IWC - Latest Insights from The EV Project and ChargePoint America PEV Infrastructure Demonstrations

Jim Francfort & John Smart
Idaho National Laboratory

IWC meeting
Houston, Texas
October 2014

www.inl.gov

Idaho National Laboratory

INL was a primary partner in two national plug-in electric vehicle (PEV) charging infrastructure demonstrations

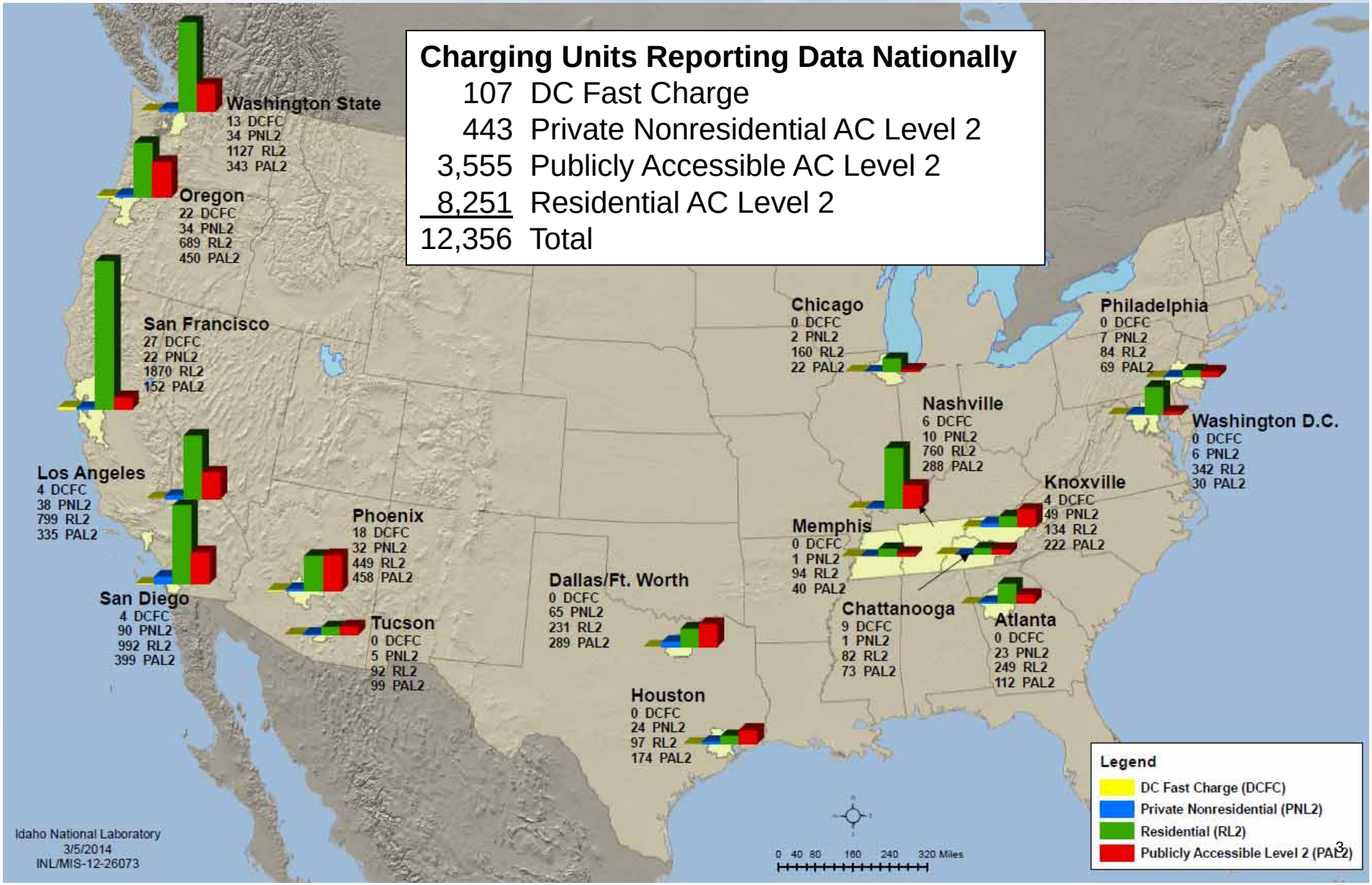
EV Project

- Purpose is to build mature EV charging infrastructure in 17 US regions. 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:

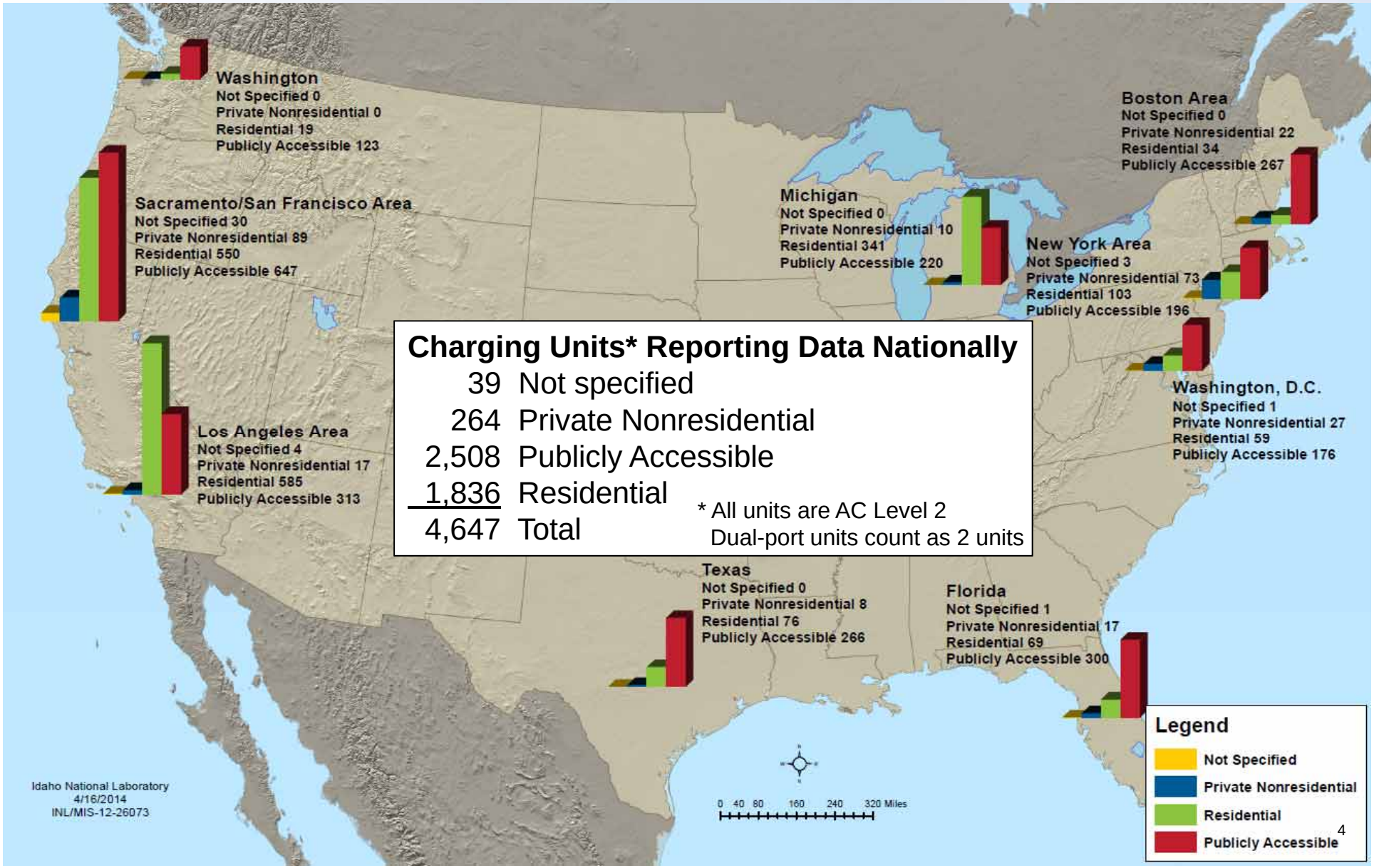
ChargePoint America

- 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

EV Project


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
Washington State
13 DCFC
34 PNL2
1127 RL2
343 PAL2
Oregon
22 DCFC
34 PNL2
689 RL2
450 PAL2
San Francisco
27 DCFC
22 PNL2
1870 RL2
152 PAL2
Los Angeles
4 DCFC
38 PNL2
799 RL2
335 PAL2
San Diego
4 DCFC
90 PNL2
992 RL2
399 PAL2
Phoenix
18 DCFC
32 PNL2
449 RL2
458 PAL2
Tucson
0 DCFC
5 PNL2
92 RL2
99 PAL2
Dallas/Ft. Worth
0 DCFC
65 PNL2
231 RL2
289 PAL2
Houston
0 DCFC
24 PNL2
97 RL2
174 PAL2
Chicago
0 DCFC
2 PNL2
160 RL2
22 PAL2
Nashville
6 DCFC
10 PNL2
760 RL2
288 PAL2
Memphis
0 DCFC
1 PNL2
94 RL2
40 PAL2
Chattanooga
9 DCFC
1 PNL2
82 RL2
73 PAL2
Knoxville
4 DCFC
49 PNL2
134 RL2
222 PAL2
Atlanta
0 DCFC
23 PNL2
249 RL2
112 PAL2
Philadelphia
0 DCFC
7 PNL2
84 RL2
69 PAL2
Washington D.C.
0 DCFC
6 PNL2
342 RL2
30 PAL2
Legend
DC Fast Charge (DCFC)
Private Nonresidential (PNL2)
Residential (RL2)
Publicly Accessible Level 2 (PAL2)
0 40 80 160 240 320 Miles
Idaho National Laboratory
3/5/2014
INL/MIS-12-26073

ChargePoint America



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**

Public EVSE Usage Fees

Blink

- **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**
  - **There is at least one DCFC at a work location that is free**

ChargePoint

- **Vary by site (per local site host discretion)**
- **Many are free (rumored 70% free / 30% cost)**

AeroVironment (States of Washington and Oregon)

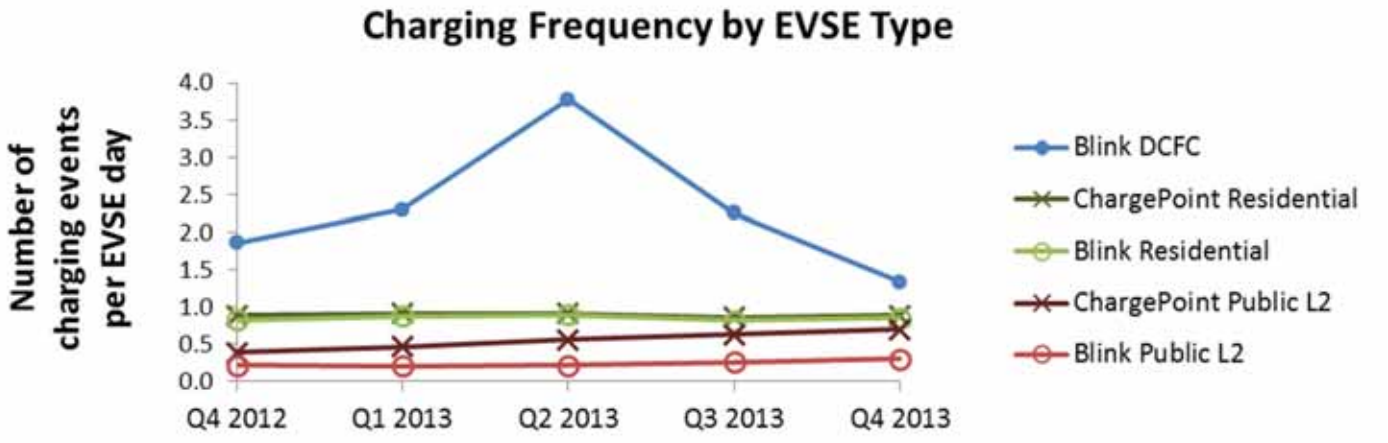
- **Free prior to Apr 1, 2014**
- **After Apr 1, 2014 – Monthly subscription fee of $19.99 for unlimited usage or "drive up" fee of $7.50 per session for DCFC and $4 per session for L2**

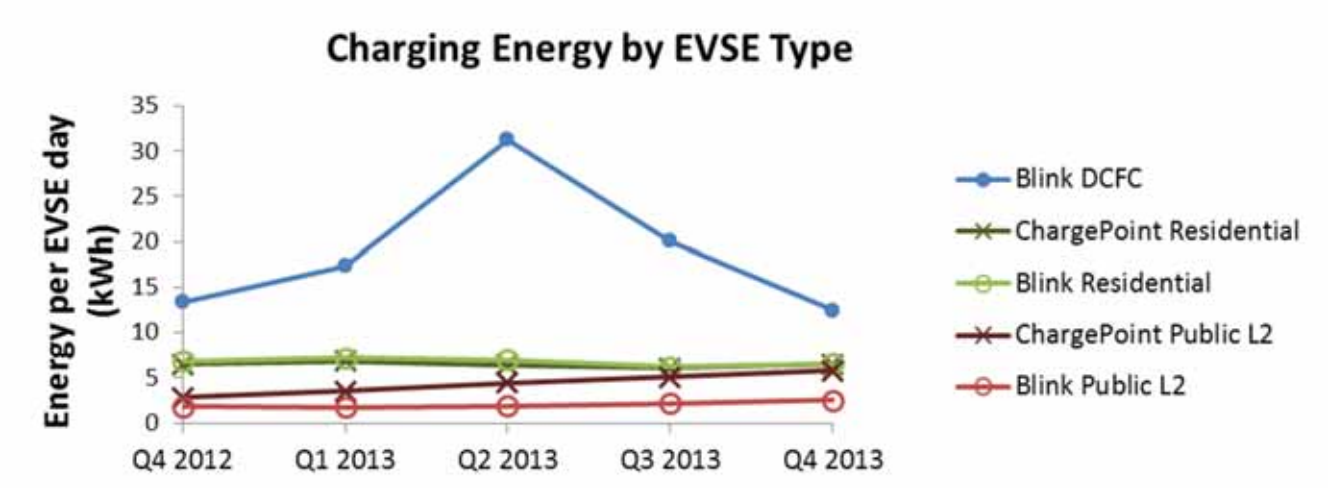
Outline

- 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
- Electric vehicle miles traveled (eVMT)
  - Leaf vs. Volt eVMT
  - Did Leaf eVMT change as public infrastructure usage changed
- Workplace charging
  - Charge triangle
  - Facebook case study
- Which public charging sites are used most frequently
  - By EVSE make and cost
  - By charging level and venue
- Determining hot spots using vehicle data
  - Bay Area examples
- I-5 Corridor EVSE usage preview
- Future work

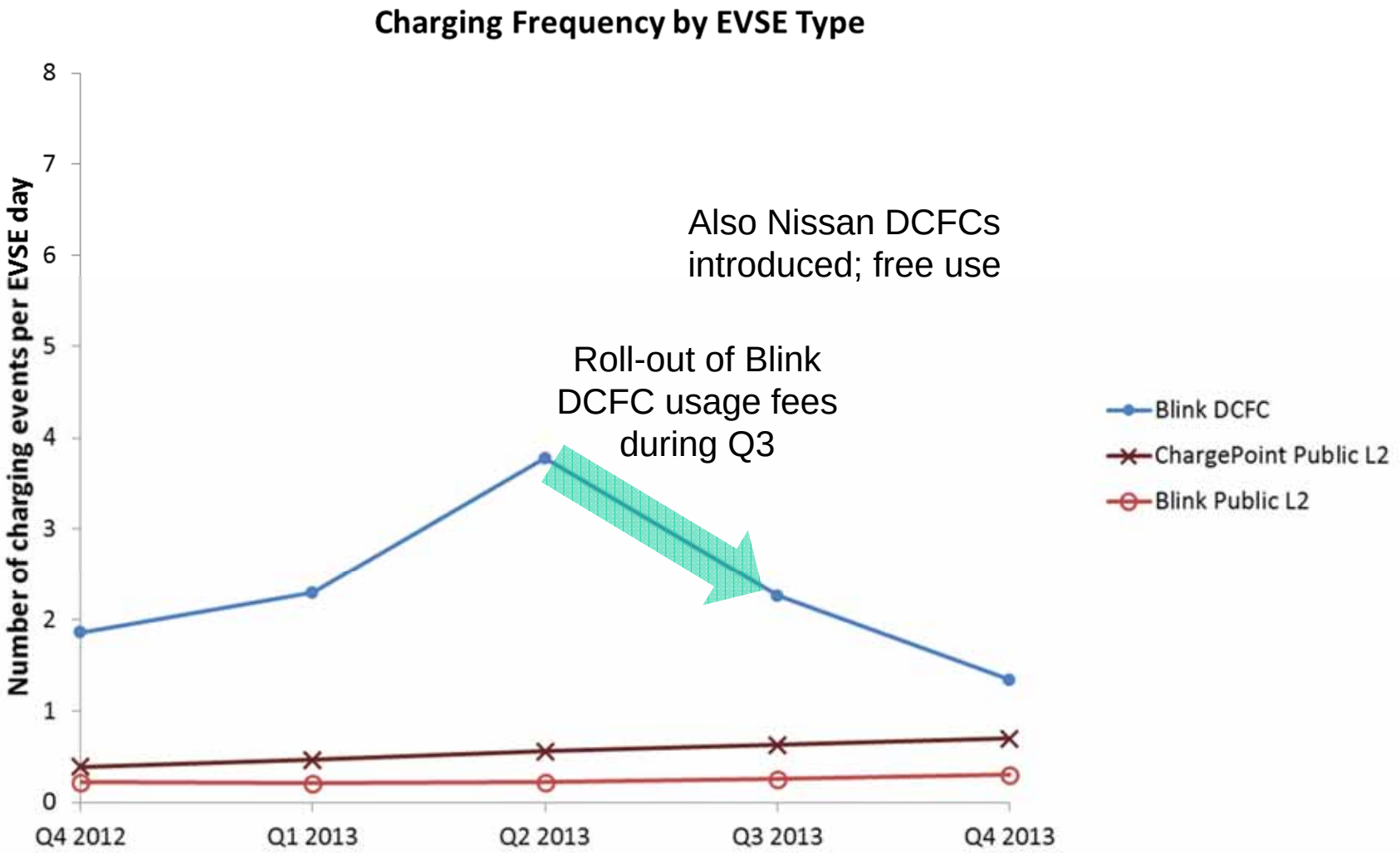
How has public AC level 2 EVSE and DC fast charger (DCFC) usage changed over time?

Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

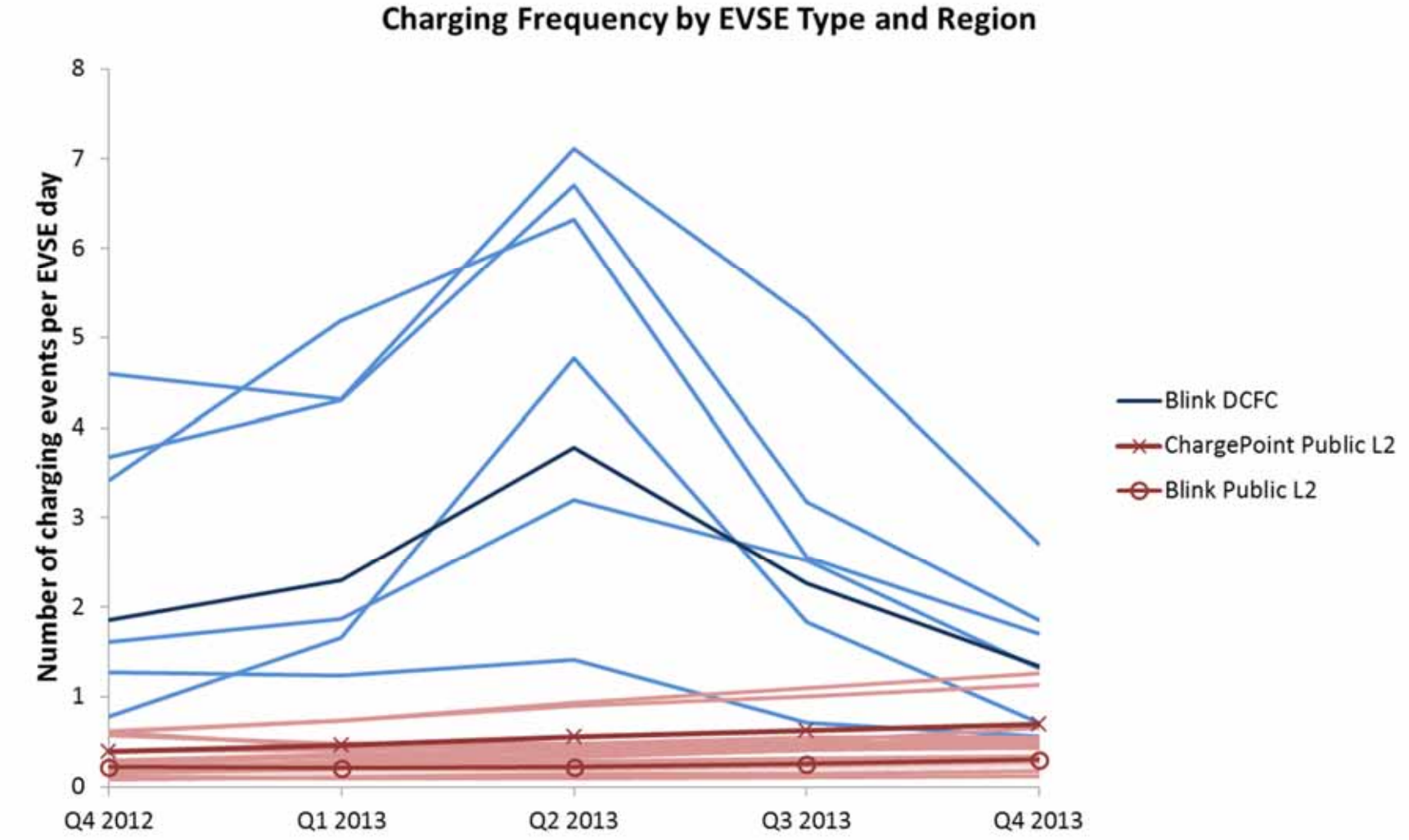




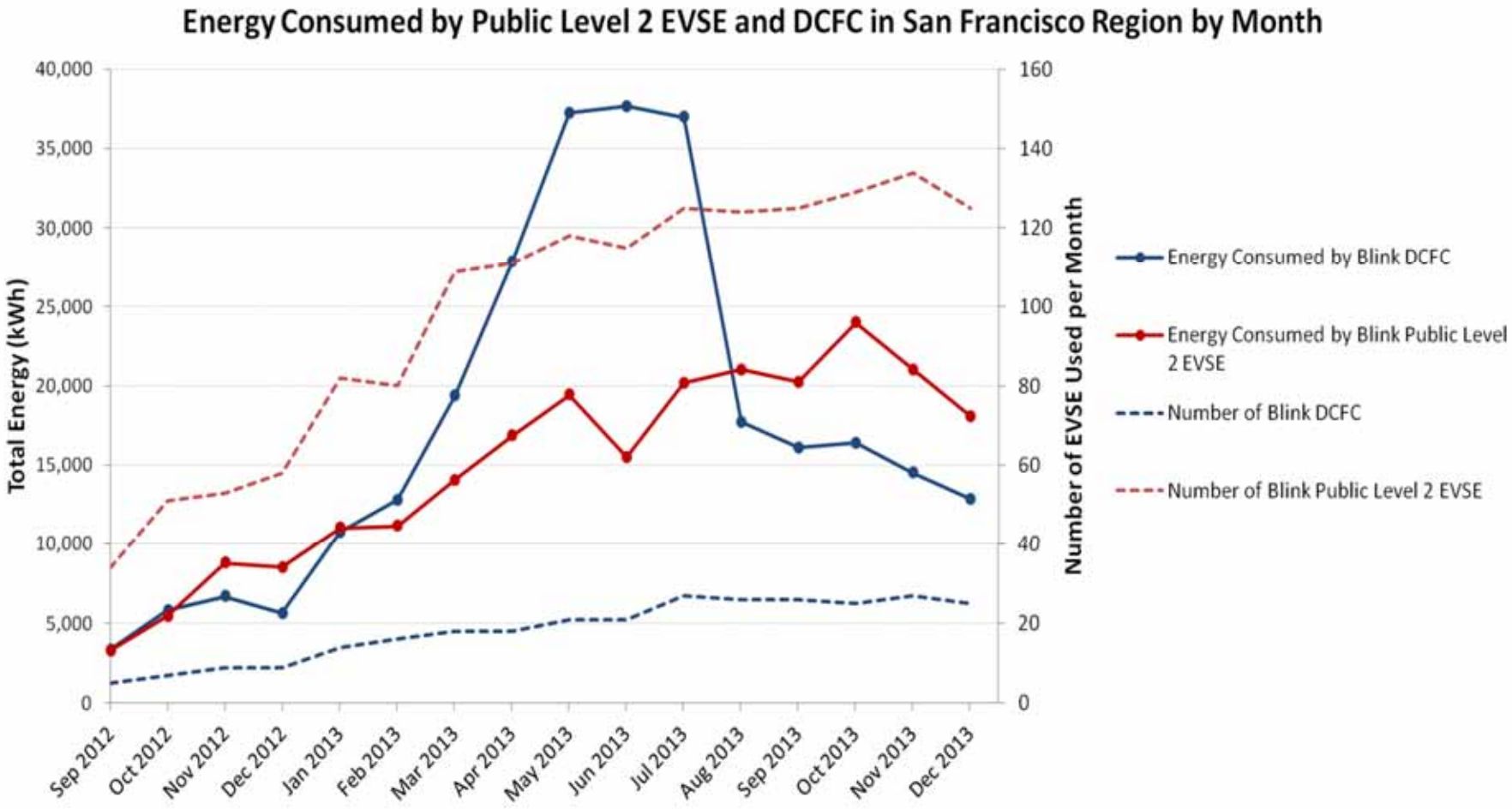
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers



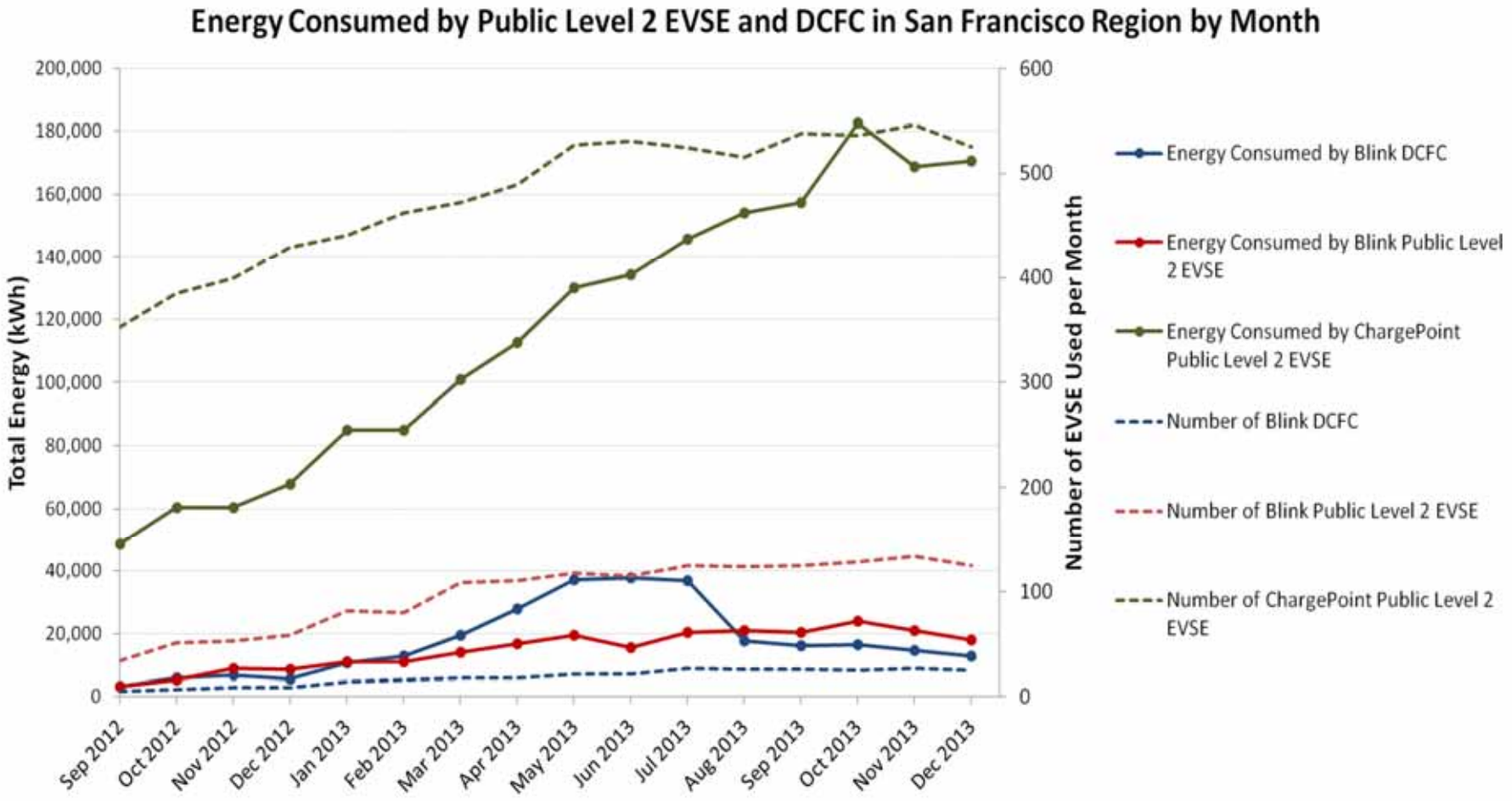
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers by Region



Total Energy Consumption at Blink Stations in San Francisco

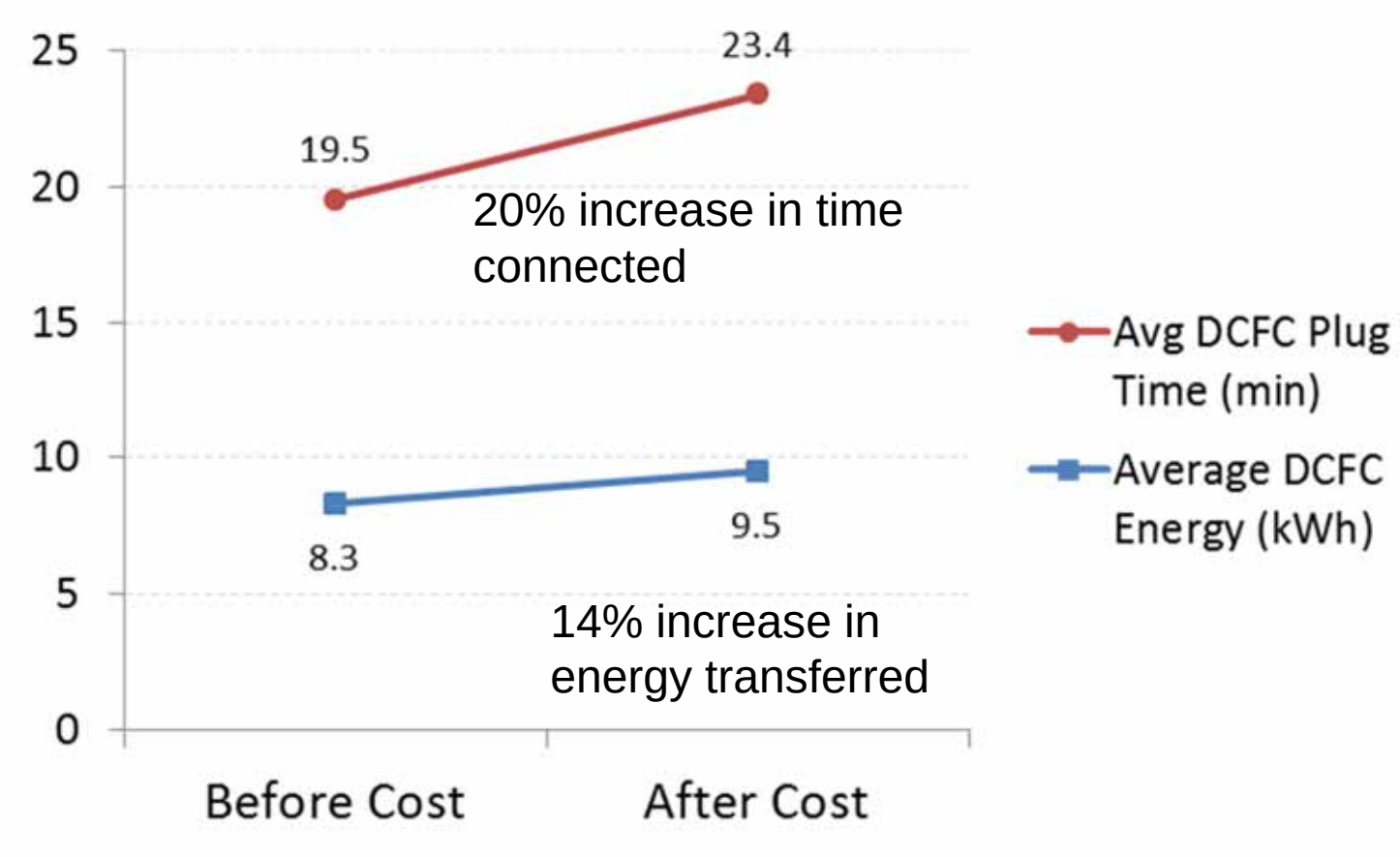


Total Energy Consumption at Blink and ChargePoint Stations in San Francisco



Unintended Consequence of Per-session Fee

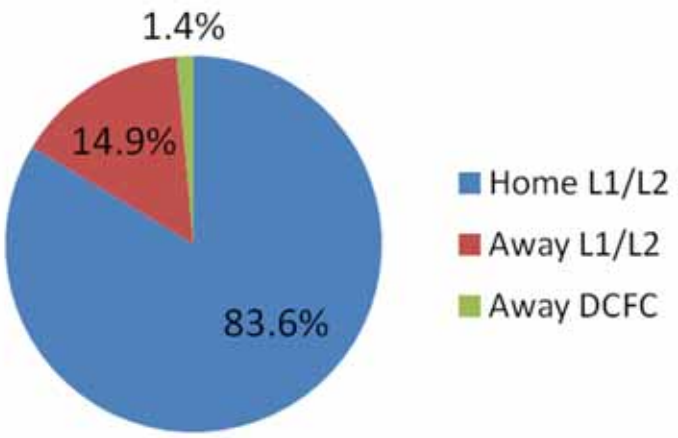
- **Pricing model leads to an "all-you-can-eat" mentality?**
- **Tapering SOC increase vs. time gives diminishing returns for time invested**



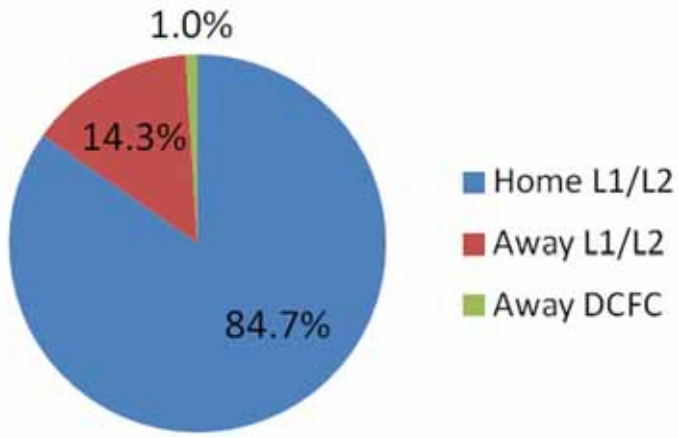
Infrastructure Usage by EV Project Leafs

- **4719 vehicles contributing data in vehicle months where home location is known**

3 months before DCFC fees (4/1/2013 – 7/1/2013)



3 months after DCFC fees (9/1/2013 – 12/1/2013)



Electric Vehicle Miles Traveled

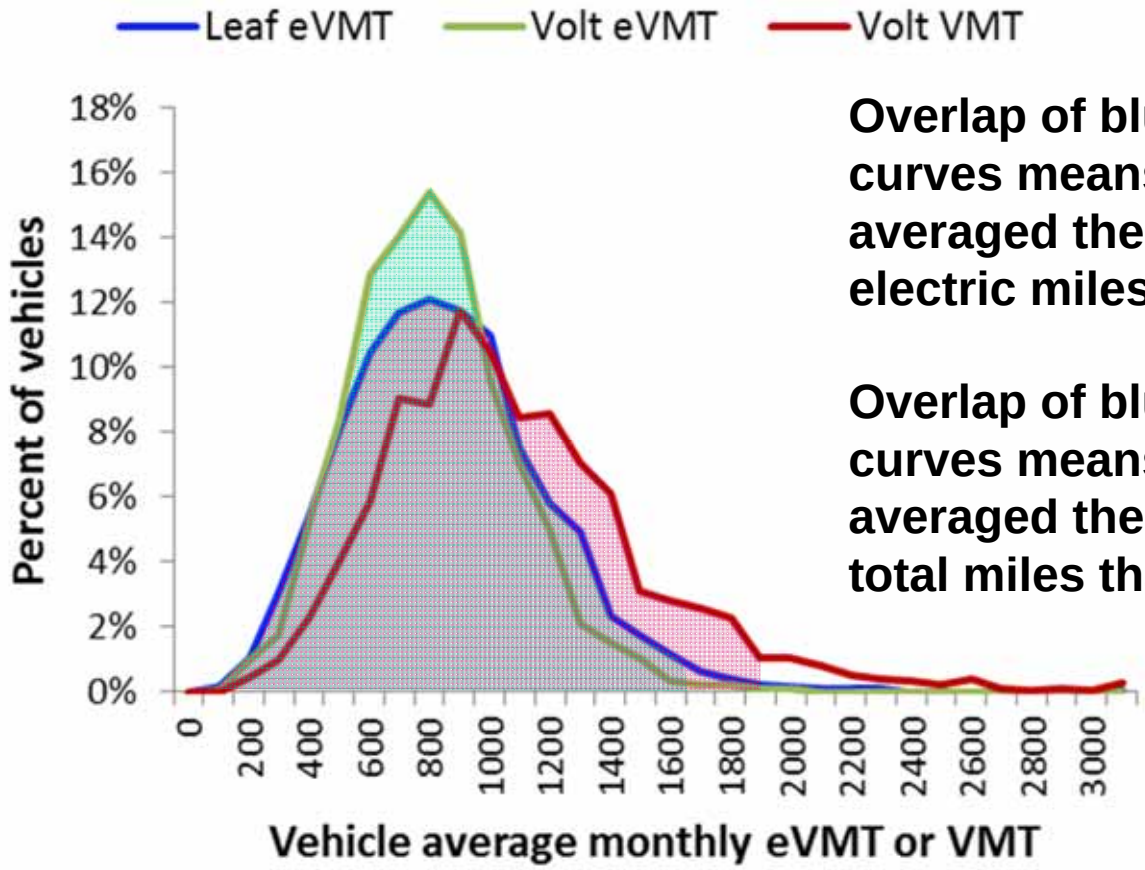
Leaf vs. Volt Average Monthly eVMT

Oct 1, 2012 through Dec 31, 2013

	Nissan Leaf	Chevrolet Volt
Number of vehicles	4,039	1,867
Number of vehicle months	35,294	20,545
Total distance traveled (miles)	28,520,792	20,950,967
Distance traveled in EV mode (miles)	28,520,792	15,599,508
Percent of distance traveled in EV mode	100%	74.5%
Average monthly total VMT	808.1	1,019.8
Average monthly eVMT	808.1	759.3

Leafs only 6% more eVMT per month than Volts

Leaf vs. Volt Distribution of Monthly eVMT

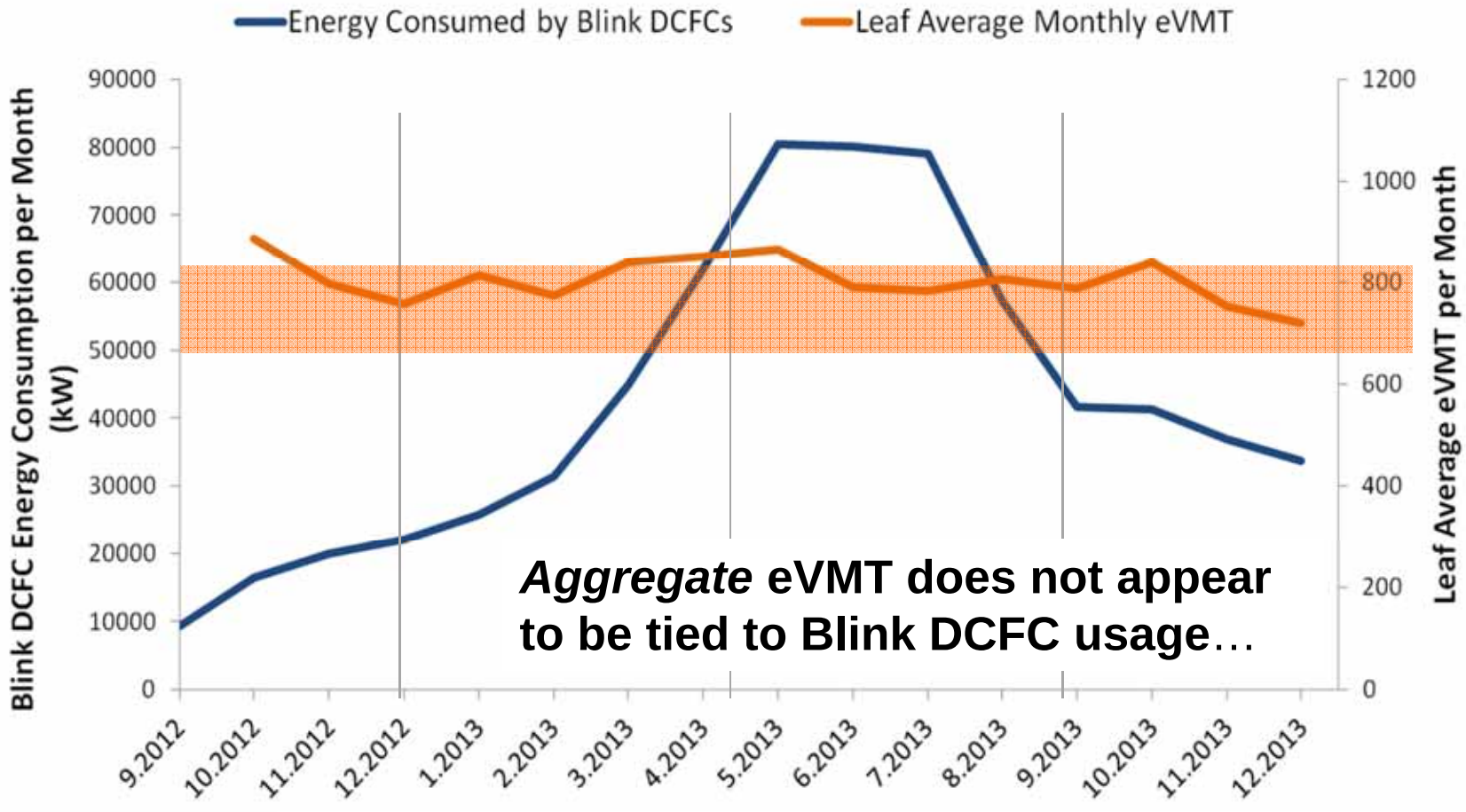


Overlap of blue and green curves means many Volts averaged the same or more electric miles than Leafs

Overlap of blue and red curves means many Leafs averaged the same or more total miles than Volts

Distribution of vehicle average monthly eVMT and VMT, where each data point in the distributions represents a single vehicle's average over the entire study period.

