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

INL's Plug-in Electric Vehicle Demonstrations and Testing

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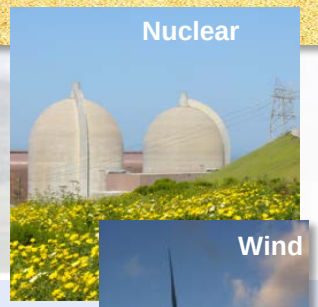
Idaho National Laboratory

This presentation does not contain any proprietary or sensitive information

Idaho National Laboratory

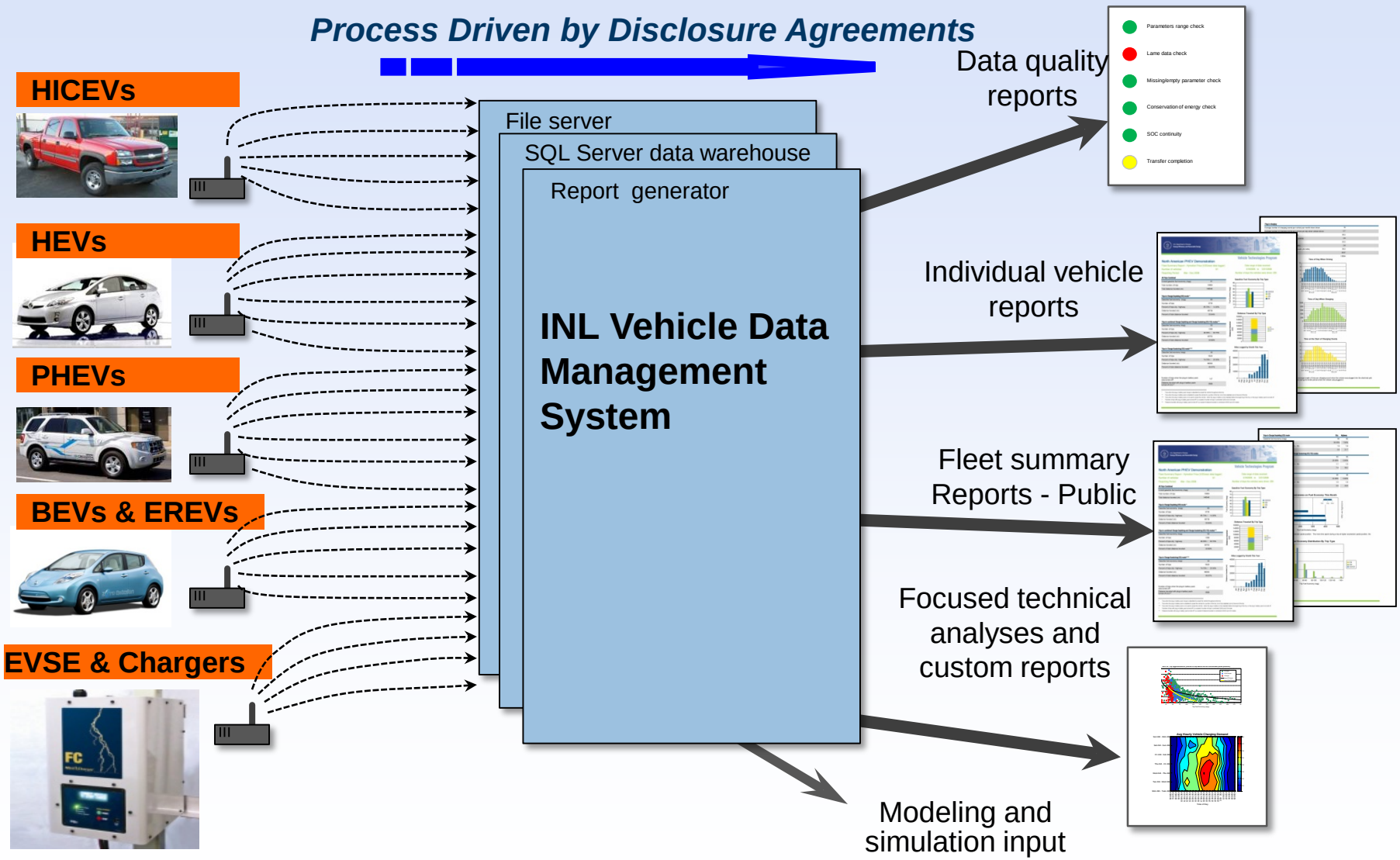


- U.S. Department of Energy (DOE) laboratory
- 890 square mile site with 4,000 staff
- Support DOE's strategic goal:
  - Increase U.S. energy security and reduce the nation's dependence on foreign oil
- Multi-program DOE laboratory
  - Nuclear Energy
  - Fossil, Biomass, Wind, Geothermal and Hydropower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

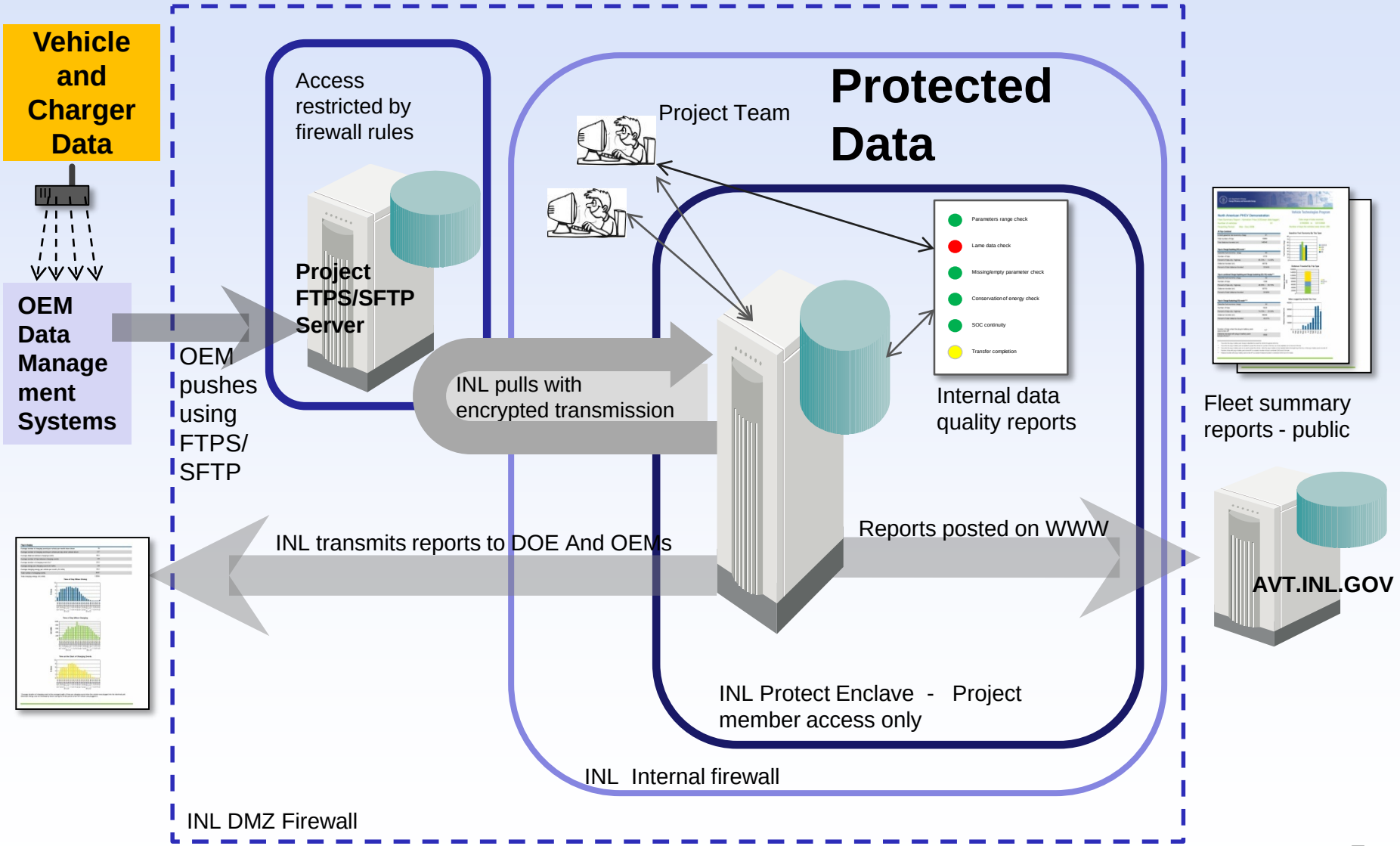
Vehicle / Infrastructure Testing Experience

