



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

Plug-in Electric Vehicles (PEVs) & the EV Project Results to Date

Jim Francfort – Idaho National Laboratory

**EV Update
Portland, Seattle and Bellevue
April 2012**

Outline

- **Background, participants, testing experience**
- **Data process and security**
- **EV Project**
 - **Description and data parameters**
 - **Leaf and EVSE results (bulk of presentation)**
- **PEV charging as a percent of U.S. generation**
- **Volt results**
- **Ford Escape Advanced Research Vehicle results**
- **Chrysler Ram PHEV results**
- **Hymotion Prius results**
- **Other research activities**
- **Summary**



Idaho National Laboratory (INL)

- Eastern Idaho based U.S. Department of Energy (DOE) Federal 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
 - Energy Critical Infrastructure Protection
 - Homeland Security and Cyber Security



AVTA Participants and Goals

- The INL portion of this work is performed in support of DOE's Advanced Vehicle Testing Activity
- Participants
 - Part of DOE's Vehicle Technologies Program (EERE)
 - The INL conducts the light-duty vehicle portion of the AVTA per DOE guidance
 - Many of these testing activities are conducted with ECOtality North American
 - Support also provided to DOE Clean Cities and FEMP
- The AVTA goal - Petroleum reduction and energy security
 - Provide benchmark data to technology modelers, research and development programs, vehicle manufacturers (via VSATT), and target and goal setters
 - Assist fleet managers in making informed vehicle and infrastructure purchase, deployment and operating decisions

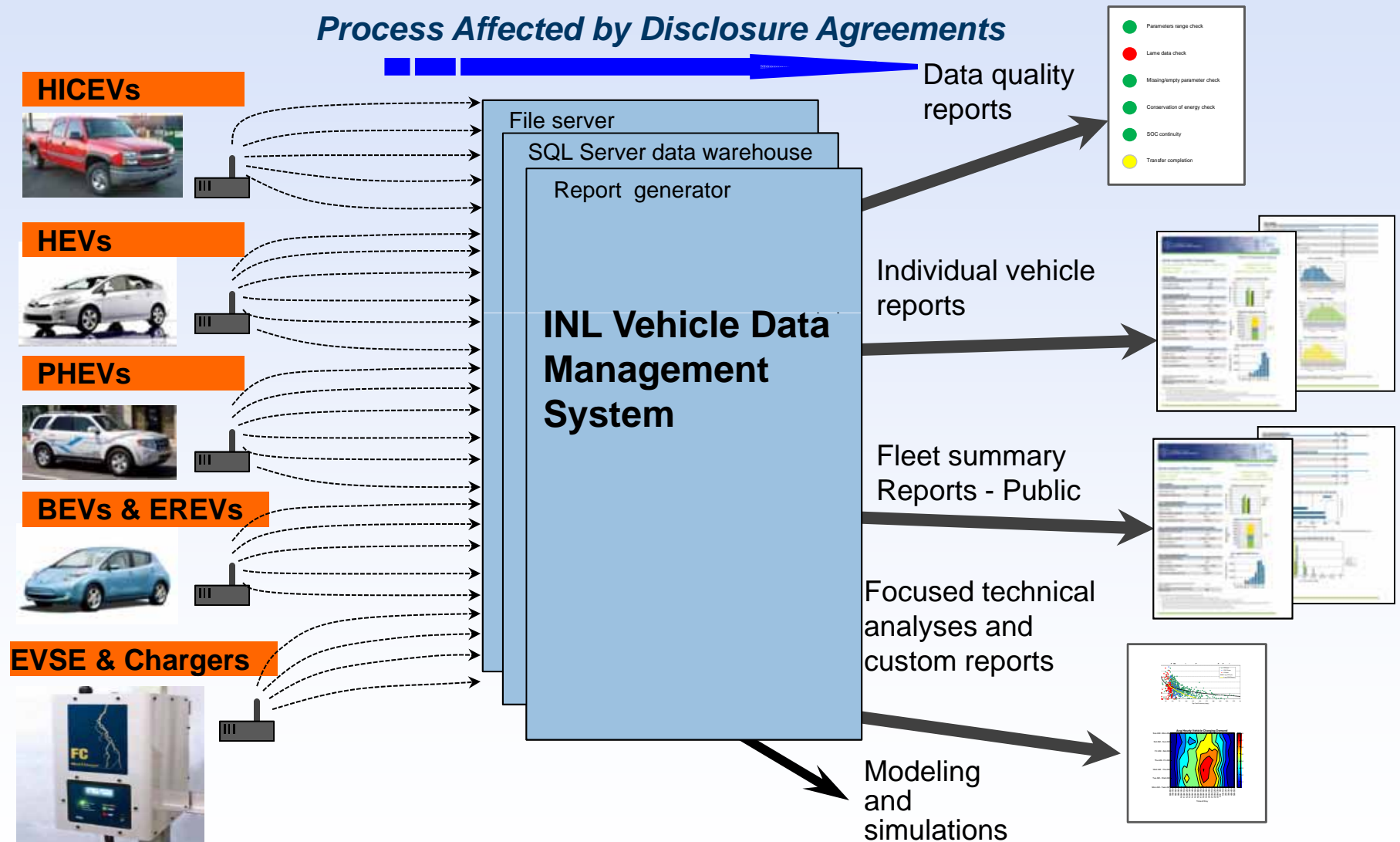


Vehicle / Infrastructure Testing Experience

- **37 million test miles accumulated on 8,000 electric drive vehicles representing 100+ models**
- **INL is accumulating 100,000+ vehicle test miles per DAY**
- **EV Project: 4,200+ Leafs and Volts, 20 million test miles**
- **PHEVs: 14 models, 430 PHEVs, 4 million test miles**
- **EREVs: 1 model, 125 EREVs, 520,000 test miles**
- **HEVs: 19 models, 50 HEVs, 6 million test miles**
- **Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 300,000 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**
- **6,000+ EVSE with data loggers**



INL Vehicle Data Management Process



Example: Vehicle/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

	Ford Escape PHEV, Ford wireless logger
	Chrysler Ram PHEV, Chrysler wireless logger
Vehicle event data (key-on, key-off)	Nissan Leaf, Nissan telematics
	Chevrolet Volt, OnStar telematics
Charger event and 15 min time-history data	ECOtality Blink networked level 2 EVSE, DC/fast chargers
	Coulomb ChargePoint networked level 2 EVSE

Managing 26 different data models

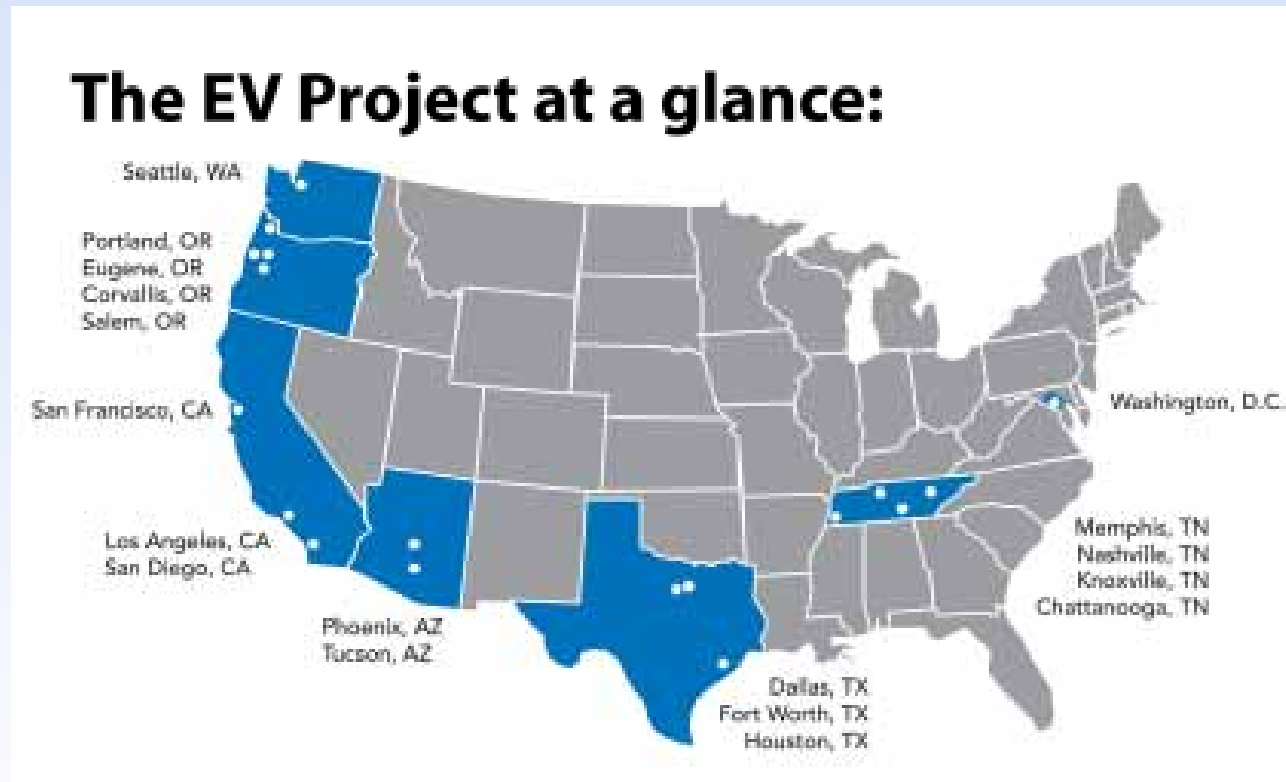


Data Security and Protection

- All raw vehicle and EVSE data, and personal information protected by NDAs (Non Disclosure Agreements) or a CRADAs (Cooperative Research And Development Agreements), 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 INL
- EV Project reporting requires that INL blend three very distinct data streams based on GPS and time/date stamps



EV Project Locations (Largest World-Wide PEV and EVSE Data Collection Activity)



- **Purpose: 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 – Charge Data Parameters Collected per Charge Event

- Date/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.)