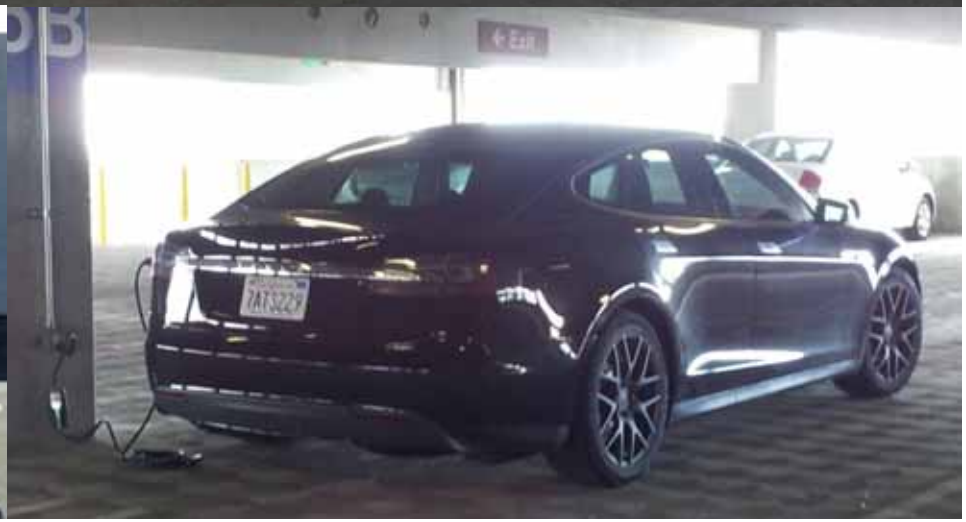
EV Project Leaf Monthly eVMT vs. Nationwide Blink DCFC Usage



… because most EV Project Leaf drivers did not charge away from home very much

Workplace Charging

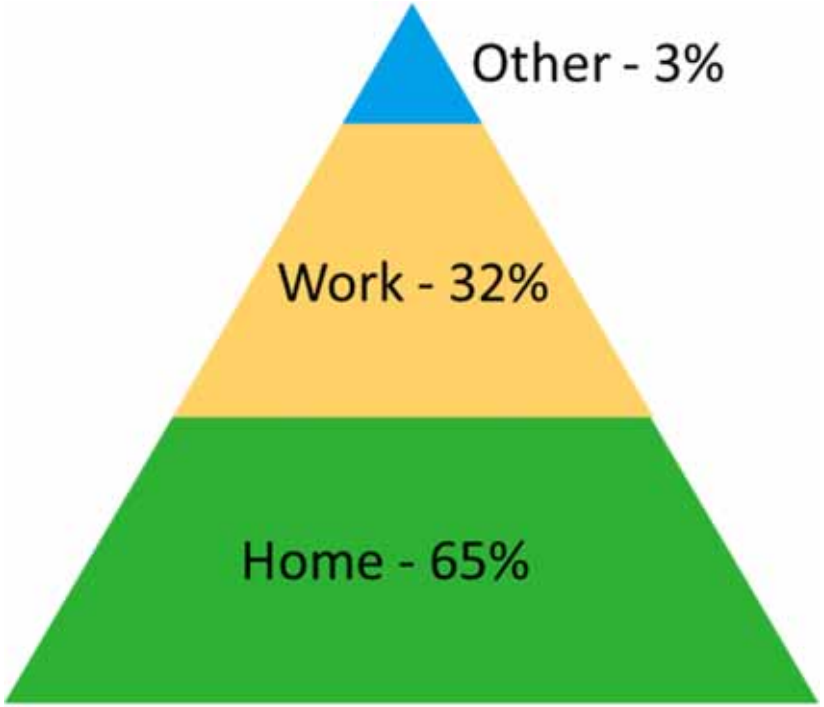
Idaho National Laboratory



Charging Location Preference – Nissan Leaf

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

Overall Charging Frequency by Location (to scale)



Careful!

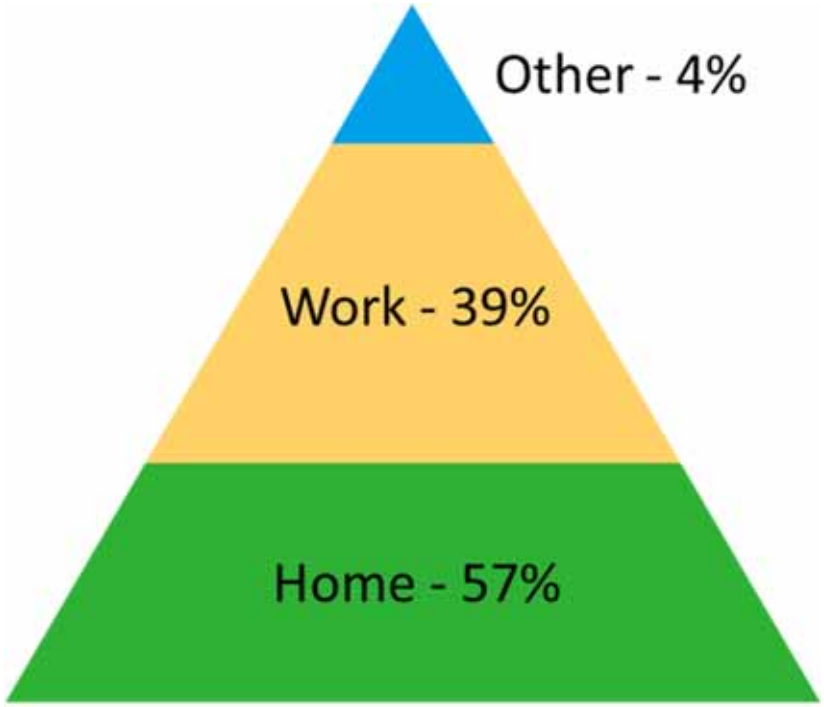
How important is this 3% to individual drivers' mobility needs?

How does cost to use workplace charging influence this behavior?

Charging Location Preference – Chevy Volt

96 Chevrolet Volts with Access to Workplace Charging, 2013

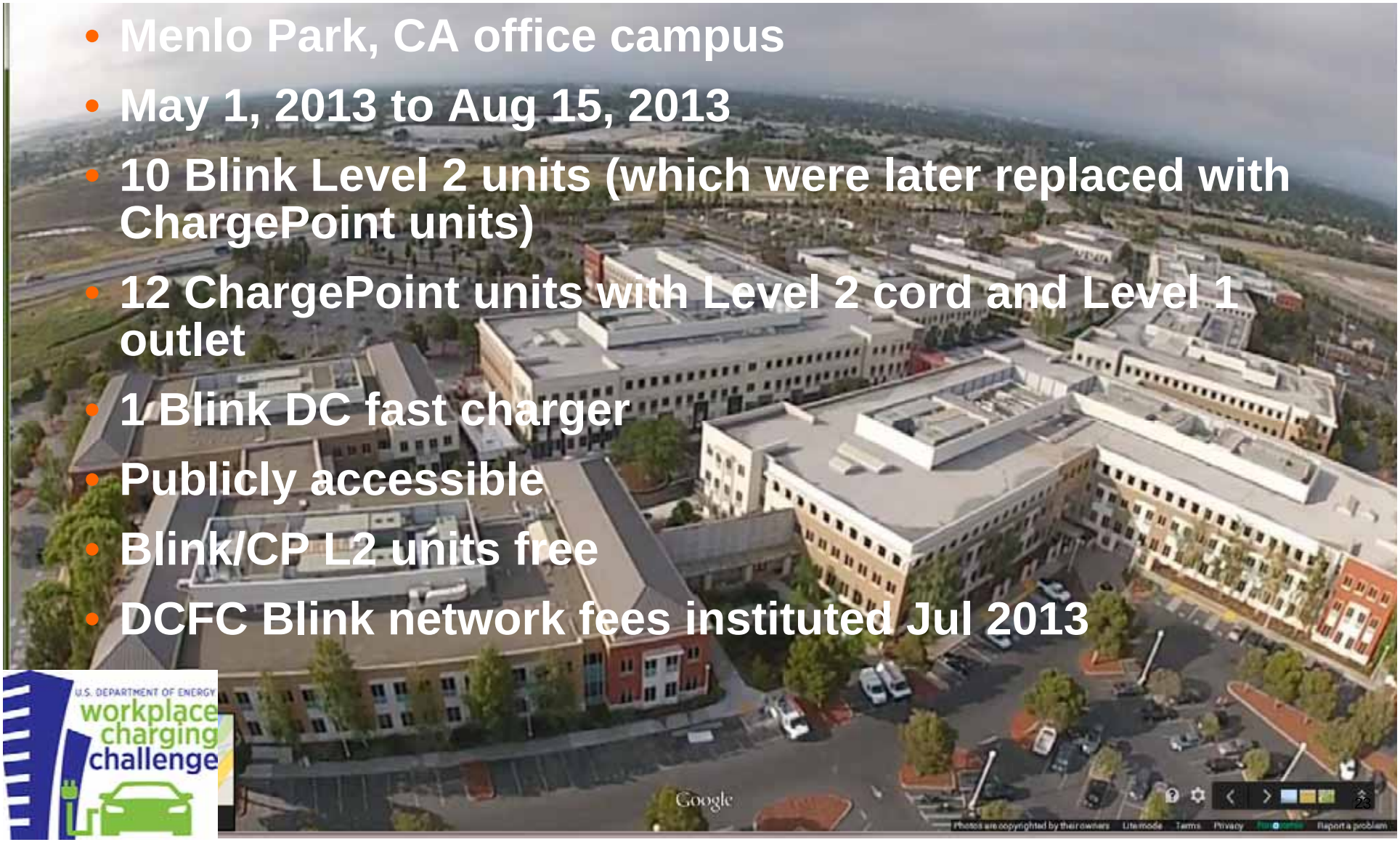
Overall Charging Frequency by Location (to scale)



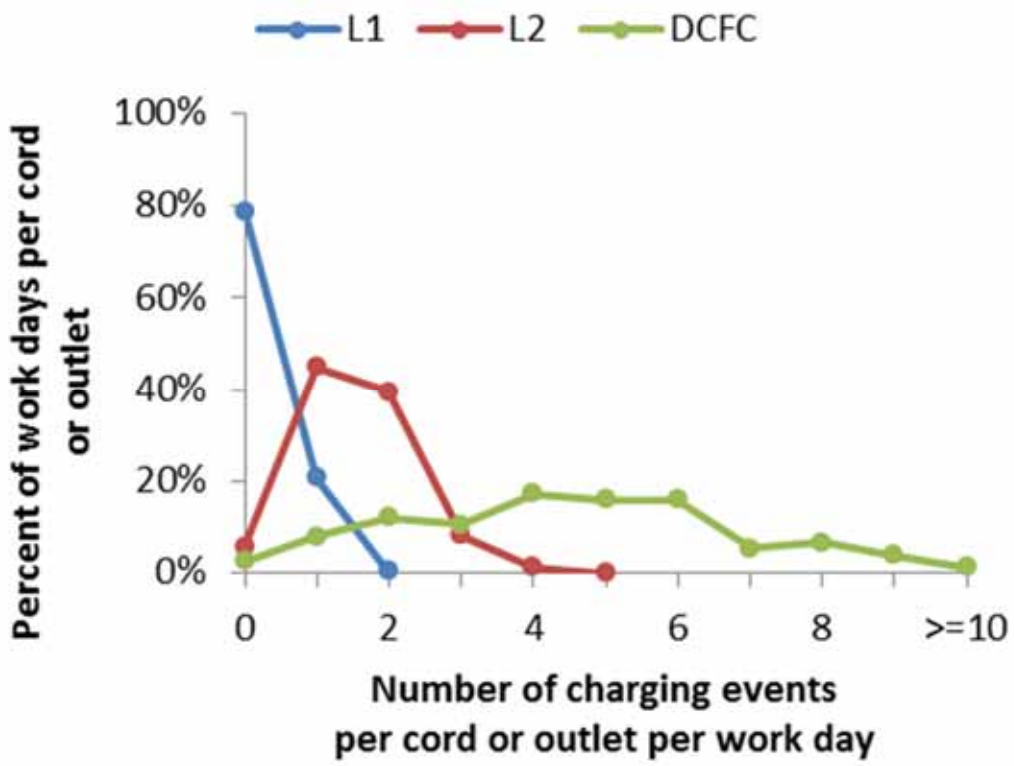
How does cost to use workplace charging influence this behavior?

Workplace Charging Case Study: Facebook

- Menlo Park, CA office campus
- May 1, 2013 to Aug 15, 2013
- 10 Blink Level 2 units (which were later replaced with ChargePoint units)
- 12 ChargePoint units with Level 2 cord and Level 1 outlet
- 1 Blink DC fast charger
- Publicly accessible
- Blink/CP L2 units free
- DCFC Blink network fees instituted Jul 2013

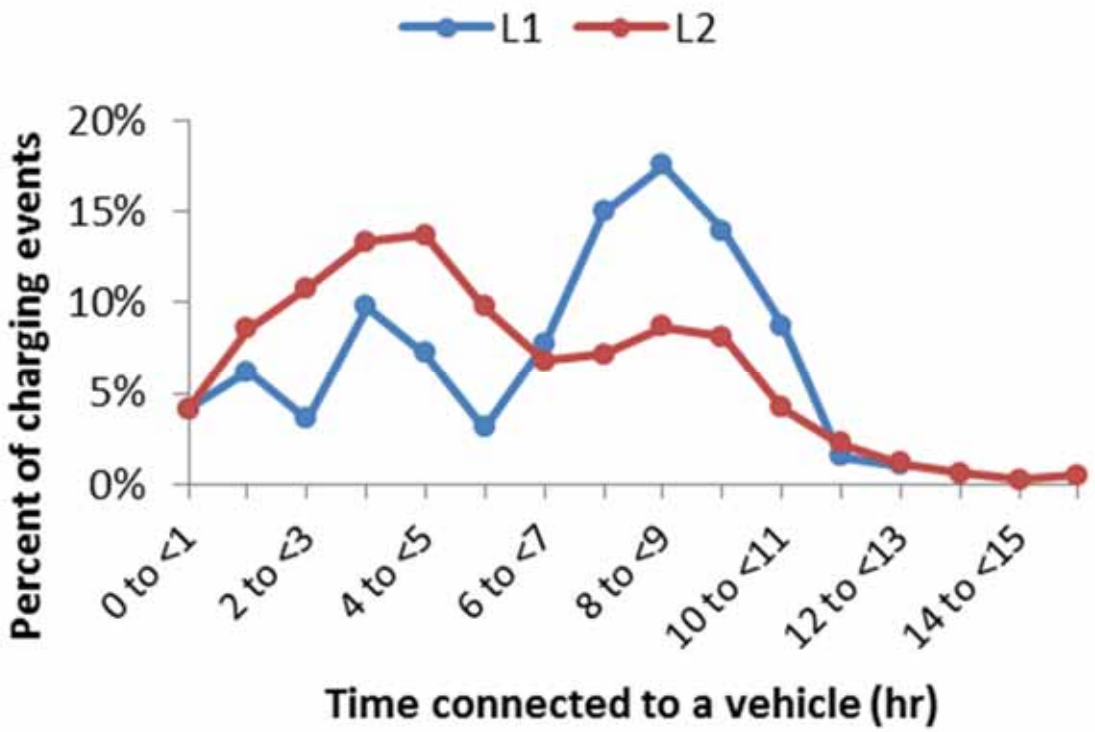


Charging Frequency at Facebook



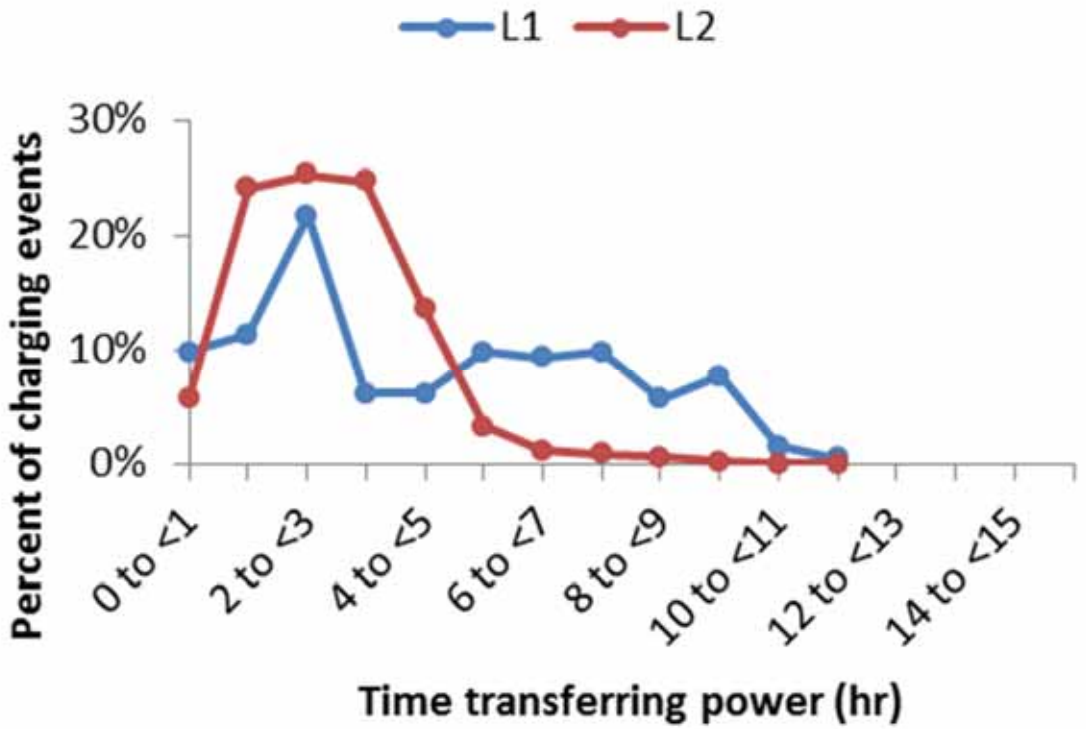
Frequency distributions of number of charging events per cord or outlet per work day for different charge power levels.

