U.S. Department of Energy's Vehicle Technologies Program

Results from The EV Project: PEV Infrastructure Deployment Costs and Driver's Charging Preferences

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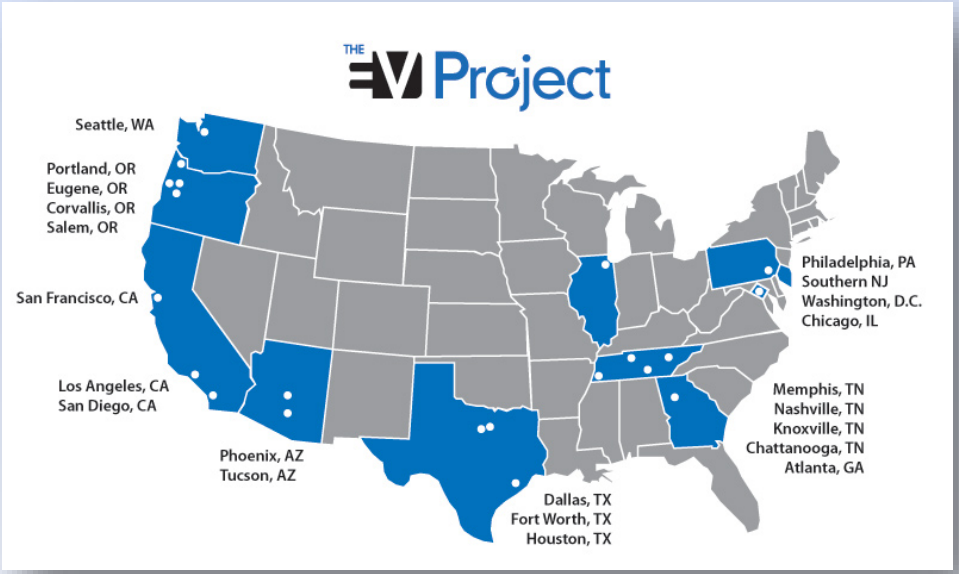
2014 HYBRID AND ELECTRIC VEHICLE TECHNOLOGIES SYMPOSIUM

INL/CON-14-31124

EV Project Goal, Locations, Participants, and Reporting



- 50%/50% DOE ARRA and ECOtality North America funded
- Goal: Build and study mature charging infrastructures and take the lessons learned to support the future streamlined deployment of grid-connected electric drive vehicles
- ECOtality is the EV Project lead, with INL, Nissan and Onstar/GM as the prime partners, with more than 40 other partners such as electric utilities and government groups
- Required 11,000 data agreements to be signed

EVSE Data Parameters Collected per Charge Event

- Data from ECOtality's Blink & other EVSE networks
- Connect and Disconnect Times
- Start and End Charge Times
- Maximum Instantaneous Peak Power
- Average Power
- Total energy (kWh) per charging event
- Rolling 15 Minute Average Peak Power
- Date/Time Stamp
- Unique ID for Charging Event
- Unique ID Identifying the EVSE
- And other non-dynamic EVSE information (GPS, ID, type, contact info, etc.)

Vehicle Data Parameters Collected per Start /Stop Event

- Data is received via telematics providers from Chevrolet Volts and Nissan Leafs
- Odometer
- Battery state of charge
- Date/Time Stamp
- Vehicle ID
- Event type (key on / key off)
- GPS (longitude and latitude)
- Recorded for each key-on and key-off event

- Additional data is received monthly from Car2go for the Smart EVs

Data Collection, Security and Protection

- All vehicle, EVSE, and PII raw data is legally protected by NDAs (Non Disclosure Agreements) or CRADAs (Cooperative Research and Development Agreements)
  - Limitations on how proprietary and personally identifiable information can be stored and distributed
  - Raw data, in both electronic and printed formats, is not shared with DOE in order to avoid exposure to FOIA
  - Vehicle and EVSE data collection would not occur unless testing partners trust INL would strictly adhere to NDAs and CRADAs
  - Raw data cannot be legally distributed by INL

EV Project – Summary of National Data

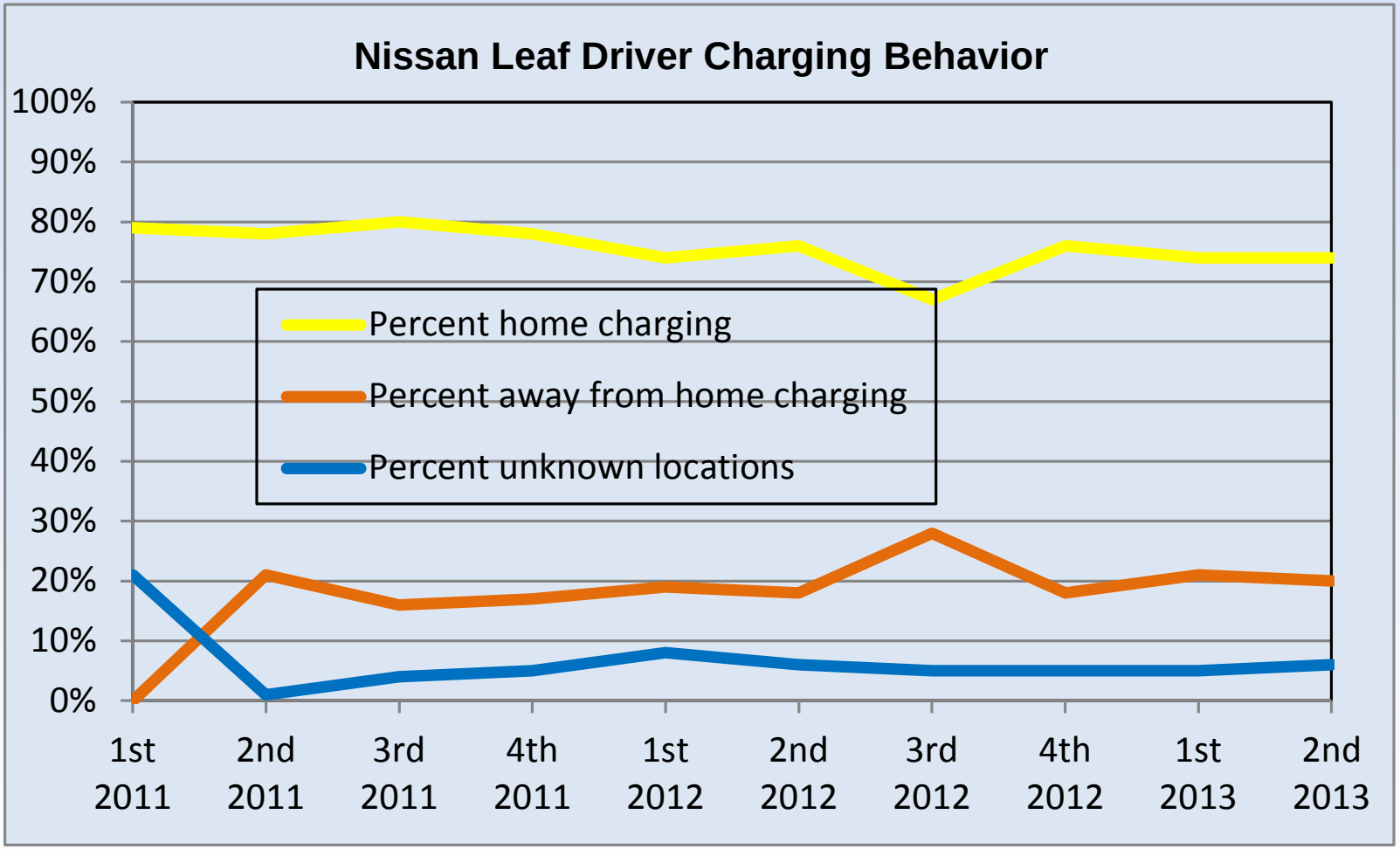
2st quarter 2013 Data Only

	Leafs	Volts
• Number of vehicles	4,261	1,895
• Number of Trips	1,135,000	676,000
• Distance (million miles)	8.04	5.75
• Average (Ave) trip distance	7.1 mi	8.3 mi
• Ave distance per day	29.5 mi	41.0 mi
• Ave number (#) trips between charging events	3.8	3.3
• Ave distance between charging events	26.7 mi	27.6 mi
• Ave # charging events per day	1.1	1.5

