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

## Plug-in 2012 – Light Duty PEV Testing by DOE's Advanced Vehicle Testing Activity

**Jim Francfort – Idaho National Laboratory**

**Plug-in 2012**
**San Antonio, Texas**
**July 25, 2012**



Idaho National Laboratory

# Outline

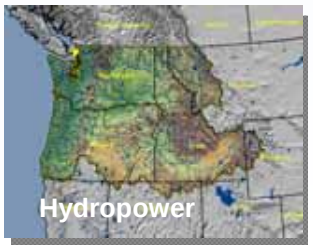
- Participants
- Goals
- Testing experience
- Data processes and data security
- EV Project
  - Description and data parameters
  - Project status
  - Leaf, Volt, and EVSE benchmarking results
- Other electric drive vehicle research activities
- Summary
- Future work

# Idaho National Laboratory (INL)

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







# AVTA Participants

- **INL manages the Advanced Vehicle Testing Activity's (AVTA) field testing of advanced technology light-duty vehicles for DOE's Vehicle Technologies Program**
- **ECOtality provides testing support via a competitively bid NETL (National Energy Testing Laboratory) contract**
- **Test partners include electric utilities, Federal, state and local government agencies, private companies, and individual vehicle owners**
- **AVTA testing supports DOE's international petroleum reduction objectives with other countries**
  - **Canada**
  - **China**
  - **European Union**

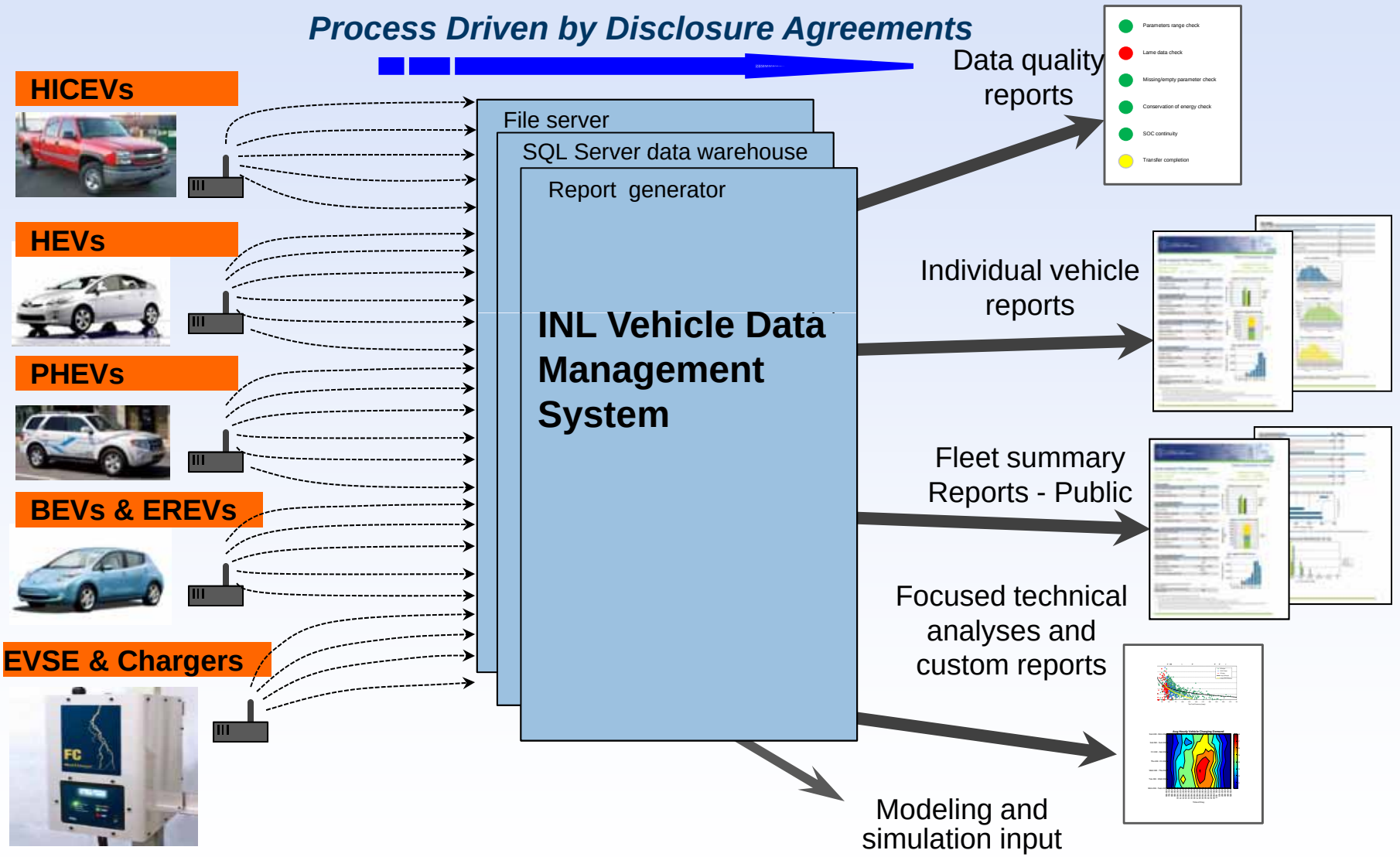
# AVTA Goals

- **The AVTA goals**
  - **Petroleum reduction and energy security**
  - **Benchmark technologies that are developed via DOE research investments**
- **Confusing people with facts via structured benchmark testing**
  - **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

- **48 million test miles accumulated on 8,200 electric drive vehicles representing 114 models**
- **EV Project: 4,700 Leafs and Volts, 6,300 EVSE (electric vehicle supply equipment), 30 million test miles**
- **PHEVs: 14 models, 430 PHEVs, 4 million test miles**
- **EREVs: 1 model, 150 EREVs, 900,000 test miles**
- **HEVs: 21 models, 52 HEVs, 6.2 million test miles**
- **Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 485,000 test miles**
- **NEVs: 24 models, 372 NEVs, 200,000 test miles**
- **BEVs: 47 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

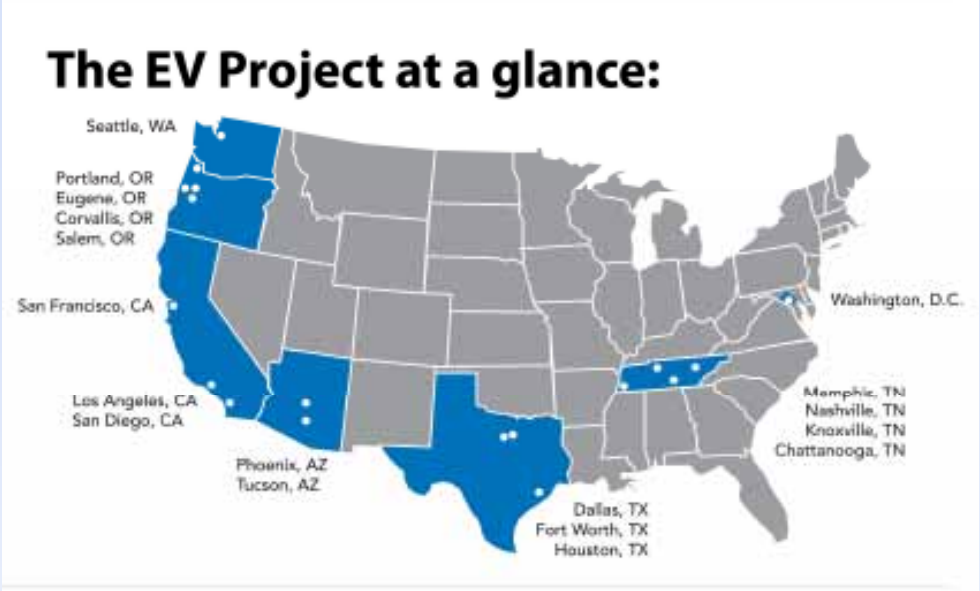


# Data Collection, Security and Protection

- **The AVTA has used data loggers on vehicles and EVSE (electric vehicle supply equipment) since 1993 to benchmark vehicle and charging equipment profiles**

- **All vehicle, EVSE, and personal raw data is legally protected by NDAs (Non Disclosure Agreements) or CRADAs (Cooperative Research and Development Agreements)**
  - **Limitations on how proprietary data can be distributed, stored, and used**
  - **No raw data can or will be distributed by INL**
  - **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 NDAs and CRADAs are strictly adhered by INL**

# EV Project Locations and Goal




- **ECOtality is the EV Project lead, with INL, Nissan and GM/OnStar as the most significant partners**
- **18 current locations with more being added**
- **Goal: Build and study mature charging infrastructures and take the lessons learned to support the future streamlined deployment of grid-connected electric drive vehicles**
- **EV Project reporting requires INL to blend three distinct data streams based on GPS and time/date stamps, and provide independent reports to DOE, ECOtality, project participants, industry, and the general public**

# EV Project – EVSE Data Parameters Collected per Charge Event

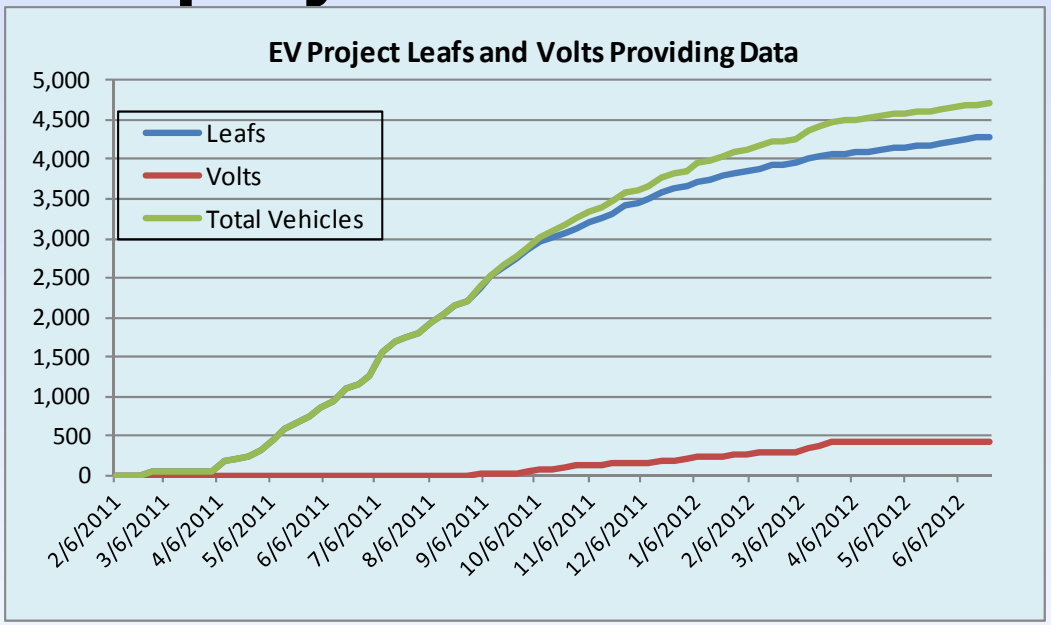
- Data from ECOtality's Blink EVSE network
- Unique ID for Charging Event
- Unique ID Identifying the EVSE
- Date/Time Stamp
- Connect and Disconnect Times
- Start and End Charge Times
- Maximum Instantaneous Peak Power
- Average Power
- Total energy (kWh) per charging event
- Rolling 15 Minute Average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