Time Connected at Facebook



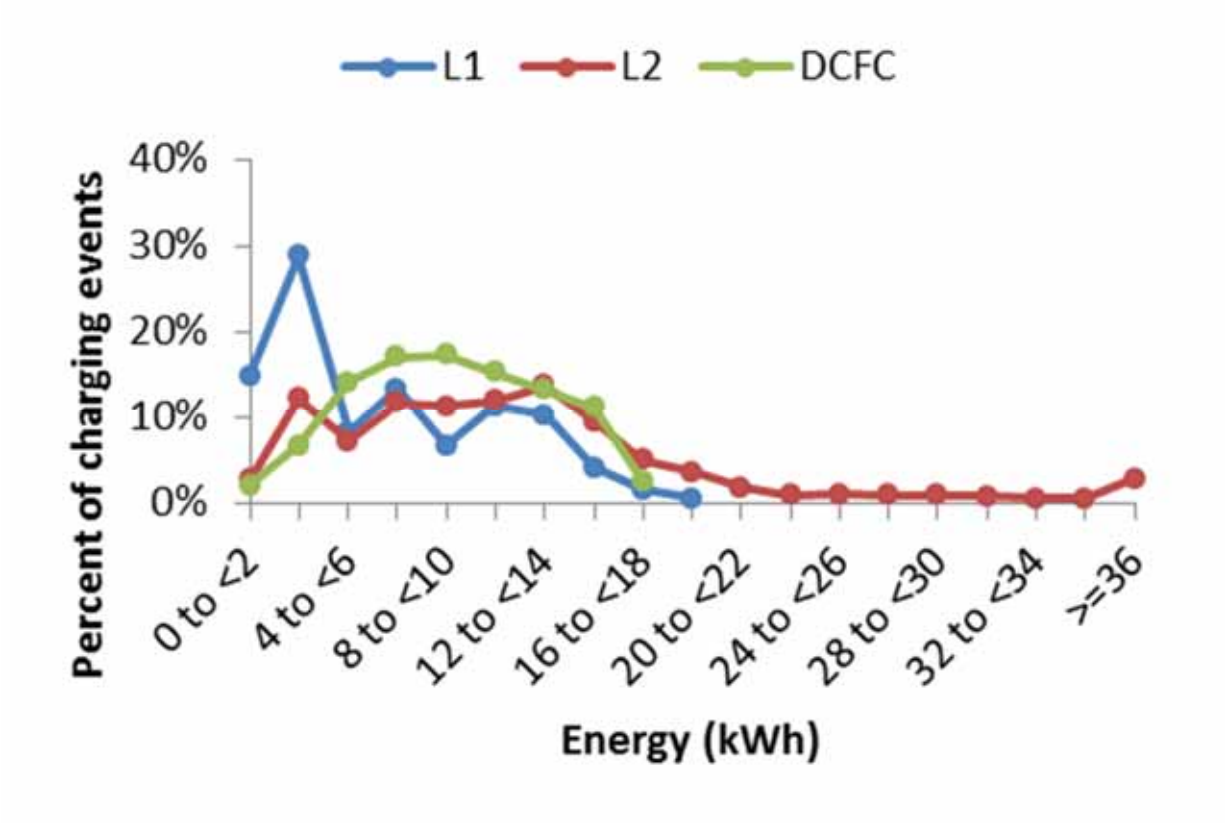
Frequency distributions of time Level 1 outlets and Level 2 cords were connected to a vehicle per charging event.

Time Drawing Power at Facebook



Frequency distributions of time Level 1 outlets and Level 2 cords transferred power to a vehicle per charging event.

Energy Consumption at Facebook



Distribution of energy consumed per charging event by charge power level.

Facebook - ChargePoint Level 1 / Level 2 EVSE Usage

- Data were collected from 12 charging units that were capable of both AC Level 1 and AC Level 2 charging
- Drivers overwhelmingly preferred AC Level 2 cords over AC Level 1 outlets
  - When drivers arrived at these units and both Level 1 and Level 2 options were available, they chose to use the Level 2 cord 98% of time
- Drivers may have consciously chosen the faster charge rate or they may have been motivated simply by convenience
  - The Level 2 cord was available on the EVSE, but a driver needed to retrieve their own Level 1 cord to plug into the Level 1 outlet on the EVSE

Facebook - DC Fast Charger Usage

- **The DC fast charger (DCFC) was typically used between 2 and 6 times per work day for 24 minutes or less per charging event**
- **11% of the time when a DC fast charge event ended and another event began on the same work day, a vehicle was already connected to the second DC fast charger cord prior to the end of the first vehicle's charging event**

Facebook - Company Policies & Practices

- **Facebook followed a few simple guidelines to encourage employees to self-manage electric vehicle supply equipment (EVSE) usage**
  - **Charging units were installed to allow access from multiple parking spaces**
  - **Drivers wanting a charge would park close to EVSE in use and leave their charge port door open**
  - **Drivers were encouraged to plug in neighboring vehicles after their vehicle completed charging**
  - **Employees were provided with an online message board – a Facebook page – allowing them to coordinate charging station usage**

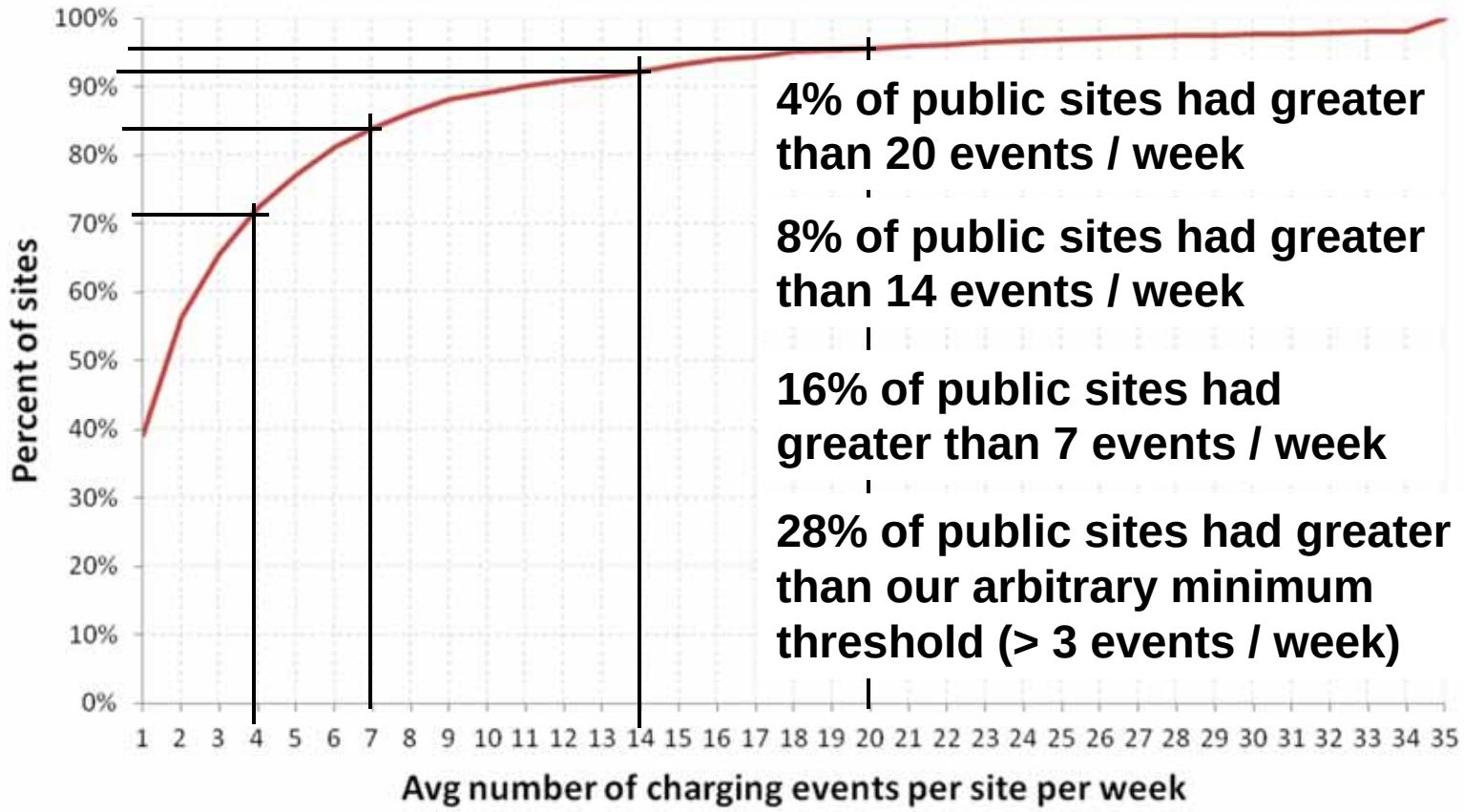
Facebook - Company Policies & Practices

- **Data from the EVSE suggest that drivers leveraged these resources to minimize the time EVSE were not in use**
  - **37% of the time when one charging event ended and the next began at the same AC Level 2 EVSE during the same work day, less than 30 seconds elapsed between the two charging events**
  - **60% of the time, less than 3 minutes elapsed between consecutive charging events**

Which public charging sites are used most frequently?

Usage of Publicly Accessible Level 2 Sites

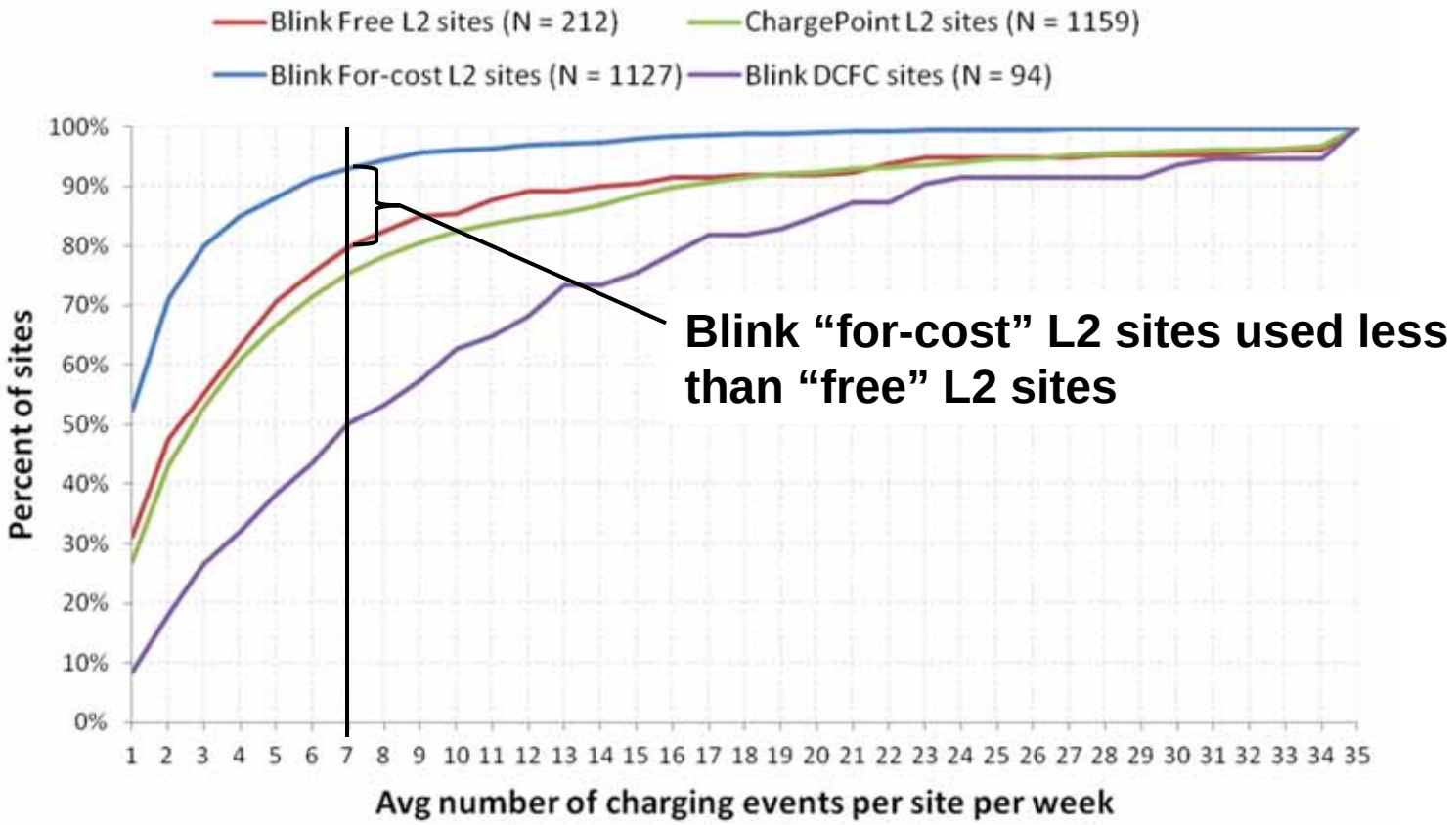
Cumulative Distribution of Charging Frequency of Blink and ChargePoint Level 2 Publicly Accessible Sites



9/1/2012 to 1/1/2014

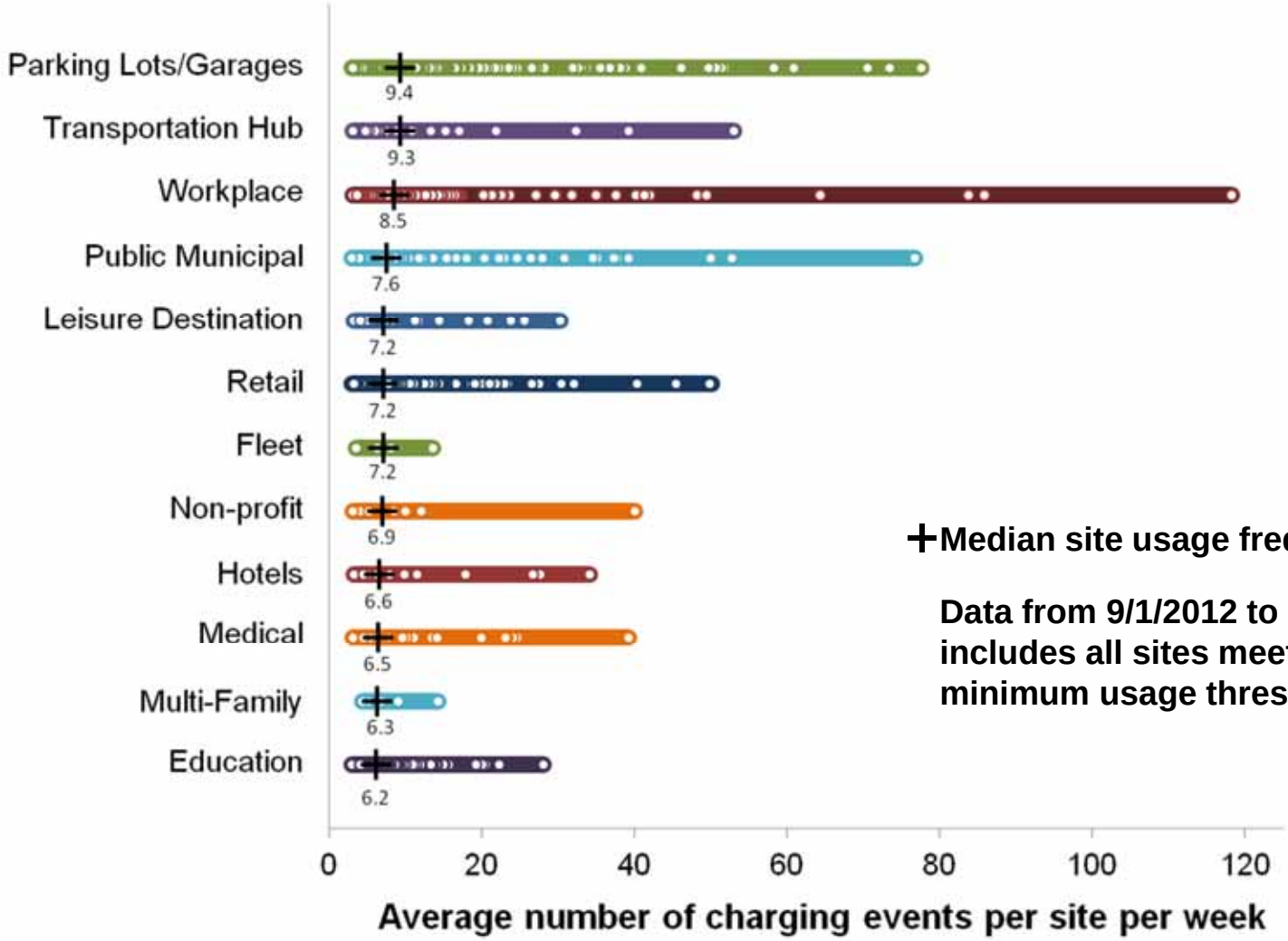
Usage of Publicly Accessible Level 2 Sites

Cumulative Distribution of Charging Frequency of Blink and ChargePoint Level 2 Publicly Accessible Sites



9/1/2012 to 1/1/2014

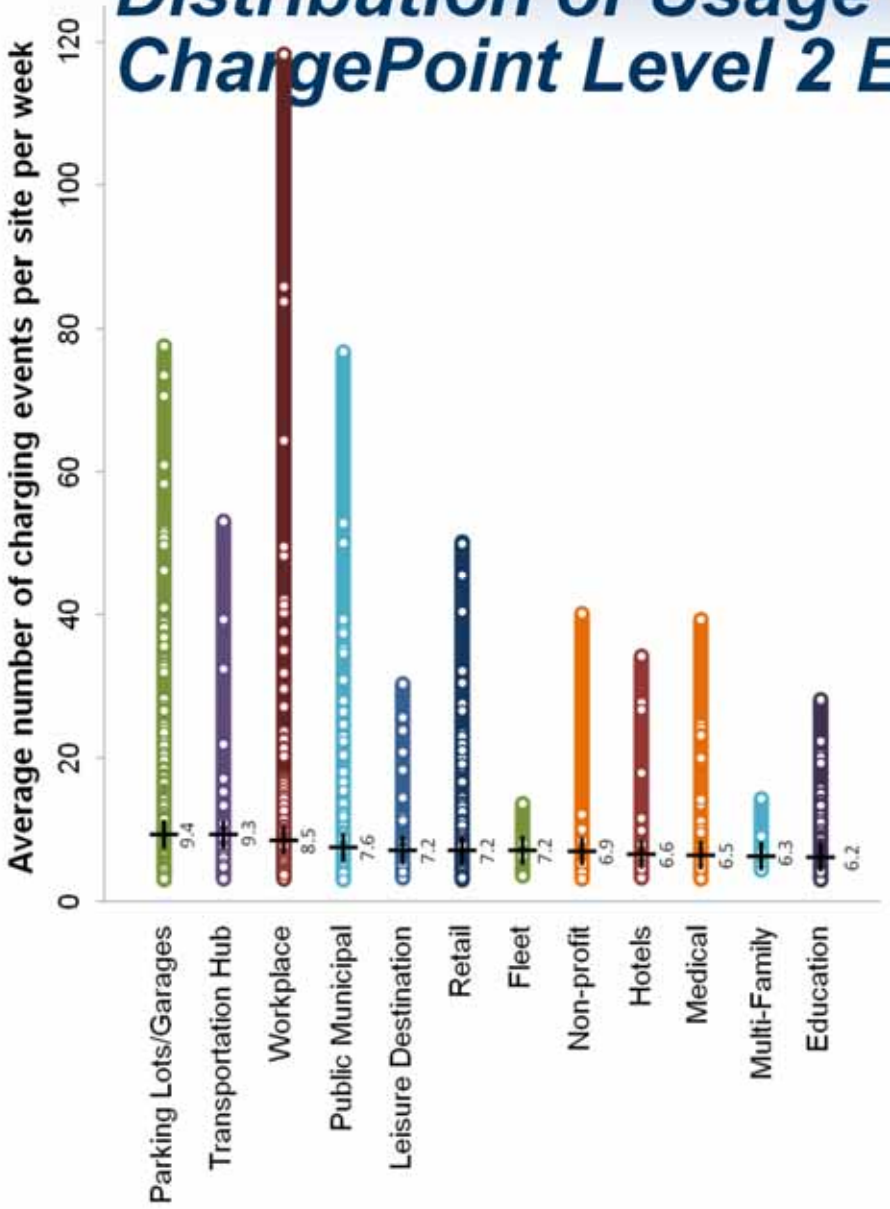
Distribution of Usage Frequency of Blink & ChargePoint Level 2 EVSE Sites by Venue



