Idaho National Laboratory

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

GITT 2013 (6/19/13) - EV Project and Charging Infrastructure Update

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USCAR, Southfield, Michigan
June 19, 2013

This presentation does not contain any proprietary or sensitive information

Presentation Outline

- INL and Vehicle Technology Experience and General Data Collection Methods
- EV Project results to date (majority of presentation)
  - Vehicle and Level 2 use
  - DCFC use (DC Fast Charger)
  - Some infrastructure lessons learned, including costs
- ChargePoint results to date
- Conductive Charging Infrastructure Testing
- Wireless Charging Infrastructure Testing
- Other Testing Activities and Where you can find this presentation

Vehicle and Charging Technology Experience and General Data Collection Methods

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

AVTA Participants

- The Advanced Vehicle Testing Activity (AVTA) is the U.S. Department of Energy, Vehicle Technologies Office (VTO) singular field, tract, and laboratory based source for testing light-duty whole vehicle systems and subsystems
  - Idaho National Laboratory manages the AVTA for VTP
  - ECOtality provides testing support via a competitively bid NETL (National Energy Testing Laboratory) contract
- For the EV Project, ECOtality is the project lead and INL provides data collection, analysis and dissemination support
- Test partners include electric utilities, Federal, state and local government agencies, private companies, and individual vehicle owners

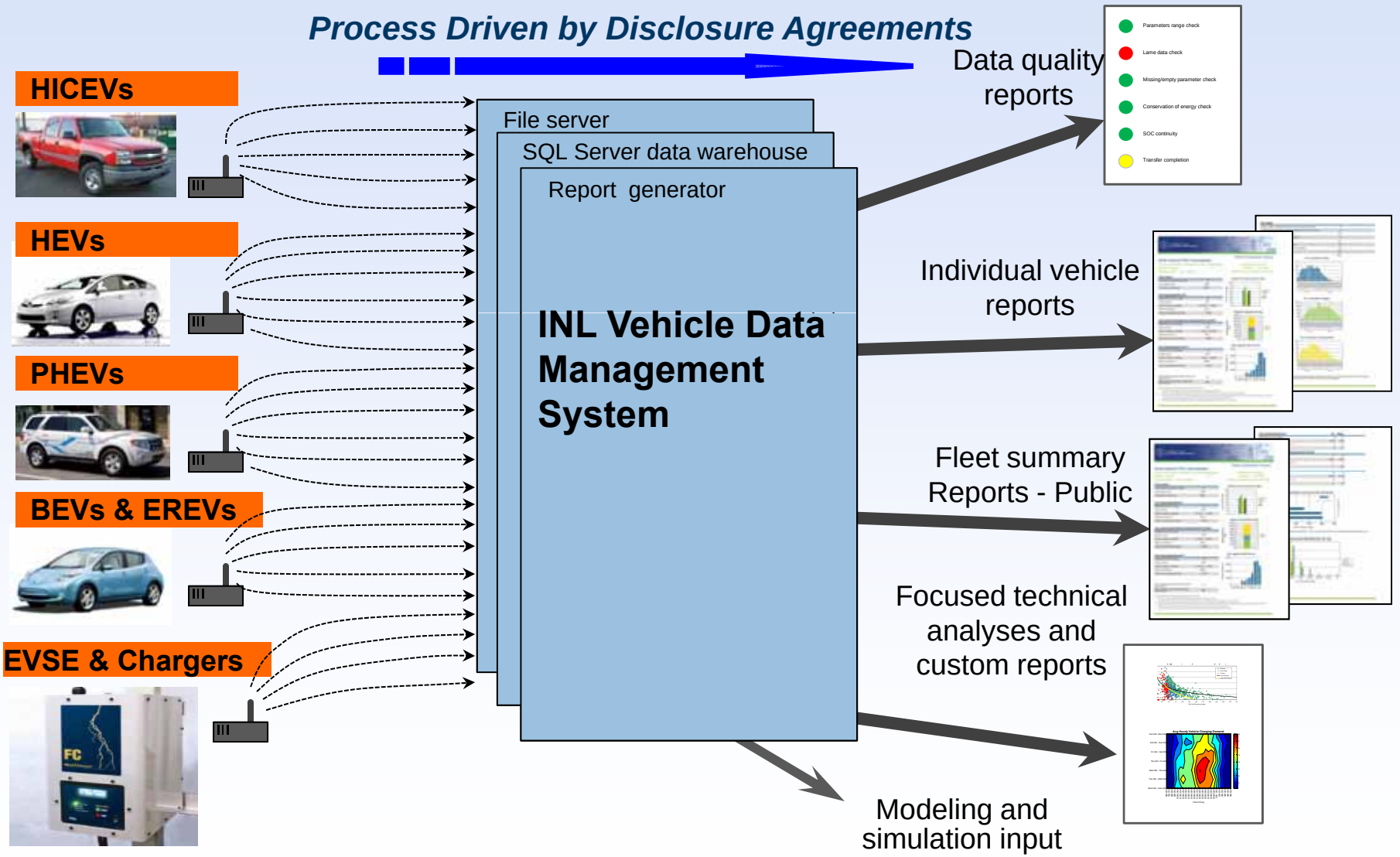
AVTA Goals

- The AVTA goals
  - Petroleum reduction and energy security
  - Benchmark technologies that are developed via DOE research investments
- Provide benchmark data to DOE, National Laboratories (ANL, NREL, ORNL, PNNL), Federal Agencies (DOD, DOI, DOT, EPA, USPS), technology modelers, R&D programs, vehicle manufacturers (via USCAR's VSATT, EESTT, GITT), and target and goal setters
- Assist fleet managers, via Clean Cities, FEMP and industry gatherings, in making informed vehicle and infrastructure deployment and operating decisions

Vehicle / Infrastructure Testing Experience

- **103.5 million test miles accumulated on 11,500 electric drive vehicles and 16,000+ EVSE and DCFC**
- **EV Project: 7,991 Leafs, Volts and Smart EVs, 11,959 EVSE and DC Fast Chargers (DCFC), 84 million test miles**
- **Charge Point: 4,217 EVSE reporting 997,000 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

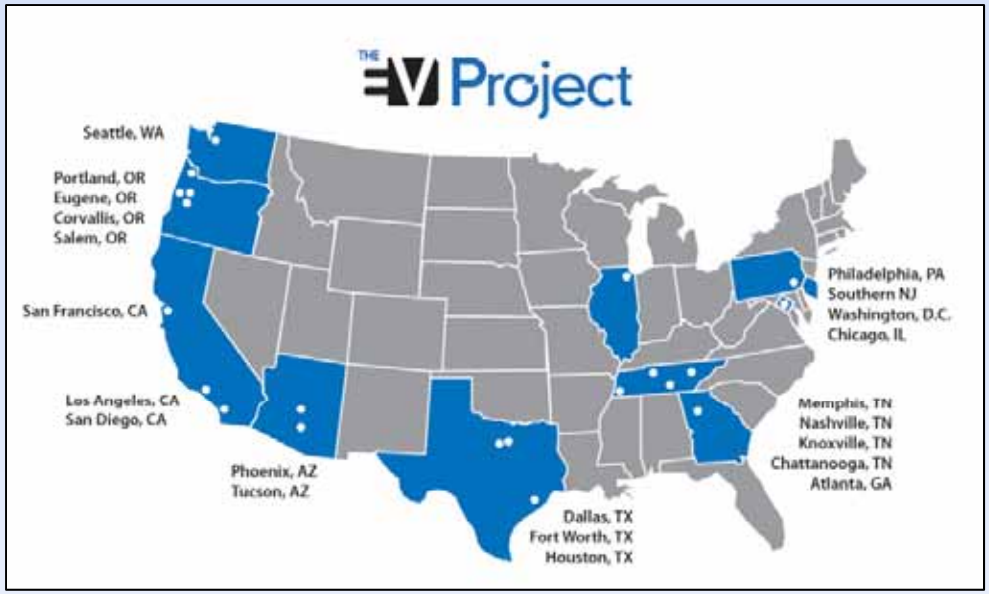


Data Collection, Security and Protection

- 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 results to date – Vehicle and Level 2 use

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
- 40 different EV Project reports are generated quarterly for the general public, DOE, ECOtality, project participants, industry, regulatory organizations, as well as per special requests

EV Project – 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.)

EV Project – 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

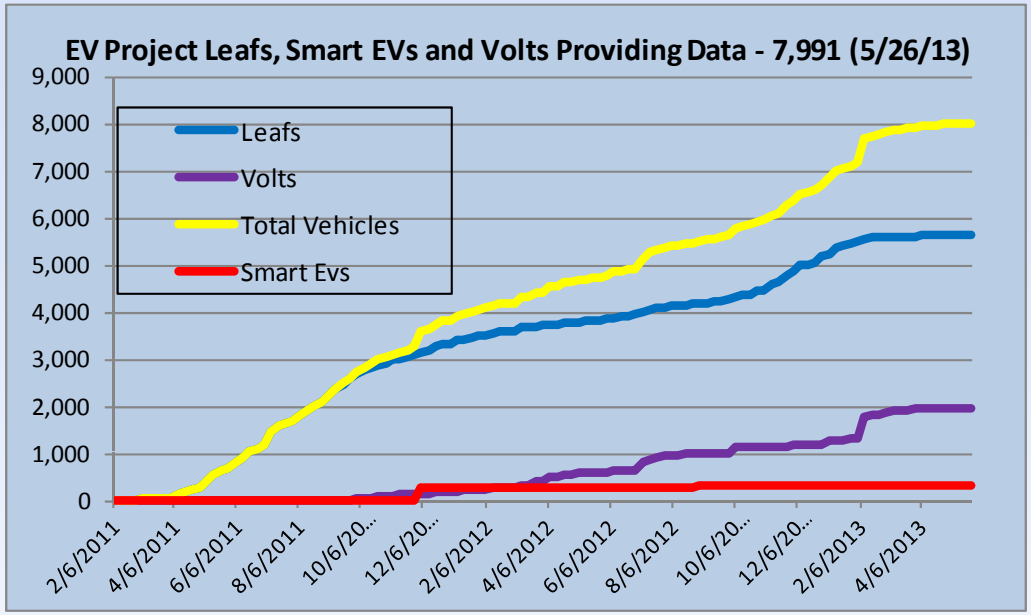
- Additional data is received monthly from Car2go for the Smart EVs

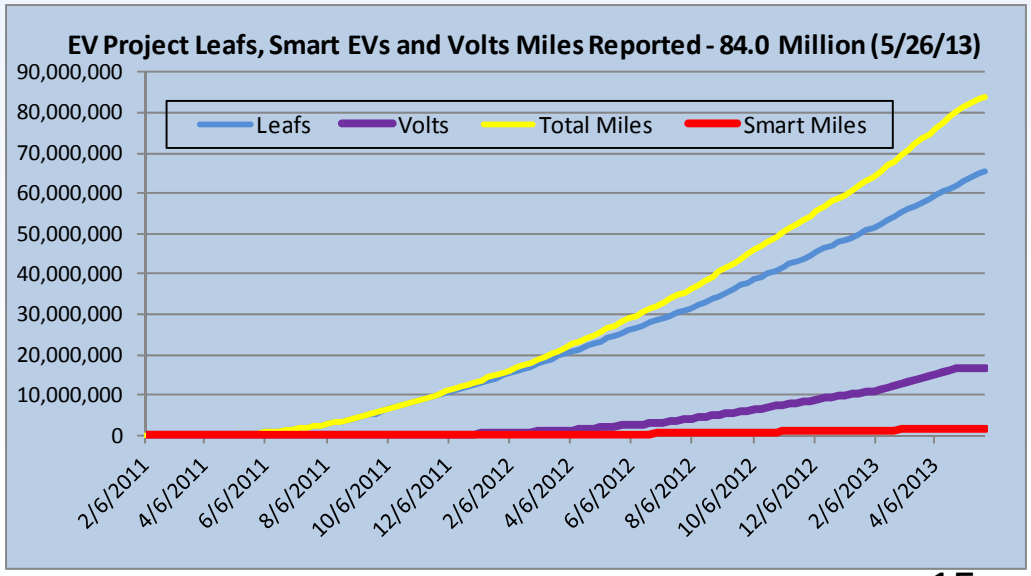
EV Project Data Complexity

- The EV Project has 44 Databases (DB)
  - Nissan Leaf & GM/OnStar Volt
  - ECOtality Blink, Aerovironment & EPRI EVSE
  - Admin (look up tables, territories, zips codes, QA parameters, etc.)
    - Each of the above six DBs has three versions (process, stage & production) = 18 DBs
  - Four GIS DBs for the Leafs, Volts, Blink EVSEs, and Base (streets, utility service territory areas, etc.)
  - Above 22 (18 + 4) DBs exist on two systems = 44 DBs
- Hundreds of algorithms and thousands of lines of code are required to generate 56,000 data parameters for populating 120 pages of public quarterly reports
- INL must blend multiple data streams, from multiple sources, all on different delivery schedules
- This is not a flat file, spreadsheet experience and this is NOT a simple task

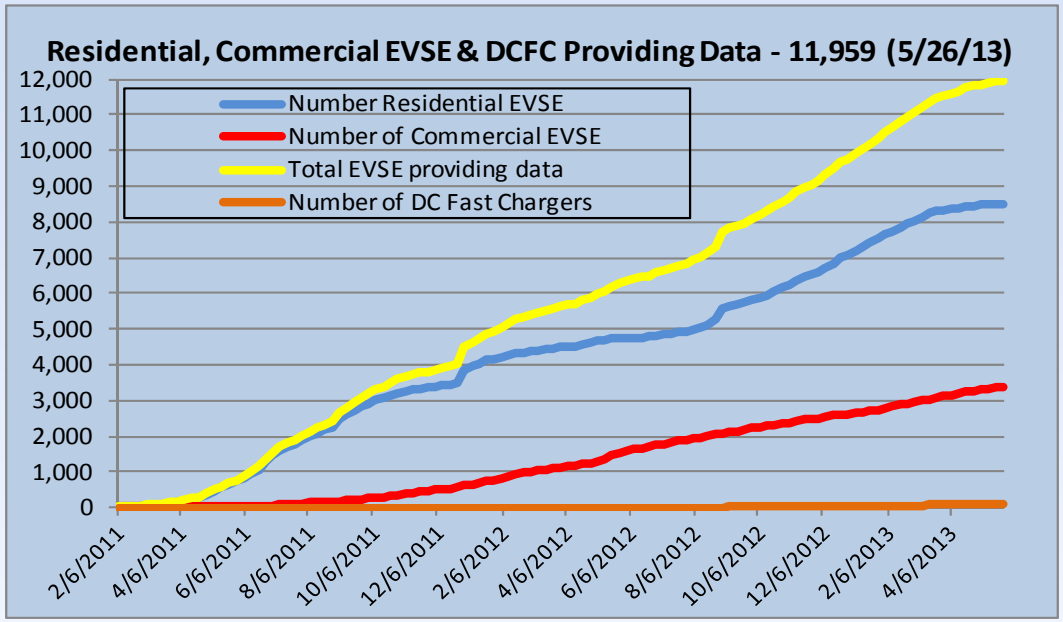
EV Project Vehicles / Miles, 5/26/13

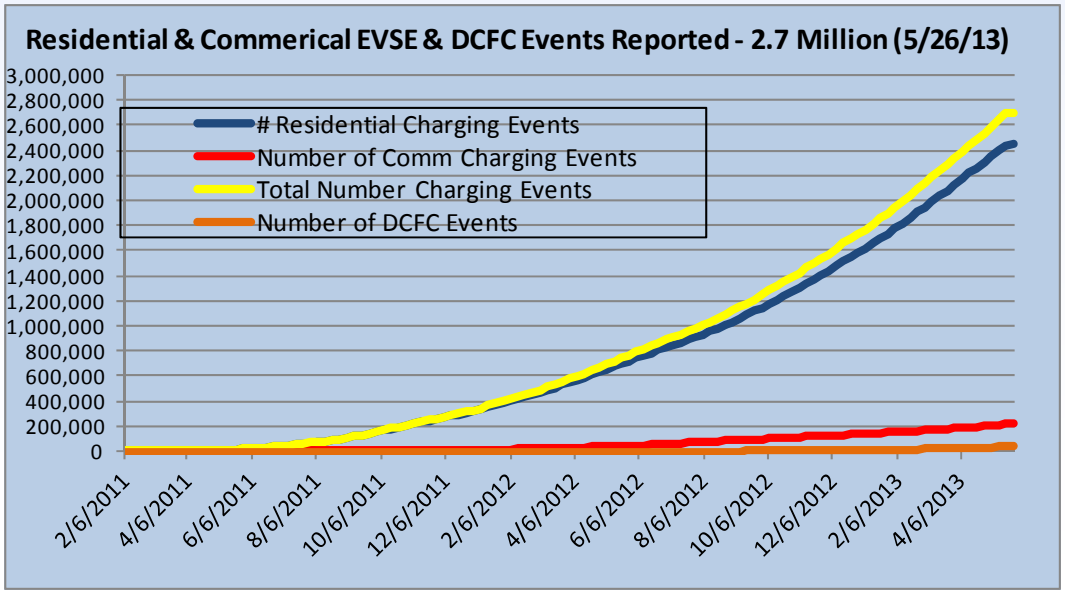
- 7,991 vehicles reporting data
  - 5,646 Leafs. 71%
  - 1,992 Volts. 25%
  - 353 Smart EVs. 4%
- 84.0 million total miles
  - Leafs 78%
  - Volts 20%
  - Smart EVs 2%
- 197,000 test miles per day = 1 million miles every 6 days





