PLUG-IN 2013

# Plug-in 2013 - EV Project Charging Infrastructure Deployment Costs, Cost Drivers and Use

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**Idaho National Laboratory**

**Session B3: Getting the Cost Out - Best Practices for PEV Infrastructure**

**October 2013**

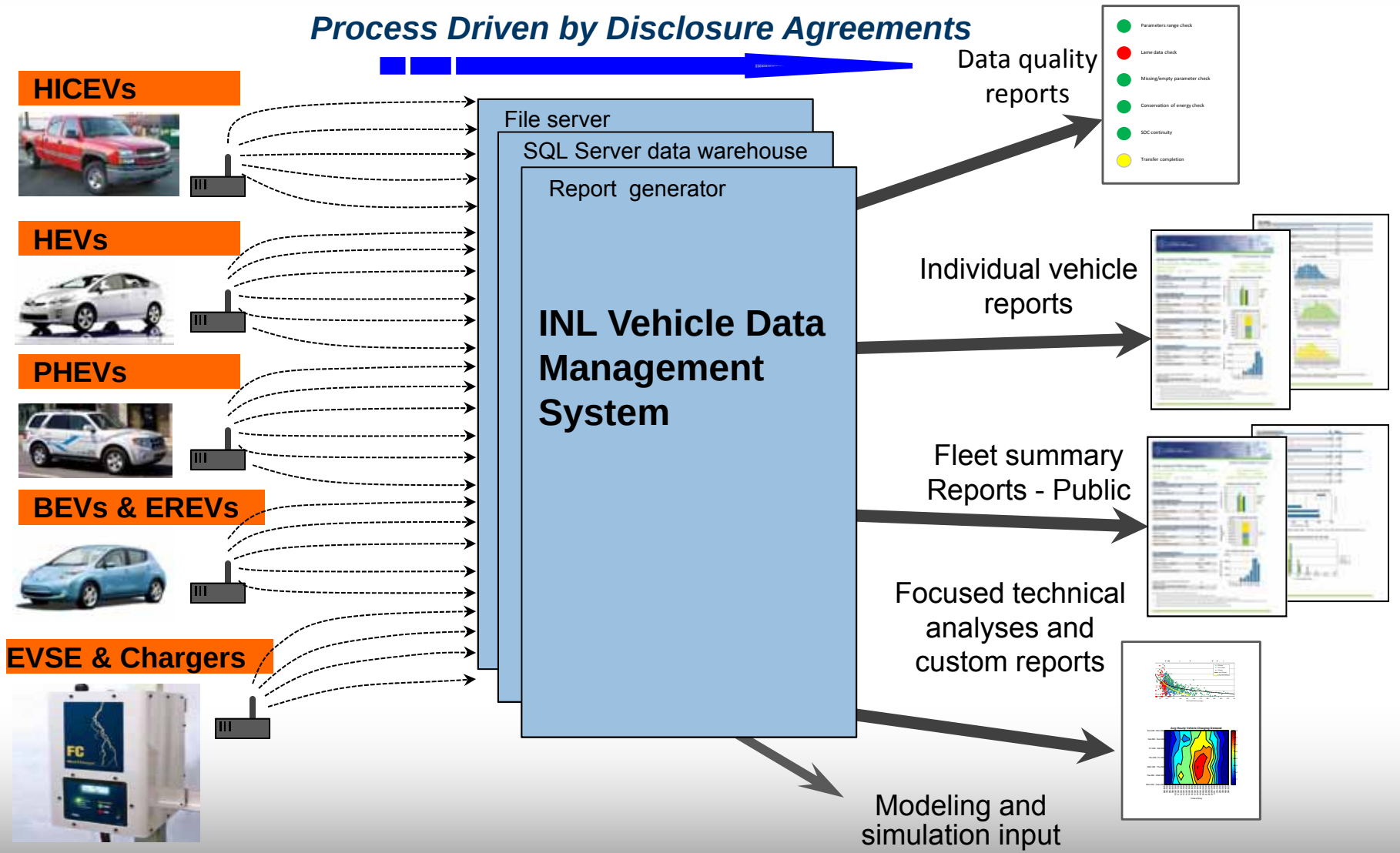
INL Idaho National Laboratory

U.S. DEPARTMENT OF ENERGY

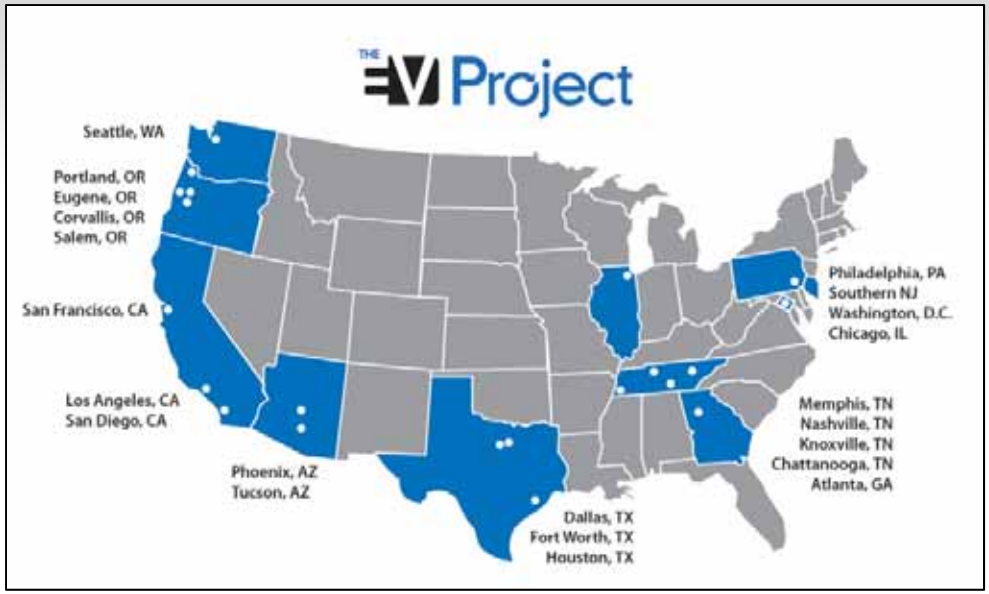
# Vehicle / Infrastructure Testing Experience

- **120 million test miles accumulated on 11,600 electric drive vehicles and 16,800+ EVSE and DCFC**
- **EV Project: 8,110 Leafs, Volts and Smart EVs, 12,604 EVSE and DC Fast Chargers (DCFC), 100 million test miles. 1 million miles every 6 days**
- **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