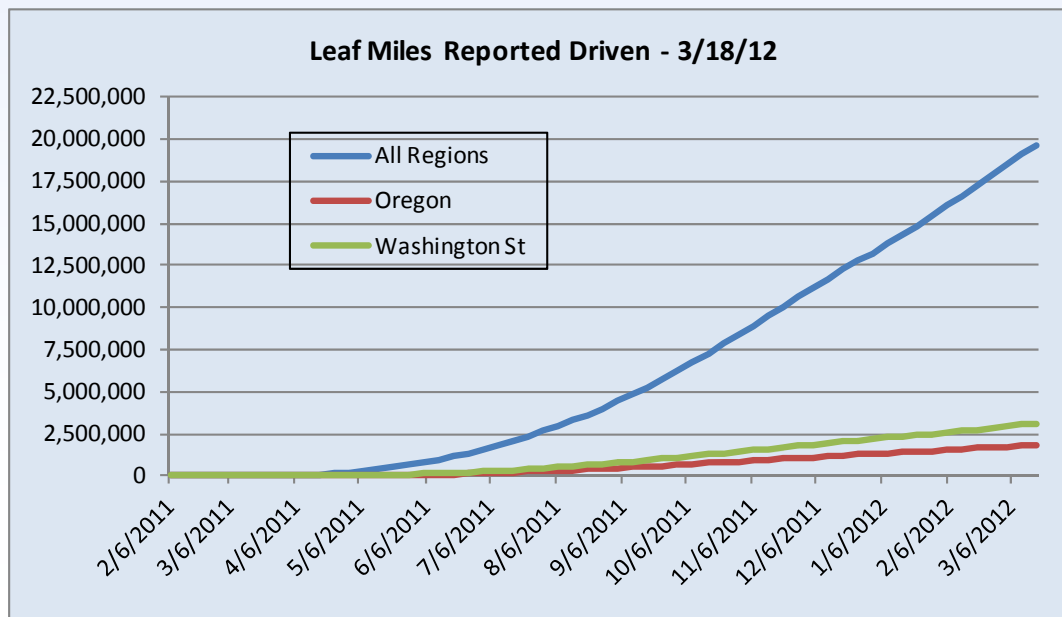
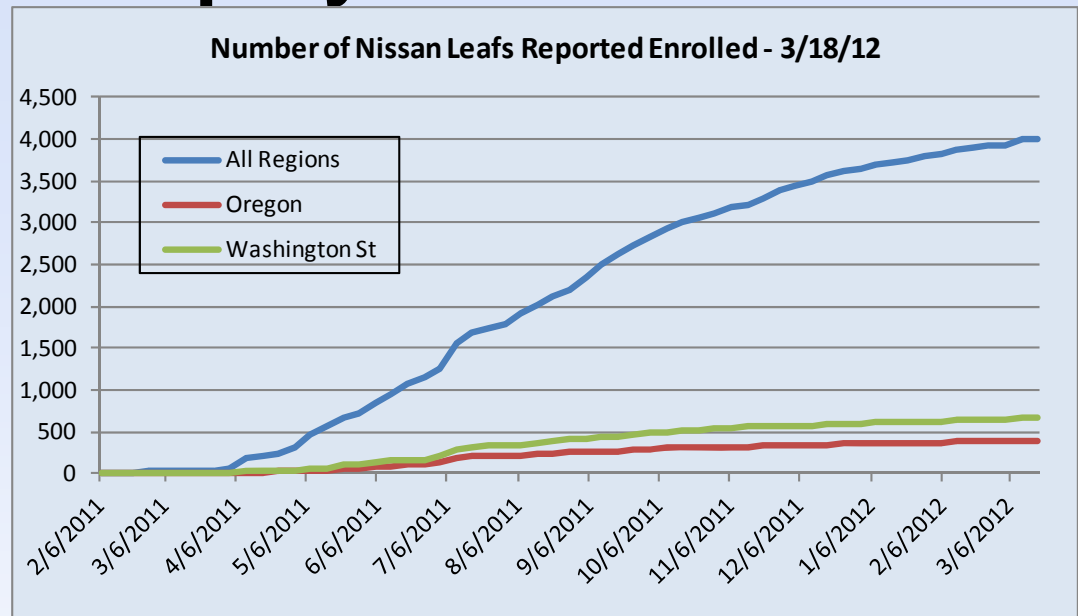
EV Project – Vehicle Data Parameters Collected per Start/Stop Event

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



EV Project – Vehicle Deployments 3/18/12

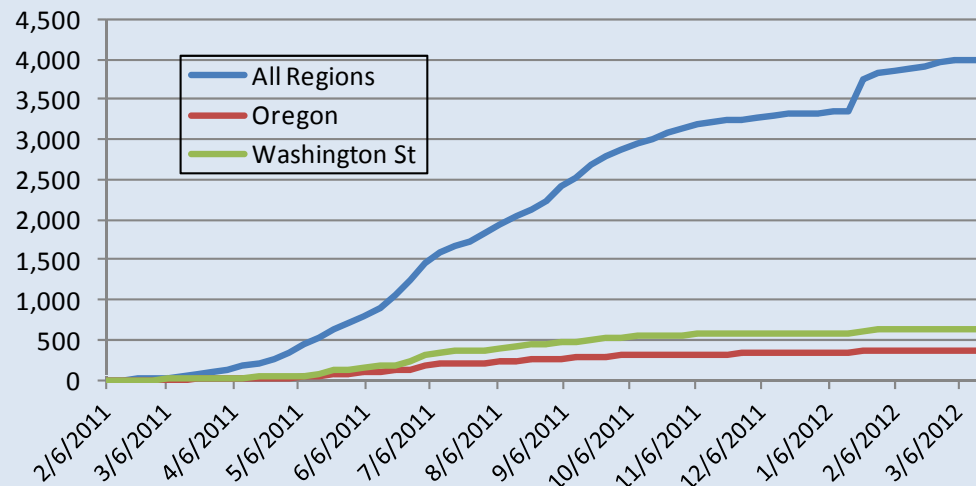
- All regions
 - 4,008 Leafs
 - 248 Volts
- OR & WA
 - 1,058 Leafs
 - 16 Volts



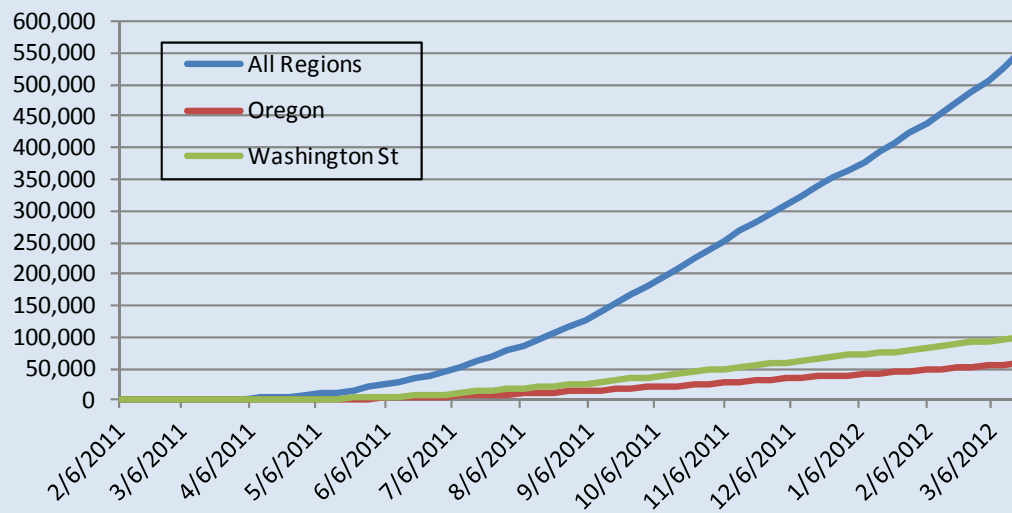
EV Project – EVSE Residential Deployments

3/18/12

Number of Residential EVSE Reported Installed - 3/18/12



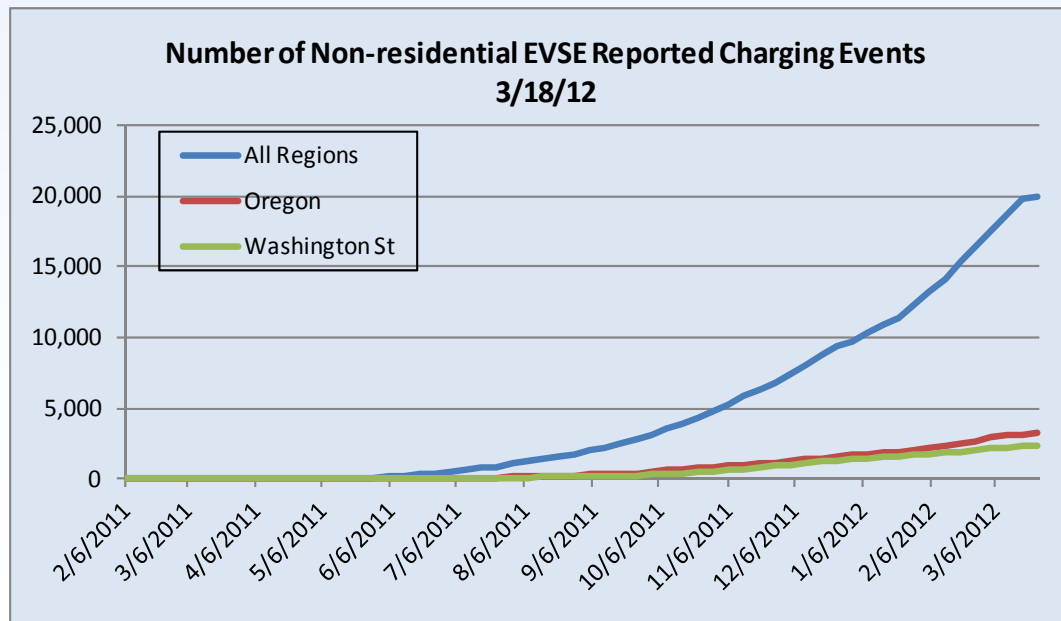
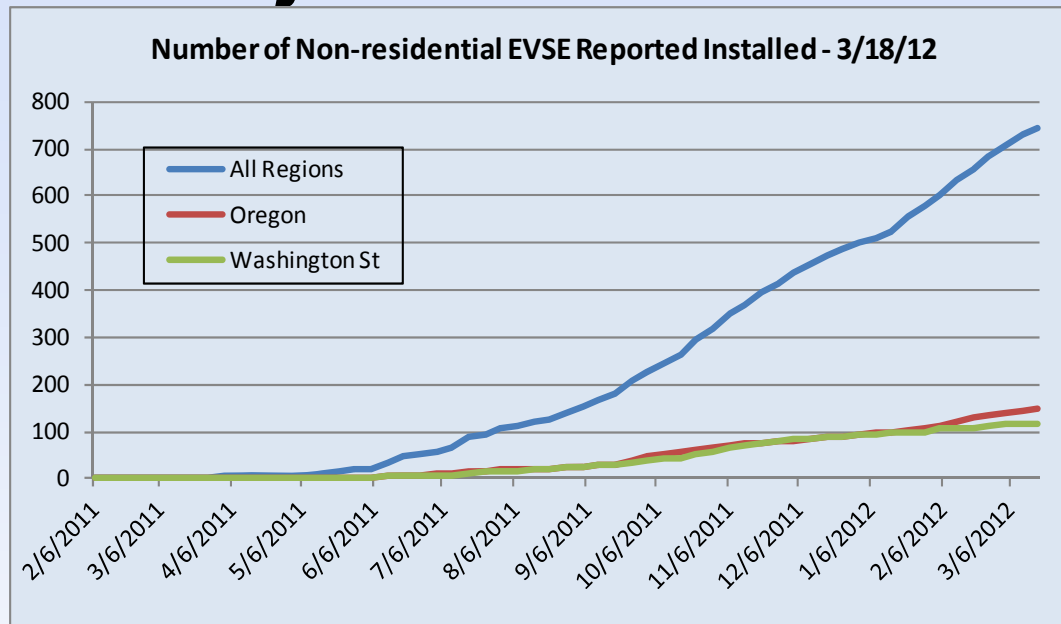
Number of Residential EVSE Reported Charging Events 3/18/12