- **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



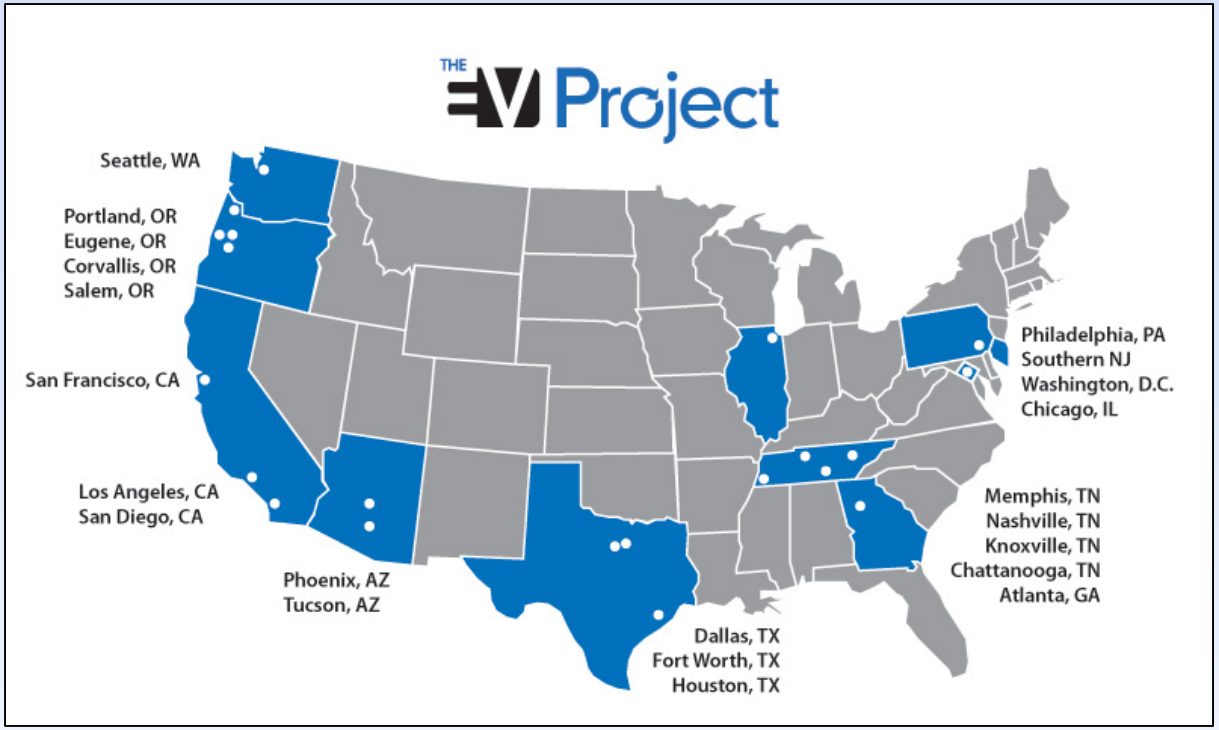
INL Vehicle/EVSE Data Transfer Process



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

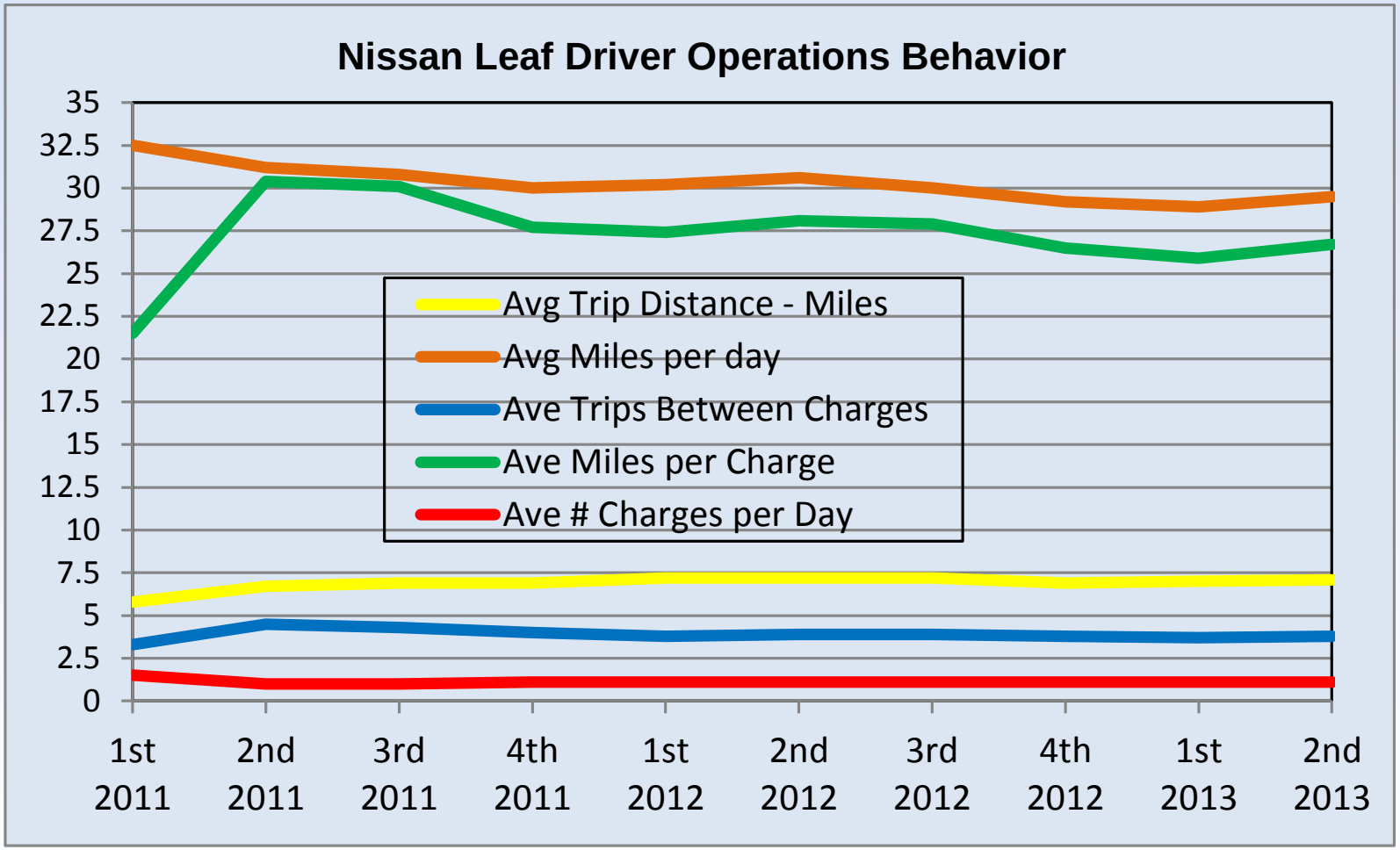
EV Project – National Data

2st quarter 2013 Data Only

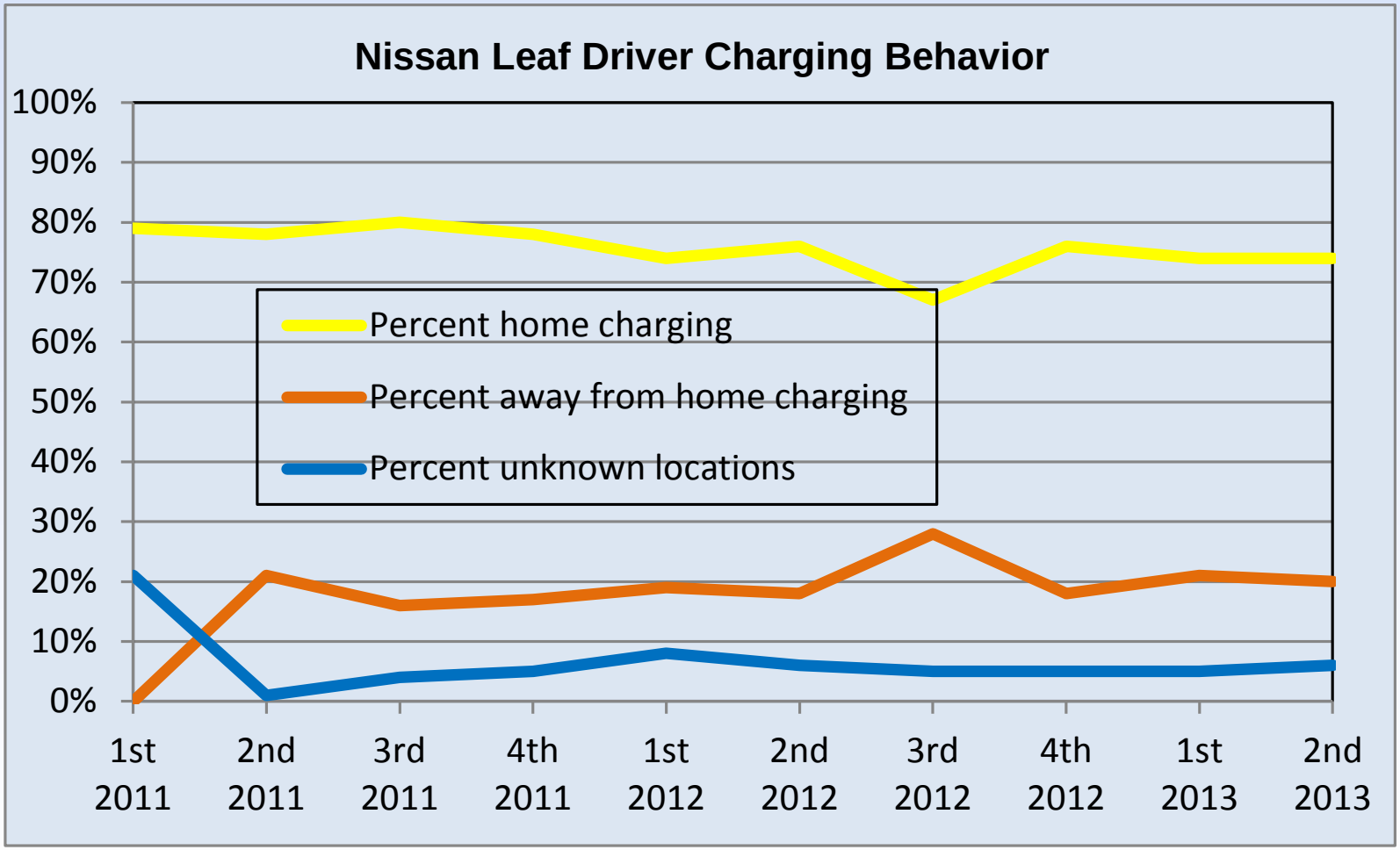
	Leafs	Volts
• Number of vehicles	4,261	1,895
• Number of Trips	1,135,000	676,000
• Distance (million miles)	8.04	5.75
• Average (Ave) trip distance	7.1 mi	8.3 mi
• Ave distance per day	29.5 mi	41.0 mi
• Ave number (#) trips between charging events	3.8	3.3
• Ave distance between charging events	26.7 mi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

