Idaho National Laboratory

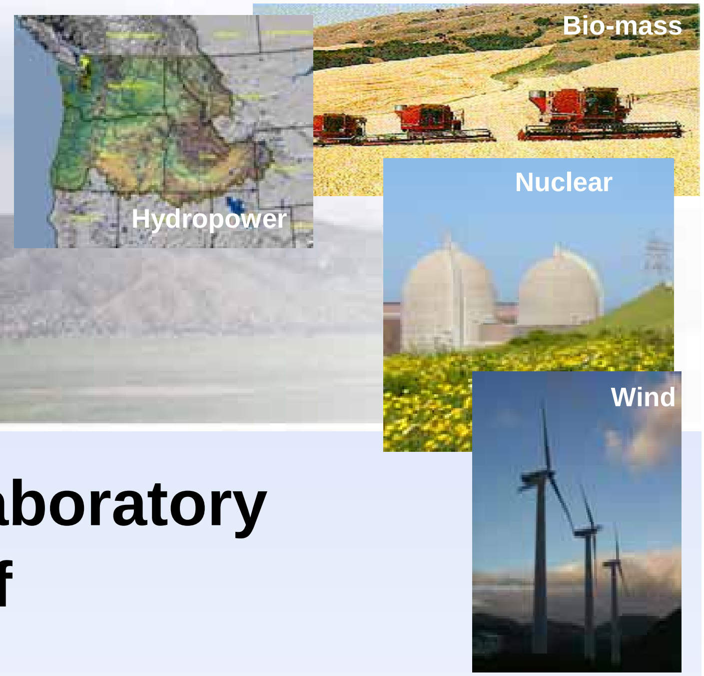
U.S. Department of Energy's Vehicle Technologies Program

PEV Collaborative Meeting: PEV Drivers' Use of 12,000 EVSE and DCFC

Jim Francfort

PEV Collaborative Member Meeting
U.C. Davis, Davis, CA
November 6, 2013

Idaho National Laboratory

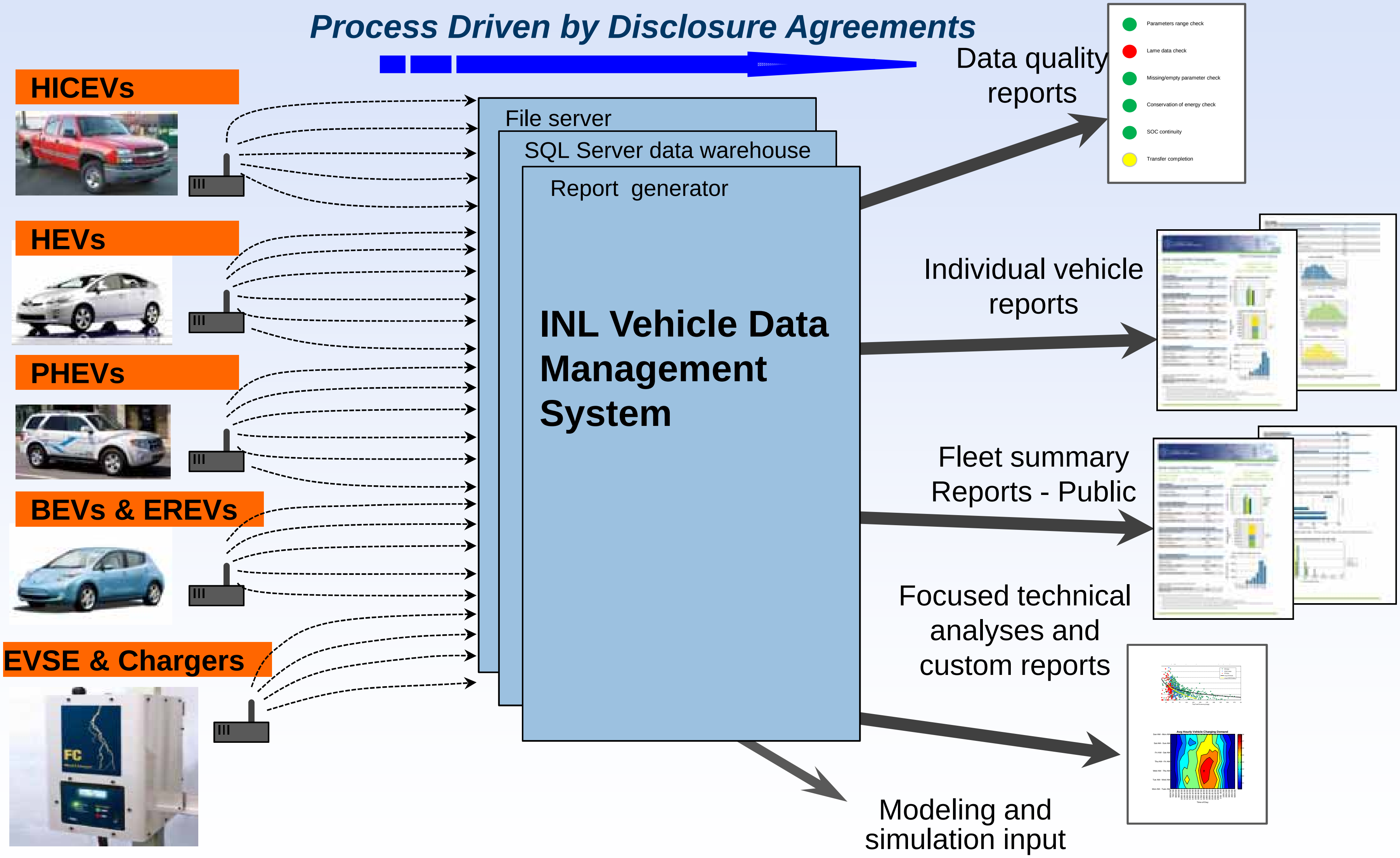


- **U.S. Department of Energy (DOE) laboratory**
- **890 square mile site with 4,000 staff**
- **Support DOE's strategic goal:**
  - **Increase U.S. energy security and reduce the nation's dependence on foreign oil**
- **Multi-program DOE laboratory**
  - **Nuclear Energy**
  - **Fossil, Biomass, Wind, Geothermal and Hydropower Energy**
  - **Advanced Vehicles and Battery Development**
  - **Homeland Security and Cyber Security**

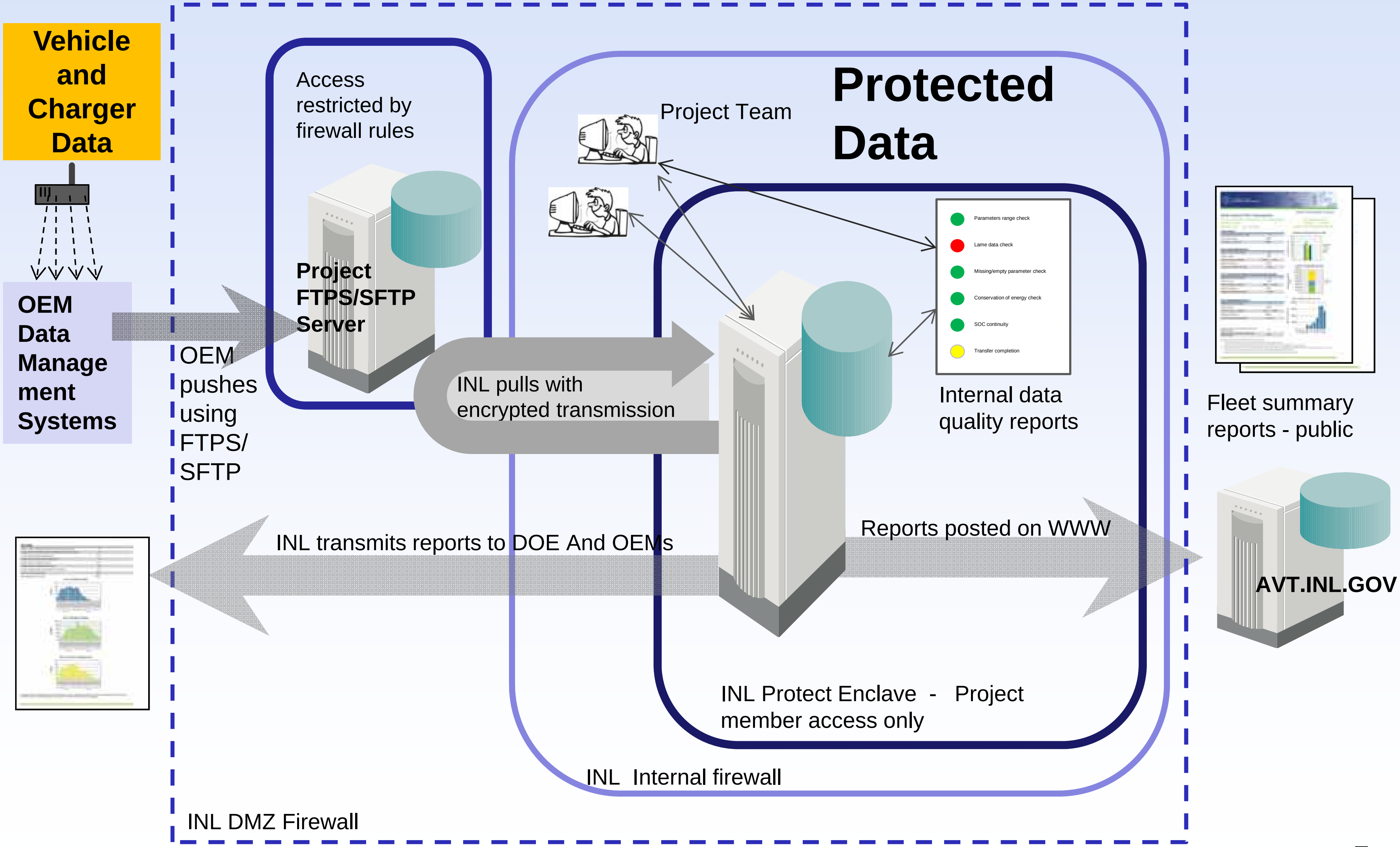
Vehicle / Infrastructure Testing Experience

- 122 million test miles accumulated on 11,600 electric drive vehicles and 16,300 EVSE and DCFC
- EV Project: 8,113 Leafs, Volts and Smarts, 12,065 EVSE and DCFC, reporting 3.5 million charge events, 103 million test miles. 1 million miles every 6 days
- Charge Point: 4,253 EVSE reporting 1.5 million charge events
- PHEVs: 15 models, 434 PHEVs, 4 million test miles
- EREVs: 2 model, 156 EREVs, 2.3 million test miles
- HEVs: 24 models, 58 HEVs, 6.4 million test miles
- Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 608,000 test miles
- NEVs: 24 models, 372 NEVs, 200,000 test miles
- BEVs: 48 models, 2,000 BEVs, 5 million test miles
- UEVs: 3 models, 460 UEVs, 1 million test miles
- Other testing includes hydrogen ICE vehicle and infrastructure testing

INL Vehicle/EVSE Data Management Process



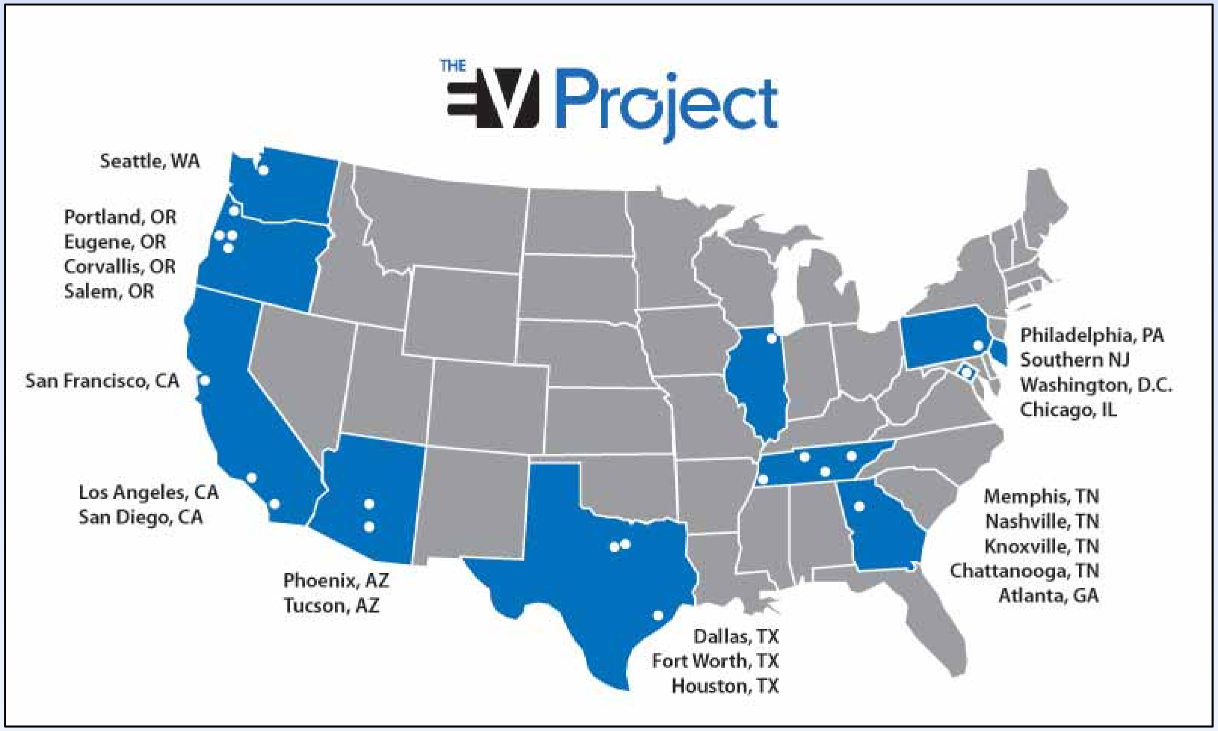
INL Vehicle/EVSE Data Transfer Process



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 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**