- INL reports vehicle and EVSE data differently than ECOtality
- Units only reported when event data occurs
- INL units counts will always be lower than ECOtality counts
- INL sees units but is required to report processed data counts

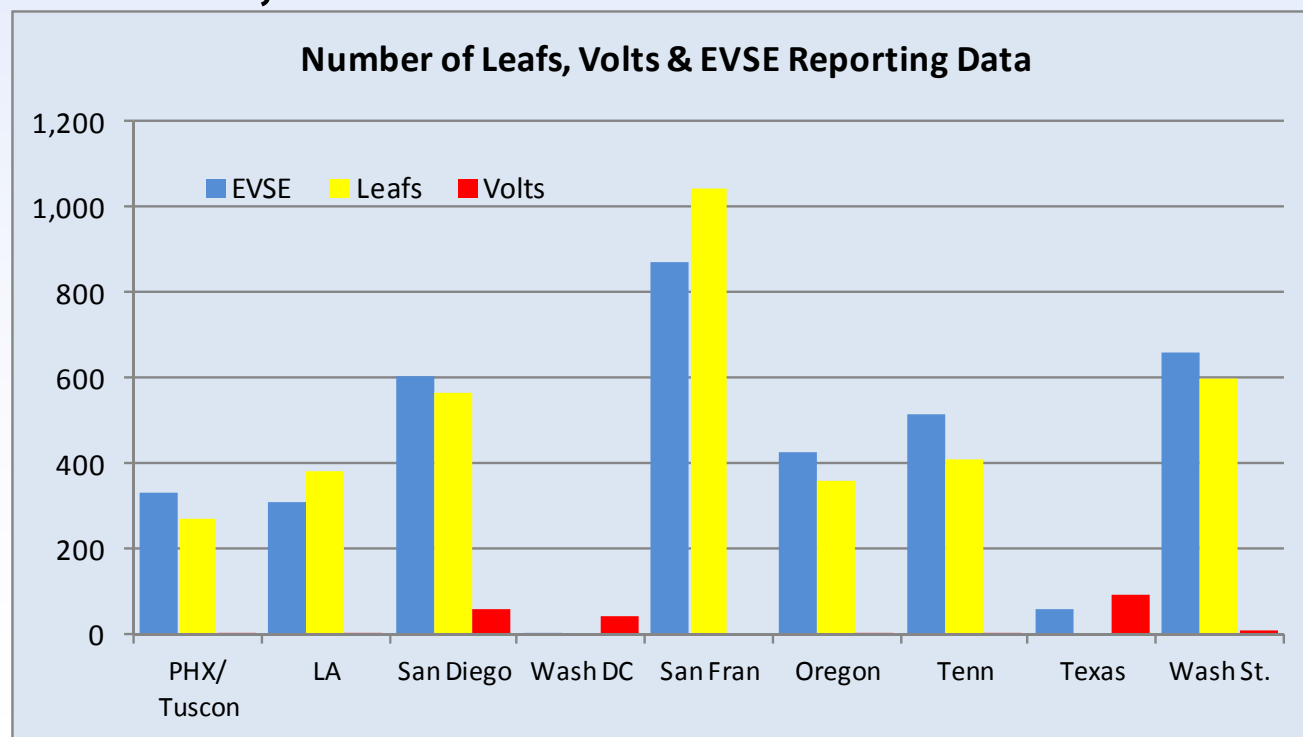


EV Project – EVSE Non-Residential Deployments 3/18/12



EV Project – Overview Report 4th Quarter

- Vehicles and charging infrastructure deployed 4th quarter and data reported to INL
- Charging infrastructure
 - 3,785 units installed
 - 370,517 charging events
 - 2,782 AC MWh
- Vehicles
 - 3,629 Leafs
 - 218 Volts
 - 13.7 million miles



EV Project Nissan Leaf Vehicle Summary Report



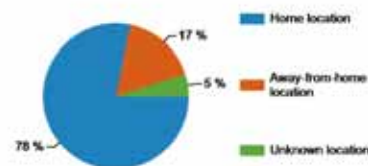
Region: ALL

Number of vehicles: 2645

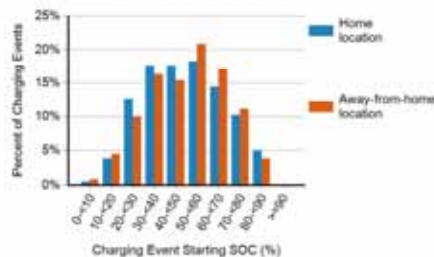
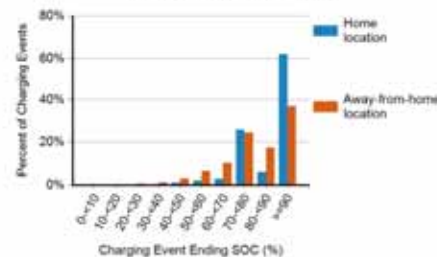
Reporting period: October 2011 through December 2011

Vehicle Usage

Number of trips	707,330
Total distance traveled (mi)	4,878,735
Avg trip distance (mi)	6.9
Avg distance traveled per day when the vehicle was driven (mi)	30.0
Avg number of trips between charging events	4.0
Avg distance traveled between charging events (mi)	27.7
Avg number of charging events per day when the vehicle was driven	1.1

Frequency of Charging by
Charging Location

Charging Location and Type	Home charging location	Away-from-home charging locations	Unknown charging locations
Number of charging events	137,864	29,543	8,955
Percent of all charging events	78%	17%	5%

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

EV Project – Nissan Leaf Usage Report

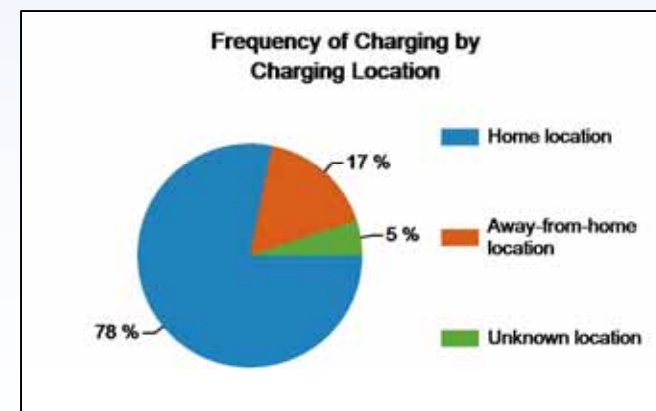
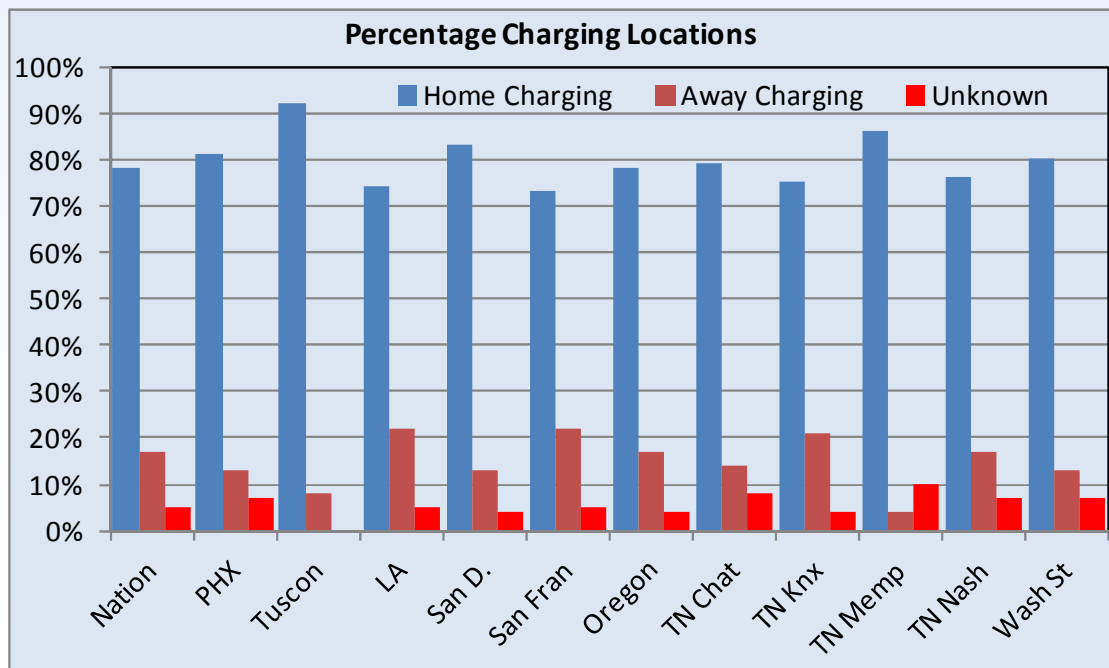
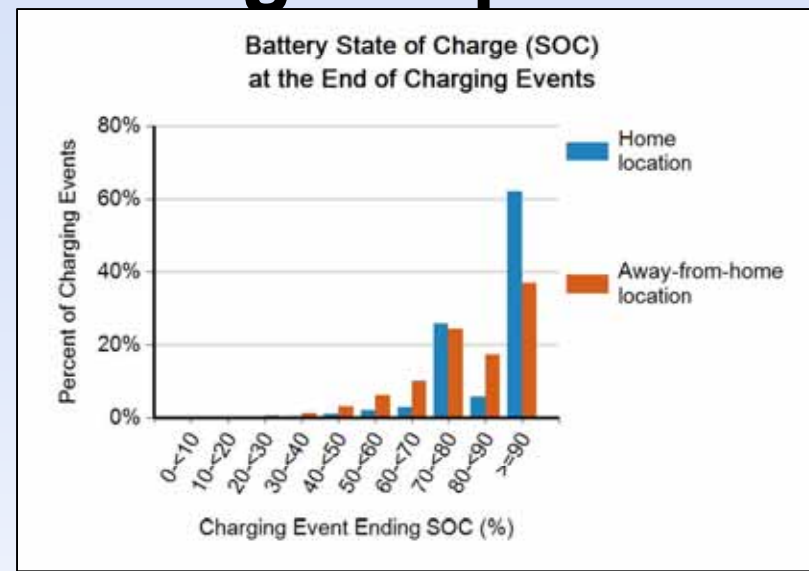
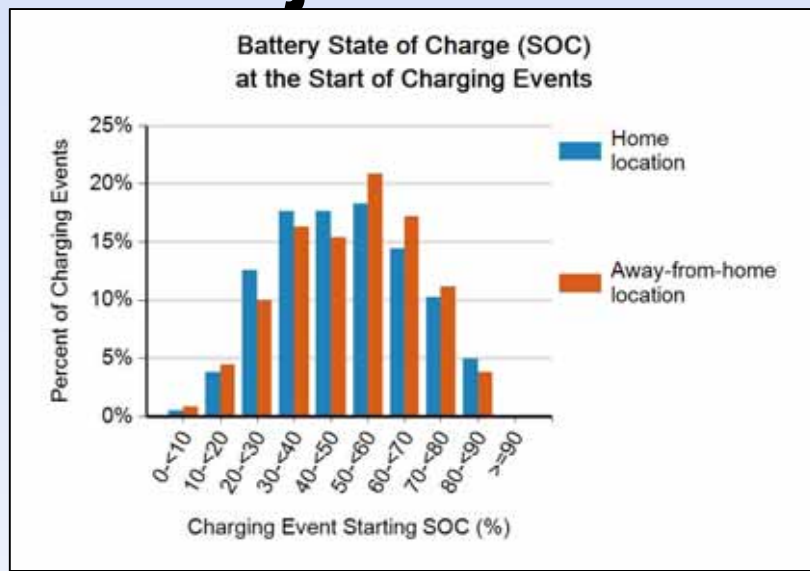
- Oct – Dec 2011
- Subset of 2,645 Leafs as this report requires matching vehicle and charging data
- See following slides
- 1 page nationally
- Plus 1 additional page for each region with more than 10 vehicles

