

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

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Idaho National Laboratory

Plug-in Electric Vehicle Infrastructure Information
Gathering Meeting

May 27, 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

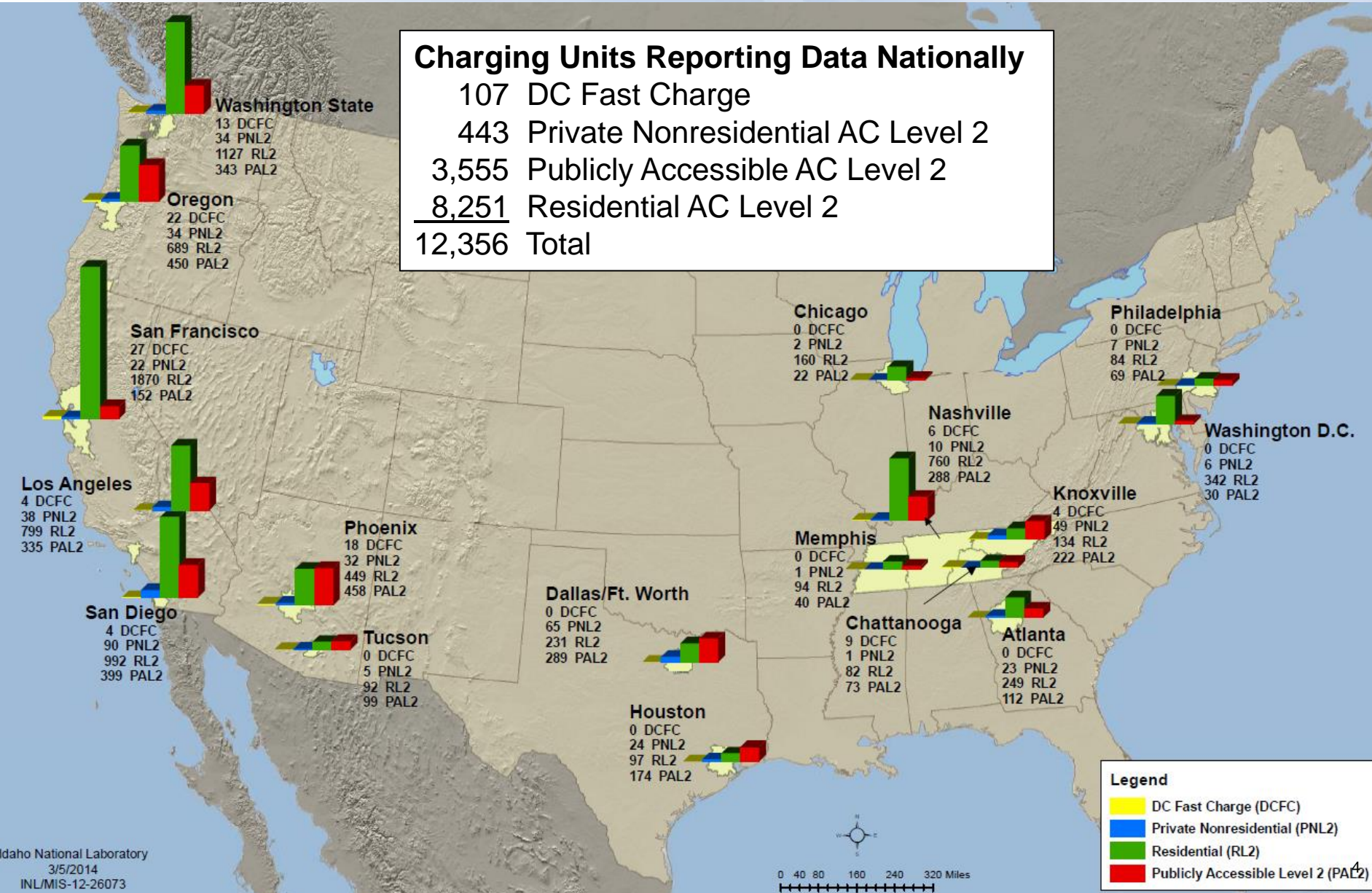
- Deploy 4,700+ residential and public AC level 2 charging units in 11 US regions
- Study customer usage of residential and public infrastructure
- INL data collection May 2011 – Dec 2013







Infrastructure Deployment in The EV Project through December 2013

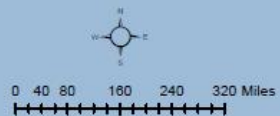
Charging Units Reporting Data Nationally

107	DC Fast Charge
443	Private Nonresidential AC Level 2
3,555	Publicly Accessible AC Level 2
<u>8,251</u>	Residential AC Level 2
12,356	Total

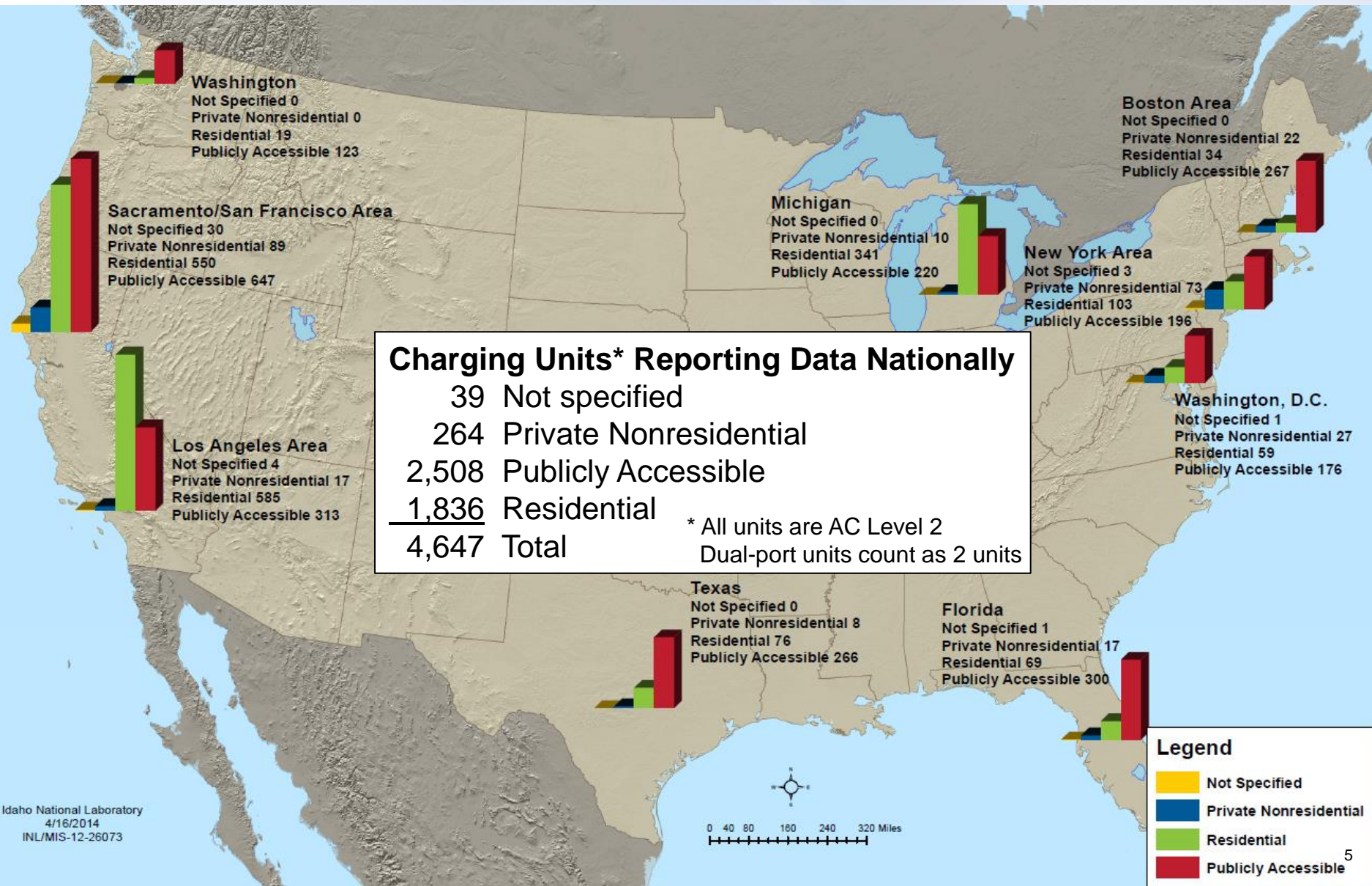


Legend

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



Infrastructure Deployment in ChargePoint America through December 2013



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

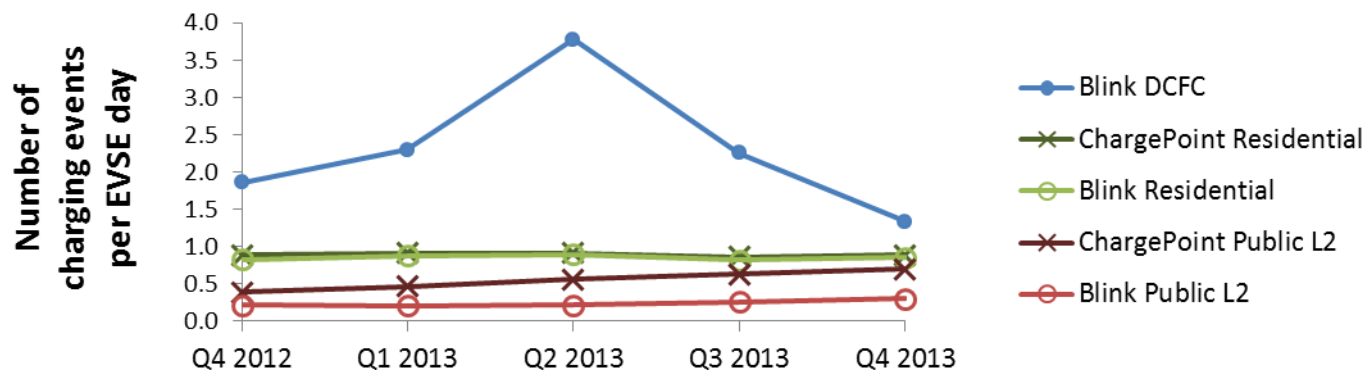
- Public AC Level 2 fees started Jul – Aug 2012
 - Varies from \$1.00 to \$2.00 **per hour connected**
 - 16% of sites were still free as of Dec 31, 2013 (per local site host discretion)
- DC Fast Charger fees started Jul 2013
 - \$5 for Blink member / \$8 for non-member **per session**