EV Project – National Data

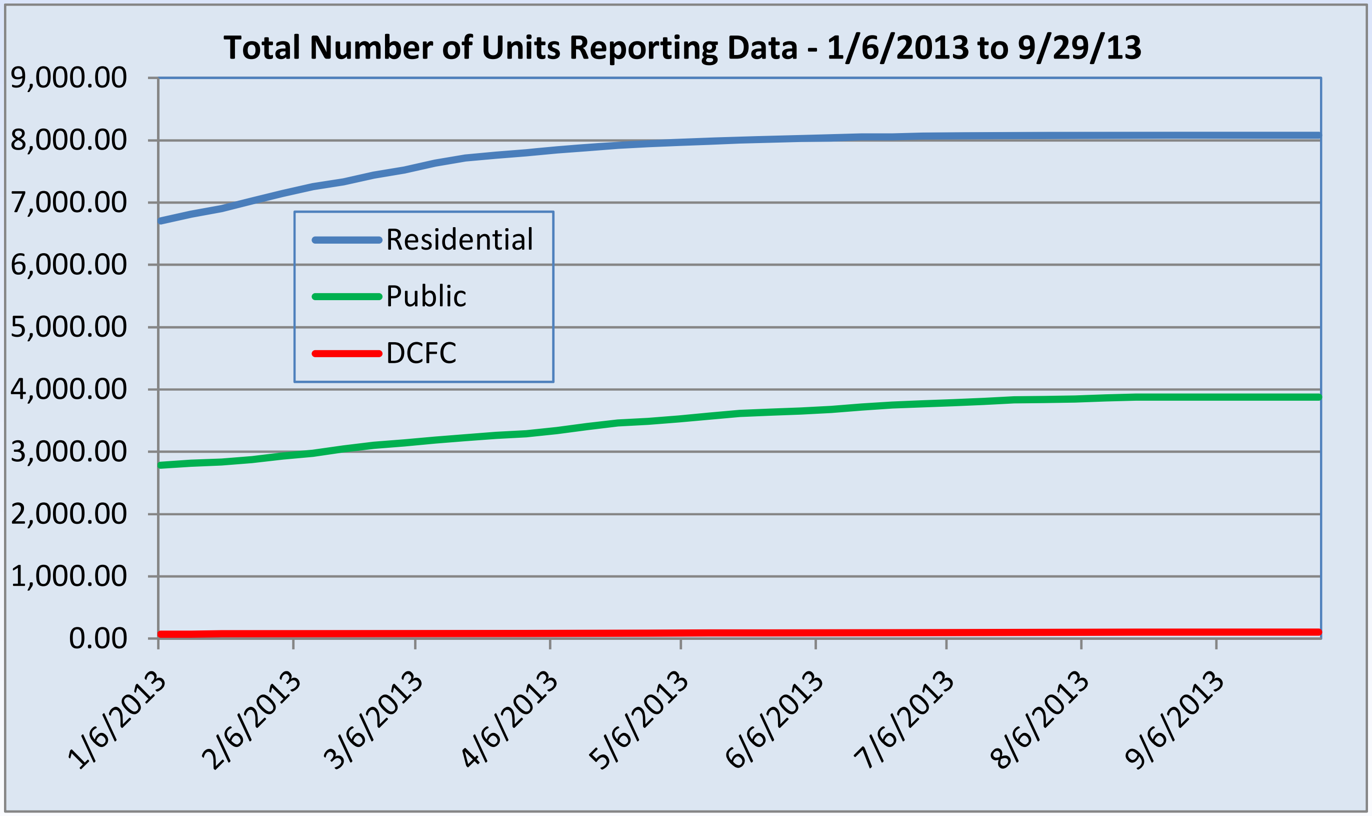
2st quarter 2013 Data Only

	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**

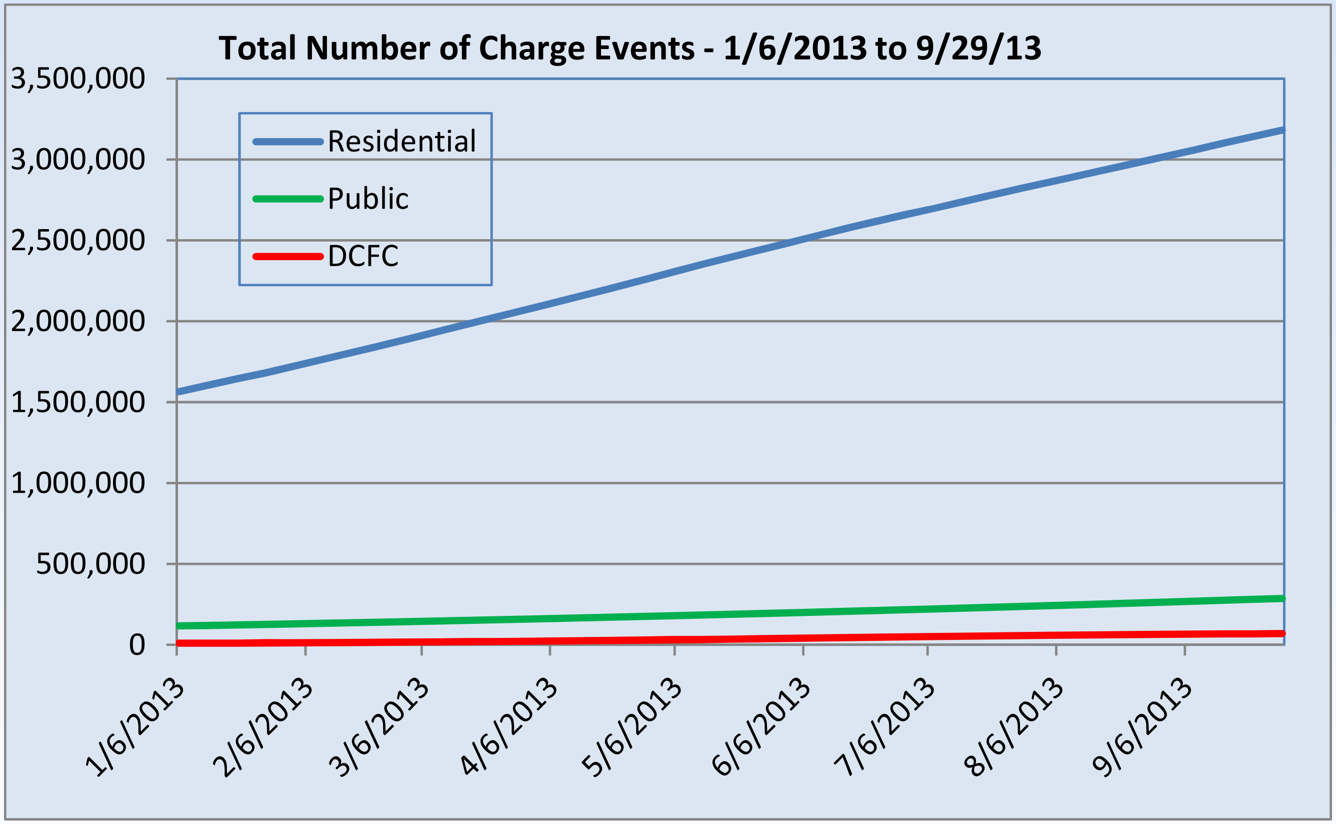
EV Project – Charging Infrastructure

- **2013 Infrastructure reporting data**

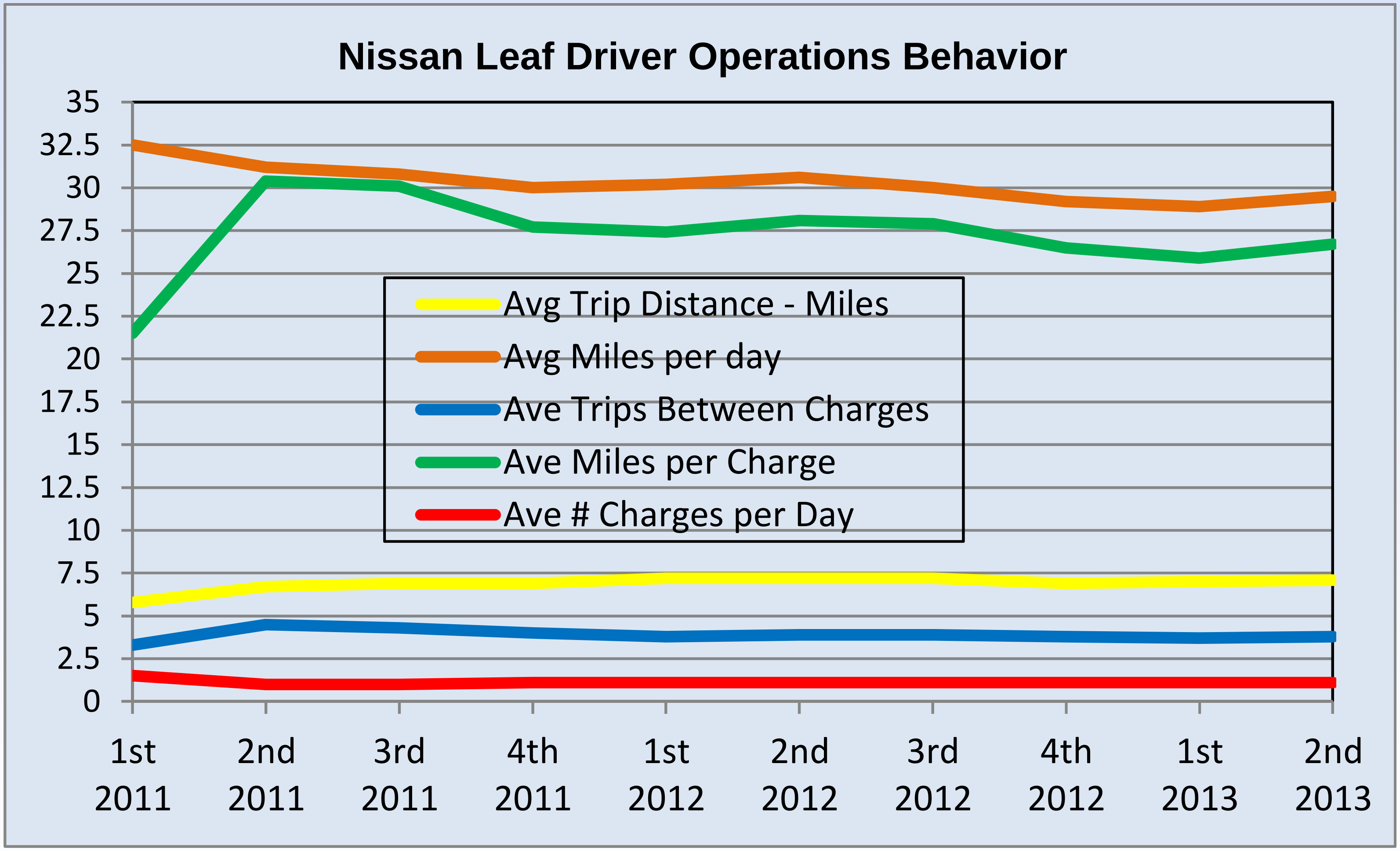


EV Project – Charging Infrastructure

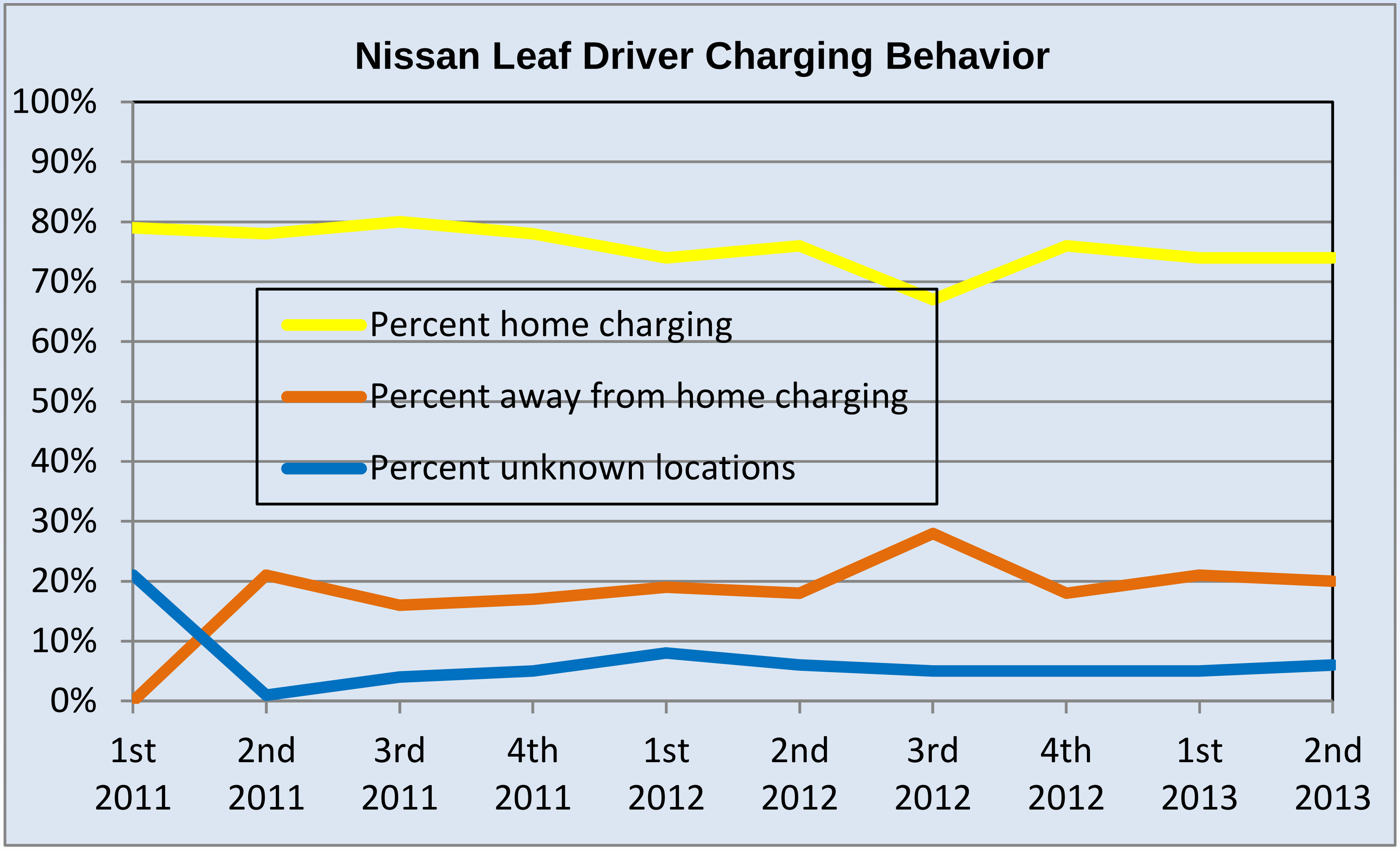
- **2013 Number of Charging Events**



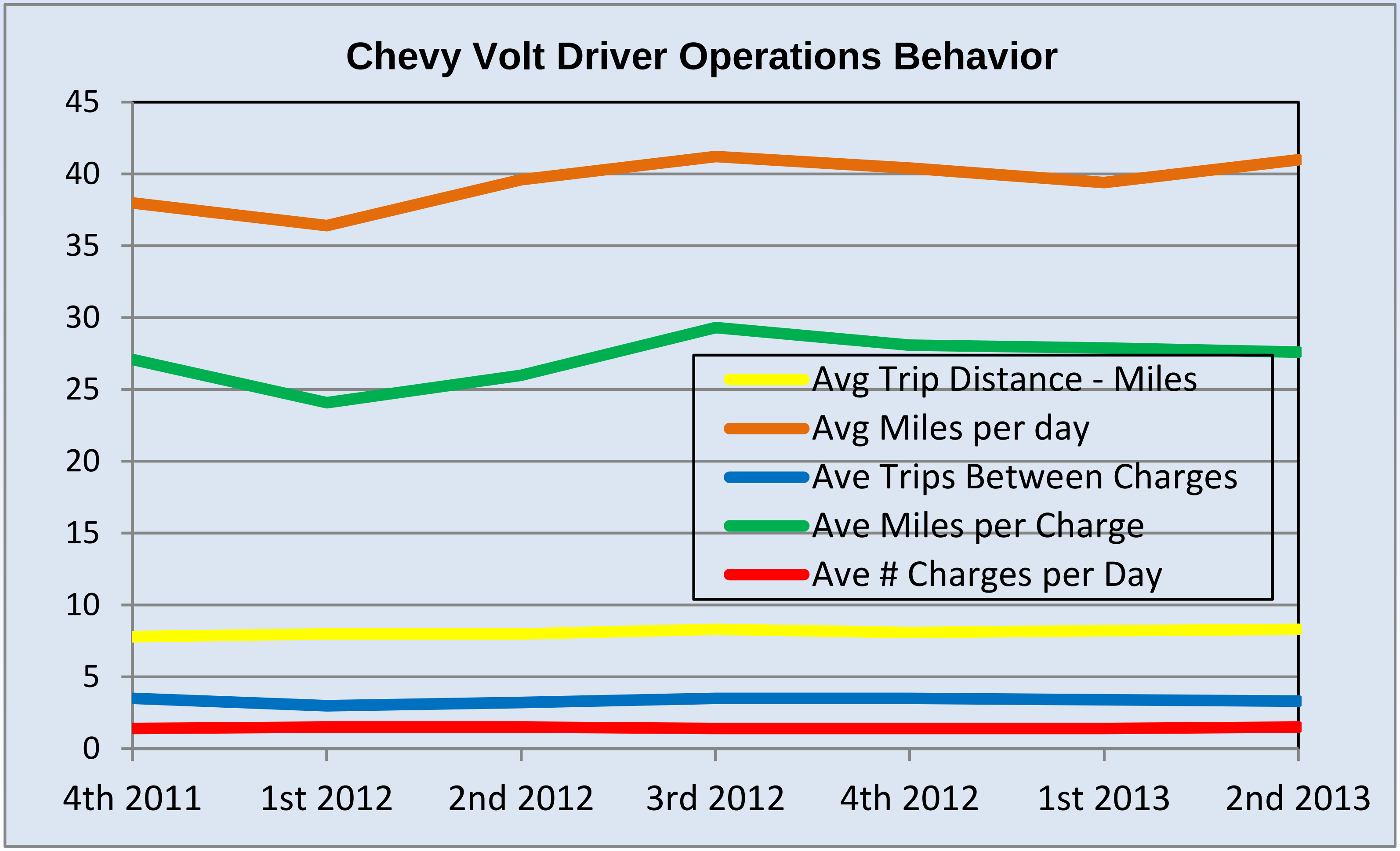
EV Project – Leaf Profiles



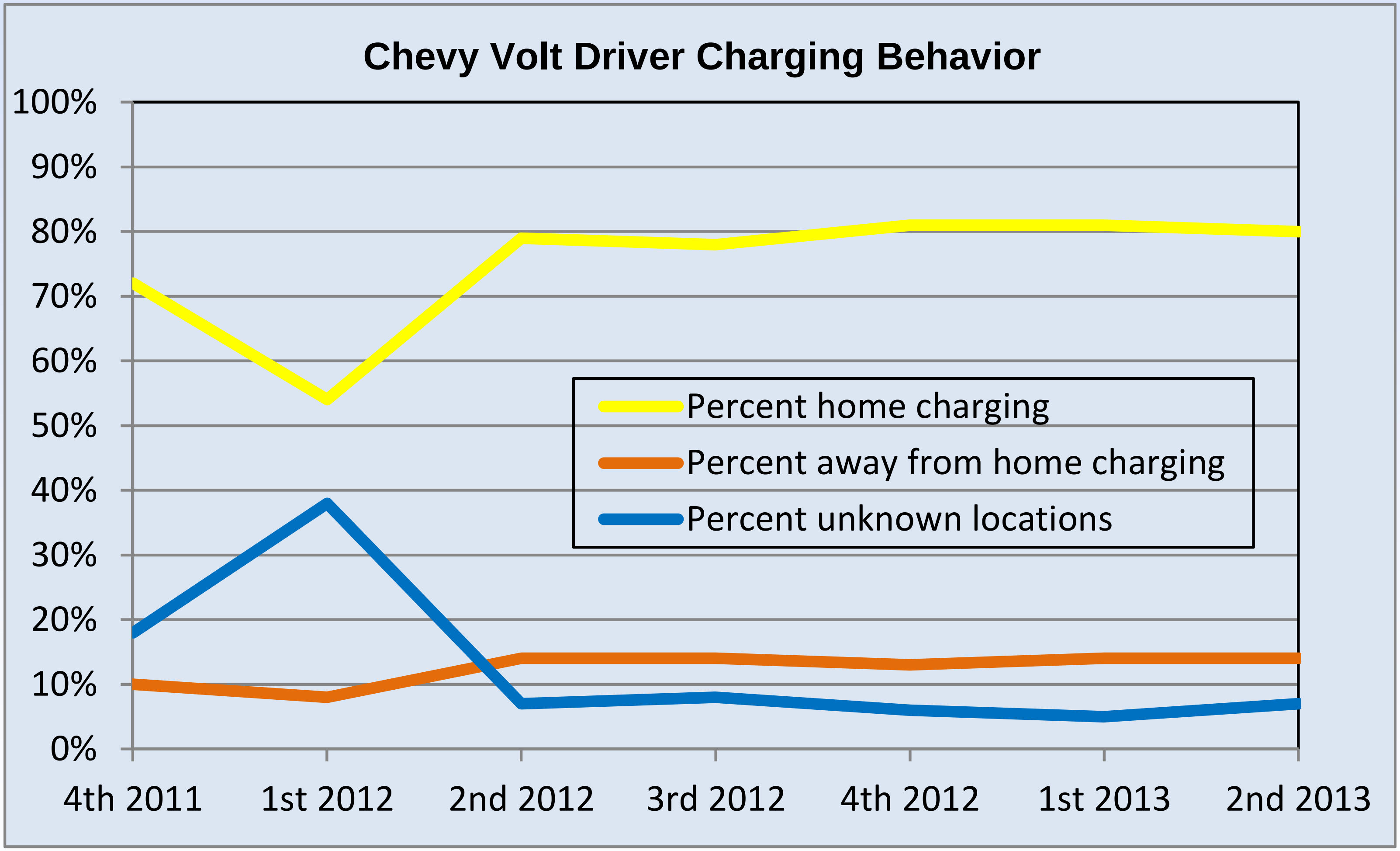
