



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

## **U.S./China 2011 Workshop – EV Project Results (Nationally and in the Los Angeles Metro Area)**

**Jim Francfort**

- Los Angeles DWP / Mayor's Office**
- U.S. China EV & Battery Workshop**
- August 2011**

# Presentation Outline

- **Idaho National Laboratory (INL) and U.S. Department of Energy's (DOE) Advanced Vehicle Testing Activity (AVTA) participants and goals**
- **Vehicle testing experience**
- **INL data handling methods**
- **American Recovery and Reinvestment Act (ARRA) and the Technology Acceleration and Demonstration Activity (TADA) data collection projects**
- **EV Project overview**
- **EV Project data collection parameters**
- **EV Project results to date**
- **Summary**

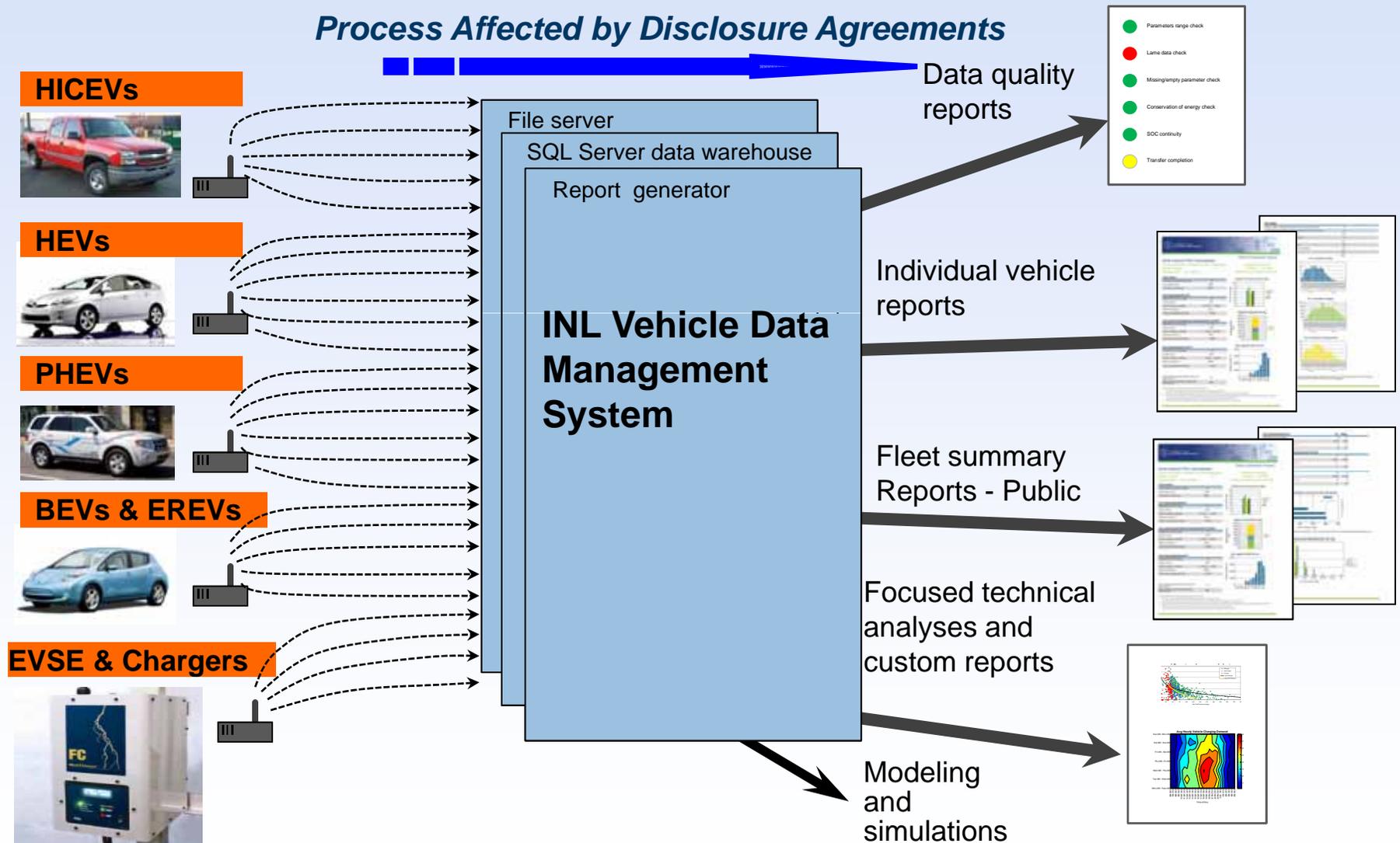
# AVTA Participants and Goals

- **Participants**
  - The AVTA is part of DOE's Vehicle Technologies Program within the DOE Office of Energy Efficiency and Renewable Energy (EERE)
  - INL conducts the AVTA per DOE guidance
  - 150+ fleets and organizations as testing partners
  - Some of the AVTA's vehicle testing activities are conducted with ECOtality North American
- **Goal - Petroleum reduction and energy security**
  - Provide benchmark data to DOE, technology modelers, research and development programs, vehicle manufacturers, and various target and goal setters
  - Assist fleet managers in making informed vehicle and infrastructure purchase, deployment and operating decisions

# Vehicle Testing Experience

- **Plug-in hybrid electric vehicles: 14 models, 430 PHEVs, 5 million test miles**
- **Extended Range Electric Vehicles: 1 model, 150 EREVs, 400,000 test miles**
- **Hybrid electric vehicles: 19 models, 50 HEVs, 6 million test miles**
- **Micro hybrid vehicles: 3 models, 7 MHVs, 200,000 test miles**
- **Neighborhood electric vehicles: 24 models, 372 NEVs, 200,000 test miles**
- **Battery electric vehicles: 47 models, 1,900 BEVs, 5 million test miles (includes 500+ USPS BEVs)**
- **Urban electric vehicles: 3 models, 460 UEVs, 1 million test miles**
- **18 million test miles accumulated on 2,900 electric drive vehicles representing 110 models**