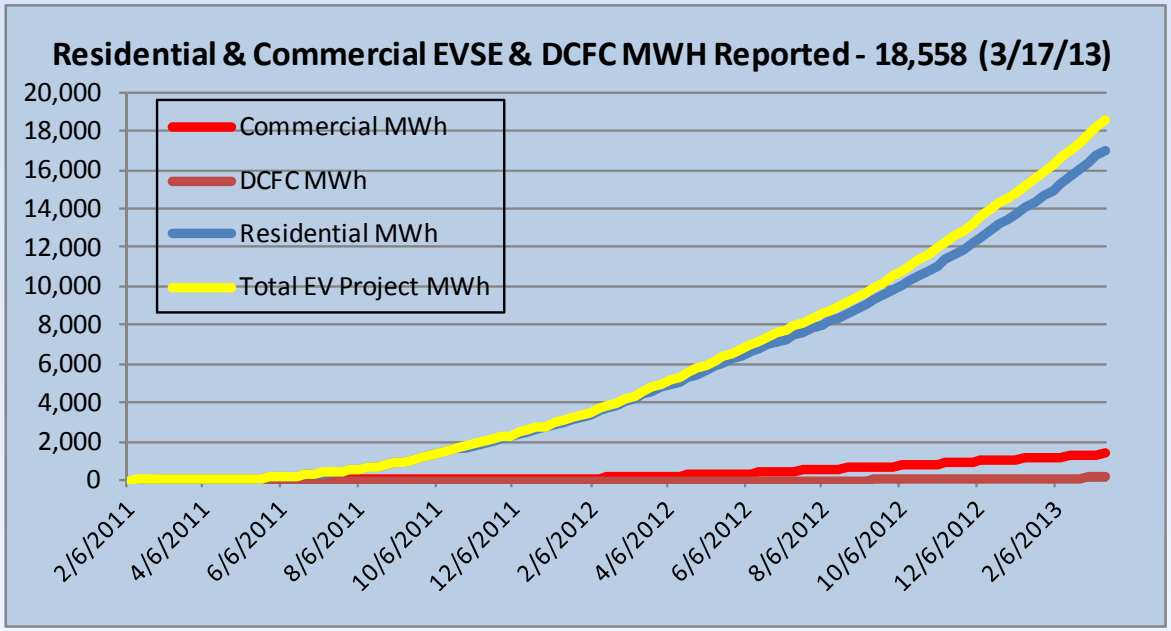
EV Project EVSE Deployed / Use, 5/26/13





- 11,959 total EVSE
  - 8,516 (71%) Residential EVSE
  - 3,363 (28%) non-residential EVSE
  - 80 (0.7%) DCFC
- 2.7 million charge events
  - 2,443,000 (91%) Residential EVSE
  - 216,000 (8%) non-residential EVSE
  - 36,000 (1.4%) DCFC

EV Project Charge Energy (MWh), 5/26/13

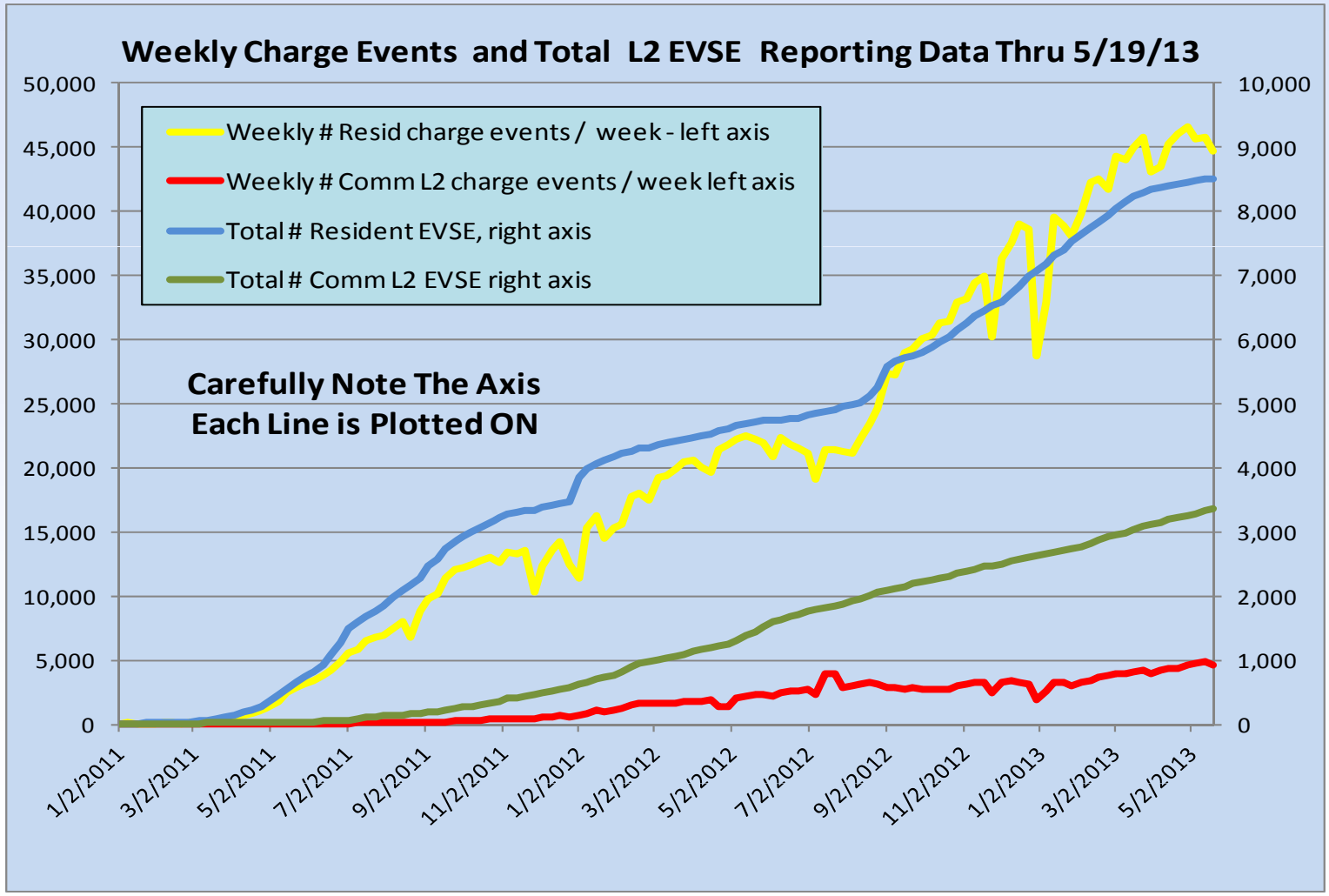


- **18,559 AC MWh total electricity charged**
  - **17,042 MWh (92%) residential**
  - **1,370 MWh (7%) non-residential**
  - **147 MWh (1%) DCFC**

- **Vehicle efficiency cannot be accurately calculated using total vehicle miles and total energy**
  - **Non-EV Project vehicles sometimes charge at EV Project EVSE**
  - **EV Project vehicles may charge at 110V or other 240V non-EV Project EVSE**

EV Project Weekly Charge Events 5/19/13

- **Note 5.4 to 1 weekly Residential EVSE use rate versus 1.4 to 1 weekly Commercial EVSE use rate (last 5 weeks)**



EV Project – National Data

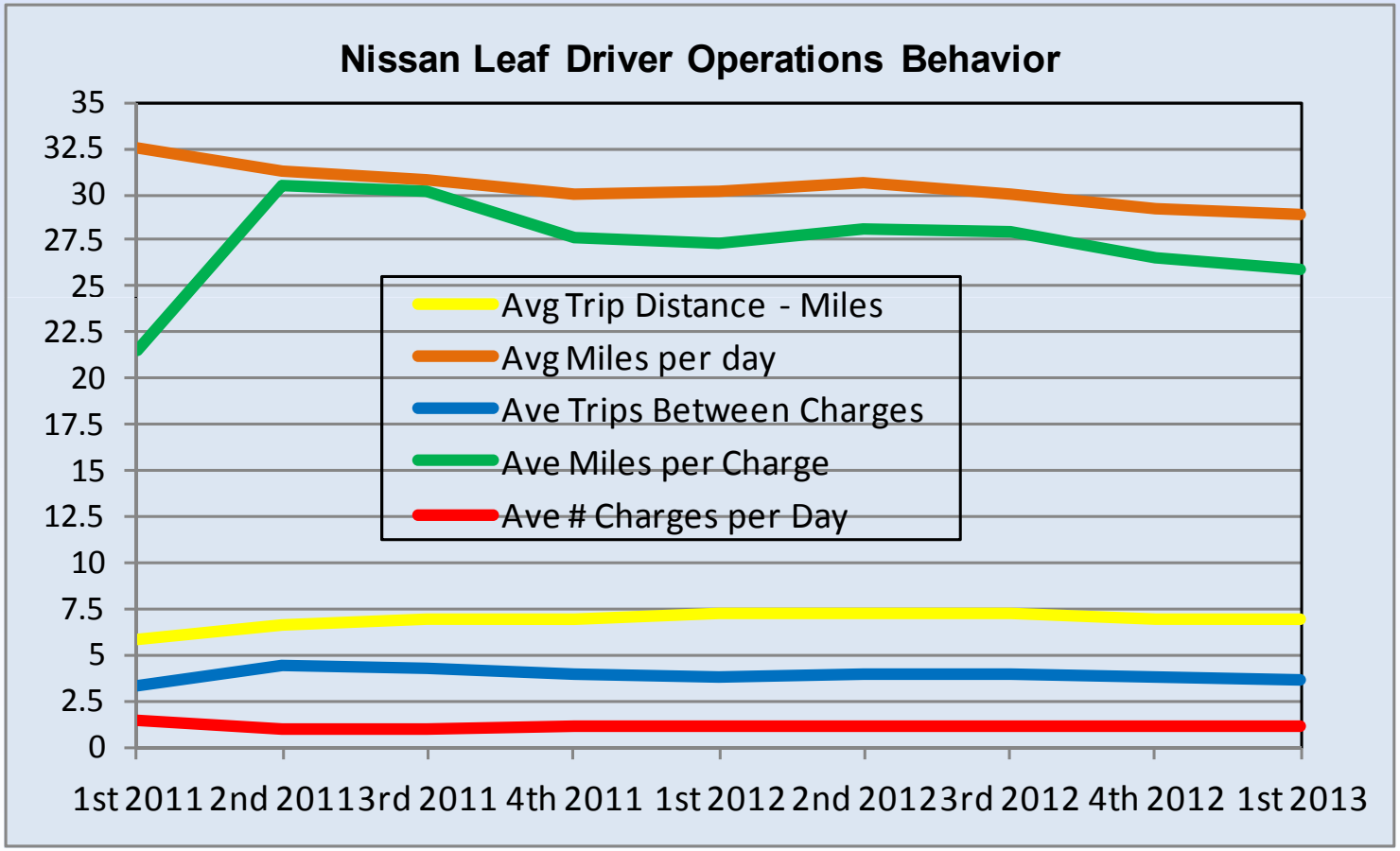
1st quarter 2013 Data Only

	Leafs	Volts
• Number of vehicles	4,240	1,766
• Number of Trips	1,075,000	526,000
• Distance (million miles)	7.6	4.4
• Average (Ave) trip distance	7.0 mi	8.2 mi
• Ave distance per day	28.9 mi	39.4 mi
• Ave number (#) trips between charging events	3.7	3.4
• Ave distance between charging events	25.9 mi	27.9 mi
• Ave # charging events per day	1.1	1.4

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

EV Project – Leaf Operations Trends

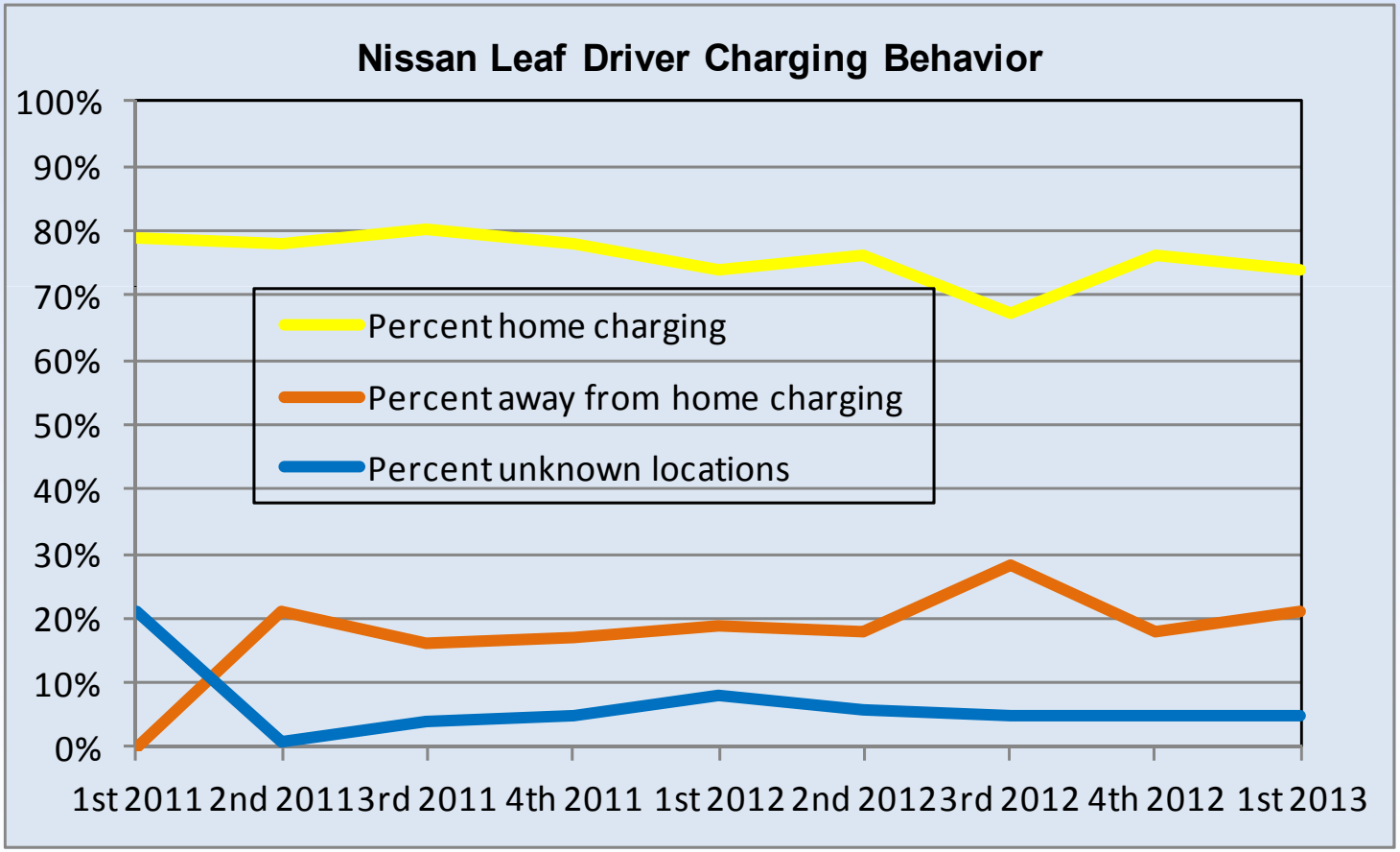
- **Quarterly slight overall decreases in average miles per day and miles per charge**



Number of Leafs reporting each quarter with matched EVSE data								
35	956	2,394	2645	2987	2911	3200	3762	4240