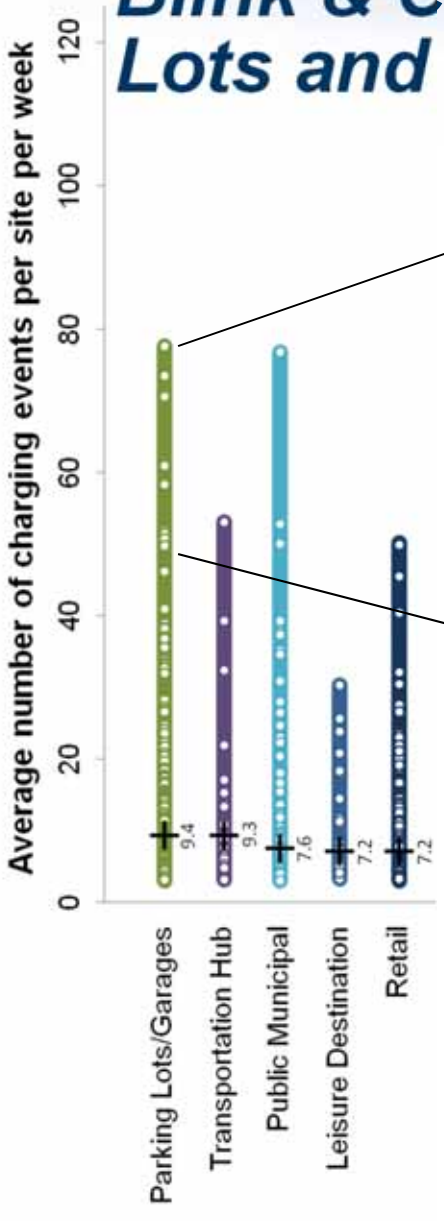
+Median site usage frequency

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

Distribution of Usage Frequency of Blink & ChargePoint Level 2 EVSE Sites by Venue

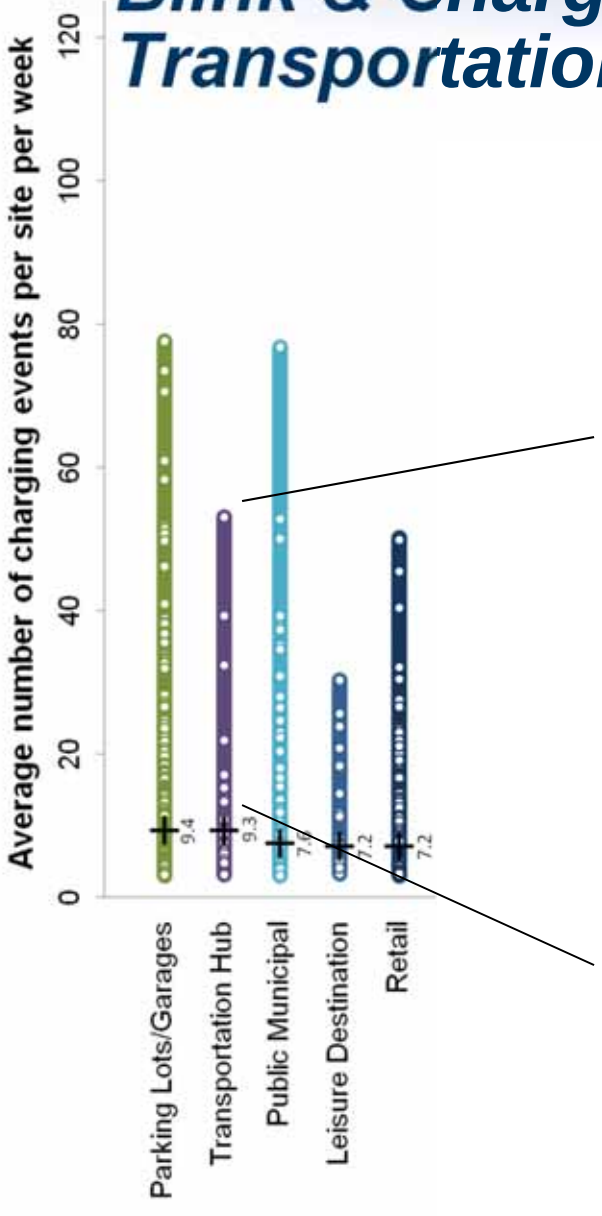


Blink & ChargePoint Level 2 Sites – Parking Lots and Garages



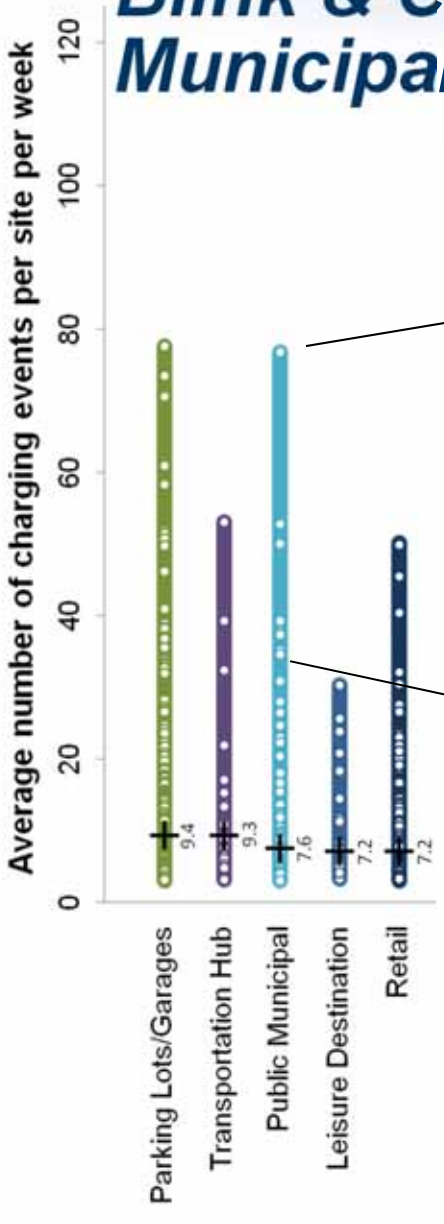
77.5 Downtown Palo Alto
73.4 Fifth & Mission Garage, San Francisco
70.6 Downtown Palo Alto
60.9 Downtown Redwood City
58.3 Parking Structure, Irvine CA
51.8 Parking Structure, Irvine CA
51.4 Parking garage, San Francisco CA
50.7 Sutter Stockton Garage, San Francisco CA

Blink & ChargePoint Level 2 Sites – Transportation Hubs



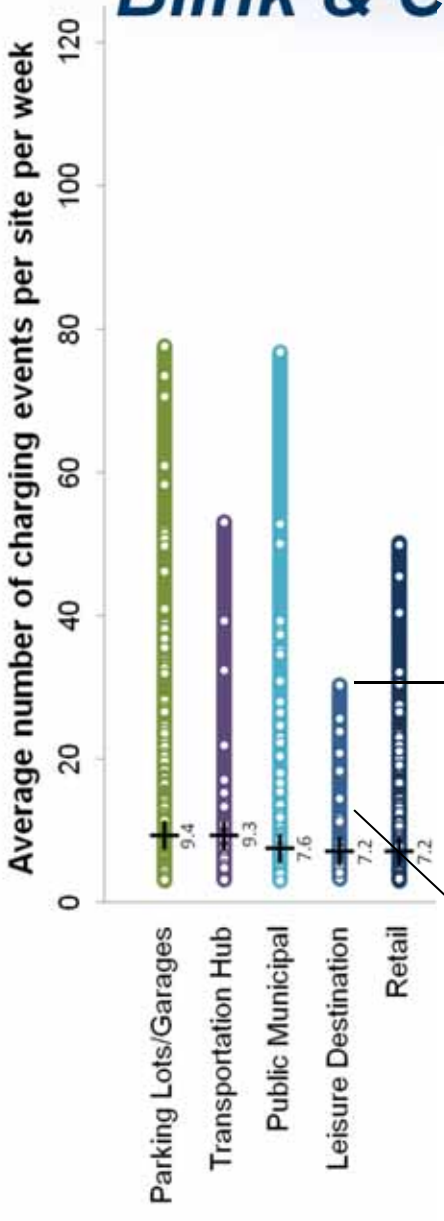
53.0	San Francisco Airport
39.3	Anaheim Canyon Metrolink
32.3	Oceanside Transit Center Metrolink train /light-rail/bus station park and ride
21.9	Oakland International Airport parking
17.0	San Francisco Airport
15.6	Expresso Airport Parking, San Leandro CA
15.2	San Francisco Airport
13.3	MBTA Alewife 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



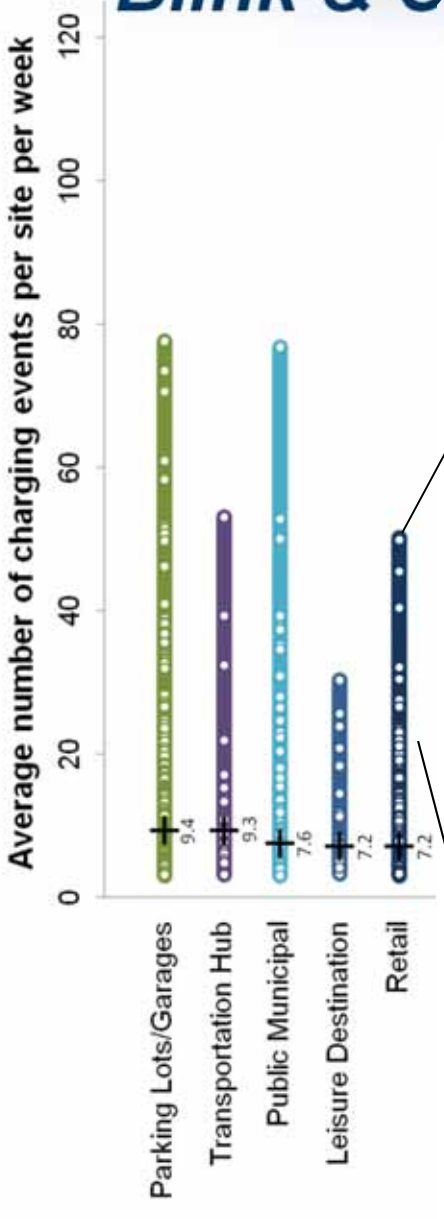
76.7	SCAQMD HQ building, Diamond Bar CA
52.8	City library, Dublin CA
50.0	City library, Redwood City CA
39.3	City hall, Hungtington Beach CA
37.7	Civic center, Campbell CA
37.3	City hall, Hermosa Beach CA
35.1	SCAQMD HQ building, Diamond Bar CA
34.6	City hall, Orange CA

Blink & ChargePoint Level 2 Sites – Leisure



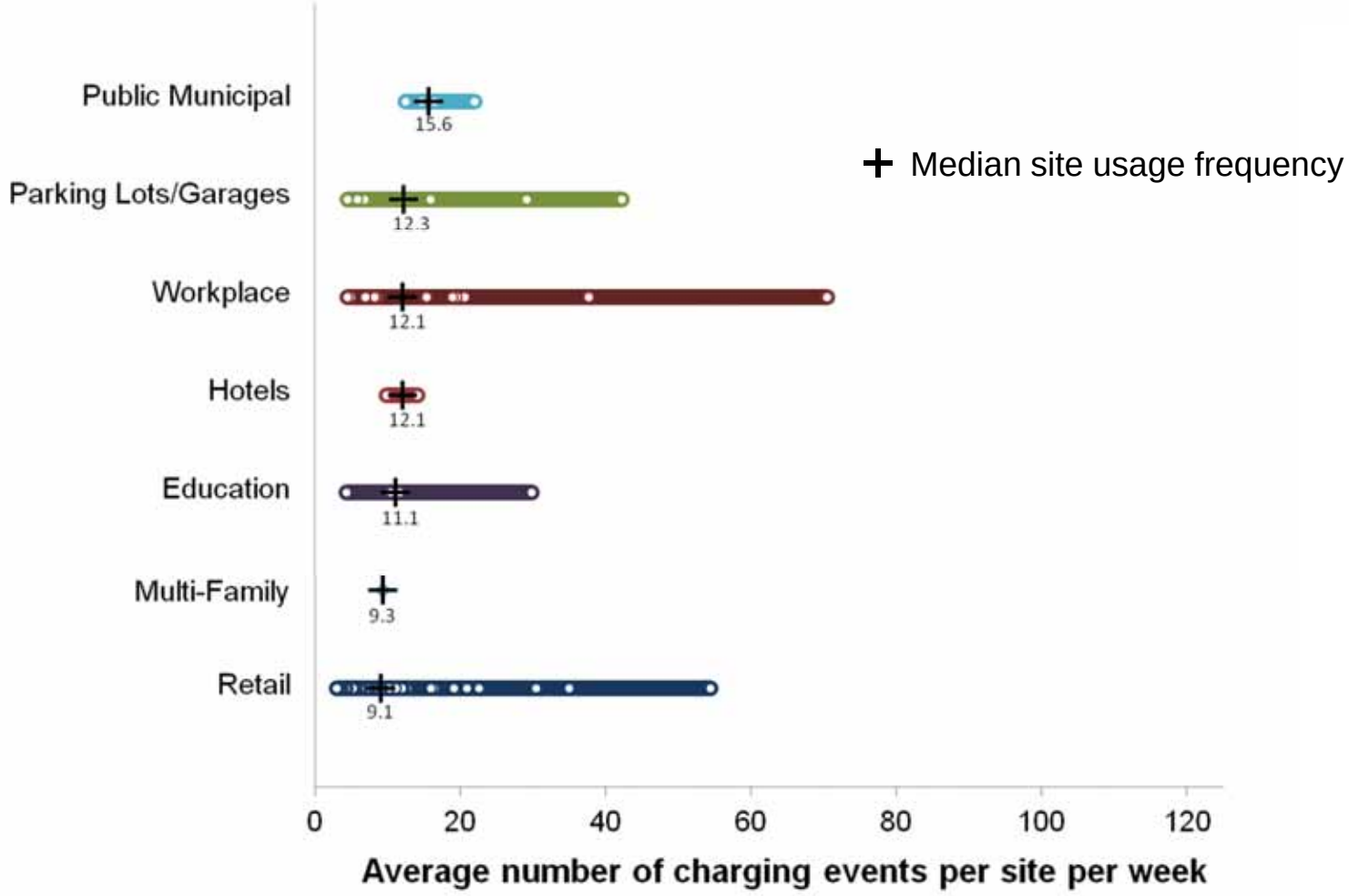
30.3	Rialto Sebastopol Cinemas, Sebastopol CA
25.7	La Cienega Tennis Center, Beverly Hills CA
23.9	Canal Park, Washington DC
20.8	Post Office Square Garage, Boston MA
18.2	Red Morton Community Center, Redwood City CA
14.4	San Diego Zoo
11.7	Balboa Park Air & Space Museum, Automotive Museum, gymnasium,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

Blink & ChargePoint Level 2 Sites – Retail



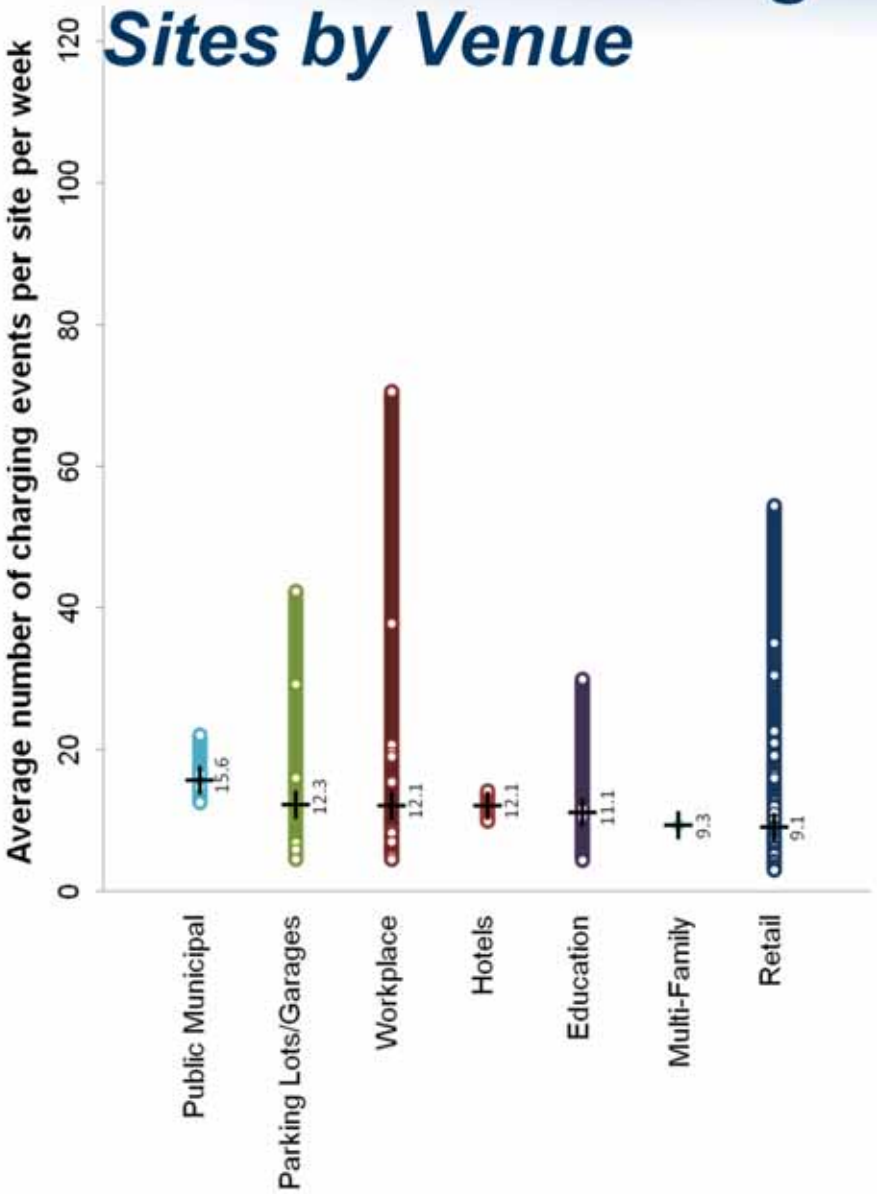
50.1	Retail-Small (Becker Surfboards), Hermosa Beach CA
49.9	Mall (Bella Terra Shopping Ctr), Huntington Beach CA
45.5	Mall (Westfield Galleria Mall), Roseville CA
40.7	Mall (The Grove), Los Angeles CA
40.3	Mall (The Americana at Brand), Glendale CA
32.1	Mall (Stanford Shopping Center), Palo Alto CA
30.4	Mall, Beverly Hills CA
27.5	Mall (Fashion Valley Mall), San Diego CA
26.6	Retail-Small (Ralph's grocery store), Marina Del Ray CA
23.4	Retail-Small (Mollie Stone's Market grocery store), Saulsalito CA
23.0	Retail-Big (Kohl's), Yorba Linda CA
22.8	Electric Lodge Performing Arts Center (dance and fitness center), Venice CA

Distribution of Usage Frequency of Blink DCFC Sites by Venue

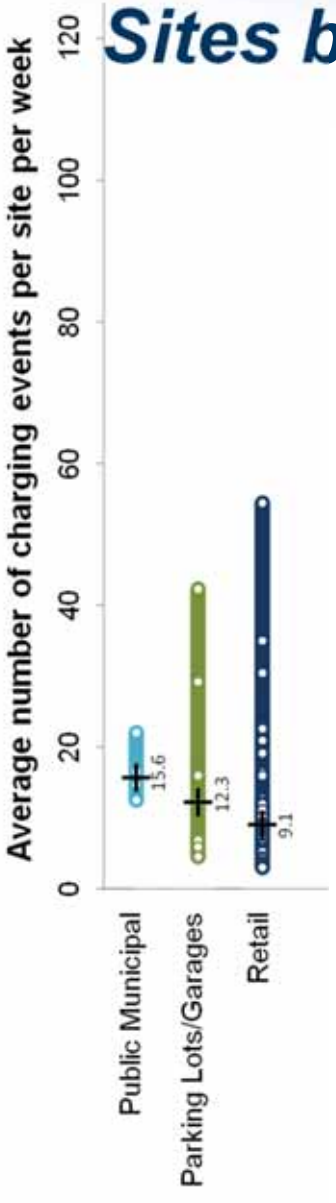


8/1/2013 to 1/1/2014 (after Blink network fees were instituted)

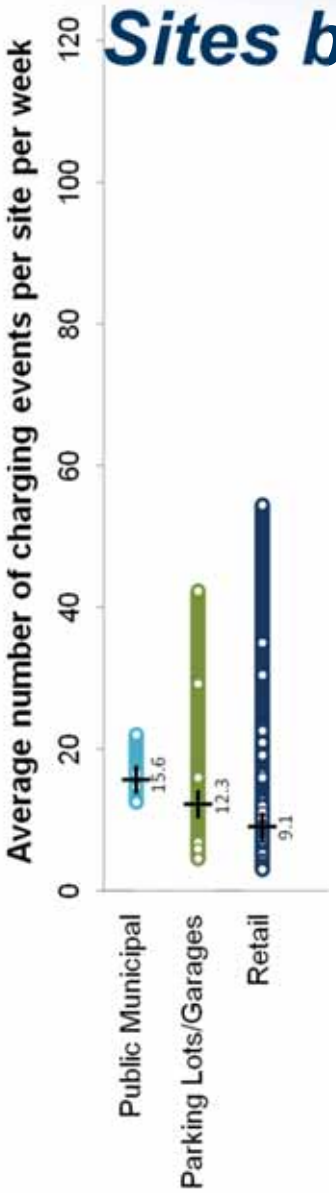
Distribution of Usage Frequency of Blink DCFC Sites by Venue