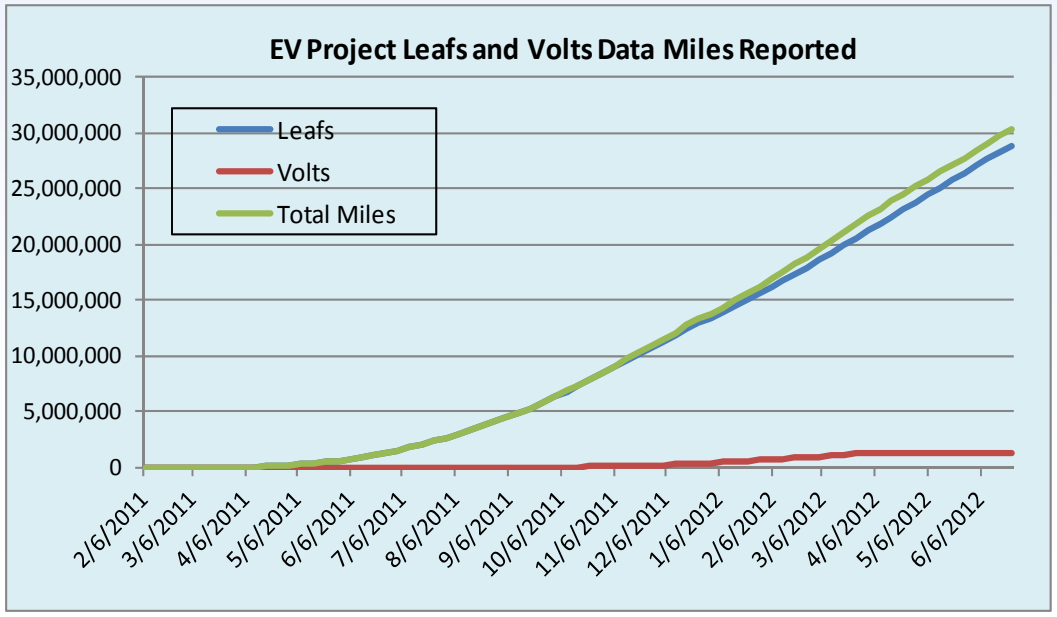
# EV Project – Vehicle Data Parameters Collected per Start/Stop Event

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

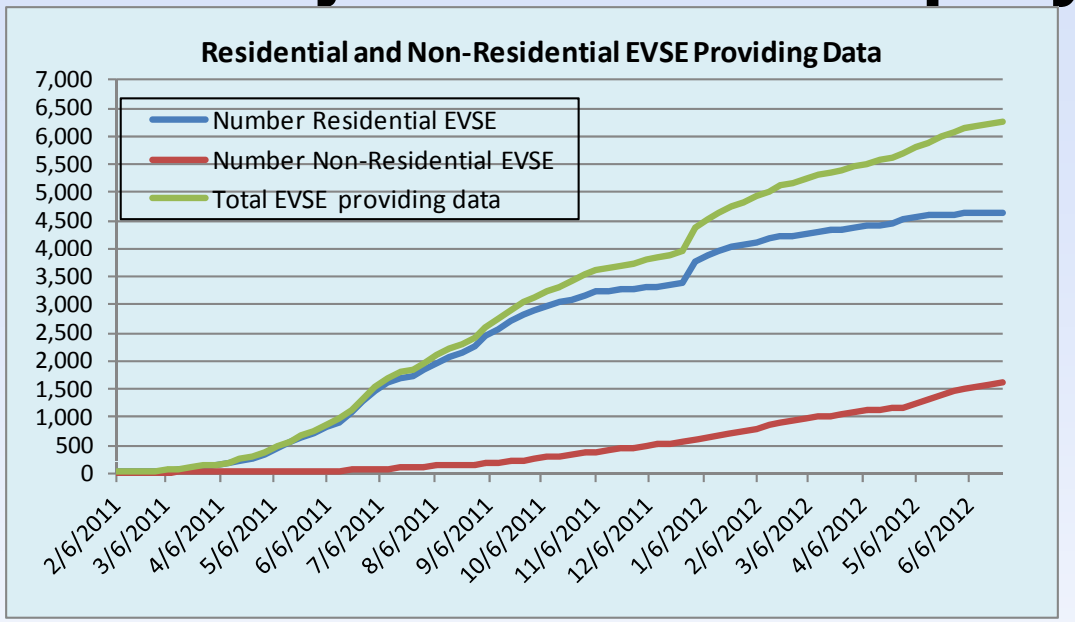
# EV Project – Vehicle Deployments / Miles

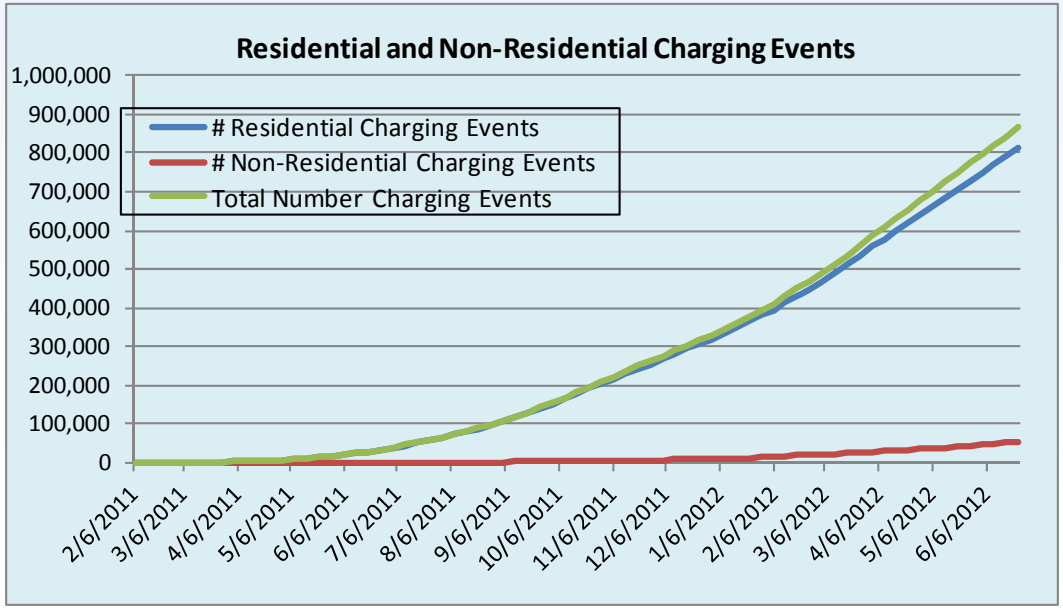
- 4,278 Leafs (6/24) and 428 Volts (4/01) reporting data
- 4,706 vehicles and growing
- 30.3 million total miles
- 105,000 test miles per day



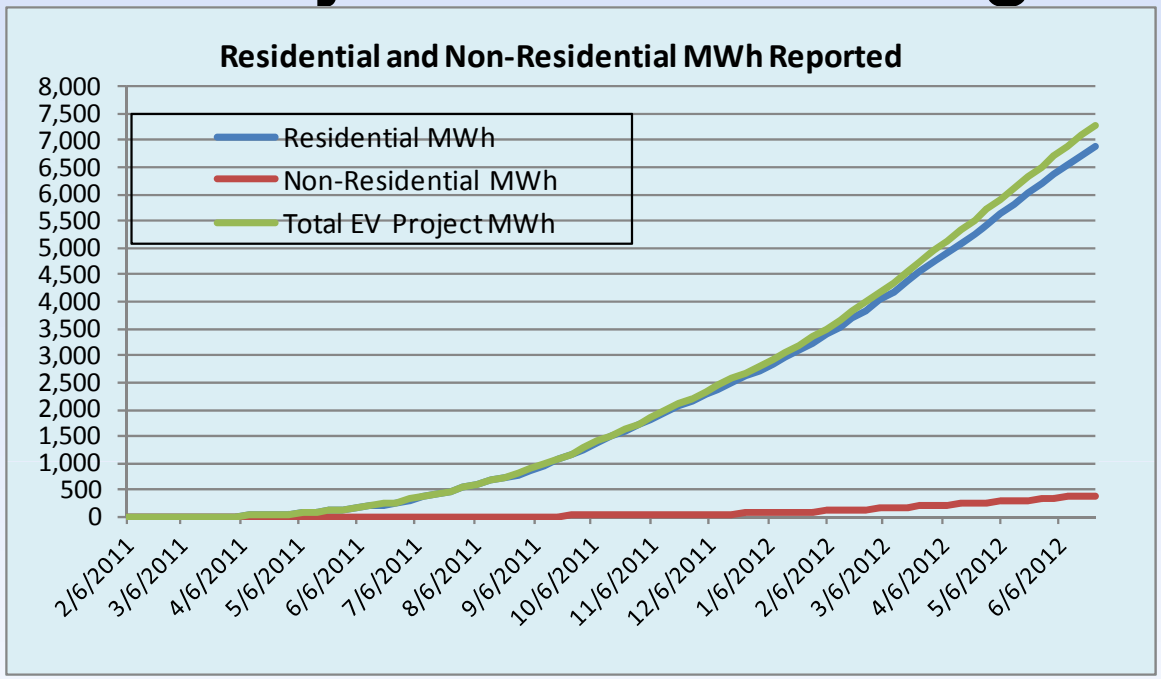
# EV Project – EVSE Deployment and Use




- 6,257 total EVSE
- 4,634 Res. EVSE
- 1,623 non-Res EVSE
- 865,000 charge events
- 3,500 charge events per day
- Non-Residential includes DCFC
- Above as of 6/24/12
- Data is continuously back-filled

# EV Project – Total Charge Energy (MWh)

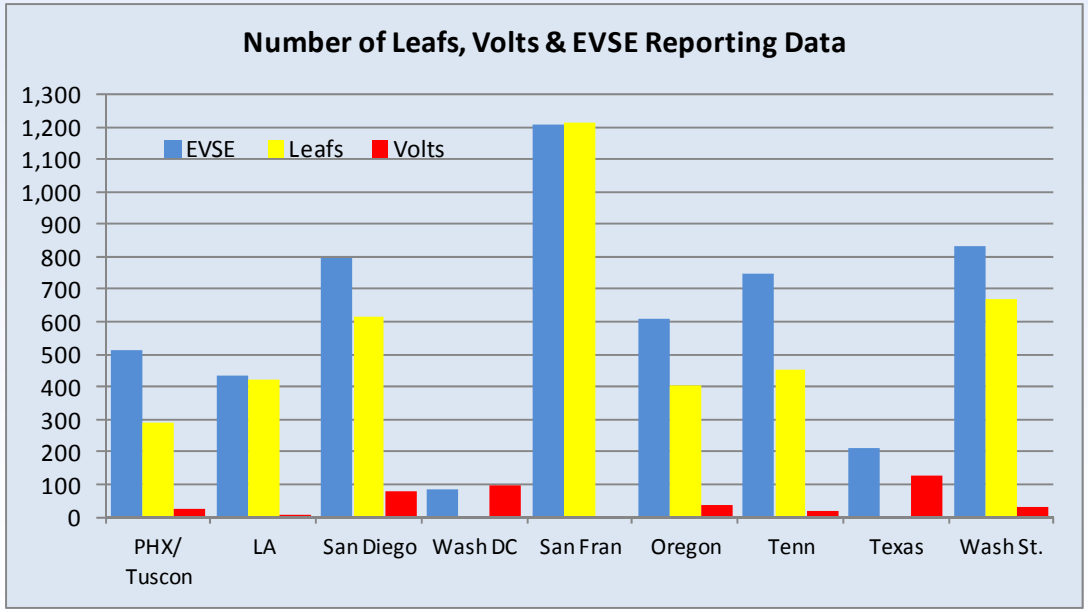



- **7,300 MWh total electricity charged**
- **6,888 MWh residential**
- **401 MWh non-residential**
- **26 MWh used for charging per day**

- **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 – Overview Report 1st Quarter

- Vehicles and charging infrastructure deployed to date 1st quarter 2012 and data received by INL
- Charging infrastructure
  - 5,432 units installed
  - 665,968 charging events
  - 5,069 AC MWh
- Vehicles
  - 4,066 Leafs
  - 427 Volts
  - 22.6 million miles
- Regional analyses are conducted and reported each quarter
- 1st quarter 2012: 93 pages and 53,000 data values calculated for 4 reports