EV Project – Nissan Leaf Usage Report

- National Data
- Vehicle Usage – 4th quarter 2011
 - Number of Trips 707,330
 - Total distance traveled (miles) 4,878,735 mi
 - Ave trip distance 6.9 mi
 - Ave distance per day when driven 30.0 mi
 - Ave # trips between charging events 4.0
 - Ave distance traveled between charging events 27.7 mi
 - Ave # charging events per day when a vehicle was driven 1.1
 - Vehicle petroleum used 0 gallons

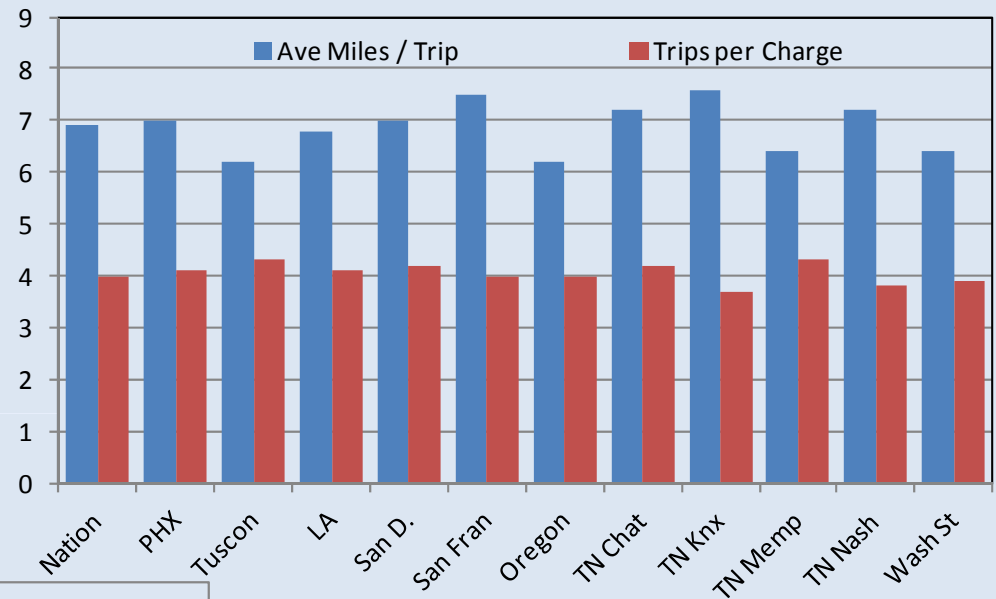


EV Project – Nissan Leaf Usage Report

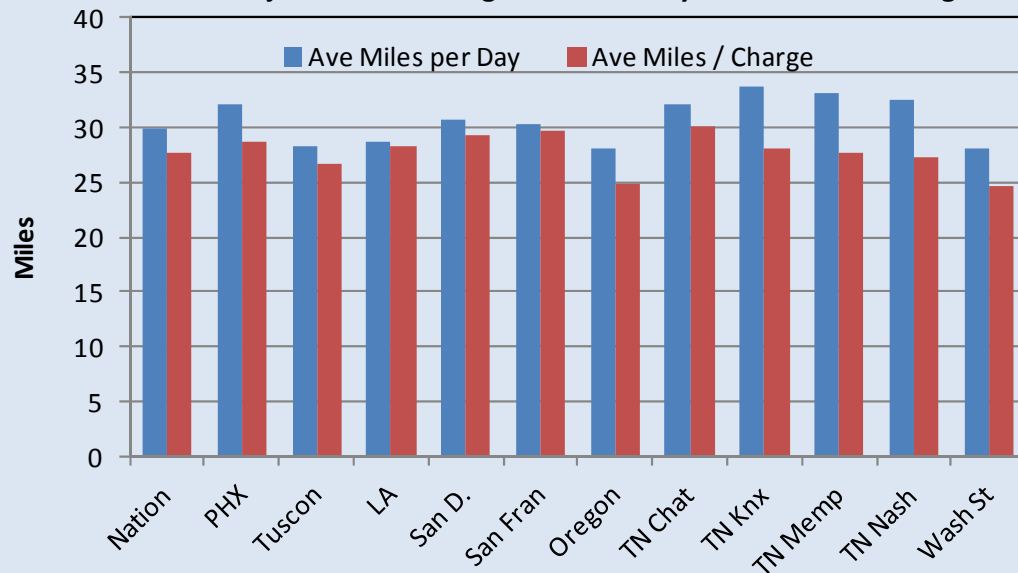


EV Project – Nissan Leaf Usage Report

EV Project Leafs: Average Miles/Trip, Trips/Charge



EV Project Leafs: Average Miles Per Day and Miles Per Charge

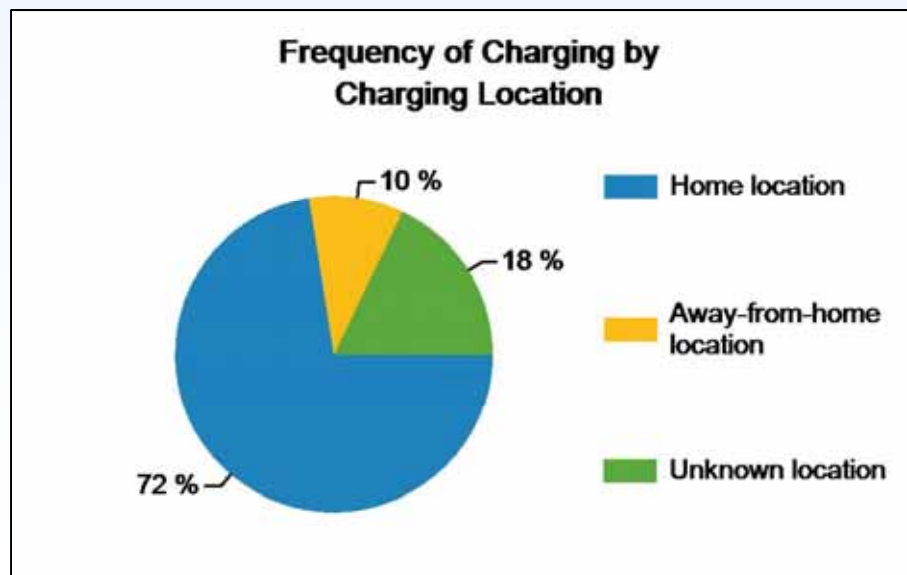
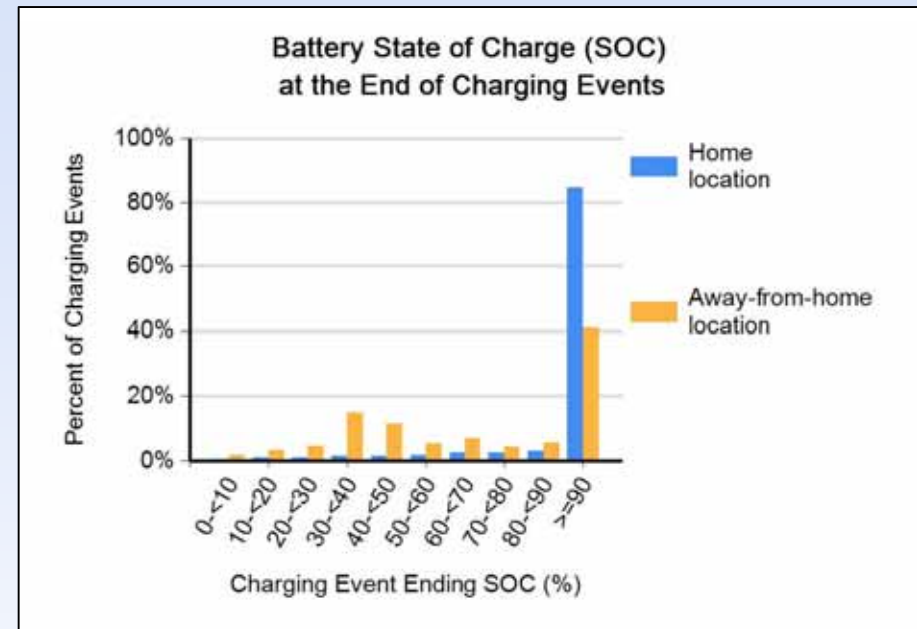
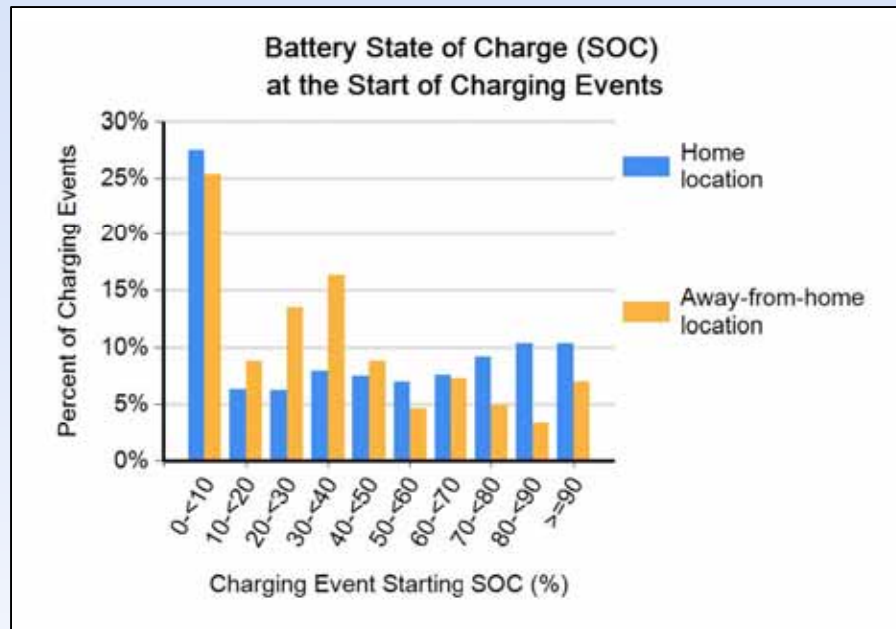