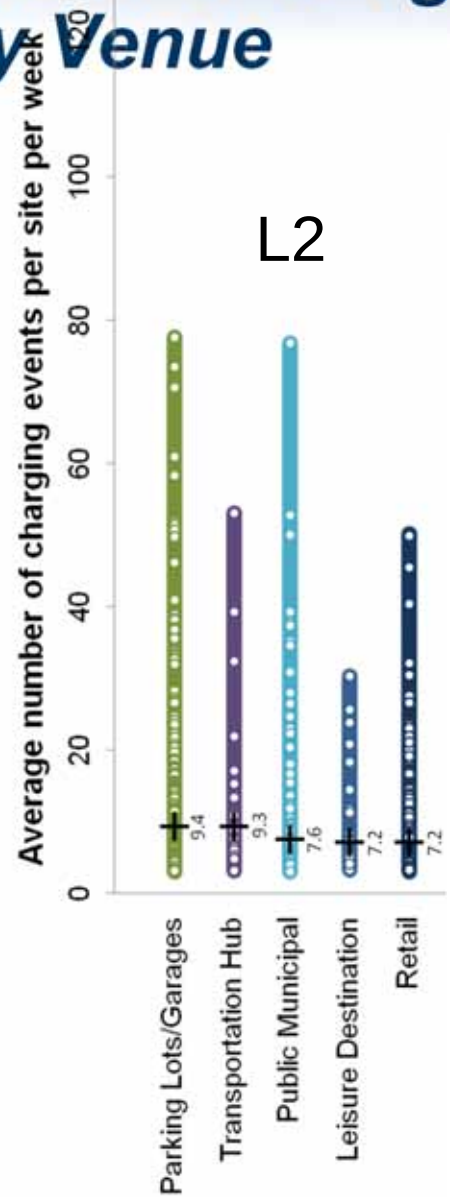
Distribution of Usage Frequency of Blink DCFC Sites by Venue



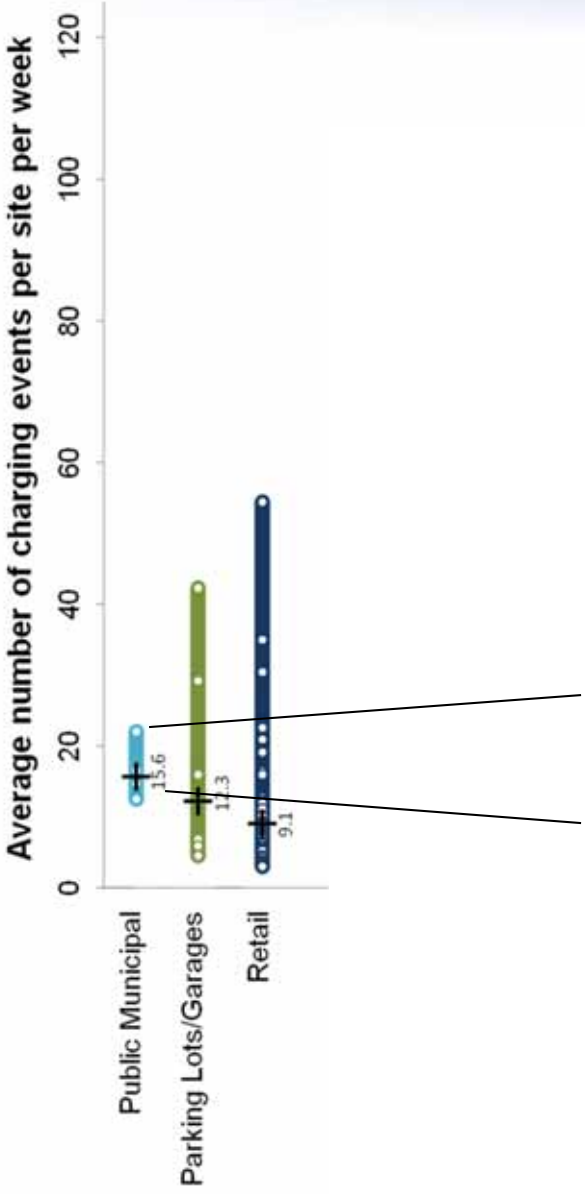
Distribution of Usage Frequency of Blink DCFC Sites by Venue



L2



Blink DCFC Sites – Public / Municipal

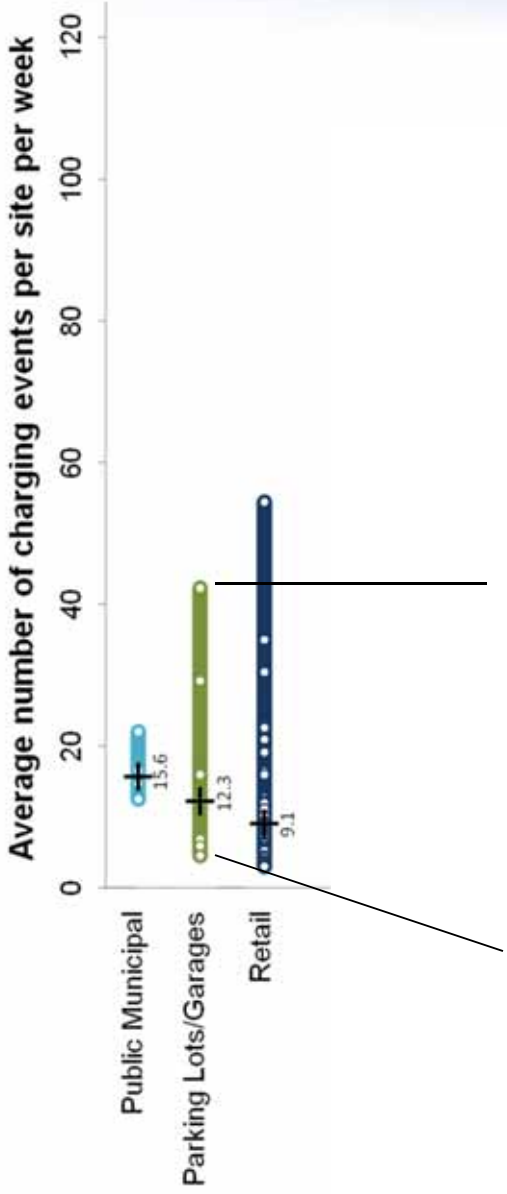


22.0 City hall , Hayward CA

16.6 South Coast AQMD HQ, Diamond Bar CA

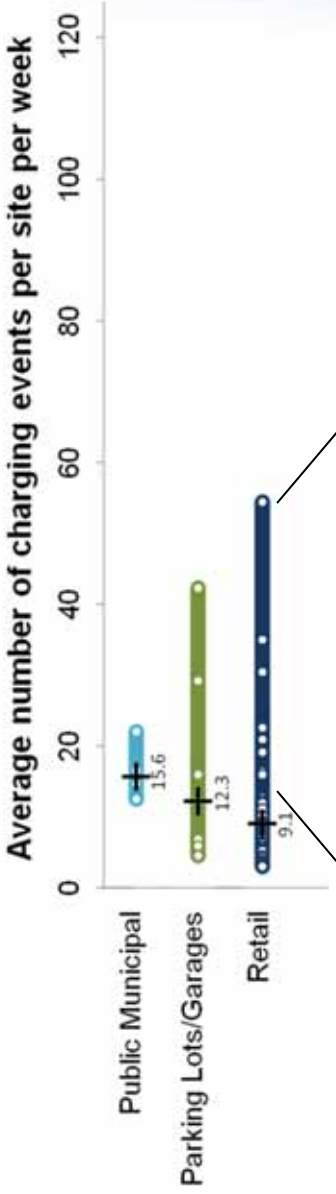
12.5 Petaluma Visitors Center near 101, Petaluma CA

Blink DCFC Sites – Parking Lots and Garages



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

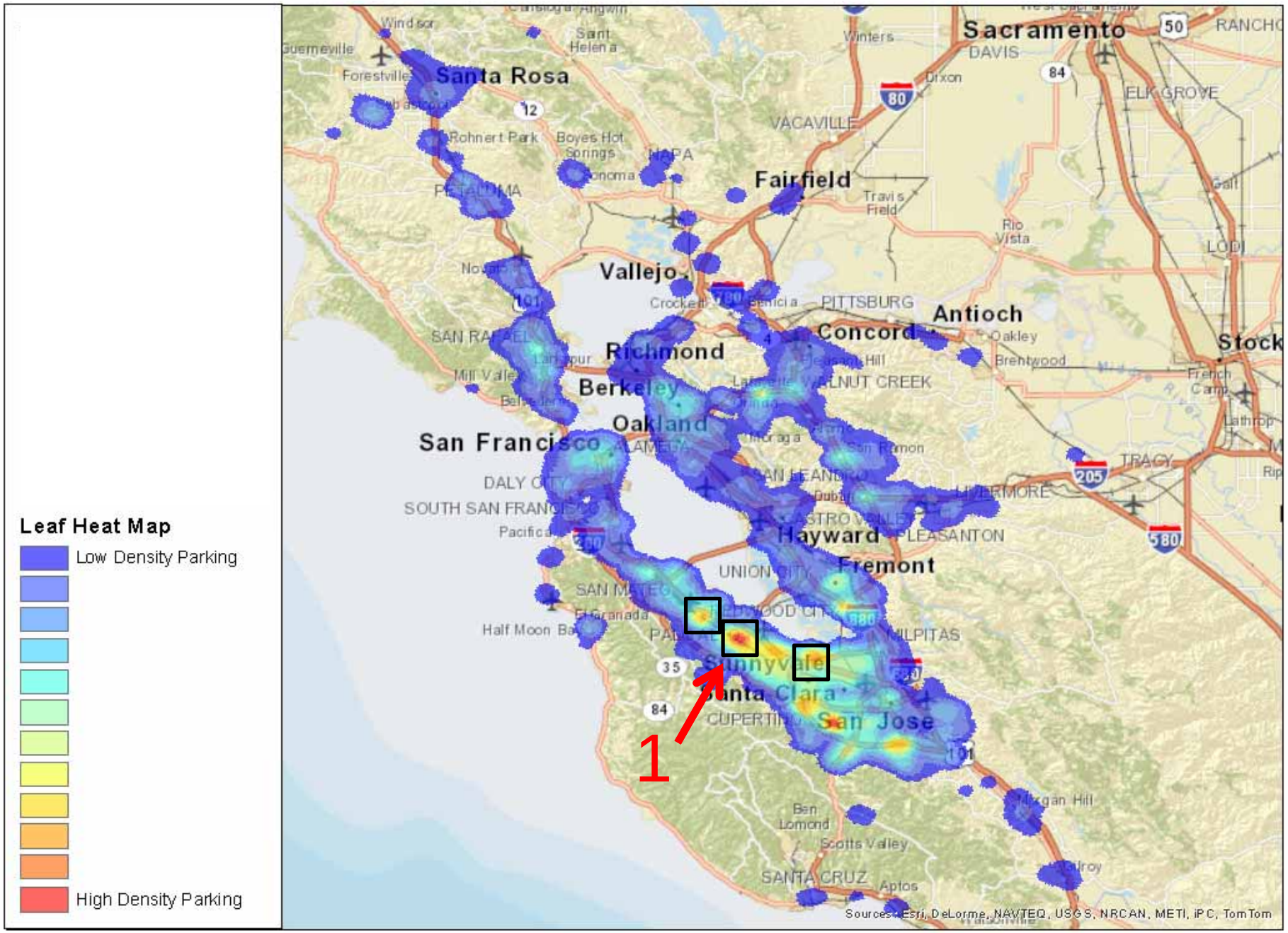
Blink DCFC Sites – Retail

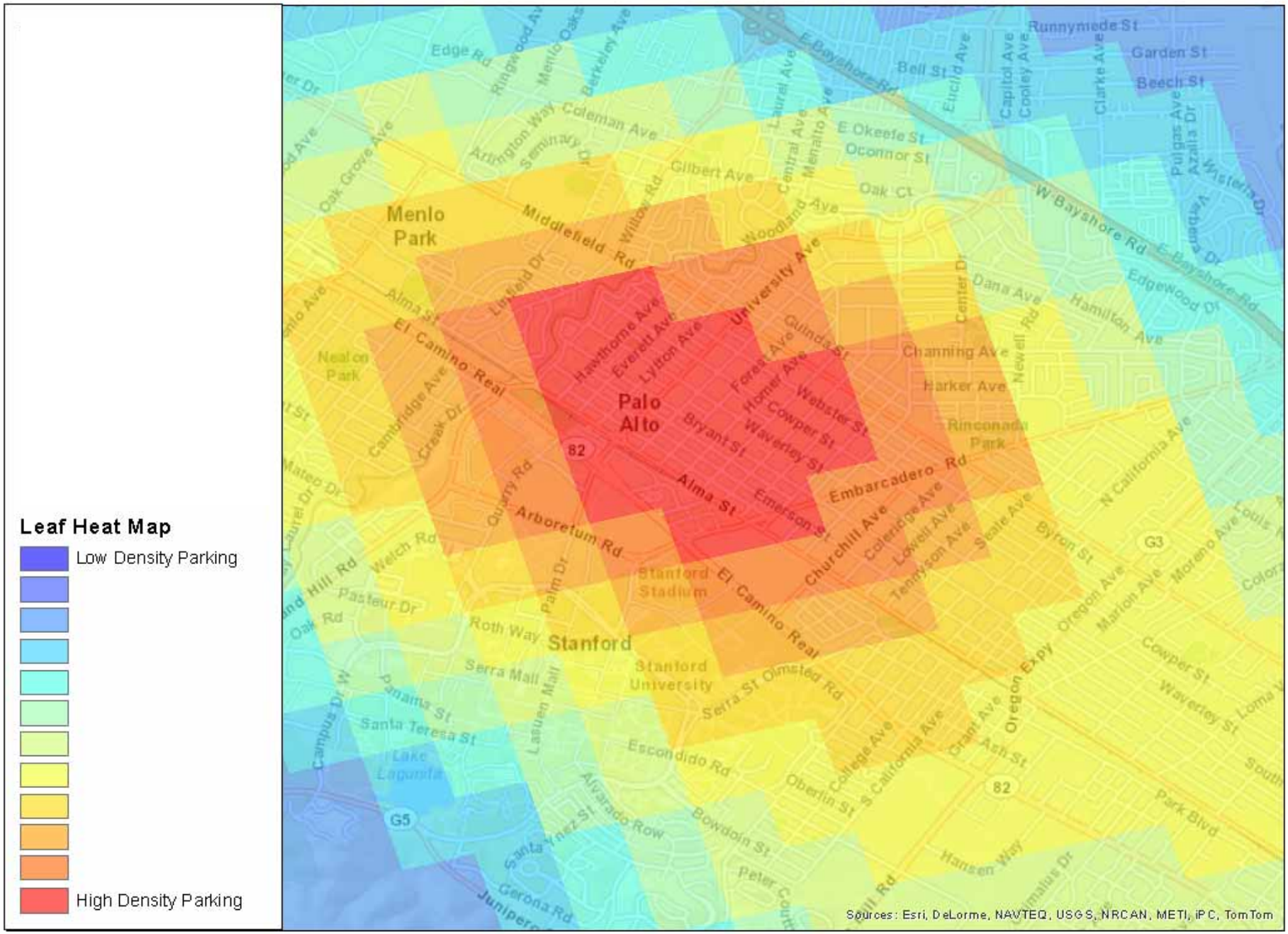


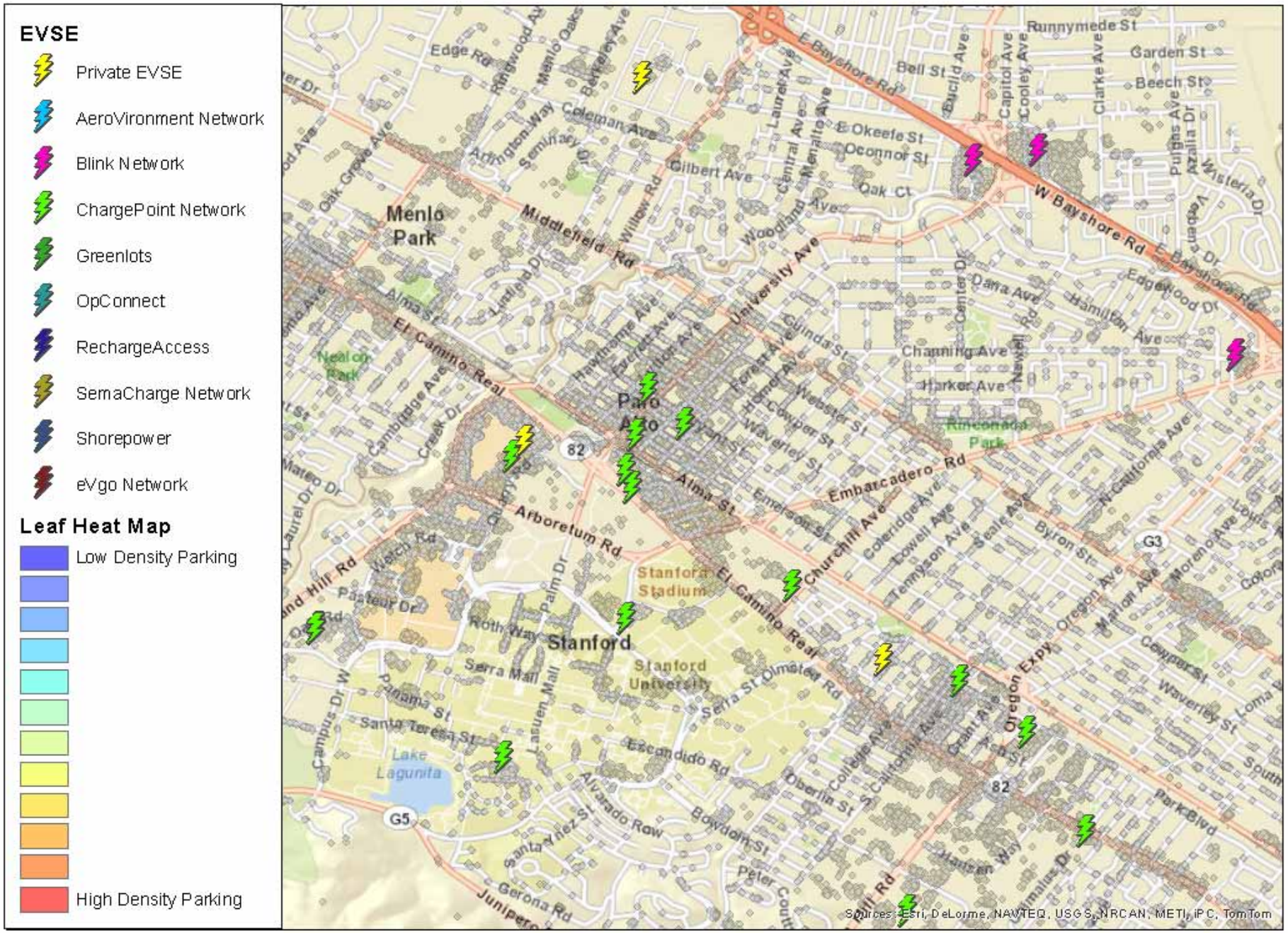
54.4	Tahoma Market on I5, Tacoma WA
35.0	Fred Meyer, Kirkland WA
30.4	Nissan dealership, Bellevue WA
23.1	Fred Meyer, Hillsboro OR
22.8	Fred Meyer, Seattle WA
22.6	Mall on I205, Happy Valley OR
20.9	Fred Meyer, Salem OR
19.1	Fred Meyer, Portland OR
16.5	Nissan dealership, Santa Rosa CA
16.4	Shopping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