# 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**

# 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**

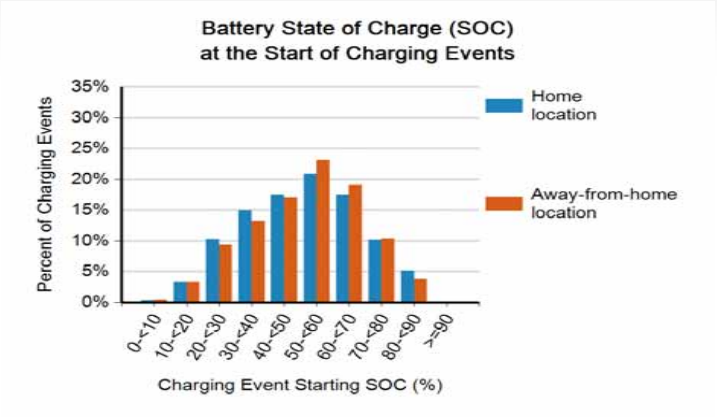

# EV Project – National Data

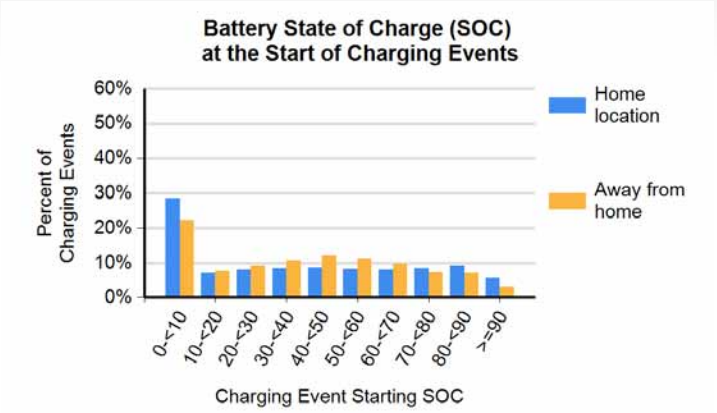
**2nd quarter 2013 Data Only**

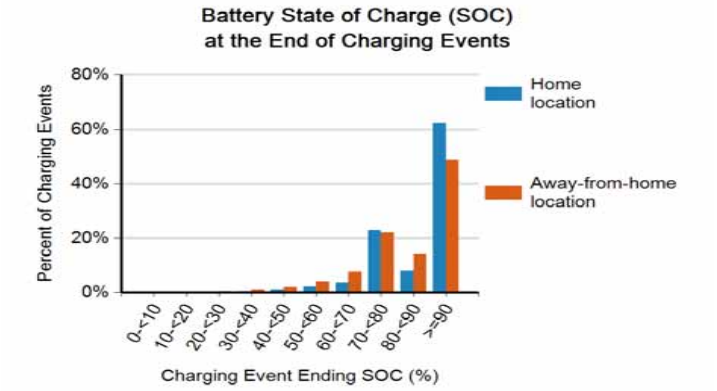
| | Leafs | Volts |
|---|---|---|
| • Number of vehicles | 4,261 | 1,895 |
| • Number of Trips | 1,135,000 | 676,000 |
| • Distance (million miles) | 8.04 | 5.75 |
| • Average (Ave) trip distance | 7.1 mi | 8.3 mi |
| • Ave distance per day | 29.5 mi | 41.0 mi |
| • Ave number (#) trips between charging 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 & Volt Charging

