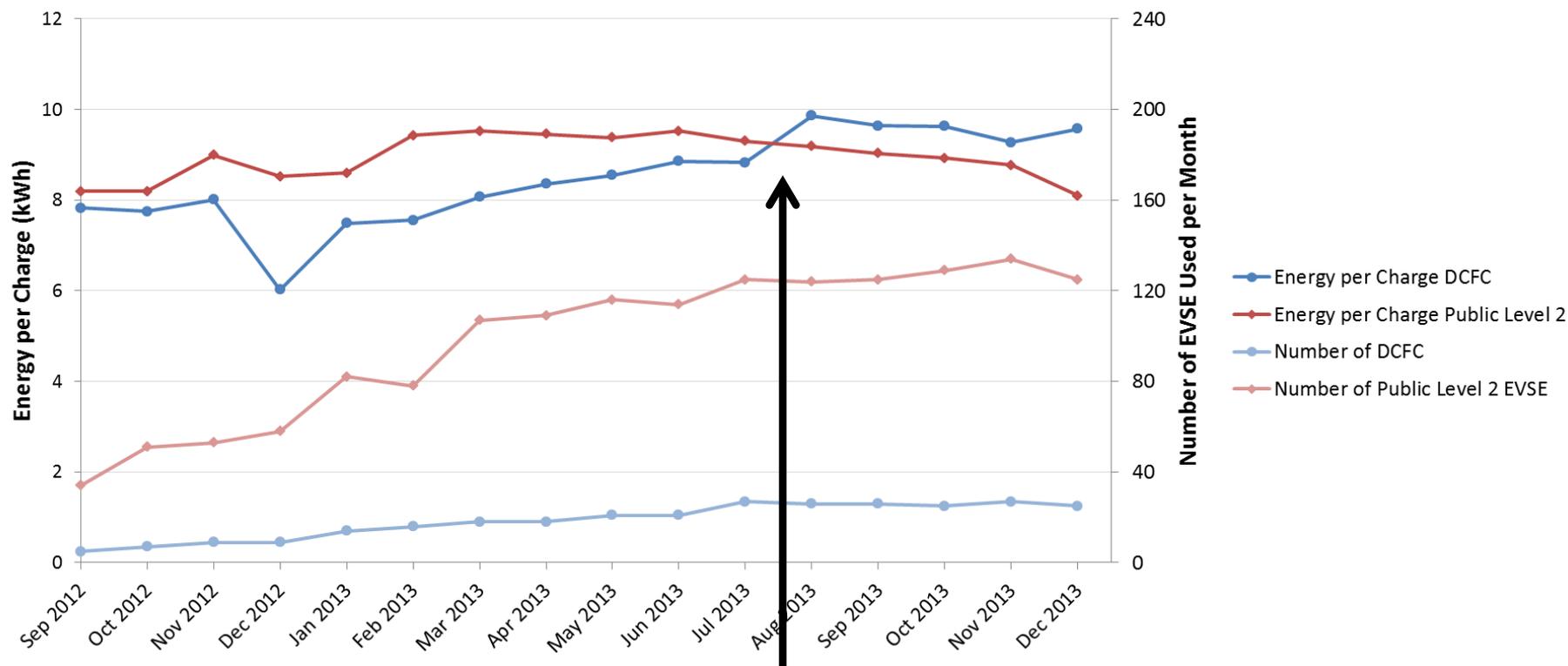
- Overall energy consumption in San Francisco for “popularity” comparison