# Vehicle/EVSE Data Management Process



# Vehicle and Infrastructure Data Sources

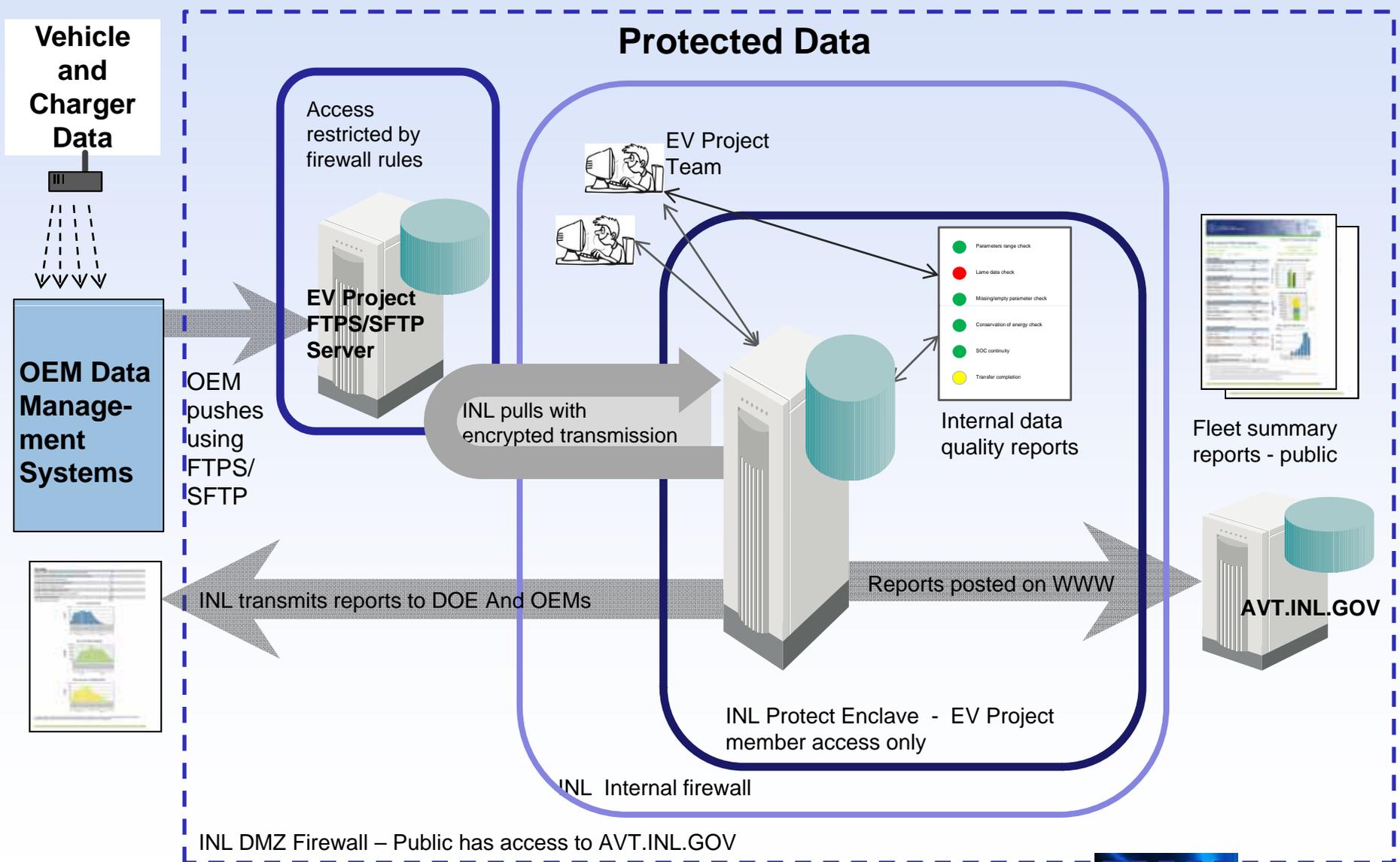
Vehicle time-history data (second-by-second)	HEV: 12 vehicle models, 1 data logger
	HICE: 1 vehicle model, 1 data logger
	Conversion PHEVs: 8 vehicle models, 3 data loggers
	<b>Ford</b> Escape PHEV, Ford wireless logger
	<b>Chrysler</b> Ram PHEV, Chrysler wireless logger
Vehicle event data (key-on, key-off)	<b>Nissan</b> Leaf, Nissan telematics
	<b>Chevrolet</b> Volt, OnStar telematics
Charger event and 15 min time-history data	<b>ECOtality</b> Blink networked level 2 EVSE, DC/fast chargers
	<b>Coulomb</b> ChargePoint networked level 2 EVSE