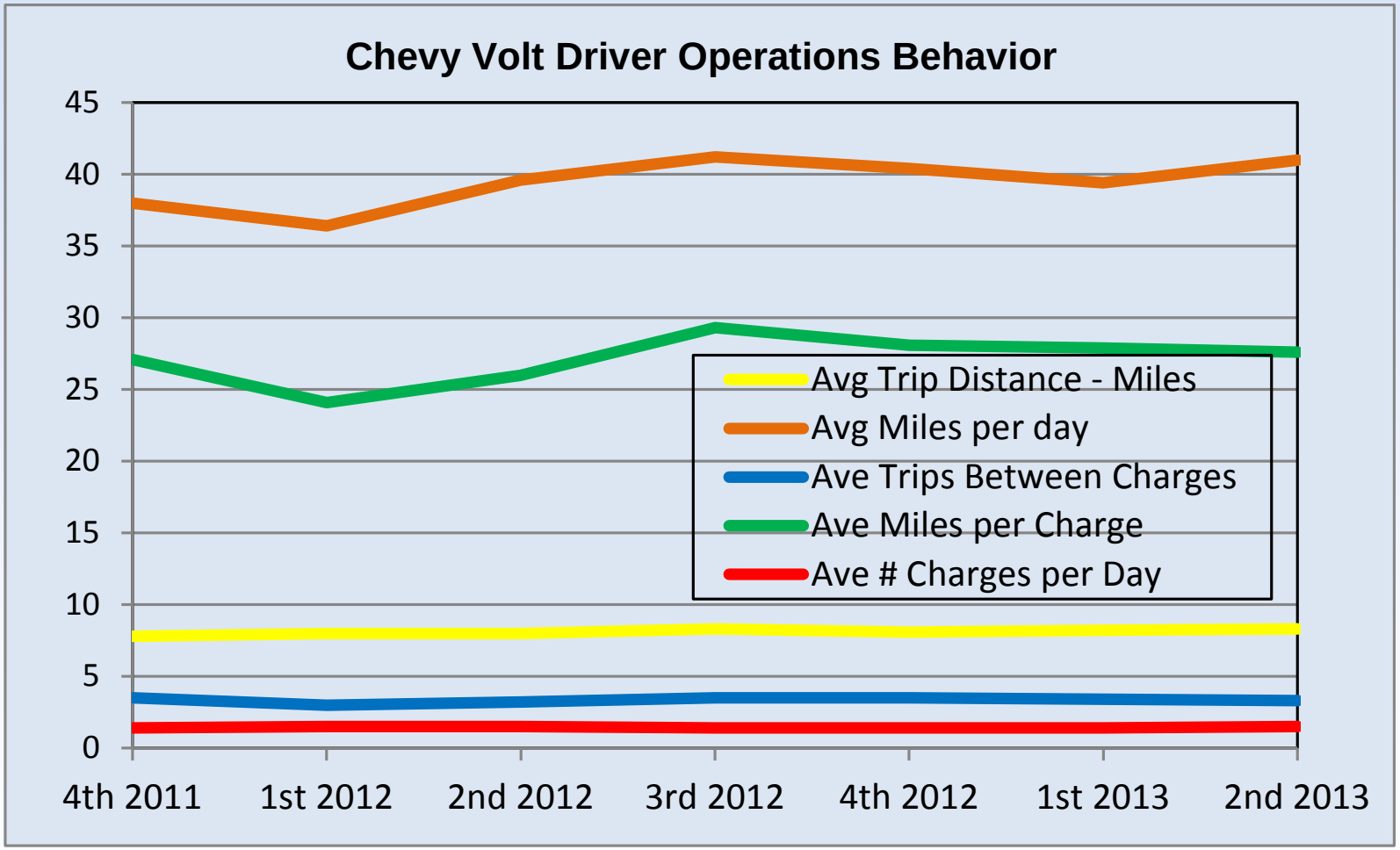
EV Project – Leaf Profiles



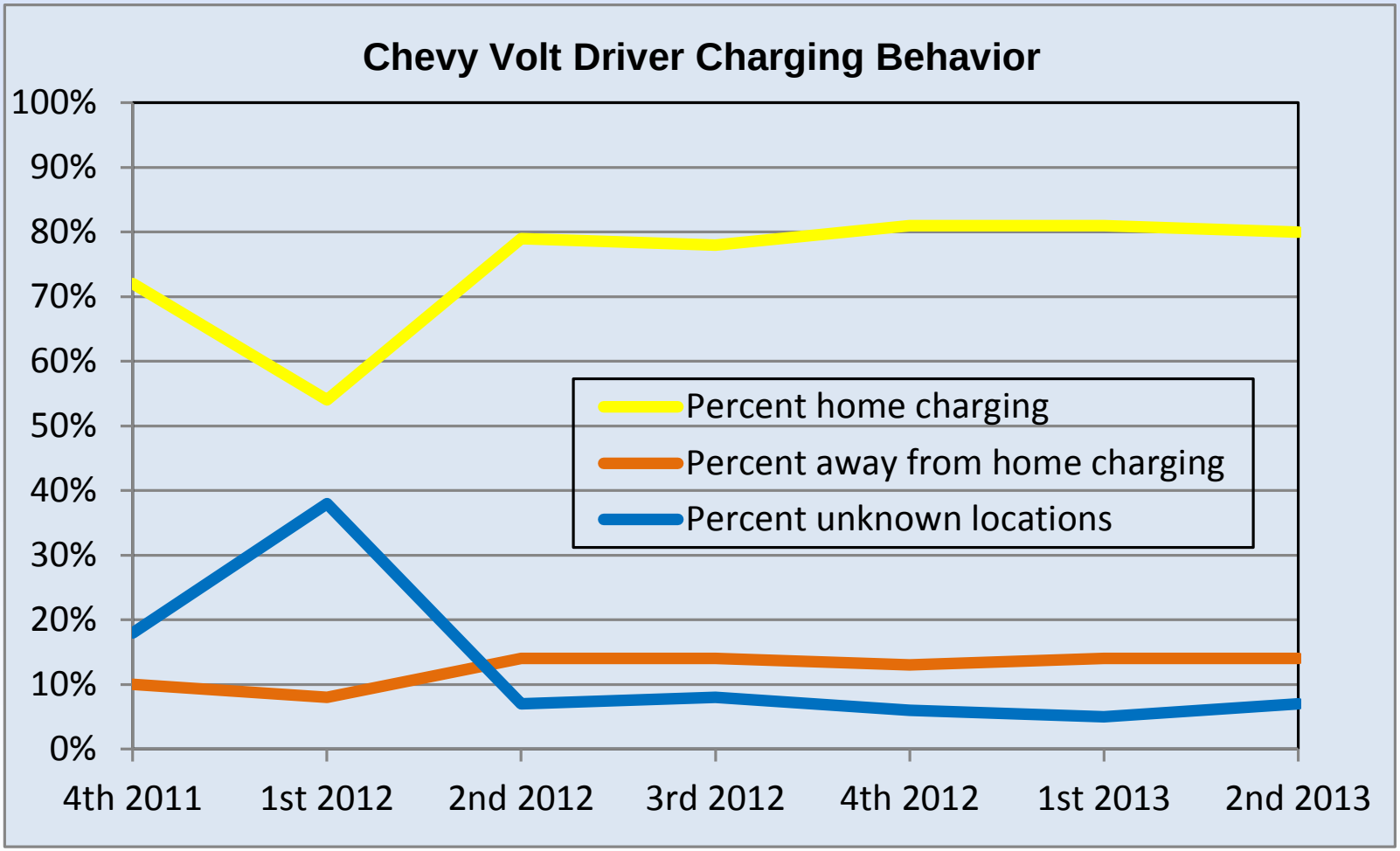
EV Project – Leaf Profiles



EV Project – Volt



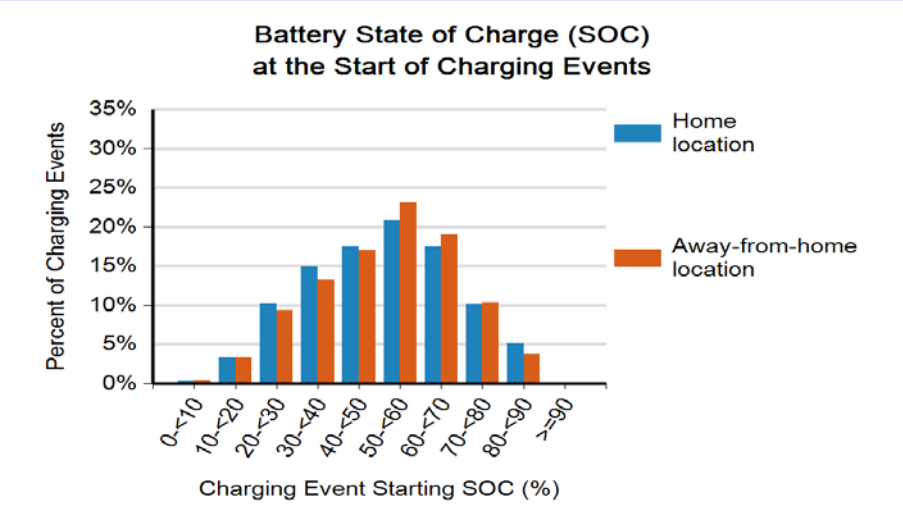
EV Project – Volt

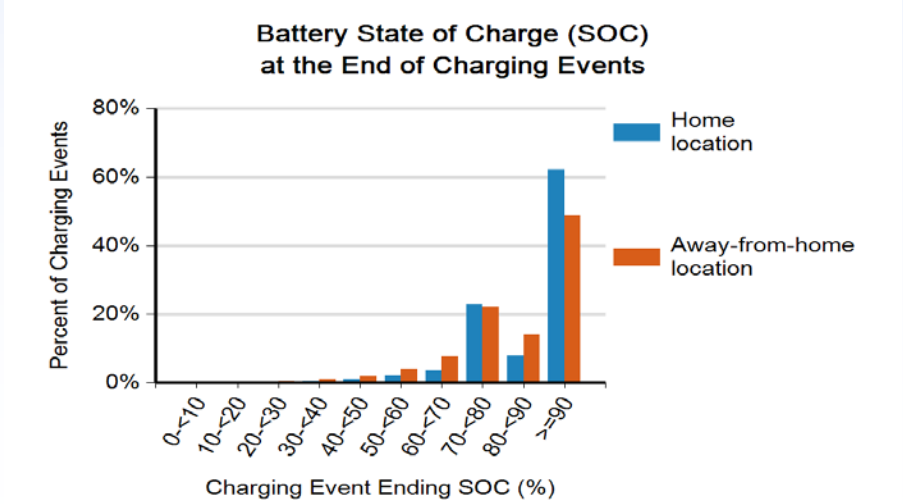


EV Project – Leaf & Volt Charging

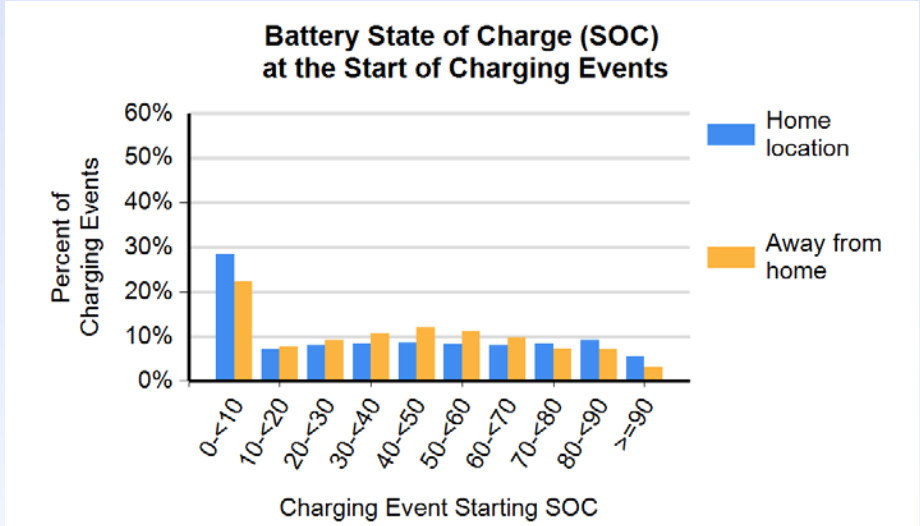