* Note that per day data is only for days a vehicle is driven

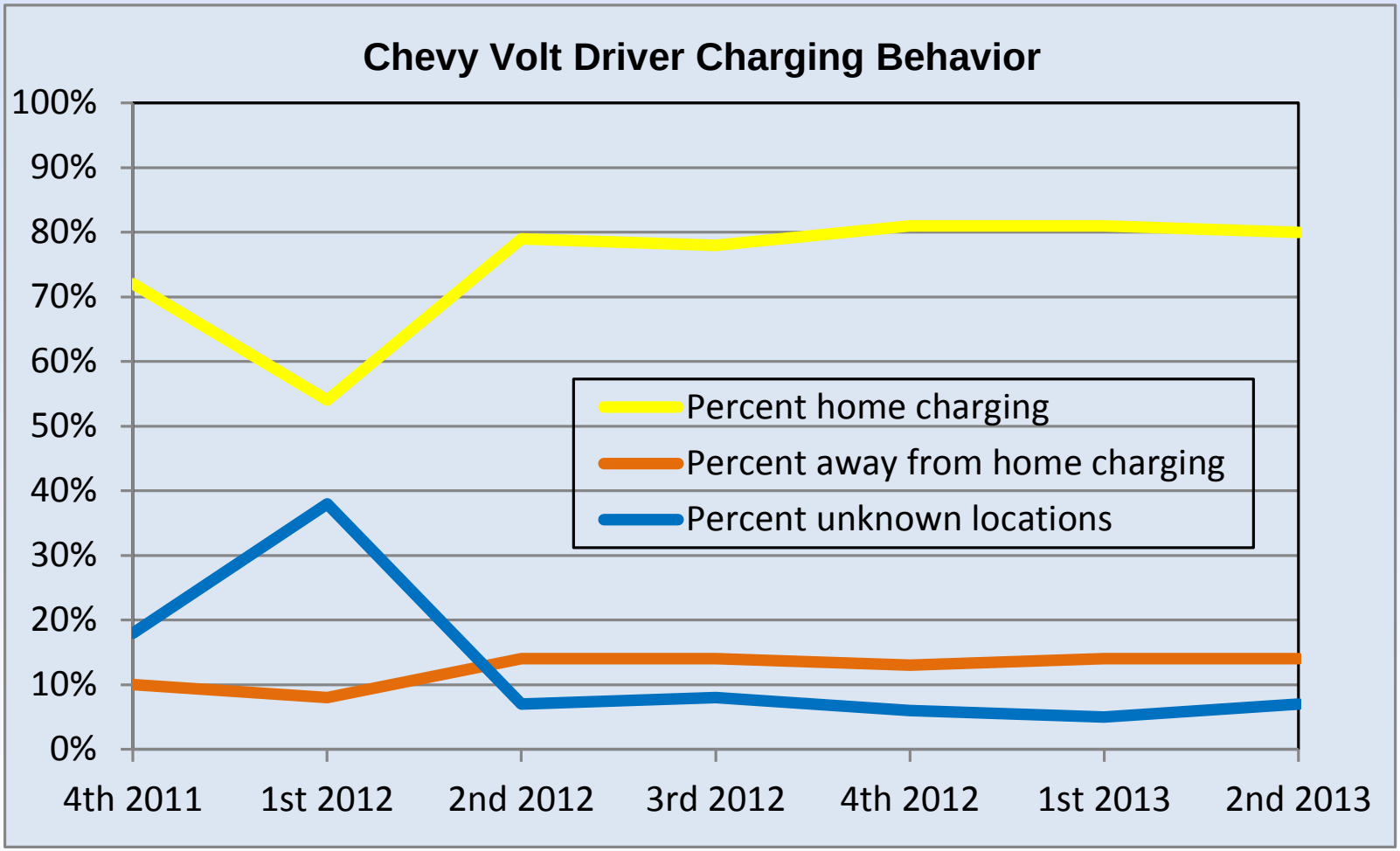
PEV Driver's Charging Preferences

EV Project – Leaf Driver's Charging Behavior



- 74% of charging at Home
- 26% of charging away from home or unknown

EV Project – Volt Driver's Charging Behavior

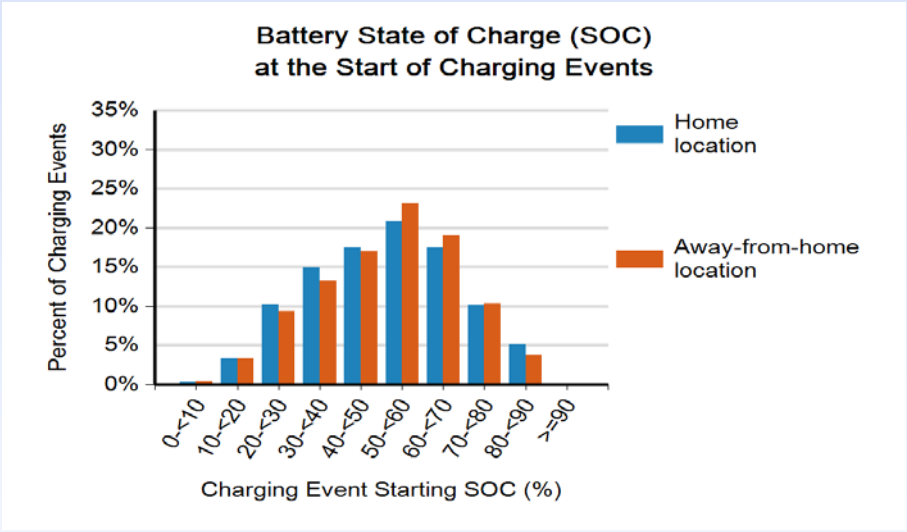


- 80% of charging at Home
- 20% of charging away from home or unknown

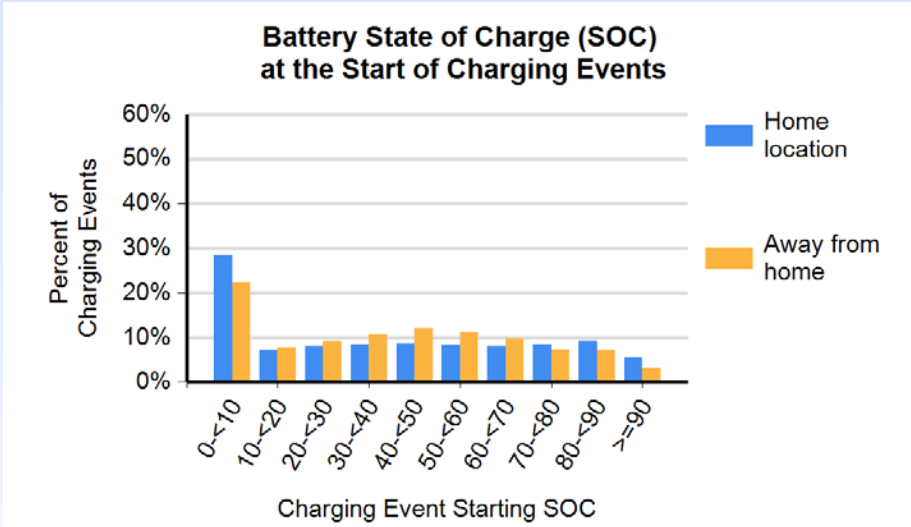
EV Project – Leaf & Volt Charging

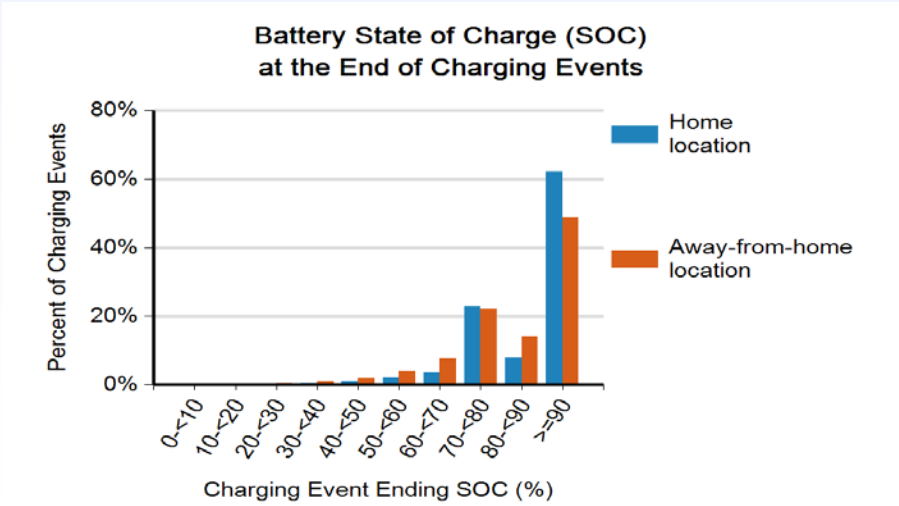
2st quarter 2013 Data Only

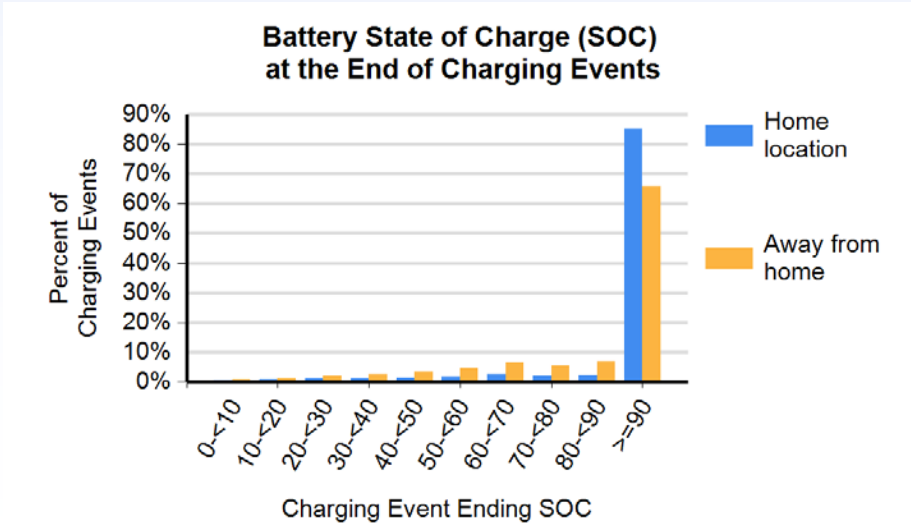