# EV Project – Vehicle Usage Report

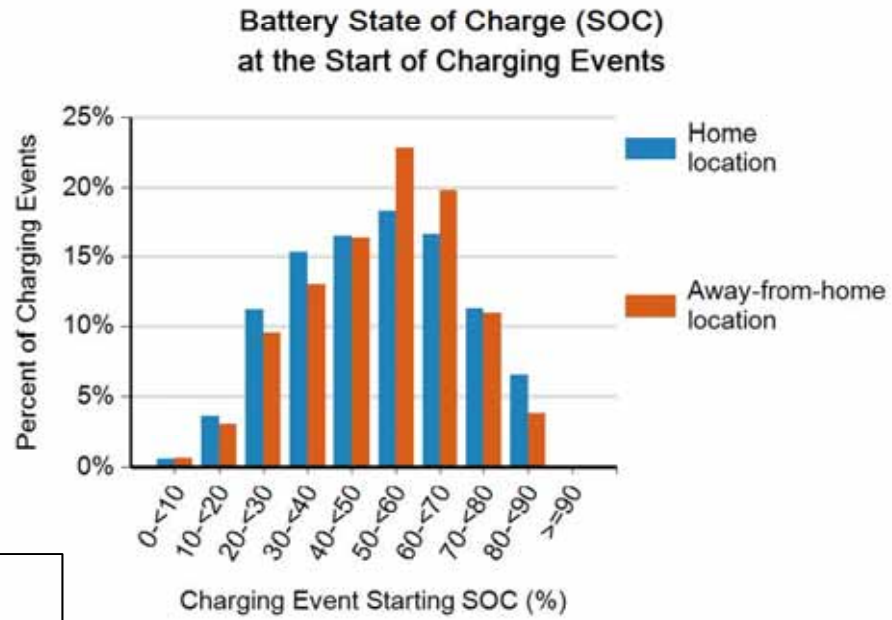
## Vehicle Usage – 1st quarter 2012

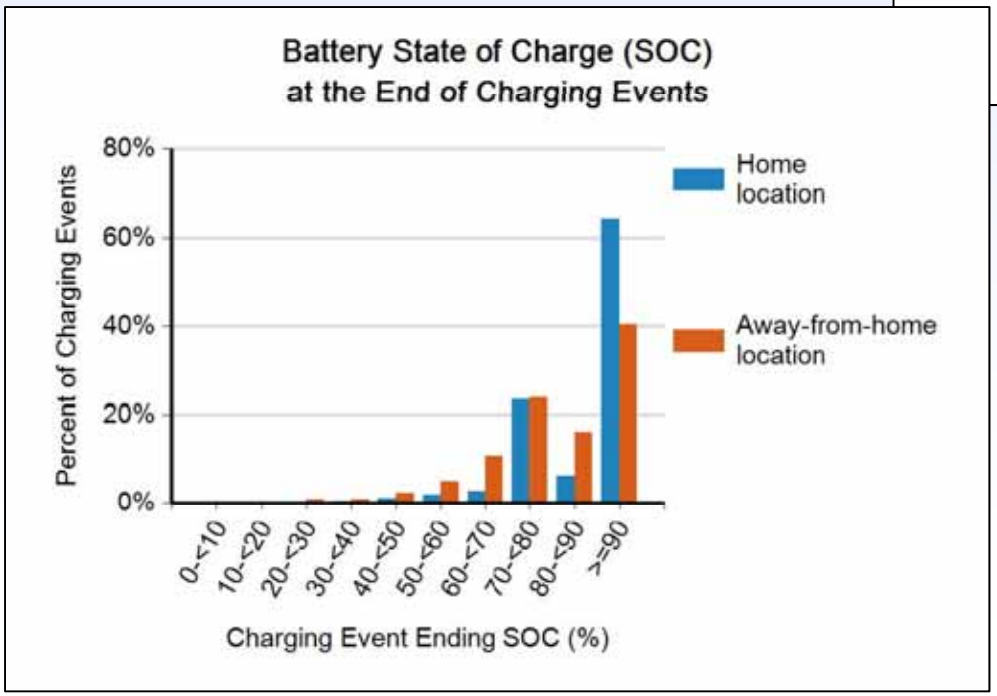
| | Leafs | Volts |
|---|---|---|
| • Number of vehicles | 2,987 | 317 |
| • Number of Trips | 773,602 | 76,425 |
| • Distance (thousands) | 5,558 mi | 610 mi |
| • Average (Ave) trip distance | 7.2 mi | 8.0 mi |
| • Ave distance per day | 30.2 mi | 36.4 mi |
| • Ave number (#) trips between charging events | 3.8 | 3.0 |
| • Ave distance between charging events | 27.4 mi | 24.1 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 Usage Report (1st ¼ 2012)

- **Battery SOC quarterly trends may indicate greater driver confidence in vehicle range and EVSE availability**

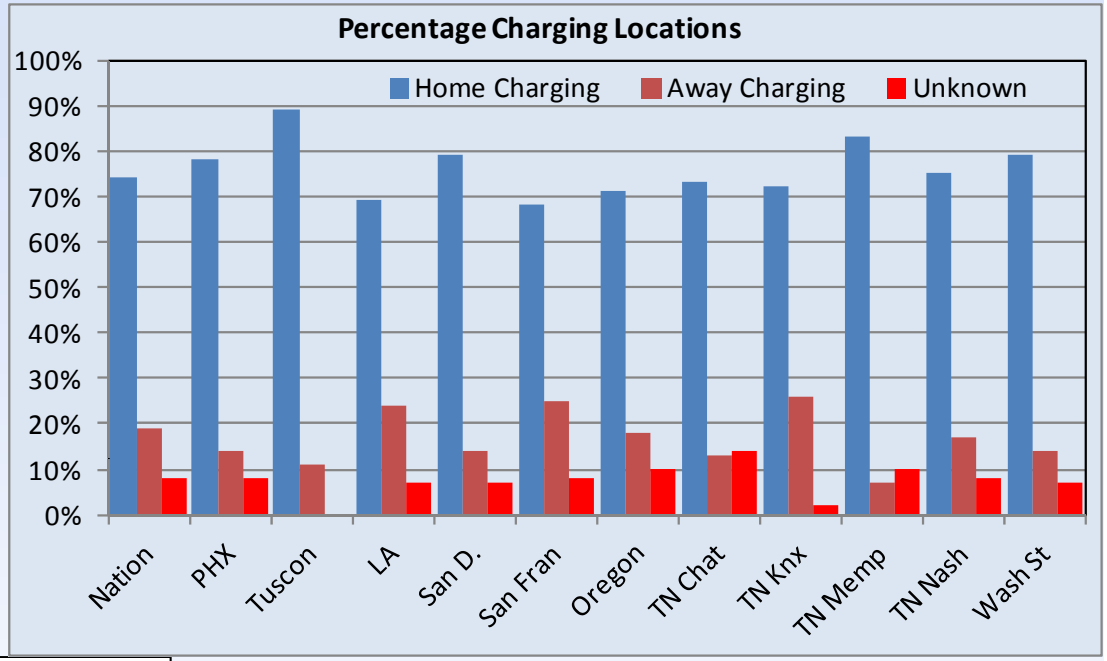


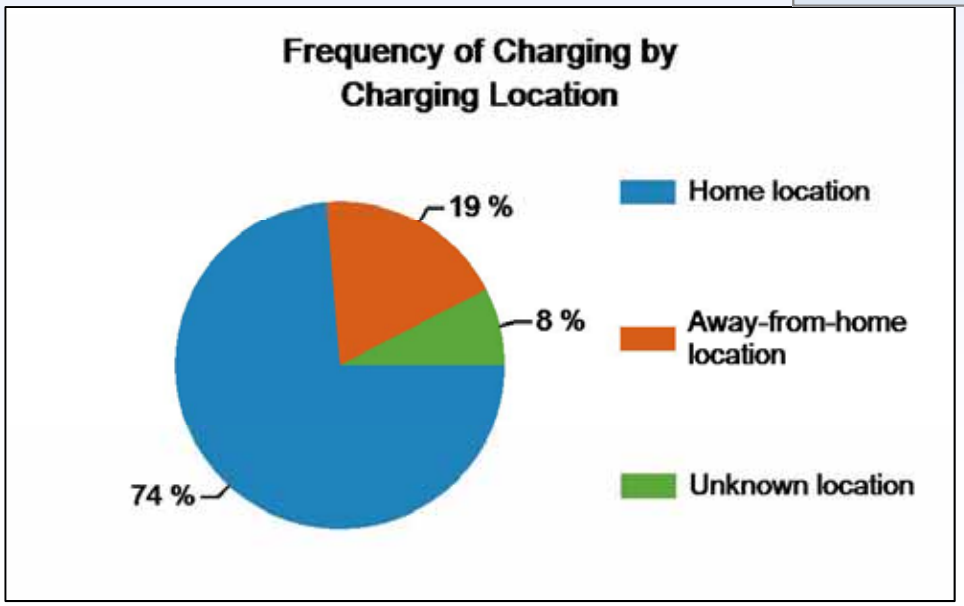




- **SOC is also available for Volts**

# EV Project – Leaf Usage Report (1st ¼ 2012)

- **Regional variations in charging behavior**
- **Possible rich versus non-rich public charge environment impacts**