2st quarter 2013 Data Only

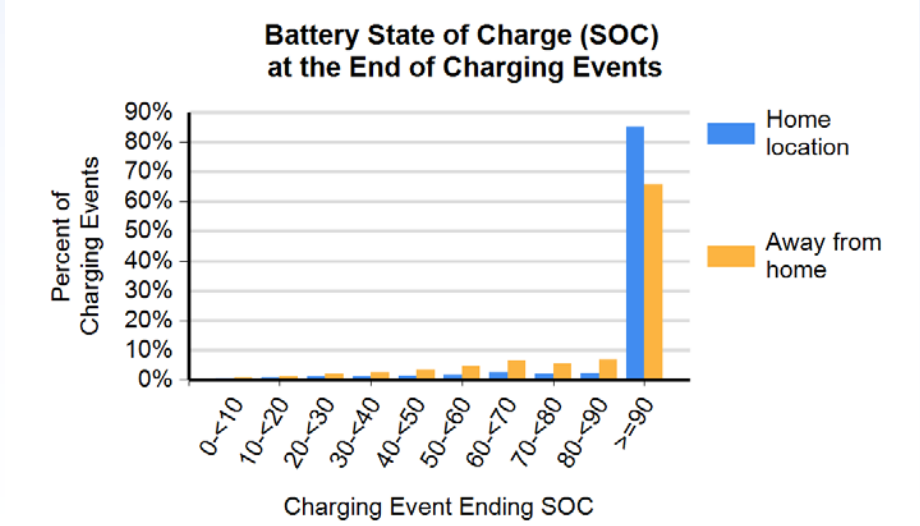
Leafs



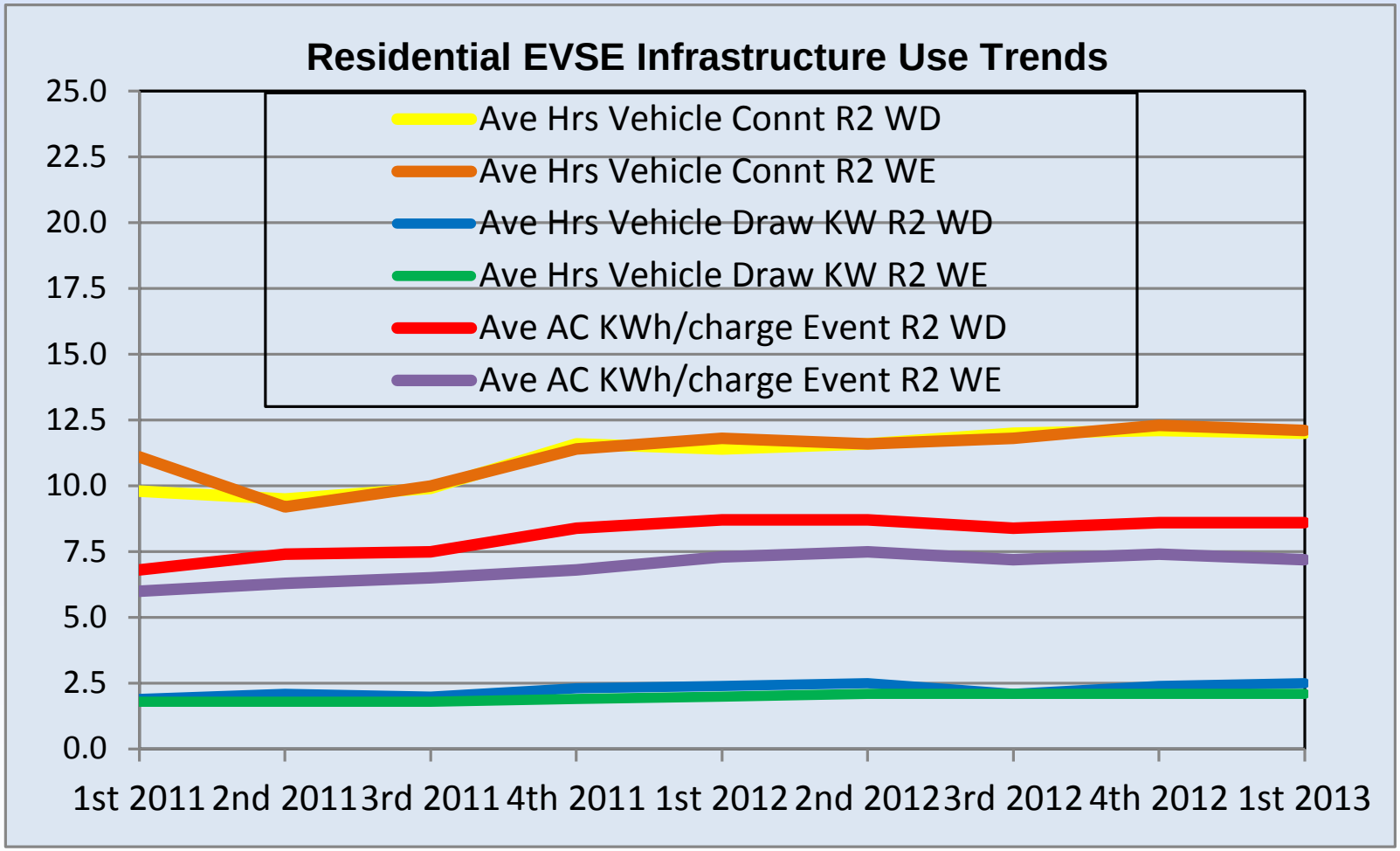


Volts

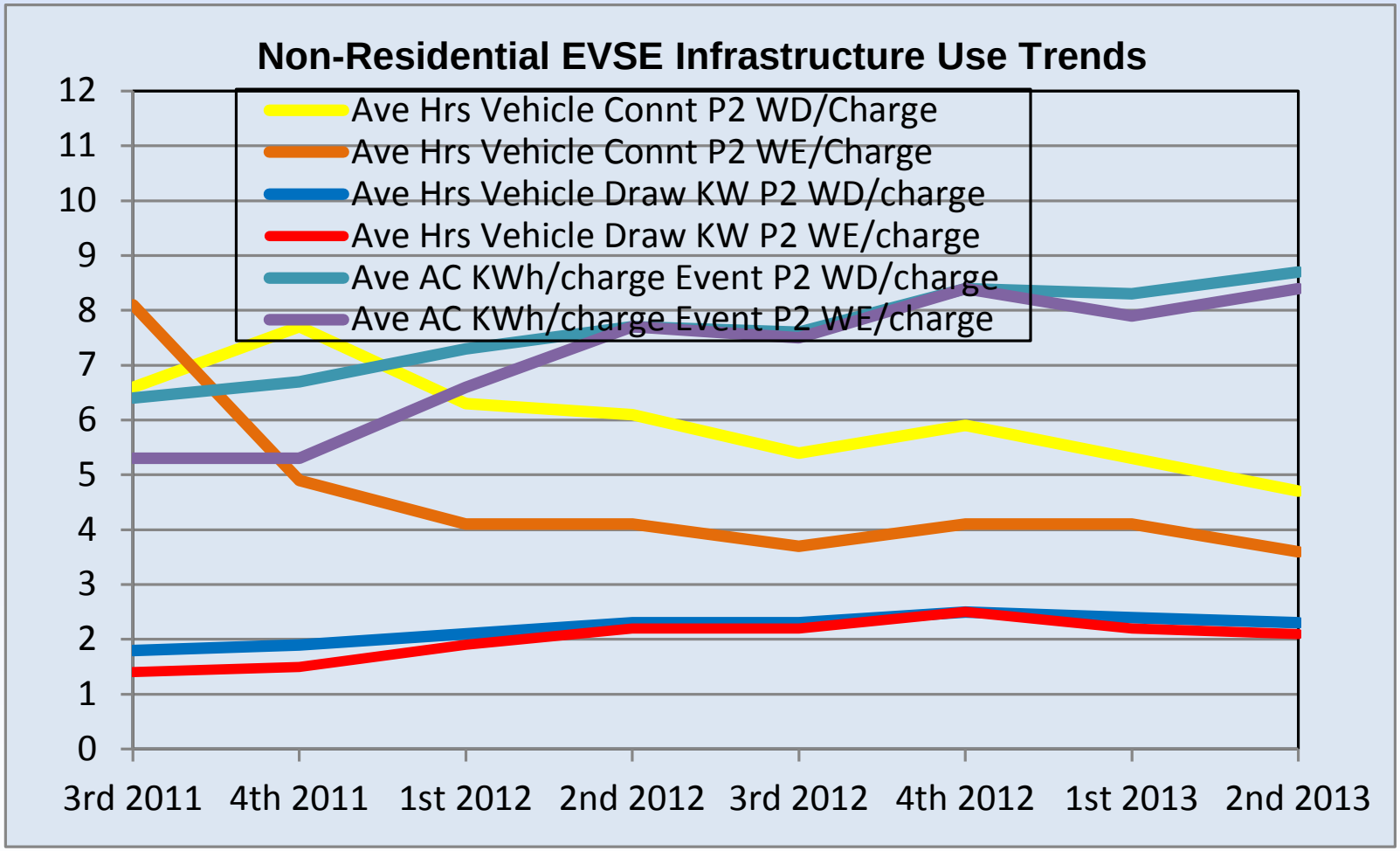




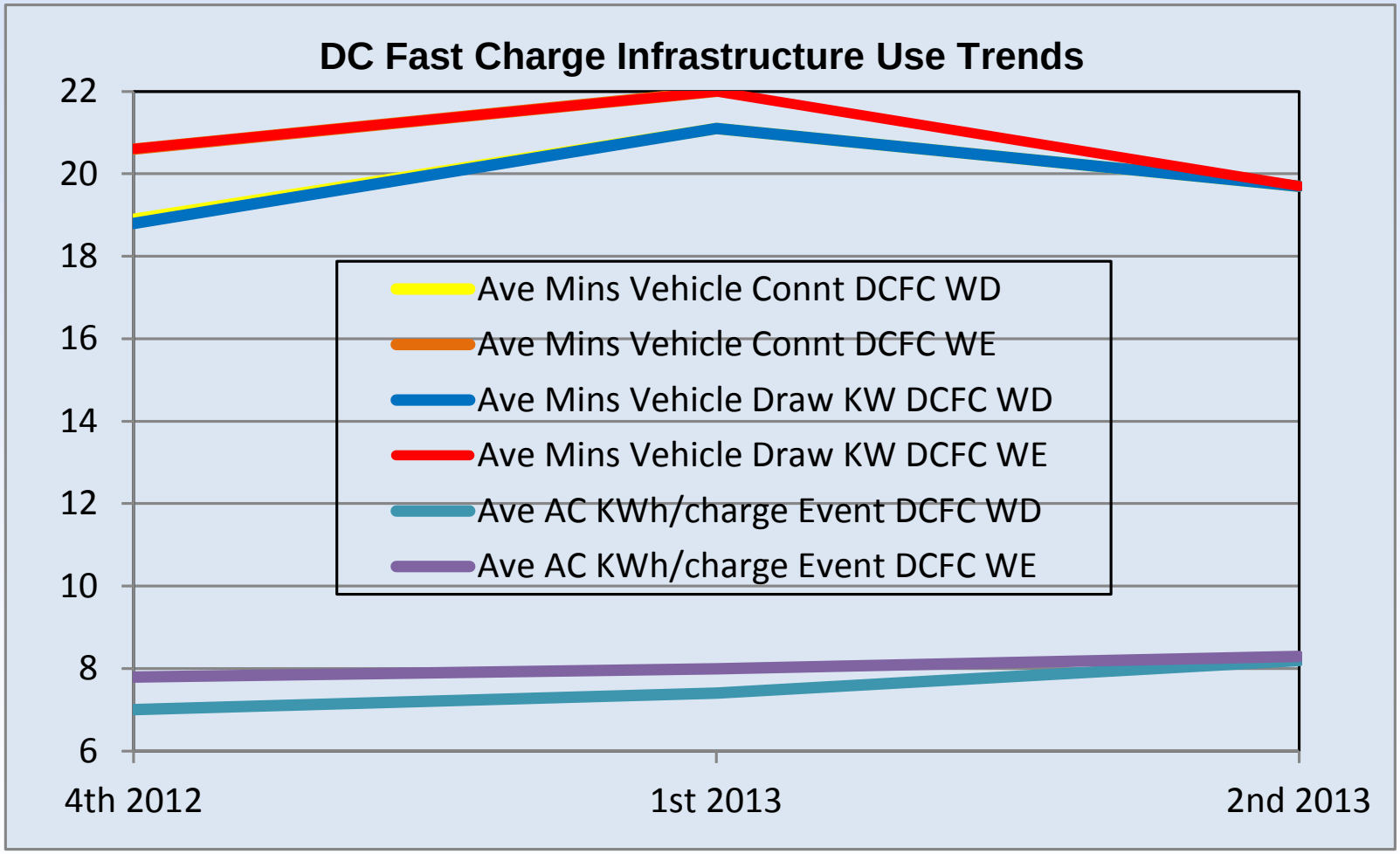
EV Project – Residential EVSE Use



EV Project – Non Residential L2 EVSE Use

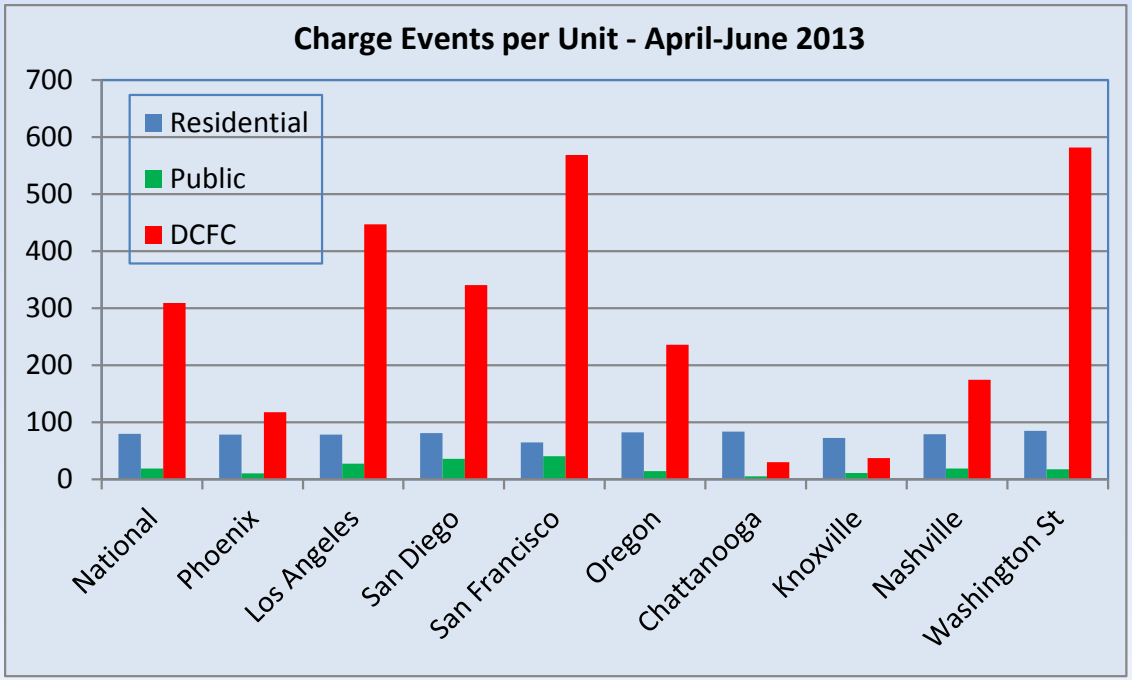