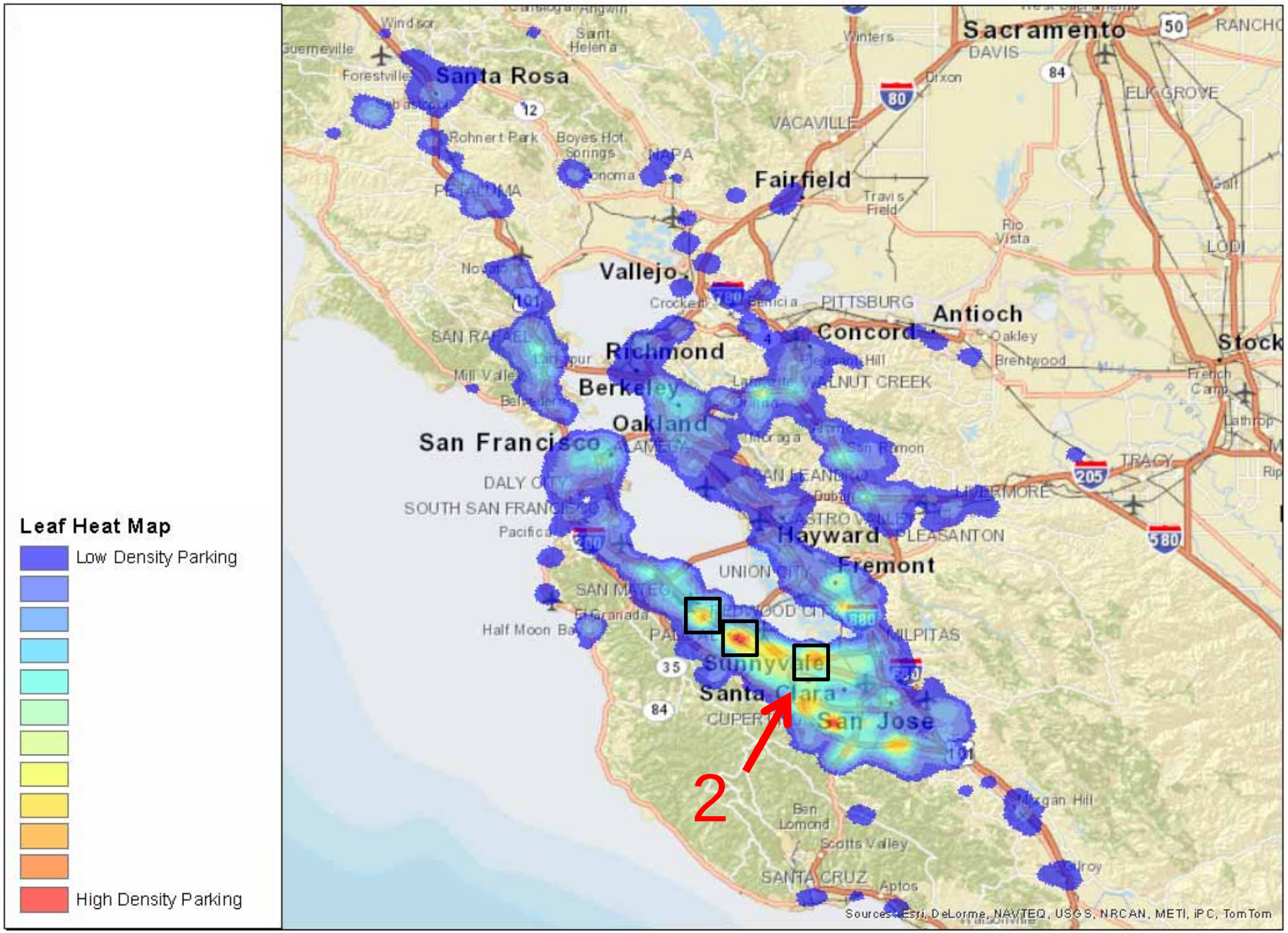
Identifying Hot Spots Using Vehicle Data

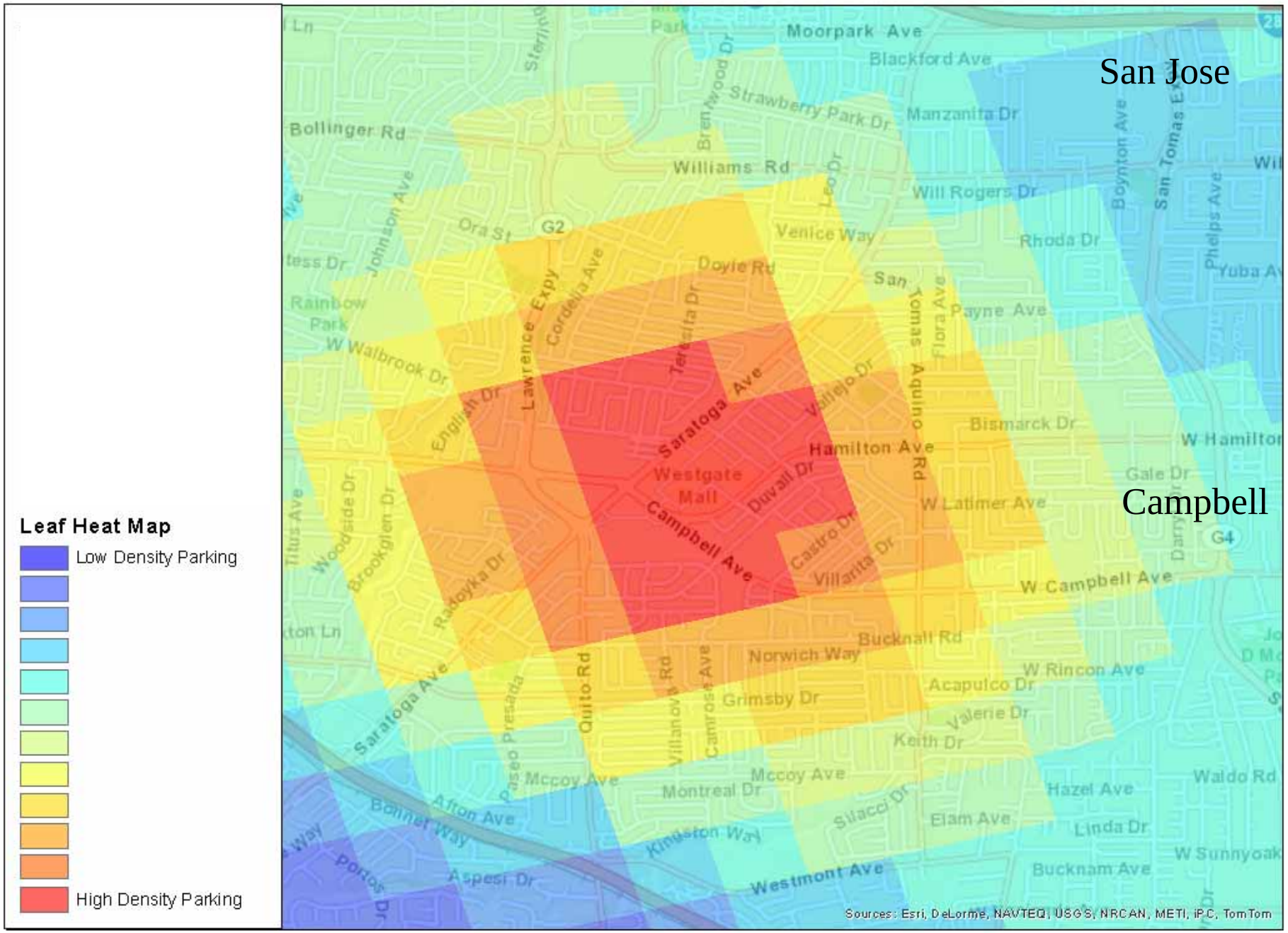
- **EV Project Leaf away-from-home parking location density in San Francisco Bay Area**
- **Cumulative through the end of 2013**

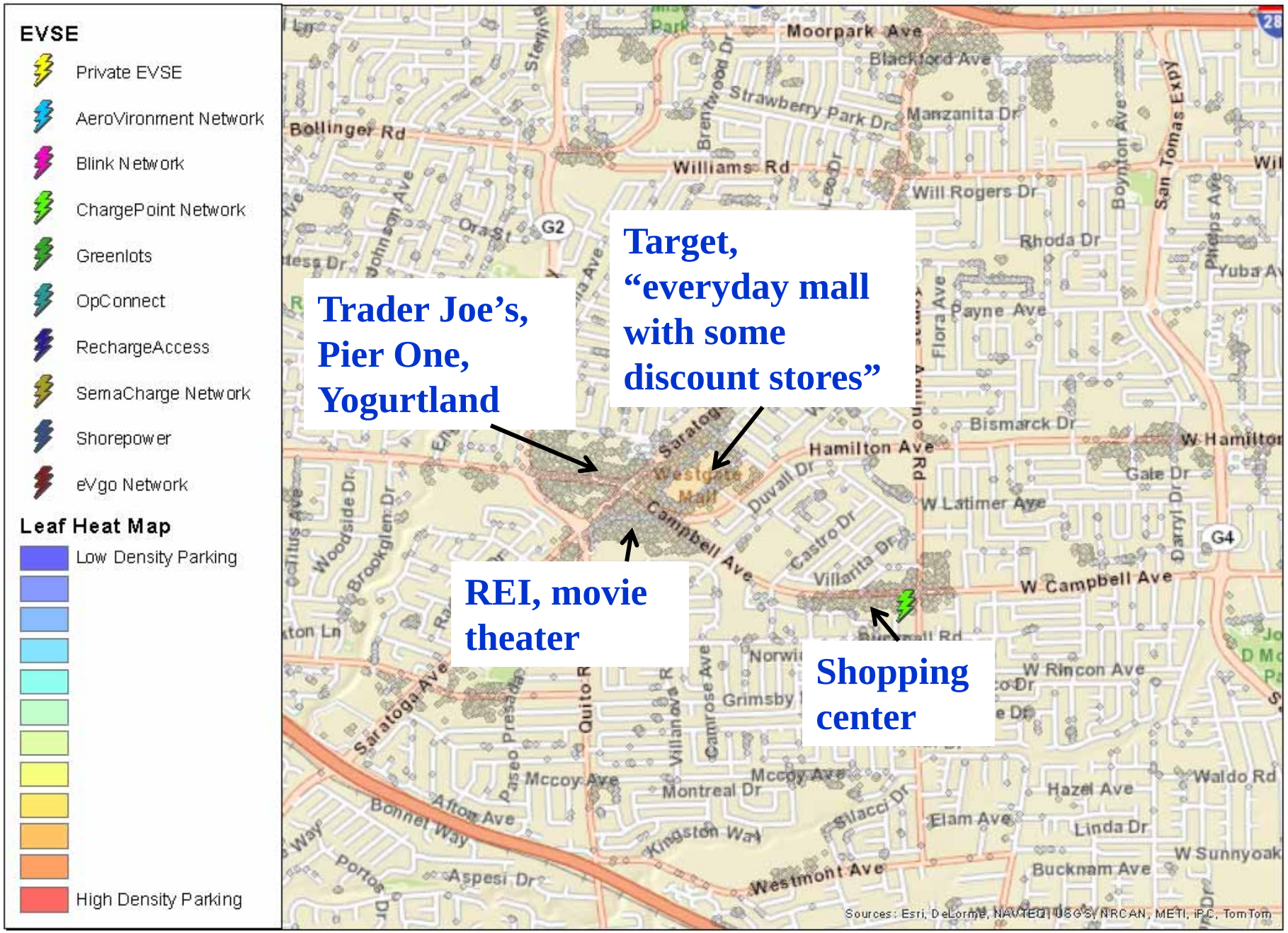

Leaf Heat Map
Low Density Parking
High Density Parking
Santa Rosa
Sacramento
Fairfield
Vallejo
Antioch
Concord
Richmond
Berkeley
Oakland
San Francisco
Hayward
Fremont
Sunnyvale
Santa Clara
San Jose
1
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

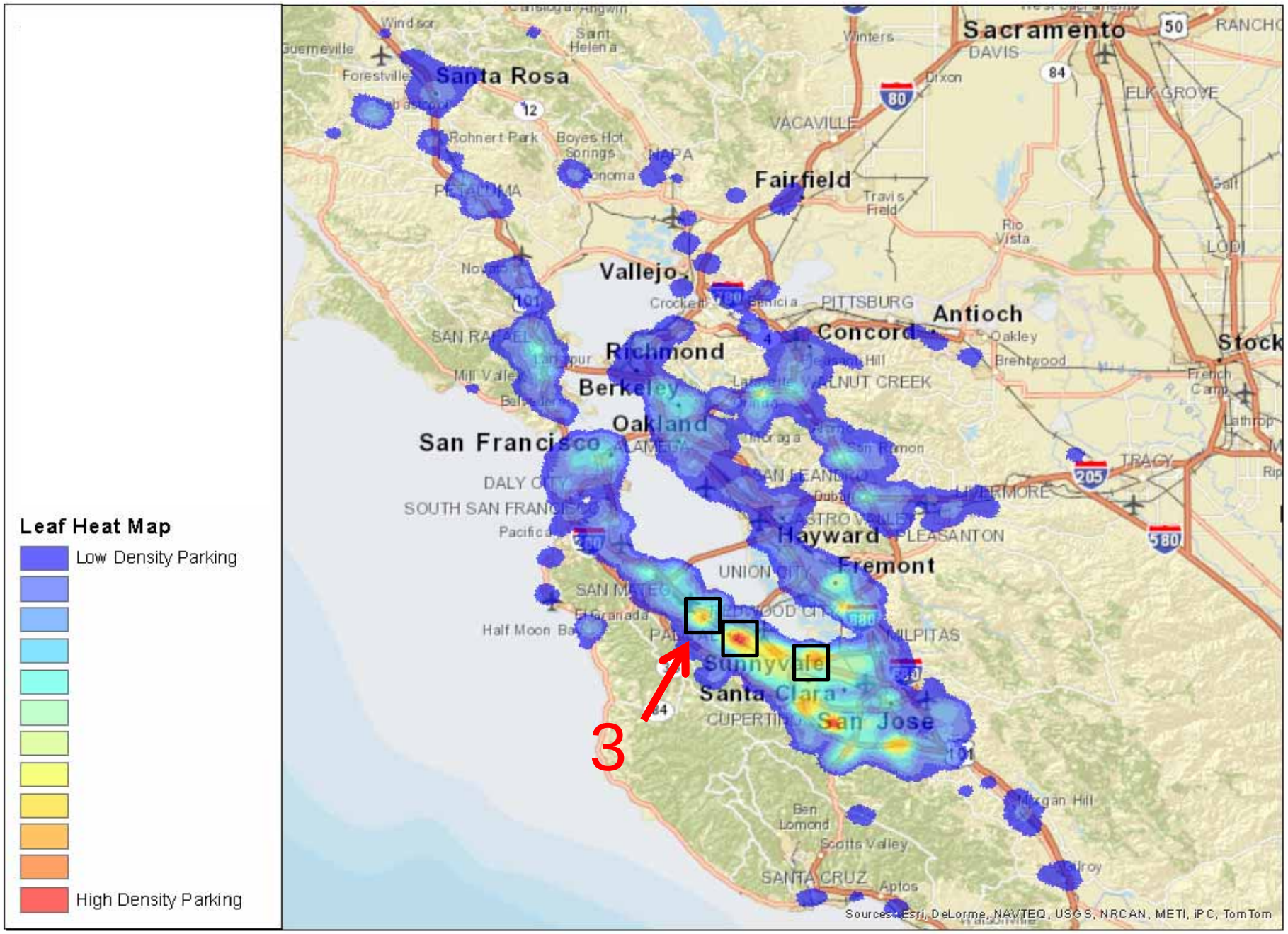

Leaf Heat Map
Low Density Parking
High Density Parking
Menlo Park
Palo Alto
Stanford
Stanford Stadium
Stanford University
University Ave
El Camino Real
Embarcadero Rd
Arboretum Rd
Alma St
Middlefield Rd
Oregon Expy
W Bayshore Rd
E Bayshore Rd
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

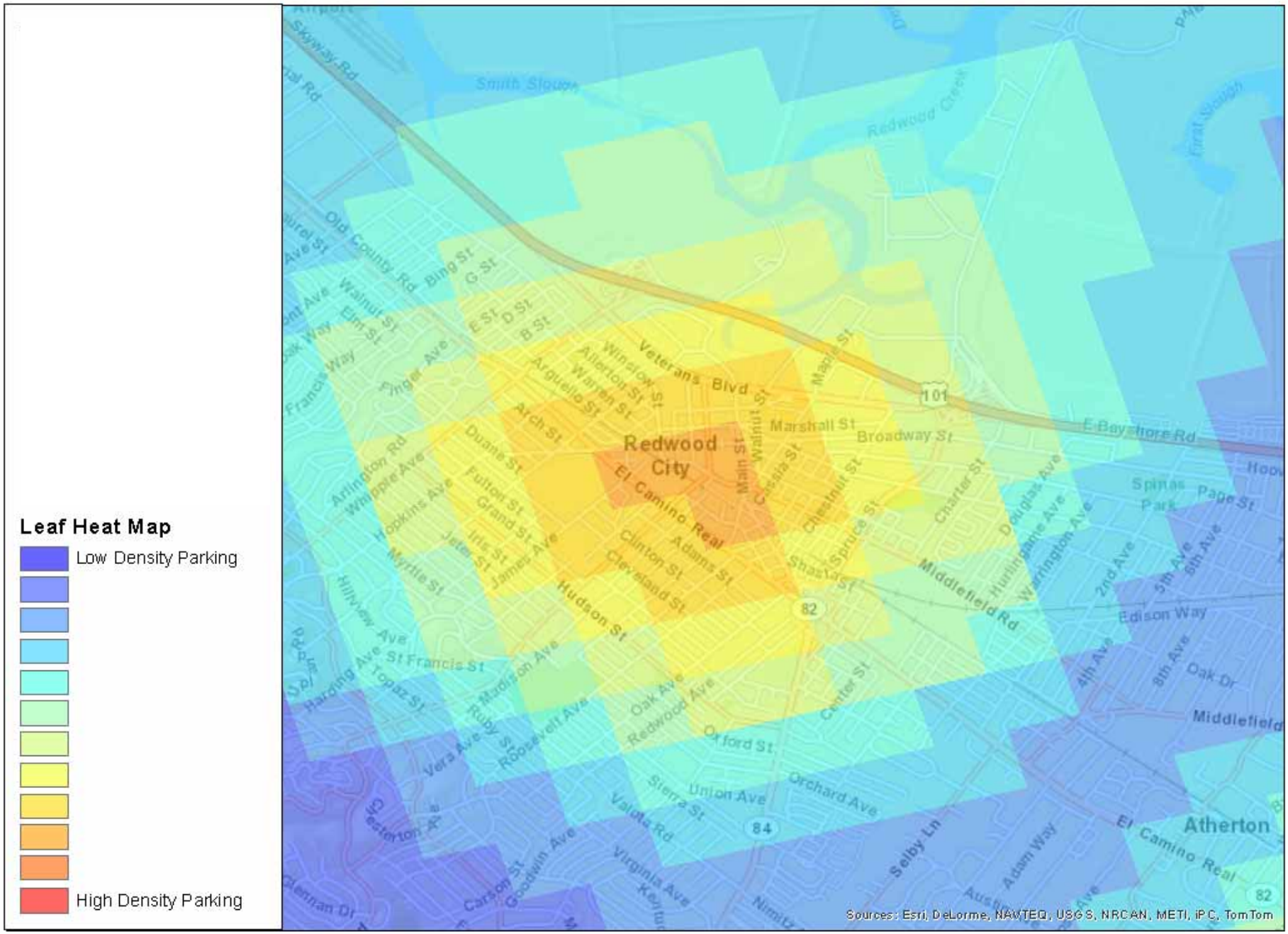

EVSE
Private EVSE
AeroVironment Network
Blink Network
ChargePoint Network
Greenlots
OpConnect
RechargeAccess
SemaCharge Network
Shorepower
eVgo Network
Leaf Heat Map
Low Density Parking
High Density Parking
Menlo Park
Palo Alto
Stanford
Stanford Stadium
Stanford University
Lake Lagunita
Rinconada Park
Nealon Park
Edge Rd
Middlefield Rd
El Camino Real
University Ave
Alma St
Arboretum Rd
Embarcadero Rd
Churchill Ave
Oregon Expy
W Bayshore Rd
E Bayshore Rd
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