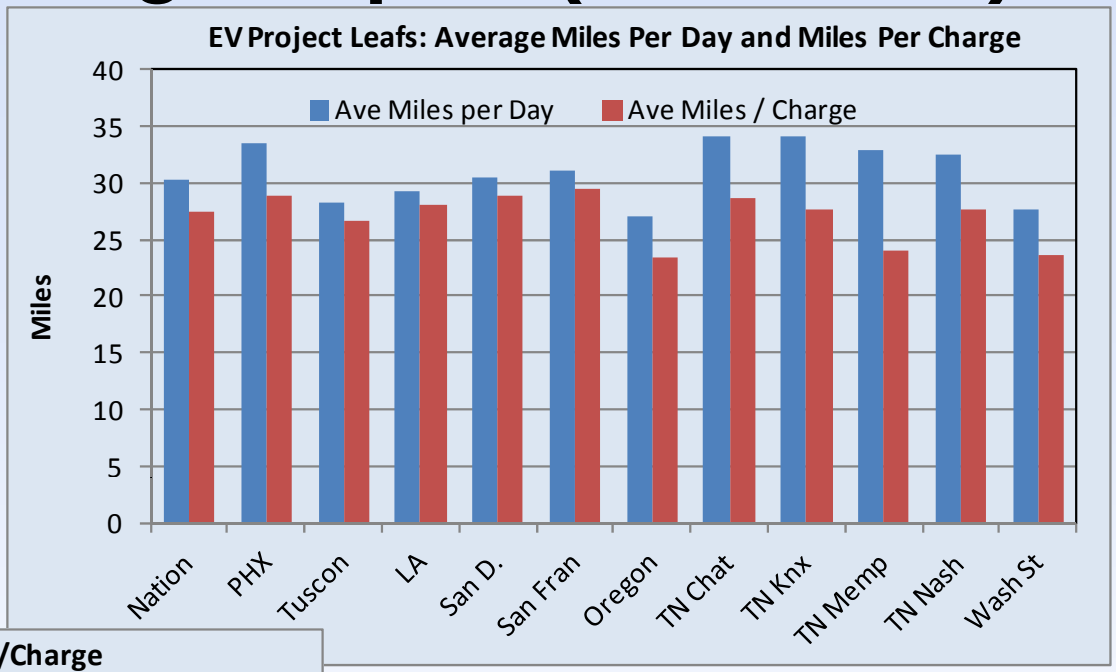


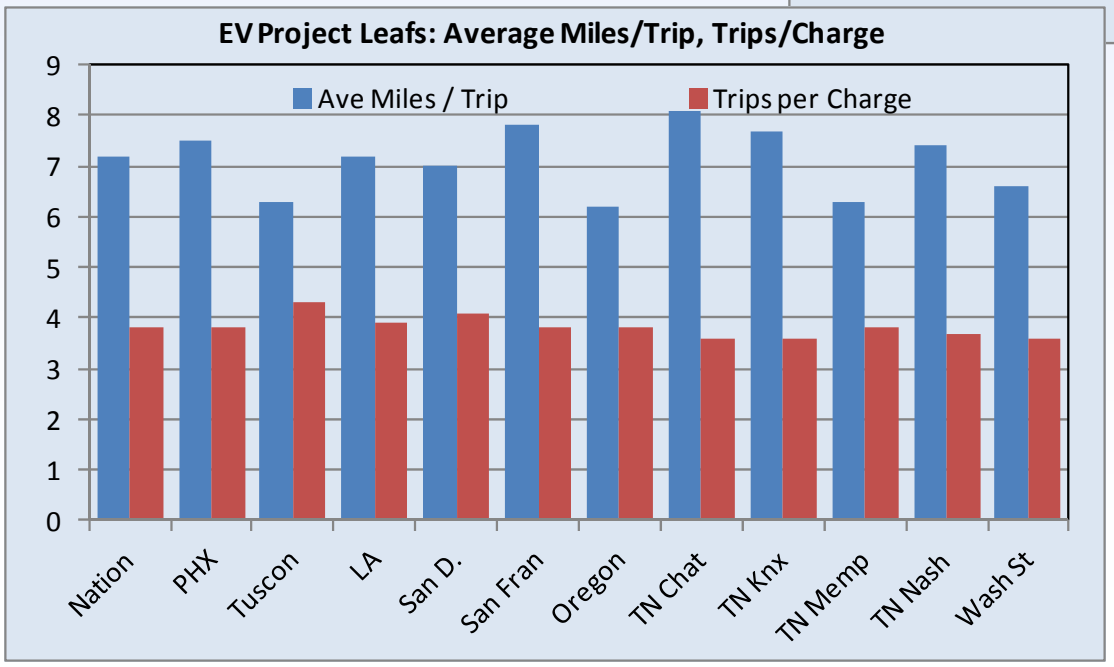




- **Data is also available for Volts**

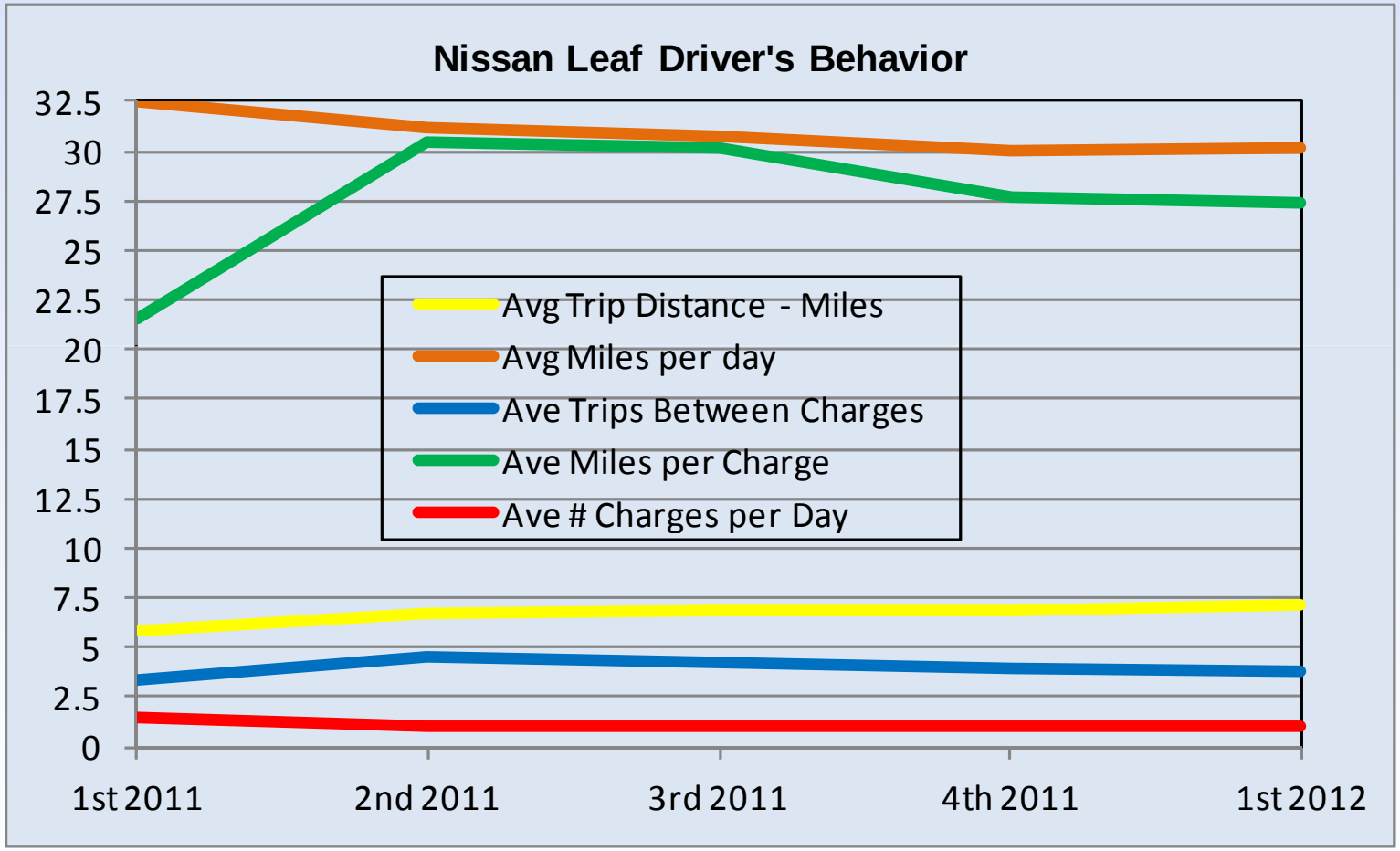
# EV Project – Leaf Usage Report (1st ¼ 2012)

- **Some regional variations in driving and charging profiles**



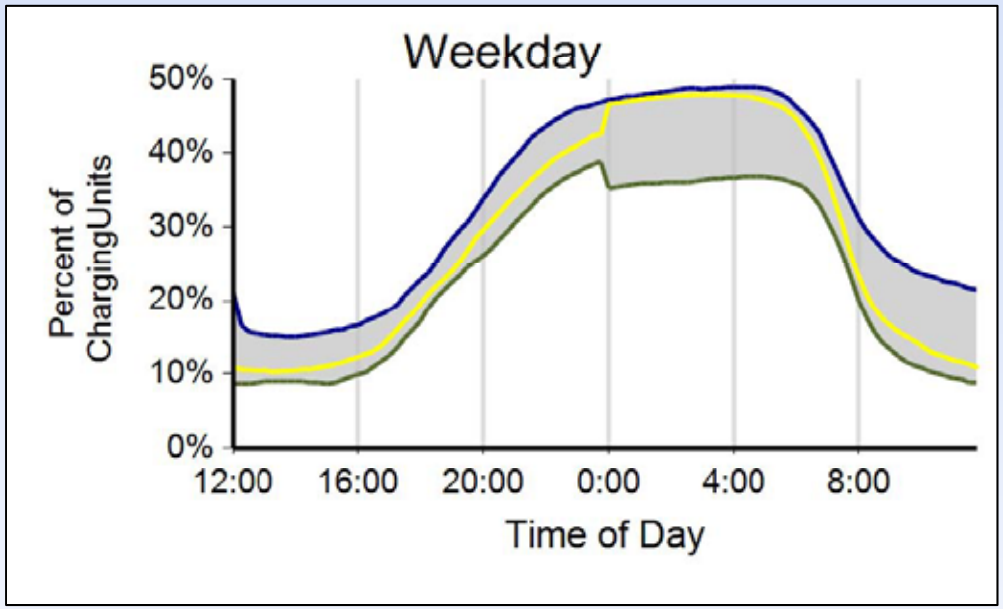



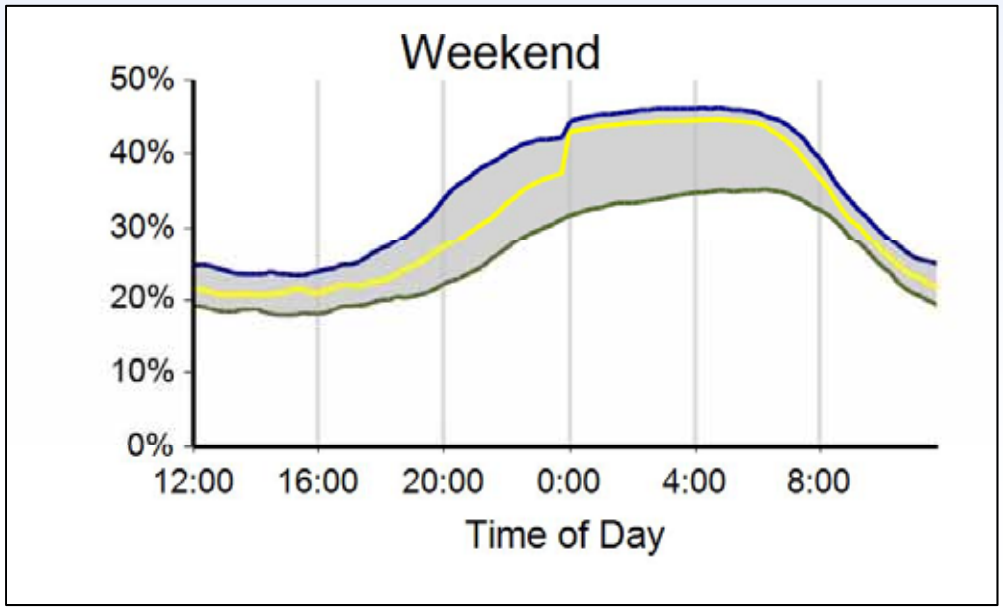
# EV Project – Leaf Usage Report 5 Quarters




- **Seasonal variations may not be significant yet, given low number of vehicles and "early adapters" in early quarters**

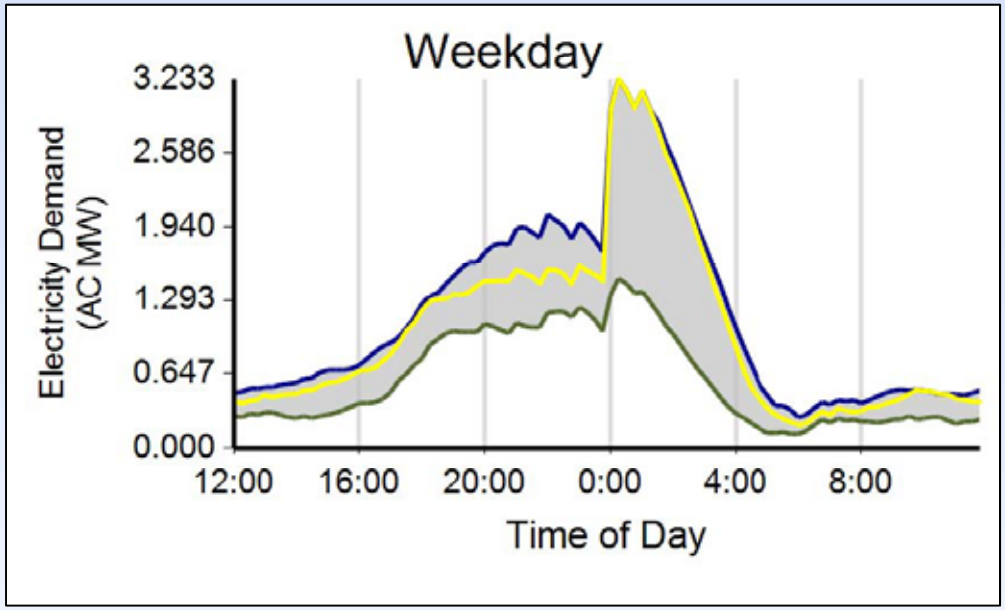
# EV Project – EVSE Infra. Summary Report