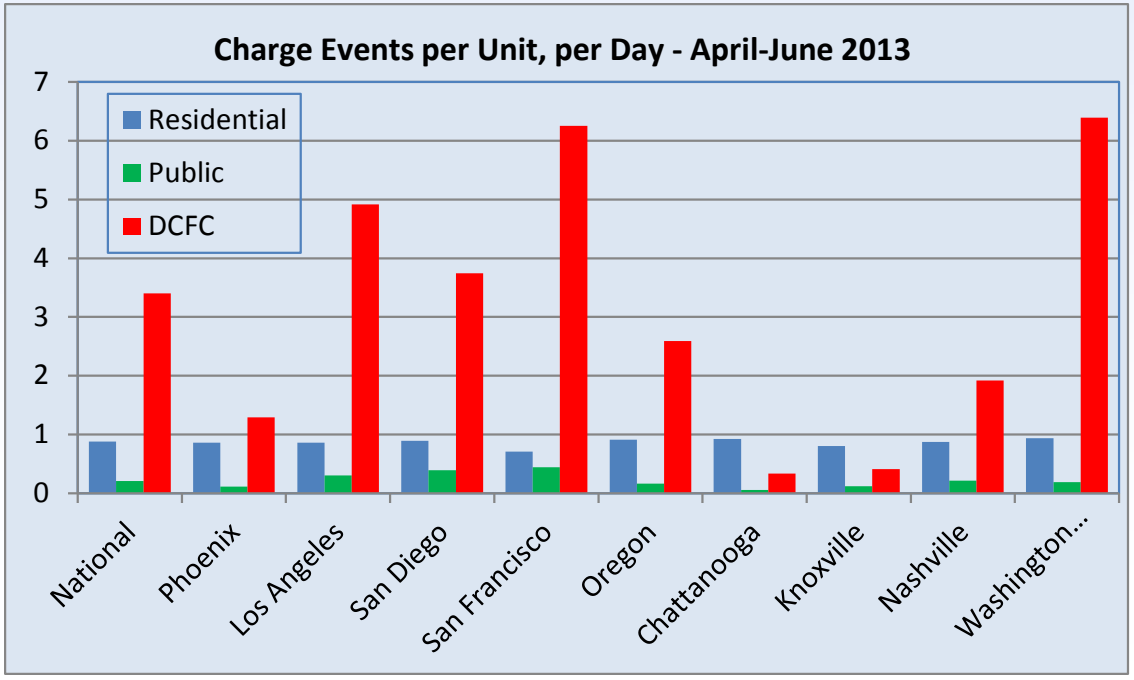
EV Project – DCFC Use



EV Project – Infrastructure use

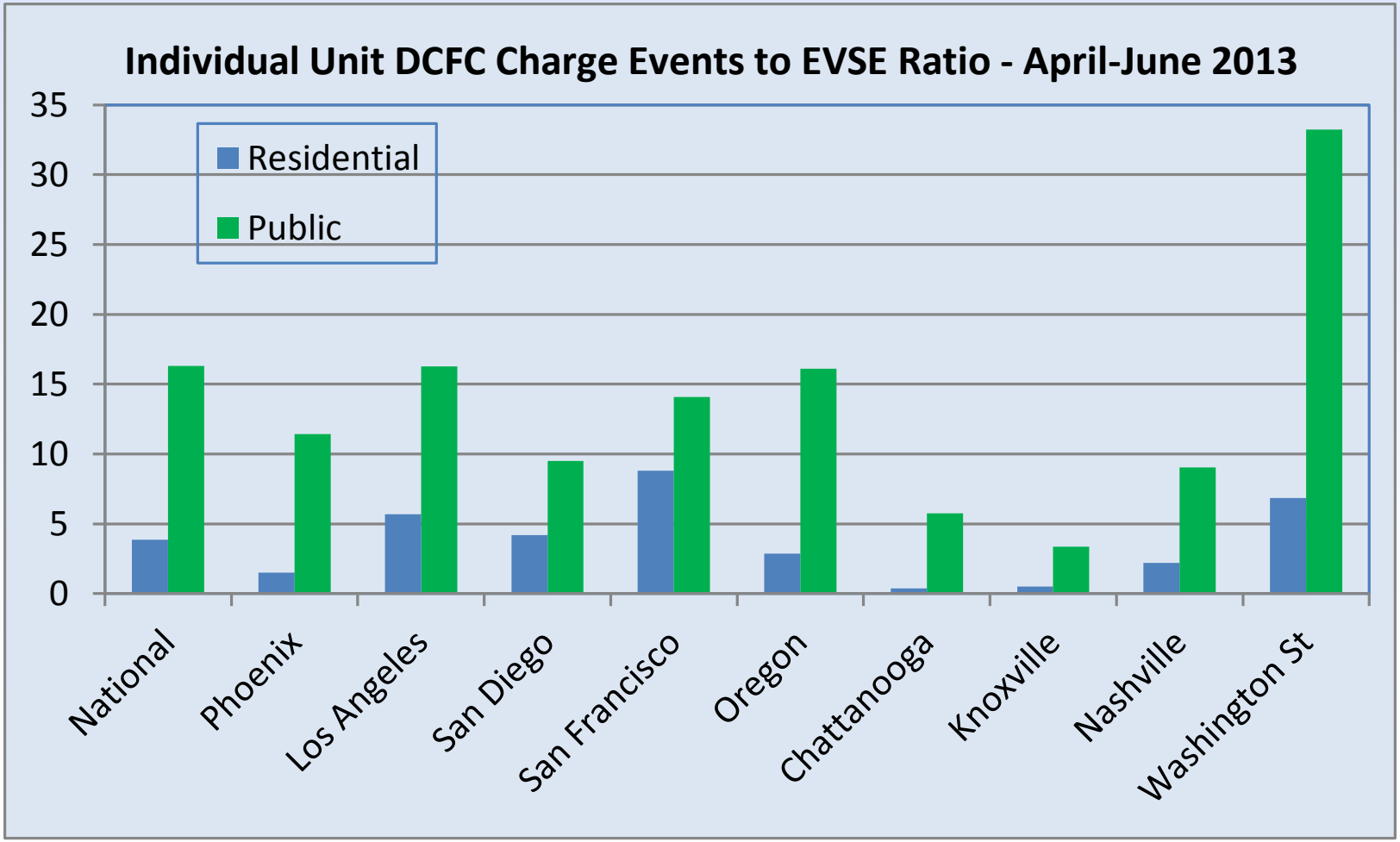
- **Per unit use, 2nd quarter 2013 reports**





EV Project

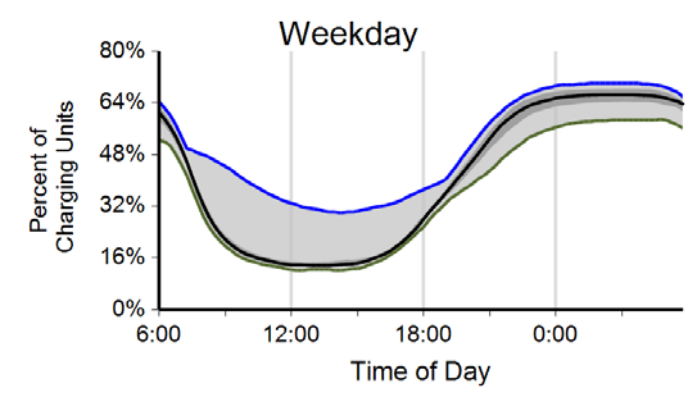
- **Per unit use, 2nd quarter 2013 reports**