EV Project – Leaf Charging Location Trends

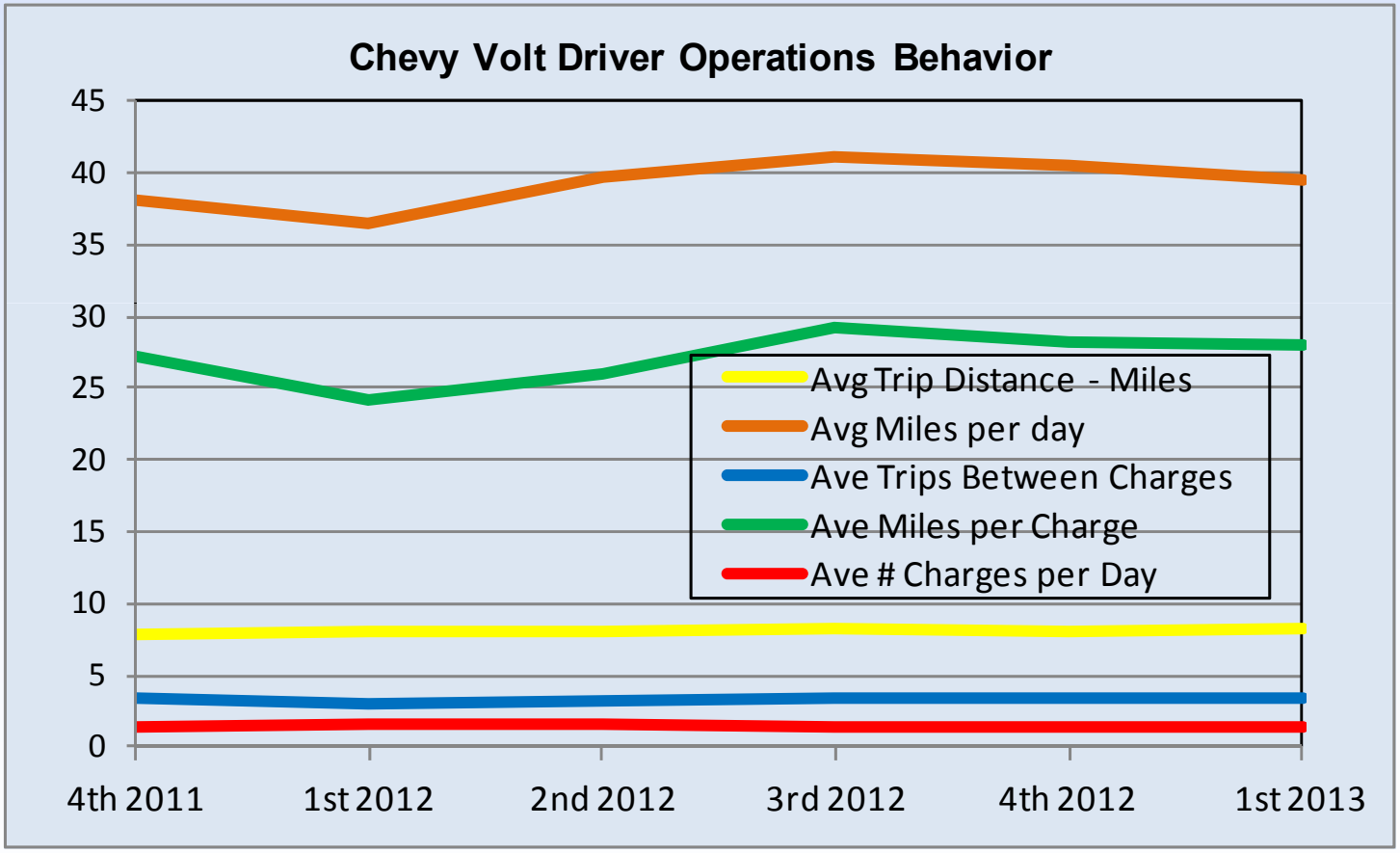
- **Revenue model impacts in 2012 4th quarter appears short term. General increase in Level 2 public charging**



Number of Leafs reporting each quarter with matched EVSE data								
35	956	2,394	2645	2987	2911	3200	3762	4240

EV Project – Volt Operations Trends

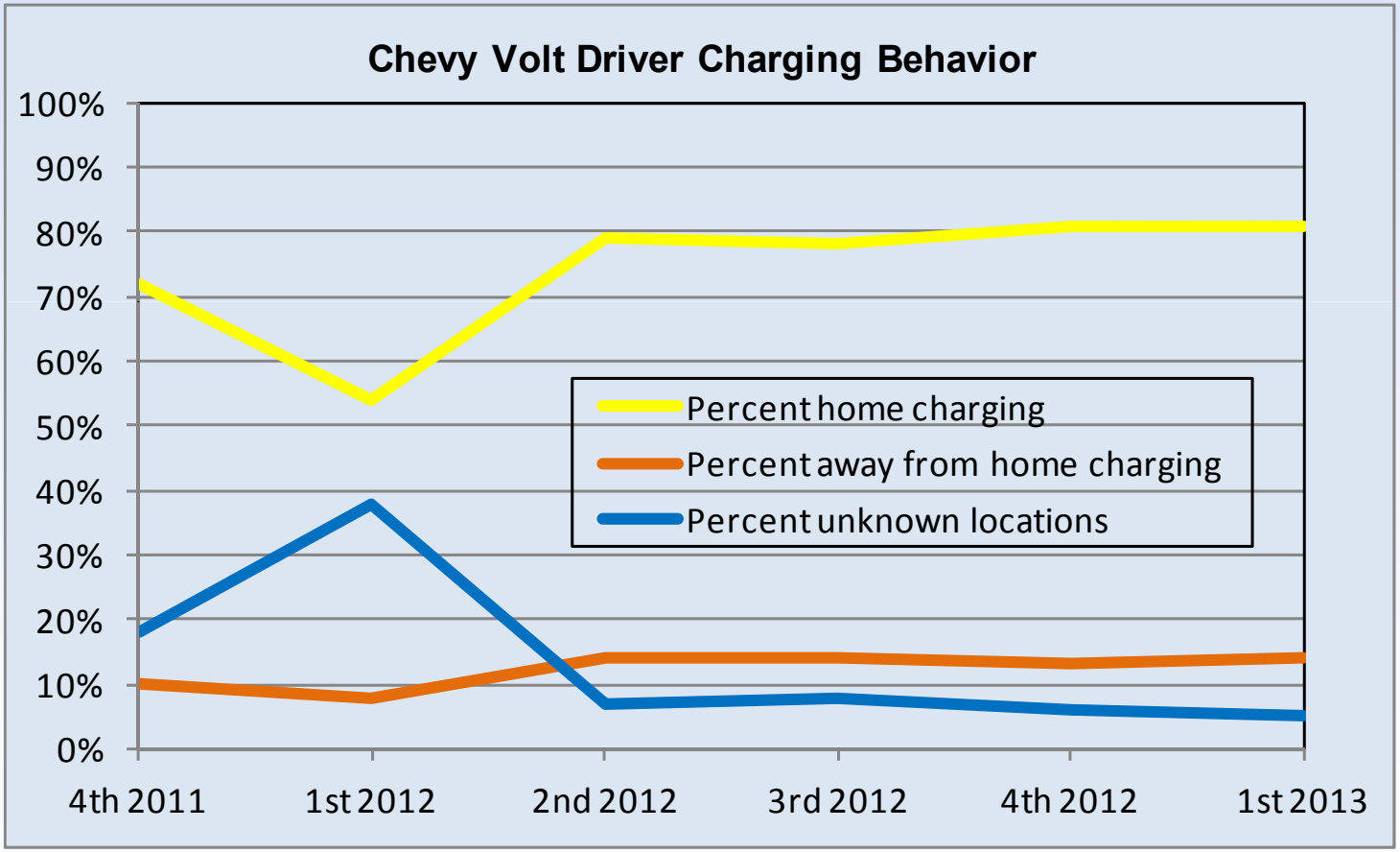
- **No consistent overall trends per quarter**



Number of Volts reporting each quarter with matched EVSE data					
45	317	408	809	1021	1766

EV Project – Volt Charging Location Trends

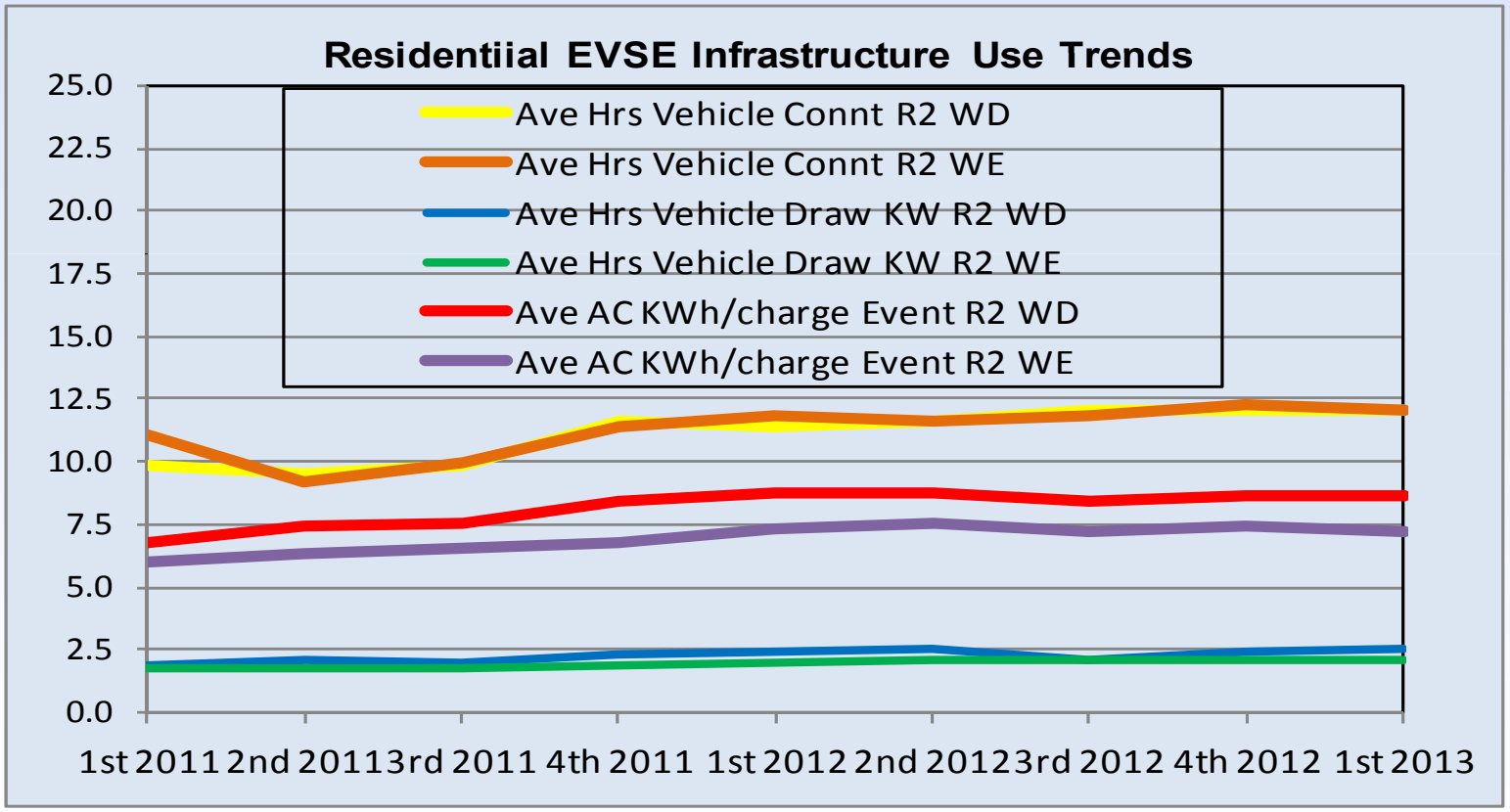
- **No significant overall Level 2 trends per quarter**



Number of Volts reporting each quarter with matched EVSE data					
45	317	408	809	1021	1766

EV Project – Residential EVSE L2 Use Trends

- **Increases in hours vehicles connected and drawing power, and increase in AC KWh transferred per charge event for residential Level 2**

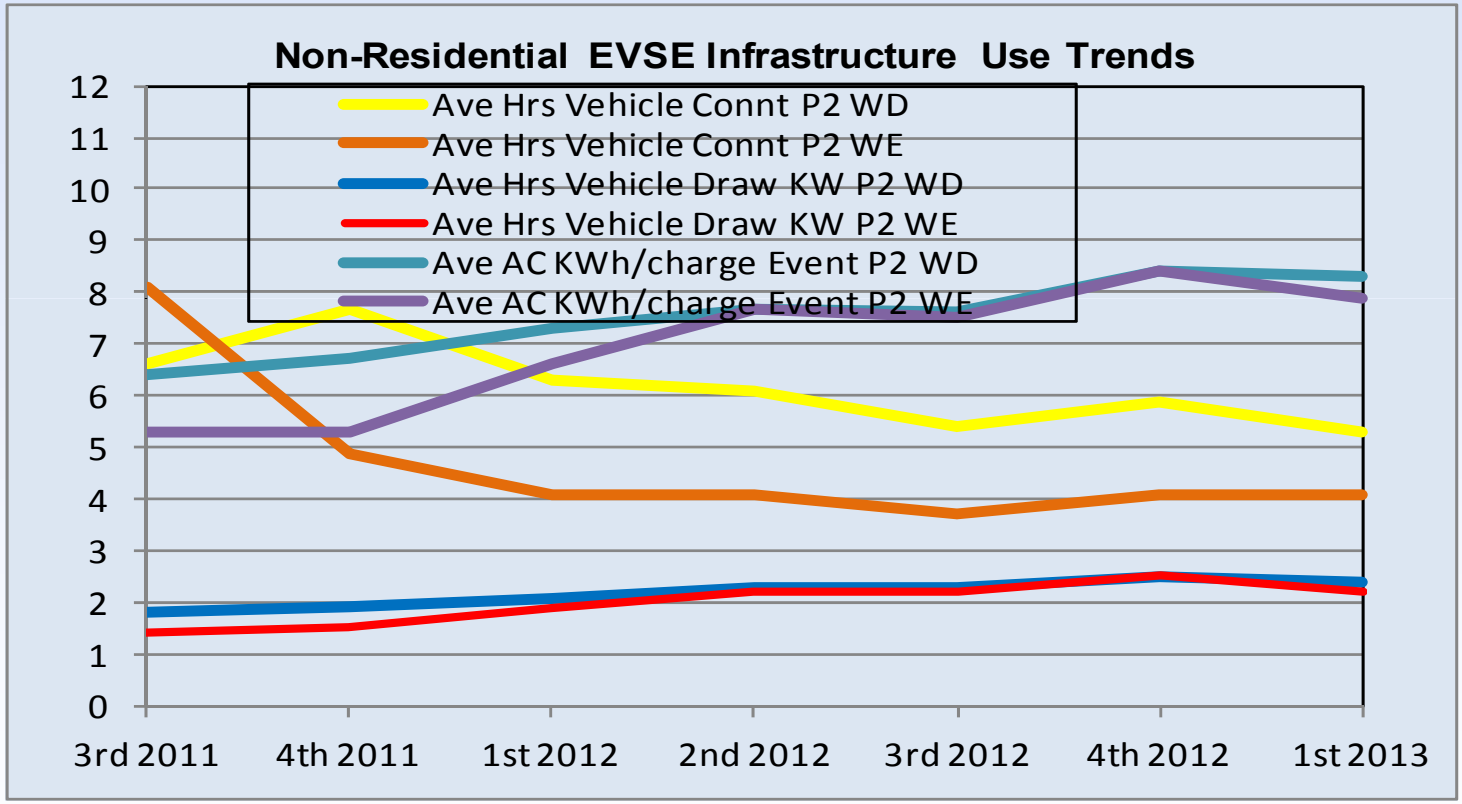


Number of Residential EVSE Level reporting each quarter								
35	955	2413	2704	3324	3338	4020	4819	6031

Residential EVSE Level 2 = R2, Weekend = WE, Weekday = WD

EV Project – Public EVSE L2 Use Trends

- Increases in kWh and time energy is drawn per charge
- Decrease in time vehicles connected