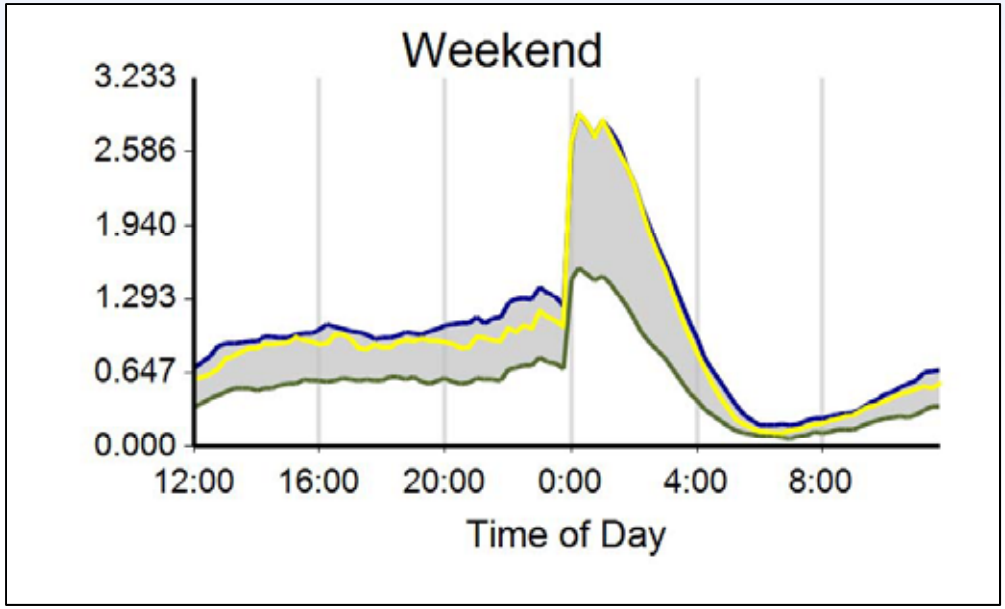



- **Graphs document when EVSE have a vehicle connected**
- **National Data**
- **Range of Percent of Charging Units with a Vehicle Connected vs. Time of Day**
- **1st quarter 2012**
- **3,324 residential and 955 publicly available Level 2 EVSE**
- **10 DC fast chargers**

# EV Project – EVSE Infra. Summary Report



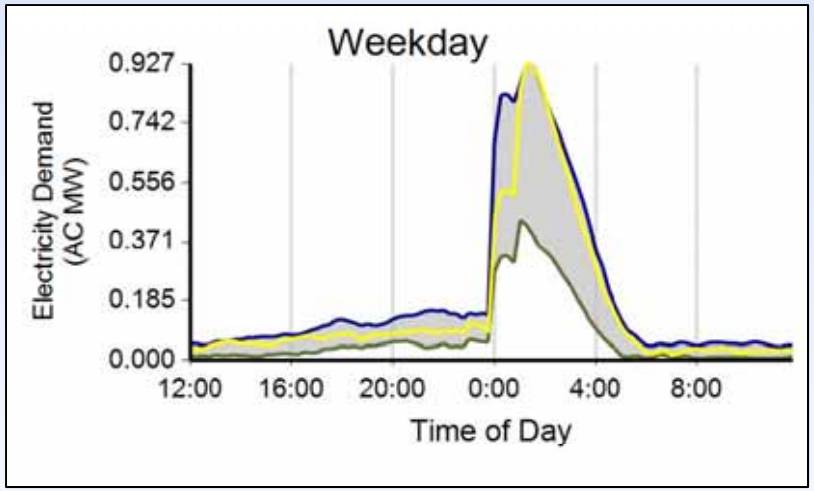




- **Charging demand**
- **National data, all EVSE**
- **Time of day kWh rates are influencing charging start times as measured by AC MW demand**
- **Range of Aggregate Electricity Demand vs. Time of Day (AC MW)**
- **1st quarter 2012**
- **3,324 residential and 955 publicly available Level 2 EVSE**
- **10 DC fast chargers**

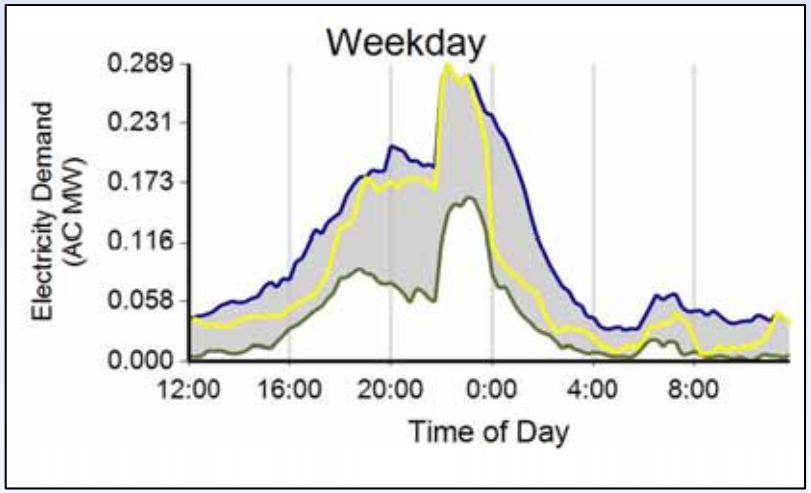
# EV Project – EVSE Infra. Summary Report

- **Residential Level 2 Weekday EVSE 1st Quarter 2012**
- **Time of day kWh rates clearly influence charge patterns**

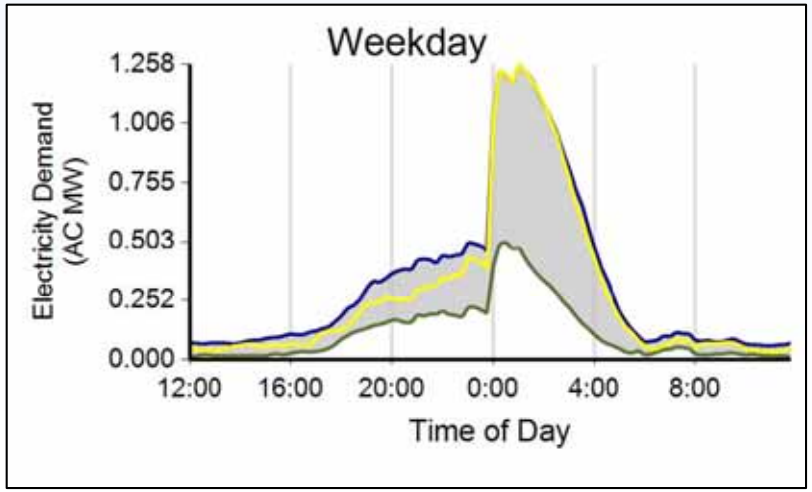
**San Diego**



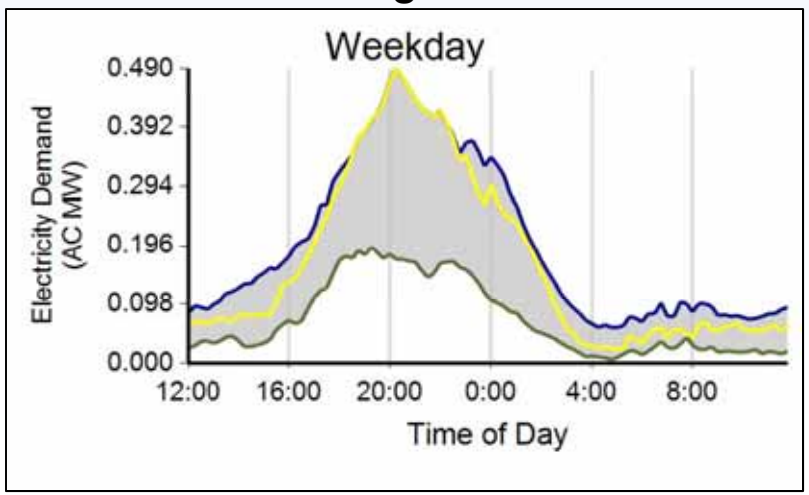

**Oregon**




**San Francisco**




**Washington State**

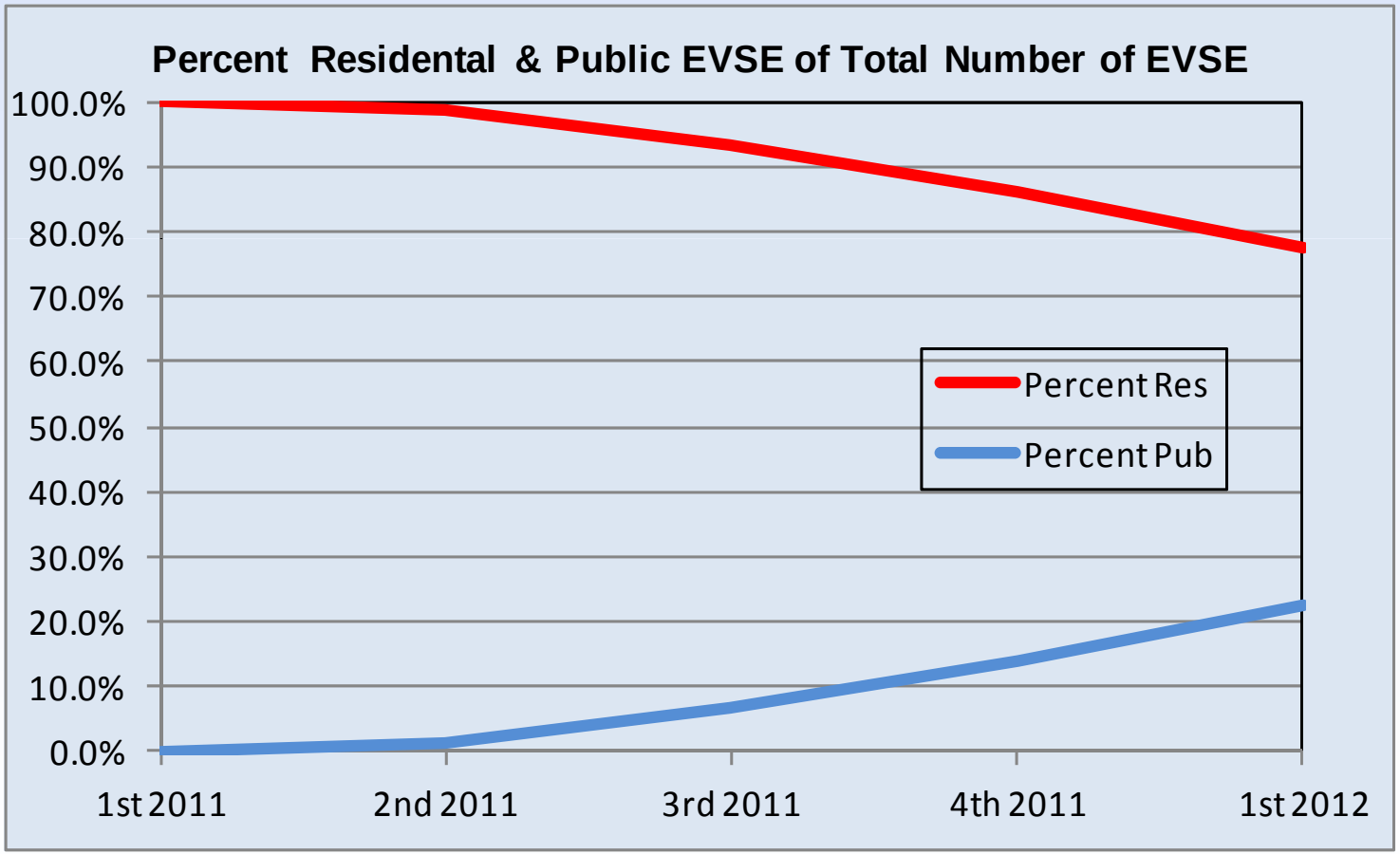


# EV Project – EVSE Infra. Summary Report

- National Data – 1st quarter 2012
  - Ave time vehicle connected R2 WD 11.4 hours
  - Ave time vehicle connected R2 WE 11.8 hours
  - Ave time vehicle drawing power R2 WD 2.4 hours
  - Ave time vehicle drawing power R2 WE 2.0 hours
  - Ave energy per charge event R2 WD 8.7 AC kWh
  - Ave energy per charge event R2 WE 7.3 AC kWh
  - Ave time vehicle connected P2 WD 6.3 hours
  - Ave time vehicle connected P2 WE 4.1 hours
  - Ave time vehicle drawing power P2 WD 2.1 hours
  - Ave time vehicle drawing power P2 WE 1.9 hours
  - Ave energy per charge event P2 WD 7.3 AC kWh
  - Ave energy per charge event P2 WE 6.6 AC kWh
- Yes, this is an ugly slide
- R: residential, P: public, WD: weekday, WE: weekend, 2: Level 2 EVSE