EV Project – Leaf Profiles



EV Project – Volt



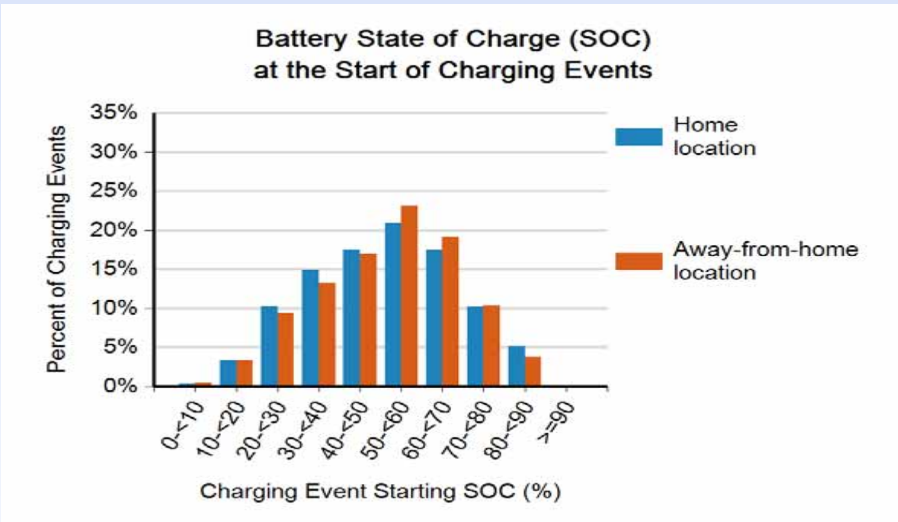
EV Project – Volt

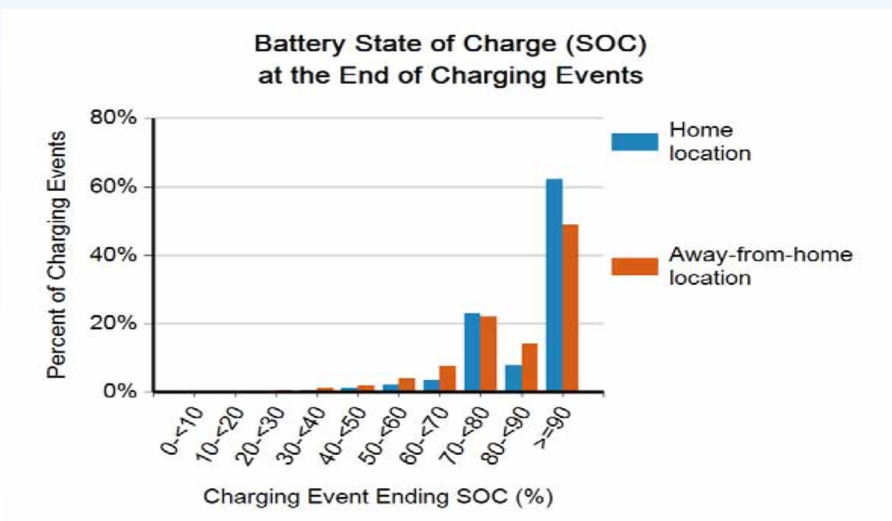


EV Project – Leaf & Volt Charging

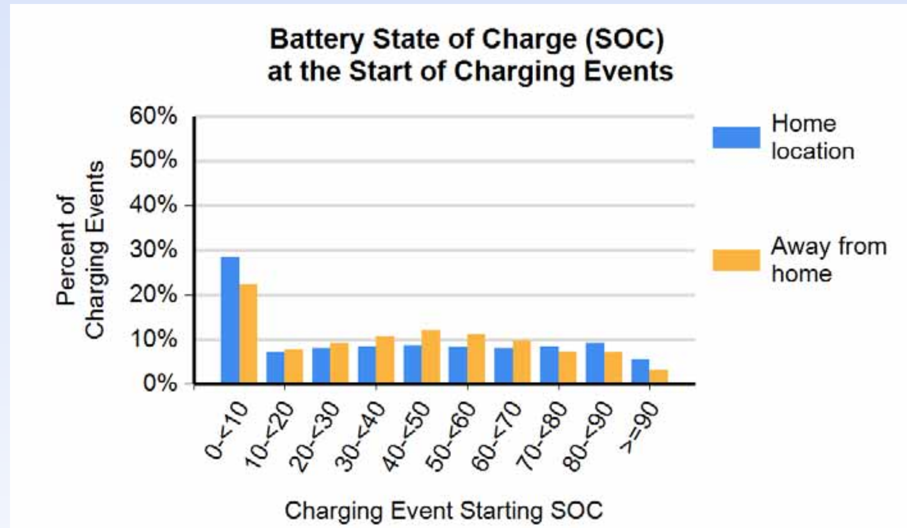
2st quarter 2013 Data Only

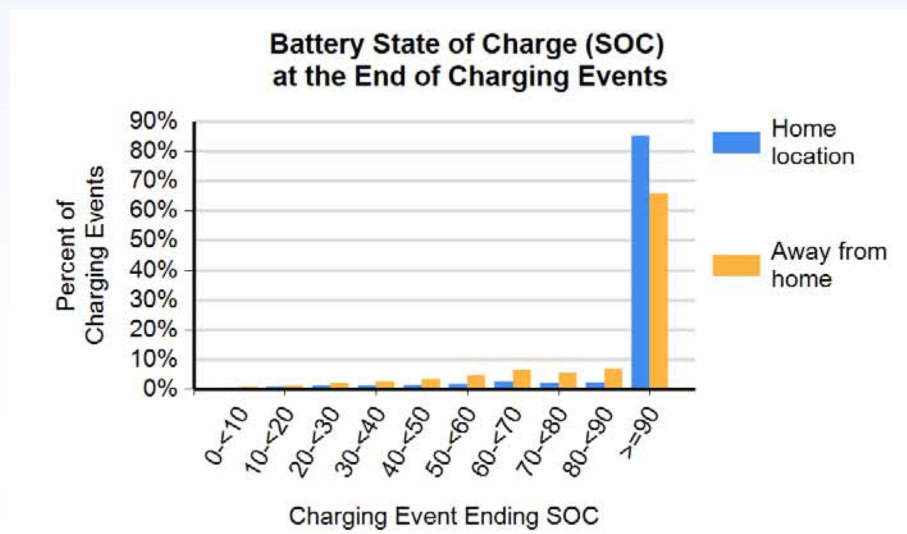
Leafs



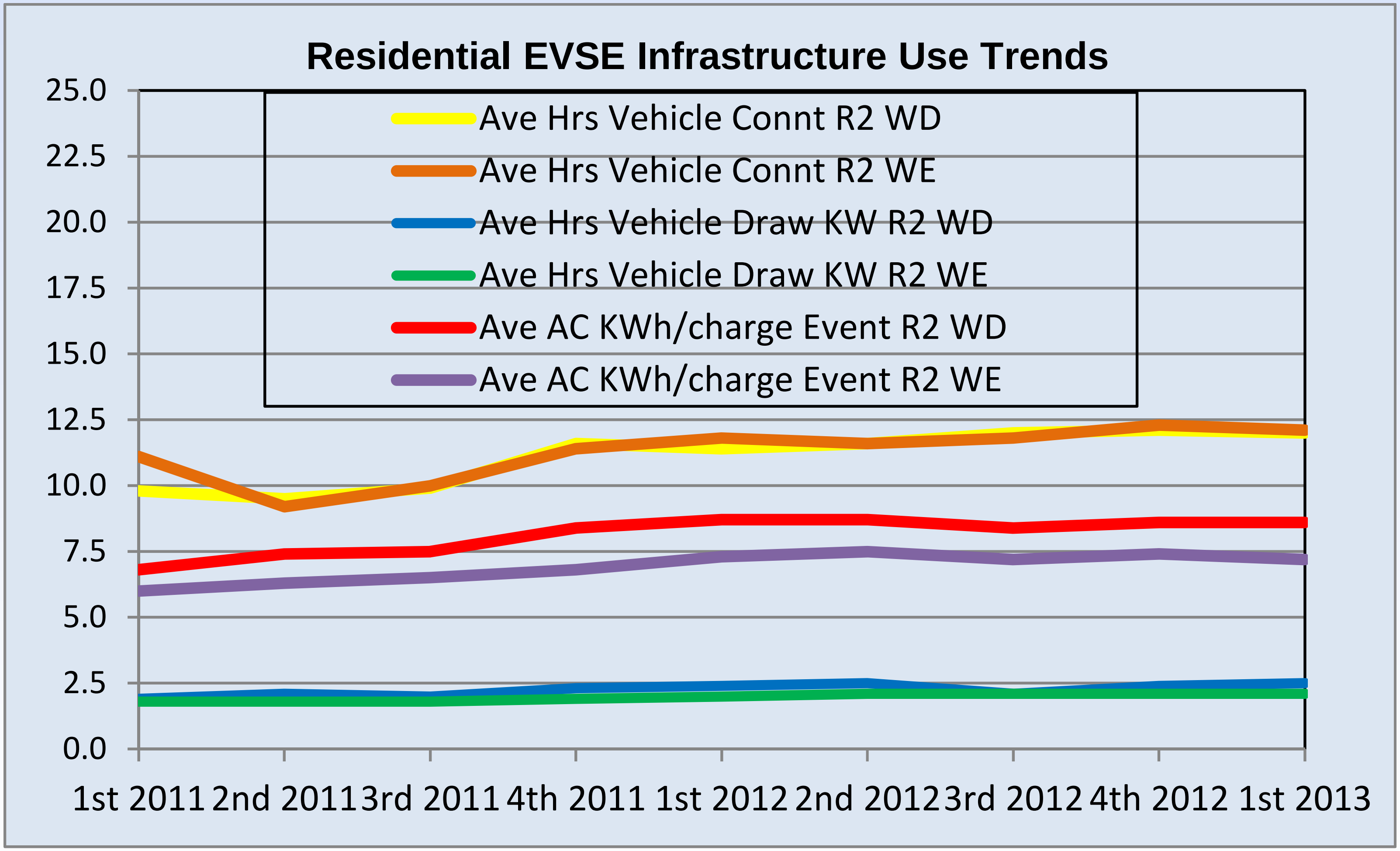


Volts

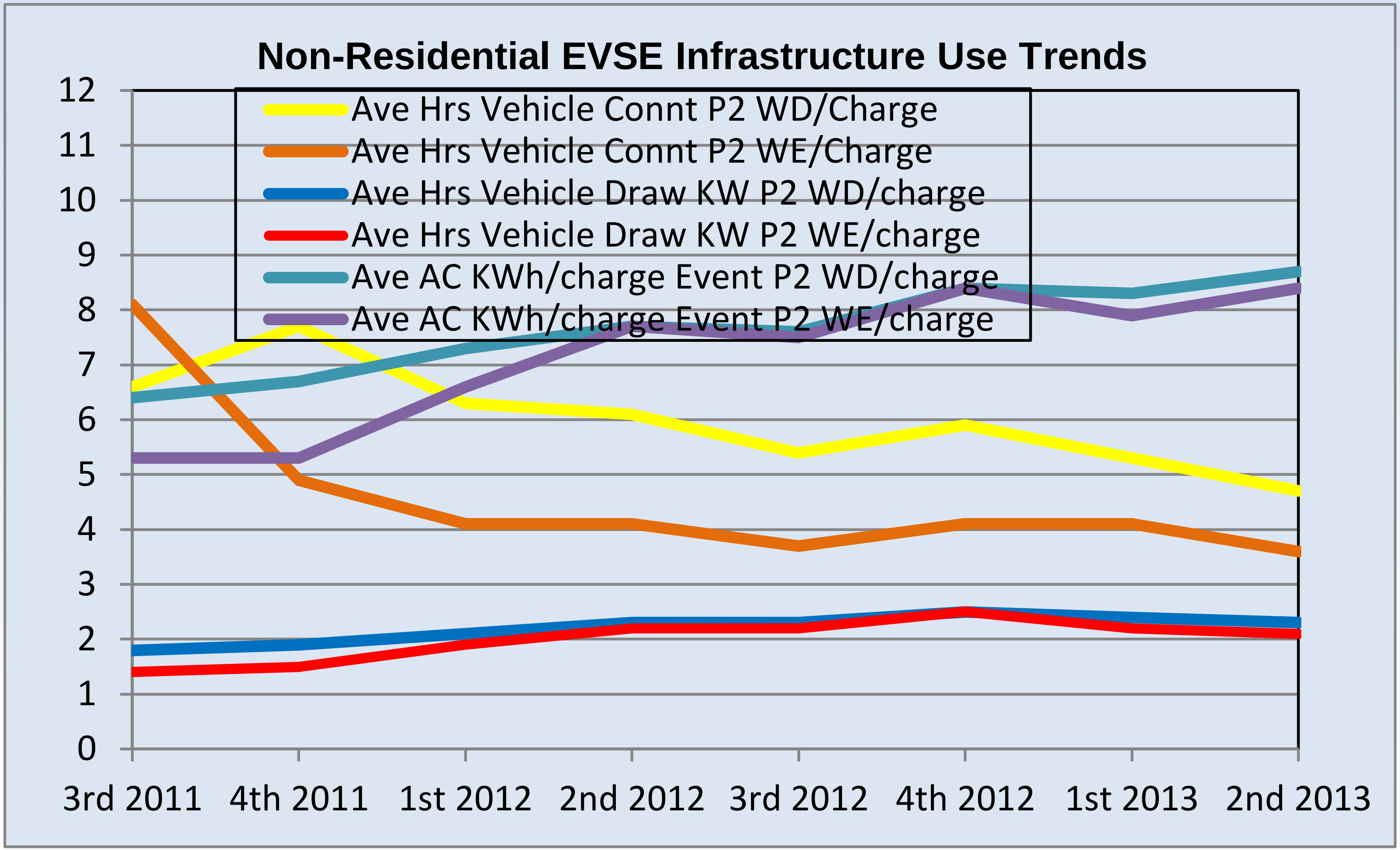




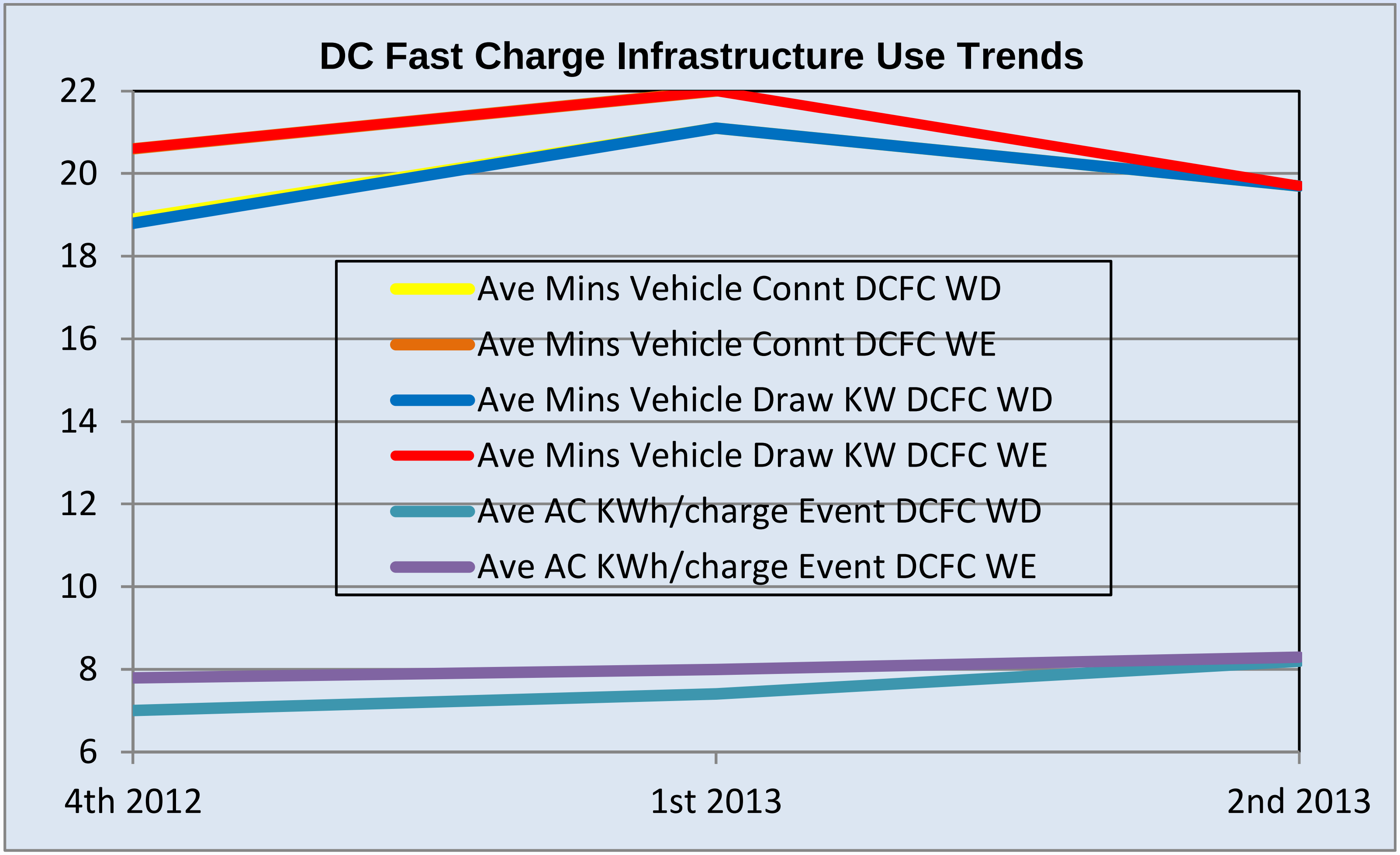
EV Project – Residential EVSE Use



EV Project – Non Residential L2 EVSE Use

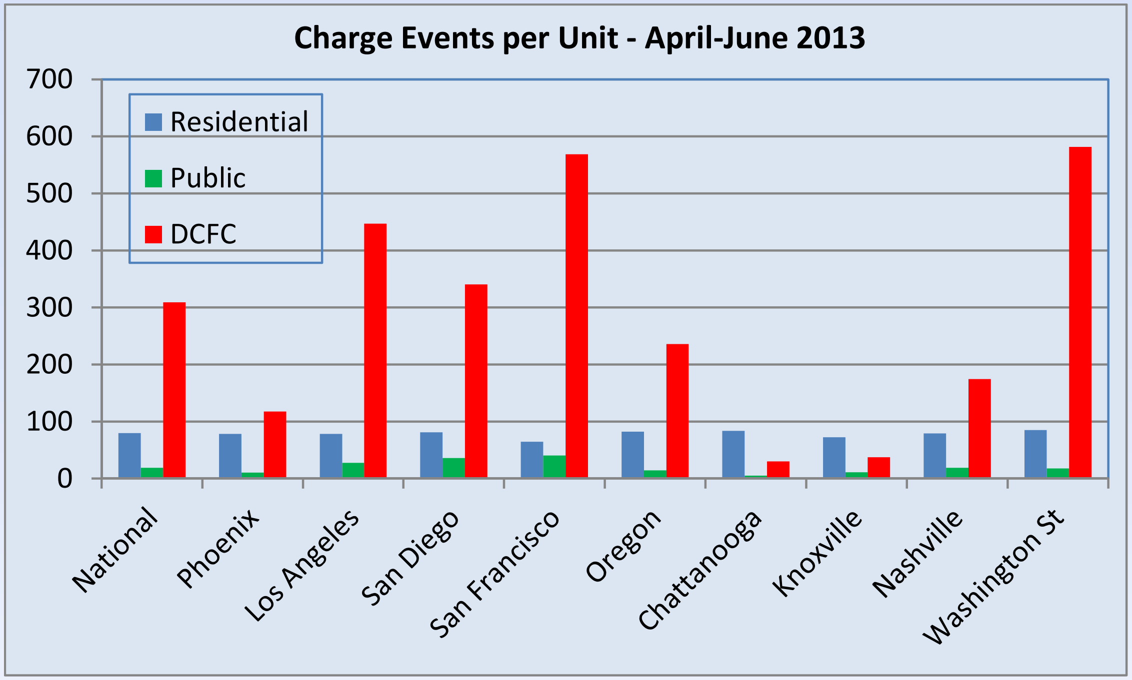