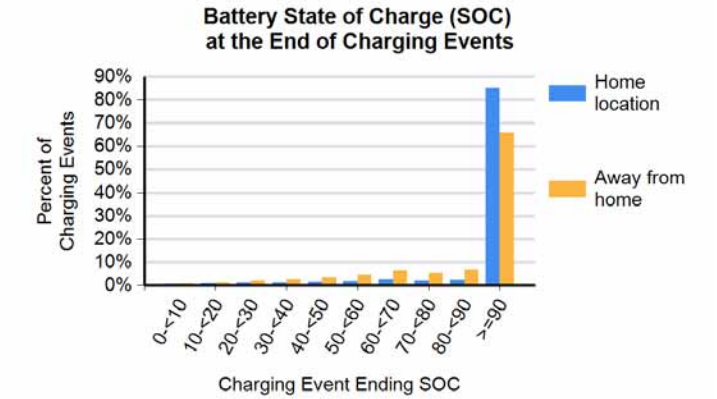


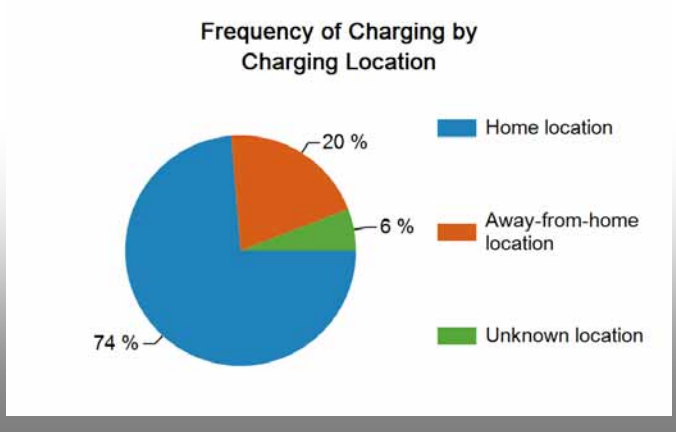



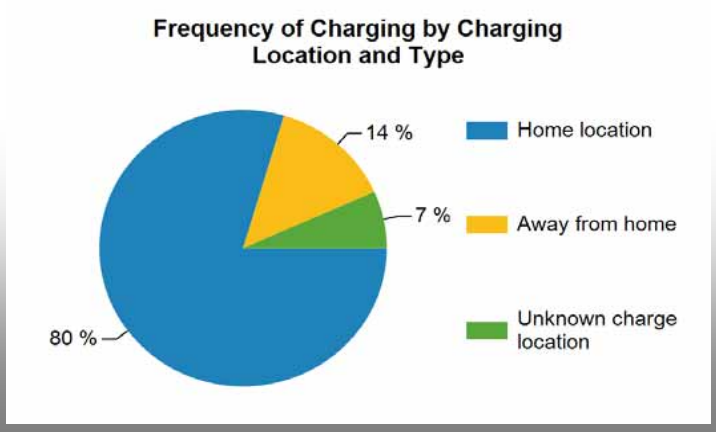




Leafs

Volts



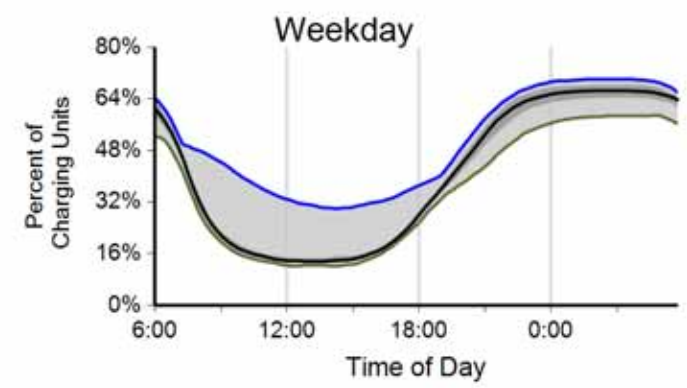



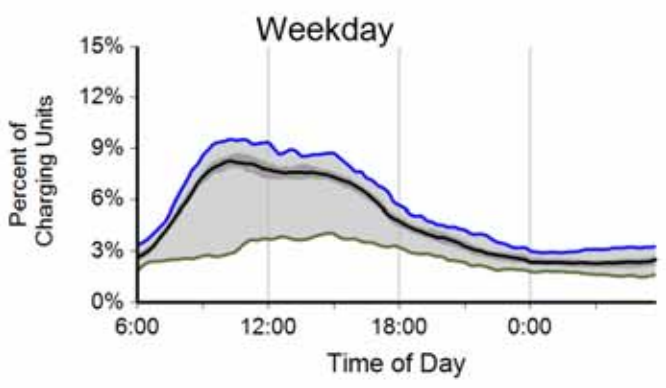
# Residential & Public Level 2 EVSE Use

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

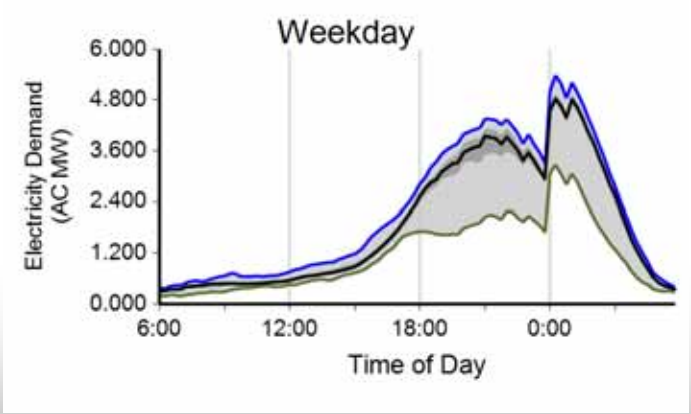
**National Residential Connect Time**



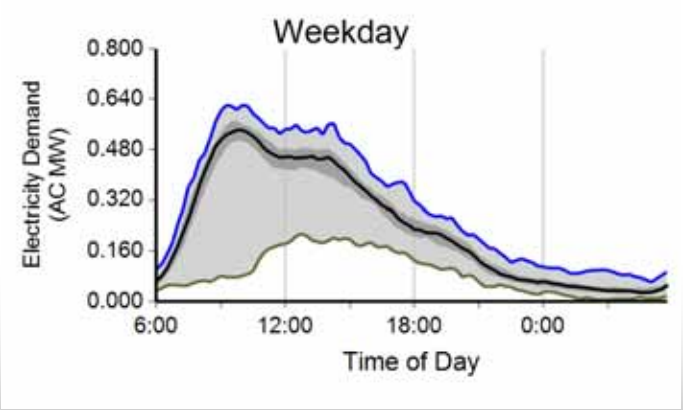

**National Public Connect Time**




**National Residential Demand**




**National Public Demand**

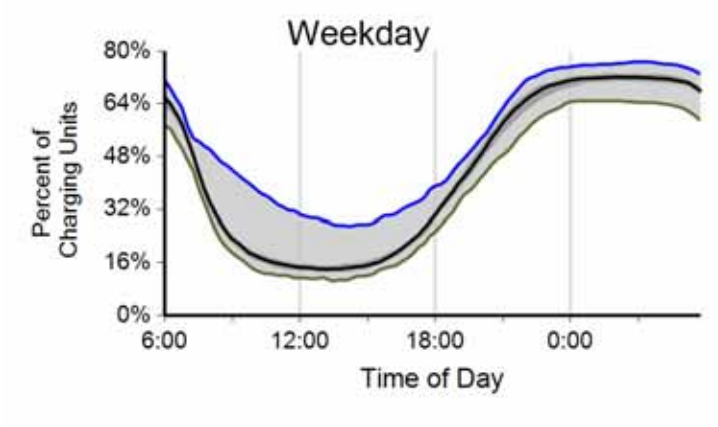