ChargePoint usage fees

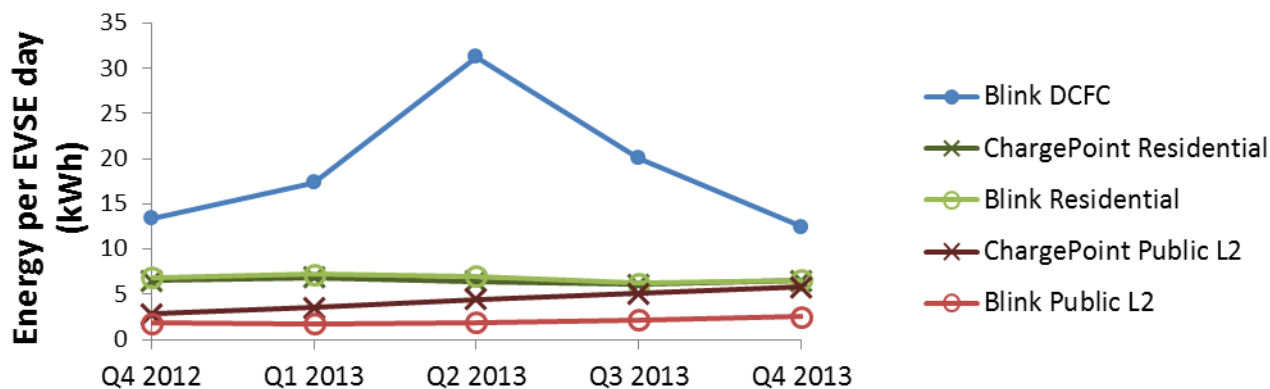
- Vary by site (per local site host discretion)
- Many are free

Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type

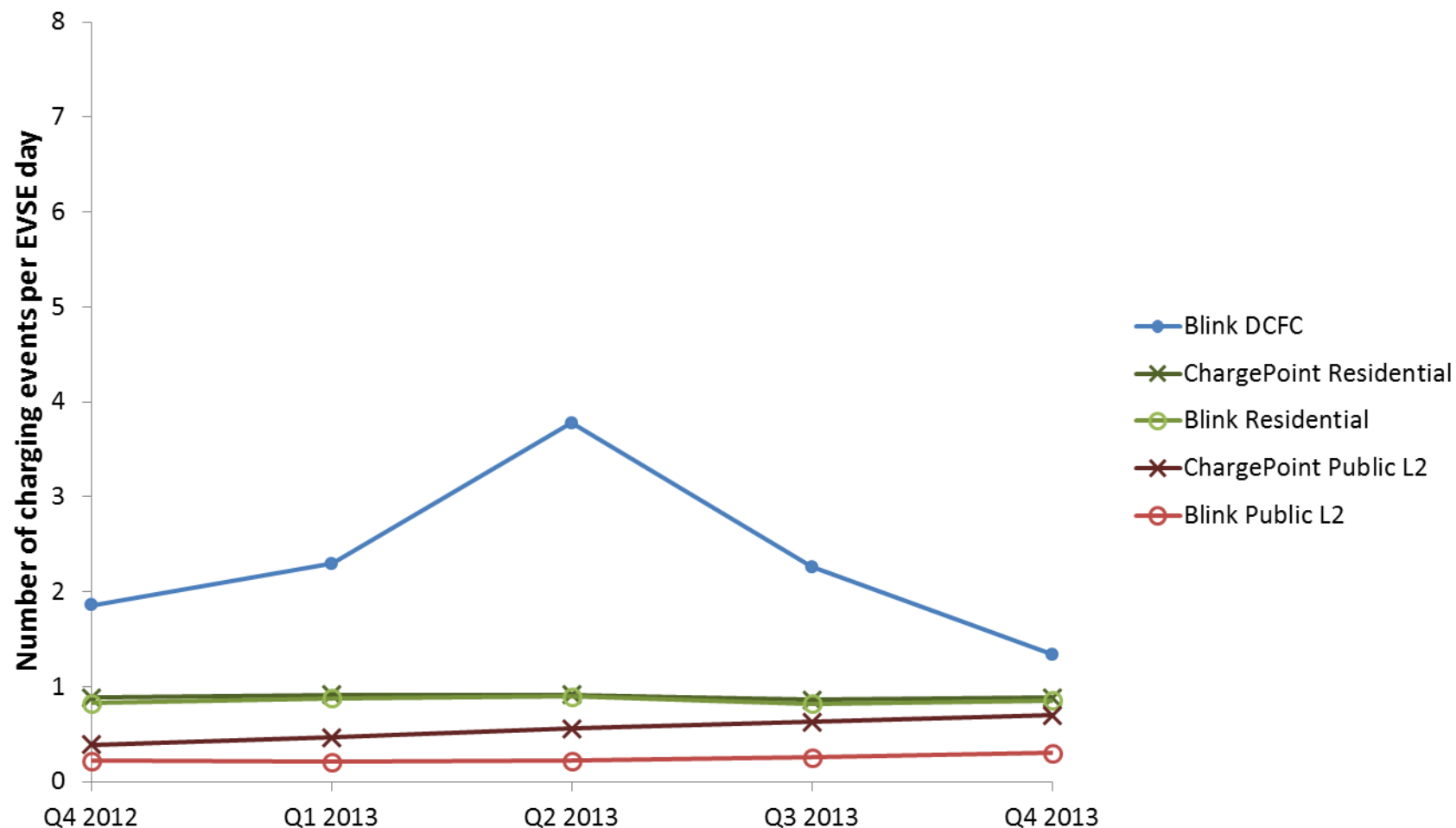


Charging Energy by EVSE Type



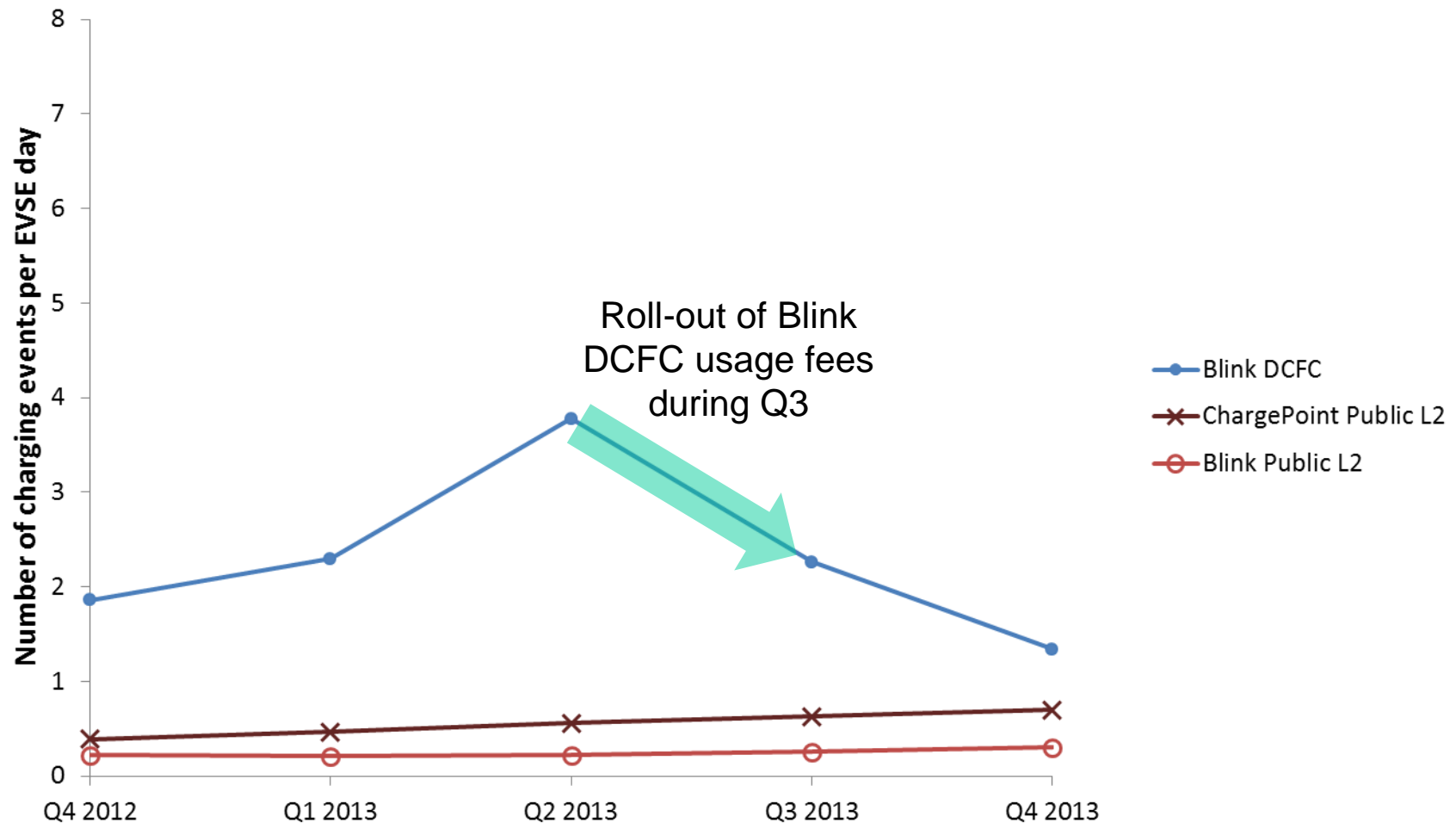
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