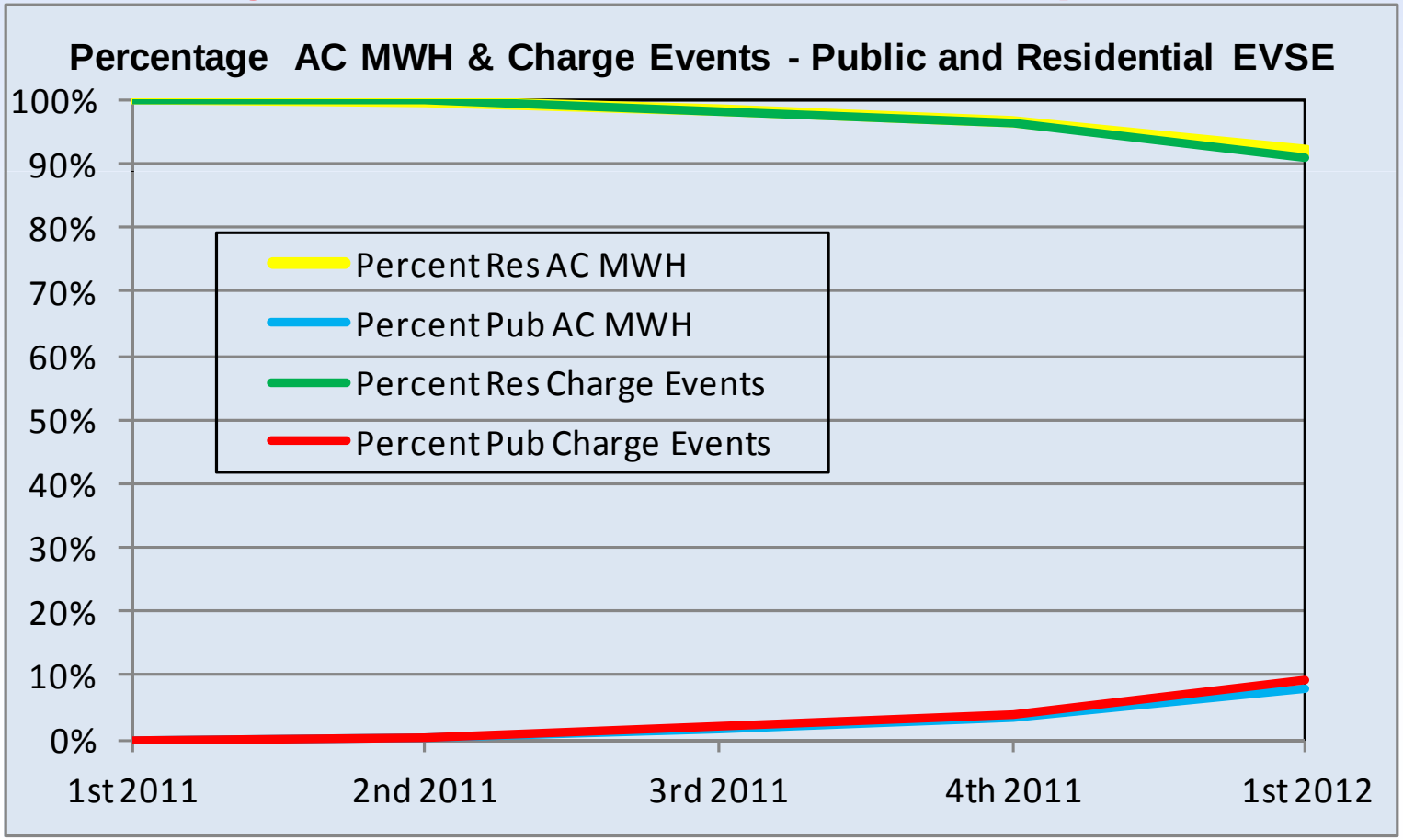
# EV Project – EVSE Infra. Summary Report

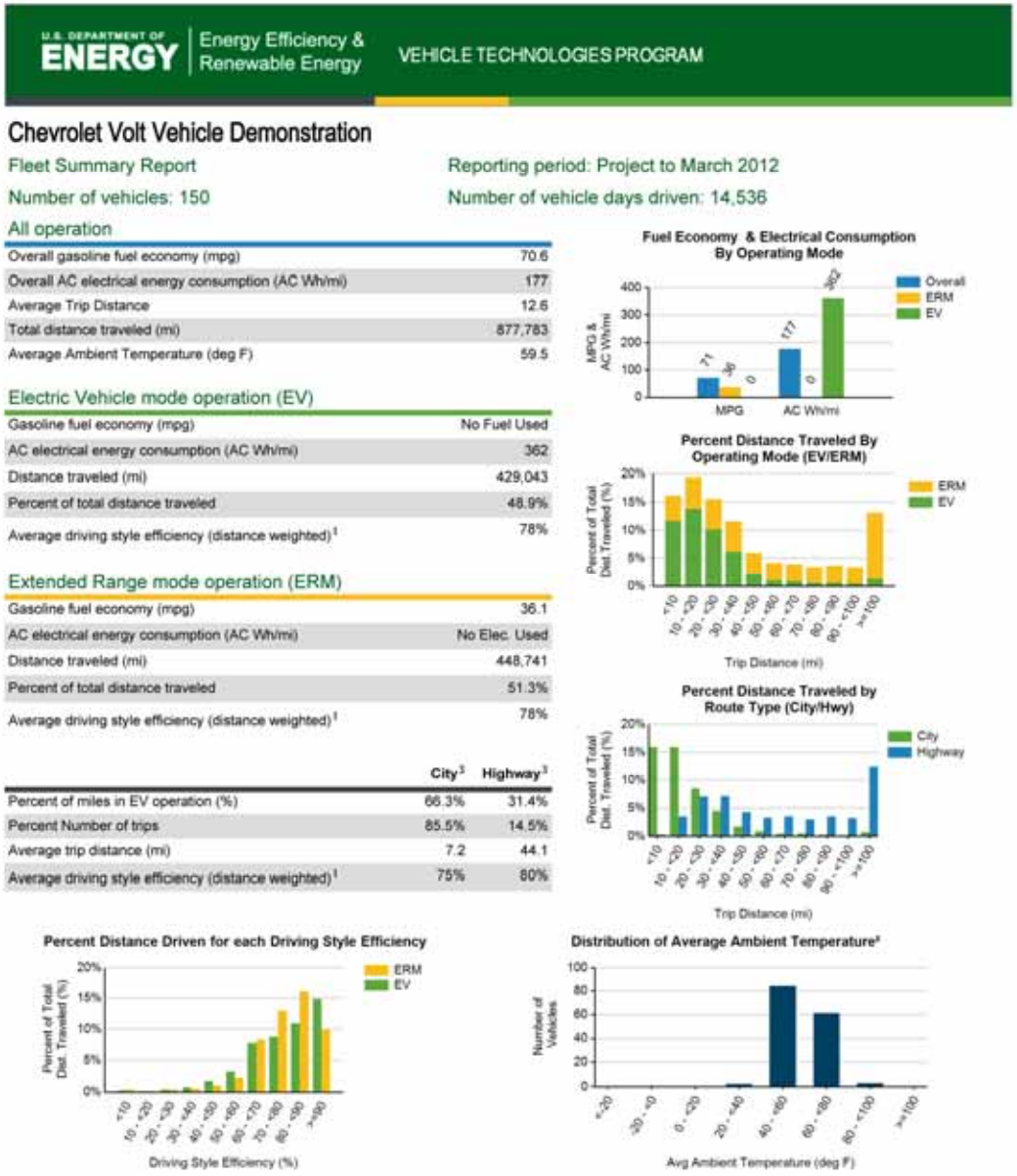
- **Percent of public EVSE deployed is increasing (22%)**
- **However, use is increasing at a slower rate (next slide)**



# EV Project – EVSE Infra. Summary Report

- **Percent charge events and AC MWH use by residential and public EVSE each reporting quarter**
- **Public EVSE use (red & blue lines) is increasing**
- **9.1% charge events and 8.0% MWh 1st quarter 2012**





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

## Chevrolet Volt Vehicle Demonstration

Fleet Summary Report — Reporting period: Project to March 2012

Number of vehicles: 150 — Number of vehicle days driven: 14,536

### All operation

| | |
|---|---|
| Overall gasoline fuel economy (mpg) | 70.6 |
| Overall AC electrical energy consumption (AC Wh/mi) | 177 |
| Average Trip Distance | 12.6 |
| Total distance traveled (mi) | 877,783 |
| Average Ambient Temperature (deg F) | 59.5 |

### Electric Vehicle mode operation (EV)

| | |
|---|---|
| Gasoline fuel economy (mpg) | No Fuel Used |
| AC electrical energy consumption (AC Wh/mi) | 362 |
| Distance traveled (mi) | 429,043 |
| Percent of total distance traveled | 48.9% |
| Average driving style efficiency (distance weighted)[1] | 78% |

### Extended Range mode operation (ERM)

| | |
|---|---|
| Gasoline fuel economy (mpg) | 36.1 |
| AC electrical energy consumption (AC Wh/mi) | No Elec. Used |
| Distance traveled (mi) | 448,741 |
| Percent of total distance traveled | 51.3% |
| Average driving style efficiency (distance weighted)[1] | 78% |

| | City[3] | Highway[3] |
|---|---|---|
| Percent of miles in EV operation (%) | 66.3% | 31.4% |
| Percent Number of trips | 85.5% | 14.5% |
| Average trip distance (mi) | 7.2 | 44.1 |
| Average driving style efficiency (distance weighted)[1] | 75% | 80% |

Fuel Economy & Electrical Consumption By Operating Mode



Percent Distance Traveled By Operating Mode (EV/ERM)



Percent Distance Traveled by Route Type (City/Hwy)



Percent Distance Driven for each Driving Style Efficiency



Distribution of Average Ambient Temperature[2]



1 The energy efficiency over the drive cycle is based on driving style. Driving in a more efficient manner results in a higher percentage for driving style.