**Managing 26 different data models**



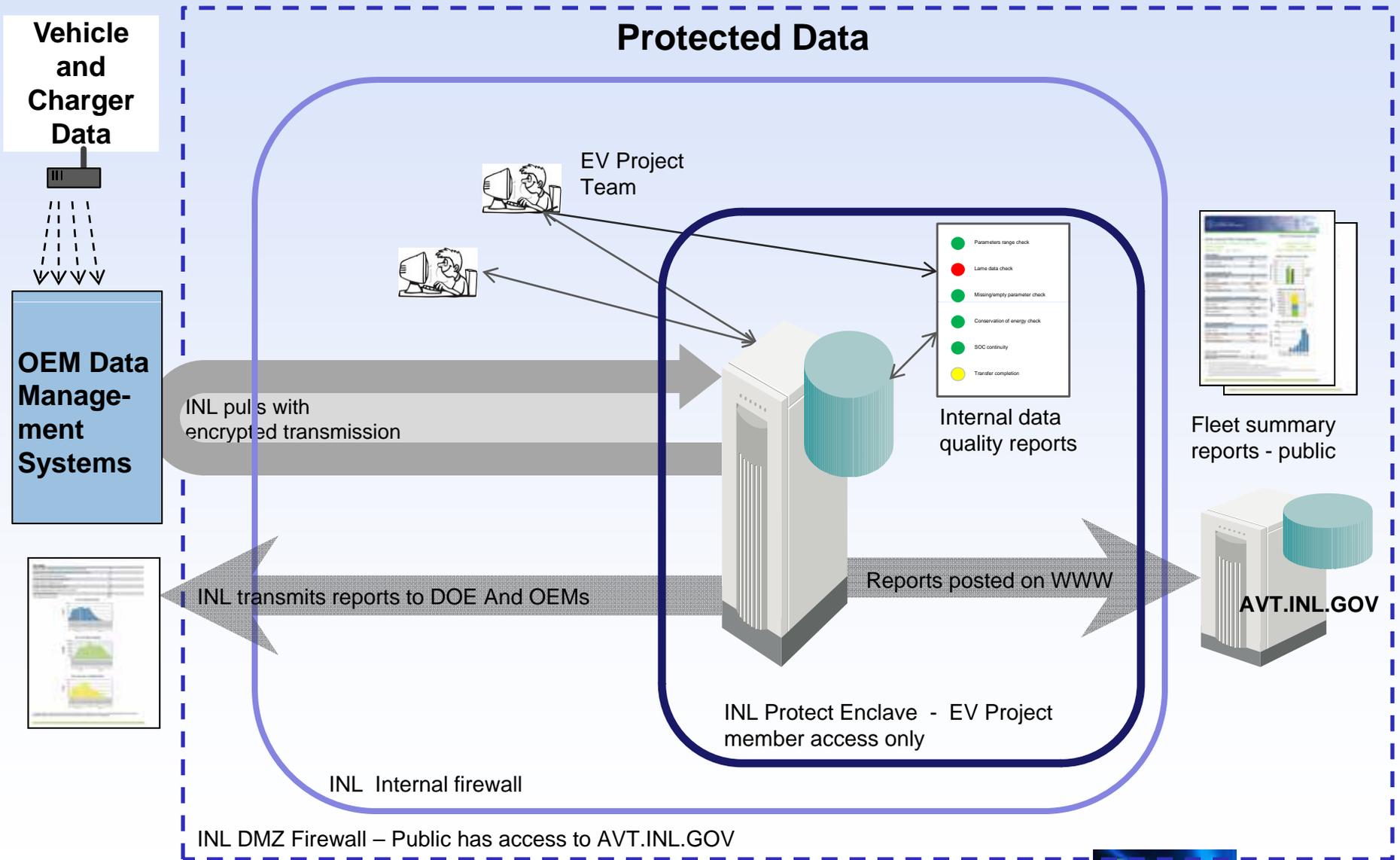
# INL Data Management System - Push

(Nissan, GM, Chrysler, Coulomb)



# INL Data Management System - Pull

(ECOtality, Ford, conversion PHEVs, HEVs, HICEs)



# Data Security and Protection

- All raw vehicle and EVSE data, and personal information protected by NDAs (Non Disclosure Agreements) or a CRADA (Cooperative Research And Development Agreement), resulting in:
  - Limitations on how the 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, cannot be shared with DOE in order to avoid exposure to FOIA
- Vehicle and EVSE data collection would not occur unless the above limitations are strictly adhered by participants
- INL can bin data results into usable information formats for analysis by EV Project participants

# INL ARRA / TADA Data Collection Support

- **INL tasked with data collection, analysis and reporting for five light-duty vehicle and infrastructure deployment projects funded by DOE via the ARRA, and TADA:**
  - **EV Project: 8,300 Leaf EVs and Volt EREVs, and 14,000 ECOtality Blink Level 2 electric vehicle supply equipment (EVSE) and fast chargers. All 22,000 pieces of equipment are equipped with data loggers (DLs)**
  - **140 Chrysler Ram PHEV Pickups and additional minivan PHEVs with DLs**
  - **150 General Motors EREV Volts with DLs**
  - **21 Ford Escape PHEV SUVs with DLs**
  - **4,000 Level 2 EVSE deployed by Coulomb with DLs**
  - **100's of EVSE deployments funded by Clean Cities**



# EV Project - Overview

- **Lead by ECOtality North America**
- **Approximately \$230 million total project funding**
- **Funded by a DOE ARRA grant (\$115 million)**
- **Partners cost share match greater than \$115 million**
- **Data being collected by INL via data streams from ECOtality (charging infrastructure), and Nissan and General Motors/OnStar (vehicles)**
- **EV Project purpose is to build and study mature electric vehicle charging infrastructure in six states and the District of Columbia (18 cities) to enable the streamlined deployment of the next 5,000,000 EVs**

# EV Project Locations

## The EV Project at a glance:



# EV Project Residential Infrastructure

- Deploy 8,300 battery electric vehicles
  - 5,700 Nissan Leaf battery EVs
  - 2,600 Chevrolet Volt extended range EVs
- Install 8,300 level 2 residential EVSE



# EV Project Commercial Infrastructure

- Install ~5,300 level 2 EVSE
  - Retail locations
  - Municipal locations
  - Employer locations
- Deploy 200 Dual Port DC Fast Chargers



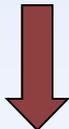
# EV Project Data Collection & Reporting

Vehicle Data

EV & EREV



Nissan GDC  
GM OnStar



INL



EVSE Data

EVSE



ECOtality Data  
Center

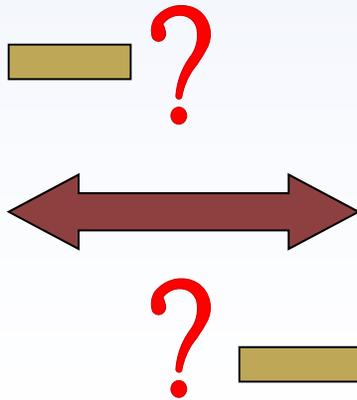


INL

MATCH



- EV Project Participant
- EV Project Participant
- Non EV Project Participant



- Non EV Project EVSE
- EV Project EVSE
- EV Project EVSE

# EV Project & Overall Data Collection Rational

- **Document electric drive vehicle technology's ability to reduce petroleum use by collecting data on:**
  - **Vehicle performance**
  - **Operational profiles and ambient conditions**
  - **Charging profiles**
- **Document fueling infrastructure technology, including:**
  - **Sitting**
  - **Use**
  - **Time-of-day pricing**
  - **Charging level (I, II, fast charging) utilization**
  - **Public vs. private charging**
  - **At-home vs public charging**
  - **Micro versus macro grid issues / impacts**

# **EV Project – Infrastructure Data Parameters Collected per Charge Event**

- **Date and Time Stamp**
- **Unique ID for Charging Event**
- **Unique ID Identifying the EVSE – may not change**
- **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**

- **Date and Time Stamp**
- **Vehicle ID**
- **Event type (key on / key off)**
- **Odometer**
- **Battery state of charge**
- **GPS (longitude and latitude)**
- **Fuel consumption (some vehicles)**
- **Recorded for each key-on and key-off event**

EV Project Overview Report

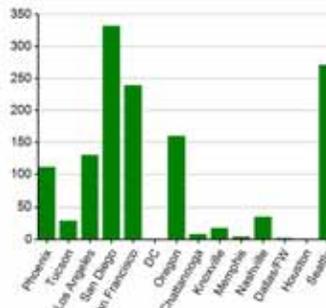
Project to Date through June 2011



Charging Infrastructure

Region*	Number of EV Project Charging Units Installed To Date	Number of Charging Events Performed	Electricity Consumed (AC MWh)
Phoenix, AZ Metropolitan Area	111	3,921	25.07
Tucson, AZ Metropolitan Area	29	1,134	6.90
Los Angeles, CA Metropolitan Area	130	4,245	28.90
San Diego, CA Metropolitan Area	332	11,150	87.67
San Francisco, CA Metropolitan Area	239	6,352	44.12
Washington, D.C. Metropolitan Area	0	0	0.00
Oregon	190	4,727	32.76
Chattanooga, TN Metropolitan Area	8	253	1.77
Knoxville, TN Metropolitan Area	17	508	3.60
Memphis, TN Metropolitan Area	4	97	0.73
Nashville, TN Metropolitan Area	35	1,083	7.83
Dallas/Ft. Worth, TX Metropolitan Area	2	21	0.06
Houston, TX Metropolitan Area	0	0	0.00
Washington State	271	8,637	57.57
Total	1,338	42,128	296.58