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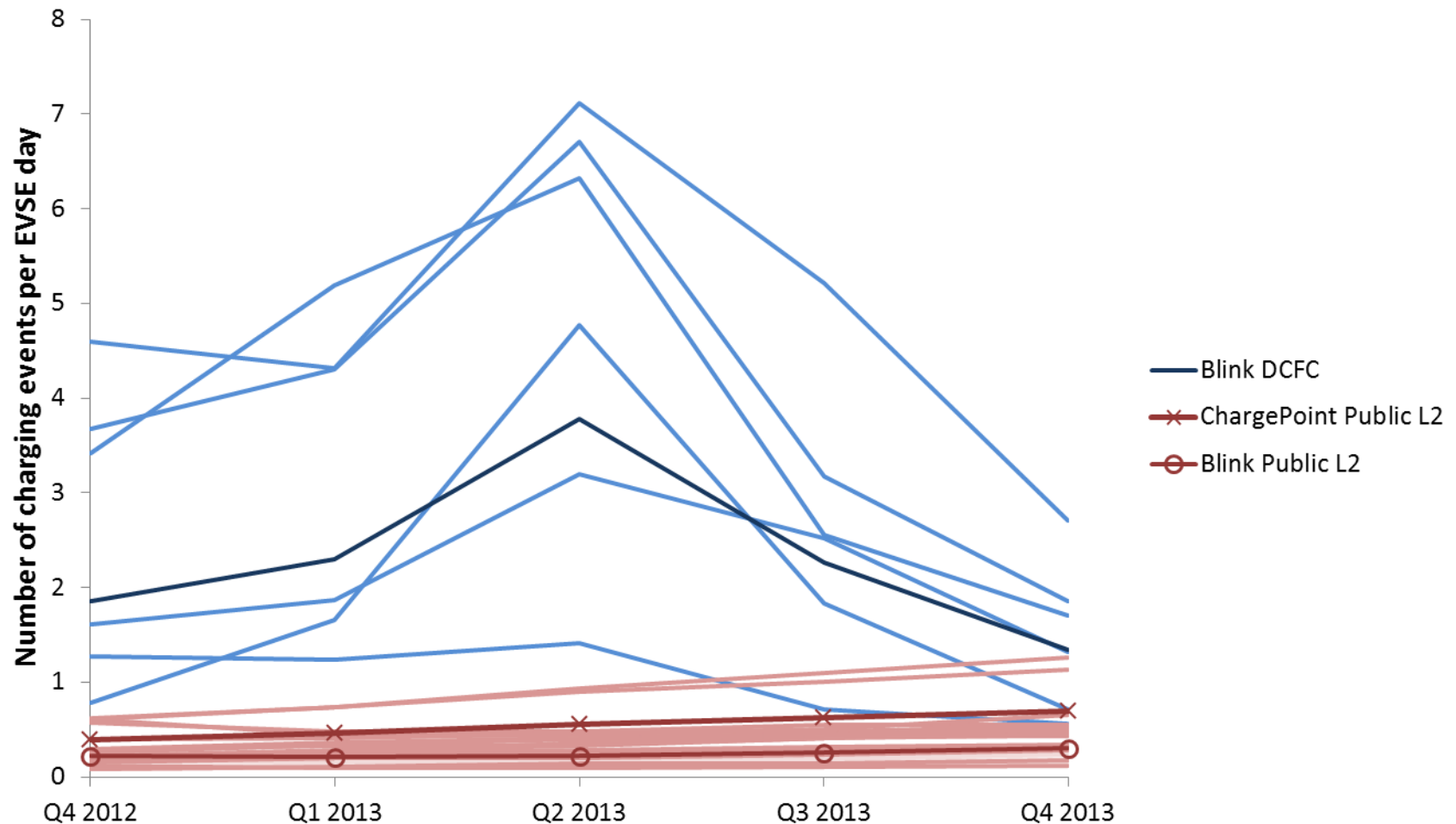
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type



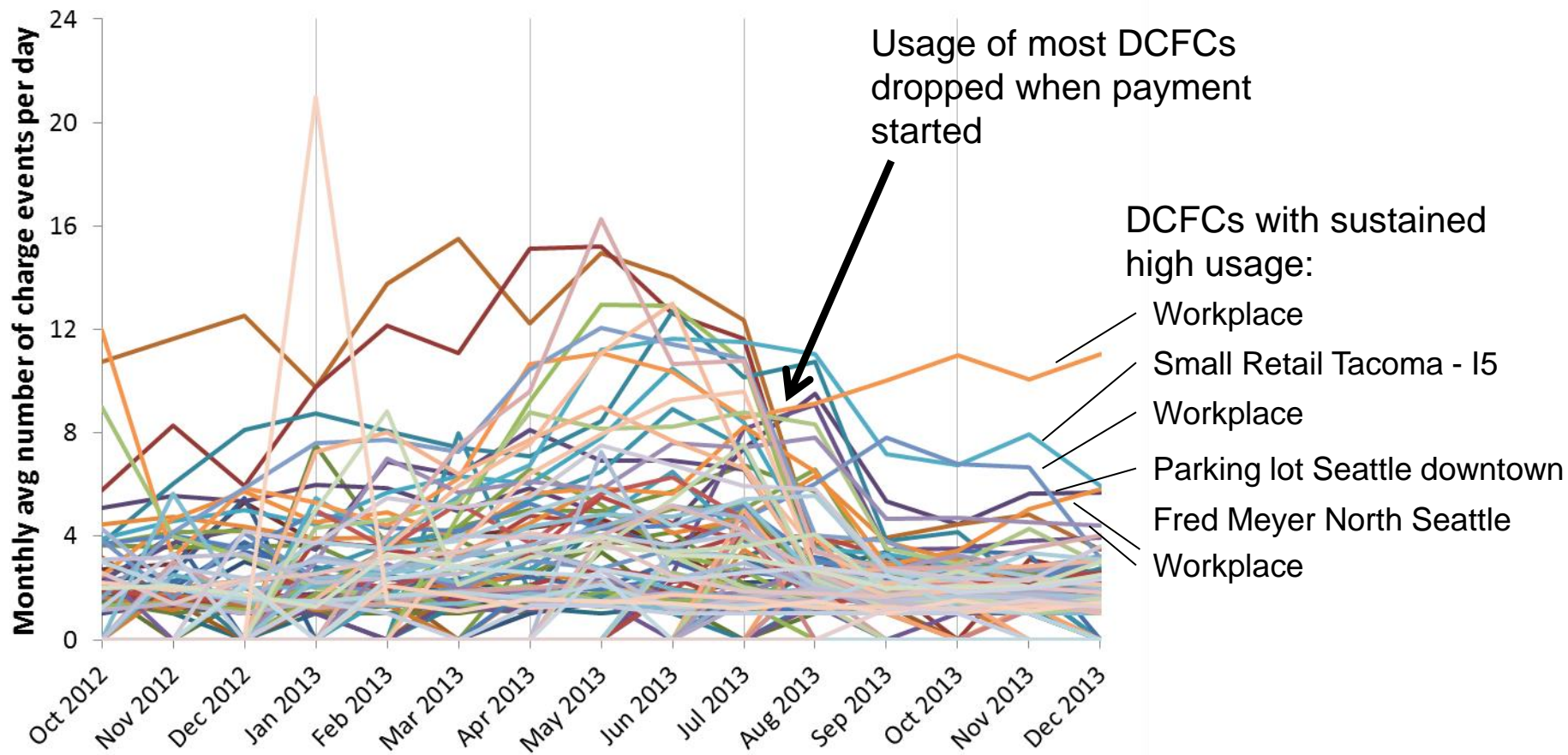
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers by Region