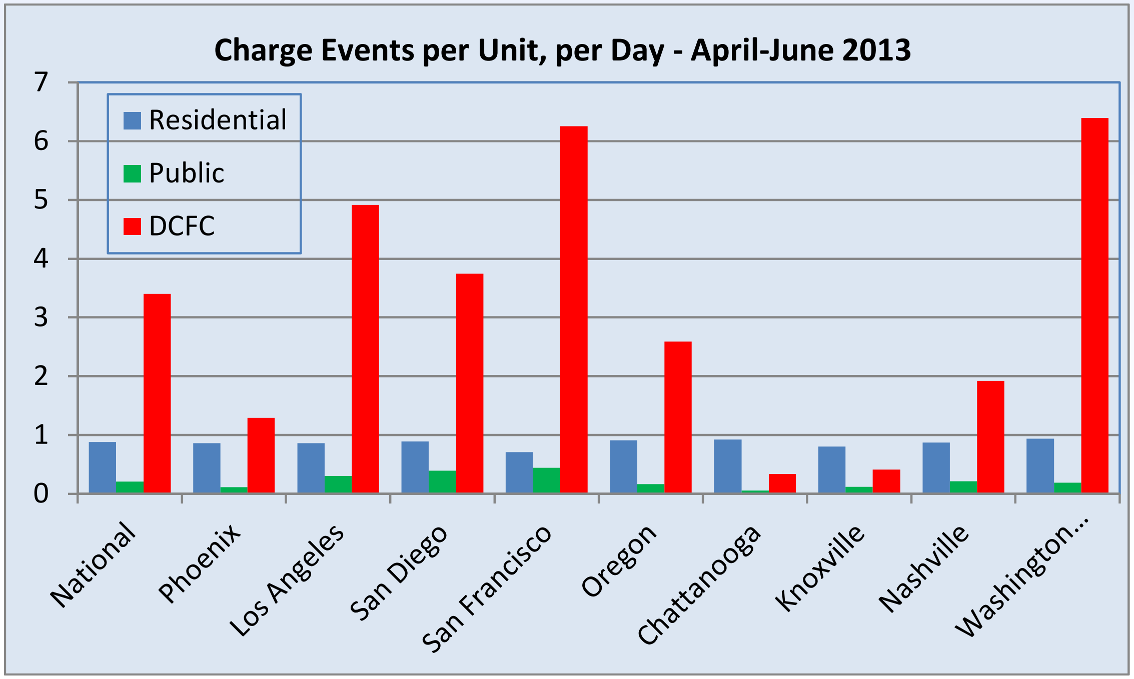
EV Project – DCFC Use



EV Project – Infrastructure use

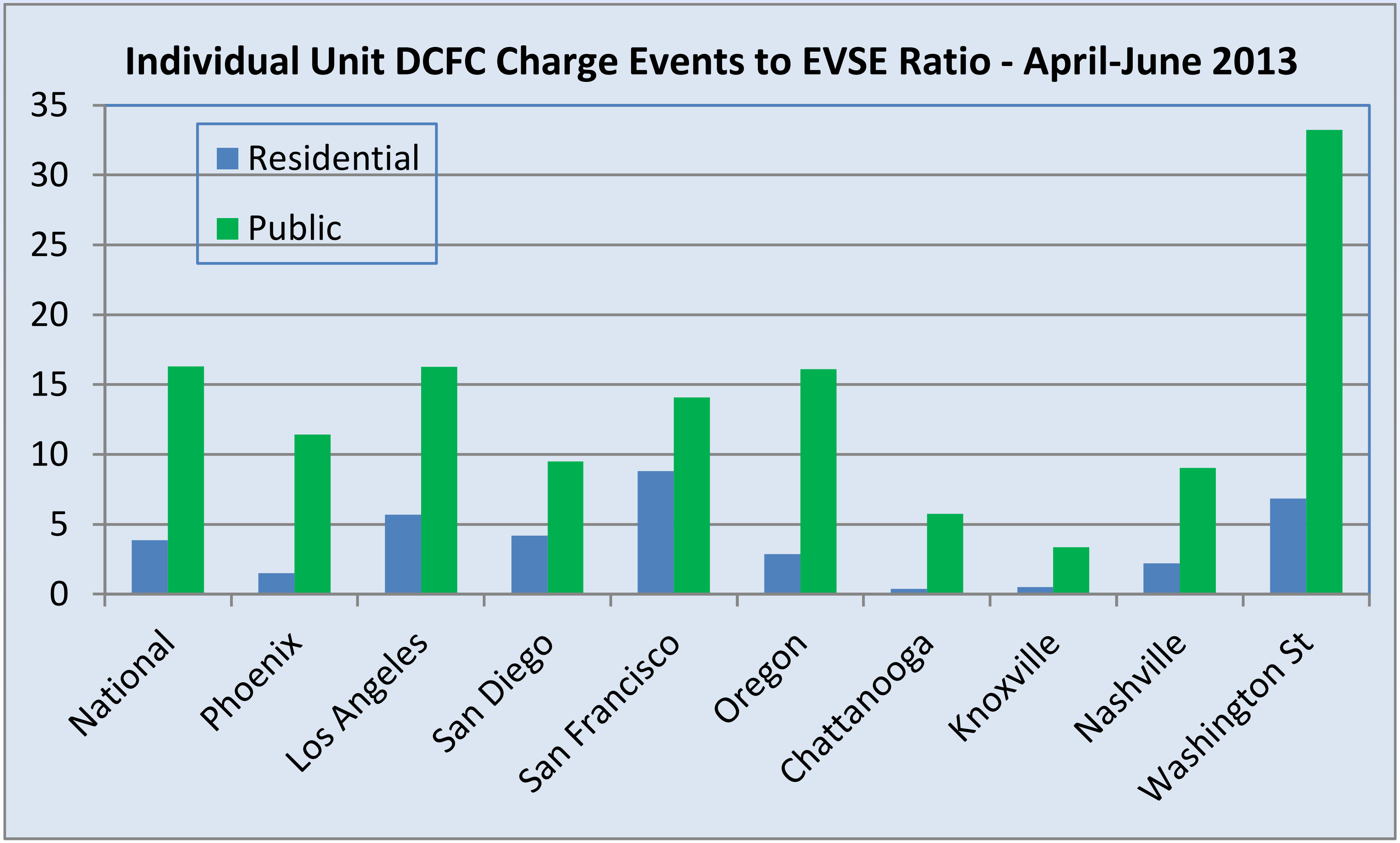
- Per unit use, 2nd quarter 2013 reports





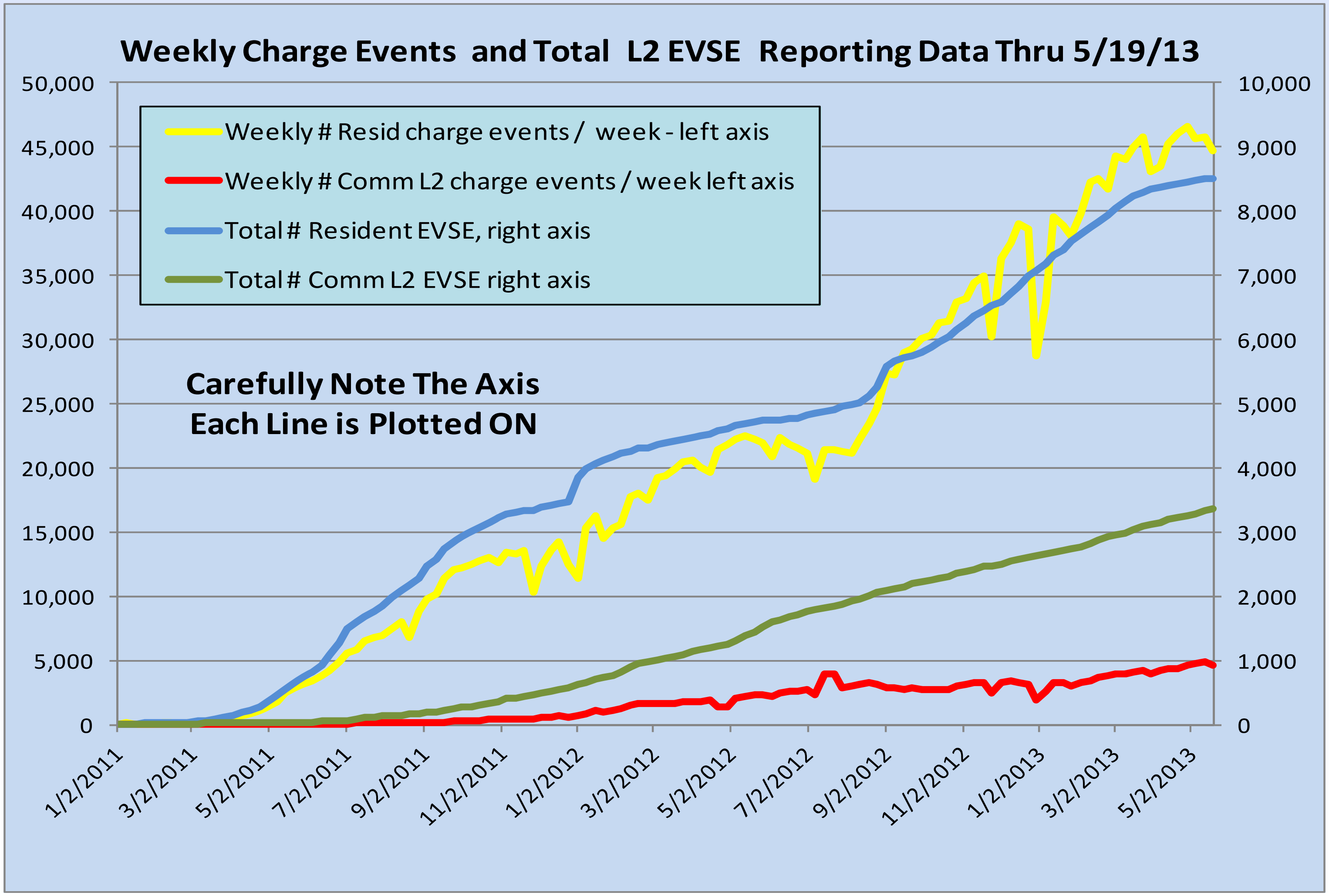
EV Project

- **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

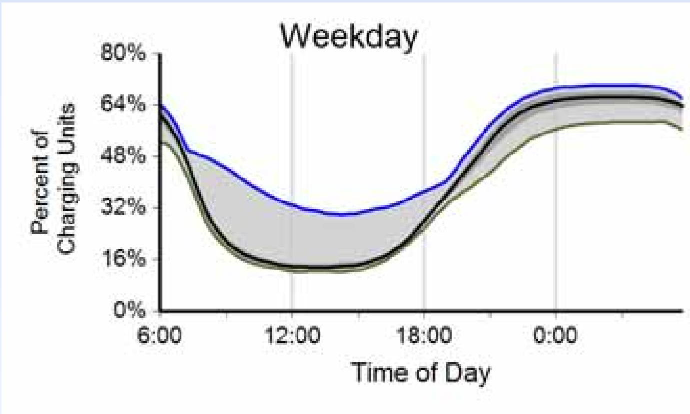
- **Note 5.4 to 1 weekly Residential EVSE use rate versus weekly Public Level 2 EVSE use rate (last 5 weeks)**



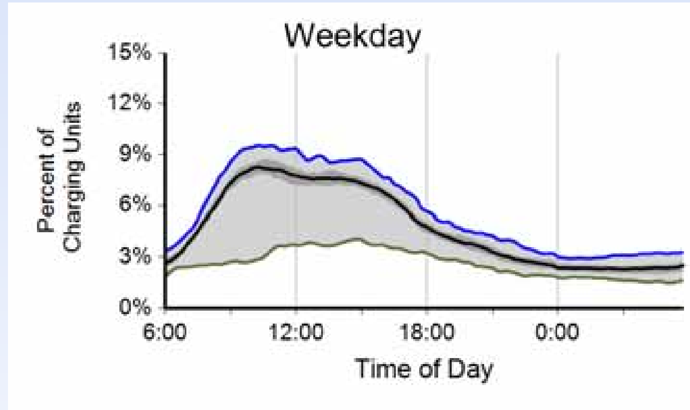
Residential & Public Level 2 EVSE Use