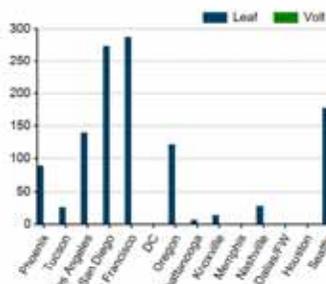
Charging Unit Installation to Date by Region



Vehicles

Region*	EV Project Nissan Leafs Enrolled to Date <sup>1</sup>	EV Project Chevrolet Volts Enrolled to Date <sup>1</sup>	Number of Trips	Distance Driven (mi)
Phoenix, AZ Metropolitan Area	89	—	15,436	124,044
Tucson, AZ Metropolitan Area	26	—	4,296	33,827
Los Angeles, CA Metropolitan Area	139	0	20,326	150,416
San Diego, CA Metropolitan Area	273	0	51,898	391,122
San Francisco, CA Metropolitan Area	267	—	39,307	321,090
Washington, D.C. Metropolitan Area	—	0	0	0
Oregon	121	—	19,255	133,861
Chattanooga, TN Metropolitan Area	7	—	889	8,131
Knoxville, TN Metropolitan Area	14	—	2,243	19,101
Memphis, TN Metropolitan Area	1	—	—	—
Nashville, TN Metropolitan Area	25	—	5,293	37,635
Dallas/Ft. Worth, TX Metropolitan Area	—	0	0	0
Houston, TX Metropolitan Area	—	0	0	0
Washington State	177	0	30,520	230,635
Total	1,162	0	189,582	1,450,314

Vehicle Enrollment to Date By Region



Note: EV Project charging units may be used by vehicles that are not part of the EV Project. Likewise, EV Project vehicles may connect to non-EV Project charging units. Therefore vehicle and charging infrastructure usage shown on this report are not directly comparable.

\* Regions: Oregon region includes the Greater Corvallis, Eugene, Portland, and Salem Metropolitan Areas  
Washington region includes the Greater Seattle and Olympia Metropolitan Areas

<sup>1</sup> Vehicle enrollment numbers refer to the EV Project only. Numbers do not reflect total regional or national vehicles sales or production.

# EV Project – Overview Report

- January thru June 2011 status report
- Charging infrastructure
  - # units installed
  - # charging events
  - AC MWh consumed
- Vehicles
  - # enrolled
  - # trips
  - Distance driven
- Results provided by EV Project region

# EV Project Overview Report – cont'd

• January thru June 2011	Nationally	L.A. Metro
• Number EVSE installed	1,338	130
• Number of charging events	42,128	4,245
• AC MWh consumed	296.6	28.5
• Nissan Leafs enrolled	1,162	139
• Total miles traveled	1,450,314	150,416
• Total number of trips	189,582	20,326



EV Project Nissan Leaf Vehicle Summary Report



Region: ALL

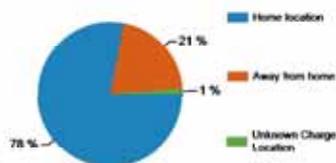
Number of vehicles: 956

Reporting period: April 2011 through June 2011

Vehicle Usage

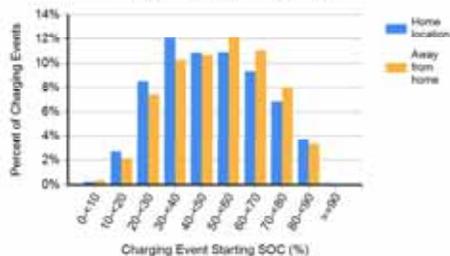
Number of trips	160,588
Total distance traveled (mi)	1,077,931
Avg trip distance (mi)	6.7
Avg distance traveled per day when the vehicle was driven (mi)	31.2
Avg number of trips between charging events	4.5
Avg distance traveled between charging events (mi)	30.4
Avg number of charging events per day when the vehicle was driven	1.0

Frequency of Charging by Charging Location and Type

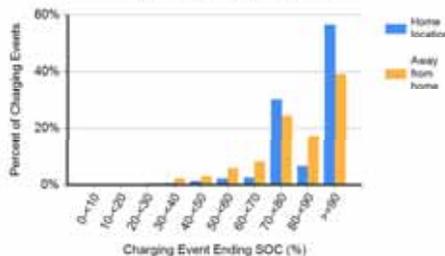


Charging Location and Type	Home charging location	Away-from-home charging locations	Unknown Charging Locations
Total number of charging events	27,663	7,340	455
Percent of all charging events	78%	21%	1%

Battery State of Charge (SOC) at the Start of Charging Events



Battery State of Charge (SOC) at the End of Charging Events



# EV Project – Nissan Leaf Usage Report

- This report requires matching vehicle and EVSE data
  - 965 Leafs and EVSE nationally
  - 103 Leafs and EVSE in the L.A. Metro area
- Documents vehicle usage
- Documents state of charge before and after charging events

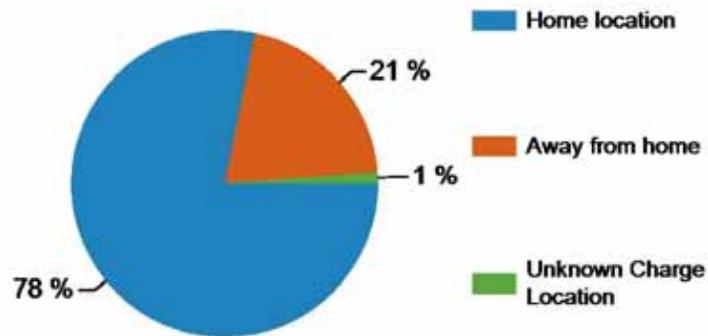
# Nissan Leaf Usage Report – cont'd

<b>April - June 2011</b>	<b>Nationally</b>	<b>L.A. Metro</b>
<b>• Number of Trips</b>	<b>160,588</b>	<b>16,846</b>
<b>• Total distance traveled (mi)</b>	<b>1,077,931</b>	<b>109,061</b>
<b>• Ave trip distance (mi)</b>	<b>6.7</b>	<b>6.5</b>
<b>• Ave miles per day when driven</b>	<b>31.2</b>	<b>29.2</b>
<b>• Ave # trips between charging events</b>	<b>4.5</b>	<b>4.6</b>
<b>• Ave distance (mi) traveled between charging events</b>	<b>30.4</b>	<b>29.9</b>
<b>• Ave number charging events per day when a vehicle was driven</b>	<b>1.0</b>	<b>1.0</b>