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



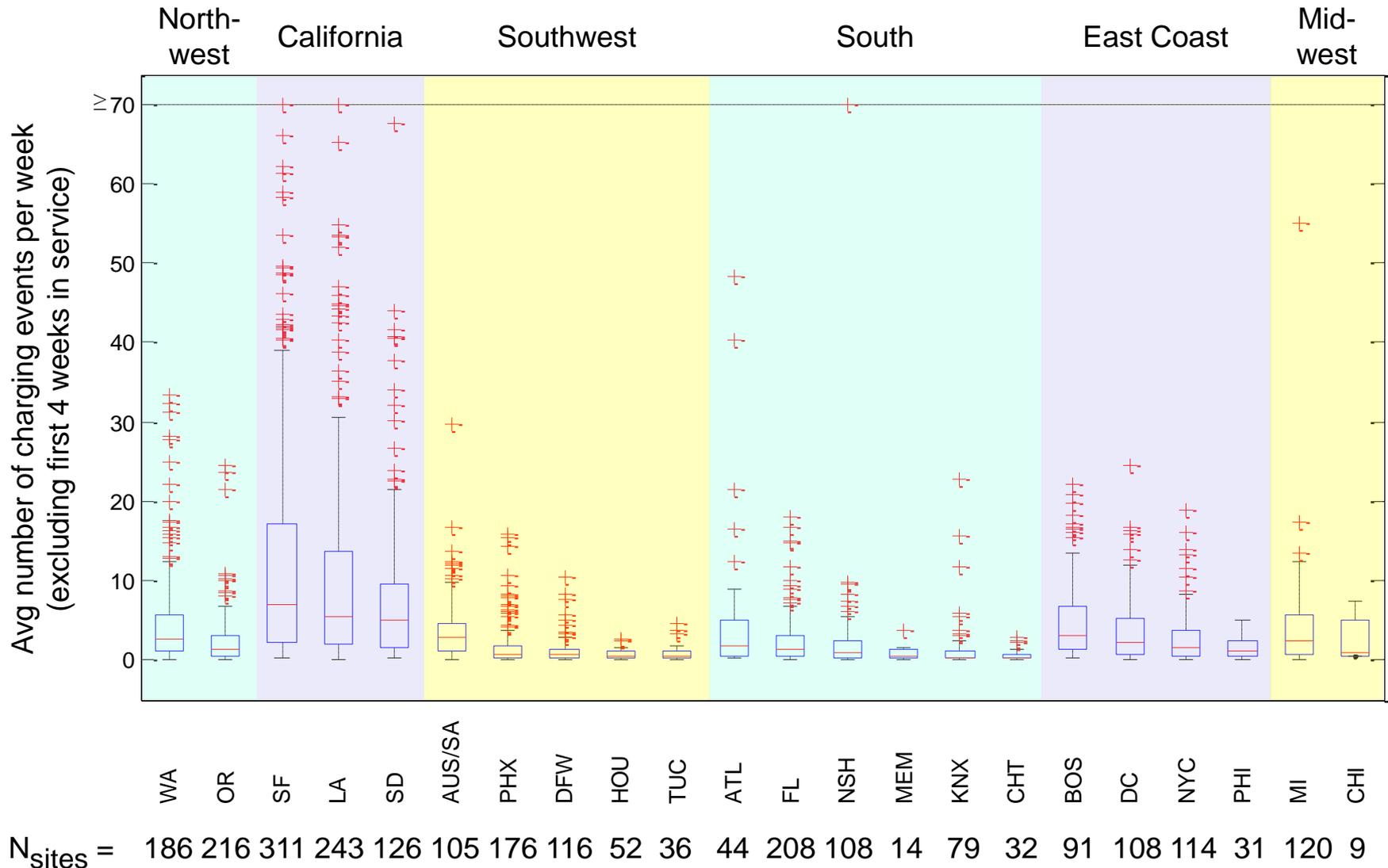
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

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



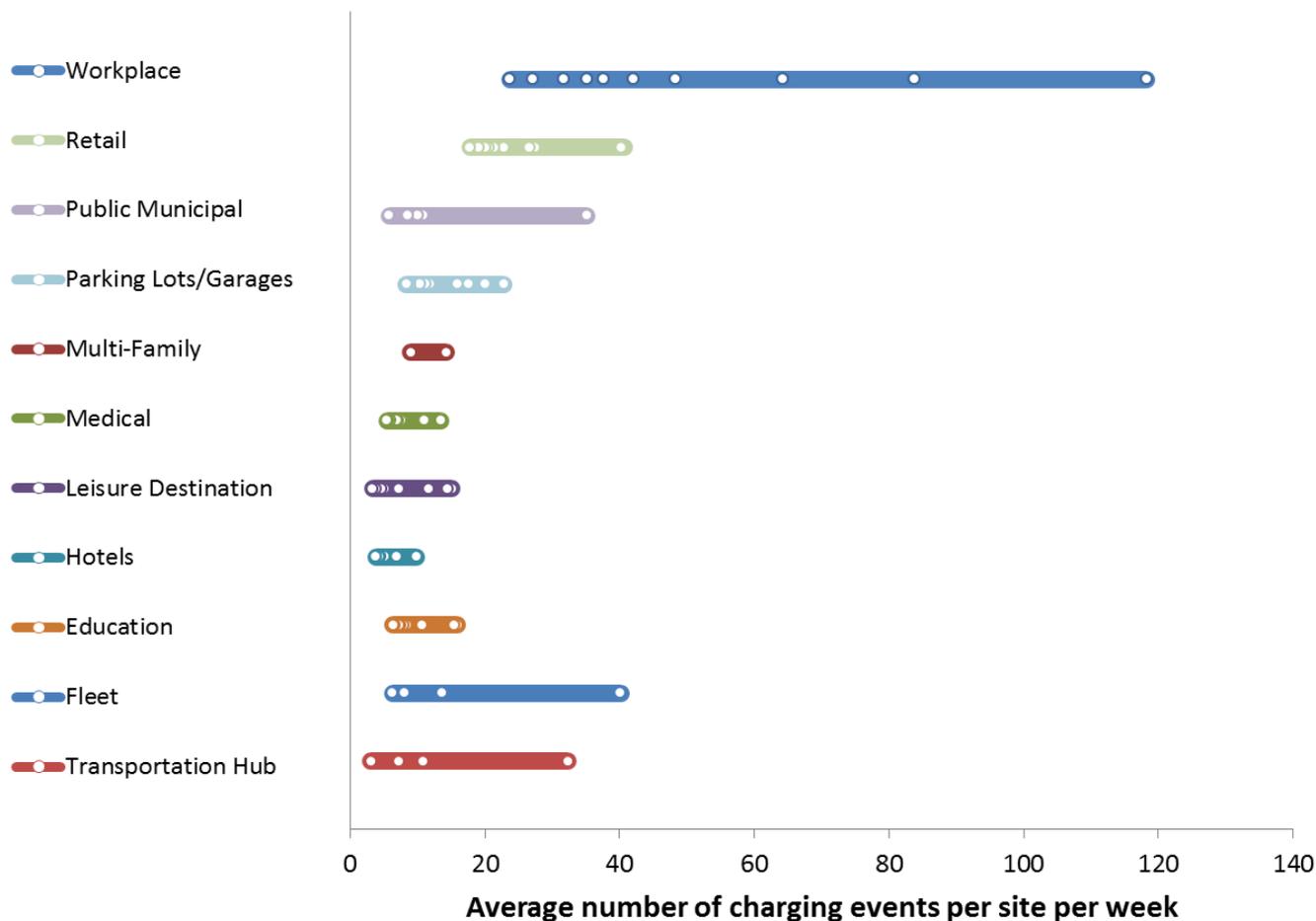
- DCFC events were longer after the introduction of payment
- Flat fee per session may prompt an “all-you-can eat” mentality