**Legend: 91 day reporting period. Data is max (blue line), mean (black line) and minimum (green line), for the reporting period. Dark gray shaded is plus and minus 25% quartile. Same legend all demand and connect time graphs**

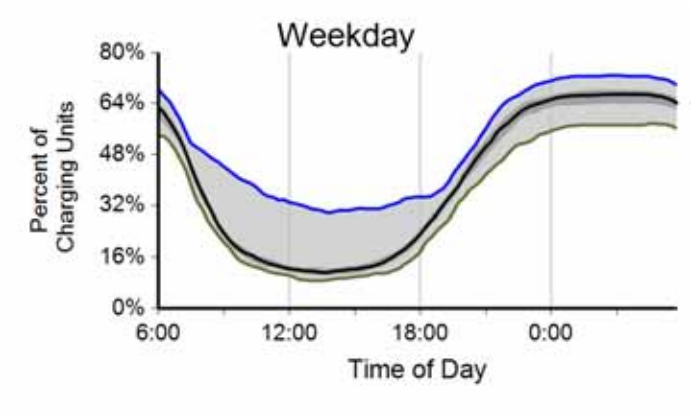
# Residential Level 2 EVSE Connect Profiles

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

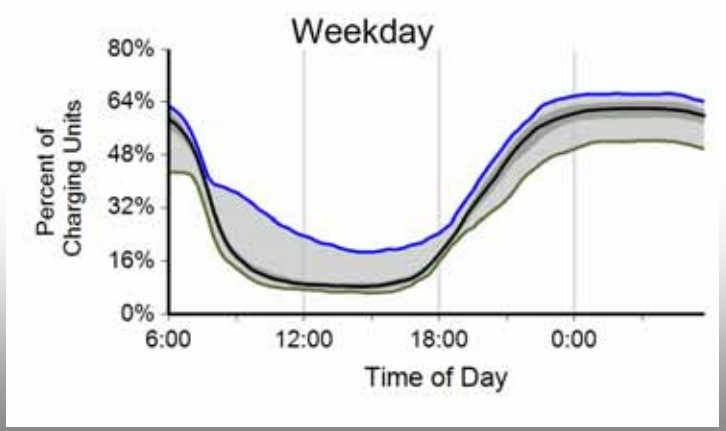
**San Diego**



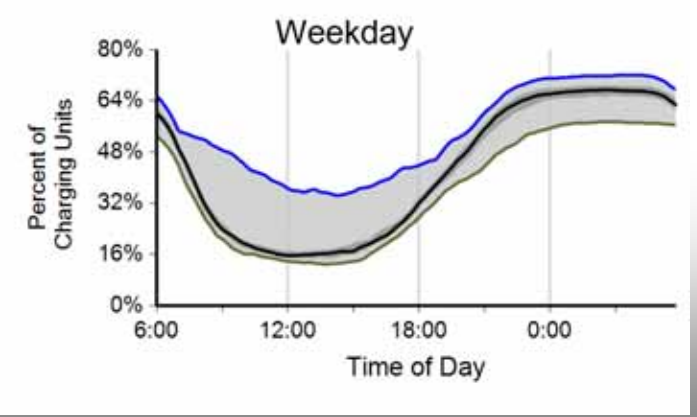

**Los Angeles**




**San Francisco**



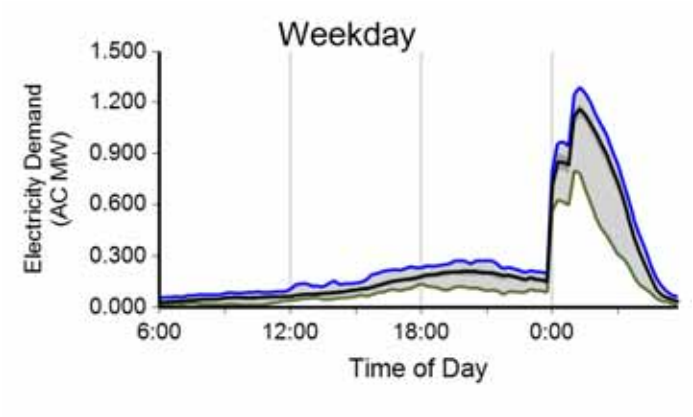

**Washington State**



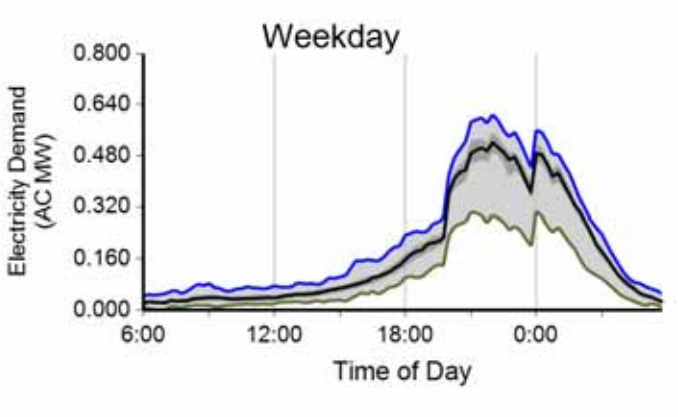
# Residential Level 2 EVSE Demand Profiles