# Nissan Leaf Usage Report – cont'd

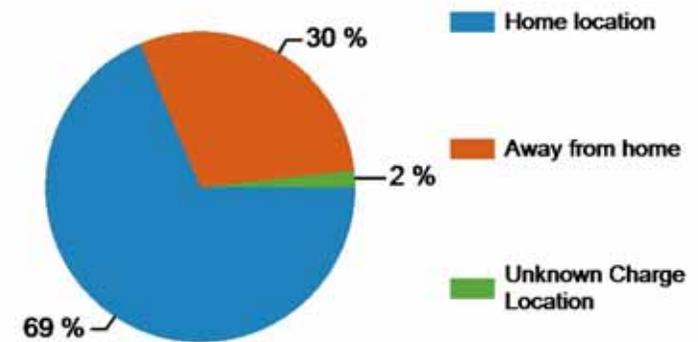
## Nationally

Frequency of Charging by Charging Location and Type



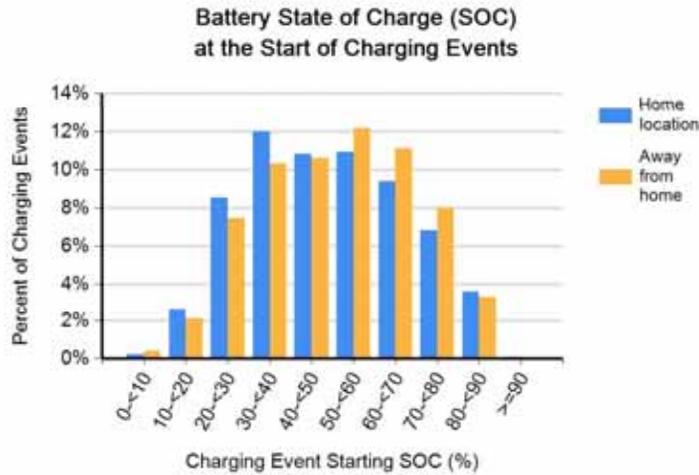
## L.A. Metro

Frequency of Charging by Charging Location and Type

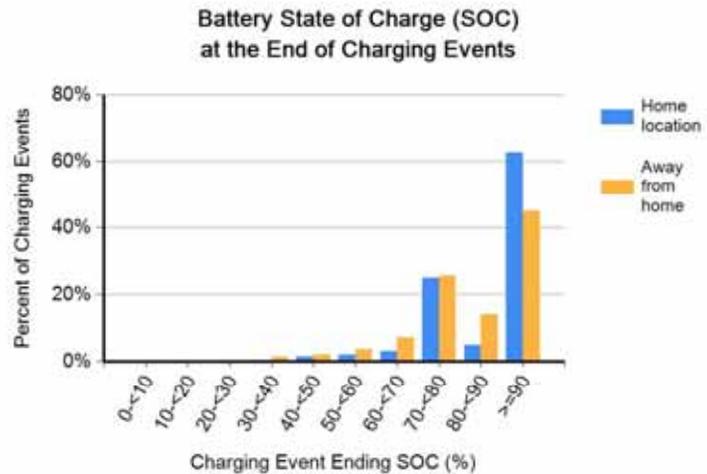
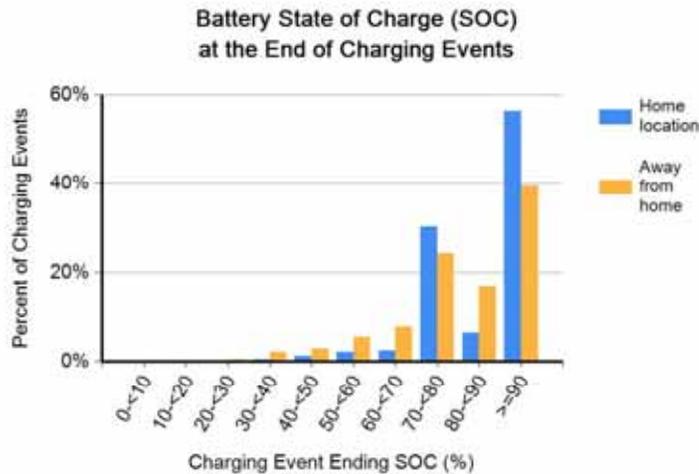
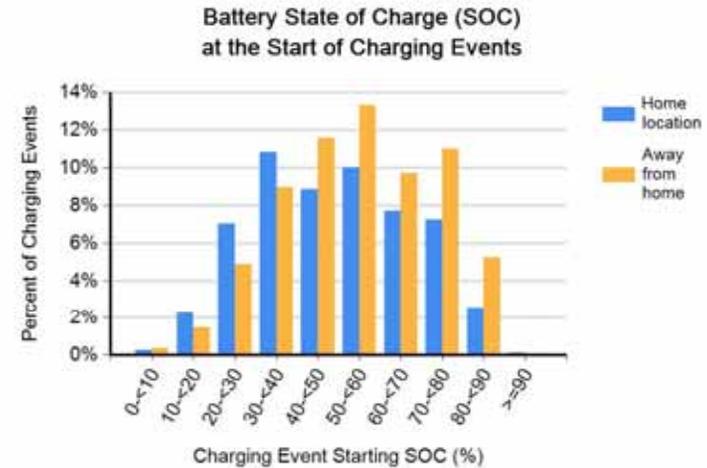


# Nissan Leaf Usage Report – cont'd

## Nationally



## L.A. Metro



EV Project Electric Vehicle Charging Infrastructure Summary Report



Region: ALL

Report period: April 2011 through June 2011

Number of EV Project vehicles in region: 956

Charging Unit Usage	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units <sup>1</sup>	955	0	11	0	966
Number of charging events <sup>2</sup>	35,134	0	56	0	35,190
Electricity consumed (AC MWh)	248.96	0.00	0.25	0.00	249.22
Percent of time with a vehicle connected to charging unit	30%	0%	5%	0%	30%
Percent of time with a vehicle drawing power from charging unit	6%	0%	1%	0%	6%