EV Project – Chevrolet Volt Usage Report

- National Data – 45 Volts
- Vehicle Usage – 4th quarter 2011
 - Number of Trips 13,819
 - Total distance traveled (miles) 108,115 mi
 - Ave trip distance 7.8 mi
 - Ave distance per day when driven 38.0 mi
 - Ave # trips between charging events 3.5
 - Ave distance traveled between charging events 27.1 mi
 - Ave # charging events per day when a vehicle was driven 1.4
 - Overall gasoline fuel economy 131 mpg
 - Overall electrical energy consumed 271 AC Wh/mi



EV Project – Chevrolet Volt Usage Report



EV Project Electric Vehicle Charging Infrastructure Summary Report

Region: ALL

Report period: October 2011 through December 2011

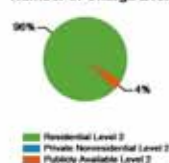
Number of EV Project vehicles in region: 2690



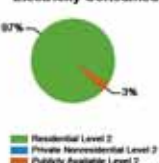
Charging Unit Usage

	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units ¹	2,704	0	438	0	3,142
Number of charging events ²	159,225	0	6,372	0	165,597
Electricity consumed (AC MWh)	1,253.63	0.00	41.42	0.00	1,295.06
Percent of time with a vehicle connected to charging unit	32%	0%	6%	0%	29%
Percent of time with a vehicle drawing power from charging unit	6%	0%	2%	0%	6%

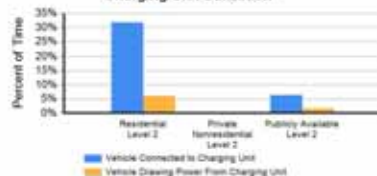
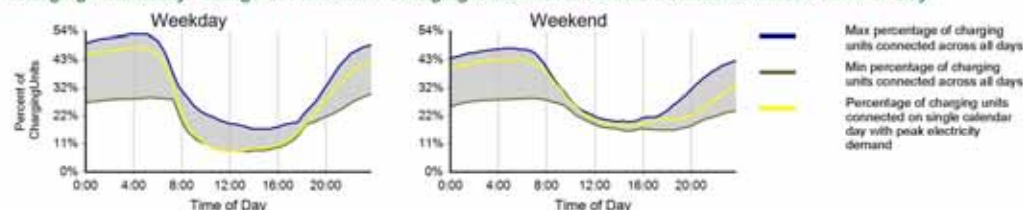
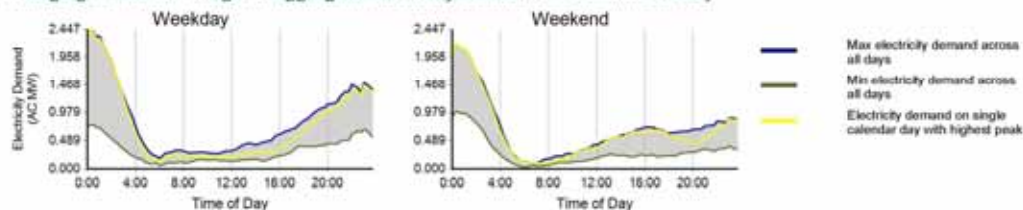
Number of Charge Events



Electricity Consumed



Charging Unit Utilization

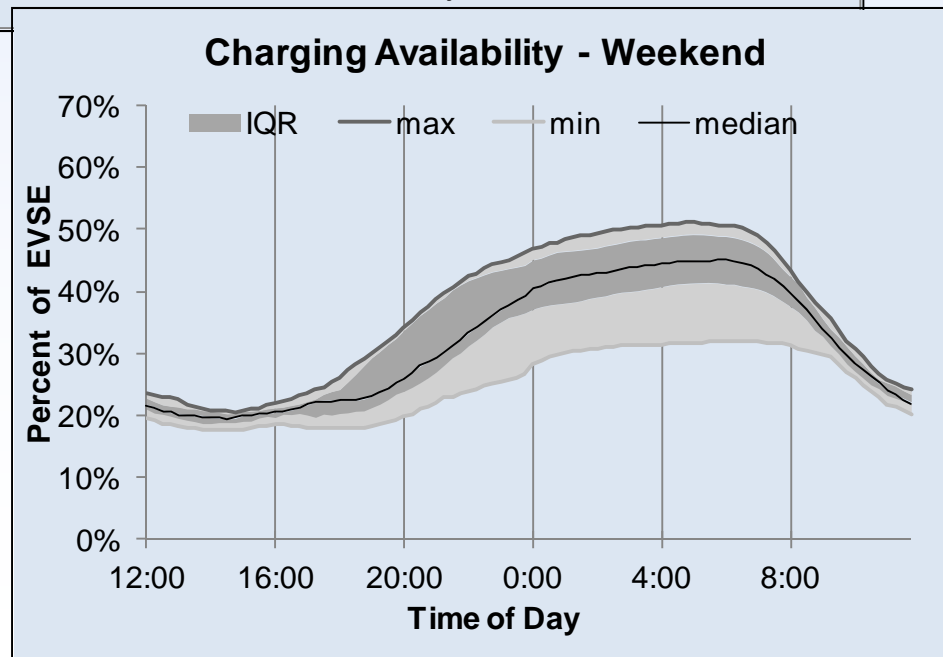
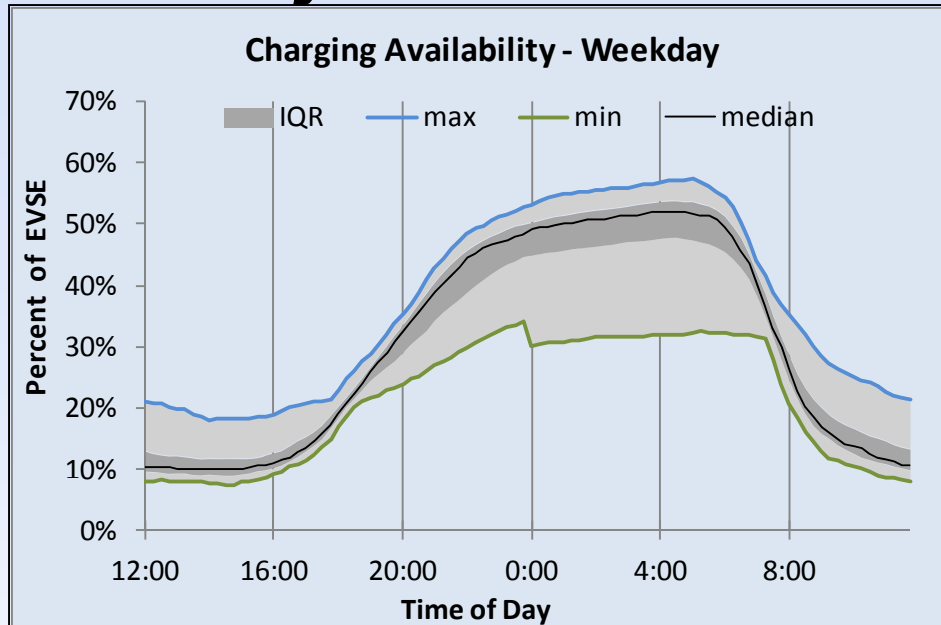
Charging Availability: Range of Percent of Charging Units with a Vehicle Connected versus Time of Day³Charging Demand: Range of Aggregate Electricity Demand versus Time of Day⁴¹ Includes all charging units that were in use by the end of the reporting period² A charging event is defined as the period when a vehicle is connected to a charging unit, during which period some power is transferred³ Considers the connection status of all charging units every minute⁴ Based on 15 minute rolling average power output from all charging units

EV Project – EVSE Infra. Summary Report

- Residential & Public EVSE usage
- Percent EVSE with a vehicle connected by time of day
- Percent EVSE with energy transferred by time of day
- Range of aggregate electricity demand versus time of day
- National and regional information – 4th quarter 57 pages