- **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**

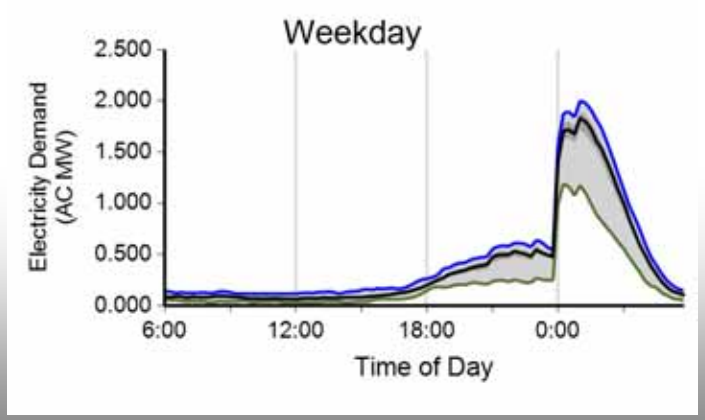
**San Diego**



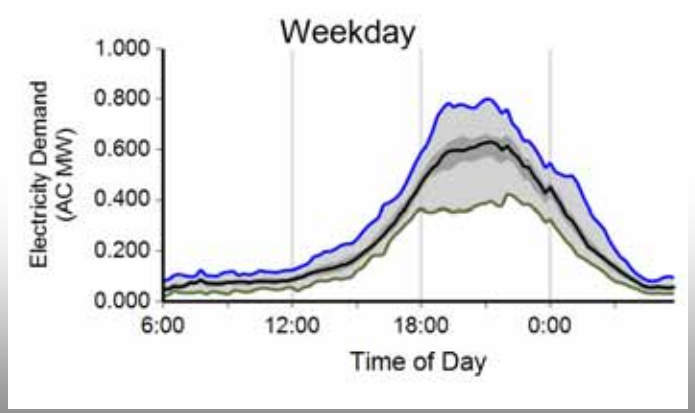

**Los Angeles**




**San Francisco**

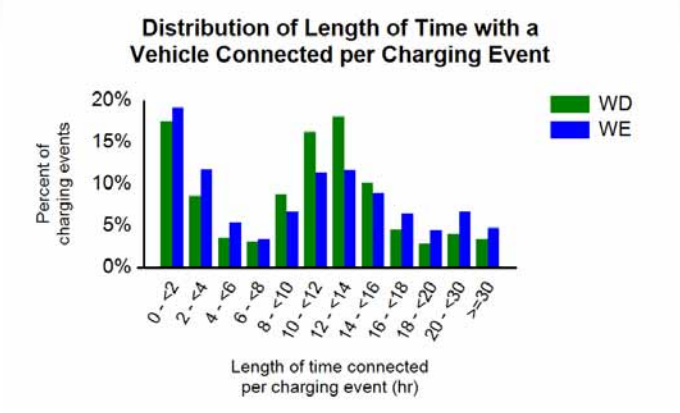


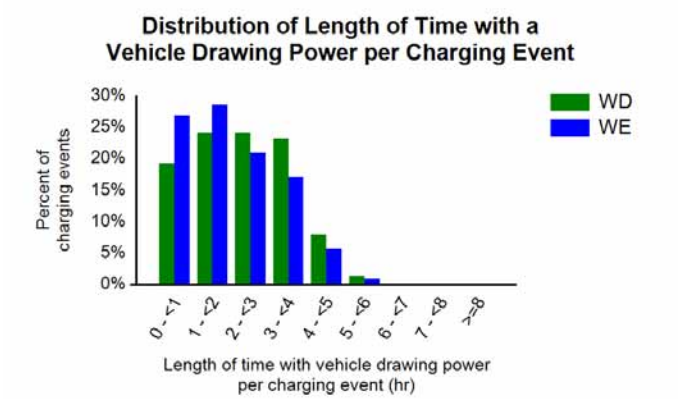

**Washington State**

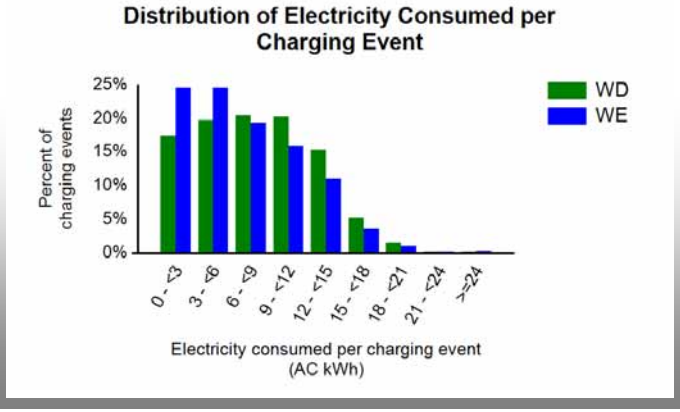


# EV Project – EVSE Connect & Power

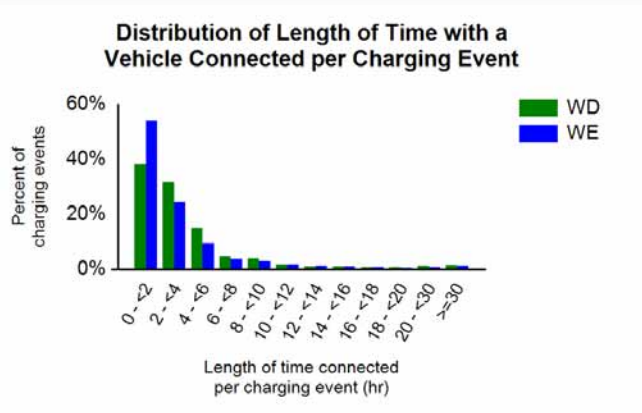
## Residential

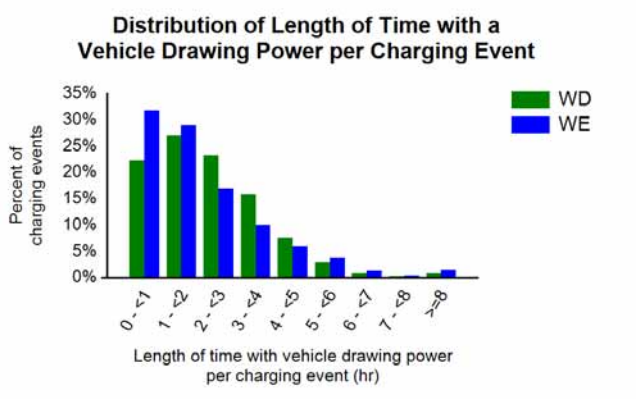


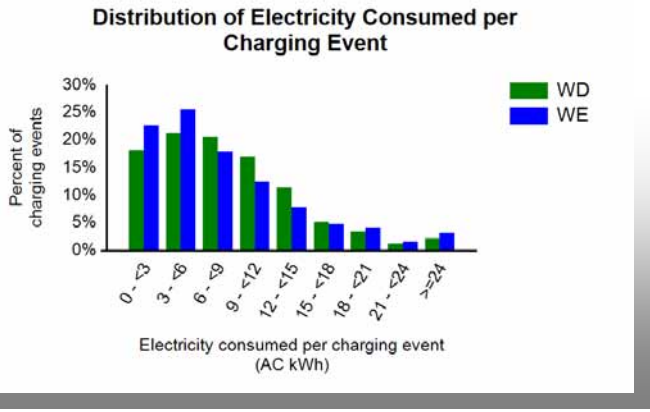




## Non Residential Public

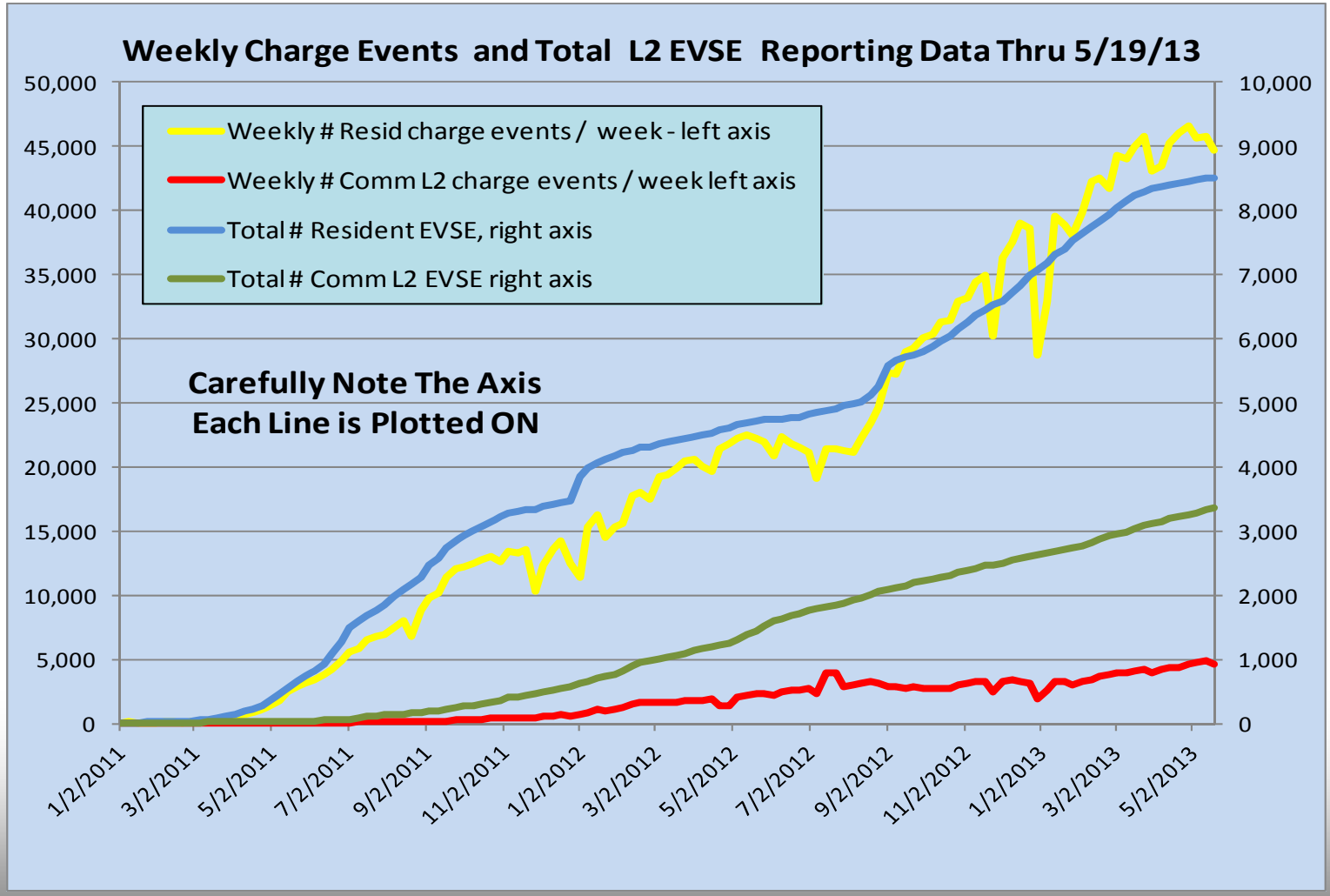


# Residential vs. Public Use Rates

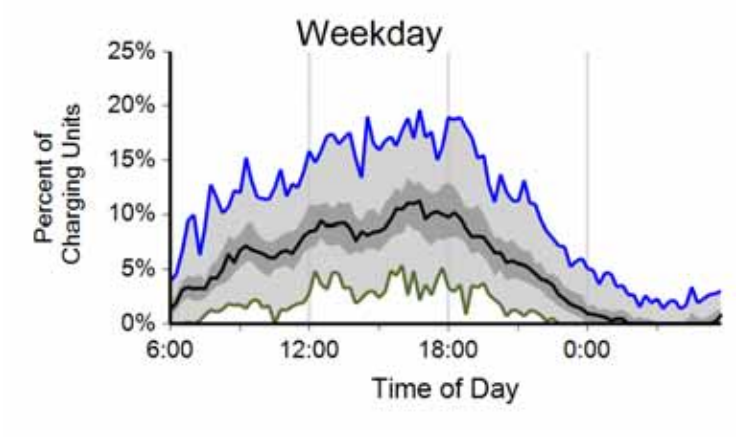
- **Note 5.4 to 1 weekly Residential EVSE use rate versus weekly Public Level 2 EVSE use rate (last 5 weeks)**