2 Plot shows average ambient temperature during all driving in the reporting period for each vehicle

3 City / Highway defined per SAE J2841

INL Idaho National Laboratory | GM | OnStar

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# Chevrolet Volt DOE ARRA Project

- **Non-public fleet drivers operating 150 Volts**
- **May '11 to March '12**
  - **878,000 total miles**
  - **All trips, 70.6 mpg, 177 AC Wh/mi**
  - **EV mode, 362 AC Wh/mi. 48.9% miles**
  - **Extended range mode, 36.1 mpg**
- **Jan to March 2012**
  - **346,000 miles**
  - **EV mode, 384 AC Wh/mi. 46.8% miles**

Idaho National Laboratory | ENERGY

# Chevrolet Volt DOE ARRA Project

- **Non-public fleet drivers**
- **150 Volts (May '11 – March '12)**
  - **Average charging events per month** **16**
  - **Average # charging events per vehicle day** **1.2**
  - **Average miles per charging event** **42 miles**
  - **Average trips between charging events** **3.4**
  - **Average time connected per event** **3.3 hours**
  - **Average energy per charge event** **7.2 AC kWh**
  - **Average charging energy per vehicle month** **117 AC kWh**
  - **Average trip distance city driving** **7.2 miles**
  - **Average trip distance highway driving** **44.1 miles**
  - **Percent of miles in EREV (electric) mode** **48.9%**

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## Ford Escape Advanced Research Fleet

Number of vehicles: 21
Reporting period: Nov 09 - June 12
Date range of data received: 11/01/2009 to 06/30/2012
Number of vehicle days driven: 9,131

### All Trips Combined

| | |
|---|---|
| Overall gasoline fuel economy (mpg) | 38 |
| Overall AC electrical energy consumption (AC Wh/mi)[1] | 100 |
| Overall DC electrical energy consumption (DC Wh/mi)[2] | 68 |
| Total number of trips | 44,178 |
| Total distance traveled (mi) | 528,632 |

### Trips in Charge Depleting (CD) mode[3]

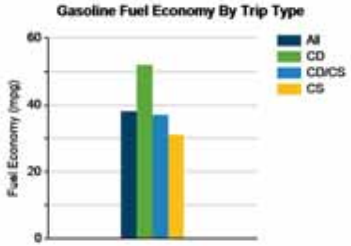
| | |
|---|---|
| Gasoline fuel economy (mpg) | 52 |
| DC electrical energy consumption (DC Wh/mi)[4] | 163 |
| Number of trips | 25,801 |
| Percent of trips city \| highway | 83% \| 17% |
| Distance traveled (mi) | 151,628 |
| Percent of total distance traveled | 29% |

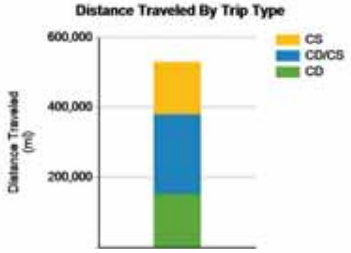
### Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes[5]

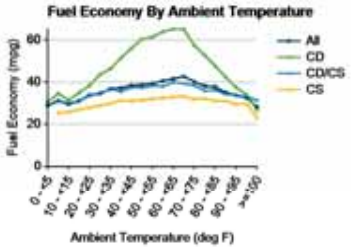
| | |
|---|---|
| Gasoline fuel economy (mpg) | 37 |
| DC electrical energy consumption (DC Wh/mi)[6] | 54 |
| Number of trips | 8,261 |
| Percent of trips city \| highway | 38% \| 62% |
| Distance traveled (mi) | 227,283 |
| Percent of total distance traveled | 43% |

### Trips in Charge Sustaining (CS) mode[7]

| | |
|---|---|
| Gasoline fuel economy (mpg) | 31 |
| Number of trips | 10,106 |
| Percent of trips city \| highway | 66% \| 34% |
| Distance traveled (mi) | 149,720 |
| Percent of total distance traveled | 28% |




Notes: 1 - 7. Please see http://avt.inl.gov/pdf/phev/fordreportnotes.pdf for an explanation of all PHEV Fleet Testing Report notes.

Since these vehicles are flex-fuel capable, some driving events are conducted with E-85, which may decrease fuel economy results

"The Ford Escape Advanced Research Fleet was designed as a demonstration of customer duty cycles related to plug-in electric vehicles. The vehicles used in this demonstration have not been optimized to provide the maximum potential fuel economy."

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# Ford Escape Adv. Research Vehicle

- 21 Ford Escape PHEVs
- Fleet drivers
- Nov 09 to June 12
- 529,000 test miles
- All trips, 38 mpg, 100 AC & 68 DC Wh/mi
- Charge Depleting (CD), 52 mpg & 163 DC Wh/mi. 29% of all miles
- Charge Sustaining (CS), 31 mpg. 28% of all miles
- Charging = 68% overall increase in mpg when comparing CD to CS trips

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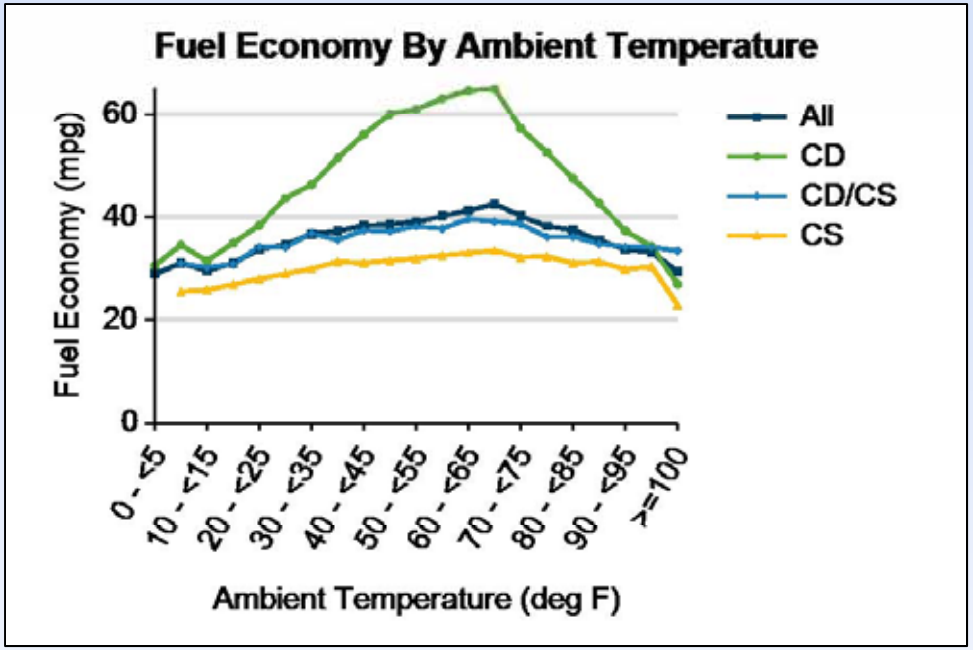


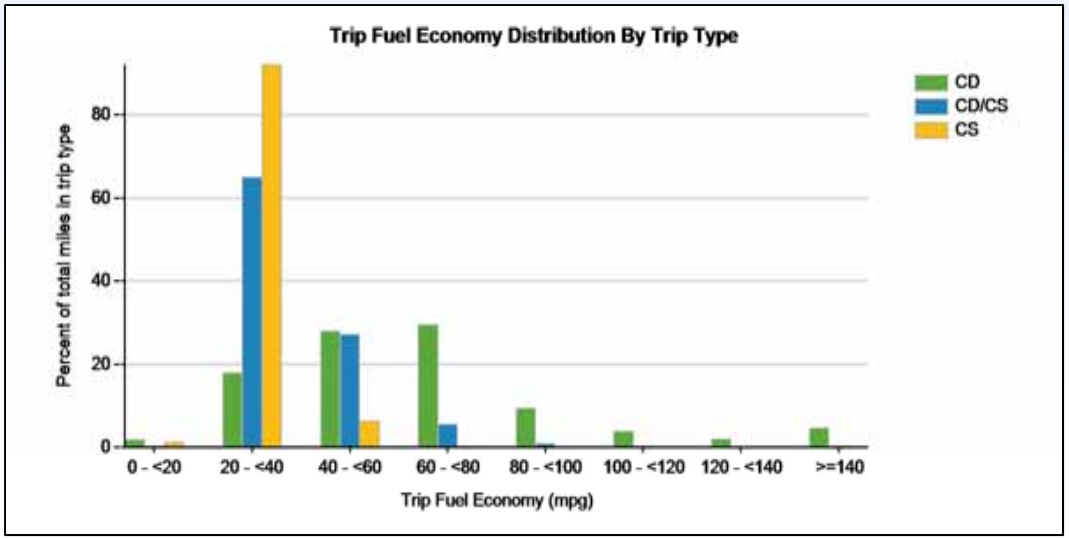


# Ford Escape Adv. Research Vehicle

- **Ambient temperature and increased engine off-times impact mpg**
- **Charging = 57% increase in city mpg and 78% increase in highway mpg (compare CD to CS)**
- **City - 36% CD and 23% CS miles engine off**
- **Highway - 11% CD and 4% CS miles engine off**

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## Chrysler RAM PHEV Fleet

Number of vehicles: 109
Reporting period: July 2011 to May 2012

**All Fleets**

Date range of data received: 7/1/2011 to 5/31/2012
Number of vehicle days driven: 14280

### All Trips Combined

| | |
|---|---|
| Overall gasoline fuel economy (mpg) | 19 |
| Overall AC electrical energy consumption (AC Wh/mi)[1] | 100 |
| Overall DC electrical energy consumption (DC Wh/mi)[2] | 69 |
| Overall DC electrical energy captured from regenerative braking (DC Wh/mi) | 44 |
| Total number of trips | 86,891 |
| Total distance traveled (mi) | 815,236 |

### Trips in Charge Depleting (CD) mode[3]

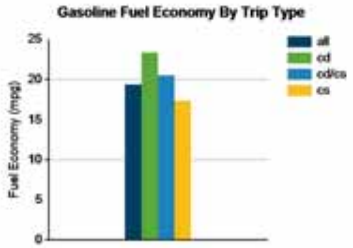
| | |
|---|---|
| Gasoline fuel economy (mpg) | 23 |
| DC electrical energy consumption (DC Wh/mi)[4] | 210 |
| Number of trips | 37,002 |
| Percent of trips city \| highway | 94% \| 6% |
| Distance traveled (mi) | 205,637 |
| Percent of total distance traveled | 25% |

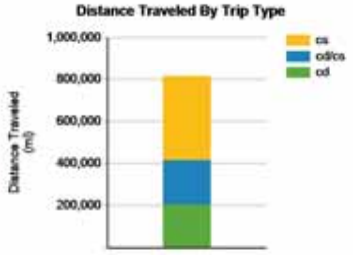
### Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes[5]

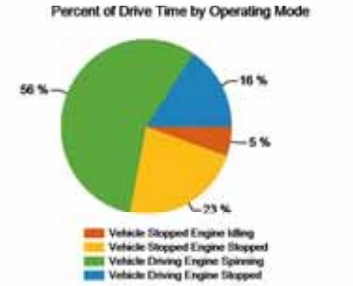
| | |
|---|---|
| Gasoline fuel economy (mpg) | 21 |
| DC electrical energy consumption (DC Wh/mi)[6] | 69 |
| Number of trips | 10,253 |
| Percent of trips city \| highway | 74% \| 26% |
| Distance traveled CD \| CS (mi) | 78,551 \| 131,86 2 |
| Percent of total distance traveled CD \| CS | 10% \| 16% |

### Trips in Charge Sustaining (CS) mode[7]

| | |
|---|---|
| Gasoline fuel economy (mpg) | 17 |
| Number of trips | 41,636 |
| Percent of trips city \| highway | 90% \| 10% |
| Distance traveled (mi) | 399,840 |
| Percent of total distance traveled | 49% |




Notes: 1 - 9. Please see http://avt.inl.gov/pdf/phev/chryslerreportnotes.pdf for an explanation of all PHEV Fleet Testing Report notes. This document also includes all report changes to date.

The Chrysler RAM PHEV Fleet was designed as a demonstration program of customer duty cycles related to plug-in electric vehicles and may not necessarily demonstrate optimized fuel economy.