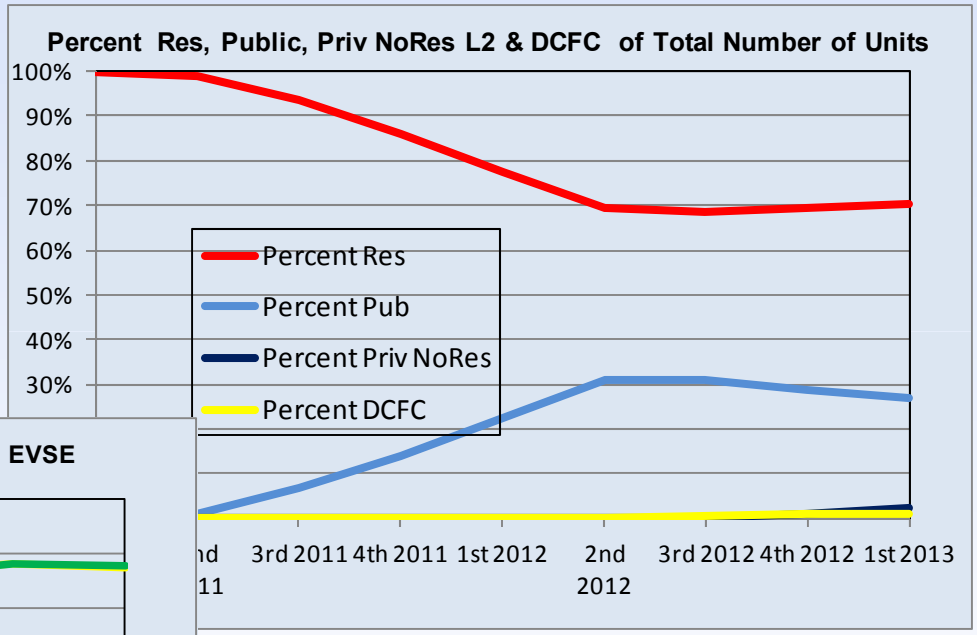
Number of Public EVSE Level reporting each quarter						
170	438	955	1483	1818	1988	2288

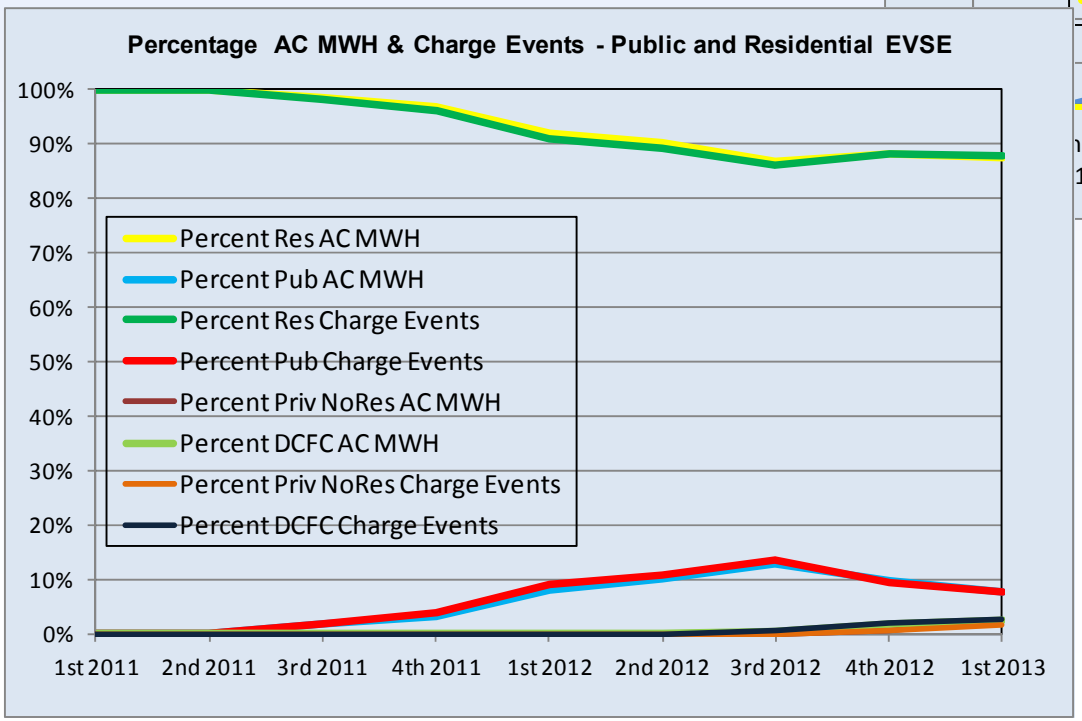
Does not include Private Nonresidential Level 2 EVSE

Public EVSE Level 2 = P2, Weekend = WE, Weekday = WD

EV Project – EVSE Infra. Summary Report

- **Residential L2 EVSE reporting in 1st quarter 2013 is 70% of all charge infrastructure – 8,580 total units**





- **Per quarterly report, as measured by kWh use and number of charge events, 88% of charging events occur at residential L2 EVSE**

EV Project Public L2 EVSE Usage 1st ¼ 2013

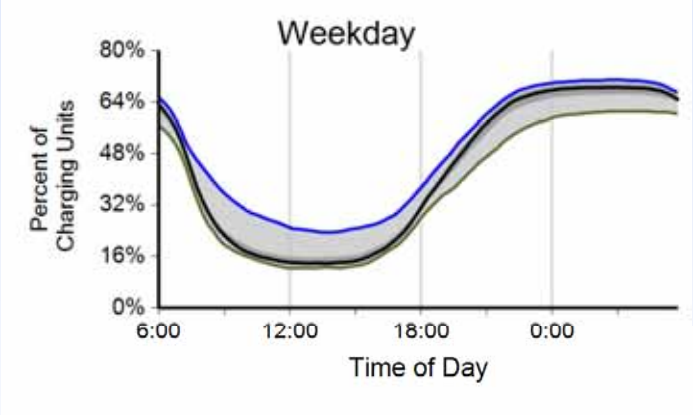
- **Public charging contribution of Car Sharing Fleet is significant in San Diego**

All territories				
Vehicles Charged	Car sharing fleet	Nissan Leaf	Chevrolet Volt	Unknown
Percent of charging events	9%	20%	5%	66%
Percent of kWh consumed	14%	18%	4%	64%
San Diego				
Vehicles Charged	**323 Car2Go fleet**	Nissan Leaf	Chevrolet Volt	Unknown
Percent of charging events	**31%**	18%	6%	45%
Percent of kWh consumed	**43%**	14%	4%	39%
Oregon (Car2Go in Portland)				
Vehicles Charged	30 Car2Go fleet	Nissan Leaf	Chevrolet Volt	Unknown
Percent of charging events	1%	29%	4%	66%
Percent of kWh consumed	12%	29%	4%	65%

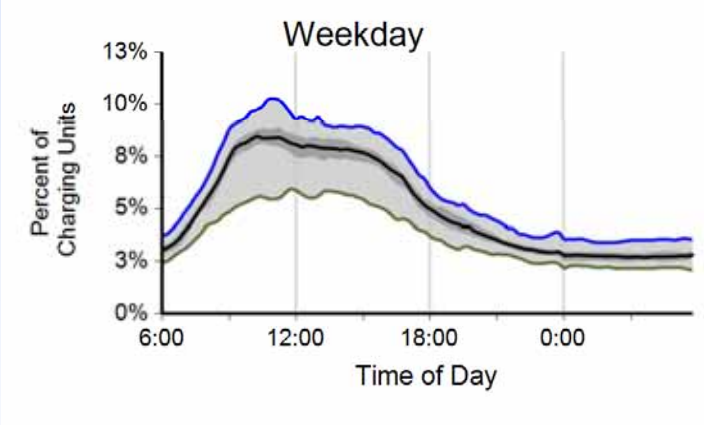
EV Project – EVSE Infra. Summary Report

- National Residential and Public Level 2 Weekday EVSE 1st Quarter 2013
- Residential and public connect time and energy use are fairly opposite profiles. Note different scales

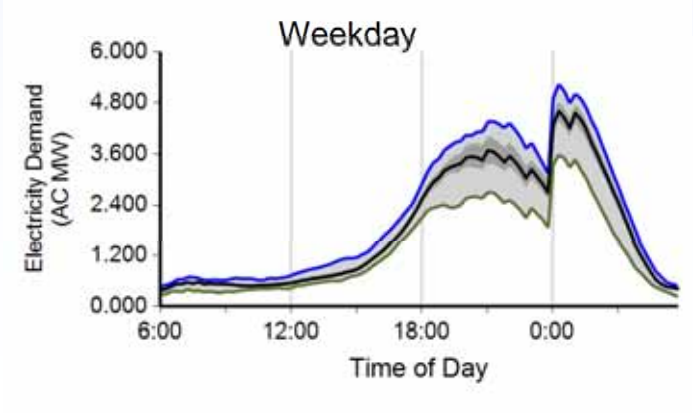
National Residential Connect Time



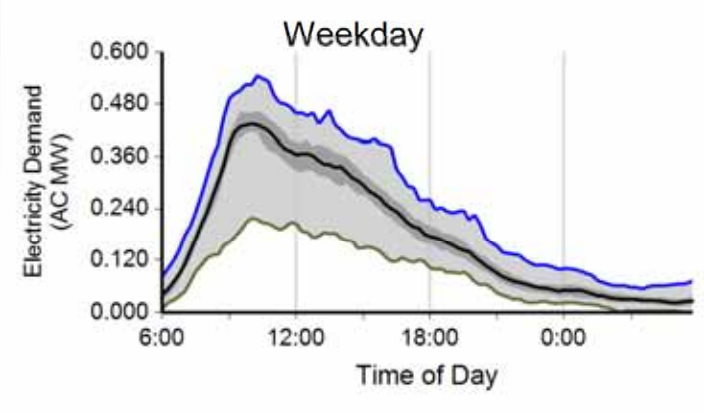
National Public Connect Time



National Residential Demand



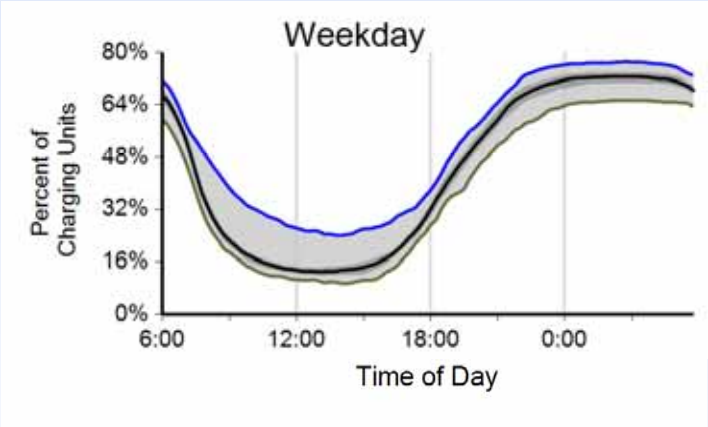
National Public Demand



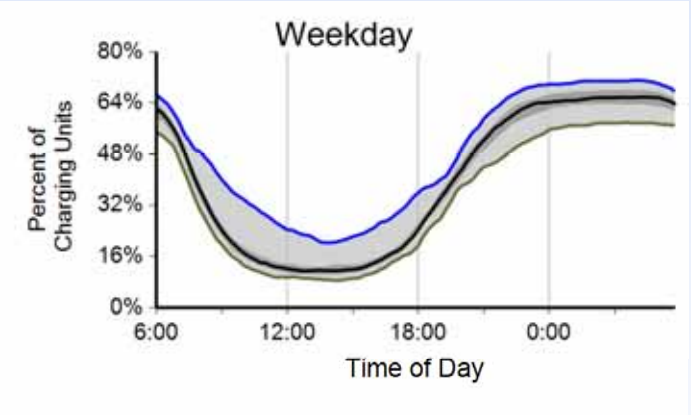
EV Project – EVSE Infra. Summary Report

- **Residential Level 2 Weekday EVSE 1st Quarter 2013**
- **San Diego and San Francisco, with residential L2 TOU rates, are similar to national and other regional EVSE connect profiles**

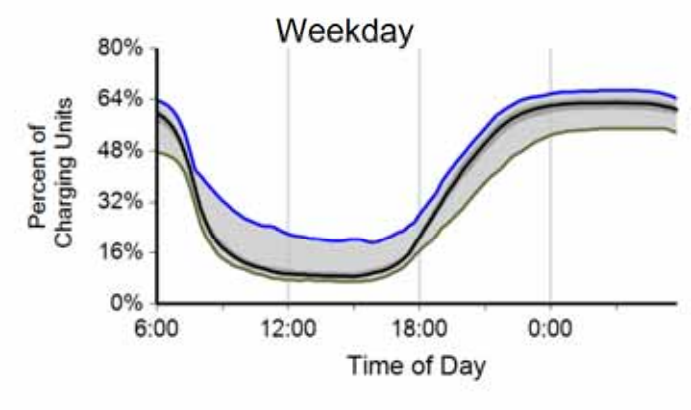
San Diego



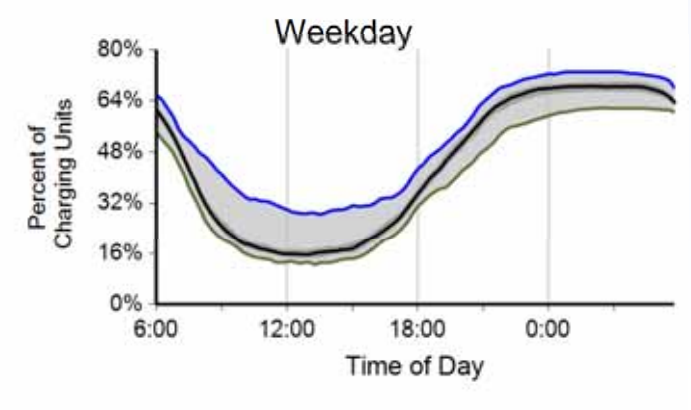
Los Angeles



San Francisco



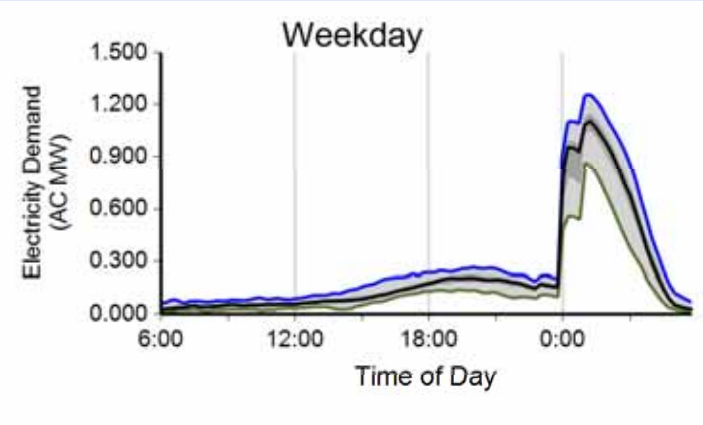
Washington State



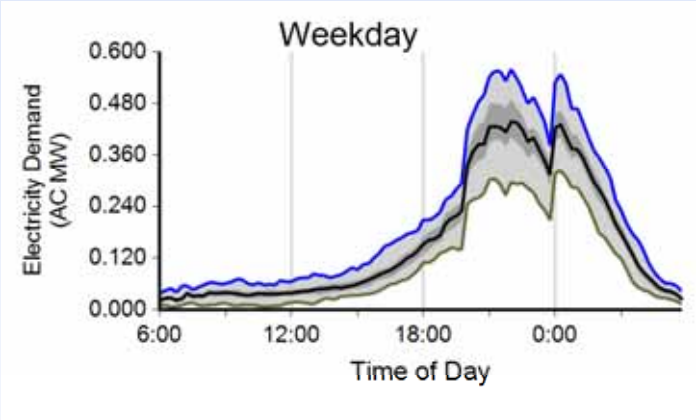
EV Project – EVSE Infra. Summary Report

- **Residential Level 2 Weekday EVSE 1st Quarter 2013**
- **TOU kWh rates in San Diego and San Francisco clearly impact when vehicle charging start times are set**