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



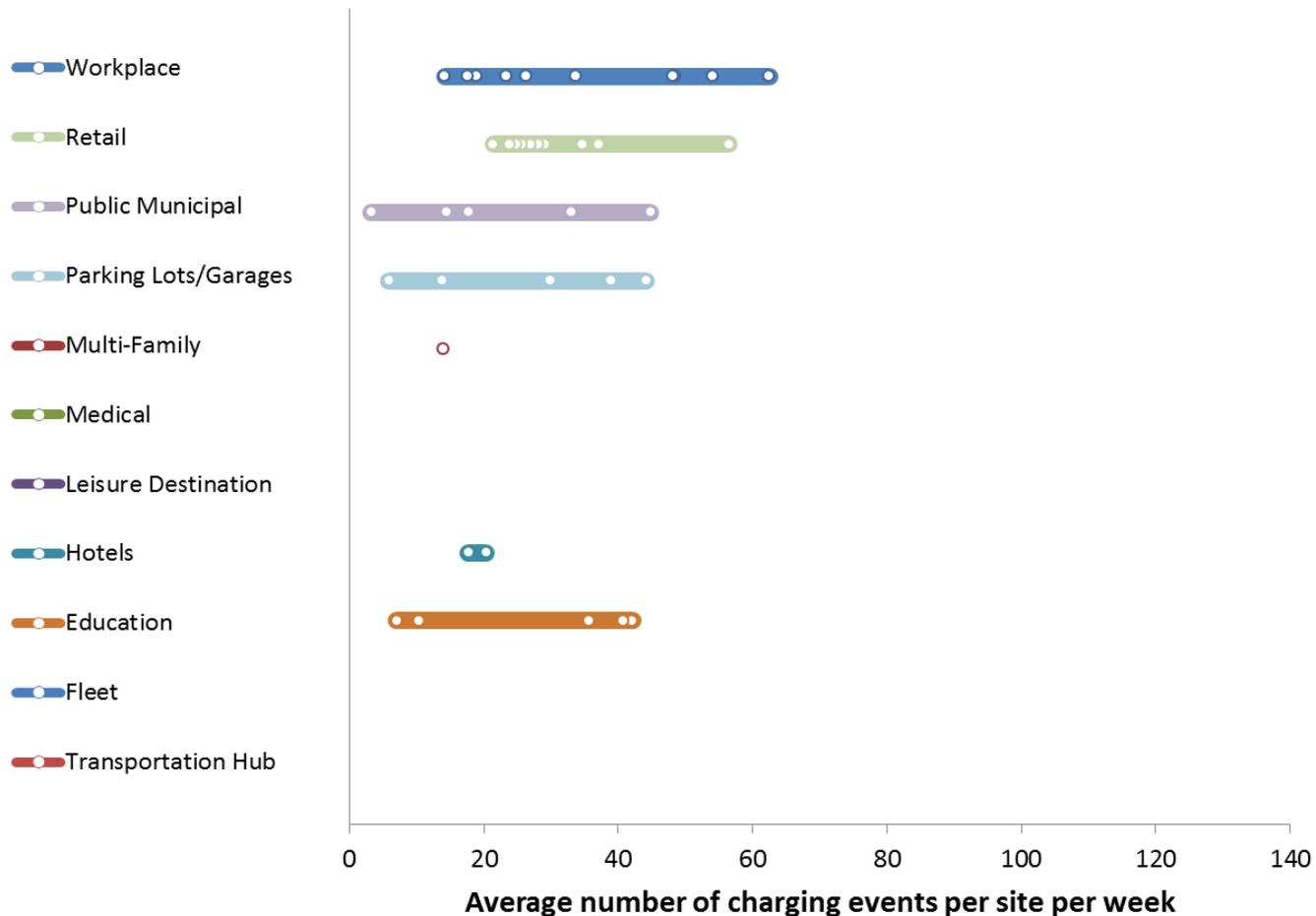
Public Blink Level 2 EVSE Usage by Venue