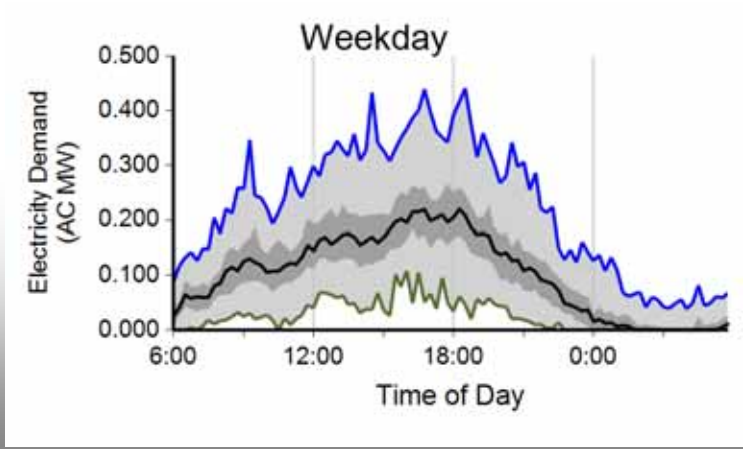
# EVSE DCFC Use

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

**Weekday Connected Profile**



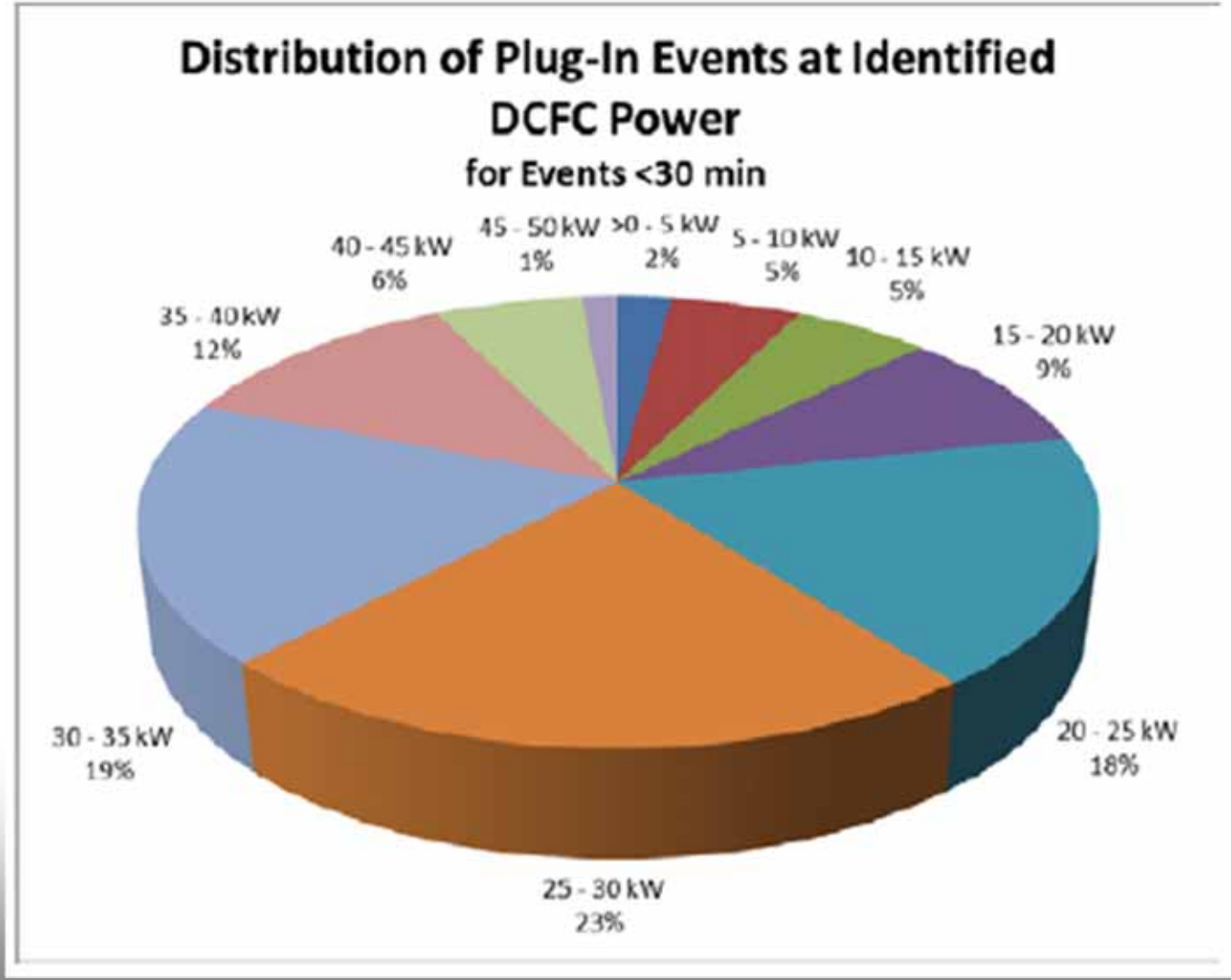

**Weekday Demand Profile**




- **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**

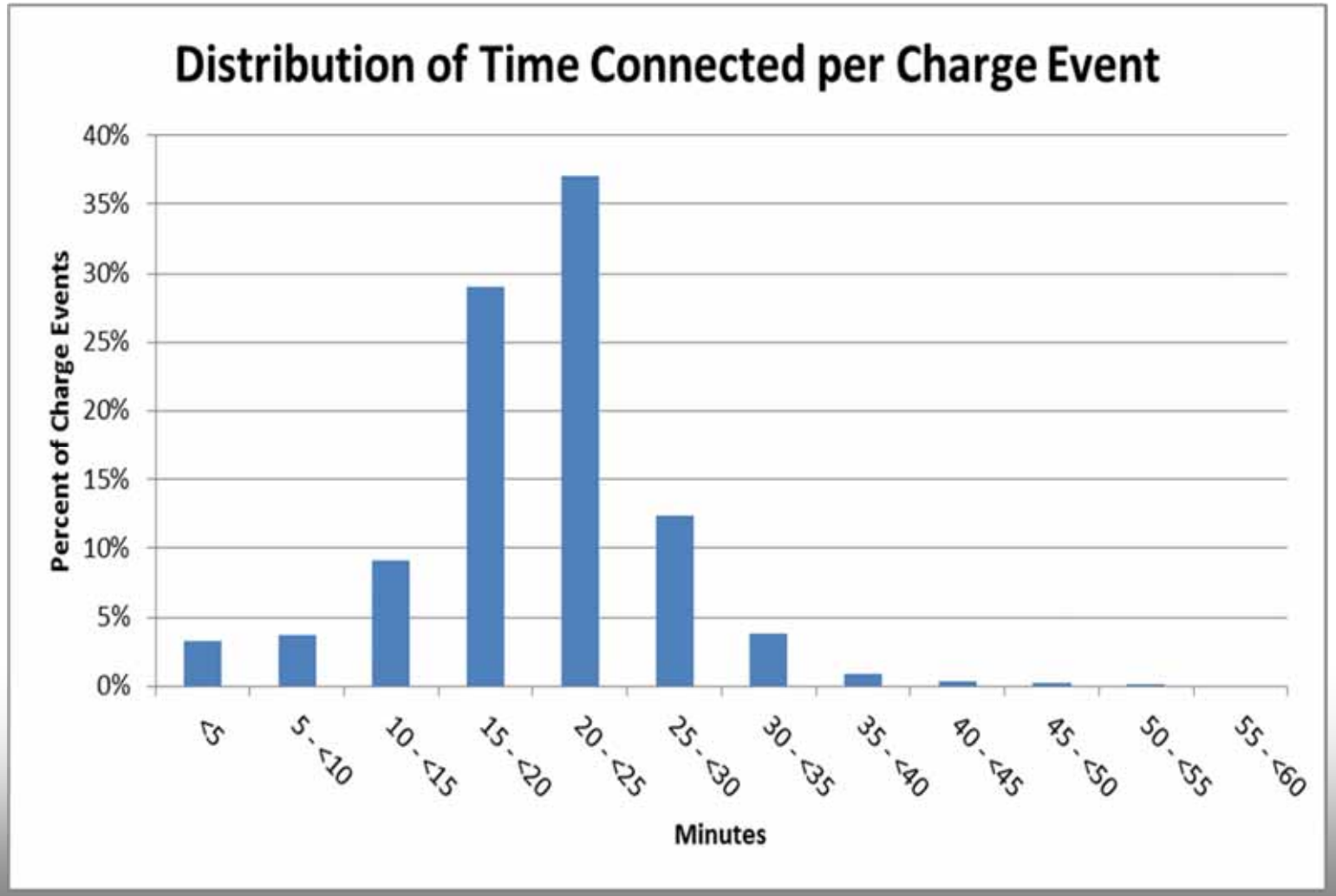
# EV Project – DCFC Power Levels

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



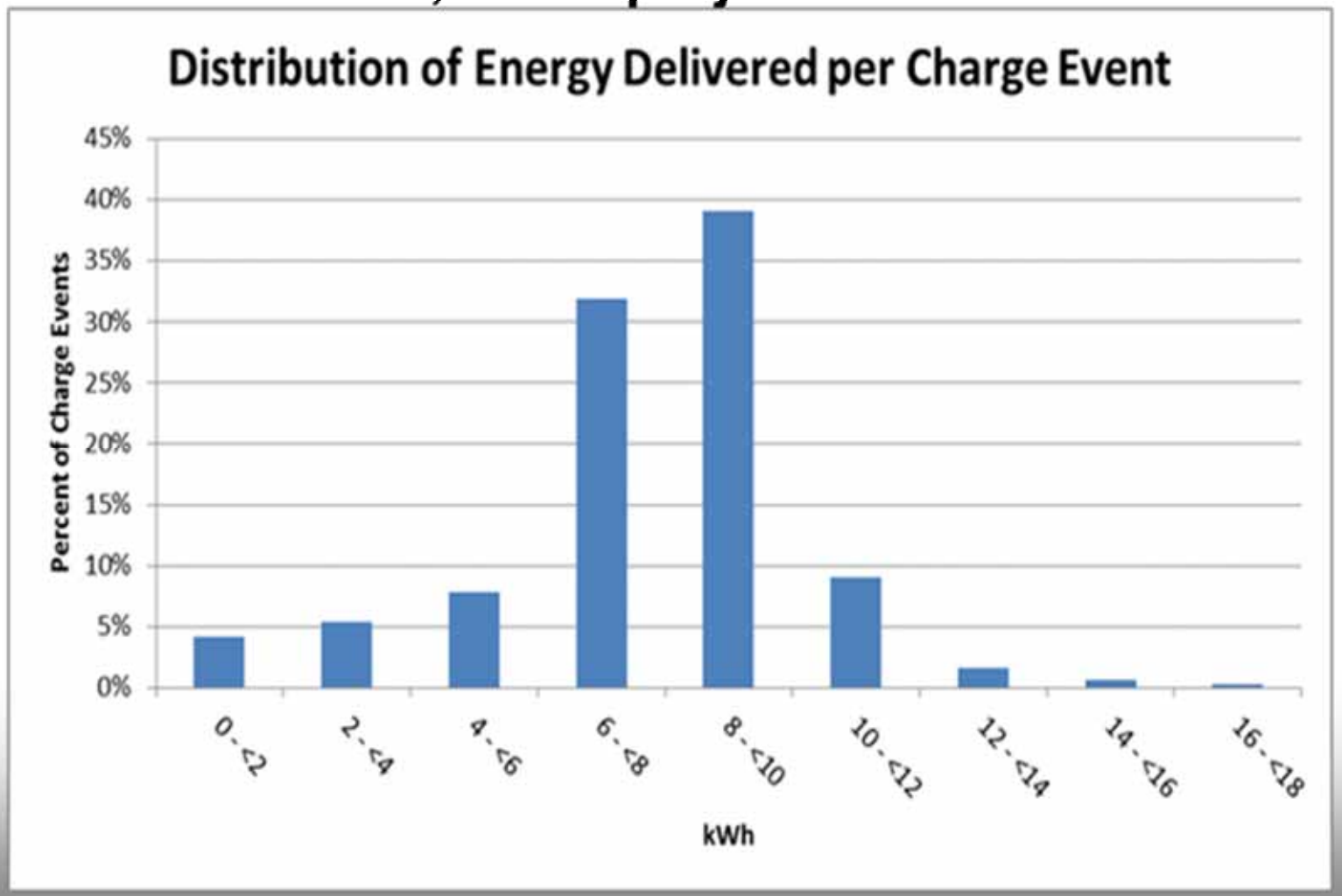
# EV Project – DCFC Connect Time

- **Distribution of time vehicle connected per DCFC event for all regions. No connect times are greater than 60 minutes**