Leafs



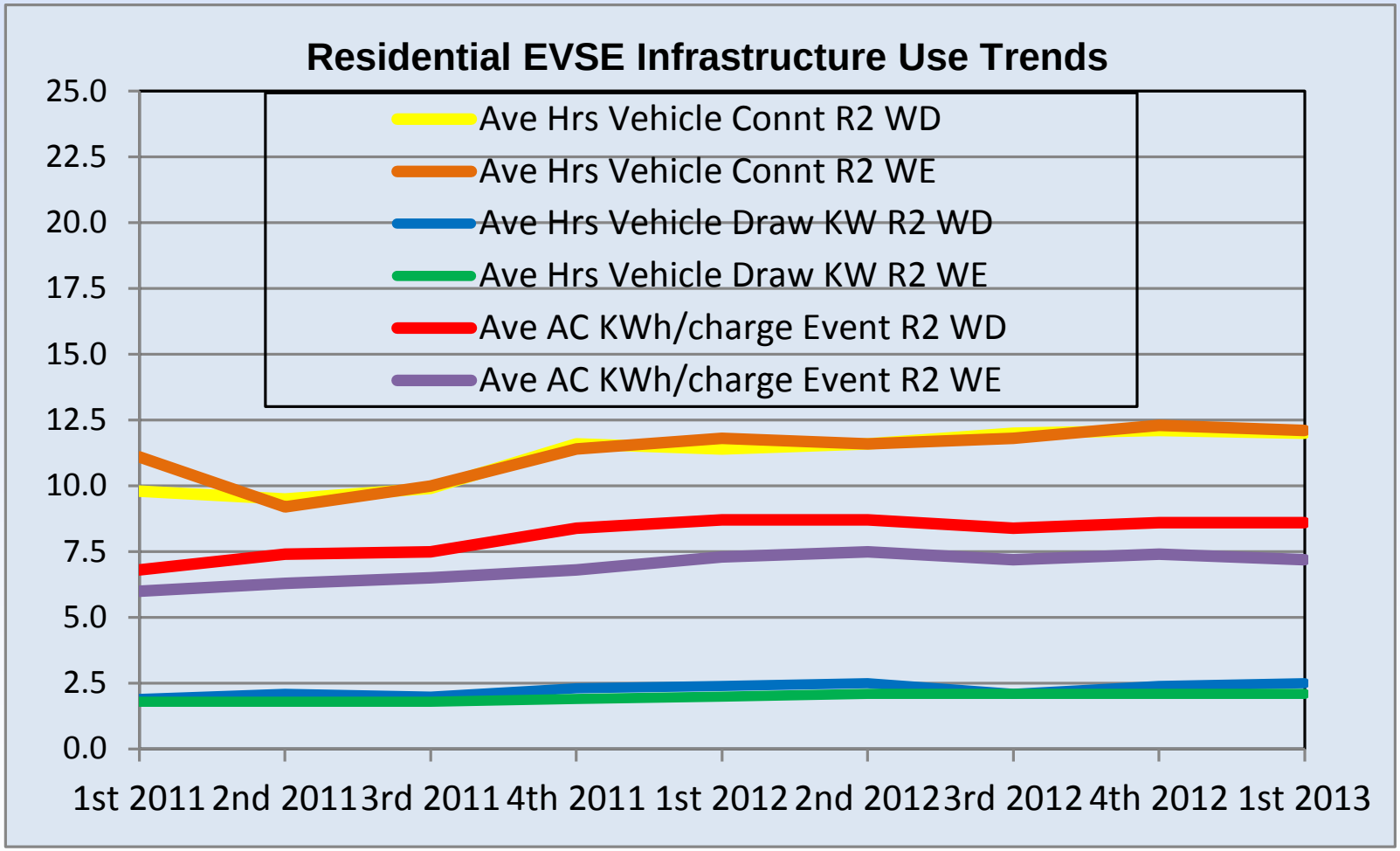
Volts



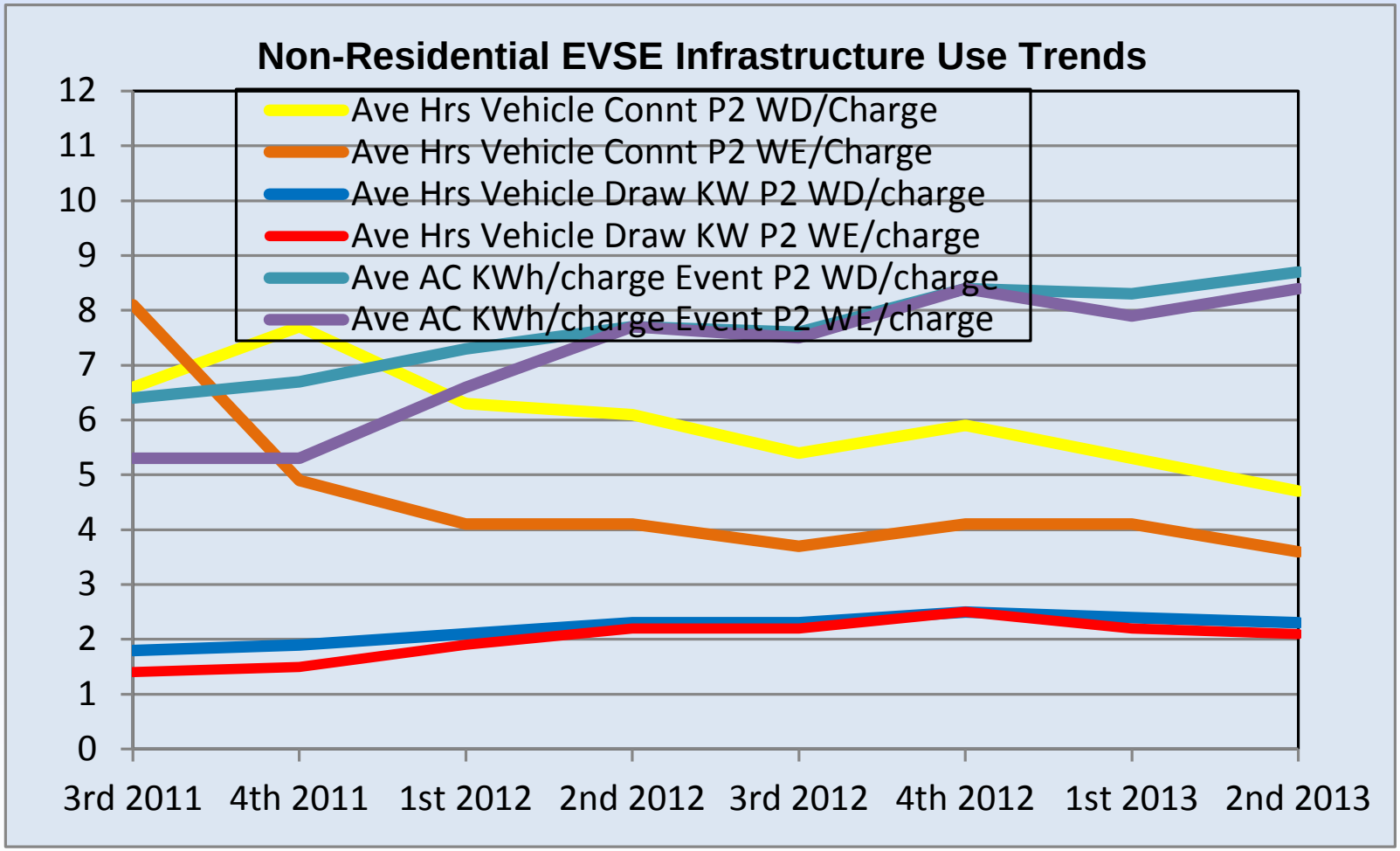




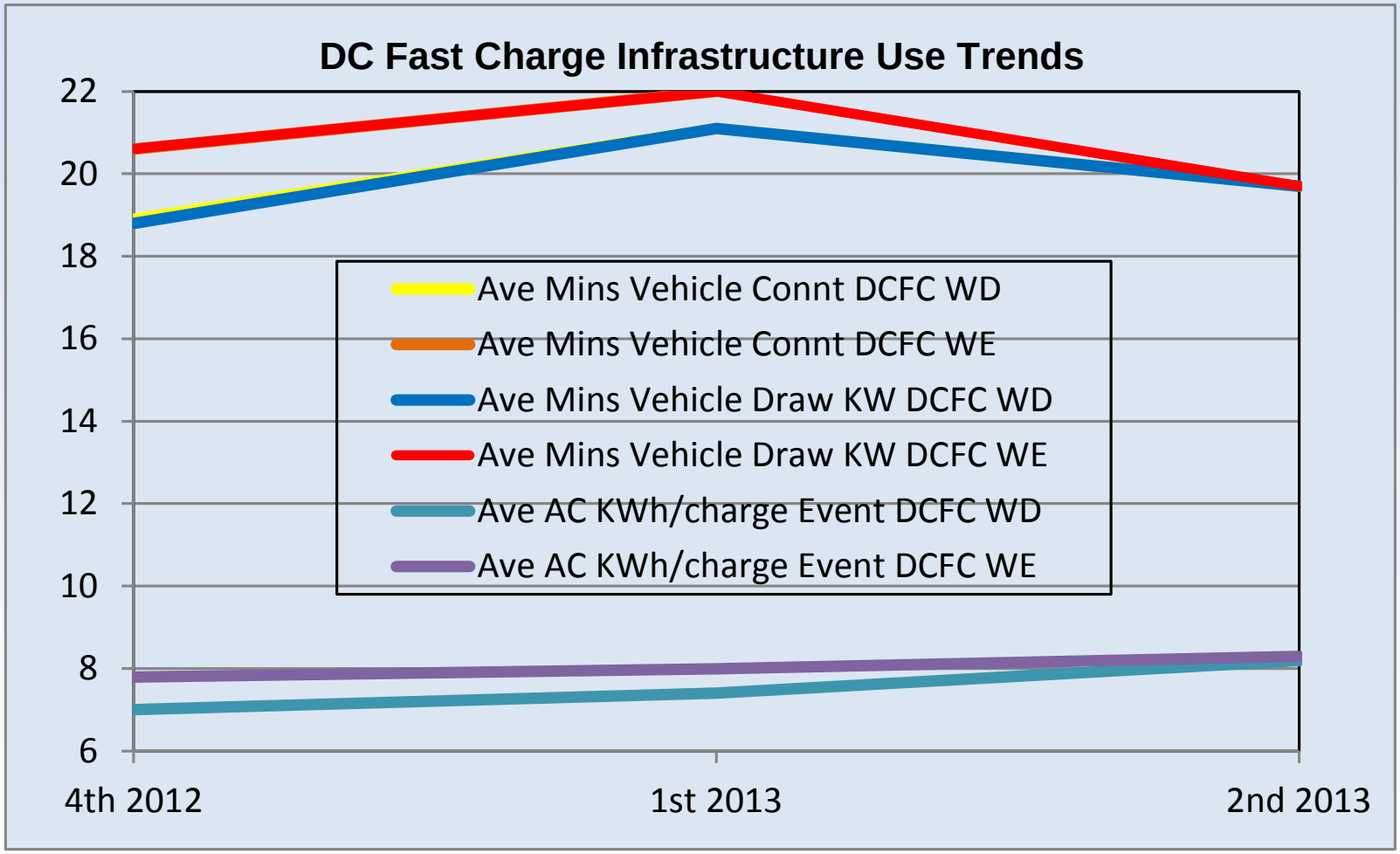
EV Project – Residential EVSE Use



EV Project – Non Residential L2 EVSE Use

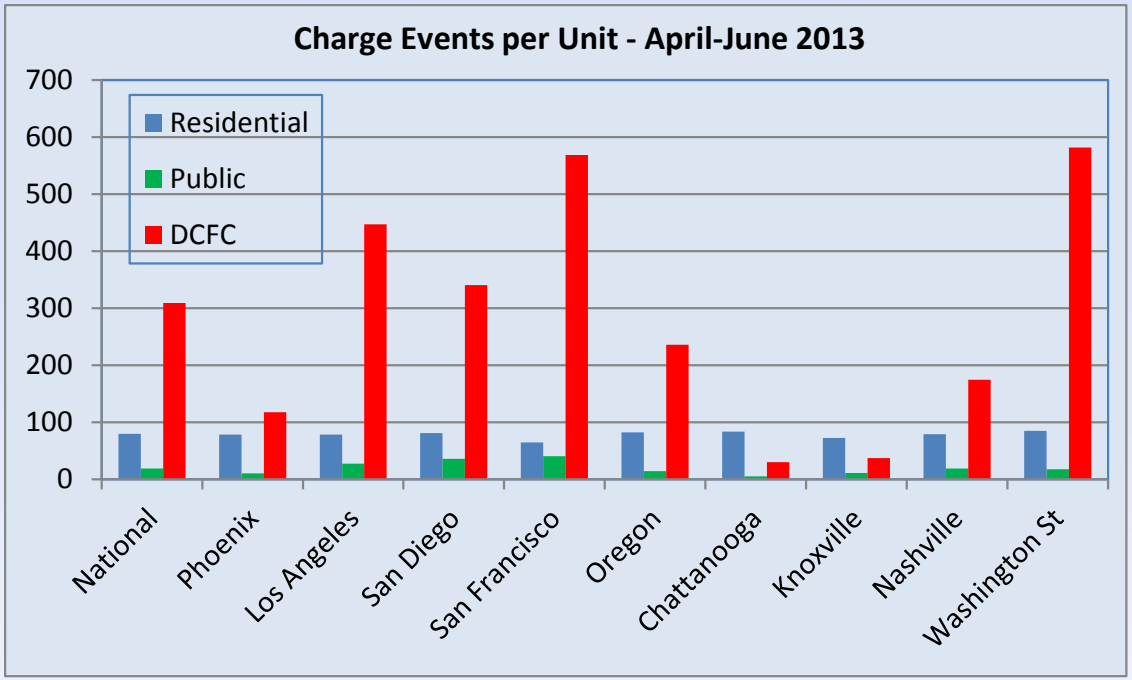


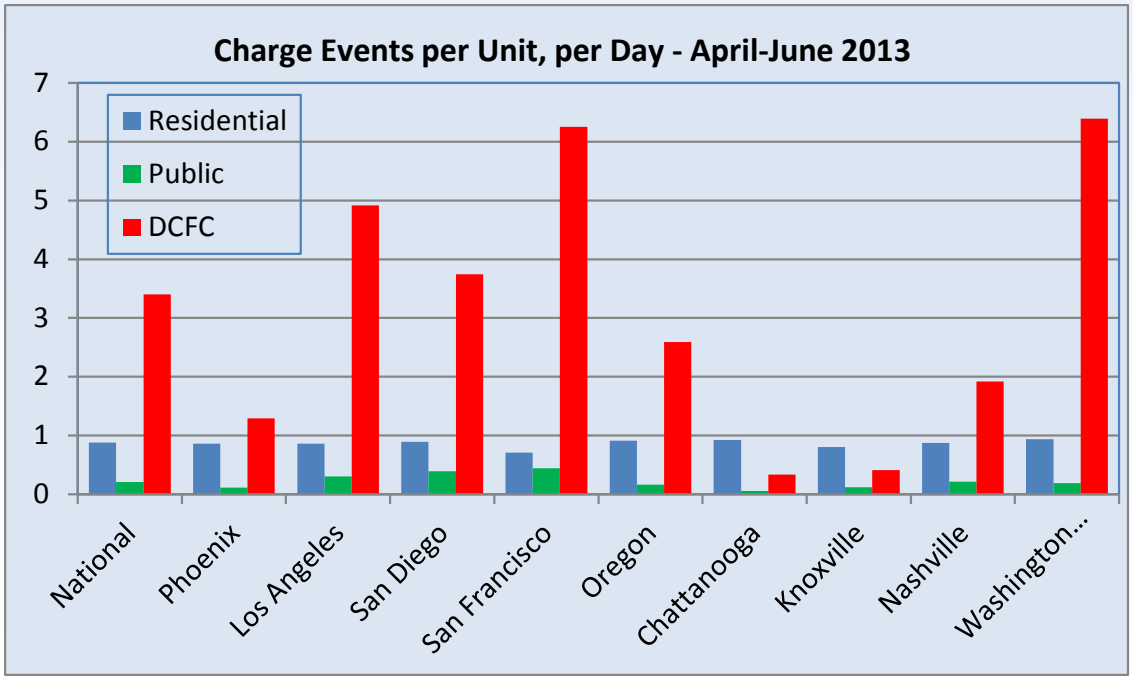
EV Project – DCFC Use



EV Project – Infrastructure use

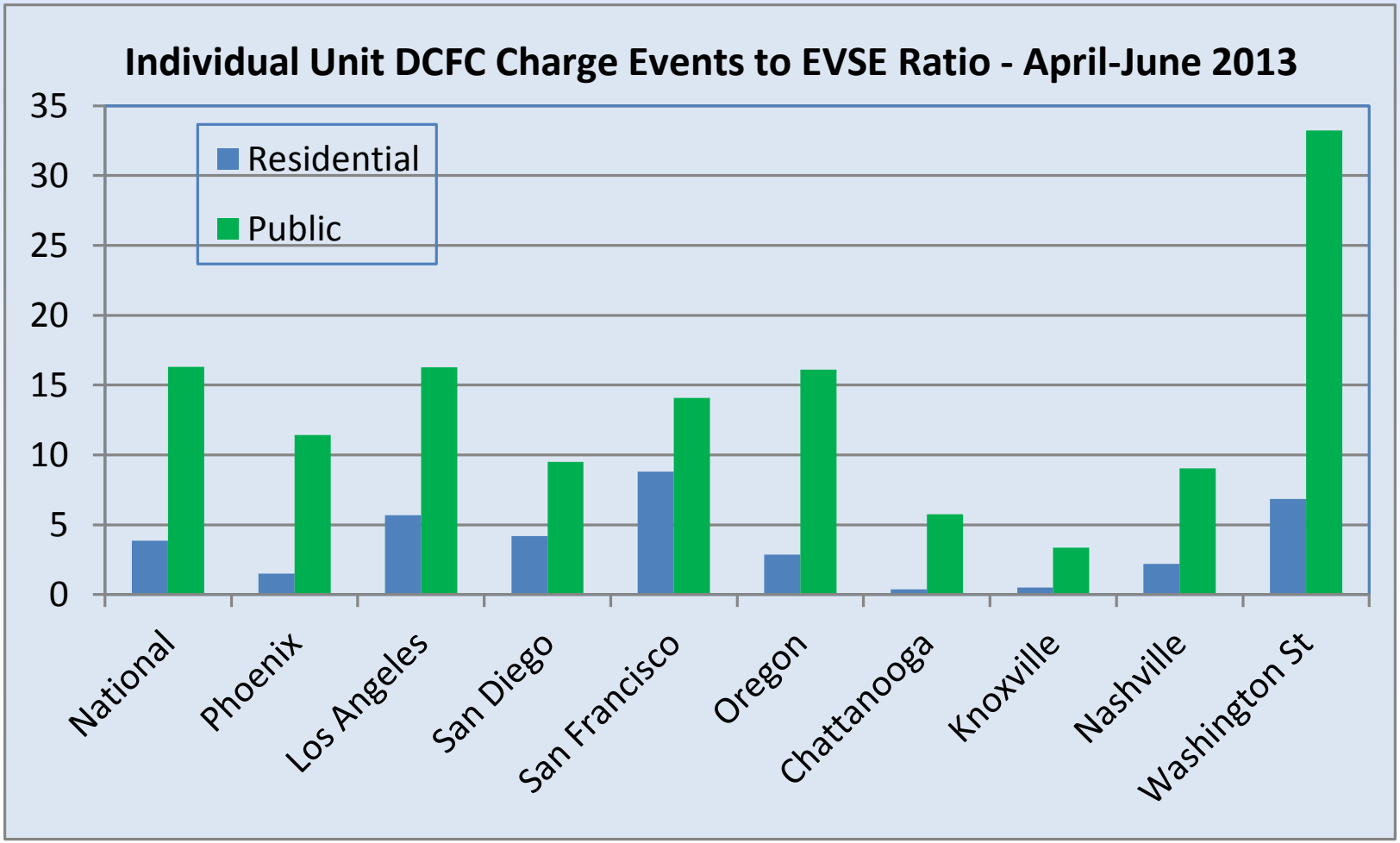
- Per unit use, 2nd quarter 2013 reports
- Residential L2 EVSE are typically utilized < 1 charge per day
- Public L2 EVSE are typically utilized <0.5 charges per day
- DCFC are utilized from <0.5 to >6 charges per day