Top 10 Most Highly Used Public Level 2 Blink EVSE Sites in Each Venue Category

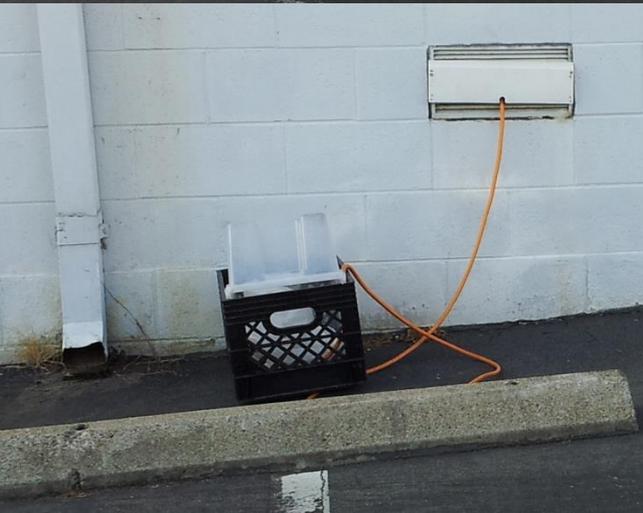


Public DCFC Usage by Venue

Top 10 Most Highly Used Public Level 2 Blink EVSE Sites in Each Venue Category



Workplace Charging



Workplace Charging Case Studies

Workplace charging sites identified in two ways:

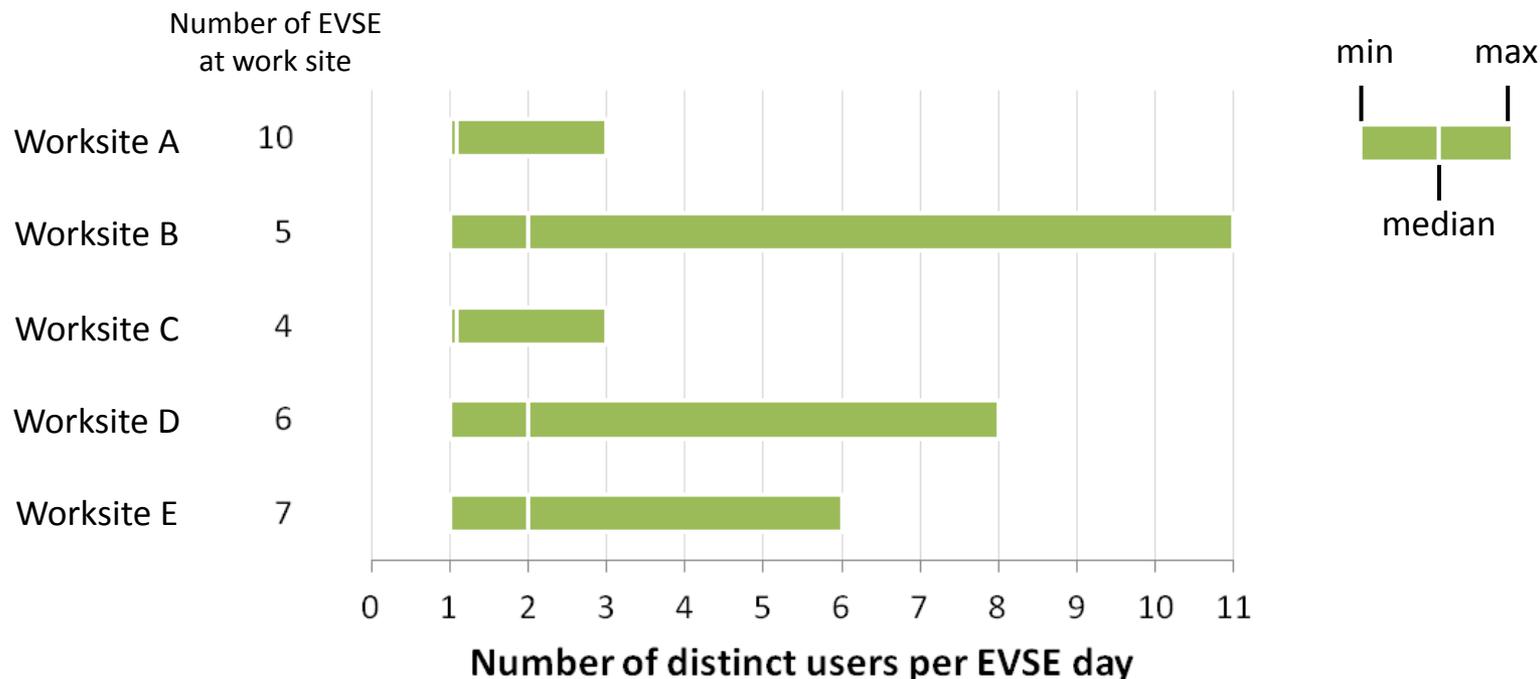
- Work sites where ChargePoint and Blink EVSE are installed
- Work sites where EV Project vehicles have charged
- Cross-referenced with AFDC database, other publicly available information, and some site visits