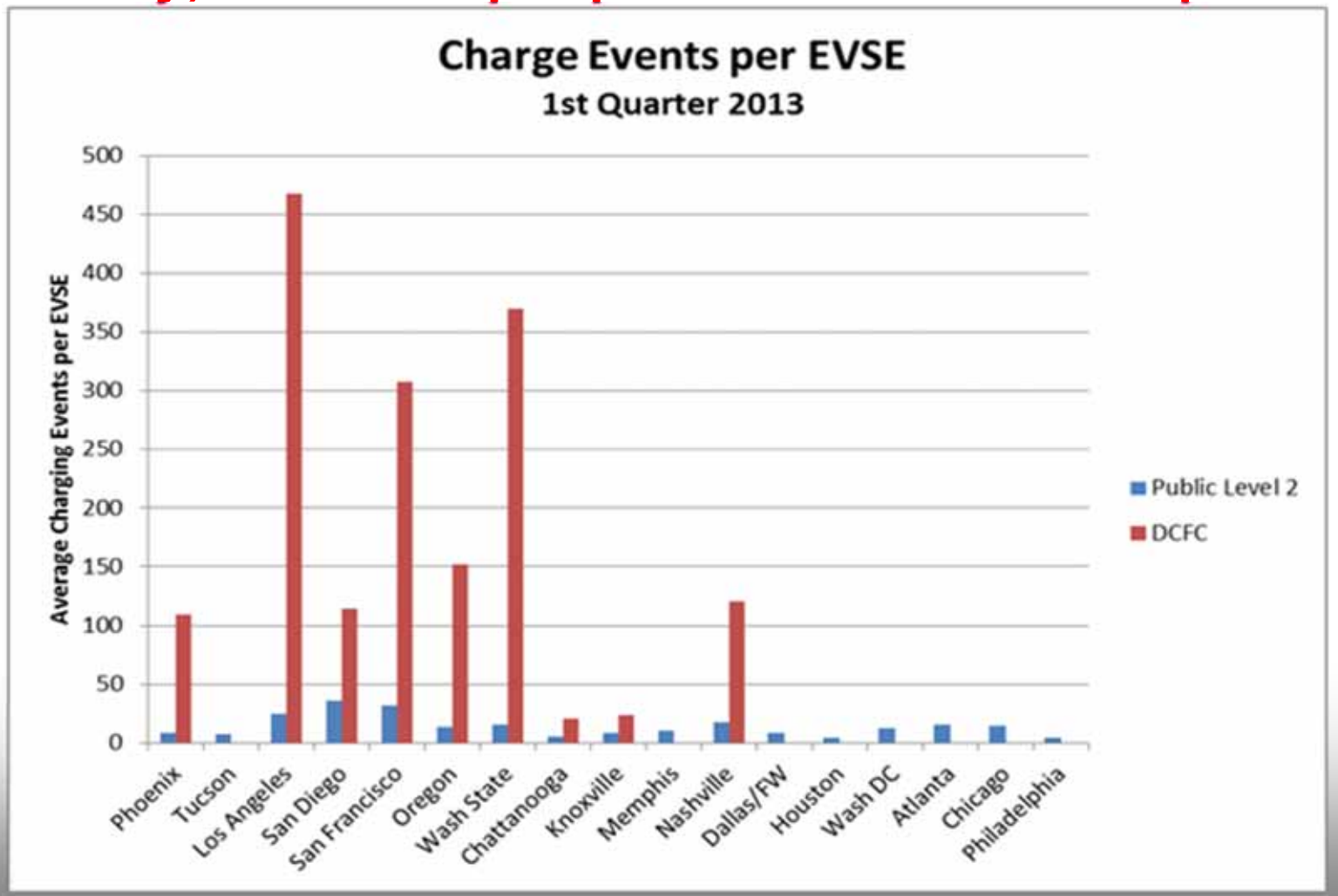
# EV Project – DCFC Energy Delivered

- **Distribution of energy delivered per DCFC event for all regions. No charge event delivered more than 18 kWh**
- **Data from all DCFC, life of project**



# EV Project – DCFC Versus Level 2 Public

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



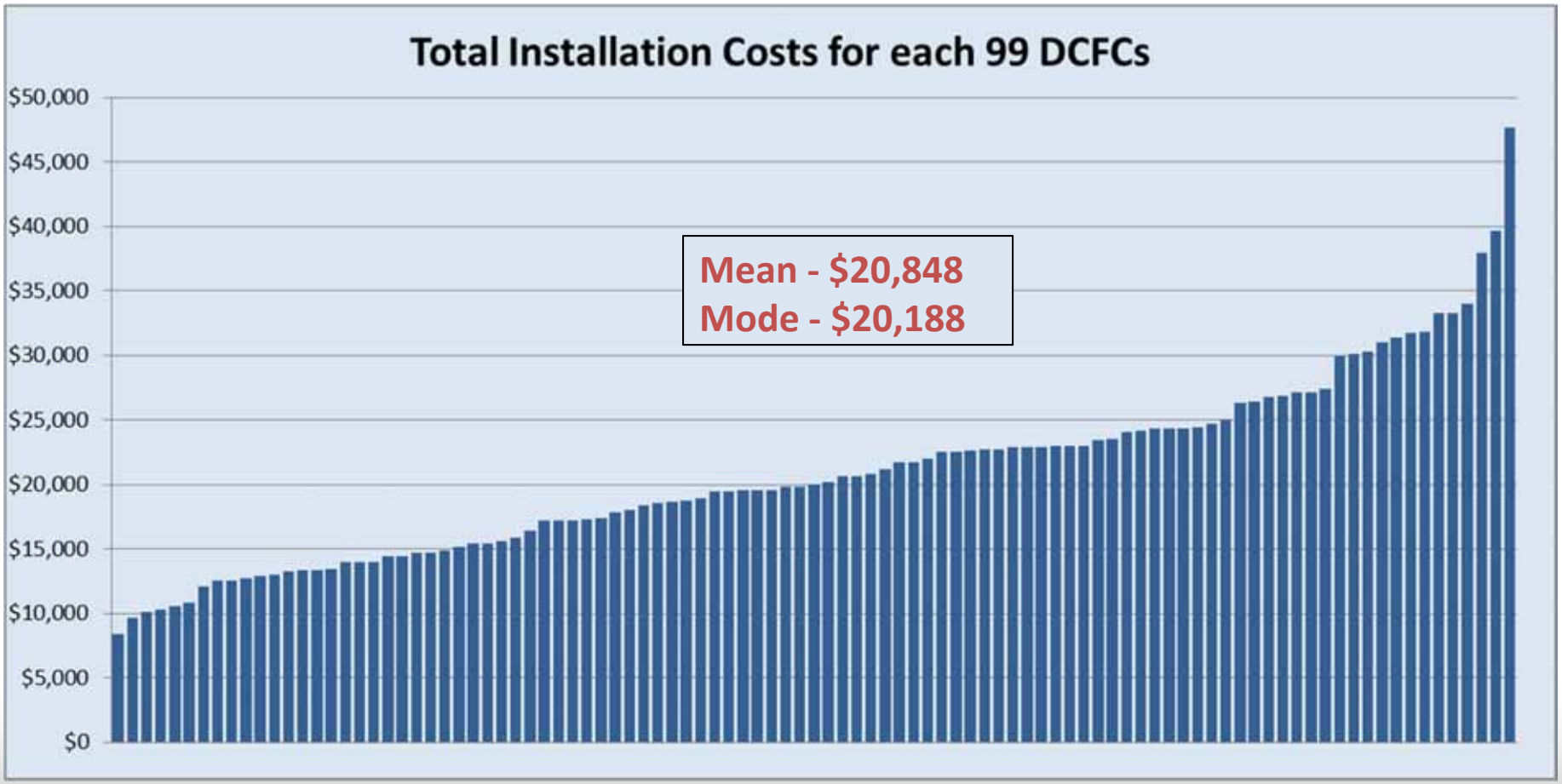
# DCFC Installation Costs / Issues

- **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 Individual Installation Costs