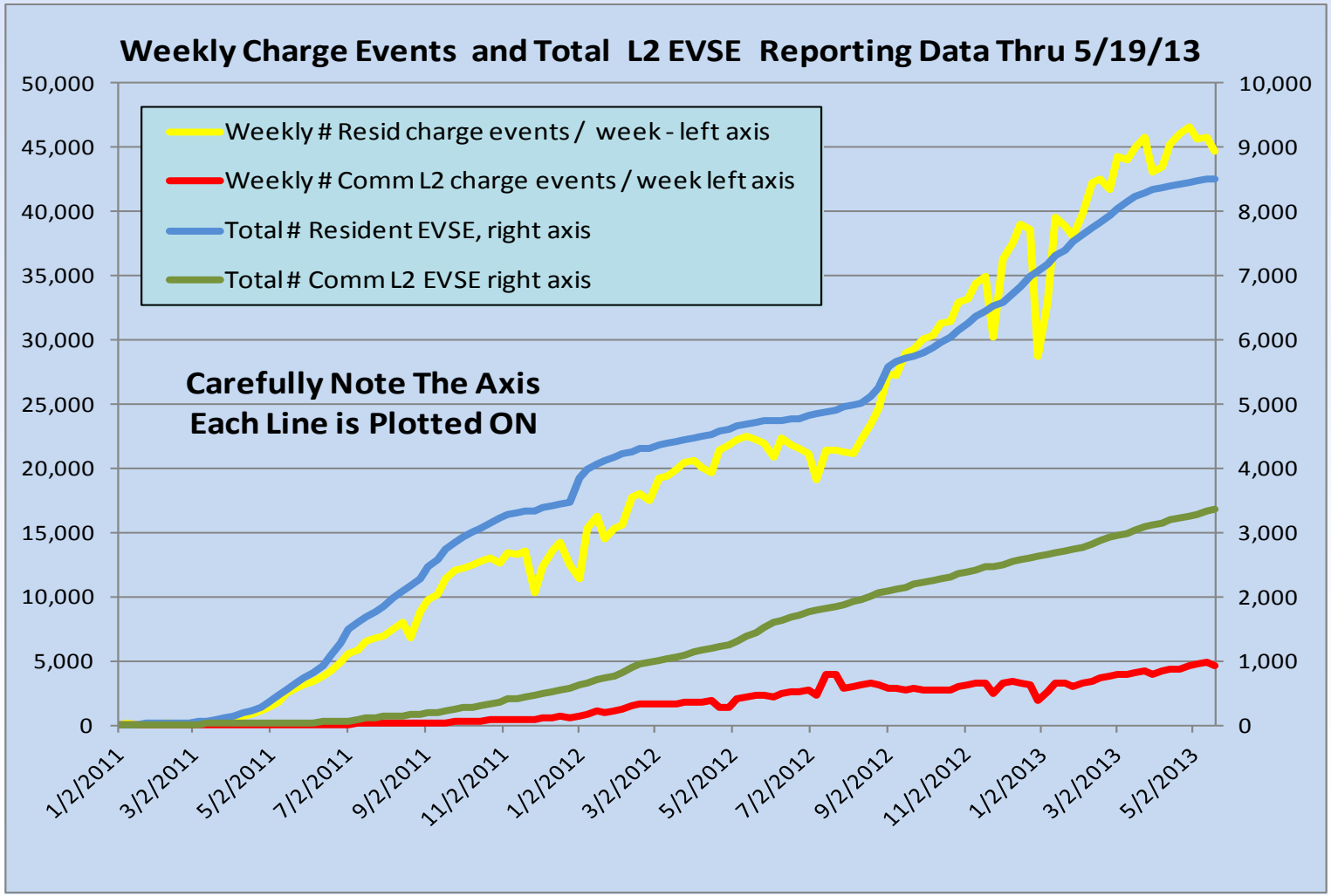
EV Project

- **Per unit use, 2nd quarter 2013 reports**
- **DCFC use per unit compared to residential and public access Level 2 EVSE**



Residential vs. Public Use Rates

- **Ratio of 5.4 : 1 weekly Residential EVSE use versus weekly Public Level 2 EVSE use (last 5 weeks)**



Charge Infrastructure Installation Costs

DCFC Installation Costs / Issues

- Current installations range from **$8,500 to $48,000** (99 units)
- Average installation cost to date is about **$21,000**
- Host has obvious commitment for the parking and ground space - not included in above costs
- Above does not include any costs that electric utility may have incurred in evaluating or upgrading service

- These are the preliminary costs to date. When all 200 DC Fast Chargers are installed, installation costs may be different
  - All the best (lower-cost) sites are installed first, so final costs may be higher
  - Lessons learned may help lower future costs and site selections, so final costs may be lower

DCFC Installation Costs

- Total installation costs (99 units)
- Includes everything EV Project has funded per DCFC installation except DCFC charging unit