Charging Frequency by EVSE Type and Region



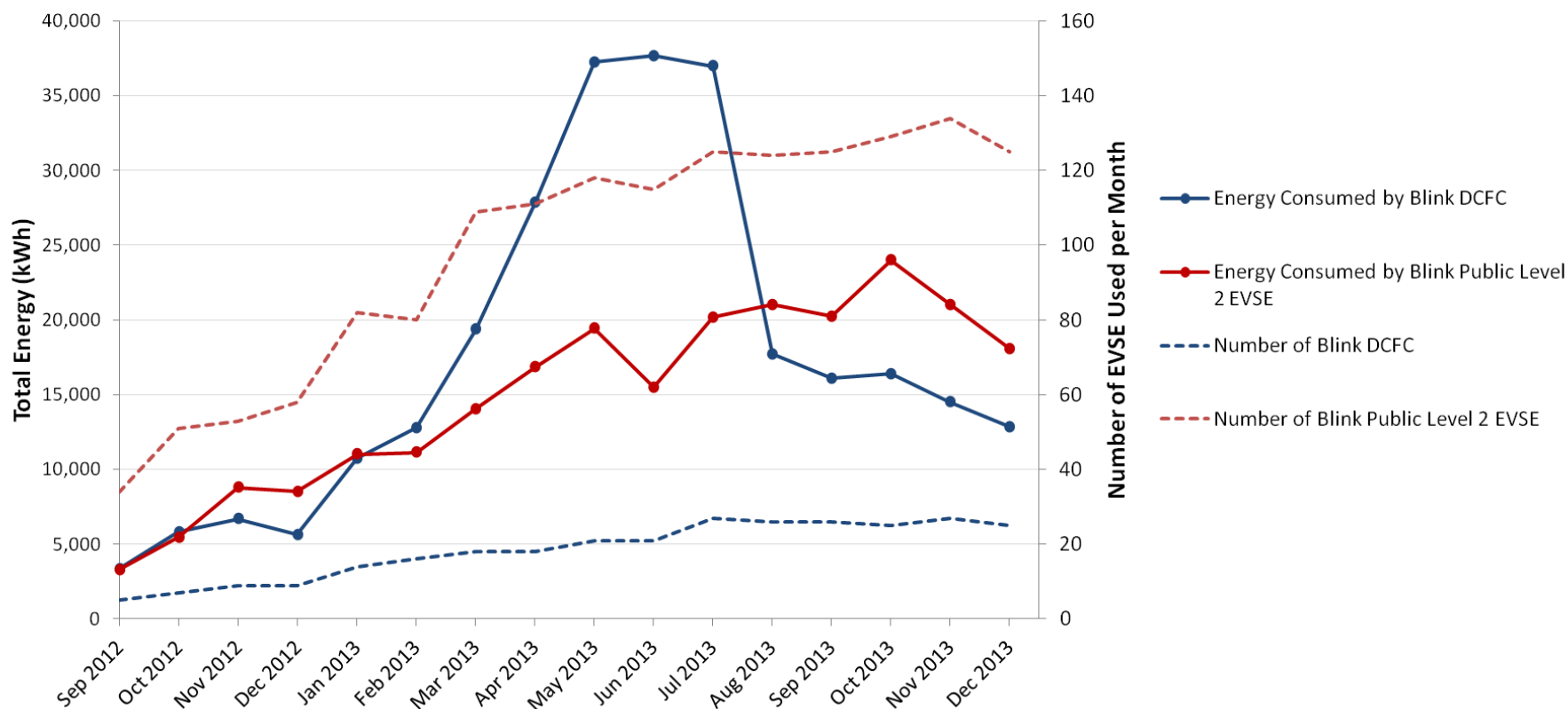
Usage Frequency of Individual DC Fast Chargers

**Monthly Average Number of Charging Events per Day
for Each DCFC**



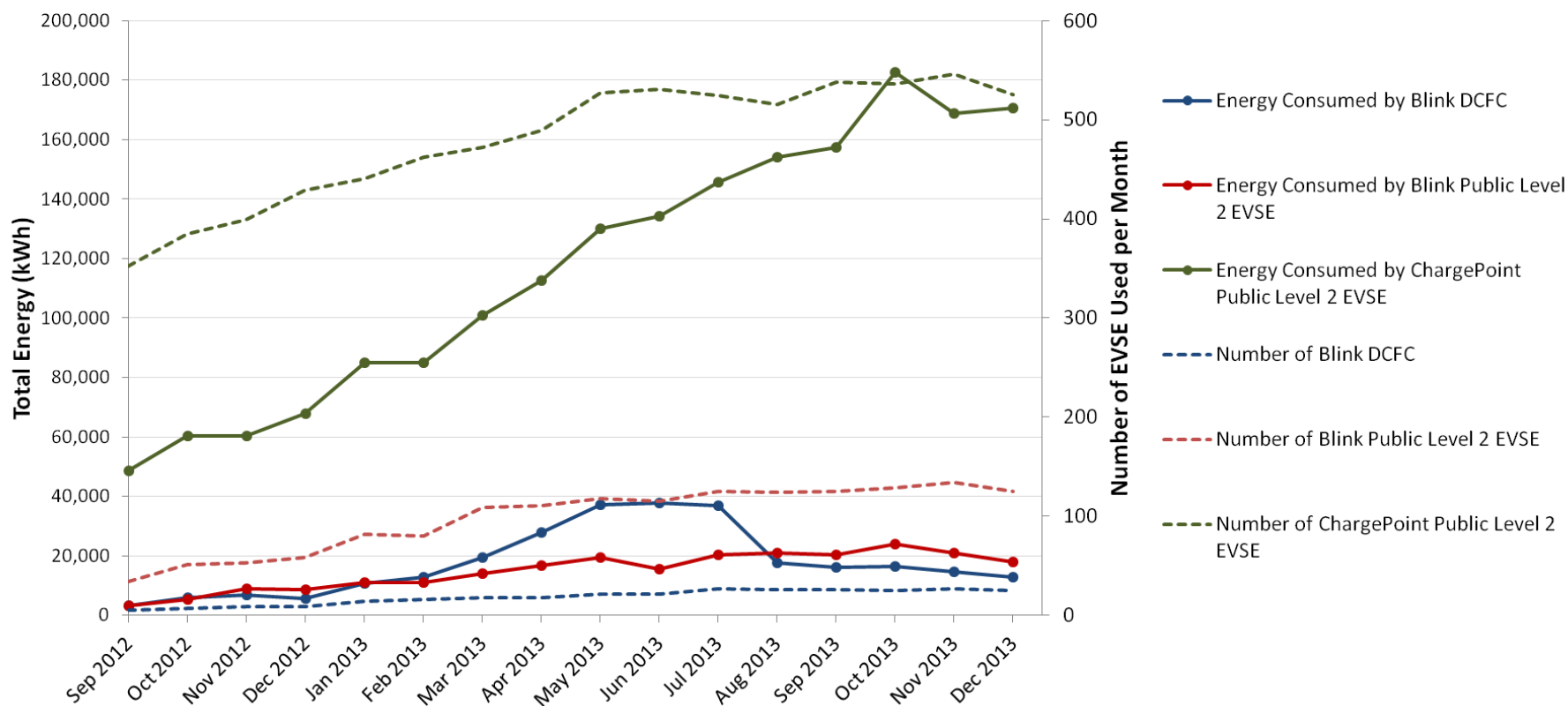
Total Energy Consumption at Blink Stations in San Francisco

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



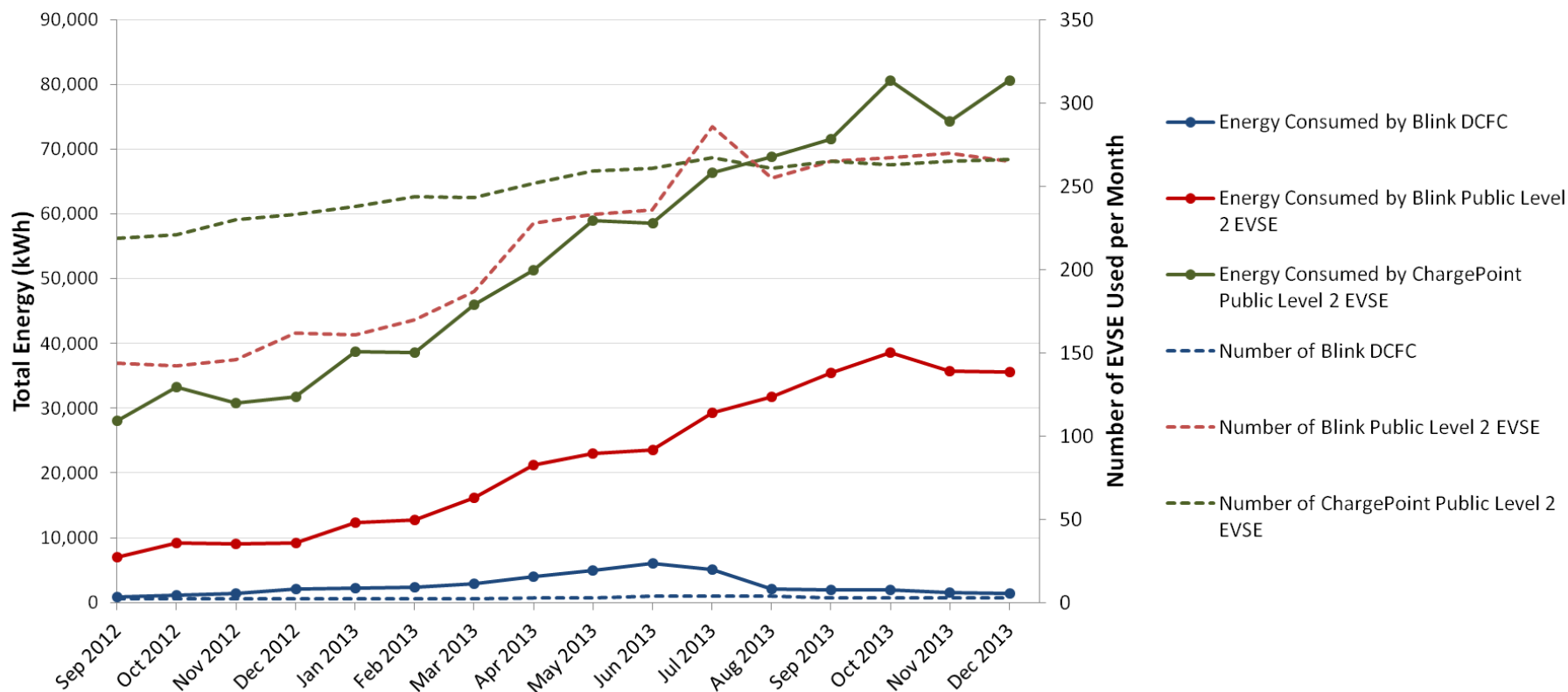
Total Energy Consumption at Blink and ChargePoint Stations in San Francisco