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

Distribution of Number of Distinct Users per EVSE Day

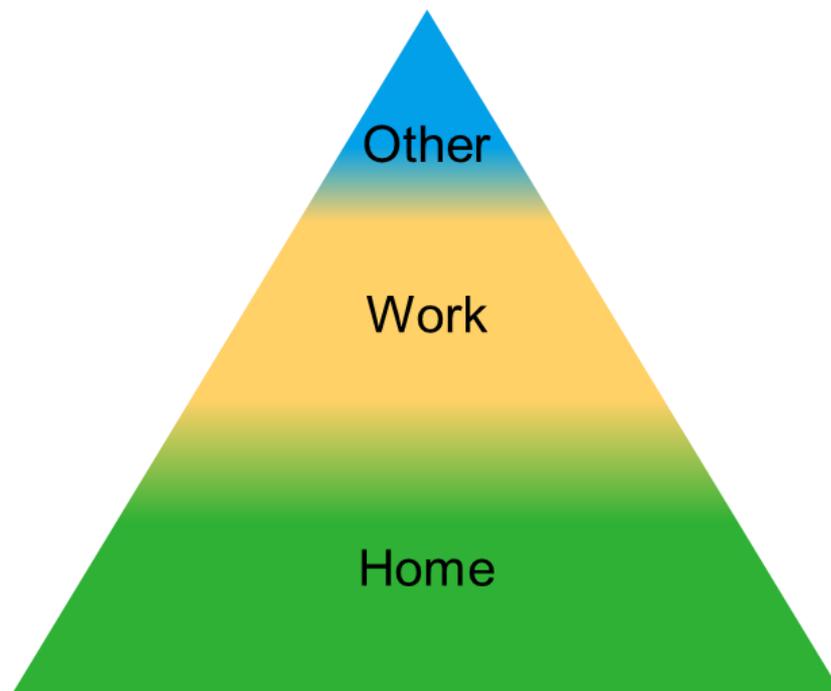


Workplace Charging Case Studies

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 – Charging Location Preference



Charging Location Preference

Of drivers who have the opportunity to charge at work:

- 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 Leaf and Volt drivers?

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

Volt

- 2013 study period
- 96 EV Project Nissan Leafs frequently parked at worksites where PEVs are known to have charged
- 29,000+ total charging events

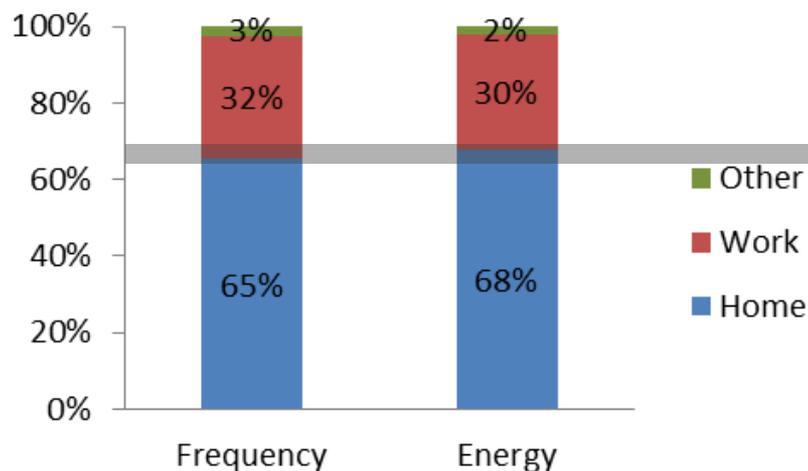
Full papers available at avt.inl.gov/evproject.shtml under “Lessons Learned White Papers”

“Where do Nissan Leaf drivers in The EV Project charge when they have the opportunity to charge at work?”

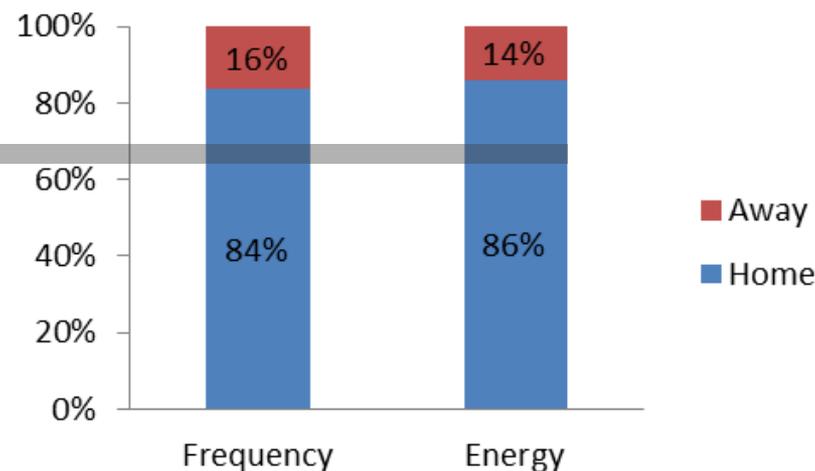
“Where do Chevrolet Volt drivers in The EV Project charge when they have the opportunity to charge at work?”