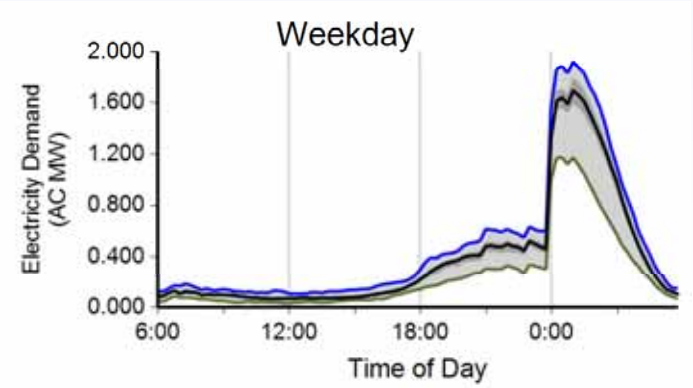
San Diego



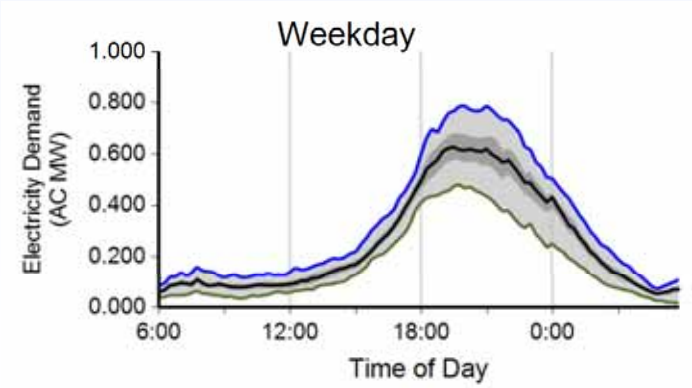
Los Angeles



San Francisco



Washington State

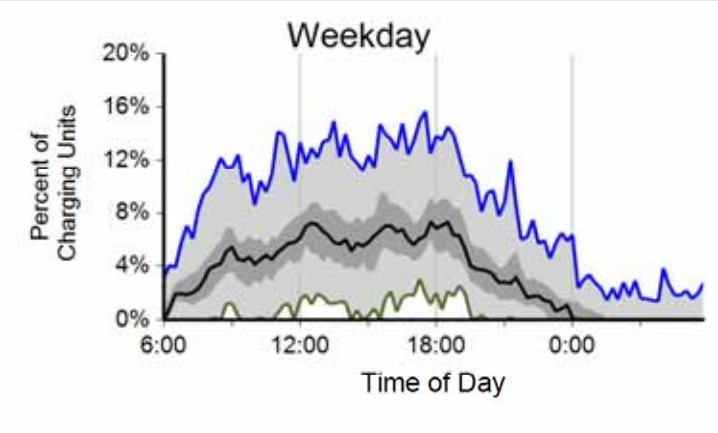


EV Project results to date – DCFC use

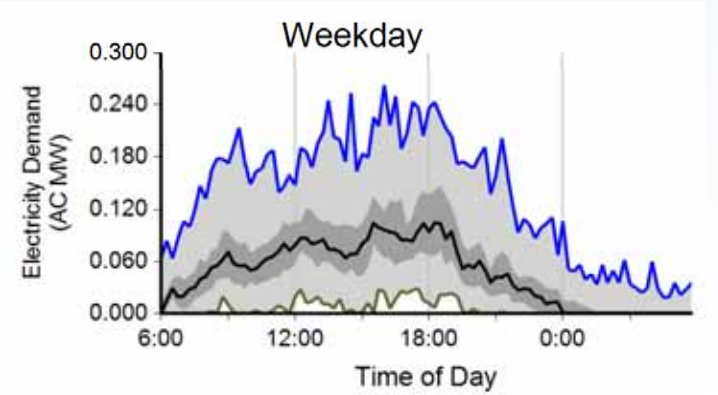
EV Project – EVSE Infra. Summary Report

- **DC Fast Chargers Weekday 1st Quarter 2013**
- **72 DCFC, 13,500 charge events and 102 AC MWh**

Weekday Connected Profile



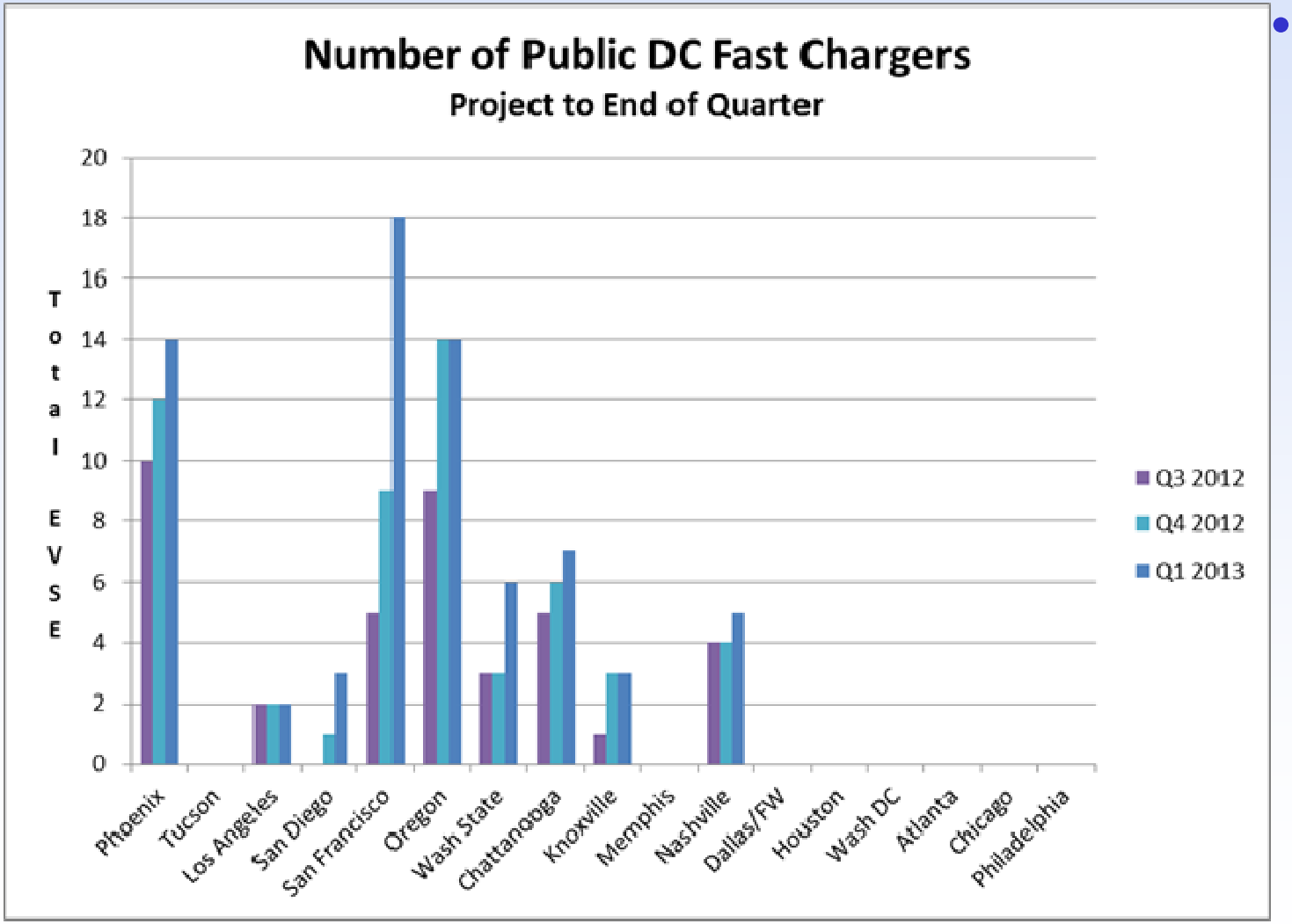
Weekday Demand Profile



- **2.3 average charge events per day per DCFC**
- **Leafs 40% charge events and 40% energy used**
- **Unknowns are Non EV Project vehicles**
- **21.3 minutes average time connected**
- **21.3 minutes average time drawing energy**
- **7.6 kWh average energy consumed per charge**

EV Project – DCFC Preliminary Data Analysis

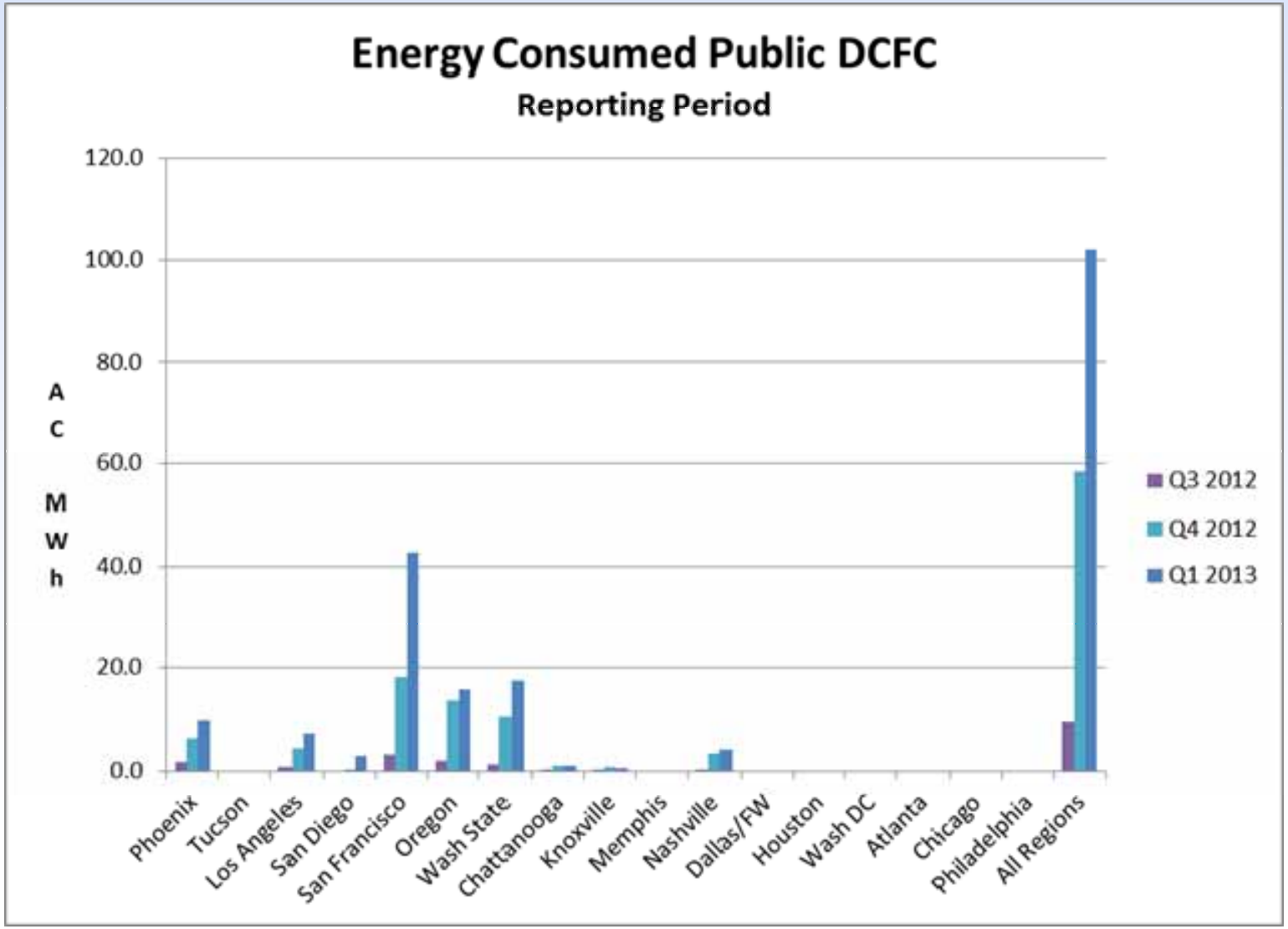
- **Growth in the number of DCFC by market over the past three reporting quarters**



- **Total DCFC by Quarter**
  - **3rd: 39**
  - **4th: 54**
  - **1st: 72**

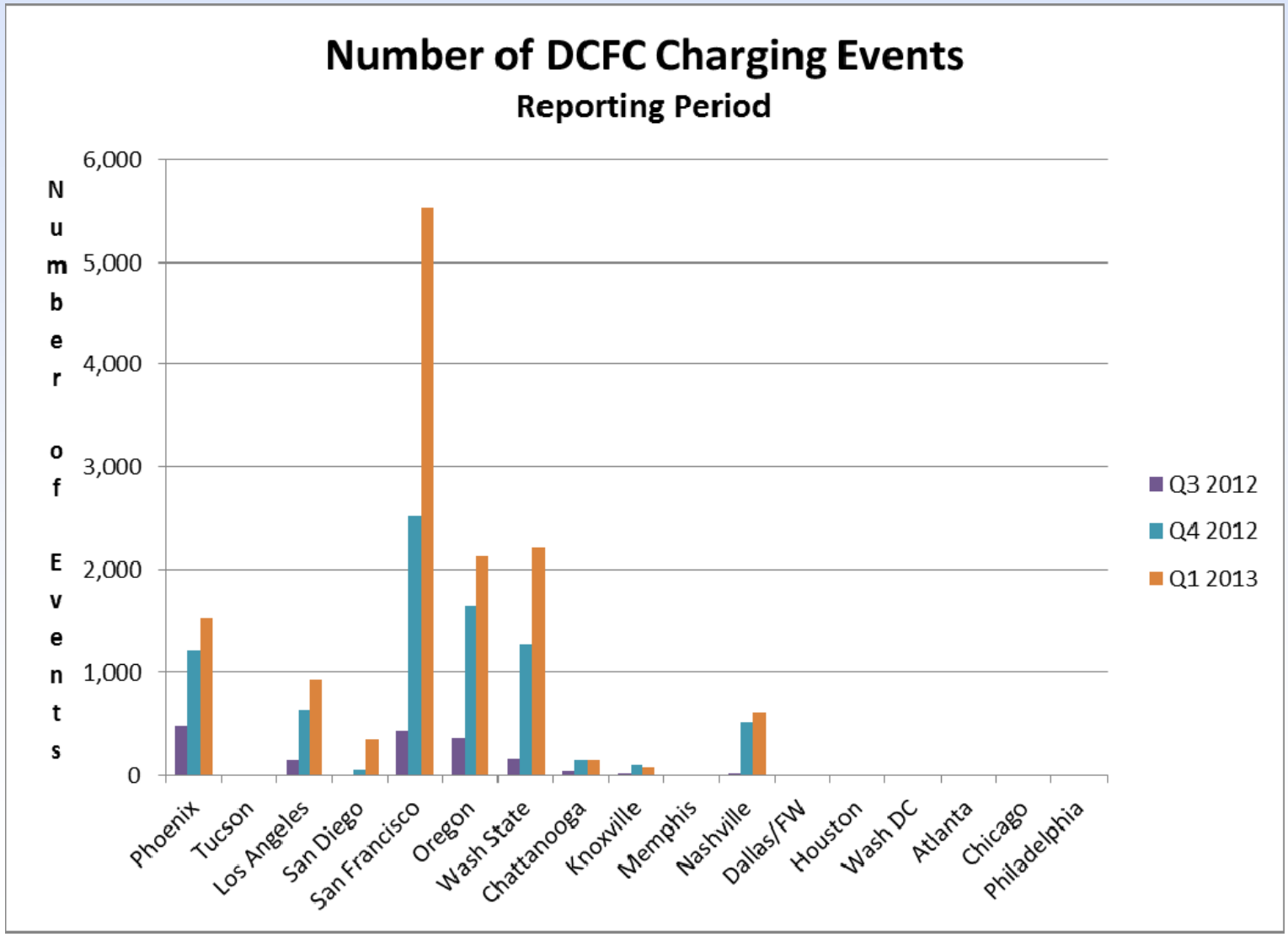
EV Project – DCFC Preliminary Data Analysis

- **DCFC energy consumed over the past three reporting quarters**



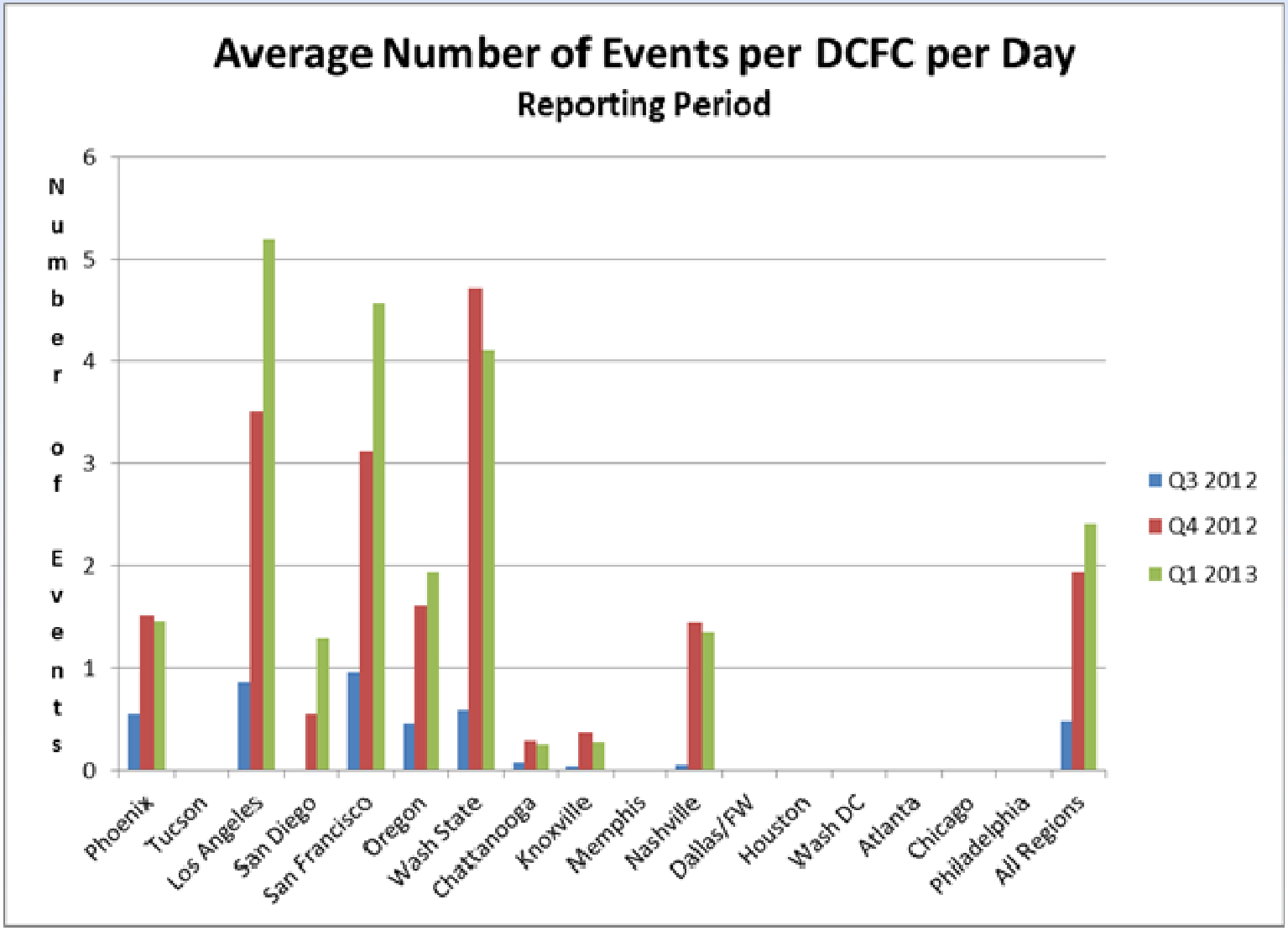
EV Project – DCFC Preliminary Data Analysis