Number of Charge Events



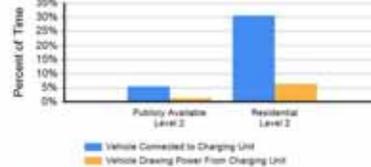
Residential Level 2  
Publicly Available Level 2

Electricity Consumed

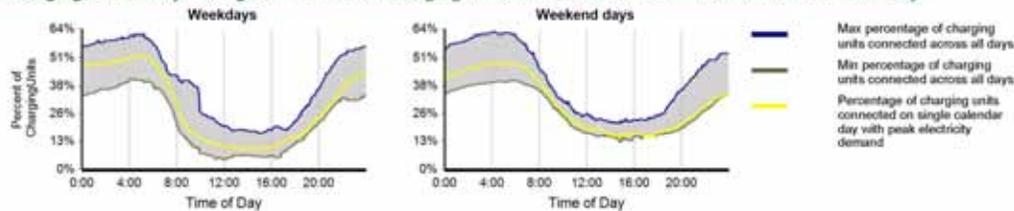


Residential Level 2  
Publicly Available Level 2

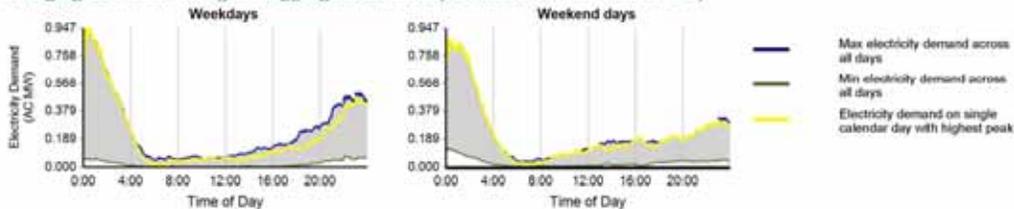
Charging Unit Utilization



Charging Availability: Range of Percent of Charging Units with a Vehicle Connected versus Time of Day<sup>3</sup>



Charging Demand: Range of Aggregate Electricity Demand versus Time of Day<sup>4</sup>



<sup>1</sup> Includes all charging units that were in use by the end of the reporting period

<sup>2</sup> A charging event is defined as the period when a vehicle is connected to a charging unit, during which period some power is transferred

<sup>3</sup> Considers the connection status of all charging units every minute

<sup>4</sup> Based on 15 minute rolling average power output from all charging units

# EV Project – Charging Infrastructure Report

- Documents EVSE usage
- Charging unit usage
- Energy use profiles
- Charging unit connection profiles
- Results by time of day and totals

# Charging Infrastructure Report – cont'd

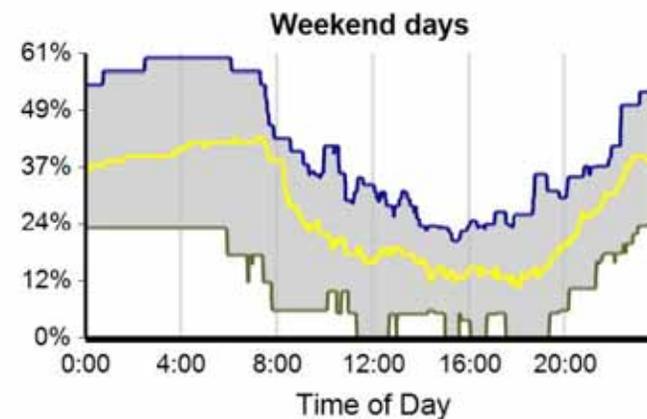
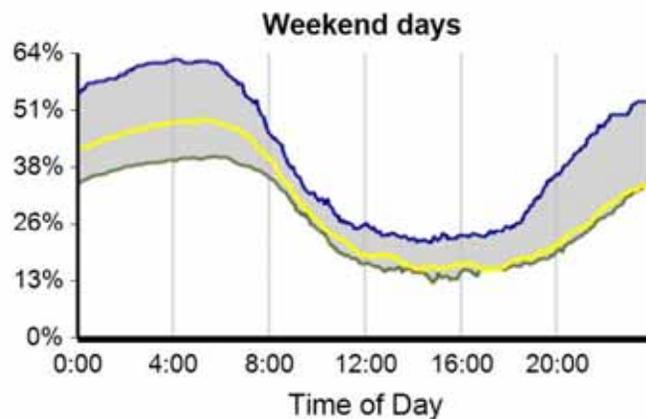
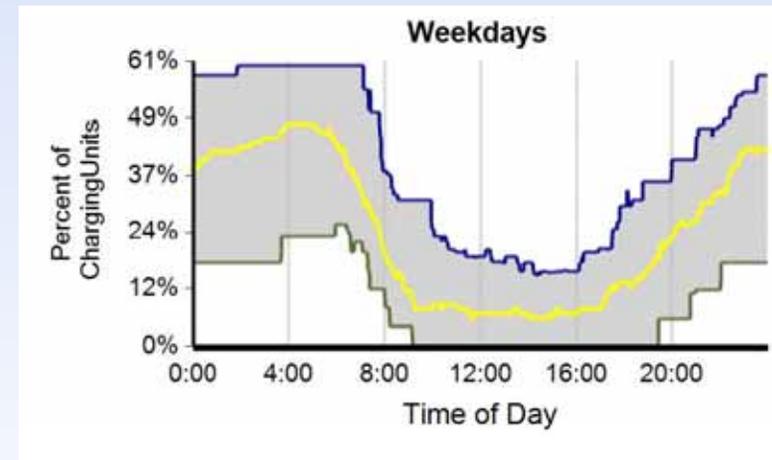
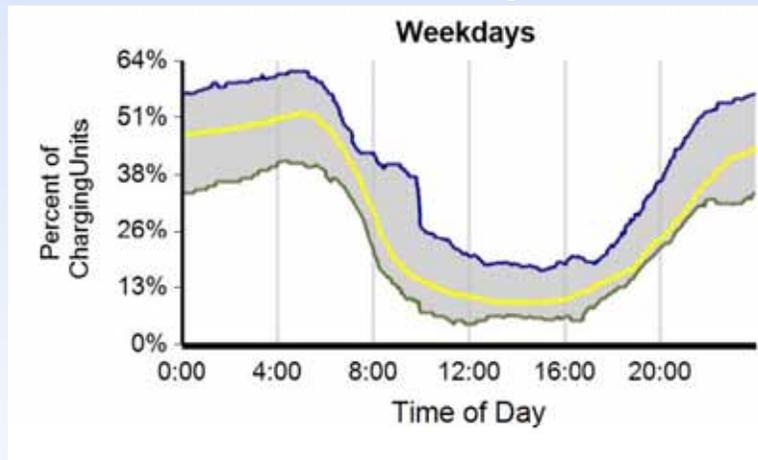
• April - June 2011	Nationally	L.A. Metro
• Number of Residential EVSE	955	102
• Number of charging events	35,134	3,365
• Electricity consumed (AC MWh)	249.0	22.8
• Percent time vehicle connected	30%	26%
• Percent time vehicle drawing power	6%	5%
• Ave hours connected per charge weekday	9.5	9.4
• Ave hours connected per charge weekend	9.2	8.7
• Ave weekday AC kWh per charge	7.4	7.0
• Ave weekend AC kWh per charge	6.3	6.2