- **Weekday EVSE 2nd Quarter 2013. Residential and public connect time and energy use are fairly opposite profiles.**

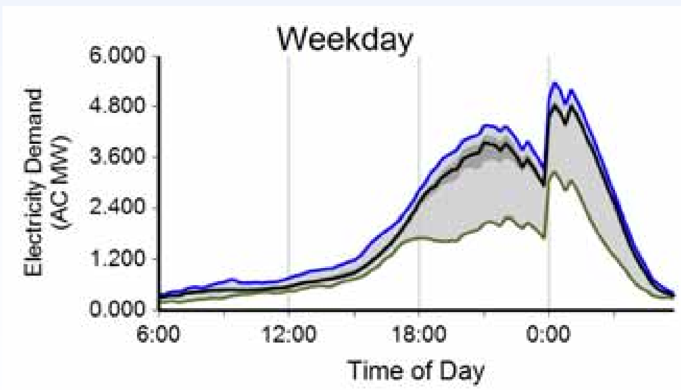
National Residential Connect Time



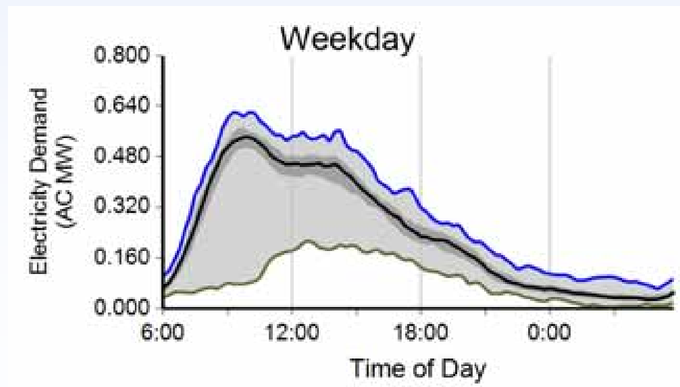
National Public Connect Time



National Residential Demand



National Public Demand

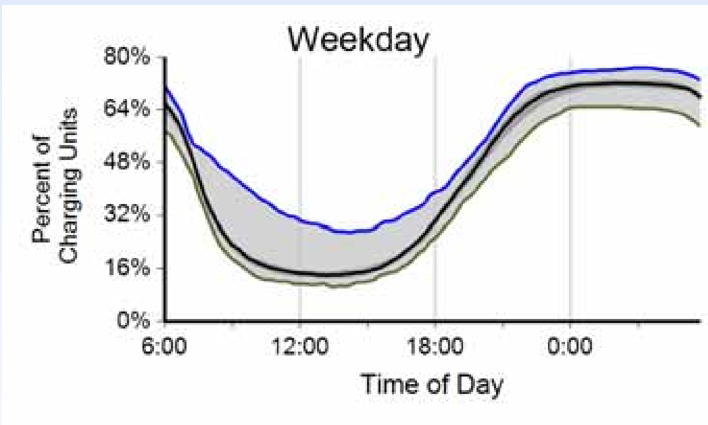


Legend: 91 day reporting period. Data is max (blue line), mean (black line) and minimum (green line), for the reporting period. Dark gray shaded is plus and minus 25% quartile. Same legend all demand and connect time graphs