- **Growth in the number of DCFC charging events by market over the past three reporting quarters**



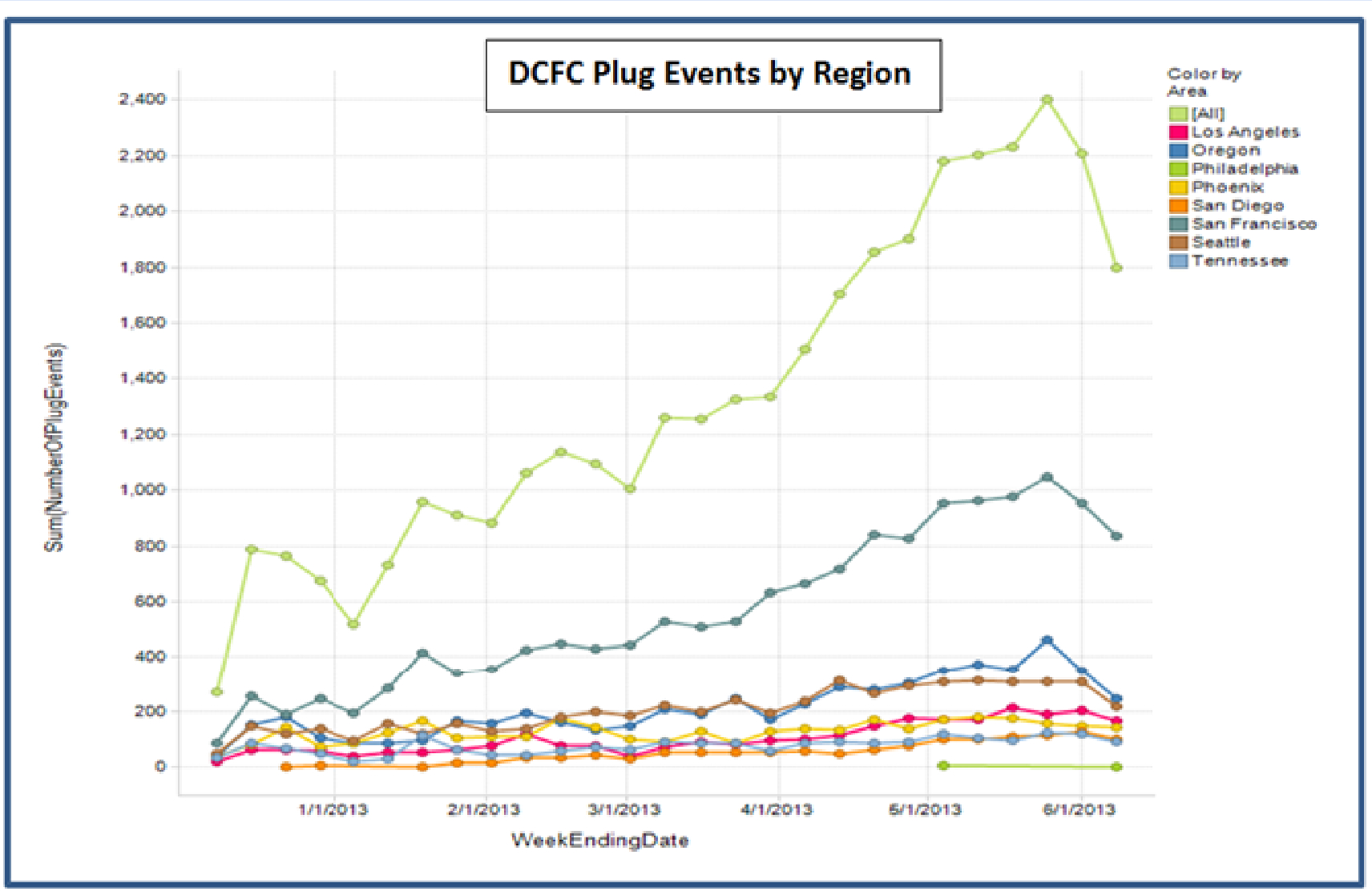
EV Project – DCFC Preliminary Data Analysis

- **Average number of charging events per day per DCFC over the past three reporting quarters**



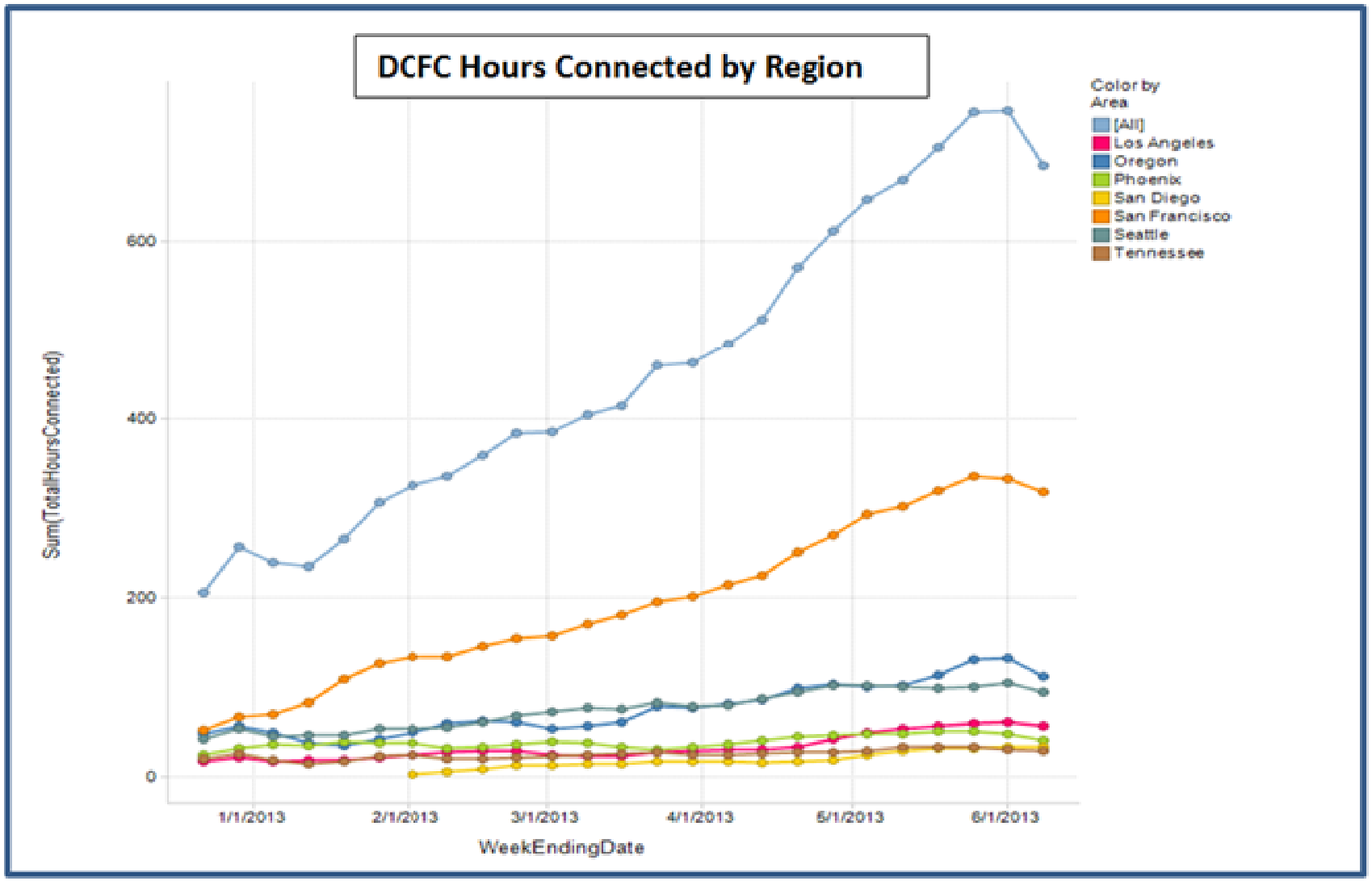
EV Project – DCFC Preliminary Data Analysis

- **2013 regional week by week numbers of DCFC charge events (note numbers for final week are not complete)**



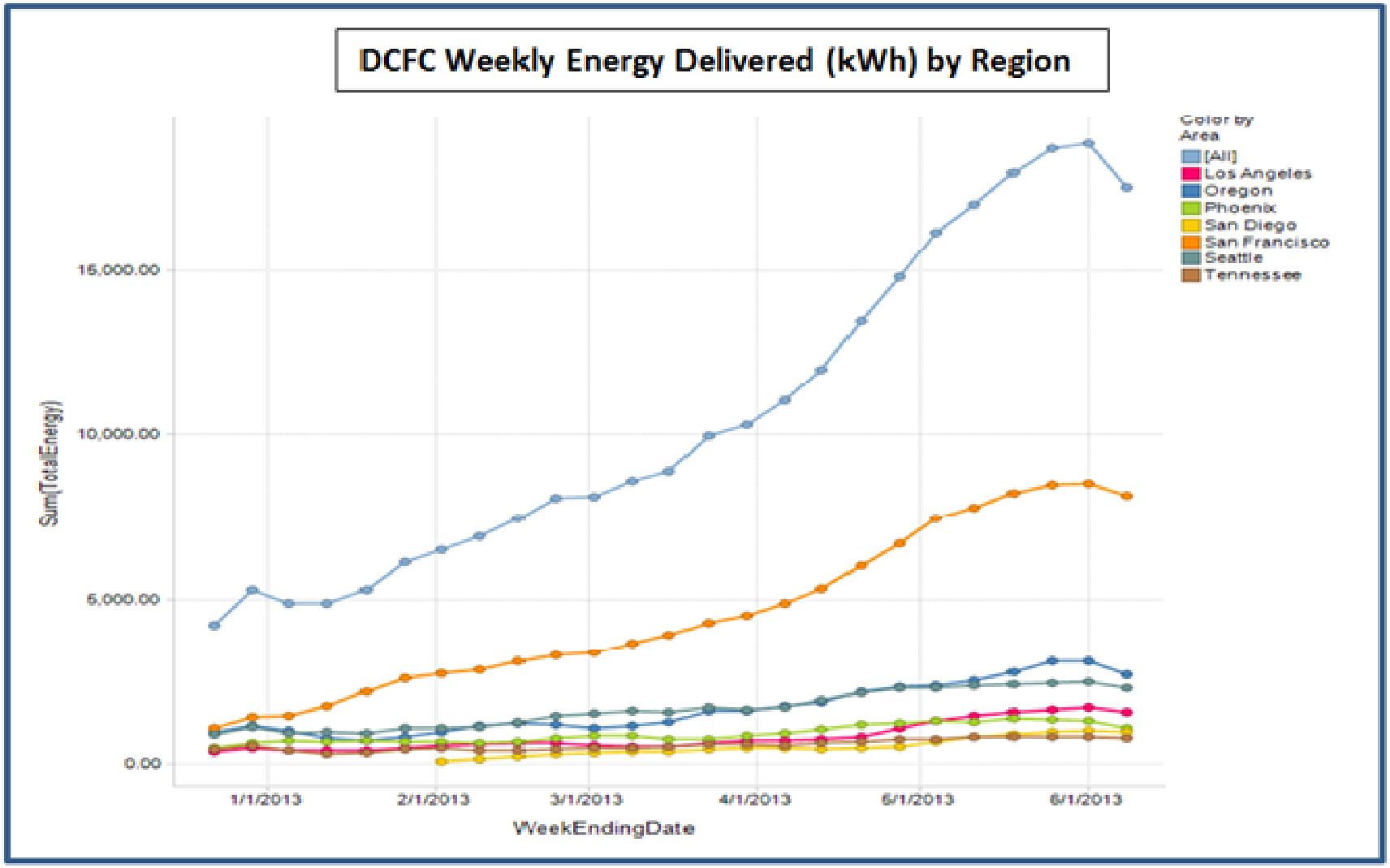
EV Project – DCFC Preliminary Data Analysis

- **2013 regional week by week total hours connected to DCFC (note numbers for final week are not complete)**



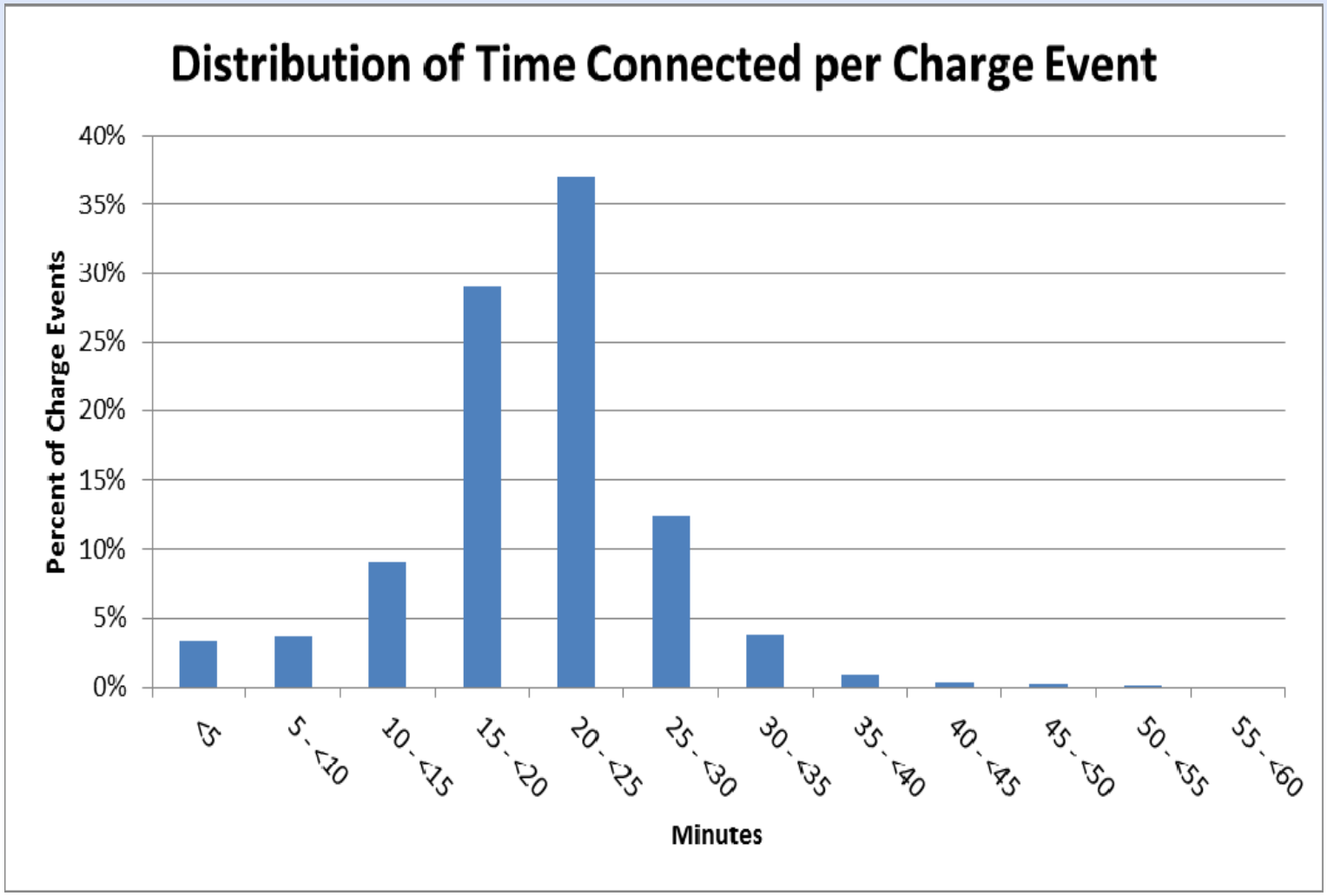
EV Project – DCFC Preliminary Data Analysis