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



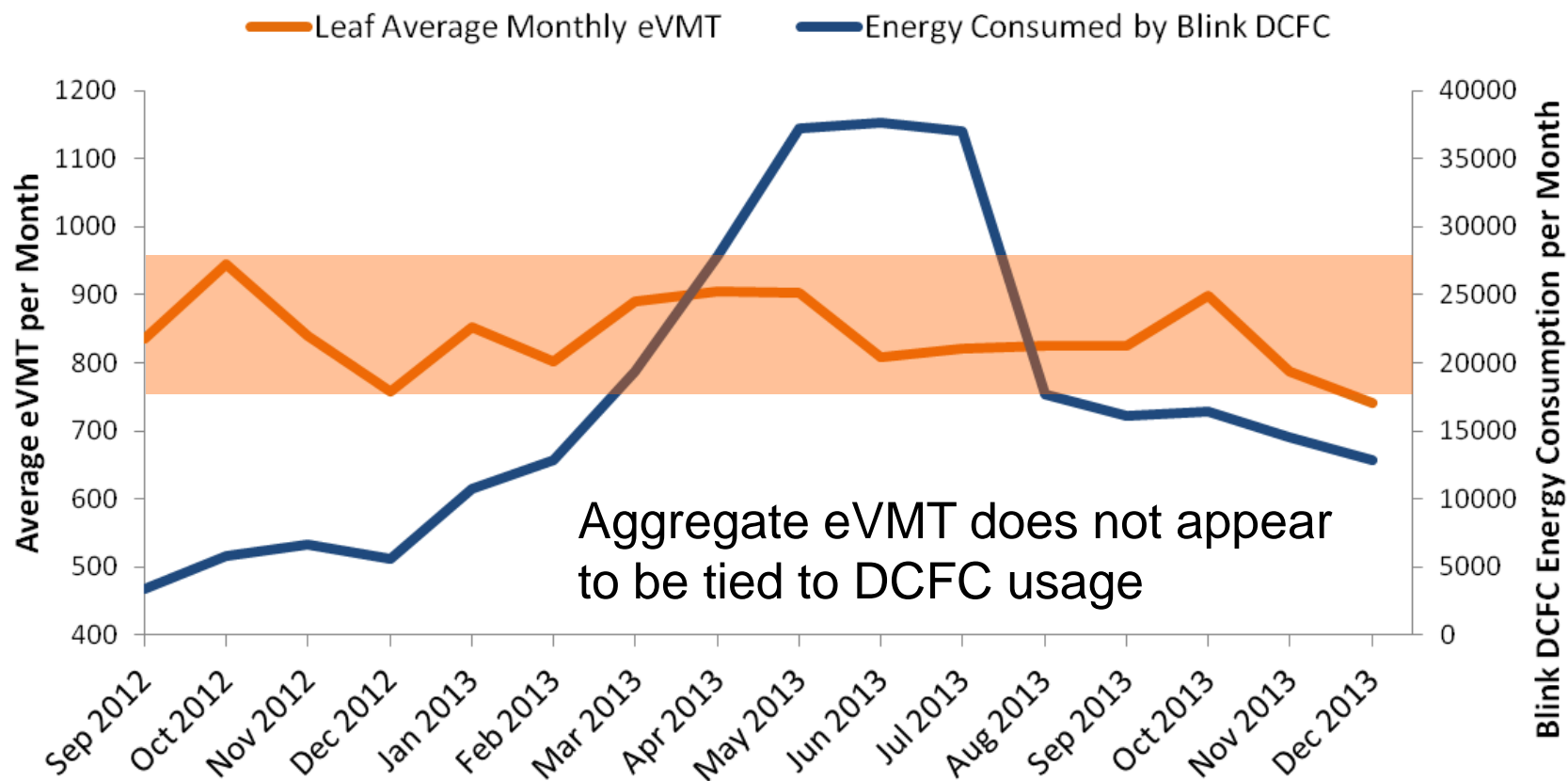
Total Energy Consumption at Blink and ChargePoint Stations in Los Angeles