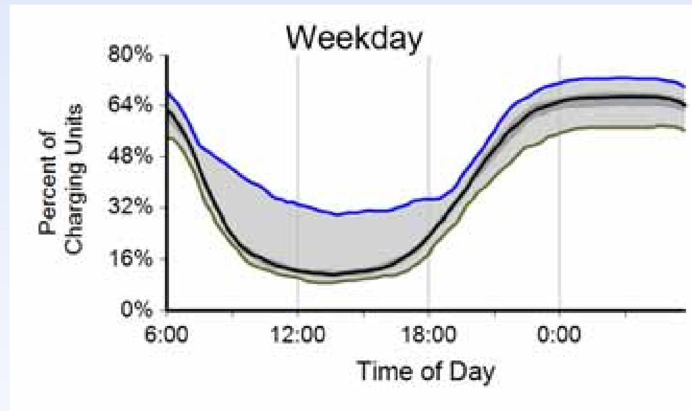
Residential Level 2 EVSE Connect Profiles

- **Weekday EVSE 2nd Quarter 2013**
- **San Diego and San Francisco, with residential L2 TOU rates, are similar to other regional EVSE connect profiles**

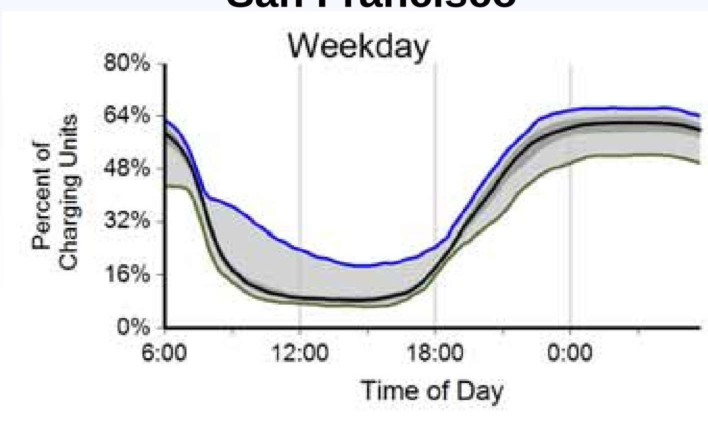
San Diego



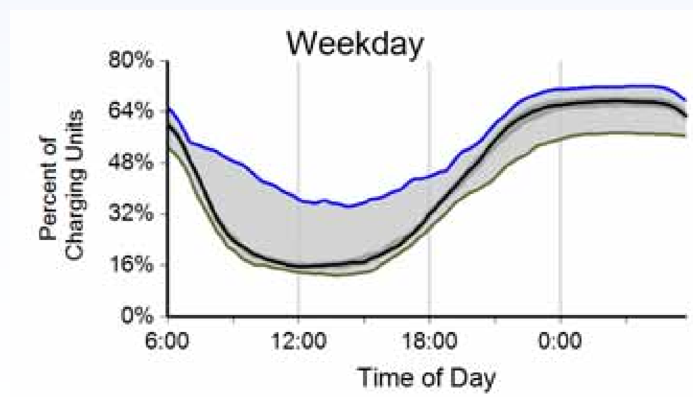
Los Angeles



San Francisco



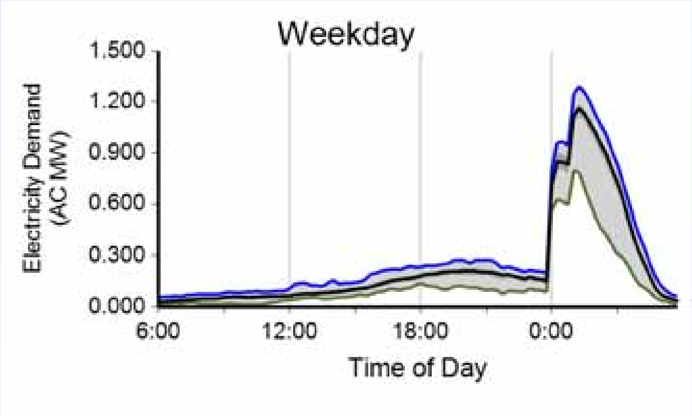
Washington State



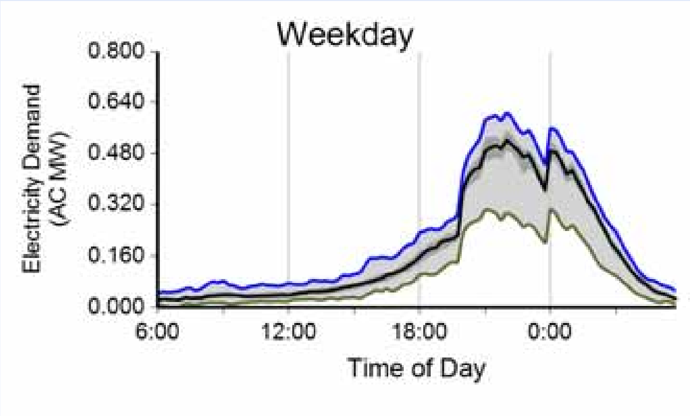
Residential Level 2 EVSE Demand Profiles

- **Residential Level 2 Weekday EVSE 2nd Quarter 2013**
- **TOU kWh rates in San Diego and San Francisco clearly impact when vehicle charging start times are set**

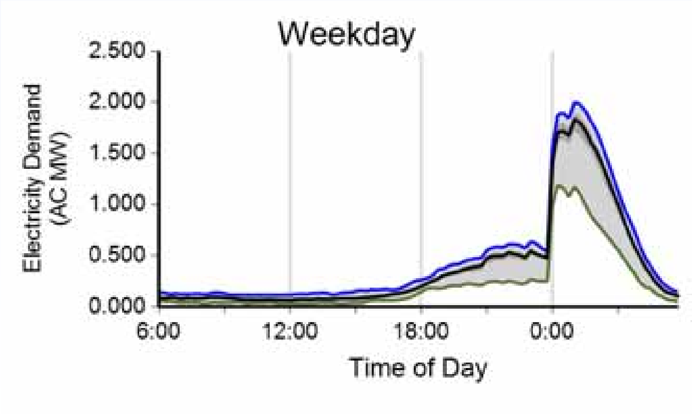
San Diego



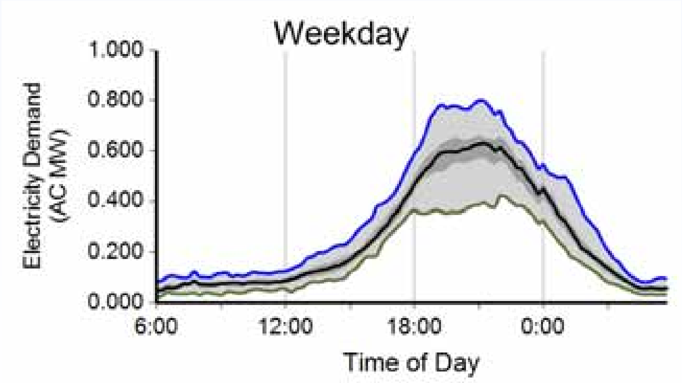
Los Angeles



San Francisco

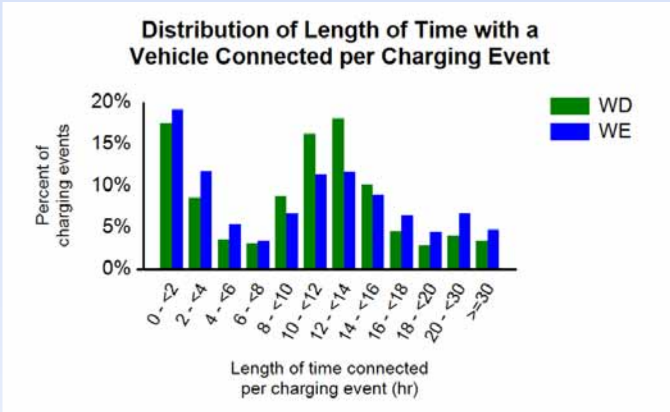


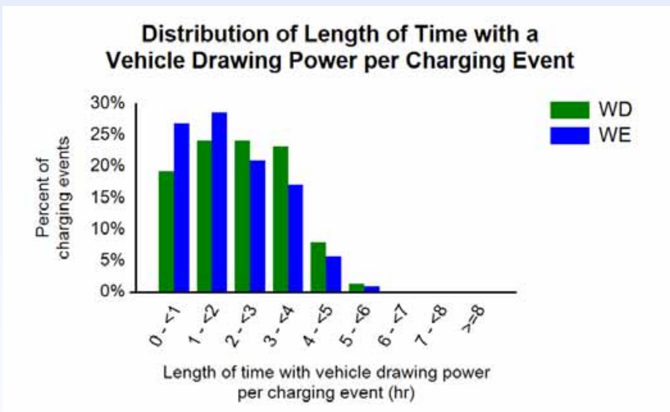
Washington State

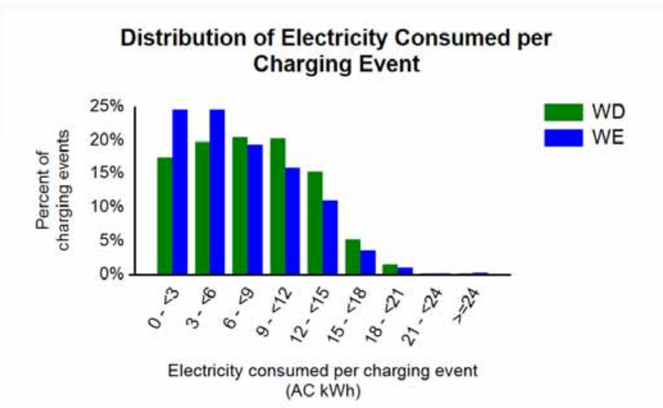


EV Project – EVSE Connect & Power

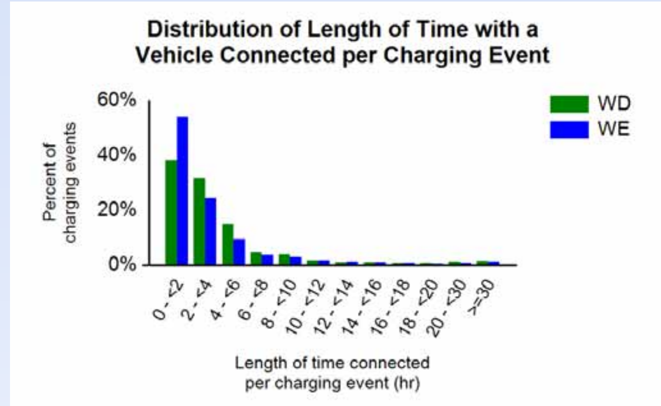
Residential

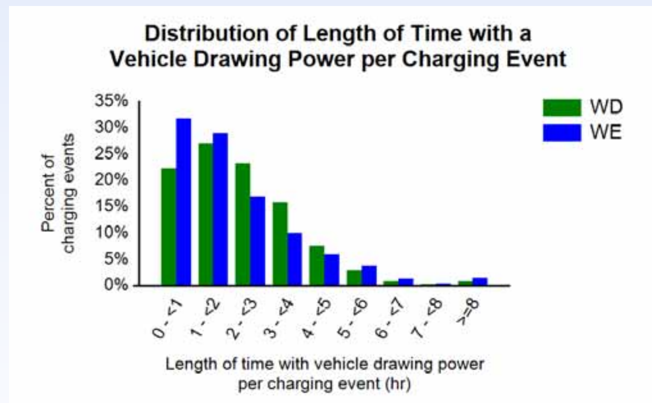


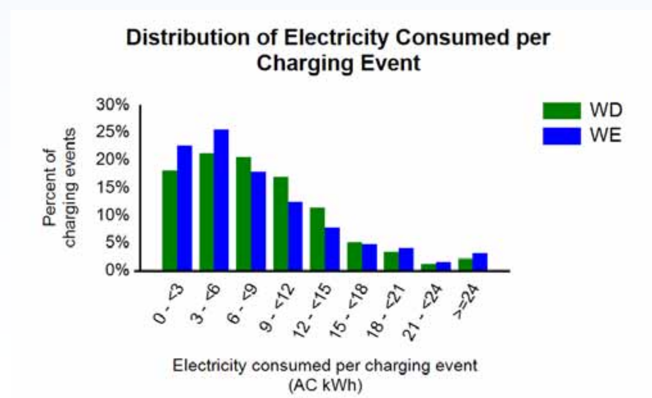




Non Residential Public



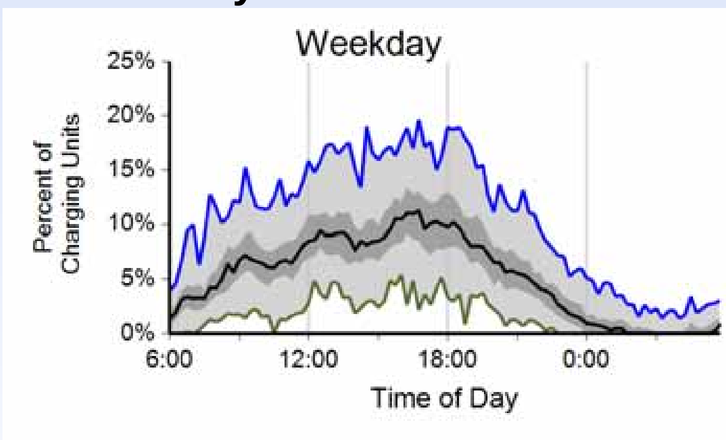




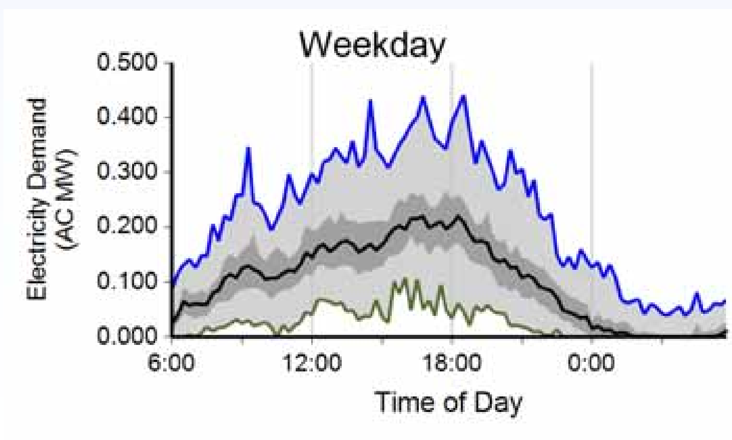
EVSE DCFC Use

- **DC Fast Chargers Weekday 2st Quarter 2013**
- **87 DCFC, 27,000 charge events and 223 AC MWh**