- **2013 regional week by week total energy delivered by DCFC (note numbers for final week are not complete)**



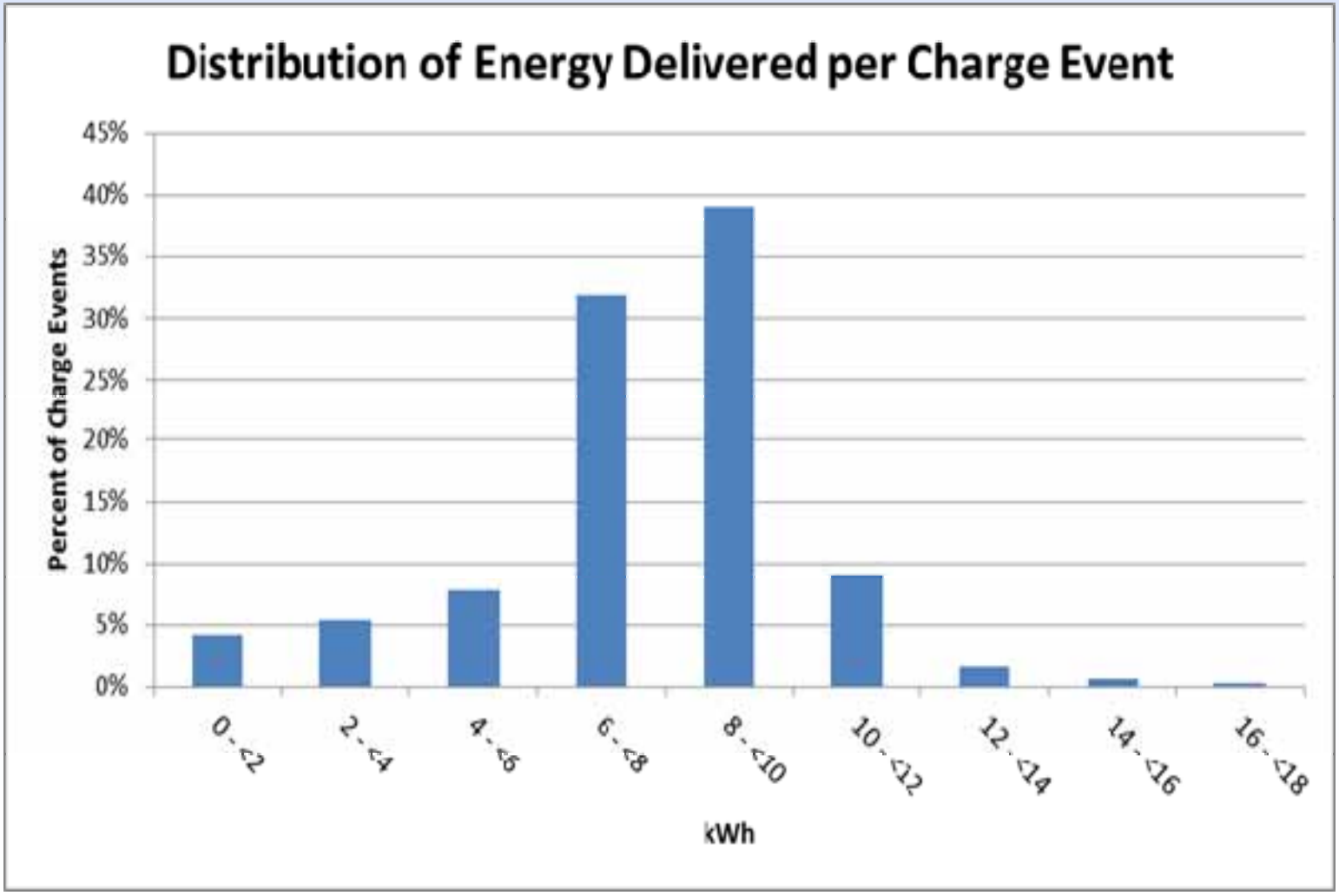
EV Project – DCFC Preliminary Data Analysis

- **Distribution of time vehicle connected per DCFC charge event for all regions (Note: no charge events have occurred where connect time is greater than 60 minutes)**



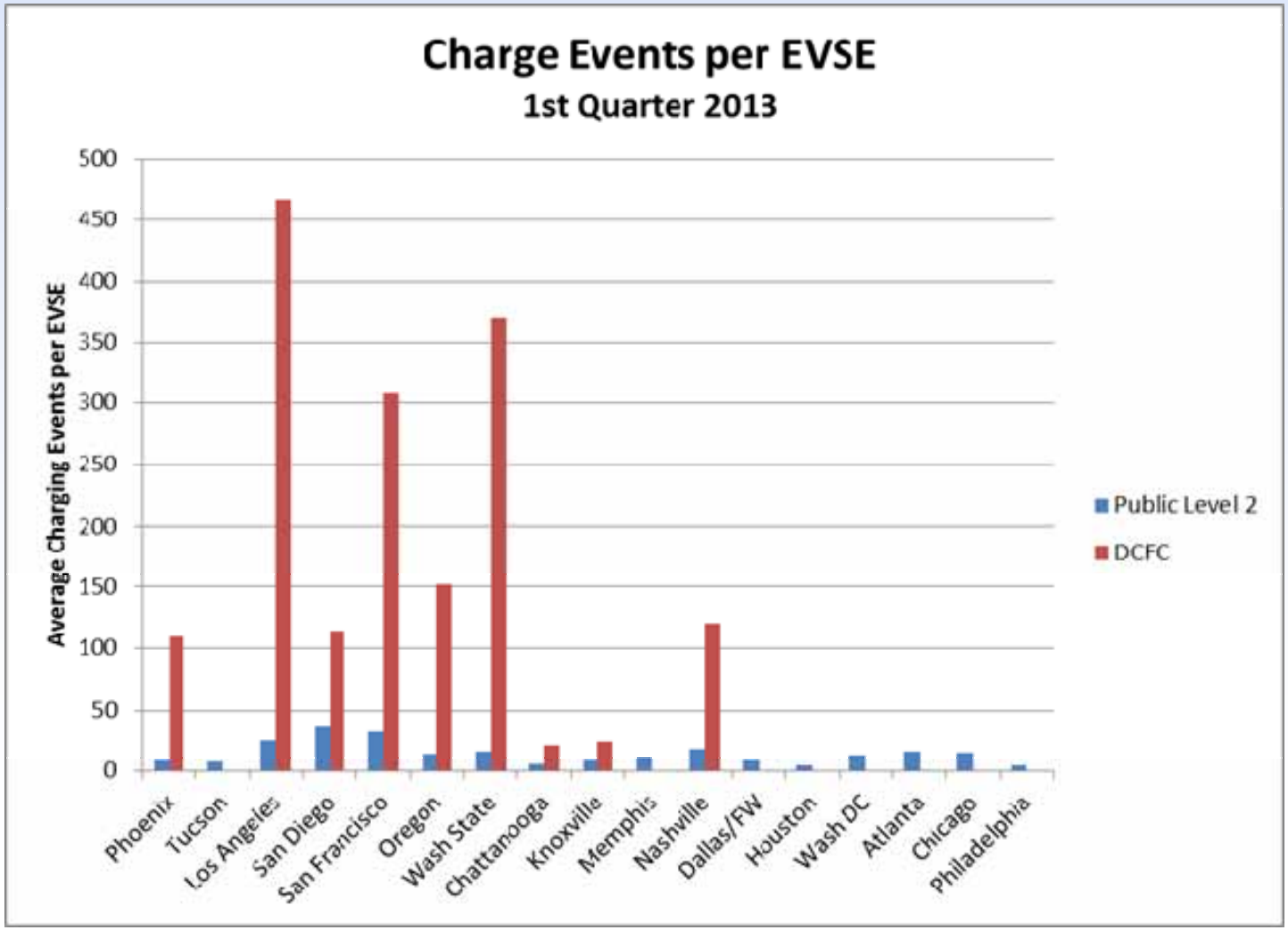
EV Project – DCFC Preliminary Data Analysis

- **Distribution of energy delivered per DCFC event time for all regions (Note: No charge event delivered more than 18 kWh)**



EV Project – DCFC Preliminary Data Analysis

- Number of charge events per publicly accessible Level 2 EVSE versus per DCFC in the 1st Quarter 2013
- Nationally, 17 events per public L2 and 188 per DCFC



EV Project results to date – Costs and Some Lessons Learned

Residential Permit Costs / Issues

- **Permit timeliness has not been a problem**
- **Majority are over-the-counter**
- **Permit fees vary significantly- $7.50 to $500.00**

Region	Count of Permits	Average Permit Fee	Minimum Permit Fee	Maximum Permit Fee
Arizona	66	$96.11	$26.25	$280.80
Los Angeles	109	$83.99	$45.70	$218.76
San Diego	496	$213.30	$12.00	$409.23
San Francisco	401	$147.57	$29.00	$500.00
Tennessee	322	$47.15	$7.50	$108.00
Oregon	316	$40.98	$12.84	$355.04
Washington	497	$78.27	$27.70	$317.25

Residential Installation Costs

- **Average residential installation cost ≈$1,375**
- **Individual installations vary widely**
- **Some user bias to lower costs**

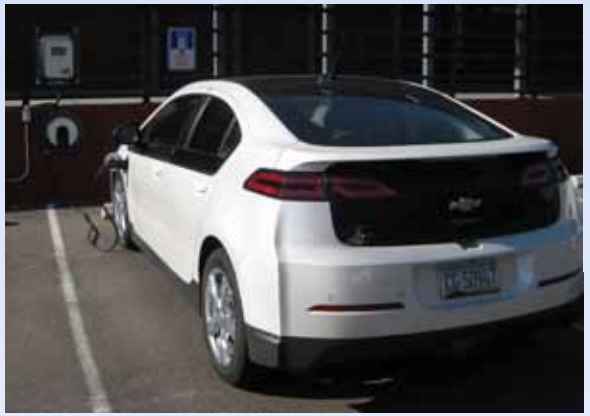
Marlets In Ascending Order Of Residential Installation Cost	Number of Installations	Average Installation Cost	Variation From Project Average
Tennessee (entire State)	542	$ 1,113.07	-19.0%
Arizona (Phoenix & Tucson)	357	$ 1,148.88	-16.4%
Washington DC	3	$ 1,197.44	-12.9%
Oregon (Portland, Eugene, Coralvls & Salem)	465	$ 1,229.06	-10.6%
Washington (Seattle & Olympia)	730	$ 1,289.56	-6.2%
Maryland	39	$ 1,311.75	-4.5%
Washington	80	$ 1,321.36	-3.8%
Virginia	38	$ 1,341.01	-2.4%
San Fransisco	1254	$ 1,386.13	0.9%
Texas (metro Houston & Dallas)	128	$ 1,422.77	3.5%
San Diego	726	$ 1,593.91	16.0%
Los Angeles	415	$ 1,794.64	30.6%

L2 Access Fees Structure

- 4th Quarter is first widespread implementation of simple and low cost access fees
- Blink member
  - Affiliate credit card with free Blink RFID "In Card"
  - Level 2 access fee of $1.00 per hour of connect time
- Guest - No Blink RFID "In Card" required
  - Guest Code using quick reservation code or website
  - Level 2 access feel of $2.00 per hour of connect time
- Future pricing
  - Pricing to reflect regional electricity rates
  - Cover electricity costs in all cases

Commercial Lessons Learned

- ADA significantly drives cost
  - Accessible charger
  - Van accessible parking
  - Accessible electric and passage routes to facility
- Permit fees and delays can be significant
  - Load studies
  - Zoning reviews



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 hardware or permitting costs
- 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
- These numbers are very preliminary

Commercial DC Fast Charger Installation Costs / Issues

- Current installations range from $6,090 to $48,000 (70+)
- Average installation cost to date is about $22,600·
- 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

Commercial 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

- **Demand and energy costs are significant for some utilities**
  - **25¢/kWh**
  - **$25/kW**
- **Some utilities offer commercial rates without demand charges**
- **Others incorporate 20 kW to 50 kW demand thresholds**
- **Nissan Leaf is demand charge free in some electric utility service territories**

No Demand Charges - Nissan Leaf	
CA	Pacific Gas & Electric
	City of Palo Alto
	Alameda Municipal Power
	Silicon Valley Power
AZ	Tucson Electric Power
OR	Eugene Water & Electric Board
	Lane Electric Co-op
TN	Middle Tennessee Electric
	Duck River Electric
	Harriman Utility Board
	Athens Utility Board
	Cookeville Electric Department
	Cleveland Utilities
	Nashville Electric Service
	EPB Chattanooga
	Lenoir City Utility Board
	Volunteer Electric Cooperative
	Murfreesboro Electric
	Sequachee Valley Electric Cooperative
	Knoxville Utility Board
	Maryville
	Fort Loudoun Electric
	Memphis Light Gas and Water Division

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

DC Fast Charge (DCFC) Fees Structure

- Encourage DCFC use with initial free charging
- Implement DCFC access fees by region in 2nd Quarter 2013 with beta testing currently underway
- Initial fee structure simple and low cost
  - Accommodate varying vehicle charge rates
  - Accommodate select limitation of charging output power
- Blink member
  - $25 per month unlimited use or $5.00 per session
- Guest
  - $8.00 per session

EV Project Lessons Learned Reports

- Lessons: http://www.theevproject.com/documents.php
- First responder training
- Accessibility at public EV charging locations
- Signage
- Impact of EV Project charging on the electric grid
- EV Project DC Fast Charge - Demand Charge Reduction
- Electric Vehicle Public Charging – Time vs. Energy
- EVSE programming for charging
  - 63% not, 21% vehicle, 15% EVSE and 2% both scheduled
- Vehicle utilization first look
  - Charge events per week by venues
- Dissemination Plan
  - http://www.theevproject.com/cms-assets/documents/118044-625722.evp-dis.pdf

Charge Point results to date

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy | VEHICLE TECHNOLOGIES PROGRAM

ChargePoint ®America Vehicle Charging Infrastructure Summary Report

Project Status to Date through: June 2012

Charging Unit - By State	Residential	Private Commercial	Public	Not Specified	Charging Units Installed to Date[1]	Number of Charging Events Performed[2]	Electricity Consumed (AC MWh)
California	791	39	518	3	1,351	213,758	1,487.7
Connecticut	11	-	-	-	11	2,569	15.1
District of Columbia	-	16	16	-	32	718	5.4
Florida	43	10	228	2	283	9,323	55.2
Maryland	18	7	46	-	71	5,956	37.9
Massachusetts	23	7	74	-	104	4,133	35.5
Michigan	252	14	172	-	438	60,436	407.1
New Jersey	51	2	17	-	70	15,397	95.7
New York	23	88	102	-	213	17,401	139.6
Texas	51	9	227	-	287	17,759	114.4
Virginia	23	17	43	-	83	10,061	65.0
Washington	12	7	123	-	142	8,153	50.0
Total	1,298	216	1,566	5	3,085	365,664	2,508.7

ChargePoint America Charging Unit Distribution
Project to Date

[1] Includes all charging units that were in use by the end of the reporting period.