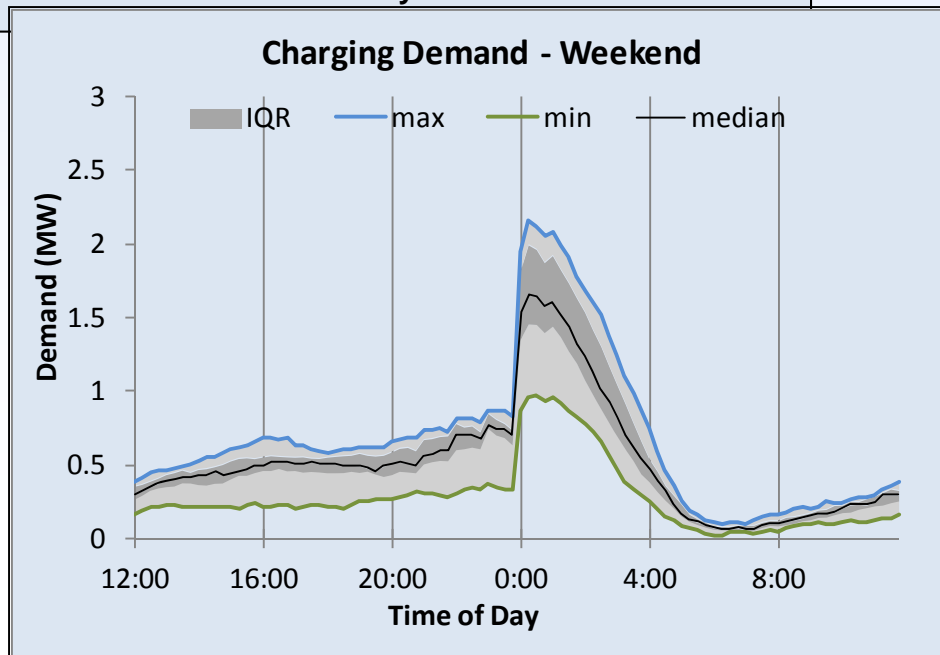
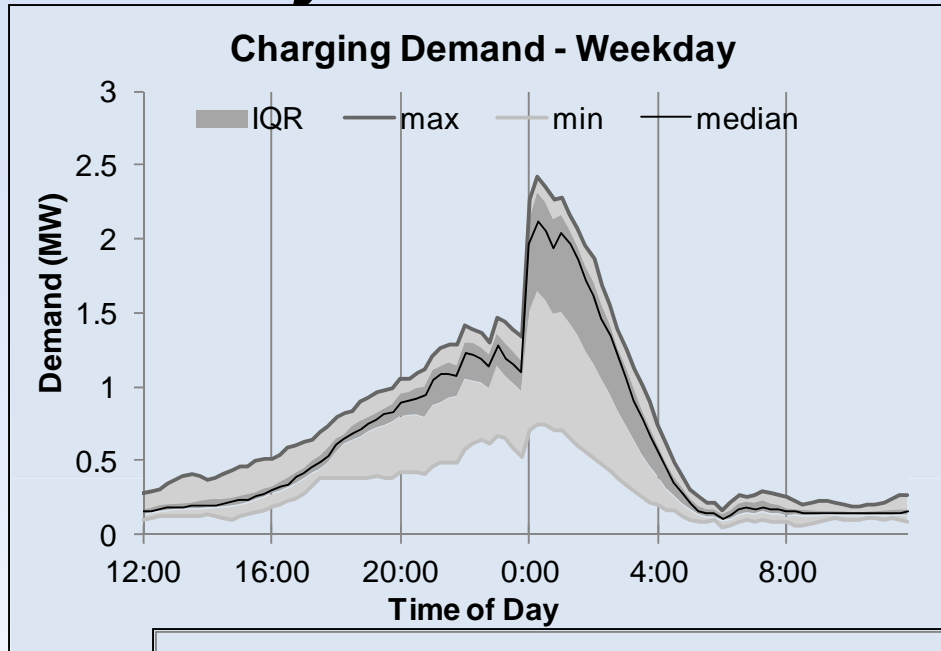
EV Project – EVSE Infra. Summary Report



- National Data
- 2,726 Residential Level 2 EVSE. Oct - Dec 2011
- Charging Availability: Range of Percent of Charging Units with a Vehicle Connected vs. Time of Day



EV Project – EVSE Infra. Summary Report

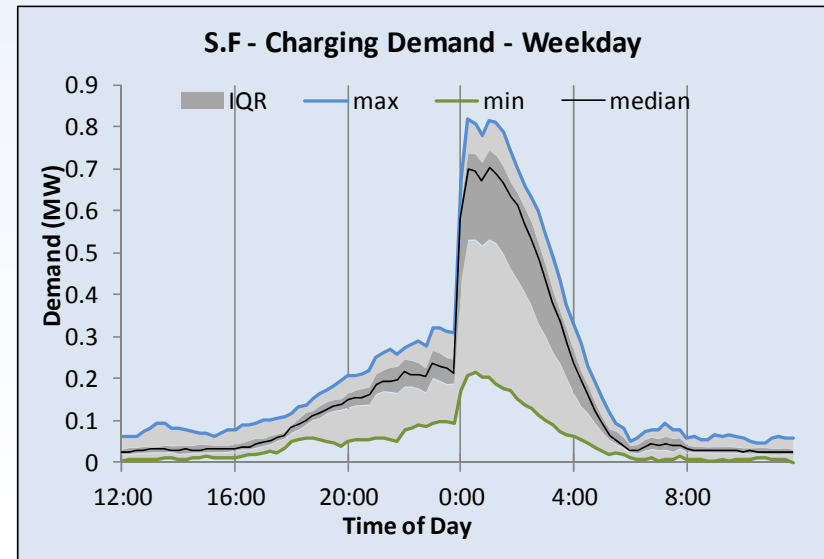
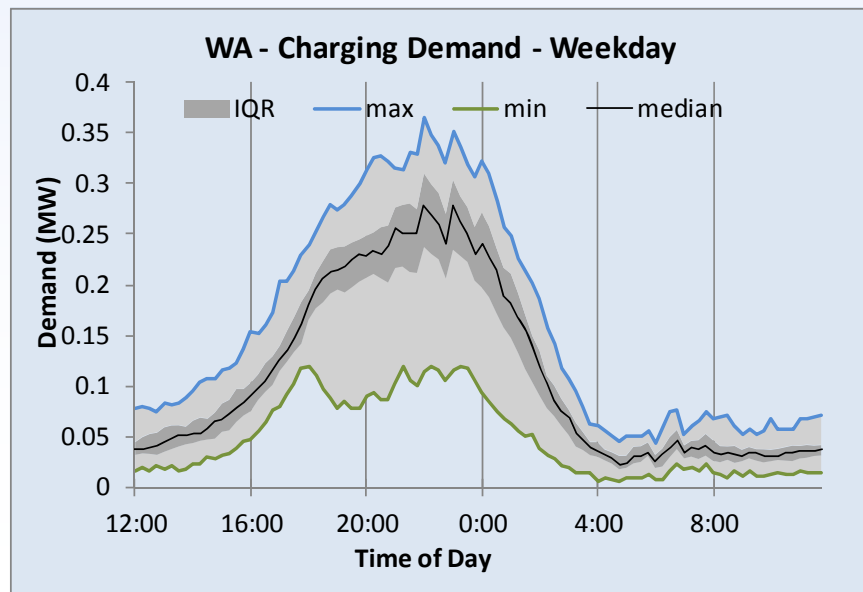
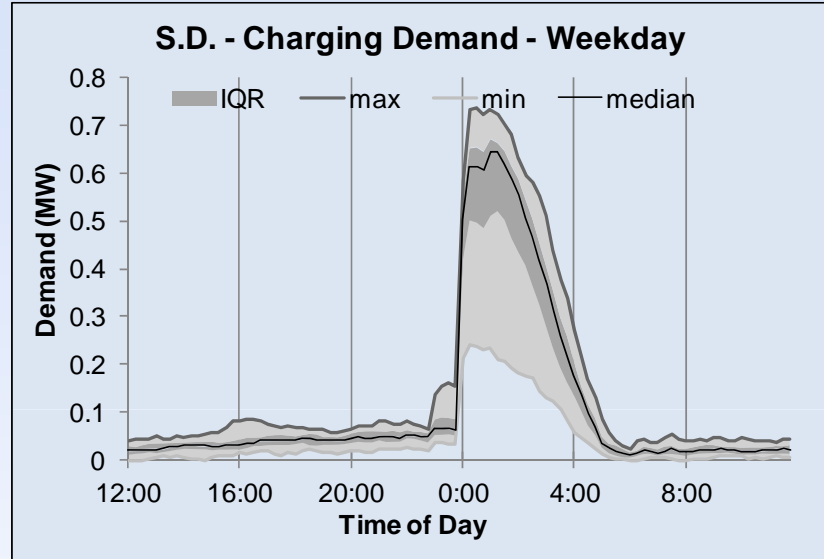
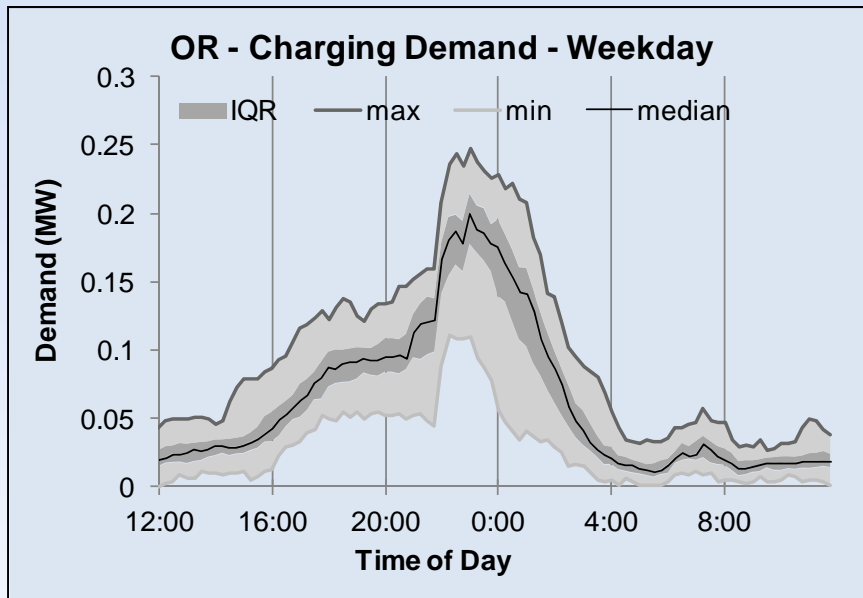


- National Data
- 2,726 Residential Level 2 EVSE. Oct - Dec 2011
- Charging Demand: Range of Aggregate Electricity Demand vs. Time of Day



EV Project – EVSE Infra. Summary Report

- Residential Level 2 EVSE, Oct - Dec 2011



EV Project – EVSE Infra. Summary Report

- **National Data – 4th quarter 2011**
 - Ave time vehicle connected R2 WD 11.6 hours
 - Ave time vehicle connected R2 WE 11.4 hours
 - Ave time vehicle drawing power R2 WD 2.3 hours
 - Ave time vehicle drawing power R2 WE 1.9 hours
 - Ave energy per charge event R2 WD 8.3 AC kWh
 - Ave energy per charge event R2 WE 6.9 AC kWh
 - Ave time vehicle connected P2 WD 7.7 hours
 - Ave time vehicle connected P2 WE 4.9 hours
 - Ave time vehicle drawing power P2 WD 1.9 hours
 - Ave time vehicle drawing power P2 WE 1.5 hours
 - Ave energy per charge event P2 WD 6.7 AC kWh
 - Ave energy per charge event P2 WE 5.3 AC kWh
- **R: residential, P: public, WD: weekday, WE: weekend,
All: weekday/end combined**



The number of Leafs that can be charged at 5.538 kWh per day using a percentage of existing electricity generation