Weekday Connected Profile



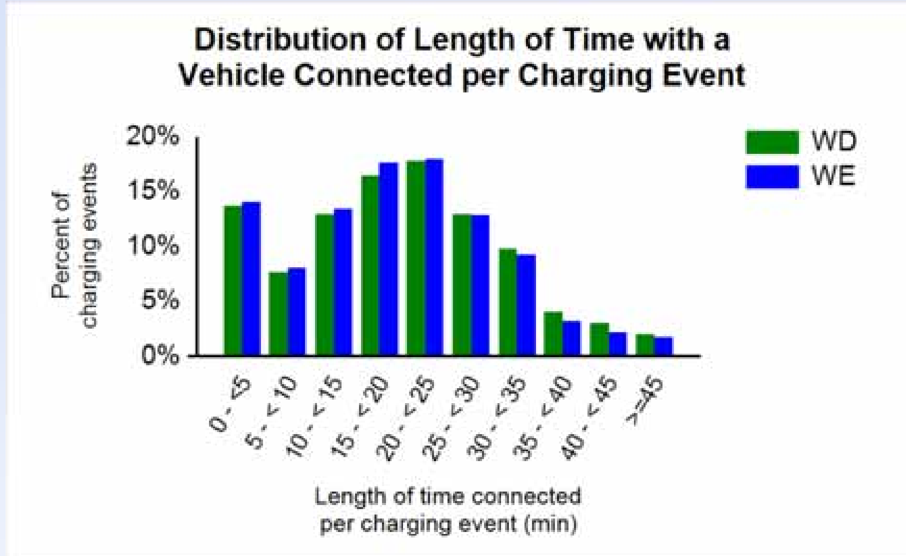
Weekday Demand Profile

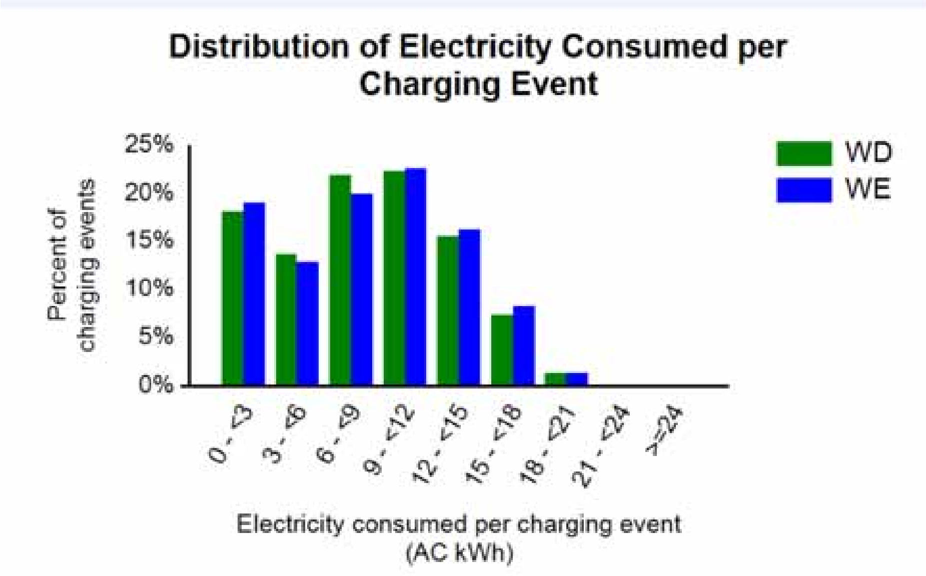


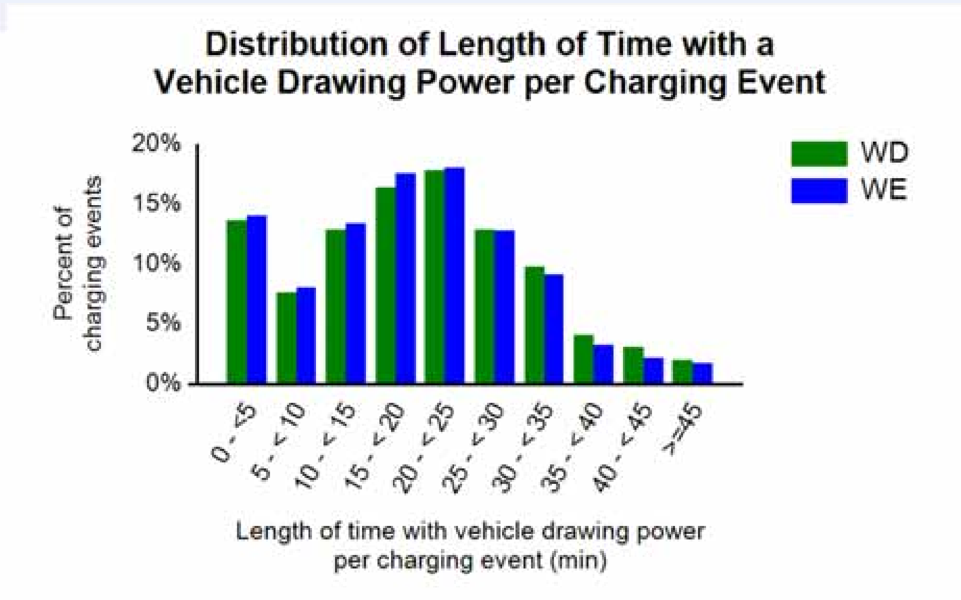
- **EV Project Leafs 25% charge events and 24% energy used**
- **Unknowns are Non EV Project vehicles**
- **3.8 average charge events per day per DCFC**
- **19.5 minutes average time connected**
- **19.5 minutes average time drawing energy**
- **8.3 kWh average energy consumed per charge**

EV Project – DCFC Profiles

- **DC Fast Chargers Weekday & Weekend**
- **2st Quarter 2013**
- **87 DCFC, 27,000 charge events and 223 AC MWh**







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**

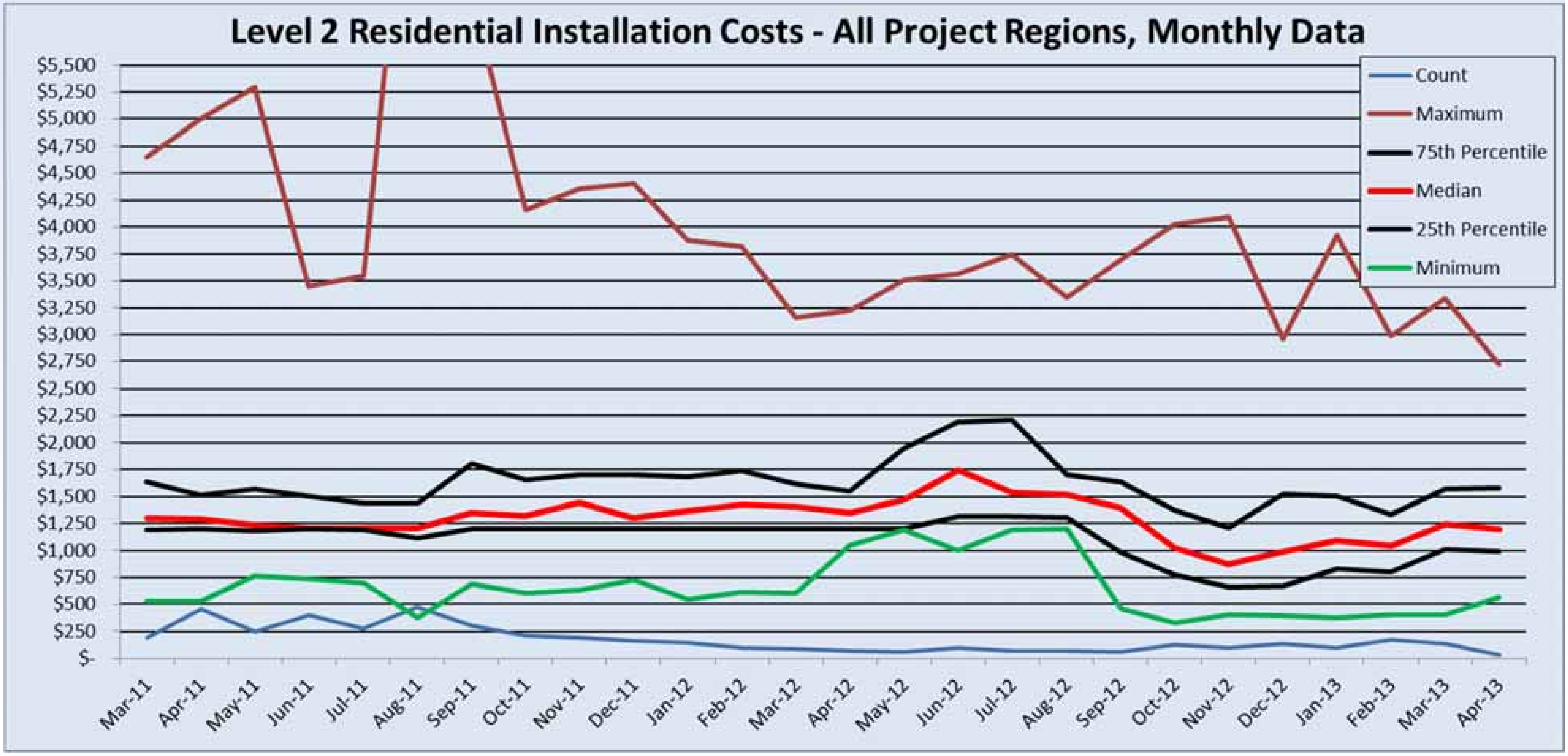
Region	Count of Permits	Average Permit Fee	Minimum Permit Fee	Maximum Permit Fee
Arizona	72	$228	$35	$542
Los Angeles	17	$195	$67	$650
San Diego	17	$361	$44	$821
Texas	47	$150	$37	$775
Tennessee	159	$71	$19	$216
Oregon	102	$112	$14	$291
Washington	33	$189	$57	$590

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 sitting 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



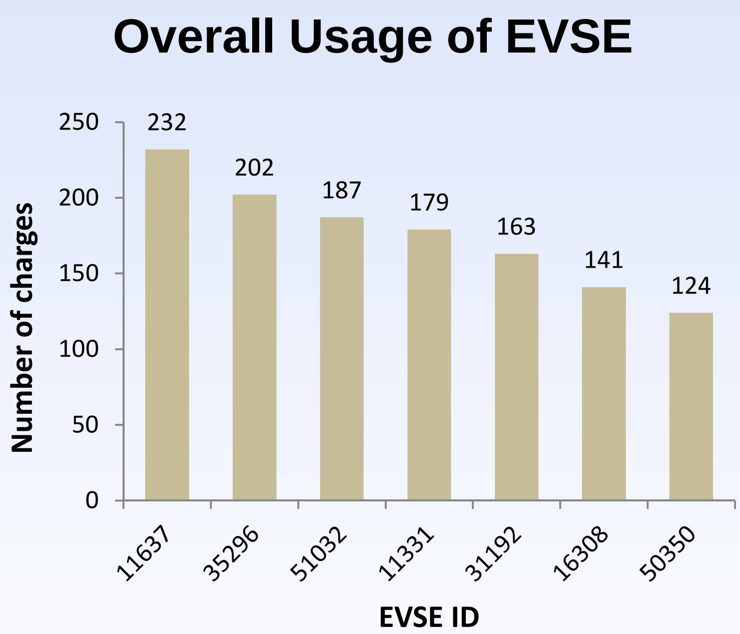
Residential Level 2 EVSE Installation Costs