Number per Region	National - 99	AZ - 17	WA - 12	CA - 37	OR - 15	TN - 16
Minimum	**$8,440**	$8,440	$18,368	$10,538	$12,868	$14,419
Mean	**$20,848**	$15,948	$24,001	$21,449	$19,584	$23,271
Maximum	**$47,708**	$33,990	$33,246	$47,708	$26,766	$31,414

DCFC Installation Costs / Issues

- Items of concern associated with installation that drive costs
  - Power upgrades needed for site
  - Impact on local transformer
  - Ground surface material and cost to “put back” (e.g. concrete, asphalt, landscaping)
  - Other underground services that may affect method of trenching power to DCFC
  - Gatekeeper or decision-maker for the property is not always apparent
  - Magnitude of operating costs and revenue opportunities are still largely unknown
  - Time associated with permissions
    - Permits, load studies, and pre-, post-, and interim inspections

DCFC Commercial Lessons Learned

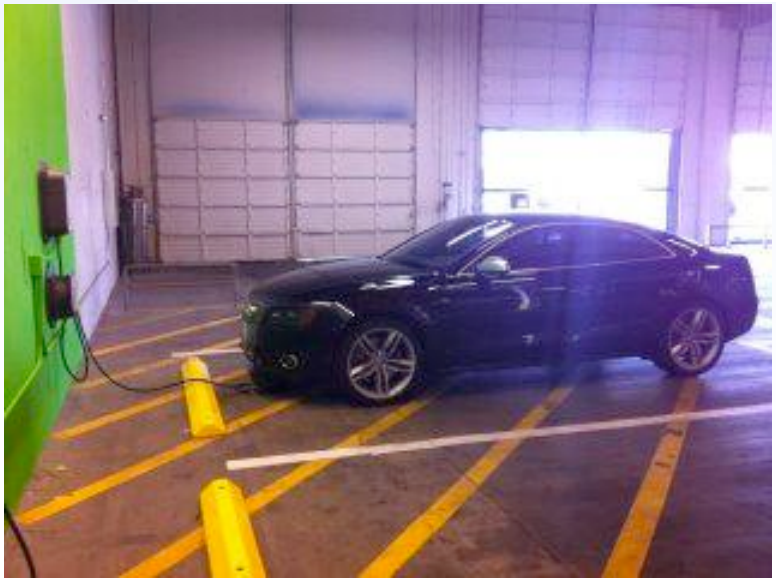
- Especially in California, DC fast charge demand charges are significant in many utility service territories

Utility Demand Charges - Nissan Leaf		Cost/mo.
CA	Glendale Water and Power	$ 16.00
	Hercules Municipal Utility:	$ 377.00
	Los Angeles Department of Water and Power	$ 700.00
	Burbank Water and Power	$ 1,052.00
	San Diego Gas and Electric	$ 1,061.00
	Southern California Edison	$ 1,460.00
AZ	TRICO Electric Cooperative	$ 180.00
	The Salt River Project	$ 210.50
	Arizona Public Service	$ 483.75
OR	Pacificorp	$ 213.00
WA	Seattle City Light	$ 61.00

Commercial Level 2 Permits Cost

- **Commercial permits range $14 to $821**

Region	Count of Permits	Average Permit Fee	Minimum Permit Fee	Maximum Permit Fee
Arizona	72	$228	$35	$542
Los Angeles	17	$195	$67	$650
San Diego	17	$361	$44	$821
Texas	47	$150	$37	$775
Tennessee	159	$71	$19	$216
Oregon	102	$112	$14	$291
Washington	33	$189	$57	$590



Commerical Level 2 Installation Costs

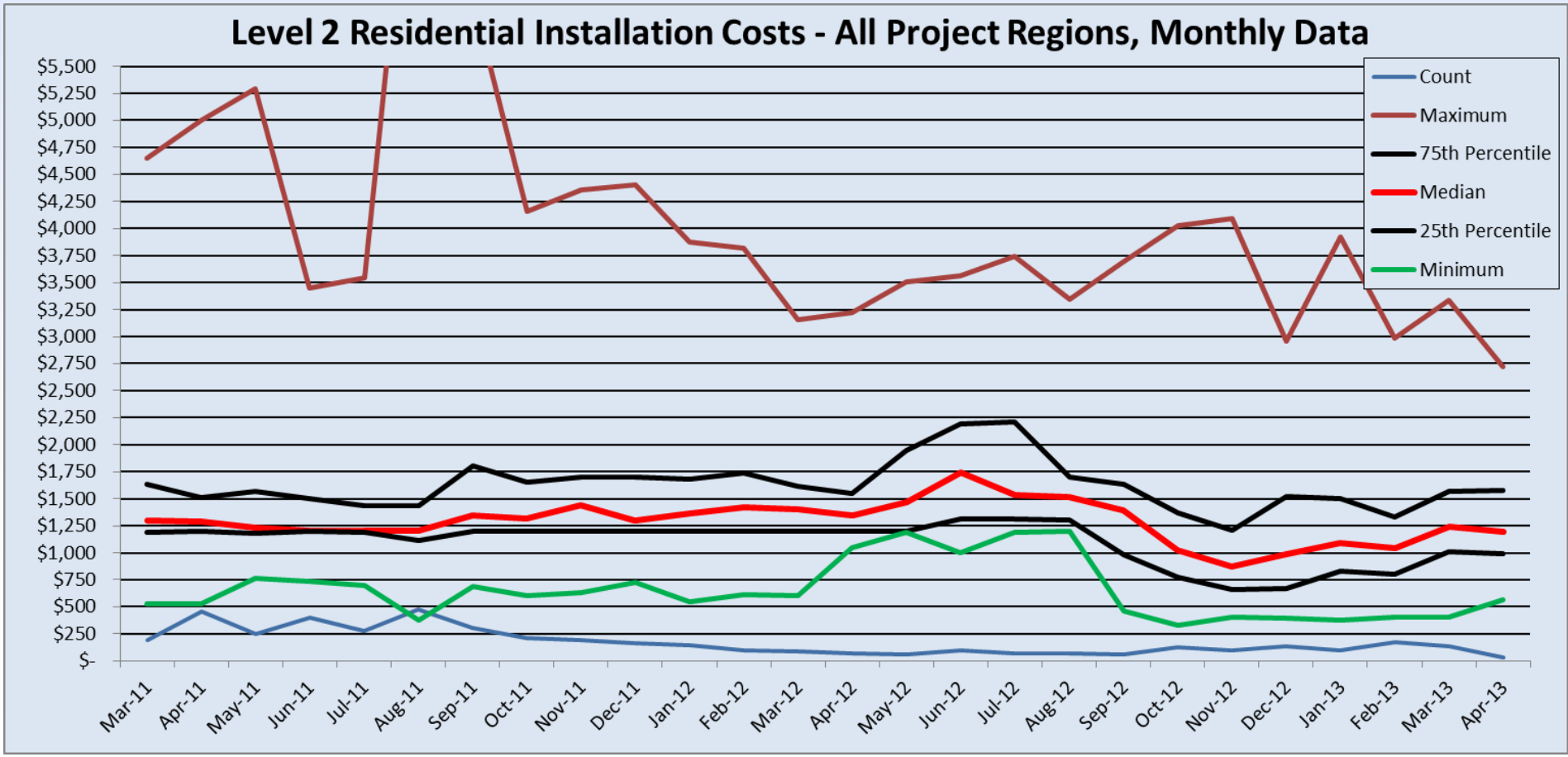
- Nationally, commercially sited Level 2 EVSE average between $3,500 and $4,500 for the installation cost
  - Does not include EVSE hardware
- There is much variability by region and by installation
  - Multiple Level 2 units at one location drive down the per EVSE average installation cost
  - Tennessee and Arizona have average installation costs of $2,000 to $2,500

- Costs are significantly driven by poor site requests
  - Example: mayor may want EVSE by front door of city hall, but electric service is located at back of building