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

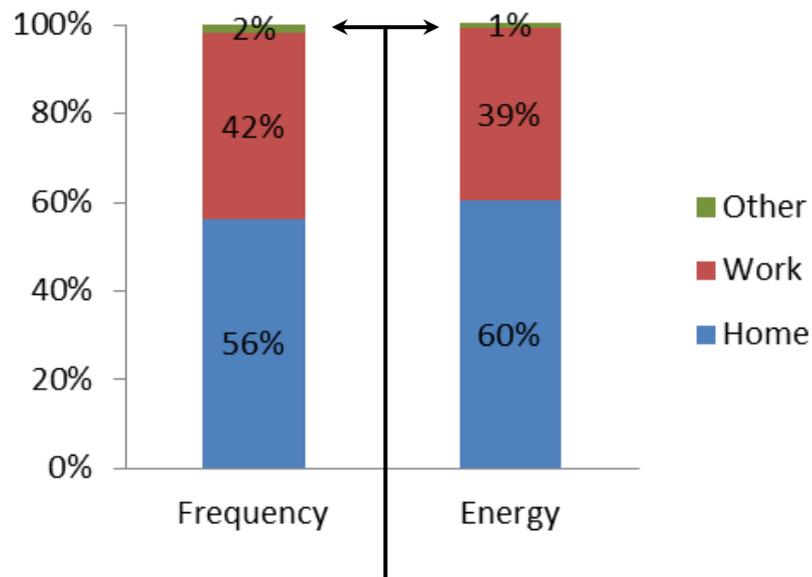


“Workplace vehicles” charged away from home more than twice as much as the overall project group
 Most of that away-from-home charging was at work

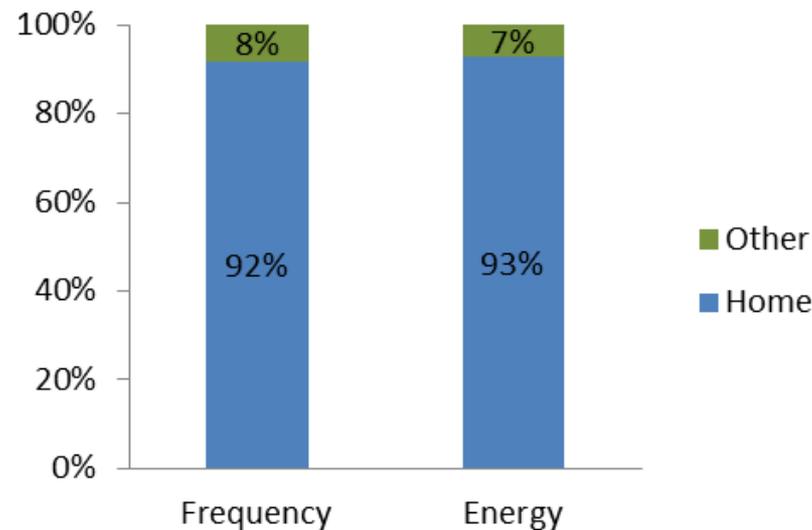
Charging Location Preference – Nissan Leaf

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

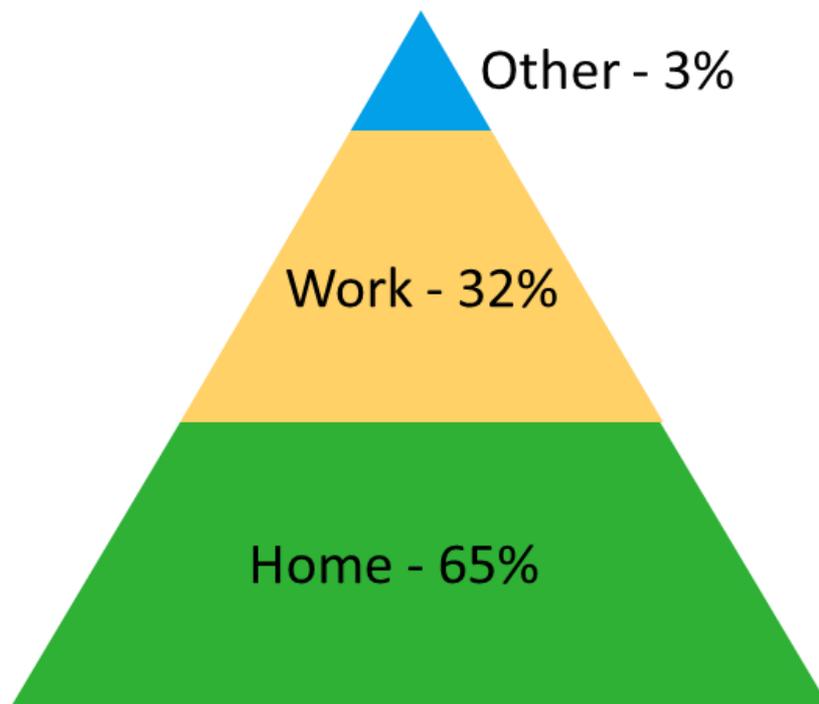


In aggregate, workplace vehicle drivers had little use for public infrastructure on days when they went to work