Energy Consumed by Public Level 2 EVSE and DCFC in Los Angeles Region by Month



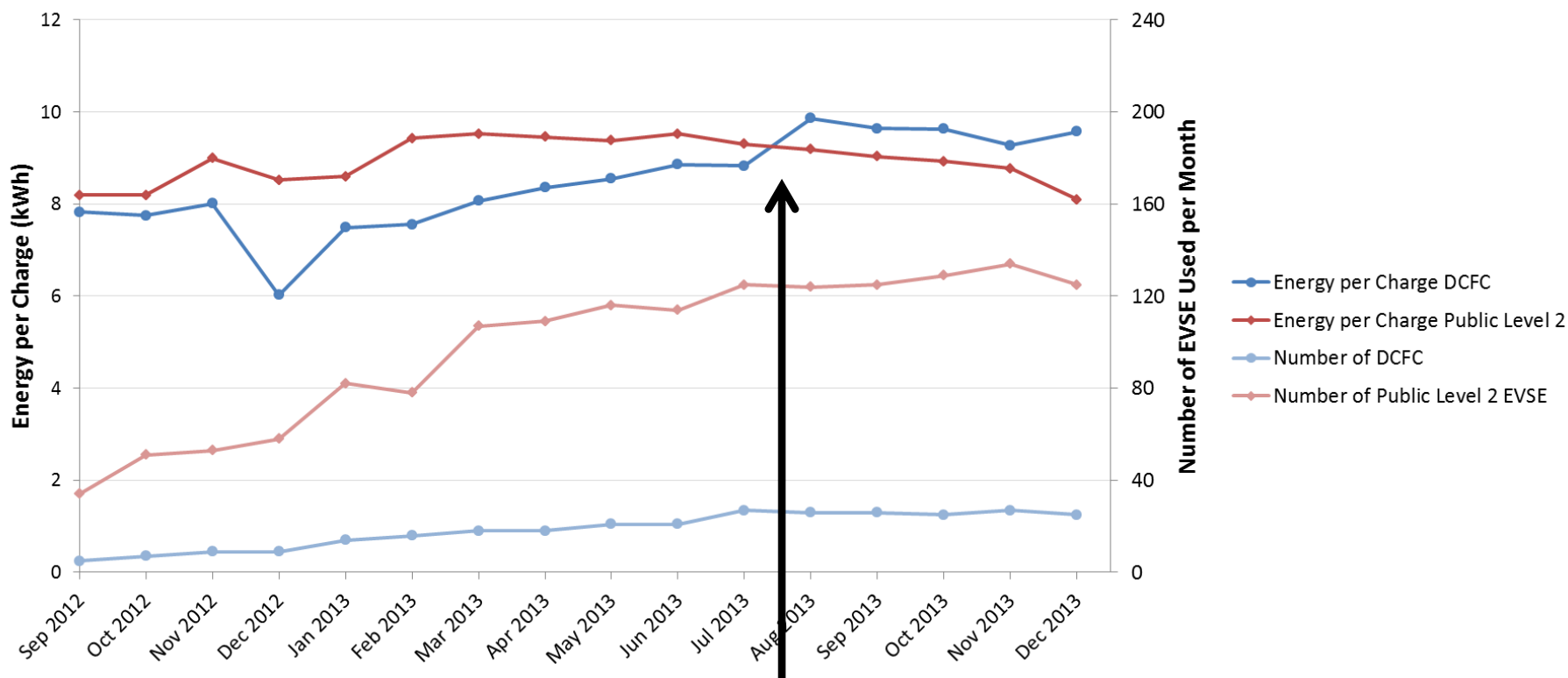
Leaf eVMT in San Francisco

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



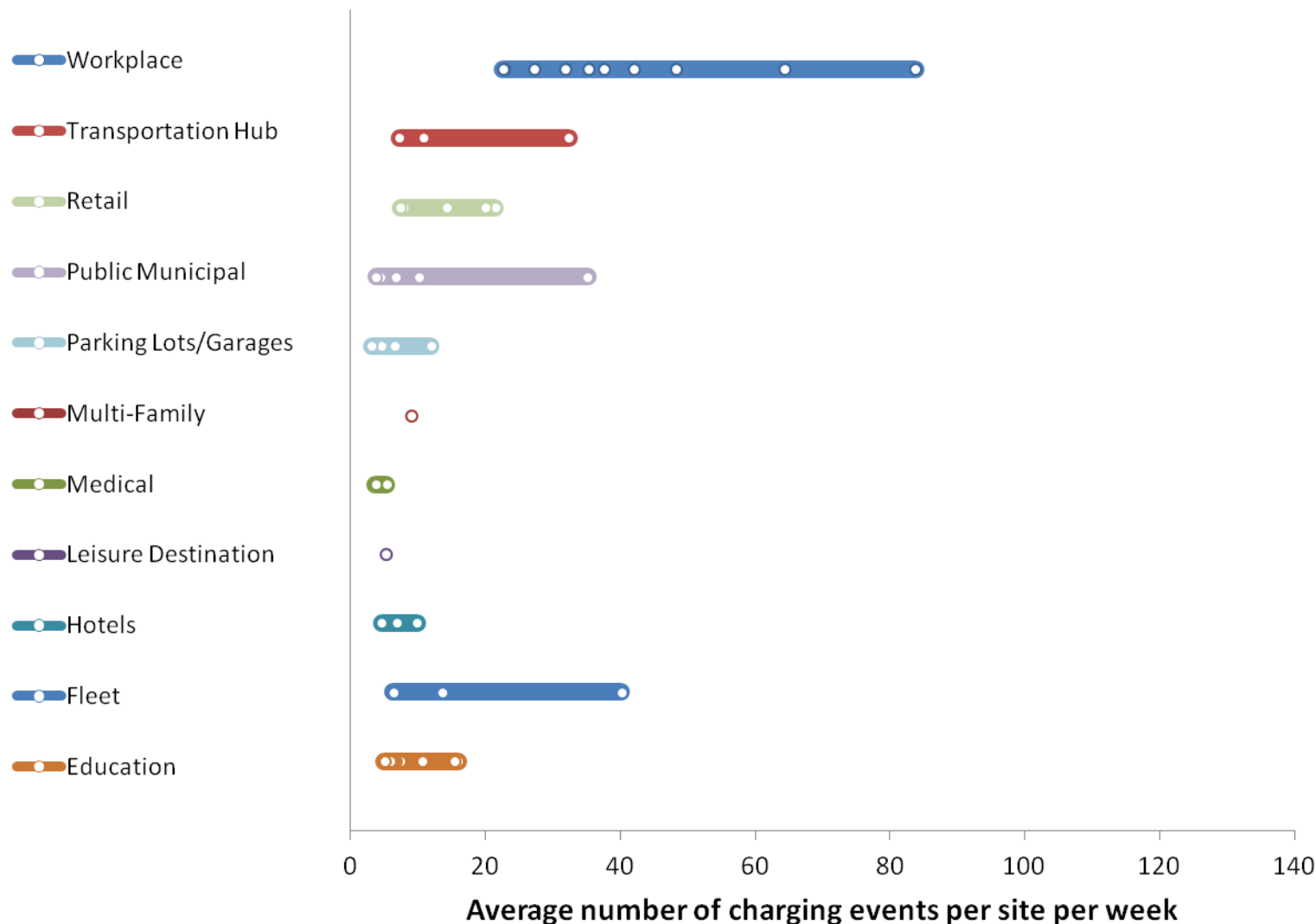
Energy per Charging Event Over Time

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

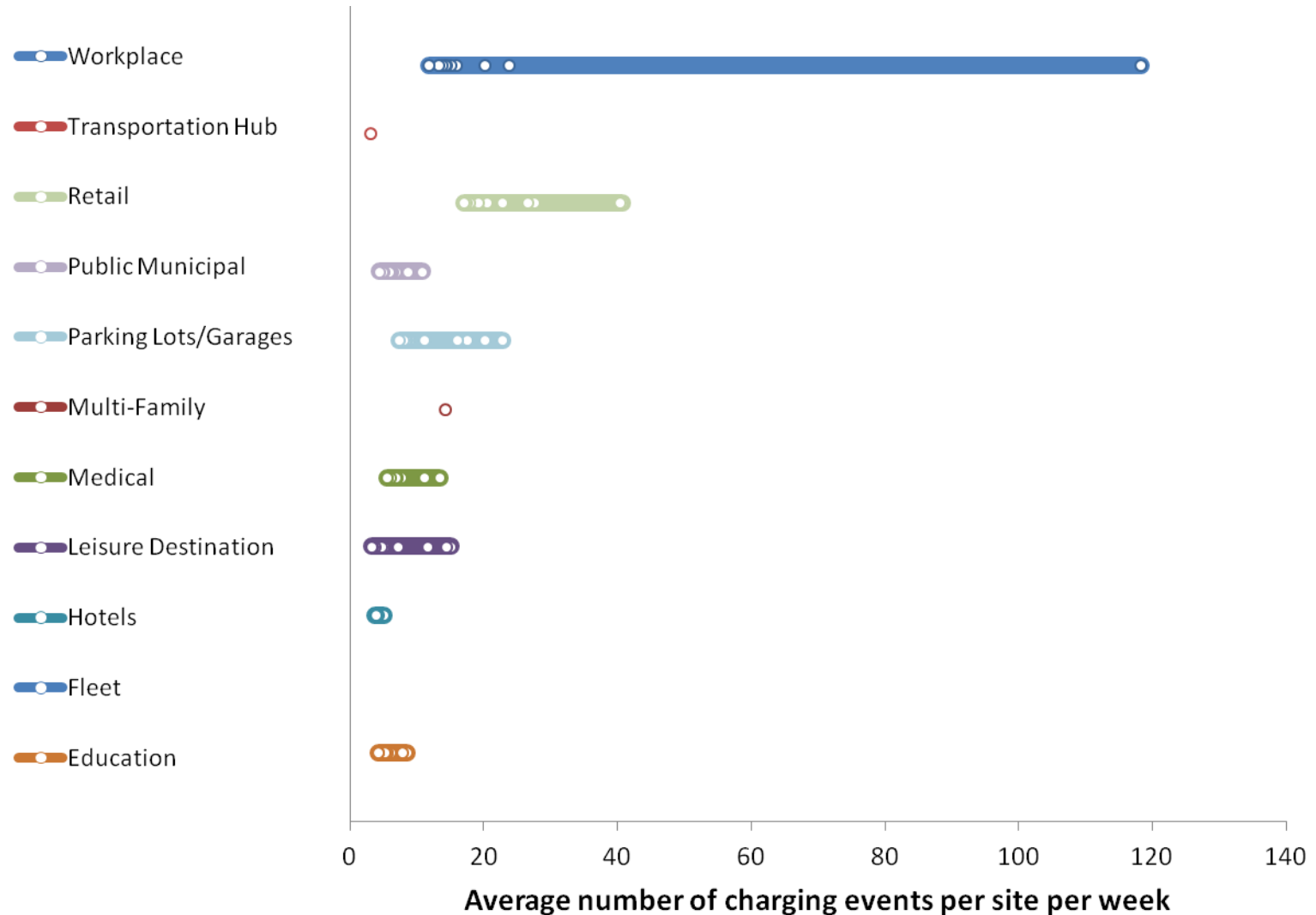


- DCFC events were longer after the introduction of payment
- Flat fee per session may prompt an “all-you-can eat” mentality

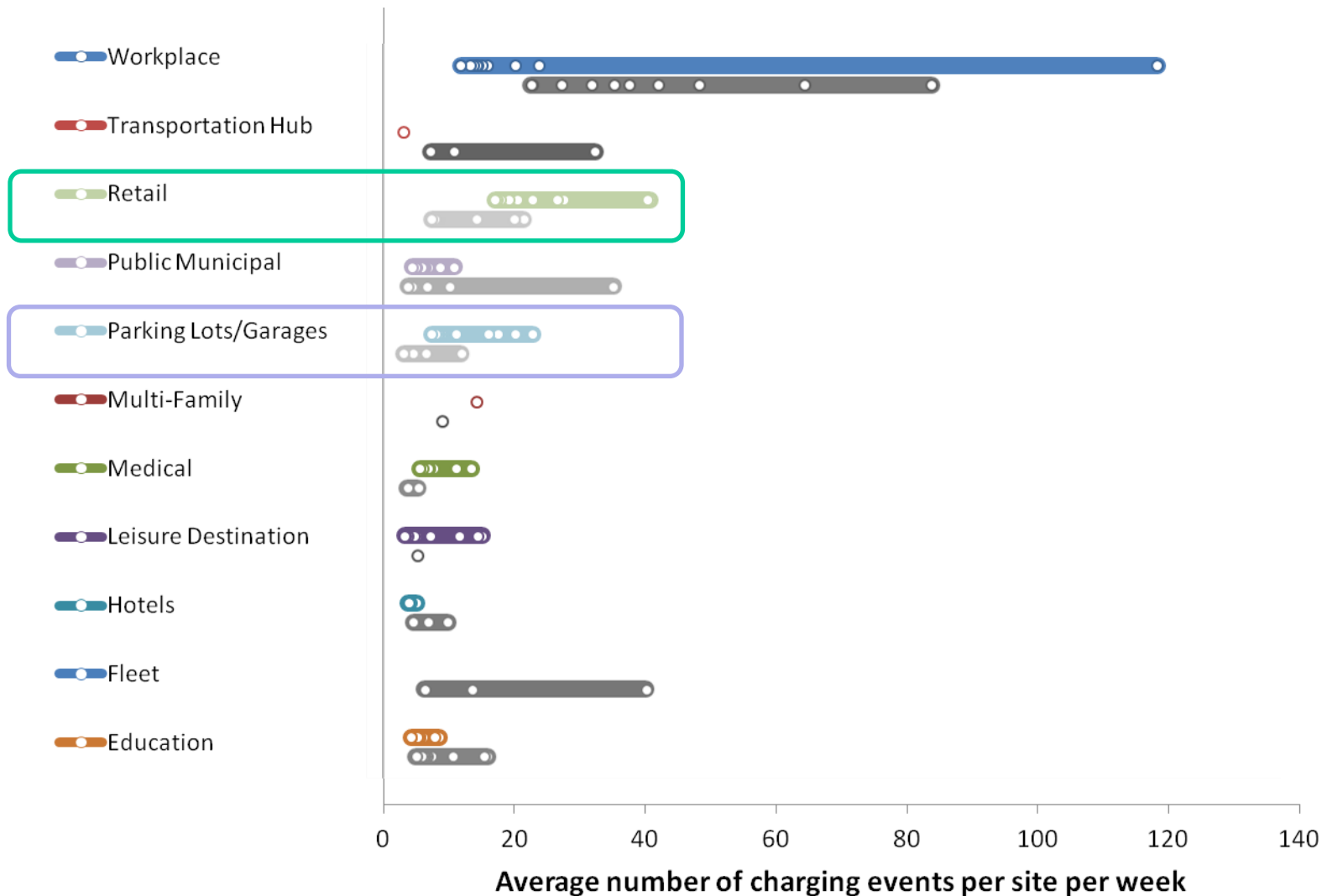
Top 10 Most Highly Used **Free** Public Level 2 Blink EVSE Sites by Venue