Residential Level 2 EVSE Installation Costs

- Max - $8,429
- Mean $1,414
- Min $250
- Medium $1,265

- Count 4,466
- Total installation costs, does not include EVSE hardware

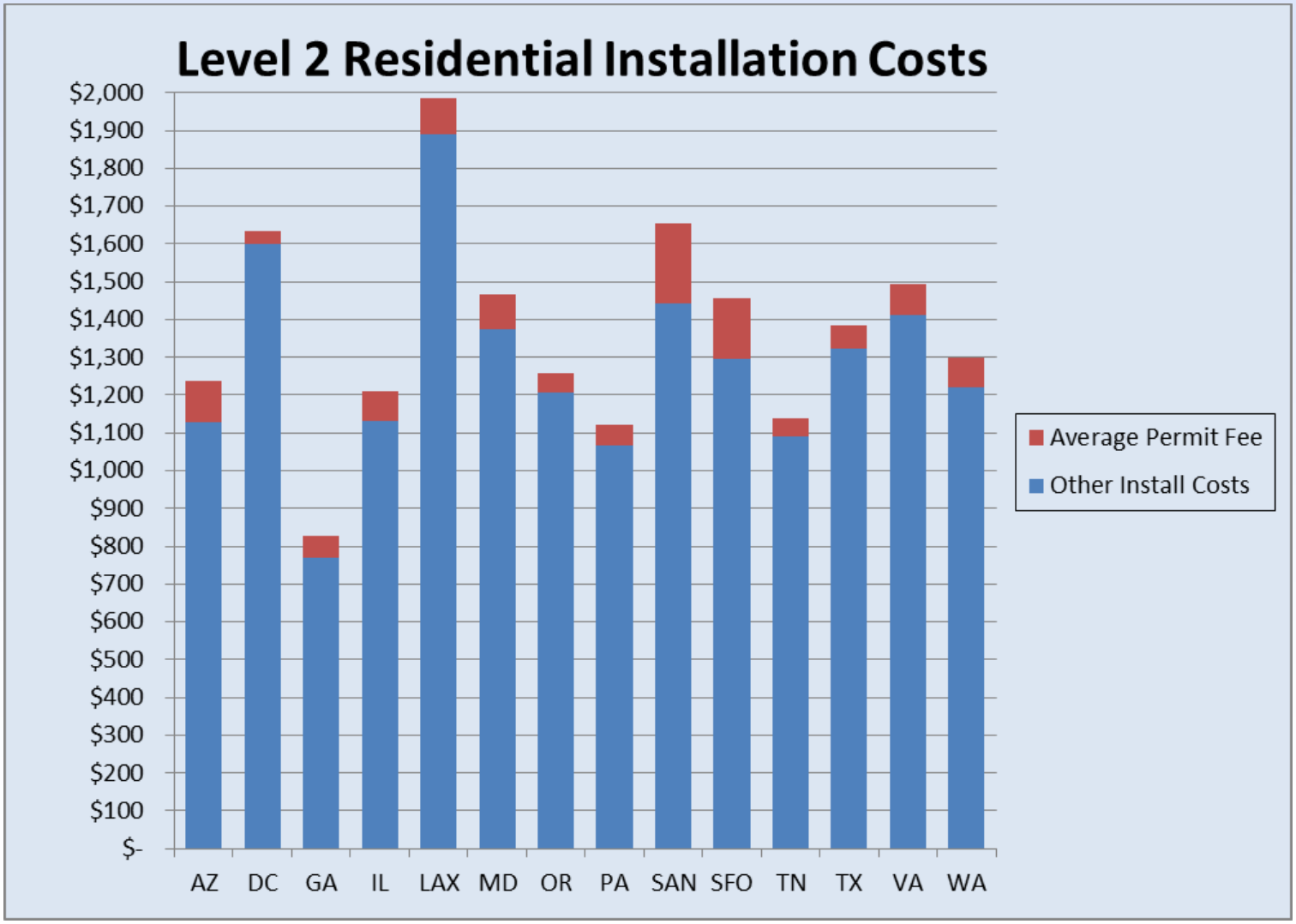


Residential Level 2 Installation Costs

- High costs driven by need to upgrade entire residential electrical service - $8,429 – or other requests such as
  - Not installing near the service panel
  - Desire to site away from the house and concrete must be cut
- Low costs driven by things like an existing 240 V outlet in the garage
- Does not include EVSE hardware

Residential Level 2 EVSE Installation Costs

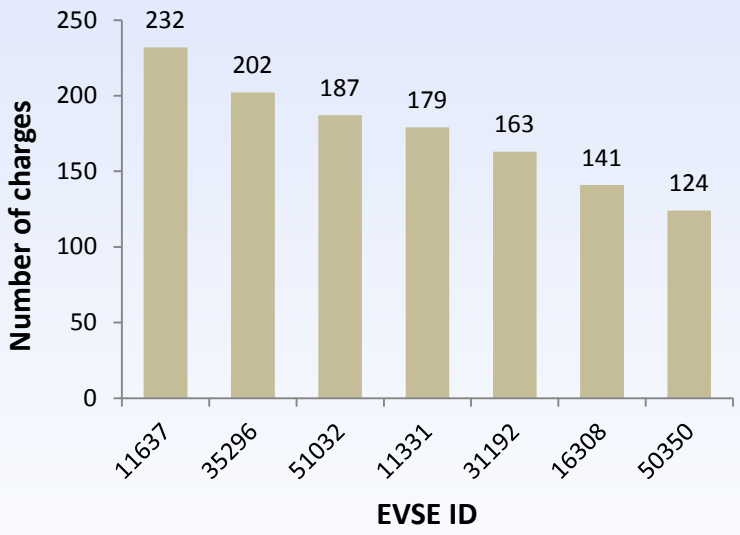
- Regional results for 4,466 units
- Permit versus other installation costs. No EVSE costs



Two examples of Utilization at sites with multiple EVSE

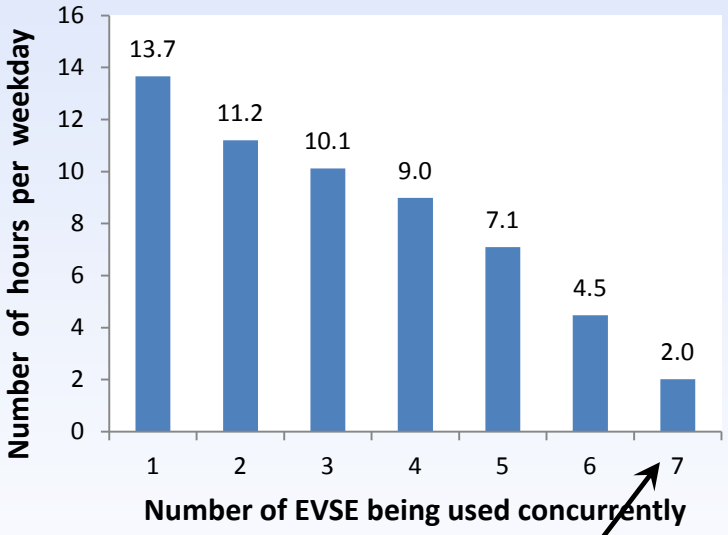
EVSE utilization at “Worksite A” in Q2 2013

Overall Usage of EVSE



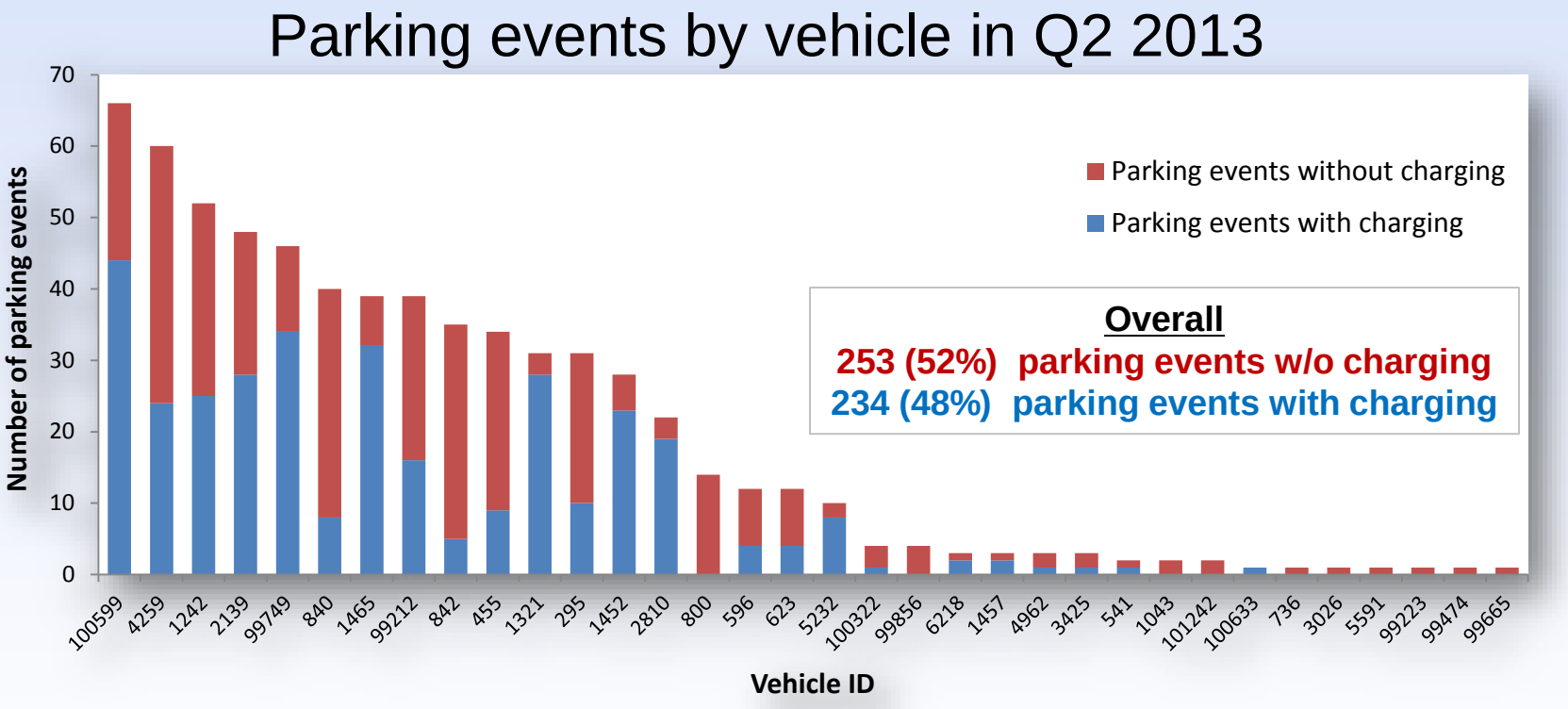
Each EVSE had significant usage in the quarter