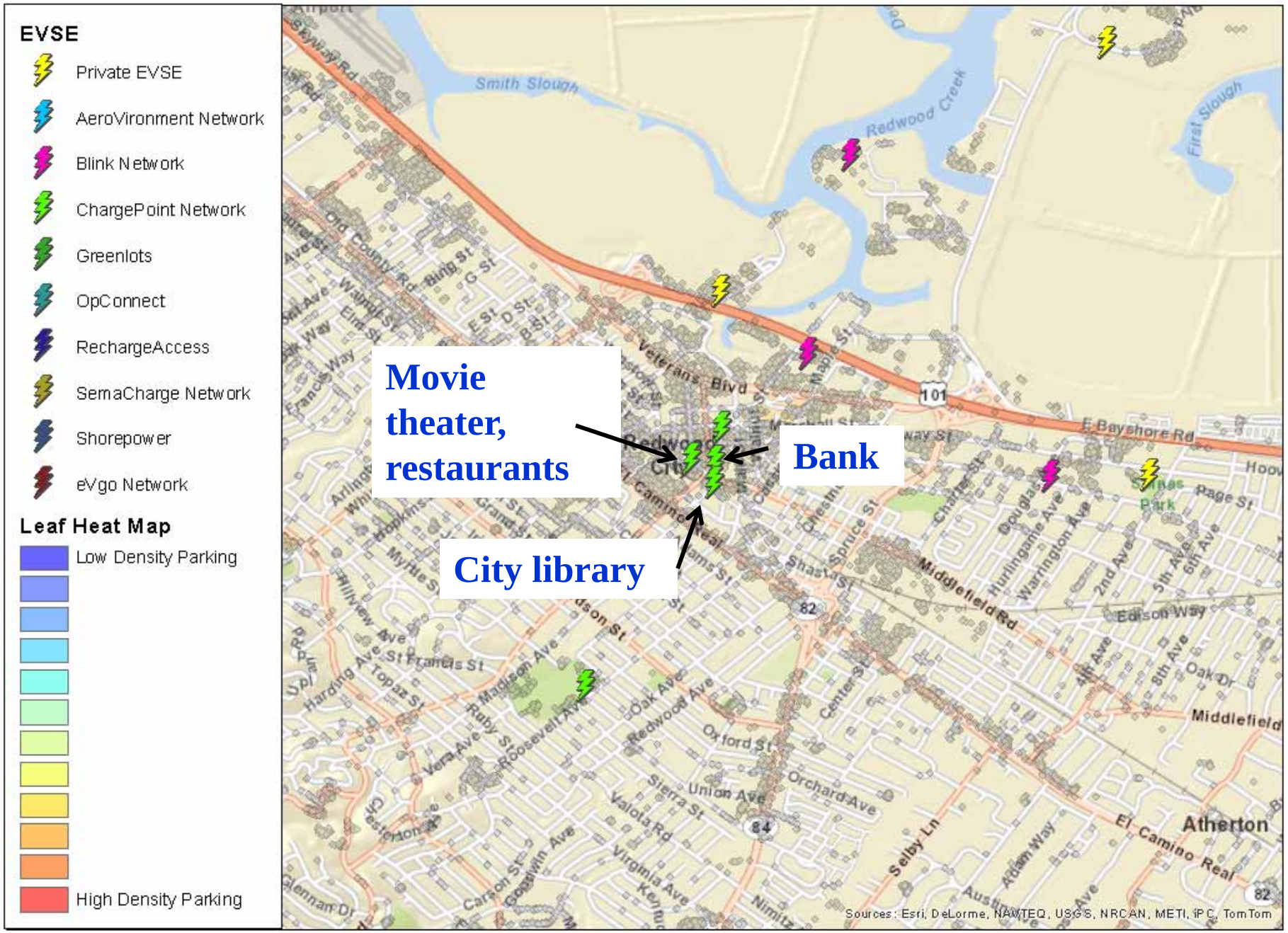

Leaf Heat Map
Low Density Parking
High Density Parking
Santa Rosa
Fairfield
Vallejo
Richmond
Berkeley
Oakland
San Francisco
Concord
Antioch
Hayward
Fremont
Sunnyvale
Santa Clara
San Jose
Sacramento
2
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom


Leaf Heat Map
Low Density Parking
High Density Parking
San Jose
Campbell
Moorpark Ave
Blackford Ave
Strawberry Park Dr
Manzanita Dr
Bollinger Rd
Williams Rd
Will Rogers Dr
Venice Way
Rhoda Dr
Doyle Rd
Payne Ave
Saratoga Ave
Hamilton Ave
Westgate Mall
Campbell Ave
Bismarck Dr
W Latimer Ave
W Campbell Ave
Bucknall Rd
Norwich Way
Grimsby Dr
Acapulco Dr
W Rincon Ave
Valerie Dr
Keith Dr
Mccoy Ave
Montreal Dr
Hazel Ave
Elam Ave
Linda Dr
Bucknam Ave
Westmont Ave
Waldo Rd
W Sunnyoak
Gale Dr
Lawrence Expy
San Tomas Aquino Rd
Quito Rd
Saratoga Ave
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

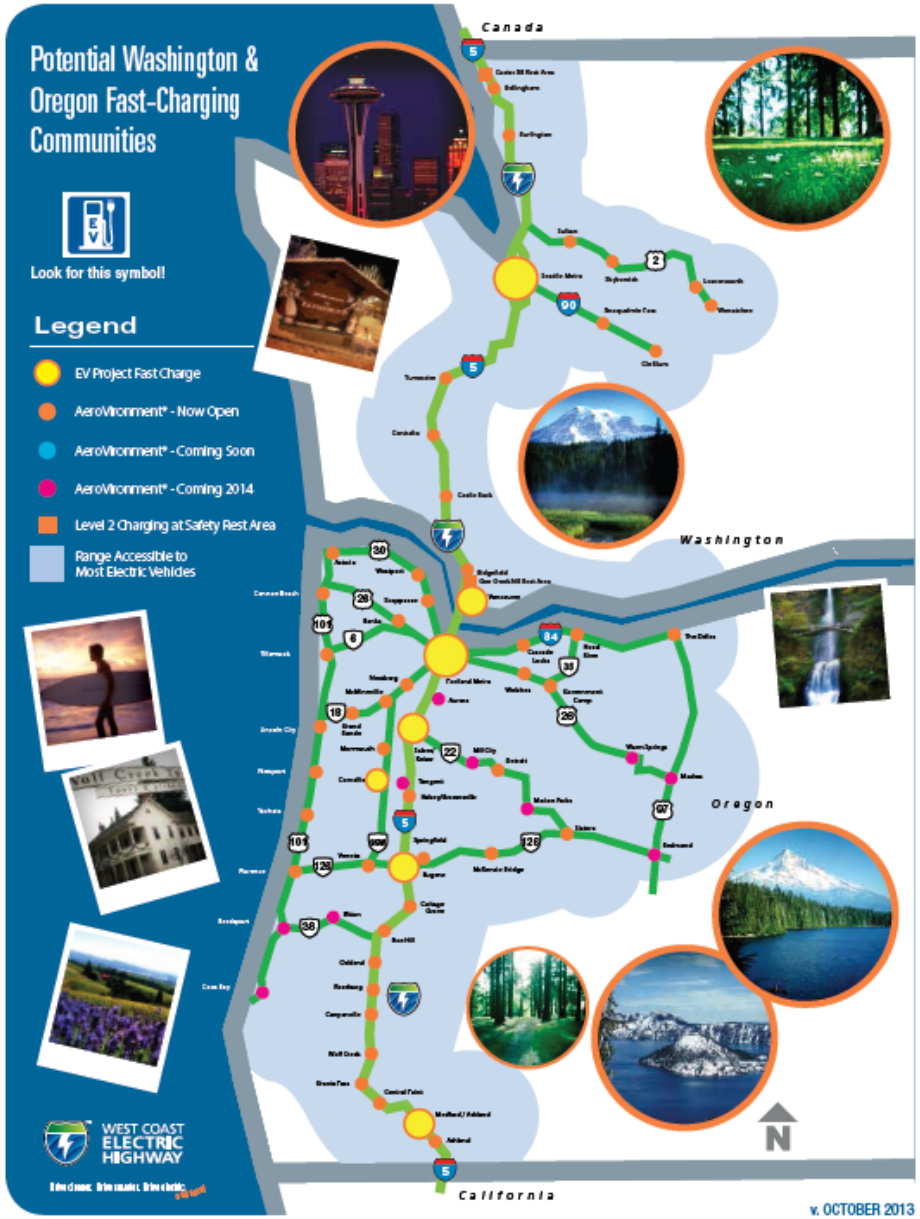

EVSE
Private EVSE
AeroVironment Network
Blink Network
ChargePoint Network
Greenlots
OpConnect
RechargeAccess
SemaCharge Network
Shorepower
eVgo Network
Leaf Heat Map
Low Density Parking
High Density Parking
Trader Joe's, Pier One, Yogurtland
Target, "everyday mall with some discount stores"
REI, movie theater
Shopping center
Moorpark Ave
Blackford Ave
Strawberry Park Dr
Manzanita Dr
Bollinger Rd
Williams Rd
Will Rogers Dr
Rhoda Dr
Payne Ave
Hamilton Ave
Bismarck Dr
W Latimer Ave
W Campbell Ave
Campbell Ave
Westgate Mall
Duvall Dr
Castro Dr
Villarita Dr
Gale Dr
Darryl Dr
W Rincon Ave
Grimsby Dr
Saratoga Ave
Quito Rd
Paseo Presada
Mccoy Ave
Montreal Dr
Kingston Way
Westmont Ave
Aspesi Dr
Bonnet Way
Hazel Ave
Elam Ave
Linda Dr
Bucknam Ave
Waldo Rd
W Sunnyoak
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom


Leaf Heat Map
Low Density Parking
High Density Parking
Santa Rosa
Sacramento
Fairfield
Vallejo
Antioch
Concord
Richmond
Berkeley
Oakland
San Francisco
Hayward
Fremont
Sunnyvale
Santa Clara
San Jose
3
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom


Leaf Heat Map
Low Density Parking
High Density Parking
Redwood City
El Camino Real
Veterans Blvd
Broadway St
Marshall St
Middlefield Rd
Atherton
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

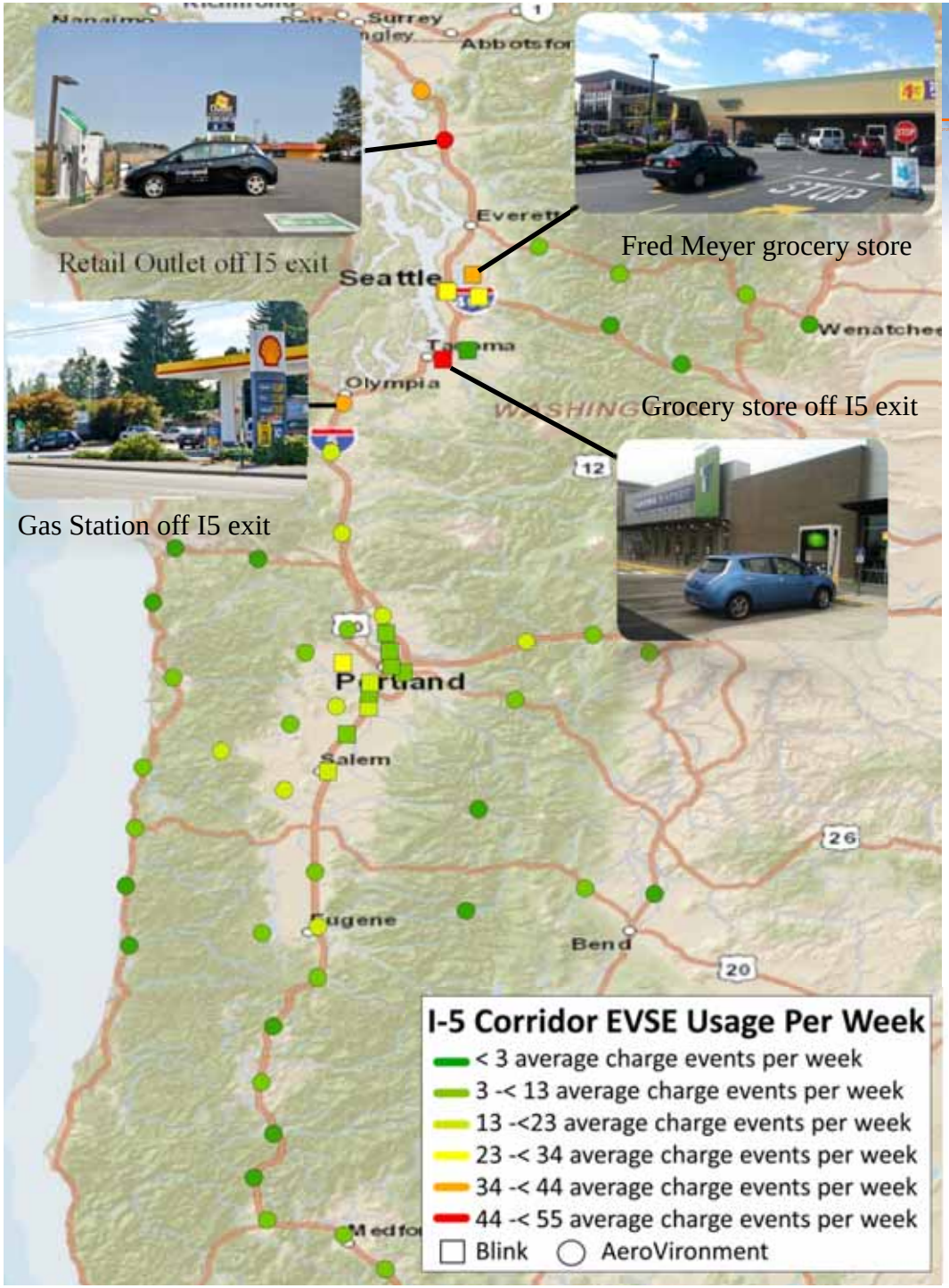

EVSE
Private EVSE
AeroVironment Network
Blink Network
ChargePoint Network
Greenlots
OpConnect
RechargeAccess
SemaCharge Network
Shorepower
eVgo Network
Leaf Heat Map
Low Density Parking
High Density Parking
Movie theater, restaurants
Bank
City library
Smith Slough
Redwood Creek
First Slough
Veterans Blvd
E Bayshore Rd
Middlefield Rd
Edison Way
Oak Dr
Middlefield
Atherton
El Camino Real
Selby Ln
Adam Way
Oxford St
Union Ave
Orchard Ave
Redwood Ave
Oak Ave
Madison Ave
Center St
Spruce St
Shasta St
Maple St
Page St
Hoover Park
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

Preview of Corridor EVSE Usage in Oregon and Washington



AeroVironment and Blink DCFCs along OR & WA Corridors

- AeroVironment provided INL data from DCFCs and Level 2 units that were installed as part of the Washington & Oregon West Coast Electric Highway
- Combined with Blink data fro DCFCs and Level
- Combined with vehicle data using GPS and time stamps



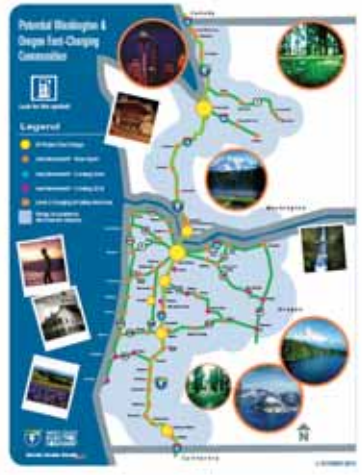
Idaho National Laboratory

AeroVironment and Blink DCFCs along OR & WA Corridors

- **9/1/2012 to 1/1/2014**
- **Highest usage in metro areas**
- **Oregon's Electric Byways appear to be attracting users off the I-5 corridor**
- **Analysis continues**

TRAVEL OREGON

WEST COAST ELECTRIC HIGHWAY



Future Work

Tasks for FY15

Leaf and Volt travel studies

- **Leaf and Volt away-from-home infrastructure usage vs. eVMT**
  - **Day-time vs. night-time; home vs. away from home; L1 vs. L2 vs. DCFC**
  - **Update Volt Aug and Sep 2013 papers**
- **Leaf driving range**
  - **How often do they drive beyond single charge range?**
  - **When they do, what infrastructure do they use? How far from home do they drive?**
  - **How important are DCFCs for range extension**?

Tasks for FY15 (cont.)

Workplace charging

- **Longitudinal driving and charging behavior of drivers with access to WP charging**
  - **How many WP charging users "need" it based on commuting patterns?**
  - **Are they off-setting home off-peak charging with WP on-peak charging?**
- **Vehicle charging frequency at small, medium, large companies with WP charging**
- **Additional case studies**

Tasks for FY15 (cont.)

EVSE usage by venue

- **Venue definitions paper**
- **Overall comparison of usage by venue**
- **Deep dives by venue (airports, retail, leisure, etc.)**

EVSE usage and PEV travel on inter-city corridors

- **OR/WA I5**
- **San Diego/LA**
- **Nashville/Knoxville (?)**
- **Chattanooga/Atlanta (?)**

Tasks for FY15 (cont.)

Demand charge impact

- **DCFCs**
- **Banks of Level 2 EVSE**

Grid demand and vehicle states as inputs to models

- **Use EV Project and ChargePoint America data to support Collaborative PEV Smart Grid Integration Requirements and Opportunities Study**

EVSE installation costs vs. use (“bang for buck” analysis)

- **~60 Lessons learned topics identified**
- **INL recently obtaining EV Project costs documentation allows additional analysis**

Upcoming EV Project White Papers

Infrastructure Issues

1. What makes an L2 commercial site highly utilized - correlation between utilization and three location based factors
2. What makes an L2 public site highly utilized - correlation between utilization and three location based factors
3. What makes a DCFC site highly utilized - correlation between utilization and three location based factors
4. What makes an L2 commercial site highly utilized - correlation between utilization and three host based factors
5. What makes an L2 public site highly utilized - correlation between utilization and three host based factors
6. What makes a DCFC site highly utilized - correlation between utilization and three host based factors

User Issues

7. What makes an L2 commercial site highly utilized - analyze correlation between utilization and three user based factors
8. What makes an L2 public site highly utilized - analyze correlation between utilization and three user based factors

Upcoming EV Project White Papers

User Issues – cont'd

9. What makes a DCFC site highly utilized - analyze correlation between utilization and three user based factors
10. Top mileage accumulators - characterize use patterns, demographics and geographic of top 50 highest mileage accumulators
11. Top residential charging users - characterize use patterns of top 50 users that never (or rarely) charge away from home
12. Top commercial/public charging users - characterize use patterns of top 50 users of commercial/public charging (by percent of their total charging)
13. Top DCFC users - characterize use patterns of top 50 users of DCFC (by percent of their total charging)

Cost Issues

14. What was the cost to add separate utility submeters at the time of EVSE installation
15. What is the impact of utility demand charges on a Level 2 host
16. What is the impact of utility demand charges on a DCFC host
17. What were the implementation challenges associated with workplace charging installation
18. What were the cost drivers for workplace charging installations

Upcoming EV Project White Papers

Cost Issues – cont'd

19. How do non-residential charging infrastructure installation costs vary by geographic location
20. What were the cost drivers for residential charging installations
21. How do residential charging infrastructure installation costs vary by geographic location
22. What were the cost drivers for DCFC installations
23. How do DCFC infrastructure installation costs vary by geographic location
24. What are the business models currently employed for commercial charging
25. What are the business models currently employed for workplace charging and what is the impact of free workplace charging
26. What are the business models currently employed for DCFC
27. How many Low Carbon Fuel Standard credits have been generated by the EV Project and how many gallons of gasoline have been saved in California
28. What are revenue streams and intangible benefits a charging site host can expect to gain from the installation of EVSE units

Grid Impact Issues

29. Characterize the demand and energy characteristics of L2 commercial EVSE

Upcoming EV Project White Papers

Grid Impact Issues – cont'd

30. Characterize the demand and energy characteristics of L2 public EVSE
31. Characterize the demand and energy characteristics of DCFC
32. Characterize the demand and energy characteristics of residential EVSE
33. Characterize clustering of L2 commercial EVSE
34. Characterize clustering of L2 public EVSE
35. Characterize clustering of DCFC
36. Characterize clustering of residential EVSE
37. Characterize global controllable demand from L2 commercial EVSE
38. Characterize global controllable demand from DCFC
39. Characterize global controllable demand from residential EVSE
40. Characterize energy storage required to reduce peak Level 2 commercial charging demand
41. Characterize energy storage required to reduce peak Level 2 public charging demand
42. Characterize energy storage required to reduce peak DCFC charging demand
43. Characterize energy storage required to reduce peak L2 public/commercial charging demand

Upcoming EV Project White Papers

Grid Impact Issues – cont'd

44. Characterize impact of 6.6kW residential charging
45. Characterize impact of 6.6kW Level 2 commercial charging
46. Characterize impact of 6.6kW Level 2 public charging
47. Characterize the capability of L1 residential charging to satisfy Volt charging needs
48. Characterize the capability of L1 residential charging to satisfy Leaf charging needs
49. SDG&E Project description and lessons learned - TOU rates
50. What was the impact of the car sharing on Publically Available charging infrastructure in San Diego
51. What were 'best practices' for residential infrastructure permitting
52. What were 'best practices' for public infrastructure permitting
53. What practices were used for non-residential charger locating (way-finding)
54. What were practices were used for workplace charging use allocation

Planning Issues

55. How does the location of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations
56. How does the use of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations

Upcoming EV Project White Papers

Planning Issues – cont'd

57. What percent of total charging energy is dispensed at Level 2 vs. DCFC
58. What percent of total charging energy is dispensed at residential vs. workplace vs. commercial vs. public venues
59. What practices were used for parking/charging enforcement issues

First FY-15 EV Project White Papers

- What were the cost drivers for workplace charging installations
- What were the cost drivers for publicly accessible charging installations
- What were the cost drivers for DCFC installations
- How do residential charging infrastructure installation costs vary by geographic location
- How do publicly accessible infrastructure installation costs vary by geographic location
- Characterize clustering of residential EVSE & grid impacts
- Characterize global controllable demand from residential EVSE "smart grid"
- How does the location of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations

First FY-15 EV Project White Papers: cont'd

- **What percent of total charging energy is dispensed at residential vs. workplace vs. commercial vs. public venues vs. DCFC locations**
- **What makes a DCFC site highly utilized - correlation between utilization and three location based factors**
- **Top commercial/public charging users - characterize use patterns of top 50 users of commercial/public charging (by percent of their total charging)**

For all EV Project and ChargePoint America publications, visit

http://avt.inl.gov/evproject.shtml

http://avt.inl.gov/chargepoint.shtml

http://avt.inl.gov

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

INL/MIS-14-33421