- **DCFC use per unit compared to residential and public access Level 2 EVSE**



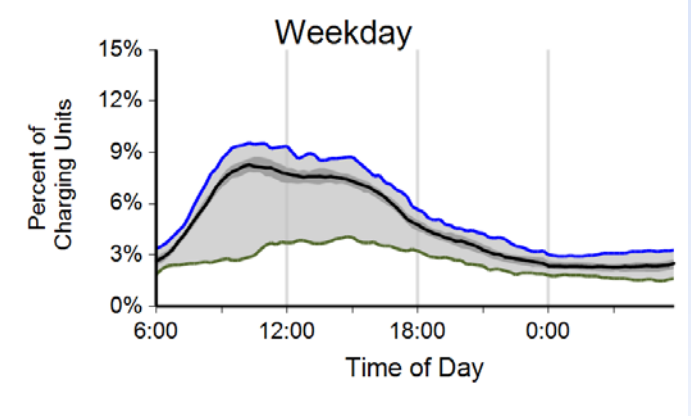
Residential & Public Level 2 EVSE Use

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

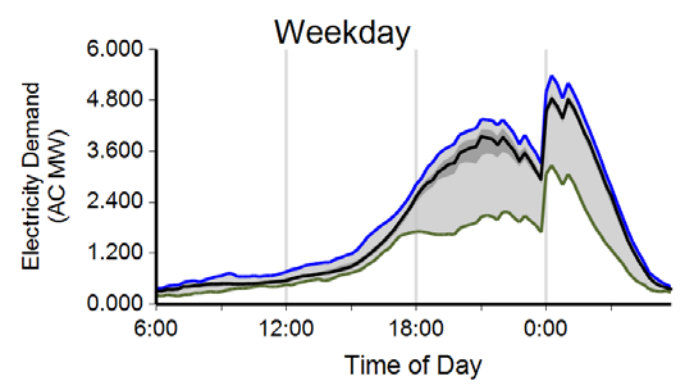
National Residential Connect Time



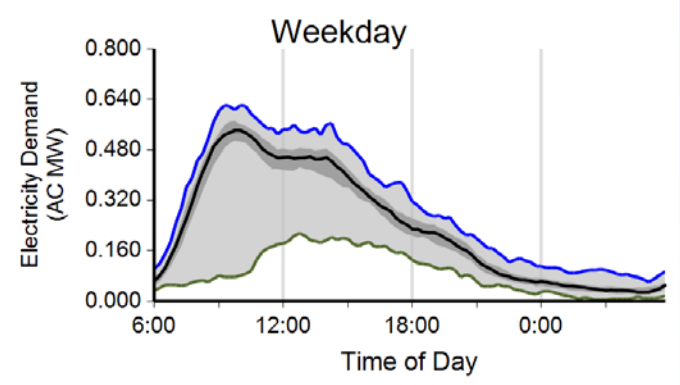
National Public Connect Time