Concurrent Usage of EVSE



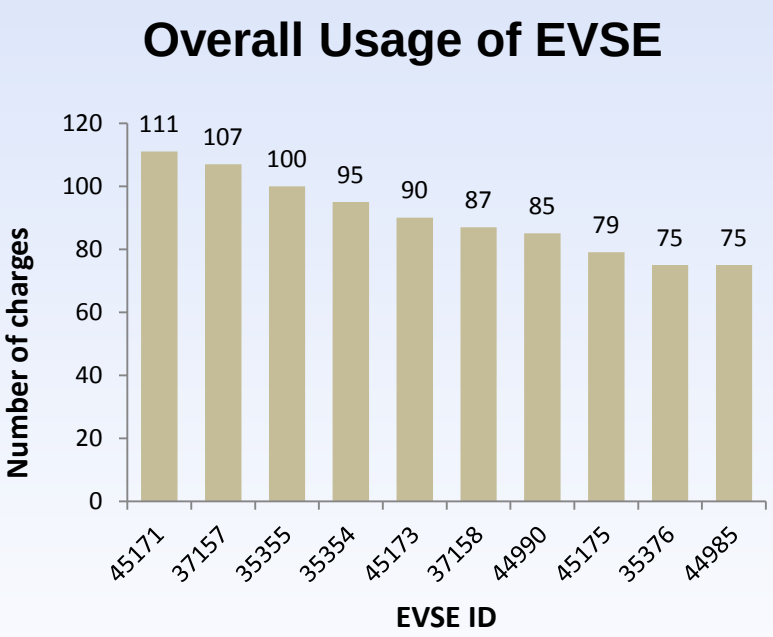
All 7 EVSE simultaneously connected to a vehicle for 2 hrs per weekday, on average

EV Project vehicles at “Worksite A”

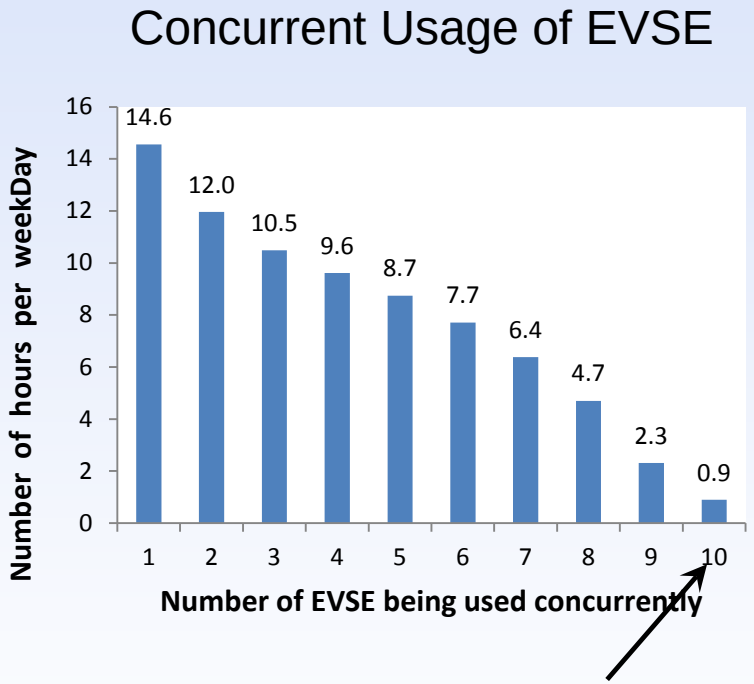


- Many vehicles parked only a few times (perhaps visitors?)
- Some frequent-parking PEVs rarely or never charged
- Drivers may have multiple parking events each day

Level 2 EVSE utilization at “Worksite B”

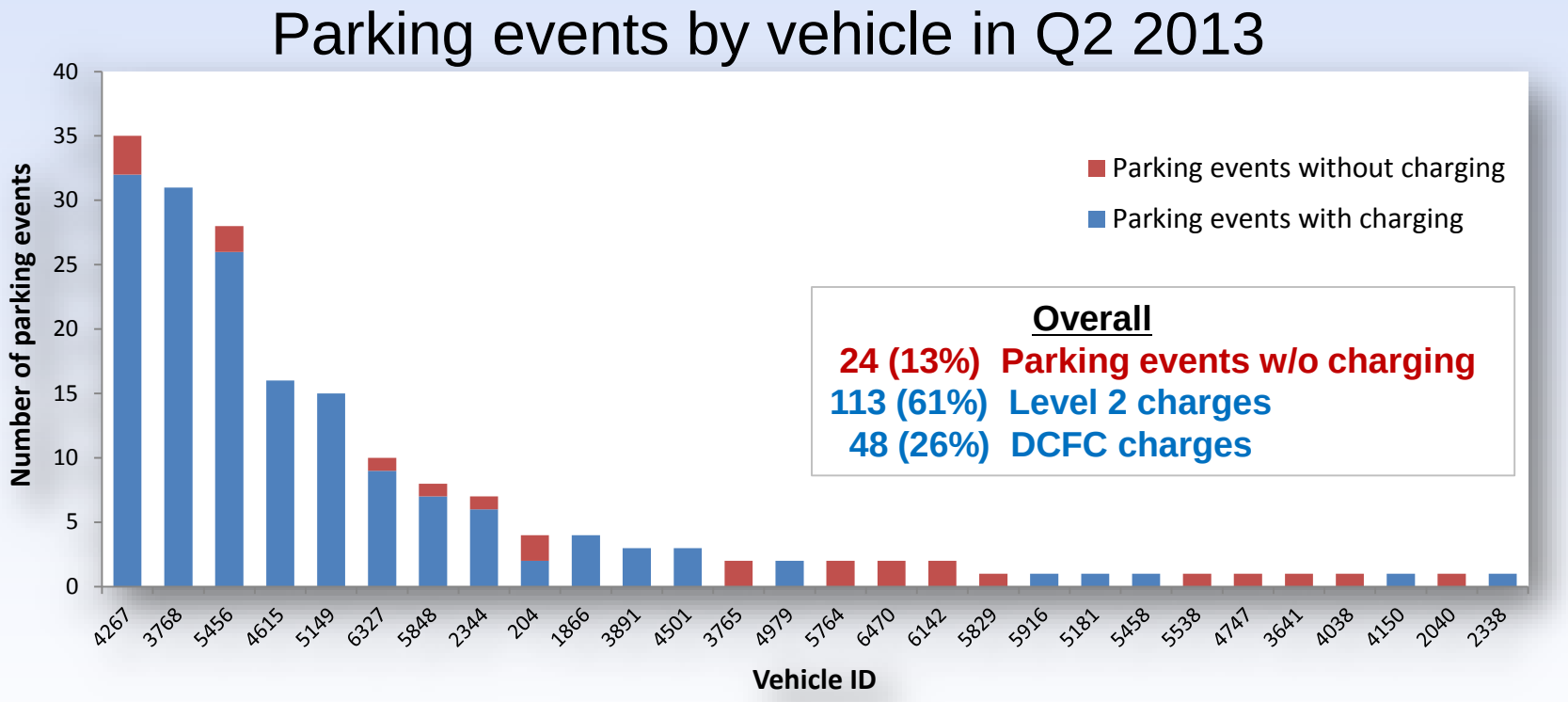


Each EVSE had significant usage in the quarter



All 10 EVSE connected to a vehicle for 1 hr per weekday on average

EV Project vehicles at “Worksite B”



- Many vehicles parked only a few times – visitors?
- Frequent-parking PEVs charged *nearly every time* they parked
- Non-employee vehicles may be using DCFC as public charger

Summary

- Residential Level2 EVSE are the primary choice for charging by PEV owners
  - 75% to 80% of charging is at residence (home)

- DCFC installation costs range from **$8,500 to $48,000**
  - Average DCFC installation cost: **$21,000**

- Commercial L2 EVSE installation cost average between **$3,500 and $4,500**
  - Multiple EVSE per site reduces the cost per EVSE

- Residential L2 EVSE installation costs: **$8,429 to $250**
  - Average DCFC installation cost: **$1,414**

Acknowledgement

This work is supported by the U.S. Department of Energy's EERE Vehicle Technologies Program

http://avt.inl.gov