# Charging Infrastructure Report – cont'd

Charging Availability: percent residential charging units with vehicle connected versus time of day

Nationally

L.A. Metro



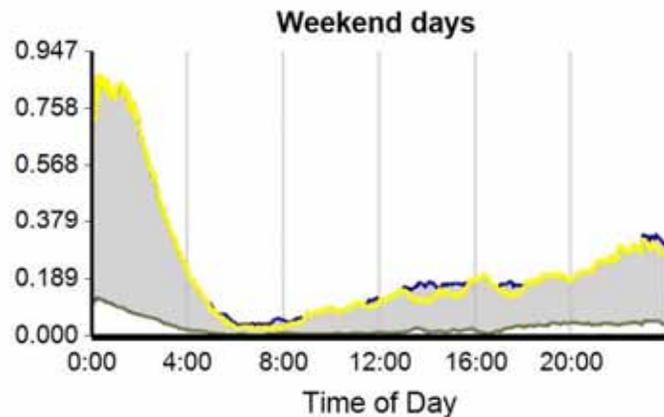
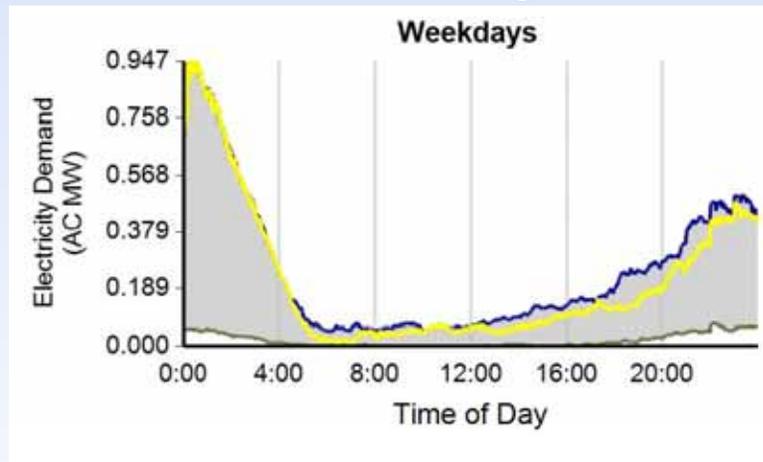
\*All graphs – Percent of Charging Units



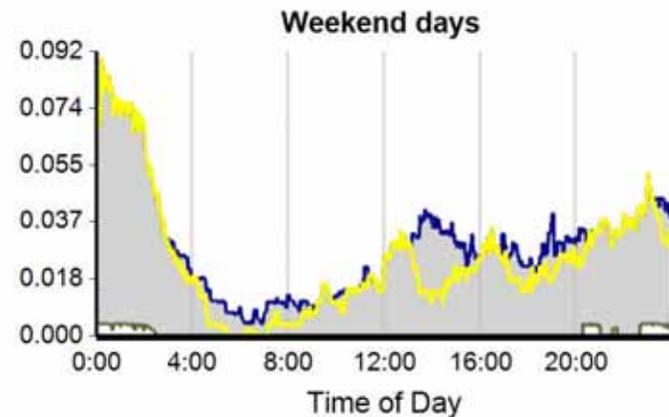
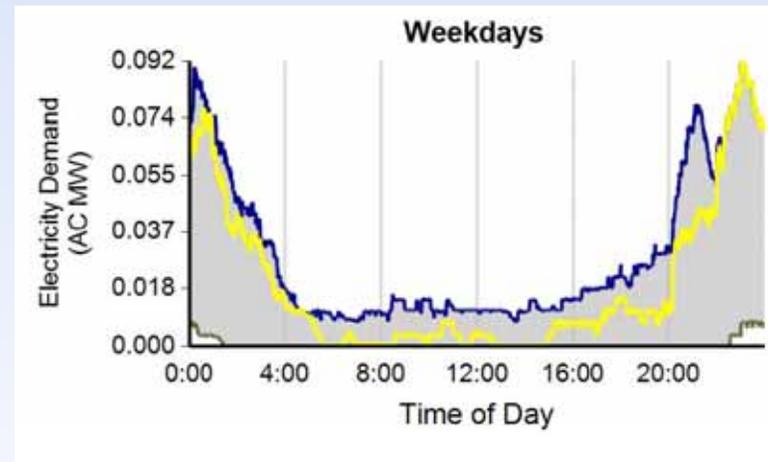
# Charging Infrastructure Report – cont'd