National Residential Demand



National Public Demand

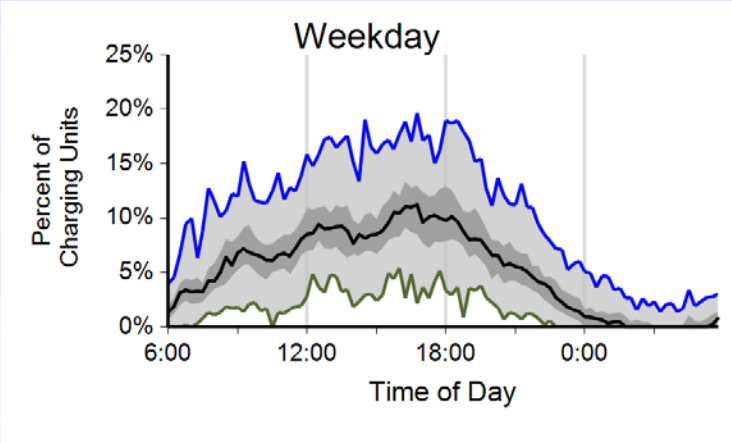


Legend: 91 day reporting period. Data is max (blue line), mean (black line) and minimum (green line), for the reporting period. Dark gray shaded is plus and minus 25% quartile. Same legend all demand and connect time graphs