Vehicle fuel economy is based on customer usage and may not be representative of maximum potential fuel economy.

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# Chrysler Ram PHEV Project

- **109 Ram PHEVs**
- **Fleet drivers**
- **July 2011 to May 2012**
- **815,000 test miles**
- **All trips, 19 mpg, 100 AC & 69 DC Wh/mi. 44 DC Wh/mi captured by regenerative braking**
- **CD, 23 mpg & 210 DC Wh/mi**
- **CS, 17 mpg**
- **Charging = 35% overall increase in mpg when comparing CD to CS trips**

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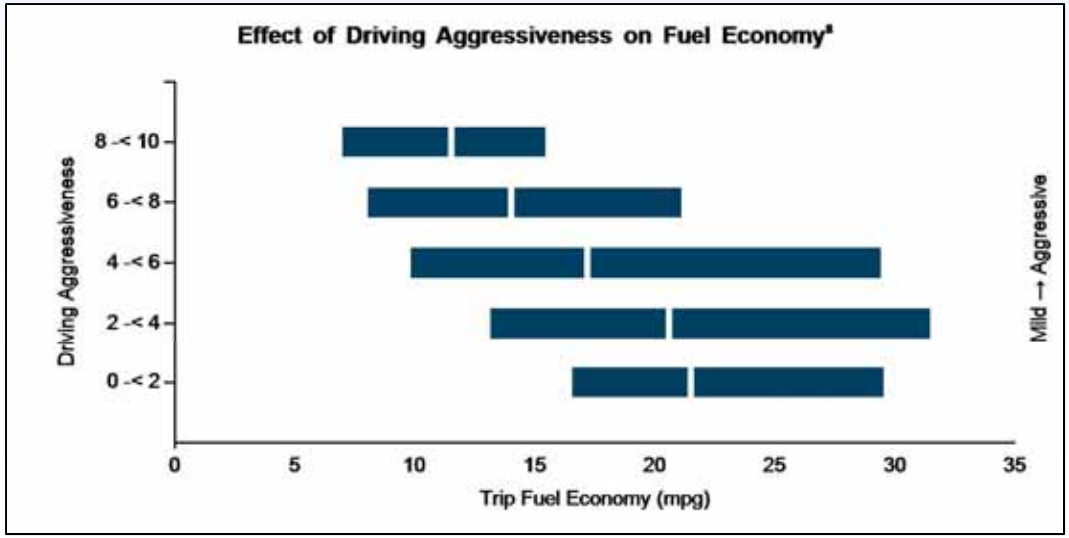
# Chrysler Ram PHEV Pickups

- Rams in fleet applications
- 39% total time gas engine is stopped
  - Vehicle driving 16% time engine stopped
  - Vehicle stopped 23% time engine stopped
- 64.1 miles per charge event
- 7.0 trips per charge event
- 0.89 charge events per vehicle day
- 2.4 average hours per charge event
- 6.4 AC kWh average energy / charge

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## ChargePoint® America Vehicle Charging Infrastructure Summary Report

Project Status to Date through: March 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 | 578 | 34 | 463 | 3 | 1,078 | 128,396 | 873.3 |
| Connecticut | 8 | - | - | - | 8 | 1,815 | 9.7 |
| District of Columbia | - | 13 | 16 | - | 29 | 503 | 3.9 |
| Florida | 24 | 10 | 204 | 2 | 240 | 3,195 | 18.1 |
| Maryland | 17 | 7 | 46 | - | 70 | 3,807 | 24.0 |
| Massachusetts | 13 | 7 | 64 | - | 84 | 1,501 | 11.5 |
| Michigan | 196 | 12 | 160 | - | 368 | 37,707 | 260.4 |
| New Jersey | 44 | 2 | 17 | - | 63 | 10,589 | 63.6 |
| New York | 20 | 88 | 85 | - | 193 | 11,530 | 91.8 |
| Texas | 39 | 9 | 182 | - | 230 | 11,729 | 75.3 |
| Virginia | 23 | 6 | 39 | - | 68 | 7,280 | 47.7 |
| Washington | 10 | 7 | 95 | - | 112 | 5,067 | 32.5 |
| Total | 972 | 195 | 1,371 | 5 | 2,543 | 223,119 | 1,511.8 |

**ChargePoint America Charging Unit Distribution**

Project to Date through March 2012



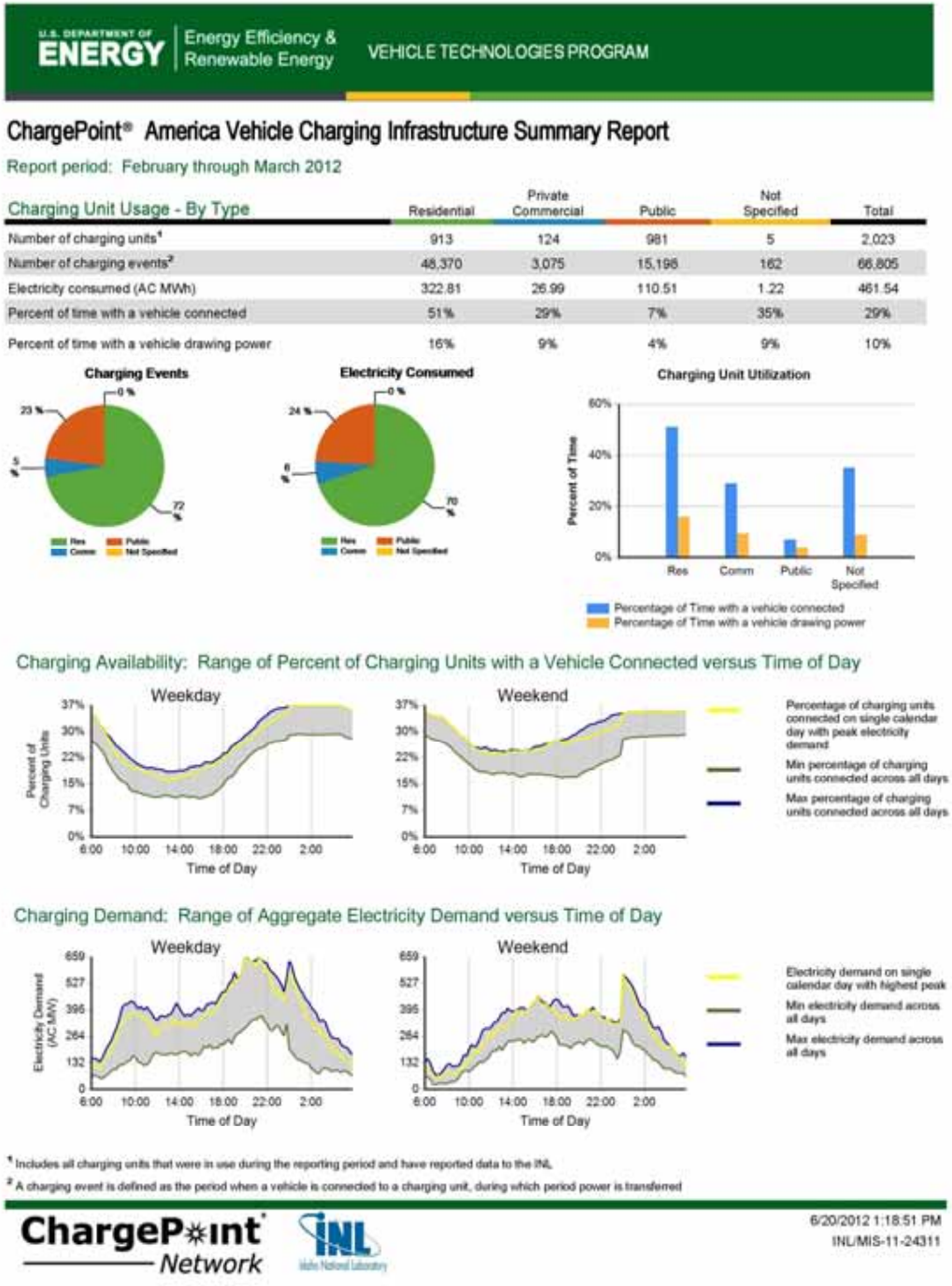

[1] Includes all charging units that were in use by the end of the rep

[2] A charging event is defined as the period when a vehicle is conn
some power is transferred

ChargePoint Network

# ChargePoint America ARRA Project

- Conducted by Coulomb
- Project to March 2012
- 2,543 EVSE installed and reporting data
- 972 Residential
- 195 Private/commercial
- 1,371 Public
- 5 unknown
- 223,000 charge events
- 1,500 AC MWh



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ChargePoint® America Vehicle Charging Infrastructure Summary Report

Report period: February through March 2012

| Charging Unit Usage - By Type | Residential | Private Commercial | Public | Not Specified | Total |
|---|---|---|---|---|---|
| Number of charging units[1] | 913 | 124 | 981 | 5 | 2,023 |
| Number of charging events[2] | 48,370 | 3,075 | 15,198 | 162 | 66,805 |
| Electricity consumed (AC MWh) | 322.81 | 26.99 | 110.51 | 1.22 | 461.54 |
| Percent of time with a vehicle connected | 51% | 29% | 7% | 35% | 29% |
| Percent of time with a vehicle drawing power | 16% | 9% | 4% | 9% | 10% |



Charging Availability: Range of Percent of Charging Units with a Vehicle Connected versus Time of Day



Charging Demand: Range of Aggregate Electricity Demand versus Time of Day



[1] Includes all charging units that were in use during the reporting period and have reported data to the INL

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

ChargePoint Network | INL Idaho National Laboratory

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# ChargePoint America ARRA Project

- Feb & March 2012 data
- 67,000 charge events
- Percent time vehicle connected
  - Residential 51%
  - Private/com 29%
  - Public 7%
- Percent time drawing power
  - Residential 16%
  - Private/com 9%
  - Public 4%
- EVSE data only

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# Additional PEV and Infrastructure Testing

- 20 Quantum PHEV Escape conversions
- 5 US Postal Service electric delivery vehicle conversions
- Conducting testing of “dumb” and “smart” EVSE
- Initiated wireless charging test program
- Initiated field and lab DC Fast and Level 2 charging study of impacts on battery life in 6 vehicles
- Conducting first responders training program with the National Fire Prevention Association and NHTSA
- Battery mule test vehicle provides field testing of traction battery packs at any power and efficiency level
- Several other EVSE providers have started to provide charging data to INL

# EV Project Summary To Date

- EV Project vehicles connected much longer than needed to recharge - opportunities to shift charging times
- Significant residential Level 2 EV Project charging occurs off-peak with charge-starts occurring at the midnight starts of super off-peak TOU kWh rates
- Significant opportunities to fully understand how the public uses public versus non-public infrastructure
- Revenue models for public charging being introduced – impacts?
- Only about 30% of EV Project data collected to date
- "Normal" research project process requires:
  - Design and execute the project, data collection completed, data analyzed, and finally, reports issued at completion of experiment
- INL/ECOtality needs to completely collect all data before definitively reporting seasonal trends and behaviors

# Future EV Project Data Analysis Subjects

- **Pricing elasticity – TOU rate influences?**
- **Regional and seasonal demographics and charging behaviors?**
- **Density of residential and non-residential EVSE as input to local micro distribution studies – transformer failures?**
- **Charge control preferences – vehicle, Blink and web based, and scheduled versus random?**
- **Rich public versus non-rich EVSE charging behaviors?**
- **Level 2 EVSE versus DCFC behaviors?**
- **Travel corridor versus convenience charging at stores?**
- **Length of vehicle ownership and miles per day / week / charge?**
- **Non-residential subcategories (public and work parking)?**
- **Etc., etc., etc.?**

# Acknowledgement

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

**This presenter is very grateful for DOE's support and the contributions of all the testing partners**

# More Information

**http://avt.inl.gov**

**This presentation can be found in the publications section of the above website**

**INL/CON-12-26634**