	Total 2009 Generation kWh	Number of Nissan Leafs that can be charged at 5.538 kWh per day (2021.37 kWh per year)
2009 kWh generation	3,950,331,000,000	
1% 2009 kWh generation	39,503,310,000	19,542,840
2% 2009 kWh generation	79,006,620,000	39,085,680
3% 2009 kWh generation	118,509,930,000	58,628,519
4% 2009 kWh generation	158,013,240,000	78,171,359
5% 2009 kWh generation	197,516,550,000	97,714,199

Generation Source: Electric Power Annual with data for 2009. November 23, 2010.
<http://205.254.135.24/cneaf/electricity/epa/epates.html>



Chevrolet Volt Vehicle Demonstration

Fleet Summary Report

Number of vehicles: 135

Reporting period: October 2011 through December 2011

Number of vehicle days driven: 4,746

All operation

Overall gasoline fuel economy (mpg)	68.6
Overall AC electrical energy consumption (AC Wh/mi)	175
Average Trip Distance	12.2
Total distance traveled (mi)	272,366
Average Ambient Temperature (deg F)	54.1

Electric Vehicle mode operation (EV)

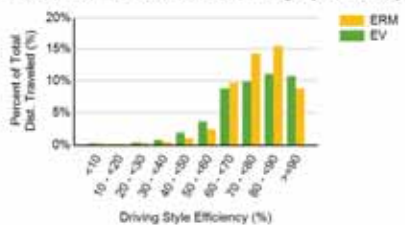
Gasoline fuel economy (mpg)	No Fuel Used
AC electrical energy consumption (AC Wh/mi)	368
Distance traveled (mi)	129,389
Percent of total distance traveled	47.5%
Average driving style efficiency (distance weighted) ¹	75%

Extended Range mode operation (ERM)

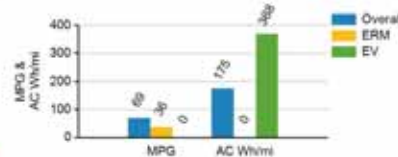
Gasoline fuel economy (mpg)	36.0
AC electrical energy consumption (AC Wh/mi)	No Elec. Used
Distance traveled (mi)	142,977
Percent of total distance traveled	52.4%
Average driving style efficiency (distance weighted) ¹	77%

	City ³	Highway ³
Percent of miles in EV operation (%)	65.1%	31.1%
Percent Number of trips	85.5%	14.5%
Average trip distance (mi)	6.9	43.5
Average driving style efficiency (distance weighted) ¹	73%	78%

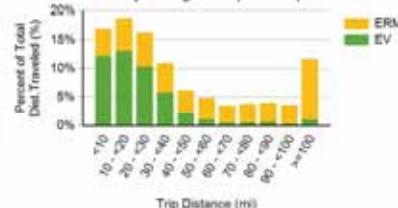
Percent Distance Driven for each Driving Style Efficiency



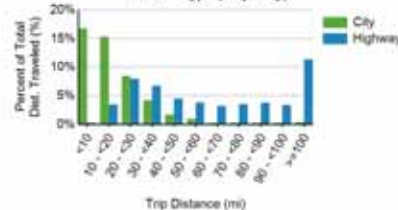
Fuel Economy & Electrical Consumption By Operating Mode



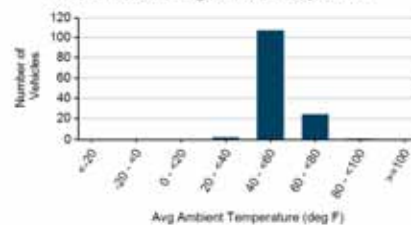
Percent Distance Traveled By Operating Mode (EV/ERM)



Percent Distance Traveled by Route Type (City/Highway)



Distribution of Average Ambient Temperature²



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

Chevrolet Volt DOE ARRA Project

- 522,000 total test miles, 142 Volts
- Oct – Dec 2011 Results
 - 135 Volts
 - 272,366 test miles
 - All trips, 68.6 mpg, 175 AC Wh/mi
 - EV mode, 368 AC Wh/mi. 47.5% - 129,389 miles. No petroleum
 - Extended range mode, 36.0 mpg
 - Average 68.8 mpg

Chevrolet Volt DOE ARRA Project

- Non-public fleet drivers
- 135 Volt 3rd quarter report (Oct – Dec 2011)
 - Average charging events per month 16
 - Average # charging events per vehicle day 1.2
 - **Average miles per charging event 43 miles**
 - **Average trips between charging events 3.5**
 - Average time connected per event 3.4 hours
 - Average energy per charge event 7.2 AC kWh
 - Average charging energy per vehicle month 114 AC kWh
 - Average trip distance city driving 6.9 miles
 - Average trip distance highway driving 43.5 miles



Ford Escape Advanced Research Fleet

Number of vehicles: 21

Date range of data received: 11/01/2009 to 02/29/2012

Reporting period: Nov 09 - Feb 12

Number of vehicle days driven: 8,023

All Trips Combined

Overall gasoline fuel economy (mpg)	38
Overall AC electrical energy consumption (AC Wh/mi) ¹	99
Overall DC electrical energy consumption (DC Wh/mi) ²	67
Total number of trips	37,731
Total distance traveled (mi)	457,591

Trips in Charge Depleting (CD) mode³

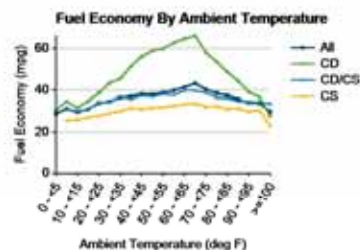
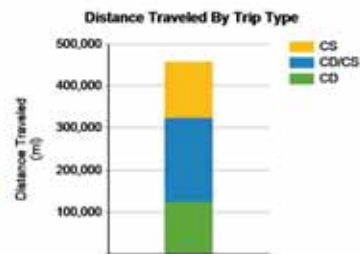
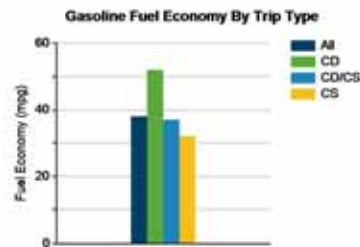
Gasoline fuel economy (mpg)	52
DC electrical energy consumption (DC Wh/mi) ⁴	165
Number of trips	21,634
Percent of trips city highway	83% 17%
Distance traveled (mi)	125,882
Percent of total distance traveled	28%

Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes⁵

Gasoline fuel economy (mpg)	37
DC electrical energy consumption (DC Wh/mi) ⁶	54
Number of trips	7,135
Percent of trips city highway	38% 62%
Distance traveled (mi)	197,332
Percent of total distance traveled	43%

Trips in Charge Sustaining (CS) mode⁷

Gasoline fuel economy (mpg)	32
Number of trips	8,953
Percent of trips city highway	66% 34%
Distance traveled (mi)	134,376
Percent of total distance traveled	29%



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.

Ford Escape Adv. Research Vehicle

- 21 Ford Escape PHEVs
- Fleet drivers
- 457,000 test miles
- All trips, 38 mpg, 99 AC & 67 DC Wh/mi
- Charge Depleting (CD), 52 mpg & 165 DC Wh/mi
- Charge Sustaining (CS), 32 mpg
- **Plugging in = 63% increase in overall MPG when comparing CD to CS trips**

Trips in Charge Depleting (CD) mode

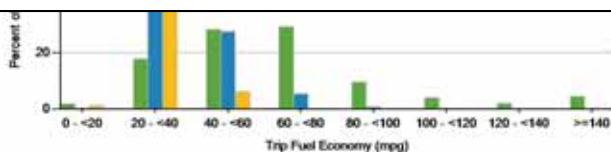
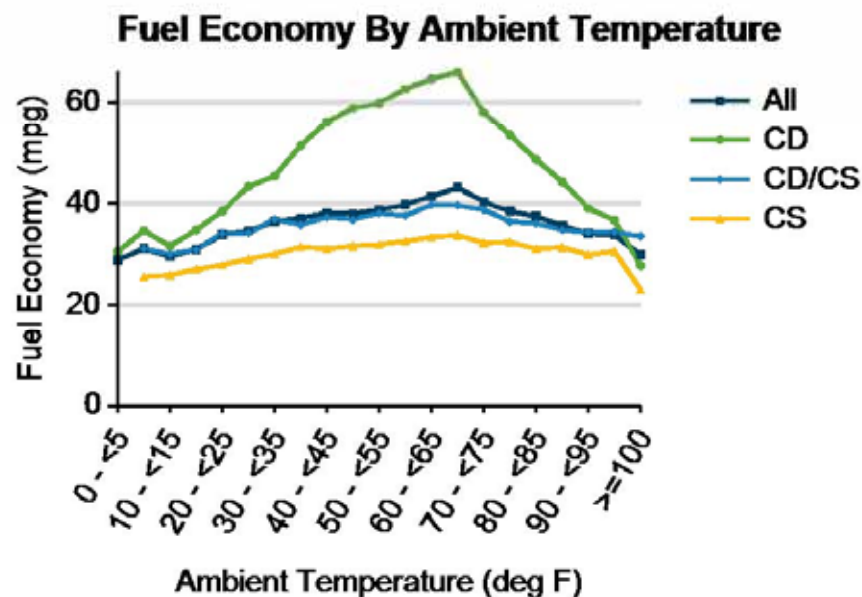
	City	Highway
Gasoline fuel economy (mpg)	48	57
DC electrical energy consumption (DC Wh/mi)	164	165
Percent of miles with internal combustion engine off	37%	12%
Average trip driving intensity (Wh/mi)	272	309
Average trip distance (mi)	3	17

Trips in Charge Depleting and Charge Sustaining (CD/CS) mode

	City	Highway
Gasoline fuel economy (mpg)	42	36
DC electrical energy consumption (DC Wh/mi)	71	51
Percent of miles with internal combustion engine off	29%	5%
Average trip driving intensity (Wh/mi)	281	327
Average trip distance (mi)	9	39

Trips in Charge Sustaining (CS) mode

Gasoline fuel
Percent of miles
Average trip d
Average trip d



Ford Escape Adv. Research Vehicle

- CD city, 48 mpg, 164 DC Wh/mi
- CD highway, 57 mpg, 164 DC Wh/mi
- CS city, 30 mpg
- CS highway, 32 mpg
- **Plugging in = 60% increase in city MPG and 78% increase in highway MPG (compare CD to CS)**
- **City - 37% CD and 23% CS miles engine off**
- **Highway - 12% CD and 4% CS miles engine off**

Chrysler RAM PHEV Fleet

Number of vehicles: 105

Date range of data received: 7/1/2011 to 1/31/2012

Reporting period: July 11 - Jan 12

Number of vehicle days driven: 6521

All Trips Combined

Overall gasoline fuel economy (mpg)	19
Overall AC electrical energy consumption (AC Wh/mi) ¹	107
Overall DC electrical energy consumption (DC Wh/mi) ²	67
Overall DC electrical energy captured from regenerative braking (DC Wh/mi)	46
Total number of trips	39,346
Total distance traveled (mi)	322,764