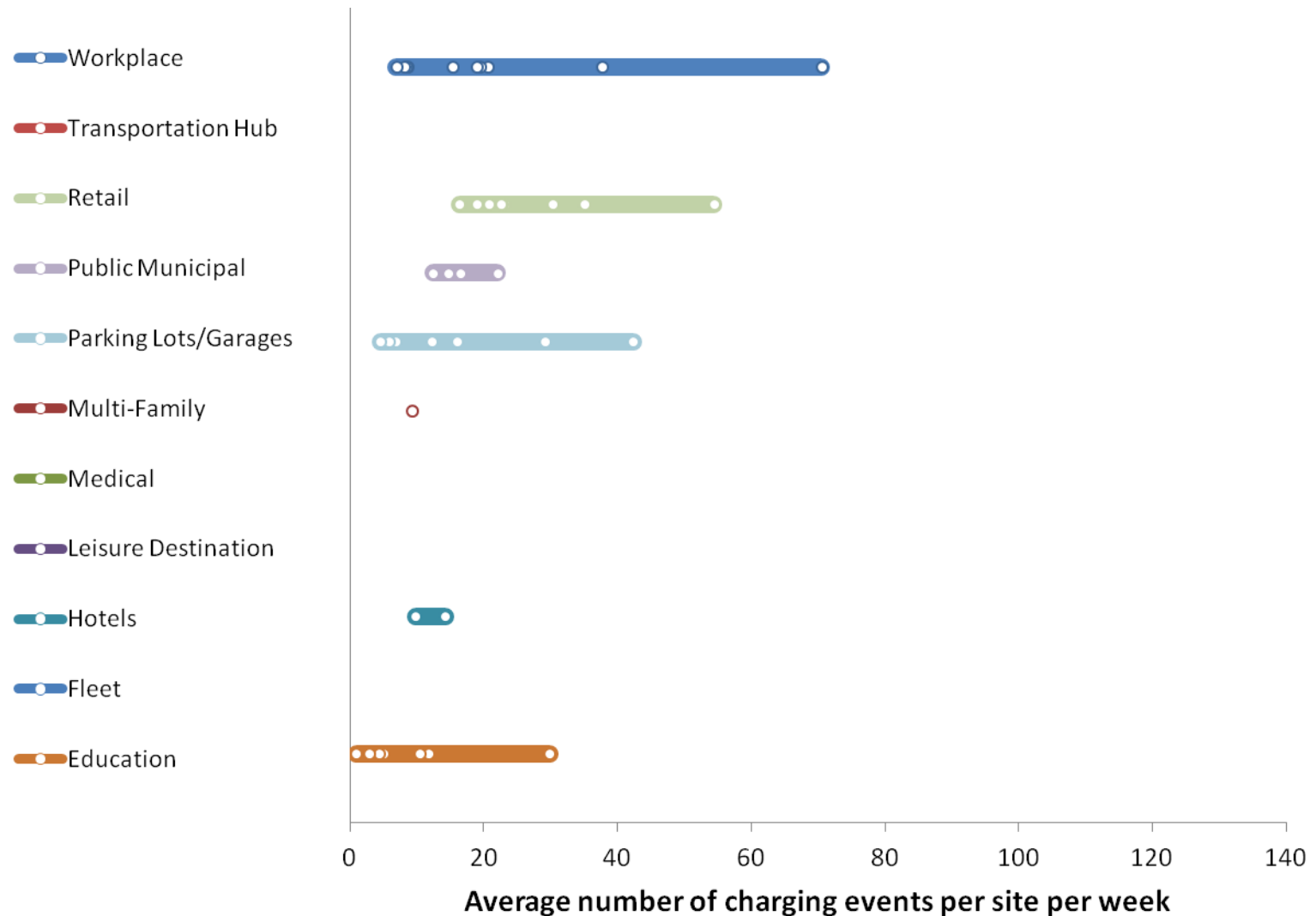
Top 10 Most Highly Used **For-Cost** Public Level 2 Blink EVSE Sites by Venue



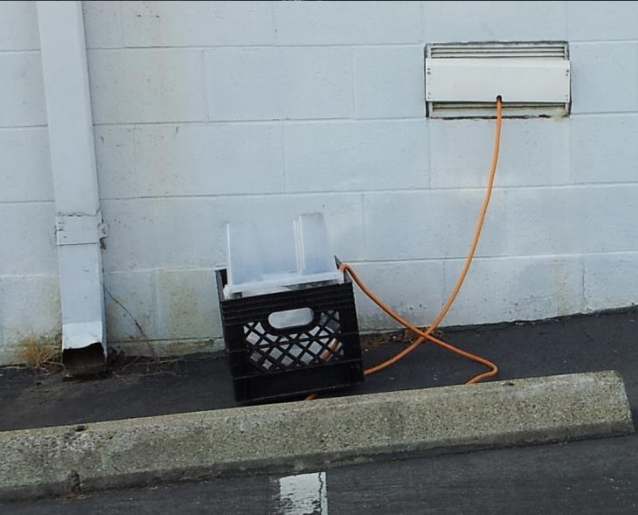
Top 10 Most Highly Used **For-Cost** / Free Public Level 2 Blink EVSE Sites by Venue



Top 10 Most Highly Used **For-Cost** Blink DCFC Sites by Venue



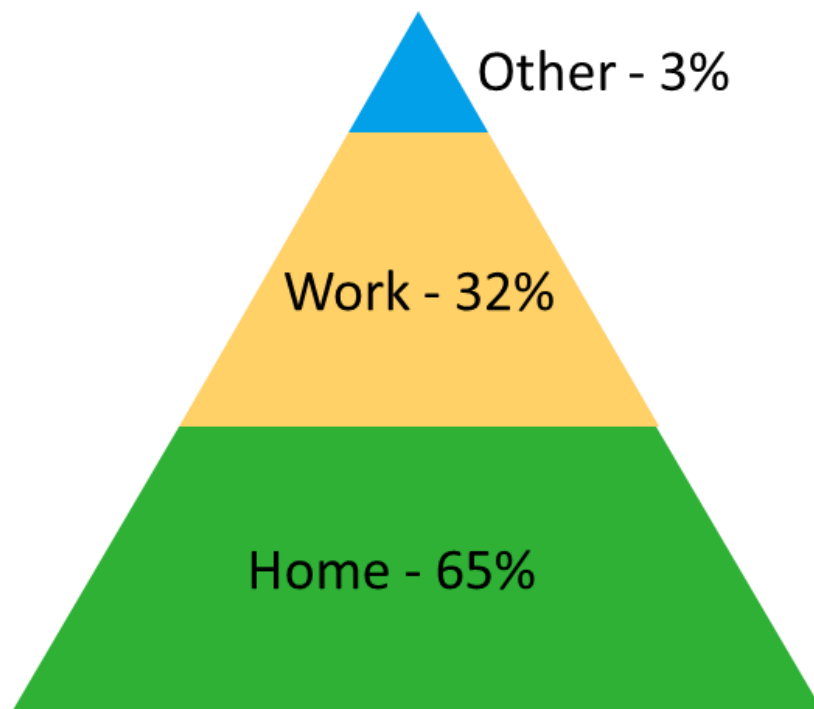
Workplace Charging



Charging Location Preference – Nissan Leaf

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

Overall Charging Frequency by Location (to scale)



Careful!

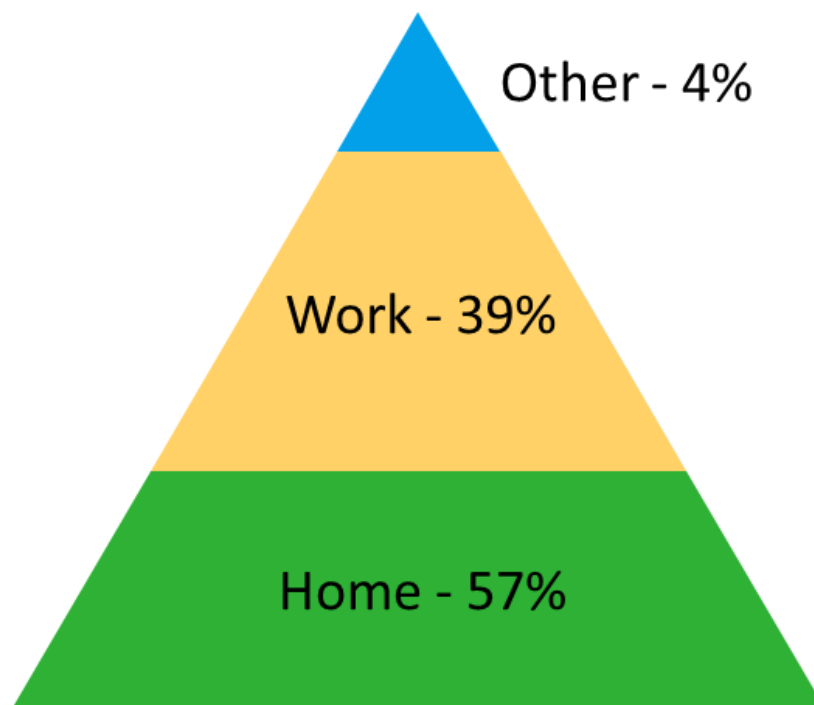
How important is this 3% to individual drivers' mobility needs?