Charging Location Preference – Nissan Leaf

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

**Overall Charging Frequency by Location
(to scale)**



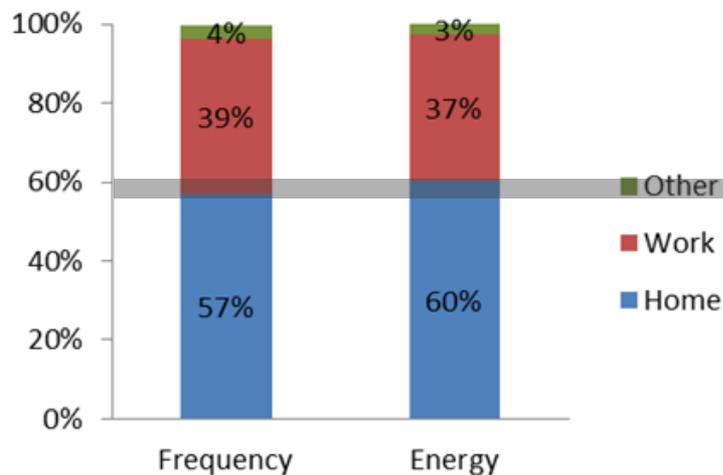
Careful!

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

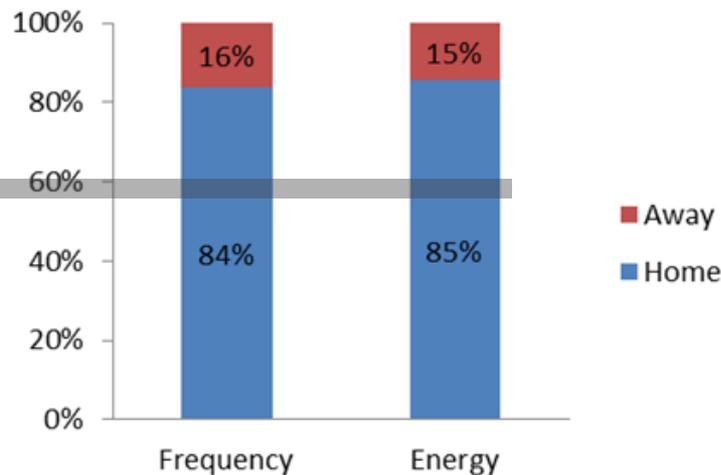
How does cost to use workplace charging influence this behavior?

Charging Location Preference – Chevy Volt

Group of Chevy Volts with Access to Workplace Charging 2013



Overall Set of EV Project Chevrolet Volts 2013



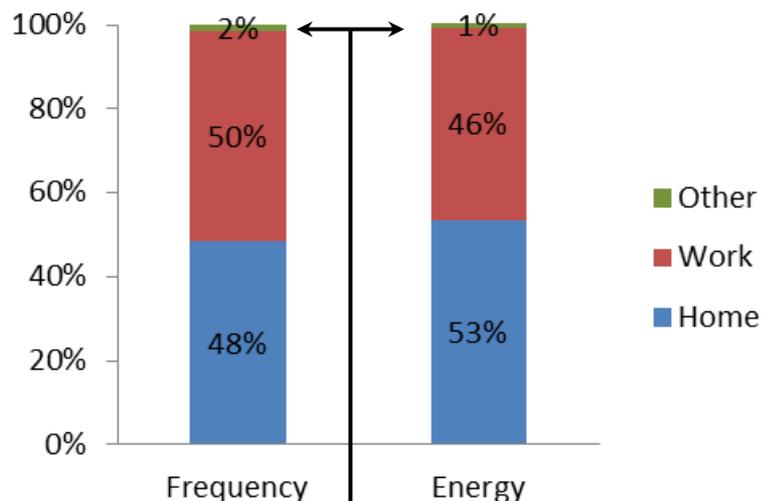
“Workplace vehicles” charged away from home over 2.5 times more than the overall project group

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

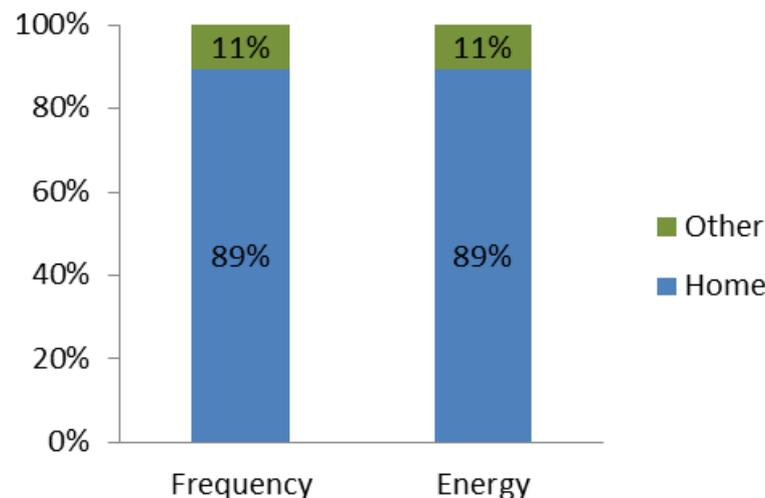
Charging Location Preference – Chevy Volt