[2] A charging event is defined as the period when a vehicle is connected to a charging unit, during which period some power is transferred

ChargePoint Network | INL Idaho National Laboratory

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Charge Point America ARRA Project

- Conducted by Coulomb
- Project to March 2013
- 4,217 EVSE installed and reporting data
  - 1,829 Residential
  - 237 Private / commercial
  - 2,121 Public
  - 30 unknown
- 997,249 charge events
- 7,119 AC MWh

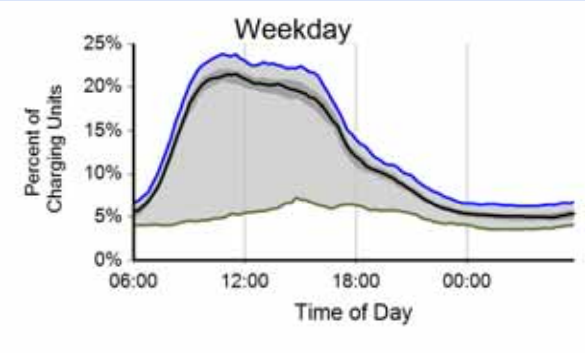
Charge Point America ARRA Project

- January – March 2013 data for 3,668 EVSE

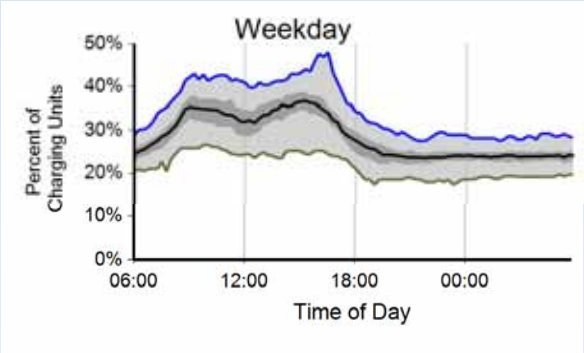
	Residential	Private Commercial	Public	Not Specified
% EVSE	45%	4%	50%	<1%
% Charge Events	63%	3%	34%	<1%
% AC MWh	62%	3%	34%	<1%
% time with vehicle connected	48%	26%	10%	29%
% time with energy transferred	9%	5%	4%	4%

Charge Point America: Jan - March 2013

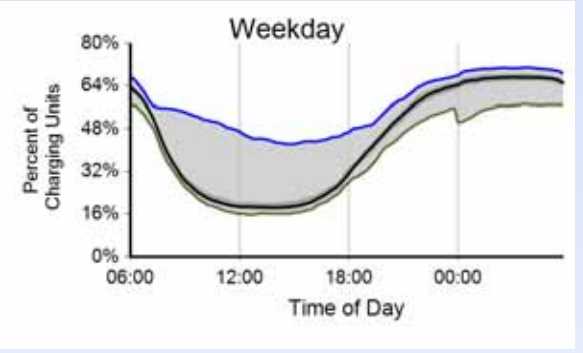
Public Connect Time



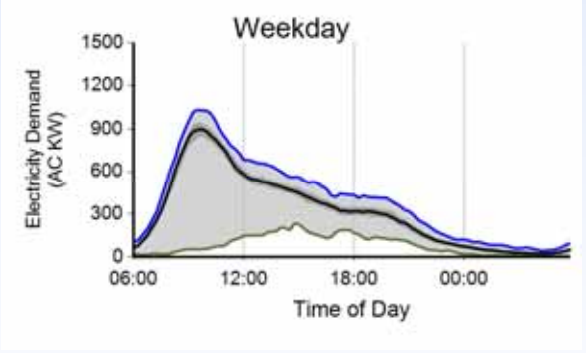
Commercial Connect Time



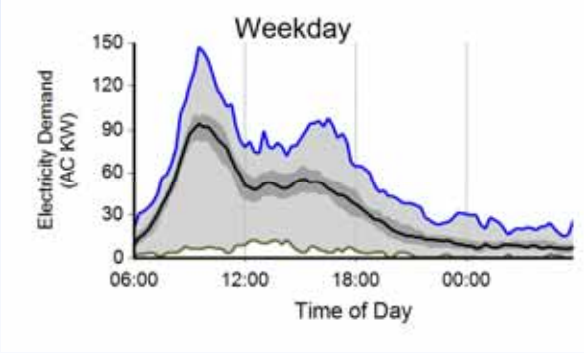
Residential Connect Time



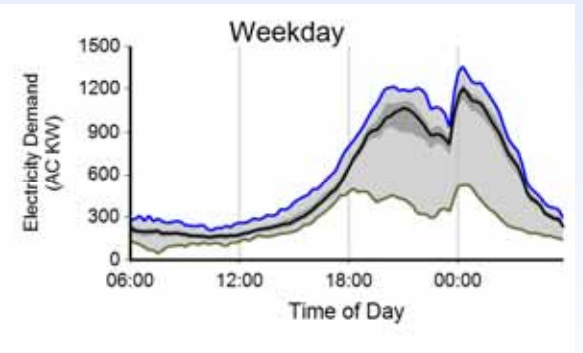
Public Demand



Commercial Demand



Residential Demand



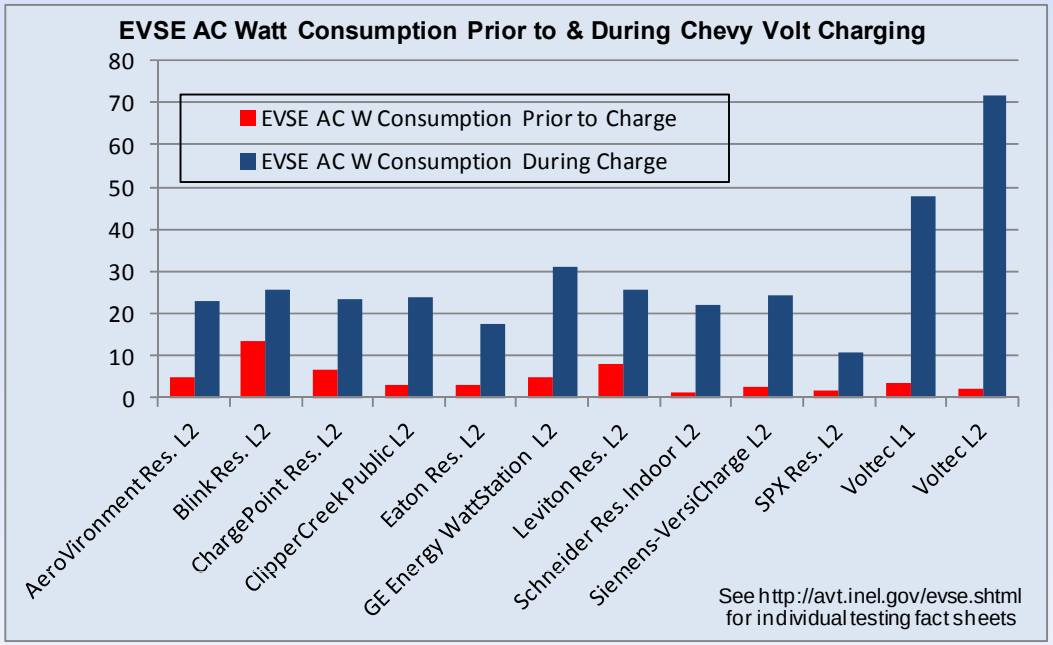
- **Public is open access. Commercial are limited access**
- **Public and commercial reflect at work charging**
- **Residential reflects end of day return-to-home charging**
- **Note difference in scales**

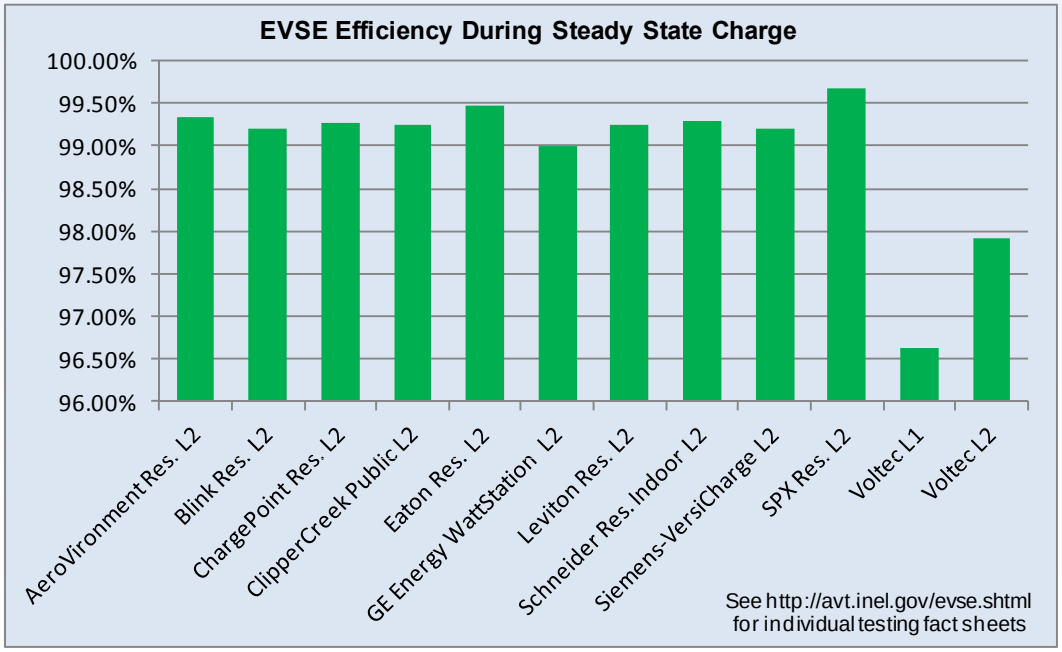
Conductive Charging Infrastructure Testing

EVSE Testing

- AC energy consumption at rest and during Volt Charging benchmarked
- Steady state charge efficiency benchmarked



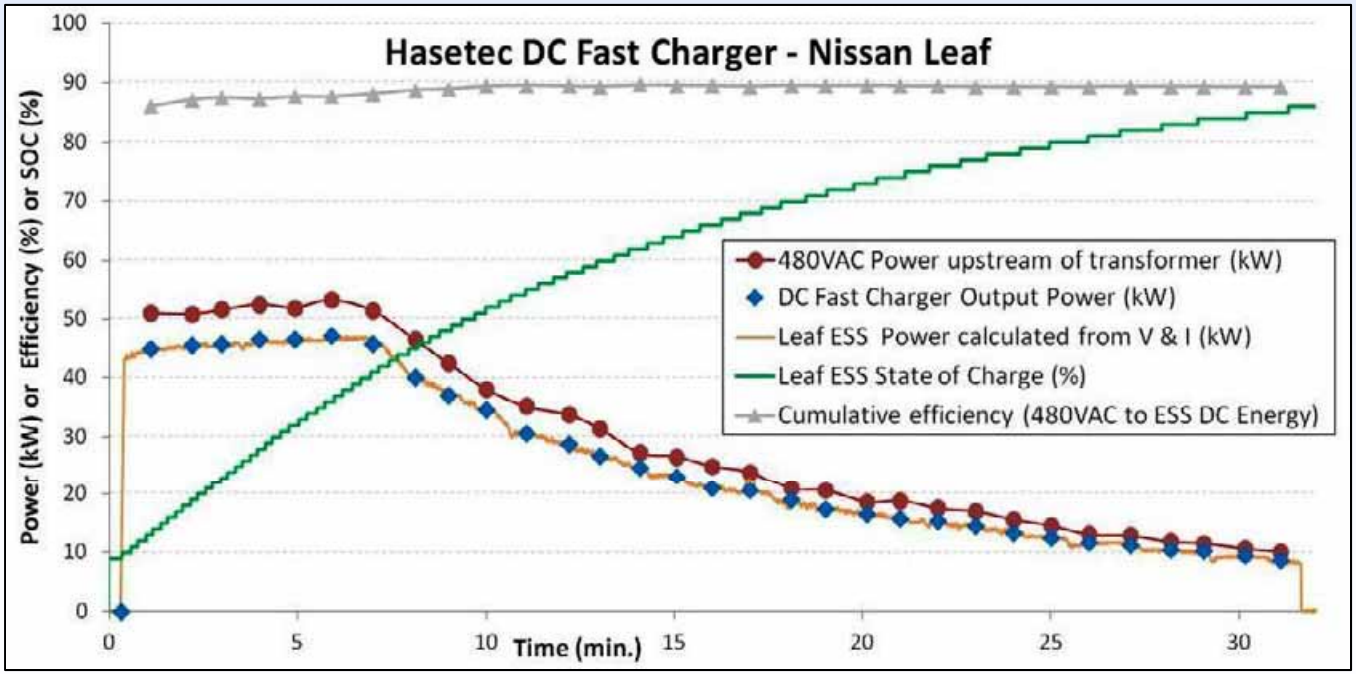





- Most EVSE consume 13 W or less at rest
- Watt use tied to features
- Most EVSE under 30 W during charge
- Most EVSE 99+% efficient during steady state charge of a Volt
- Three new EVSE for testing received

Hasetec DC Fast Charging Nissan Leaf

- 53.1 AC kW peak grid power
- 47.1 DC kW peak charge power to Leaf energy storage system (ESS)
- 15.0 Grid AC kWh and 13.3 DC kWh delivered to Leaf ESS
- 88.7% Overall charge efficiency (480VAC to ESS DC)

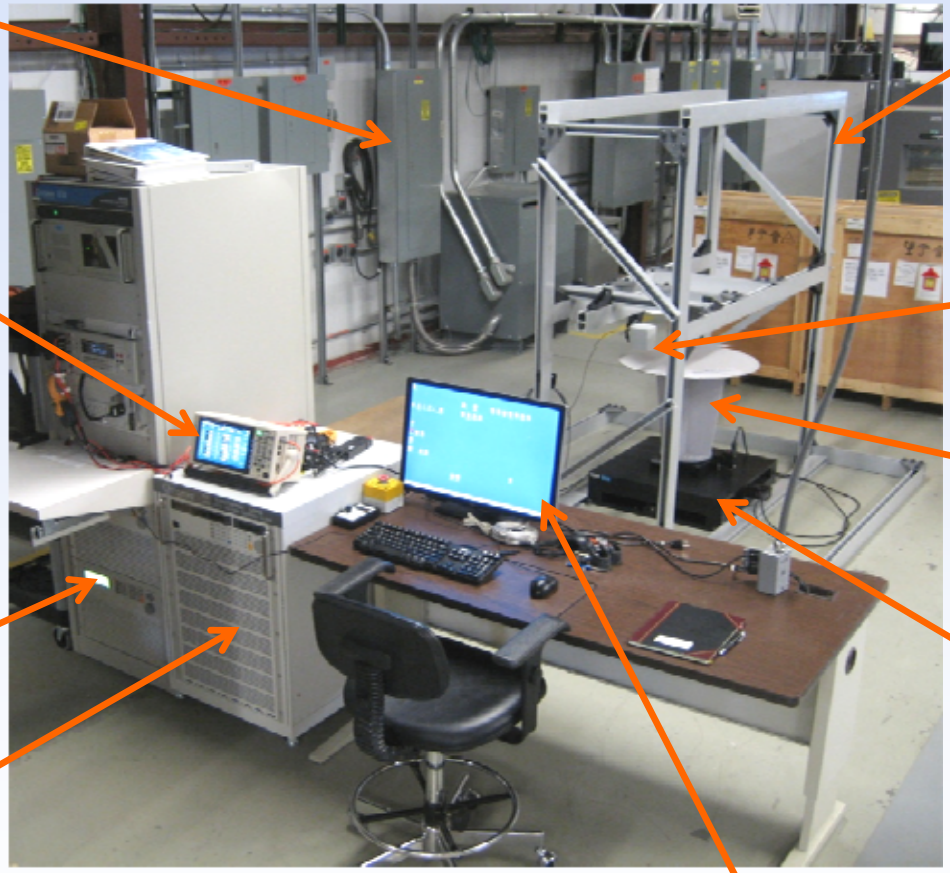


Wireless Charging Infrastructure Testing

INL Wireless Interoperability Test Bed

- First two wireless systems received from Evatran
- Shared formal test plan with other DOE labs
- Started NDAs with two OEMs for testing vehicles / wireless charge systems
- Discussing testing with another OEM
- Supporting SAE J2954 committee and UL with refinement of testing procedures
- Identified suitable INL runway for 300 meter testing of wireless systems to FCC standard
- Along with other DOE labs, much time spend on SAE wireless committee conference calls
- Structured testing of first wireless system scheduled for this week

INL Wireless Charging Bench Testing



Other Testing Activities

and

Where you can find this presentation

Additional Infrastructure Work

- Initiated I-5 corridor DCFC study
- Six Leaf DCFC and L2 charging study on battery life
  - Two vehicles driven on road and L2 charged
  - Two driven identical routes DCFC charged
  - One L2 and one DCFC in battery lab
  - At 20k miles each Leaf similar minimal capacity fade

- INL conducted with NFPA and US DOT, traction battery fire first responder suppression burns – reviewing report
- INL initiated ~400 New York EVSE data collection with NYSERDA, NYPA, Port Authority of NY/NJ, and Energetics
- 30 EVSE and 10 vehicle conductive interoperability testing with SAE scheduled for late summer
- INL will receive data from six NYC Nissan Leaf taxis, six Level 2 EVSE, three DCFCs, and Taxi & Limo Commission
- Conducting TOU rate study for DOE Office of Electricity
- If I only had another 30 minutes I could have 100 slides….

Acknowledgement

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

More Information

http://avt.inl.gov

This presentation will be posted in the publications section of the above website, alphabetically as "GITT 2013 (6/19/13) - EV Project and Charging Infrastructure Update"

INL/MIS-13-29455