Charging Demand: range of aggregate electricity demand versus time of day

## Nationally



## L.A. Metro



\*All graphs – AC MW electricity demand

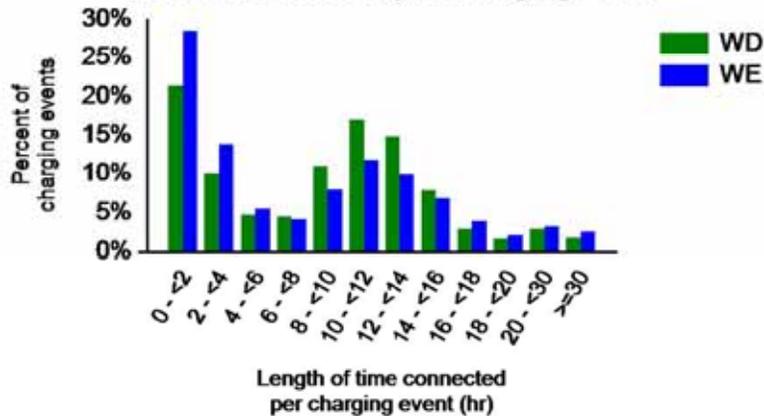


# Charging Infrastructure Report – cont'd

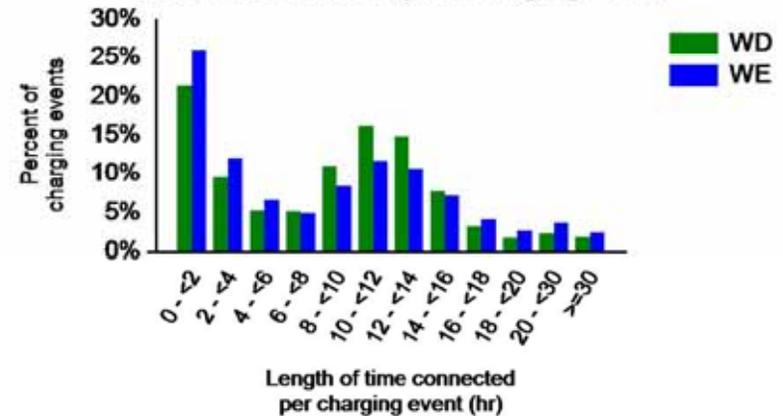
## Nationally

## L.A. Metro

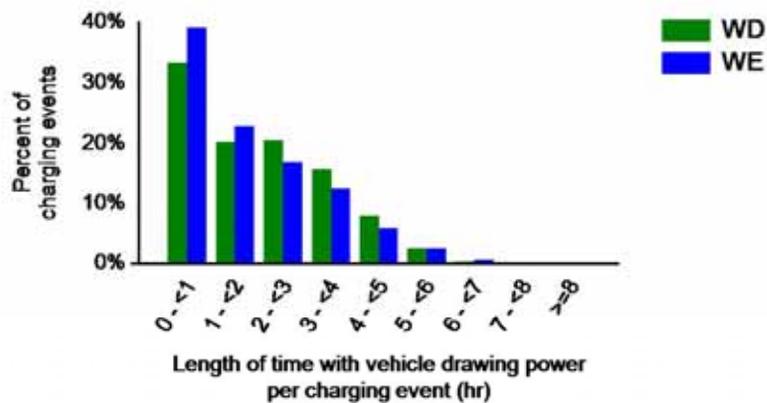
Distribution of Length of Time with a Vehicle Connected per Charging Event



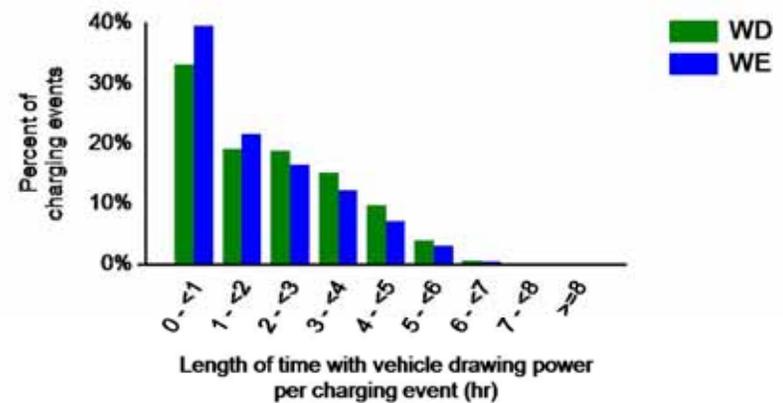
Distribution of Length of Time with a Vehicle Connected per Charging Event



Distribution of Length of Time with a Vehicle Drawing Power per Charging Event



Distribution of Length of Time with a Vehicle Drawing Power per Charging Event

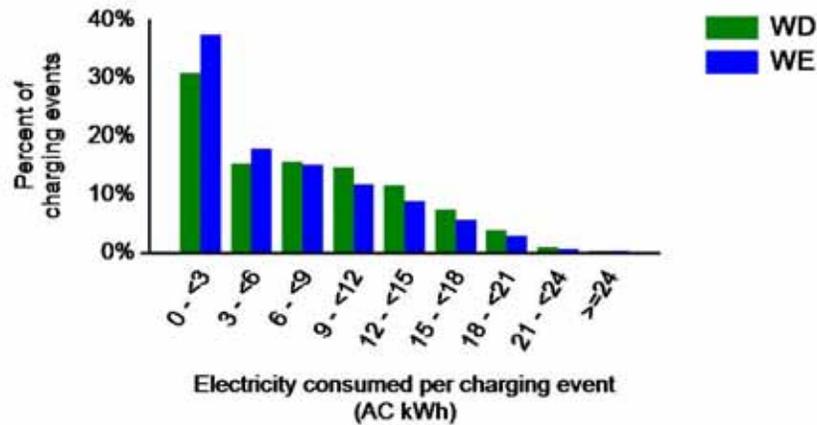


# Charging Infrastructure Report – cont'd

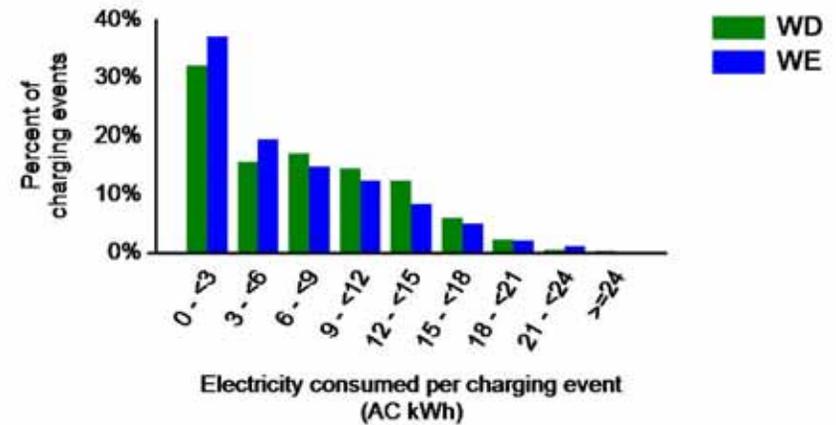
## Nationally

## L.A. Metro

Distribution of Electricity Consumed per Charging Event



Distribution of Electricity Consumed per Charging Event



# Summary

- **Ongoing INL/DOE data collection activities will provide 100 million miles of vehicle operations and charger use**
  - **Document private versus public charging behaviors**
  - **Document Level 2 versus fast charging behaviors**
  - **Document different revenue models potential impacts on charging behaviors**
  - **Document charging behaviors by time of day and day of week**
  - **Document potential electric utility micro and macro impacts from charging behaviors**
  - **Important to wait for data results before drawing conclusions!!!**

# Acknowledgement

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

## More Information

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

INL/MIS-11-22836