- **Total installation costs (99 units)**
- **Does not include DCFC hardware**



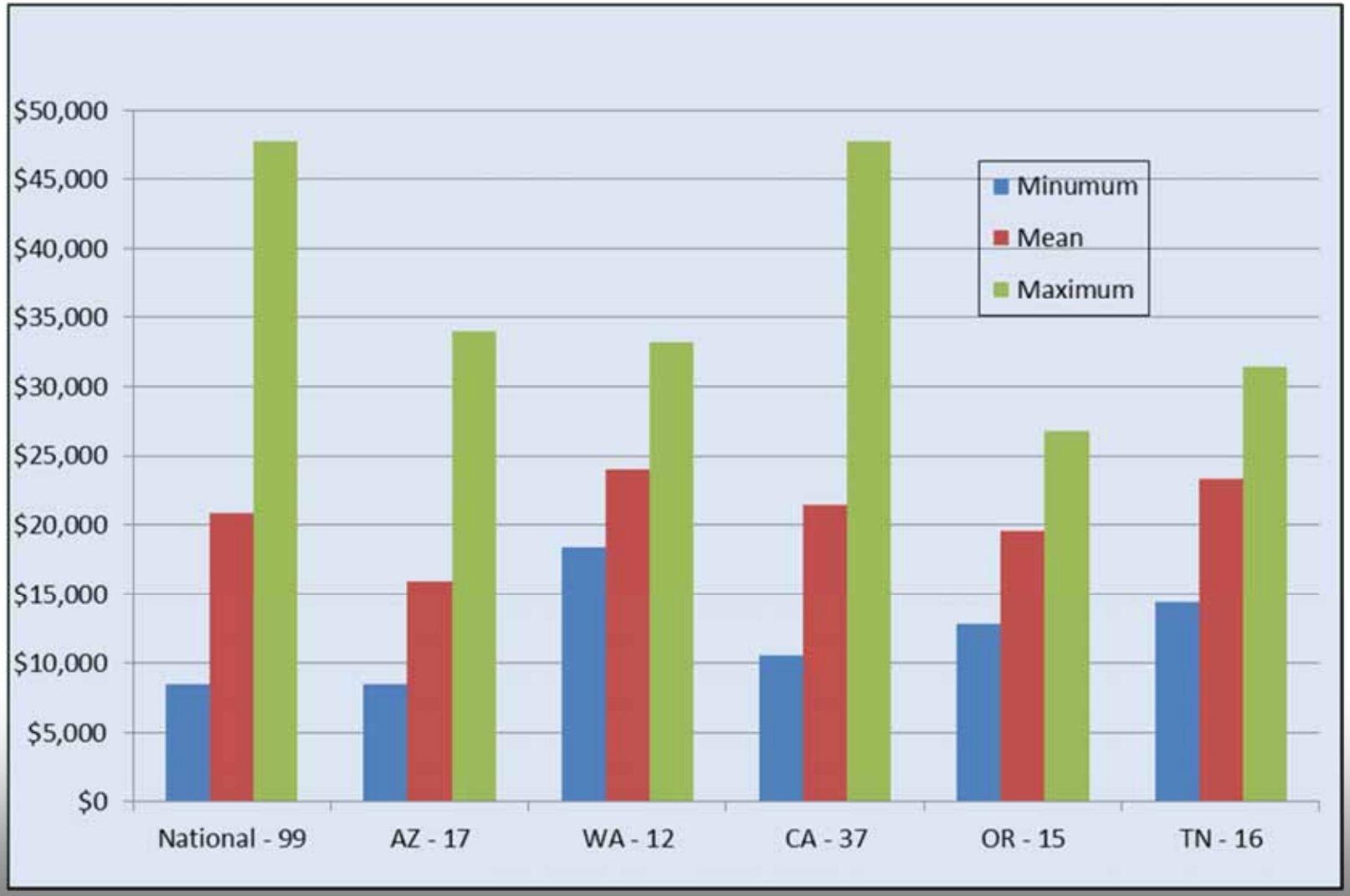
# DCFC Installation Costs

- **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 Individual Installation Costs

- **Total installation costs (99 units)**
- **Does not include DCFC hardware**



# 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 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 |

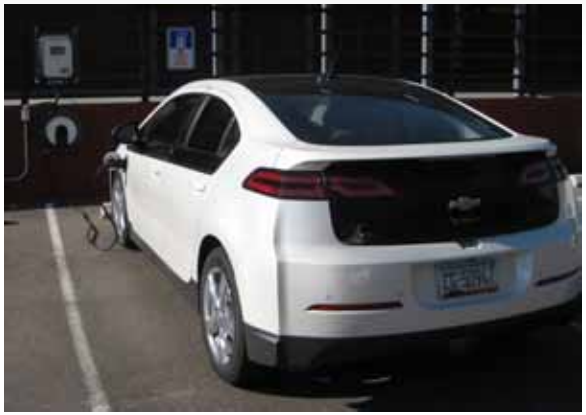
# DCFC Commercial Lessons Learned

- **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 |

# L2 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 |

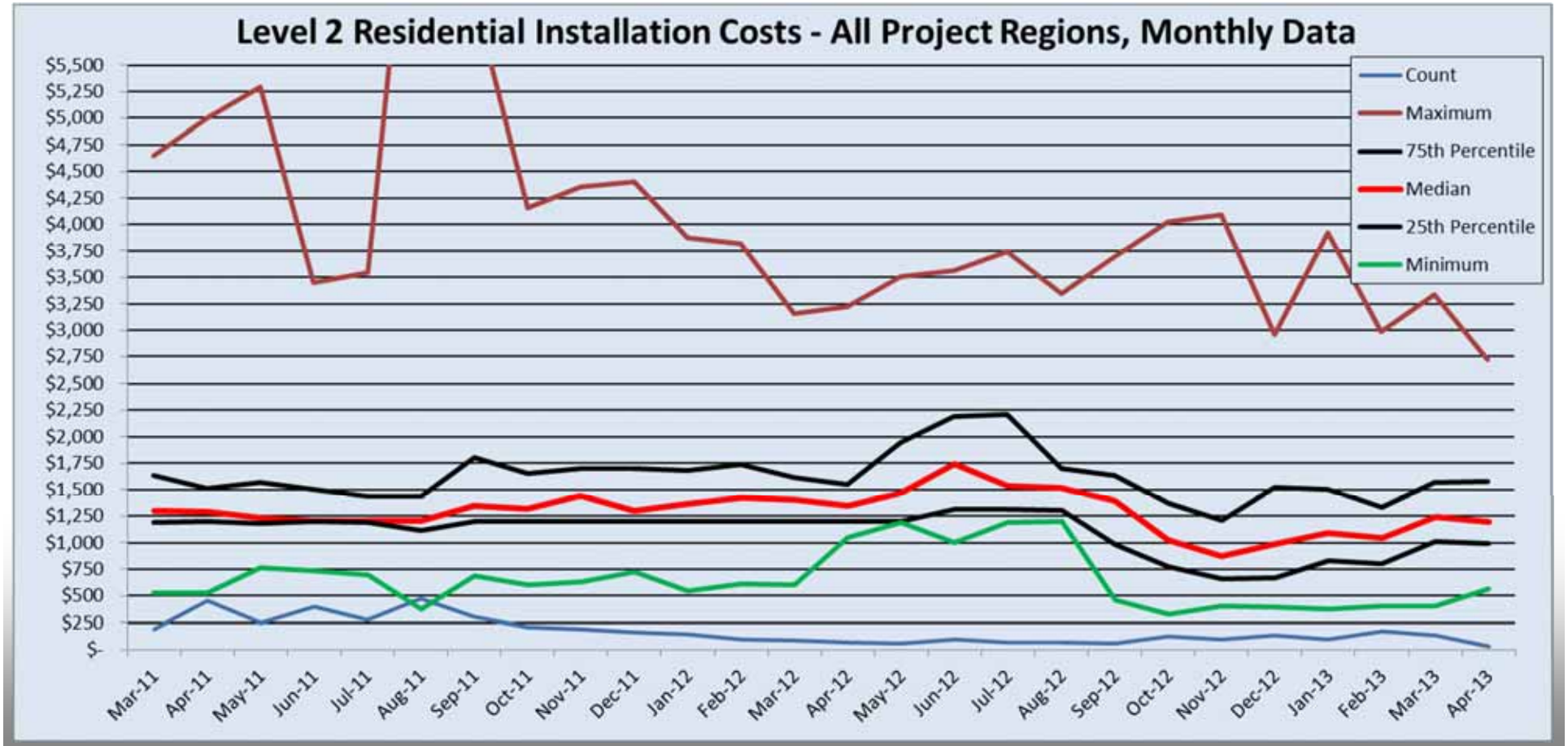
# Commerical Level 2 Installation Costs

- **Nationally, commercially sited Level 2 EVSE average between $3,500 and $4,500 for the installation cost**
  - **Does not include 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 do 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 EVSE Installation Costs

- **Regional results for 4,466 units**
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# Residential Level 2 Installation Costs

- **High cost drivers**
  - **Upgrading or replacing ($8,429) residential electrical service**
  - **Not installing near the service panel**
  - **Desire to site away from the house**
  - **Cutting concrete or asphalt driveway or other surfaces**
- **Low cost drivers**
  - **Existing 240 V outlet in the garage ($250)**
  - **Simple addition of a breaker and minimal conduit run**
  - **Room in the garage**

# Acknowledgement

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**Presentation in the Publications Link (Left blue bar menu)**

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