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

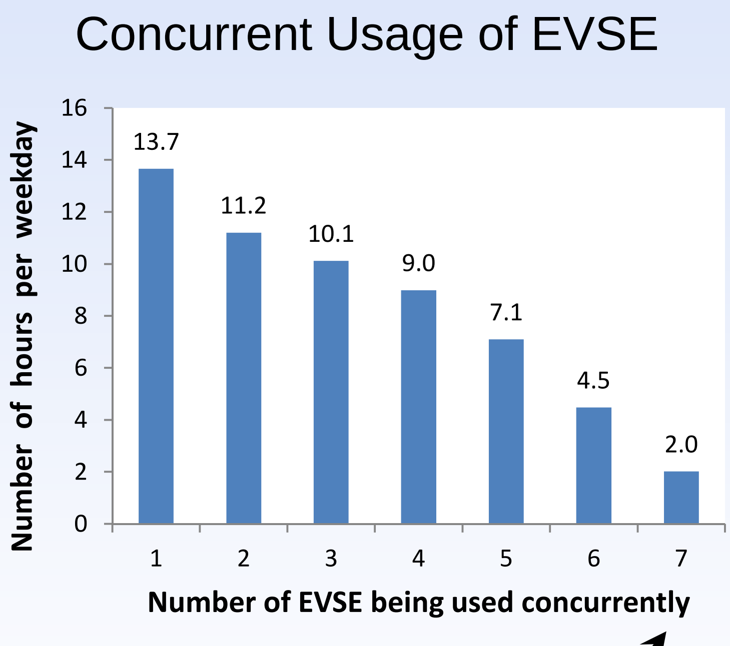
Residential Level 2 Installation Costs

- **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**

EVSE utilization at "Worksite A" in Q2 2013

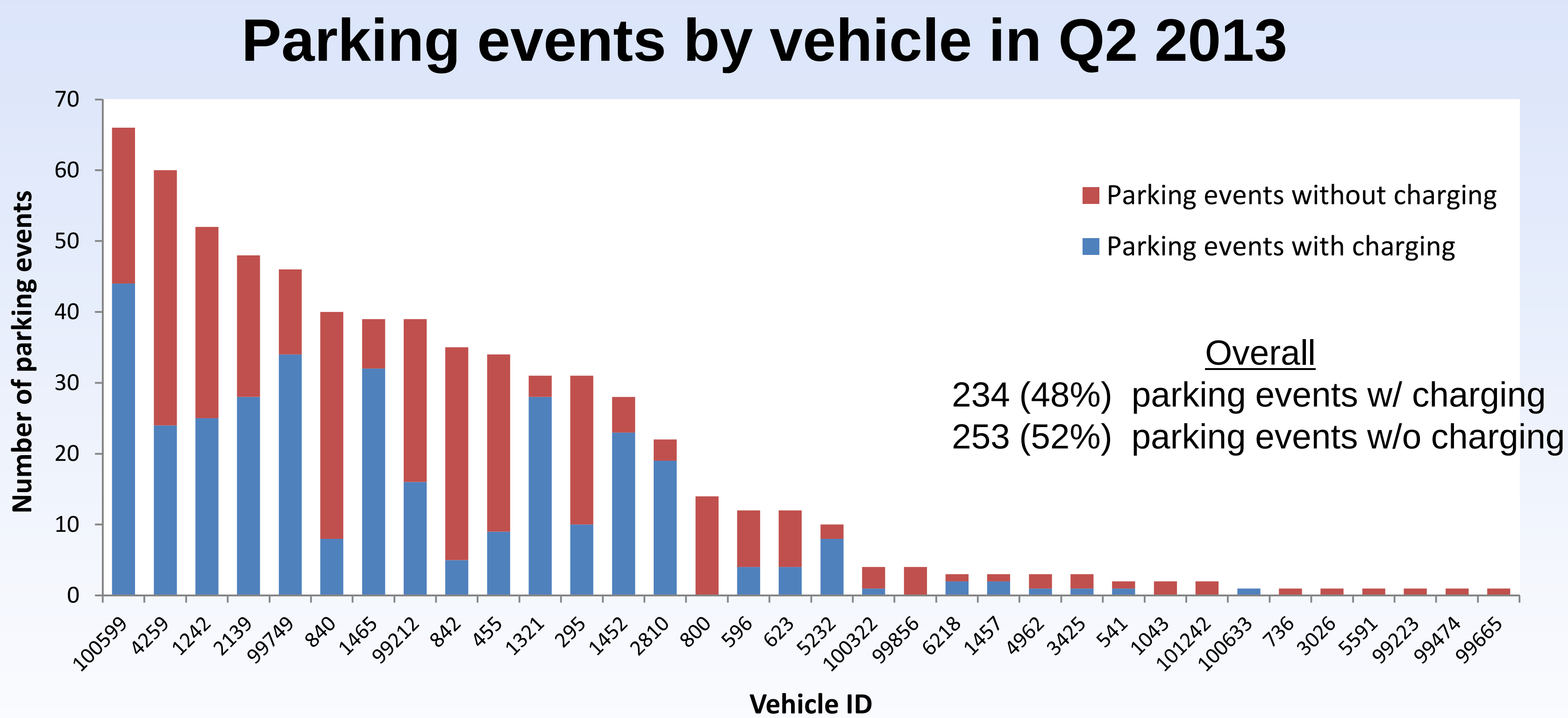


Each EVSE had significant usage in the quarter



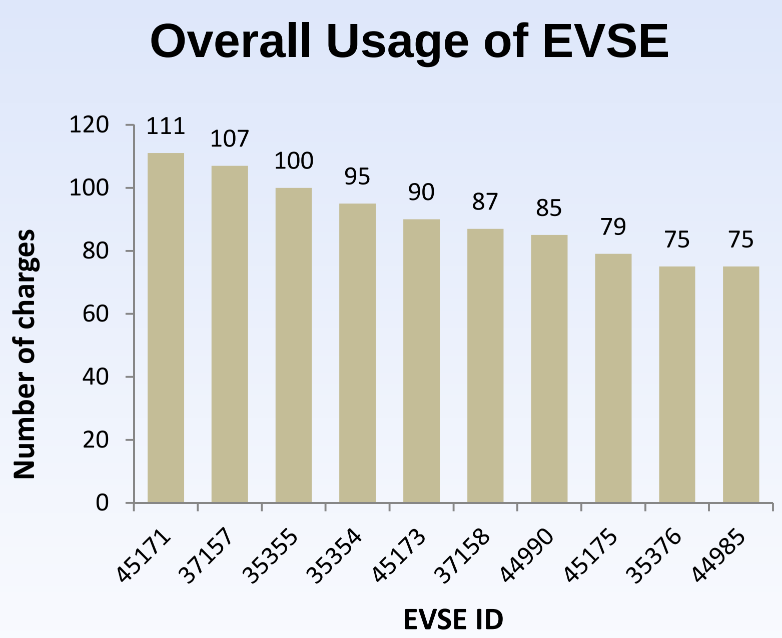
All 7 EVSE simultaneously connected to a vehicle for 2 hrs per weekday, on average

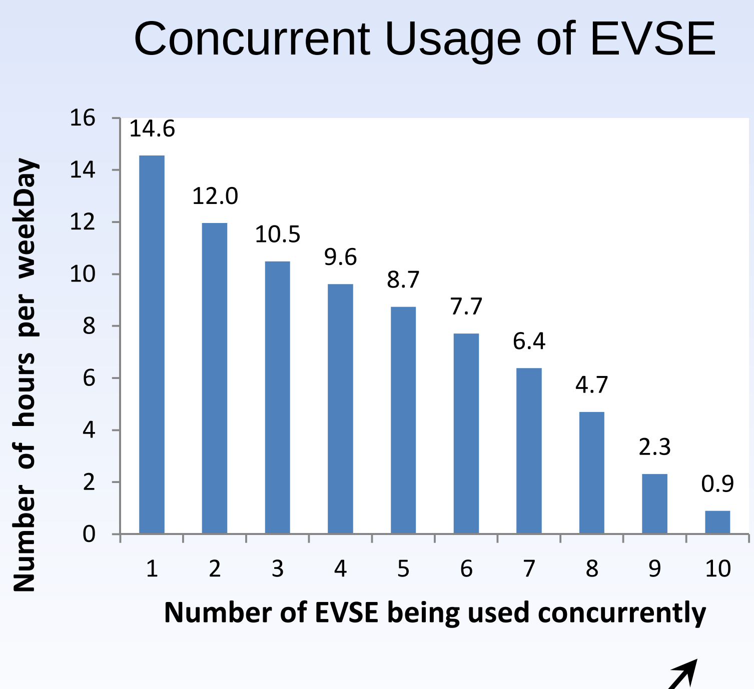
EV Project vehicles at "Worksite A"



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

Level 2 EVSE utilization at “Worksite B”

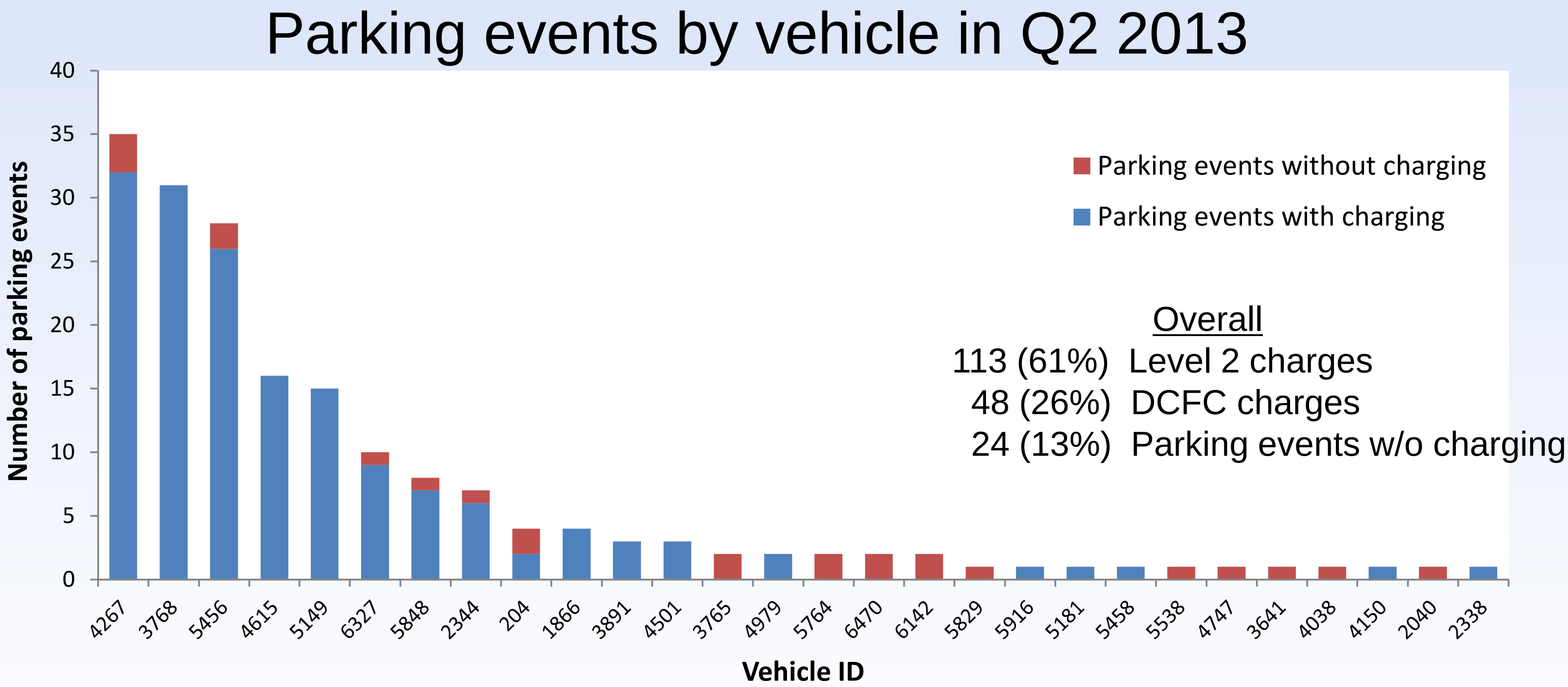




Each EVSE had significant usage in the quarter

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

EV Project vehicles at "Worksite B"

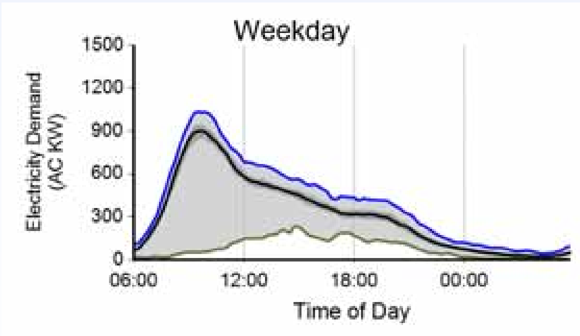


- Many vehicles parked only a few times – visitors?
- Frequent-parking PEVs charged *nearly every time* they parked
- Non-employee vehicles may be using DCFC as public charger

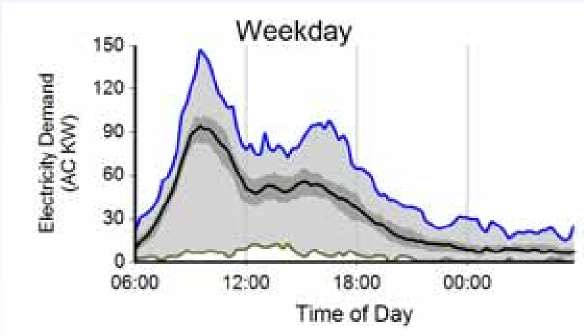
ChargePoint Infrastructure Reporting

- **4,200 ChargePoint EVSE demonstration**
  - **Demonstrates residential, private commercial and public grid use**
  - **Supports what kind of and where grid infrastructure should be placed**
  - **Document regional grid-use variations**

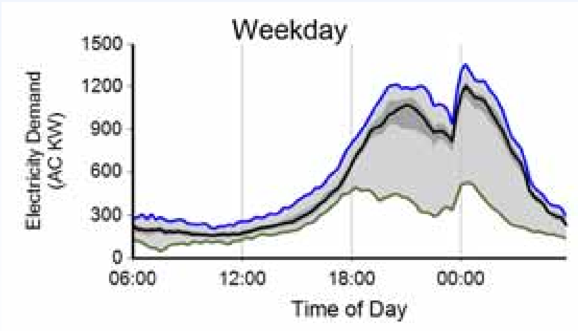
Public Demand



Commercial Demand

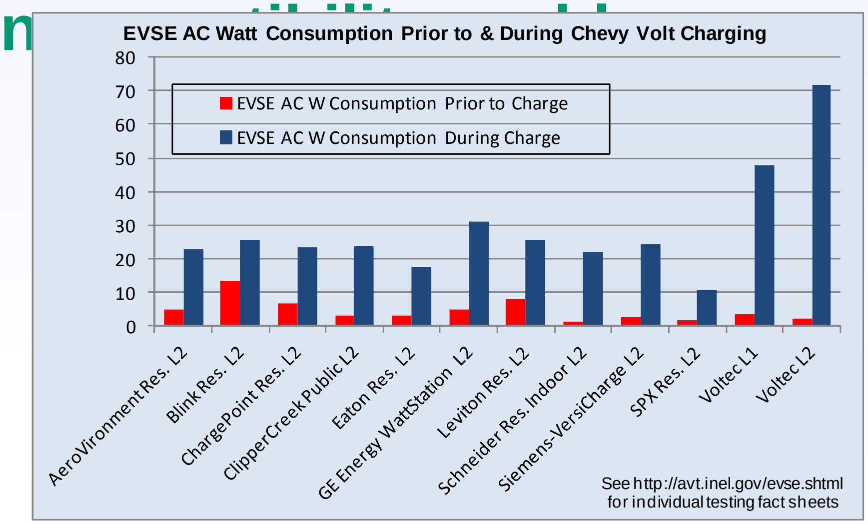


Residential Demand



Conductive EVSE & DCFC Testing

- **Tested and reported 13 Levels 1 & 2 EVSE, and DC Fast Chargers (DCFC), with additional units in the test queue**
- **Developing with SAE multi EVSE, DCFC and PEV compatibility testing regime**
  - **Benchmarks grid-to-vehicle and grid-to-battery efficiencies, standby power requirements, power quality feedbacks**
  - **Reduces SAE J1772 in**



Wireless Charging Testing

- **Testing two lab and vehicle based Wireless Charging systems with additional NDA's being signed**
- **Developing with SAE wireless charging testing procedures**
  - **Benchmark grid-to-vehicle and grid-to-vehicle wireless efficiencies, standby power requirements, power quality, FCC compliance, and safety**
  - **Supports SAE's development testing procedures**
  - **Independent assessments of alternative charging technology**

Acknowledgement

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