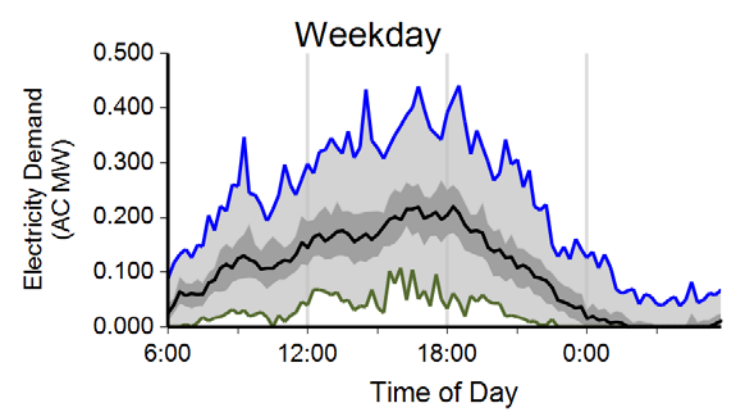
EVSE DCFC Use

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

Weekday Connected Profile



Weekday Demand Profile

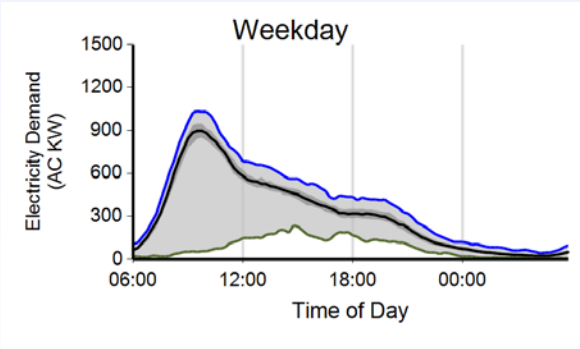


- EV Project Leafs 25% charge events and 24% energy used
- Unknowns are Non EV Project vehicles
- 3.8 average charge events per day per DCFC
- 19.5 minutes average time connected
- 19.5 minutes average time drawing energy
- 8.3 kWh average energy consumed per charge

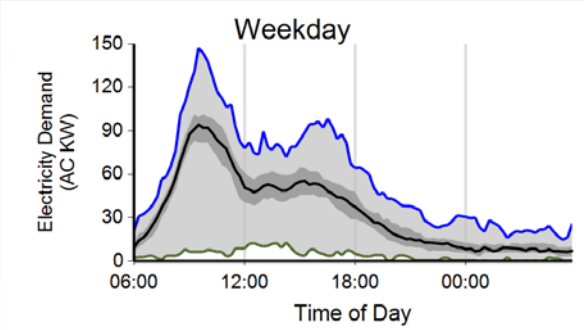
ChargePoint Infrastructure Reporting

- **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**

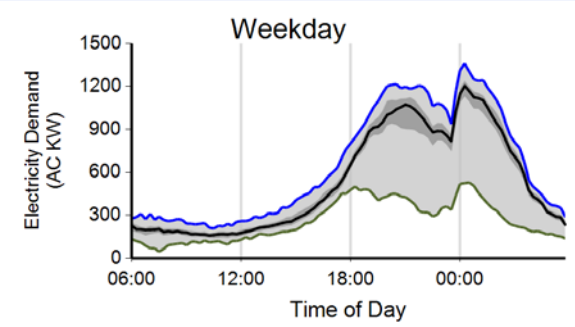
Public Demand



Commercial Demand

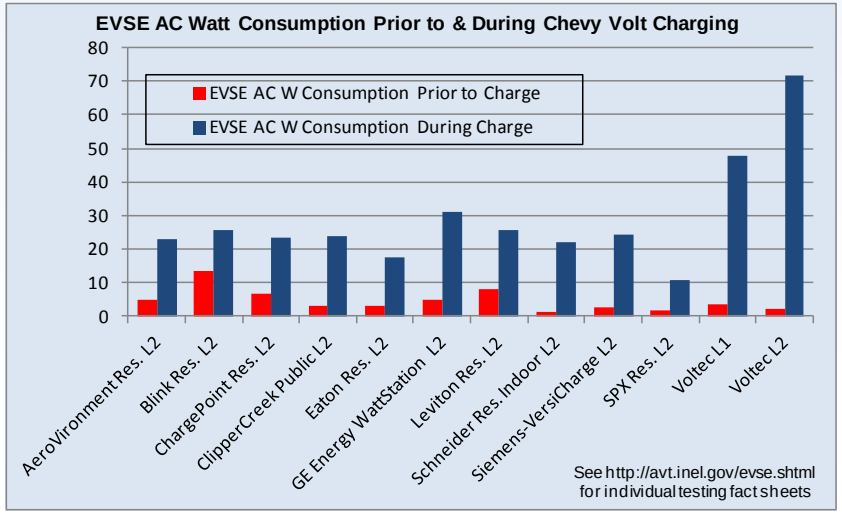


Residential Demand



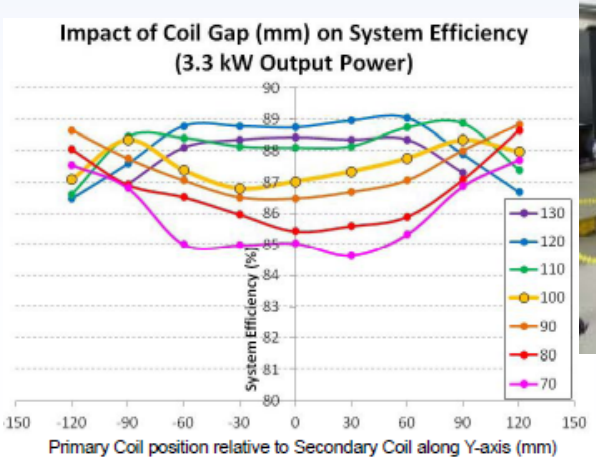
Conductive EVSE & DCFC Testing

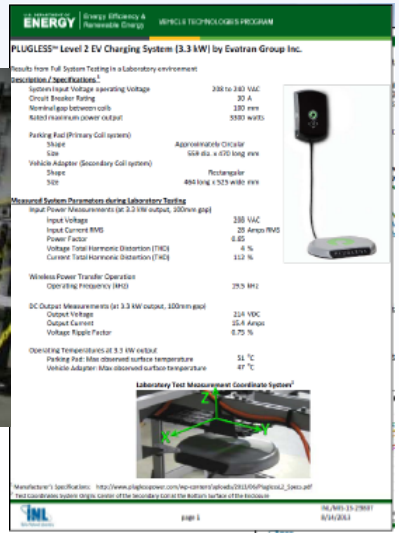
- Tested and reported 13 Levels 1 & 2 EVSE, and DC Fast Chargers (DCFC), with additional units in the test queue
  - Benchmarks grid-to-vehicle and grid-to-battery efficiencies, standby power requirements, power quality feedbacks
- Developing with SAE multi EVSE, DCFC and PEV compatibility testing regime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

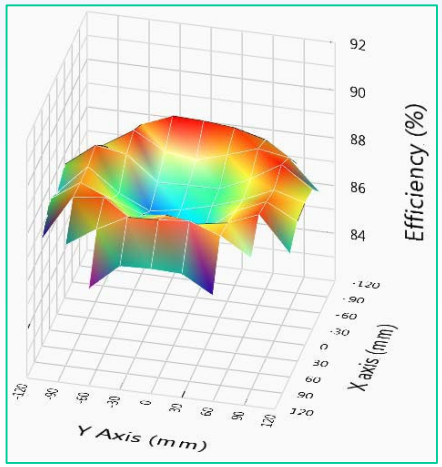


Wireless Power Transfer (WPT) Activities

- Testing lab and vehicle based WPT systems
  - Efficiency, EMF and safety testing
- NDA's being signed with additional WPT companies
- Supporting SAE's development of WPT test 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







Other Grid Infrastructure Activities

- EVSE Grid Study for DOE Office of Electricity
  - Time of use rate impacts on pricing elasticity
- Cyber security testing of 5 Level 2 EVSE
  - Examines vulnerabilities from EVSE to back office operations, and potentially connected utilities
- New York City electric taxi and infrastructure study
  - For the NYC Taxi and Limousine Commission and DOE, document BEV taxi travel and EVSE and DCFC grid use in highly congested environment
  - Supports inner city EVSE and DCFC planning

Other Grid Infrastructure Activities – cont'd

- Nissan Leaf DCFC Testing
  - Grid and battery impacts from DCFC charging
  - Probable secondary use distributed storage study
- Battery Mule Testing of advanced batteries
  - Traction battery testing will provide secondary use battery for distributed energy study
- Chevy Volt and other OEM demonstrations
  - Demonstrates BEV, PHEV and EREV grid use
- Grid Interaction Technical Team
  - Project(s) selection and execution as team member

Acknowledgement

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http://avt.inl.gov

INL/CON-13-30604