How does cost to use workplace charging influence this behavior?

Charging Location Preference – Chevy Volt

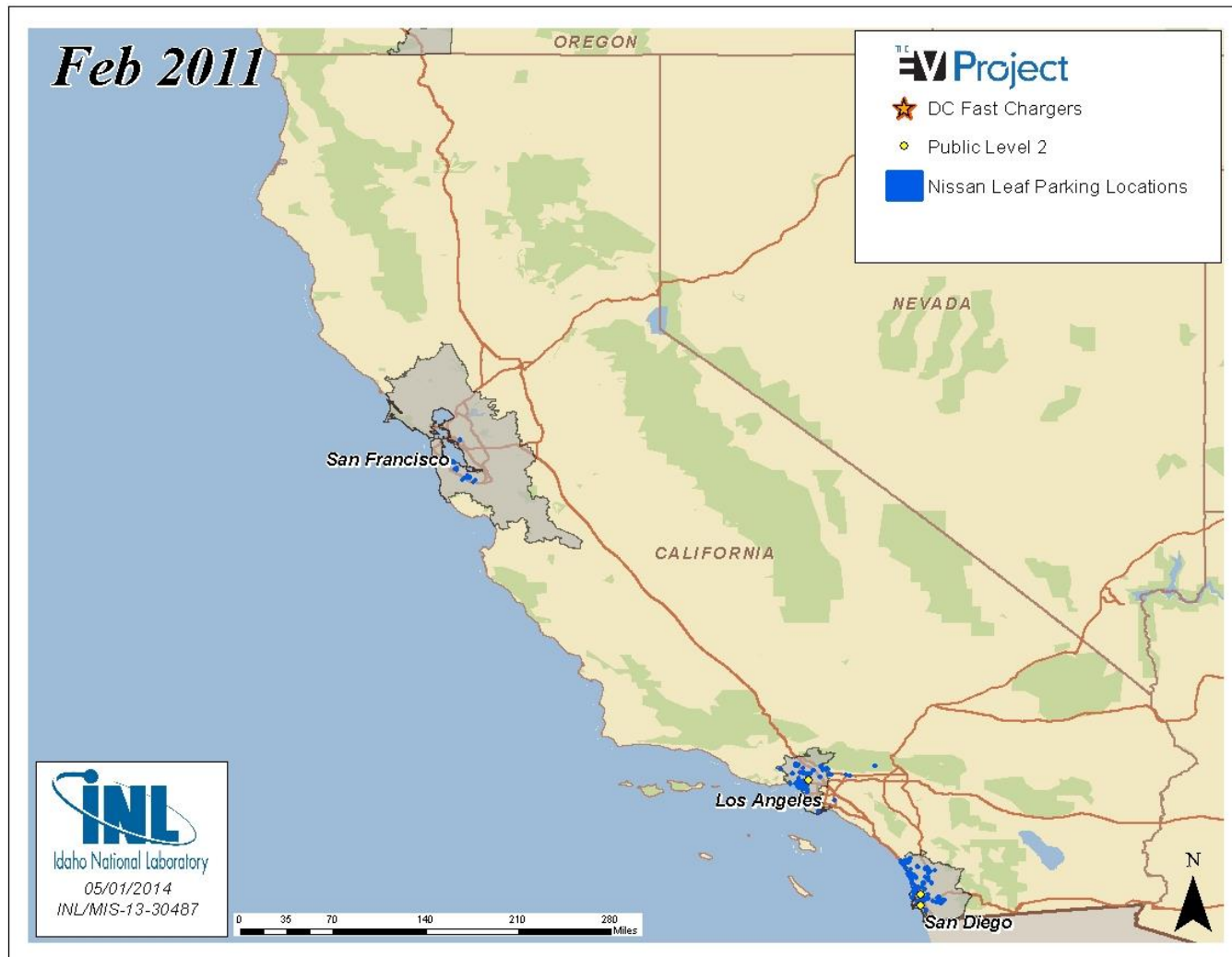
96 Chevrolet Volts with Access to Workplace Charging, 2013

Overall Charging Frequency by Location (to scale)



How does cost to use workplace charging influence this behavior?

Travel Extents of EV Project Leafs Based in CA



Feb 2011

Project

★ DC Fast Chargers

● Public Level 2

■ Nissan Leaf Parking Locations

San Francisco

CALIFORNIA

NEVADA

Los Angeles

San Diego

INL
Idaho National Laboratory

05/01/2014
INL/MIS-13-30487

0 35 70 140 210 280 Miles

N

Mar 2011

Project

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EV Project

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● Public Level 2

○ Non-EV Project

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Los Angeles

San Diego

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...)



Additional Information

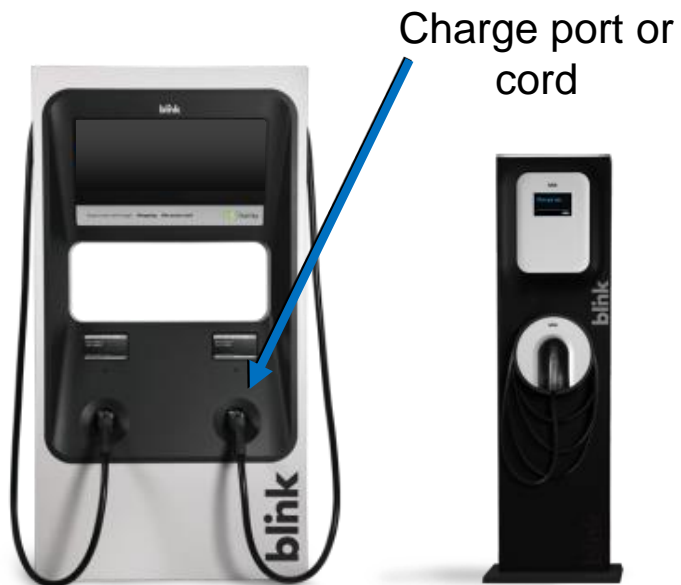
Measures of “Goodness”

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



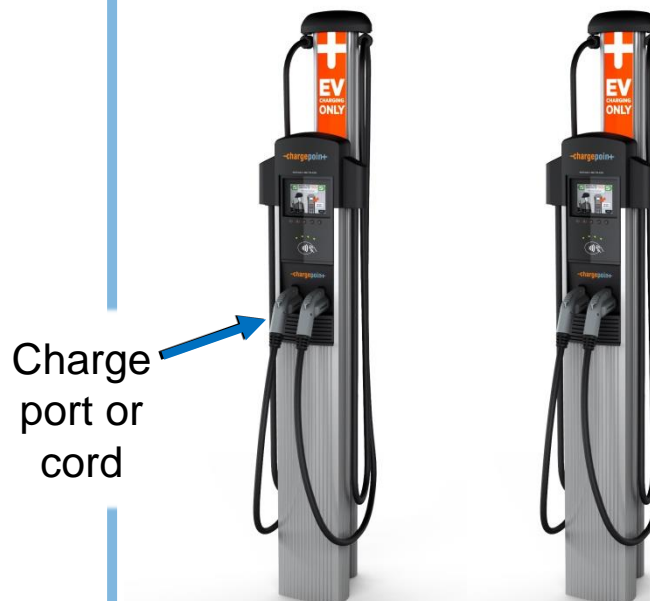
Dual-port
DC fast charge
EVSE unit or
charging station

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

Charging Site Location Considerations

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

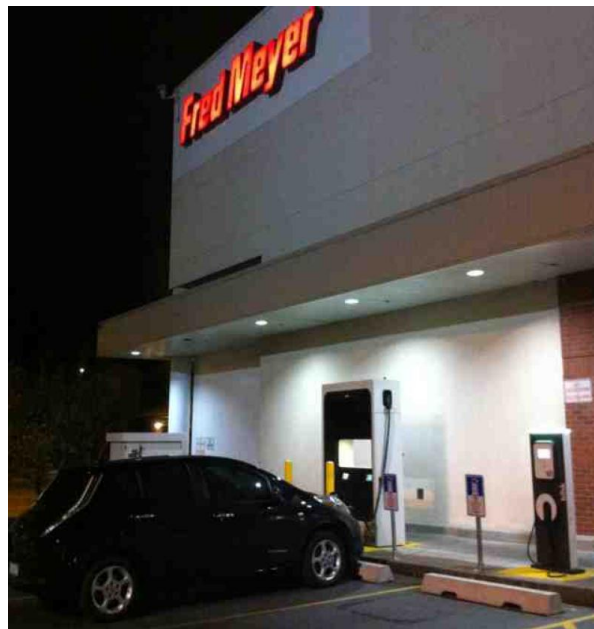
“Charger is between 2 handicap spaces. To charge and not get ticketed you need to park behind the charger in any of 3 spaces closest to the elevator / entrance in non EV dedicated spots. Good Luck.”
– Comment from plugshare.com user

- 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