Group of Chevrolet Volts with Access to Workplace Charging, 2013

Days When Vehicles Were Parked at Work



Days When Vehicles Were Not Parked at Work

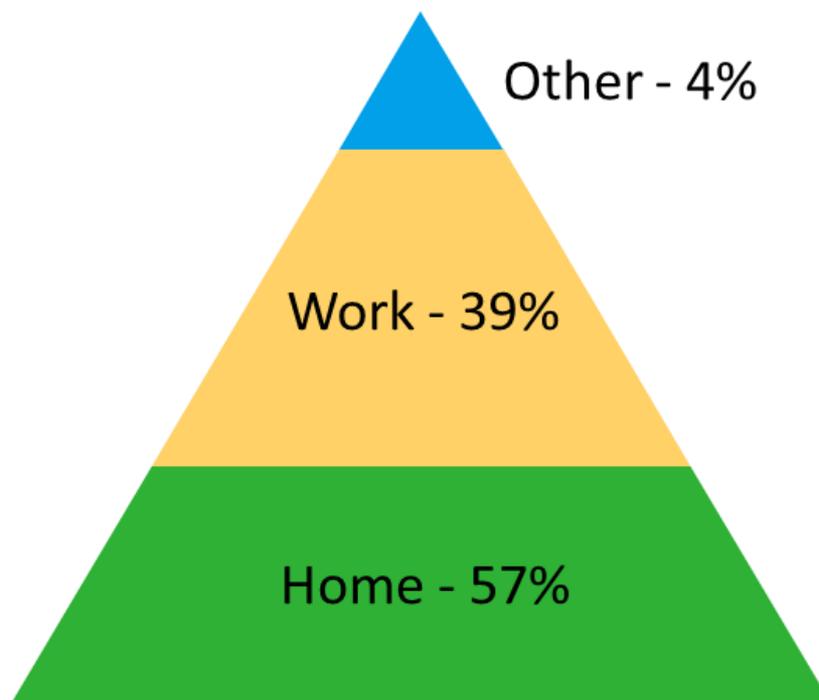


In aggregate, workplace vehicle drivers had little use for public infrastructure on days when they went to work

Charging Location Preference – Chevy Volt

Group of Chevrolet Volts with Access to Workplace Charging, 2013

**Overall Charging Frequency by Location
(to scale)**



How does cost to use workplace charging influence this behavior?

Conclusion

- How much are public AC level 2 EVSE and DC fast chargers used?
 - San Francisco, Los Angeles, Washington State lead the country in public EVSE use
 - On a per-unit basis, DCFC usage is much greater than Level 2 EVSE
 - Overall usage of public Level 2 EVSE exceeded DCFC usage in San Francisco in Q4 2013 (after payment started for DCFC)
- What was the impact of implementing payment for use of DCFC?
 - DCFC usage dropped dramatically
 - Some evidence that all-you-can-each pricing model causing longer sessions which could lead to congestion and lost customers
- Which stations are used most 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
- Where are drivers using workplace charging stations?
 - Multiple users per EVSE per day at workplaces
 - Those with access to workplace charging use it and do not use public EVSE much
 - Need to analyze effect of cost and other factors

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

Additional Information

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

Charging Site Location Considerations

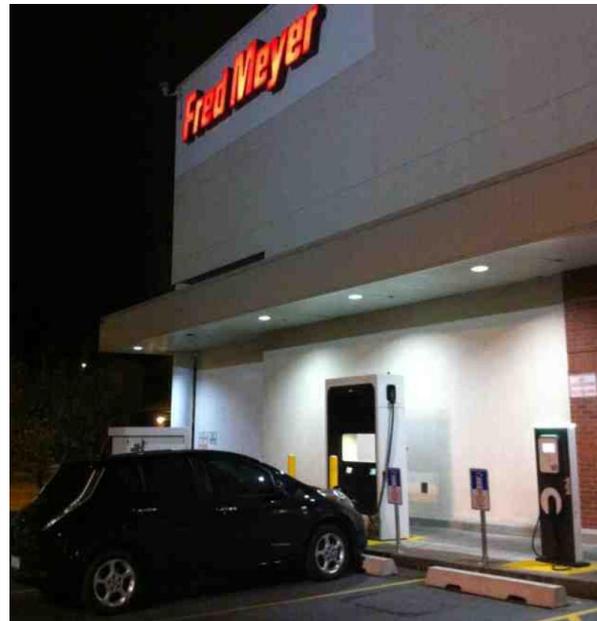
- EVSE installations with respect to Americans with Disabilities Act (ADA) requirements are not consistent
 - “Charger is between 2 handicap spaces. To charge and not get ticketed you need to park behind the charger in any of 3 spaces closest to the elevator / entrance in non EV dedicated spots. Good 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 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