Trips in Charge Depleting (CD) mode³

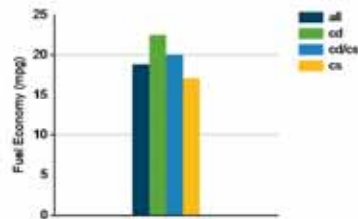
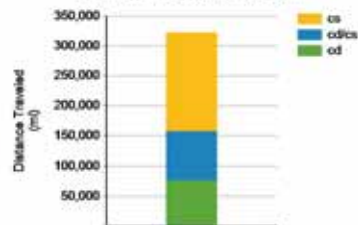
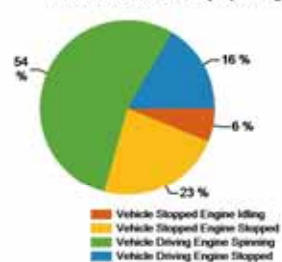
Gasoline fuel economy (mpg)	22
DC electrical energy consumption (DC Wh/mi) ⁴	218
Number of trips	16,256
Percent of trips city highway	96% 4%
Distance traveled (mi)	76,551
Percent of total distance traveled	24%

Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes⁵

Gasoline fuel economy (mpg)	20
DC electrical energy consumption (DC Wh/mi) ⁶	69
Number of trips	4,430
Percent of trips city highway	79% 21%
Distance traveled CD CS (mi)	29,110 51,854
Percent of total distance traveled CD CS	9% 16%

Trips in Charge Sustaining (CS) mode⁷

Gasoline fuel economy (mpg)	17
Number of trips	18,660
Percent of trips city highway	91% 9%
Distance traveled (mi)	165,403
Percent of total distance traveled	51%

Gasoline Fuel Economy By Trip Type**Distance Traveled By Trip Type****Percent of Drive Time by Operating Mode**

Notes: 1 - 9. Please see <http://aivt.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.

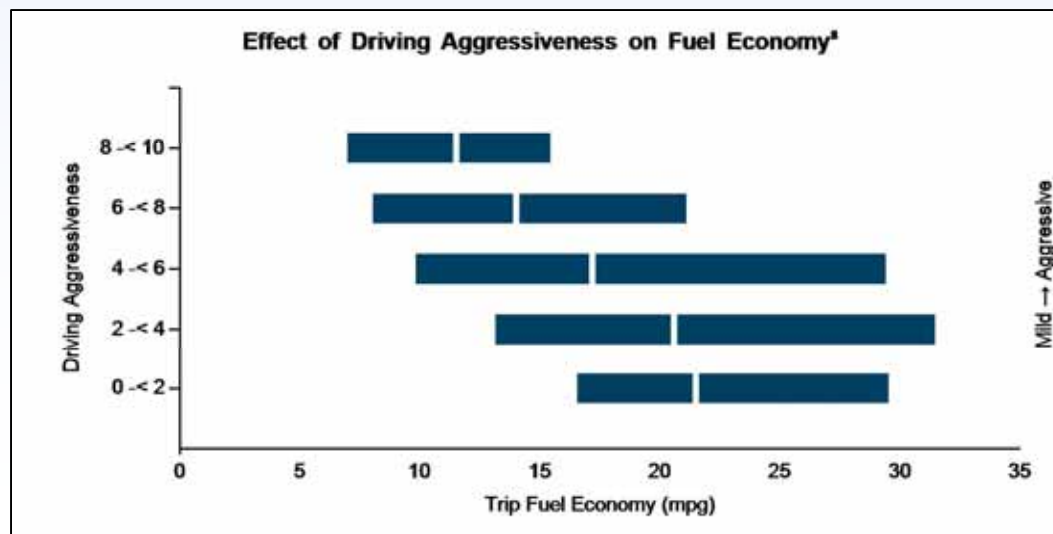
Vehicle fuel economy is based on customer usage and may not be representative of maximum potential fuel economy.

Chrysler Ram PHEV Project

- 105 Chrysler Ram PHEVs
- July 2011 to Jan 2012
- 323,000 test miles
- All trips, 19 mpg, 107 AC & 67 DC Wh/mi. **46 DC Wh/mi captured regenerative braking**
- CD, 22 mpg & 218 DC Wh/mi
- CS, 17 mpg
- **Plugging in = 29% increase in overall MPG when comparing CD to CS trips**

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
- **7.8 trips per charge event**
- 0.77 charge events per vehicle day
- 2.4 average hours per charge event
- 6.8 kWh average energy / charge



North American PHEV Demonstration

Fleet Summary Report: Hymotion Prius (V2Green data logger)

Number of vehicles: 184

Reporting Period: Apr 08 - Sept 11

Vehicle Technologies Program

Date range of data received:

4/18/2008 to 9/30/2011

Number of days the vehicles were driven: 1254

All Trips Combined

Overall gasoline fuel economy (mpg)	48
Overall AC electrical energy consumption (AC Wh/mi) ¹	52
Overall DC electrical energy consumption (DC Wh/mi) ²	38
Total number of trips	310,808
Total distance traveled (mi)	2,899,288

Trips in Charge Depleting (CD) mode ³

Gasoline fuel economy (mpg)	62
DC electrical energy consumption (DC Wh/mi) ⁴	142
Number of trips	125,321
Percent of trips city / highway	67% / 13%
Distance traveled (mi)	569,686
Percent of total distance traveled	20%

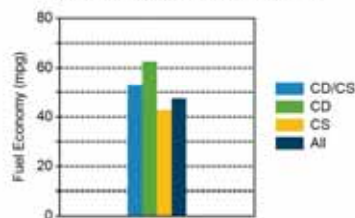
Trips in both Charge Depleting and Charge Sustaining (CD/CS) modes ⁵

Gasoline fuel economy (mpg)	53
DC electrical energy consumption (DC Wh/mi) ⁶	49
Number of trips	22,078
Percent of trips city / highway	47% / 53%
Distance traveled (mi)	576,256
Percent of total distance traveled	20%

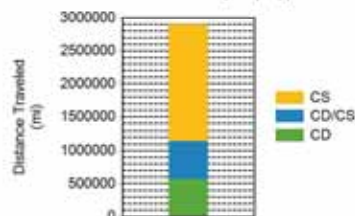
Trips in Charge Sustaining (CS) mode ⁷

Gasoline fuel economy (mpg)	43
Number of trips	163,400
Percent of trips city / highway	77% / 23%
Distance traveled (mi)	1,756,775
Percent of total distance traveled	61%
Number of trips when the plug-in battery pack was turned off by the vehicle operator ⁸	13962
Distance traveled with plug-in battery pack turned off by the vehicle operator (mi) ⁹	299,452

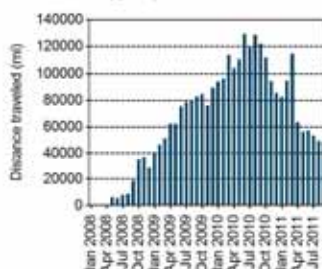
Gasoline Fuel Economy By Trip Type



Distance Traveled By Trip Type



Miles Logged by Month This Year



Notes: 1 - 9. Please see <http://lavt.inl.gov/pdf/phevi/ReportNotes.pdf> for an explanation of all PHEV Fleet Testing Report notes.

Hymotion Prius PHEV Conversion

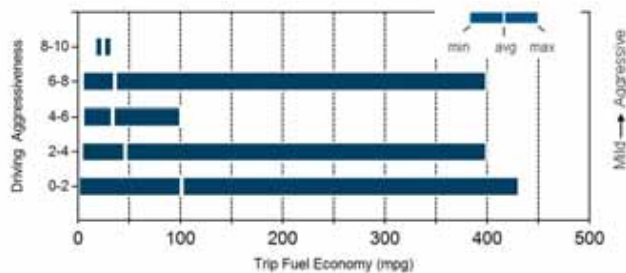
- 184 vehicles with GridPoint data logger
- 2.9 million total mostly fleet test miles
- CD 62 mpg and 142 DC Wh/mi
- CS 43 mpg
- **Plugging in = 44% increase in overall MPG when comparing CD to CS trips**
- CD 33% city & 15% Hwy trips engine off
- CS 23% city & 8% Hwy trips with engine off

Hymotion Prius PHEV Conversion

- CD city, 60 mpg, 165 DC Wh/mi
- CD highway, 66 mpg, 109 DC Wh/mi
- CS city, 36 mpg
- CS highway, 46 mpg
- **Plugging in = 67% increase in city mpg and 44% increase in highway mpg when comparing CD to CS**
- **CD 33% city & 15% Hwy trips engine off**
- **CS 23% city & 8% Hwy trips with engine off**

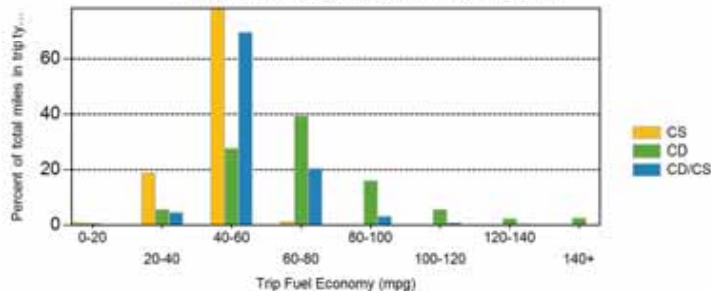
Trips in Charge Depleting (CD) mode		City	Highway
Gasoline fuel economy (mpg)		60	66
DC electrical energy consumption (DC Wh/mi)		165	109
Percent of miles with internal combustion engine off		32%	15%
Average trip aggressiveness (on scale 0 - 10)		1.8	1.8
Average trip distance (mi)		3.0	15.1
Trips in both Charge Depleting and Charge Sustaining (CD/CS) modes			
Gasoline fuel economy (mpg)		53	53
DC electrical energy consumption (DC Wh/mi)		79	44
Percent of miles with internal combustion engine off		26%	9%
Average trip aggressiveness (on scale 0 - 10)		1.9	1.6
Average trip distance (mi)		8.7	41.5
Trips in Charge Sustaining (CS) mode			
Gasoline fuel economy (mpg)		36	46
Percent of miles with internal combustion engine off		22%	8%
Average trip aggressiveness (on scale 0 - 10)		2.0	1.7
Average trip distance (mi)		3.5	35.3

Effect Of Driving Aggressiveness on Fuel Economy This Year



Aggressiveness factor is based on accelerator pedal position. The more time spent during a trip at higher accelerator pedal position, the higher the trip aggressiveness.

Trip Fuel Economy Distribution By Trip Type



Other INL Data Collection Projects

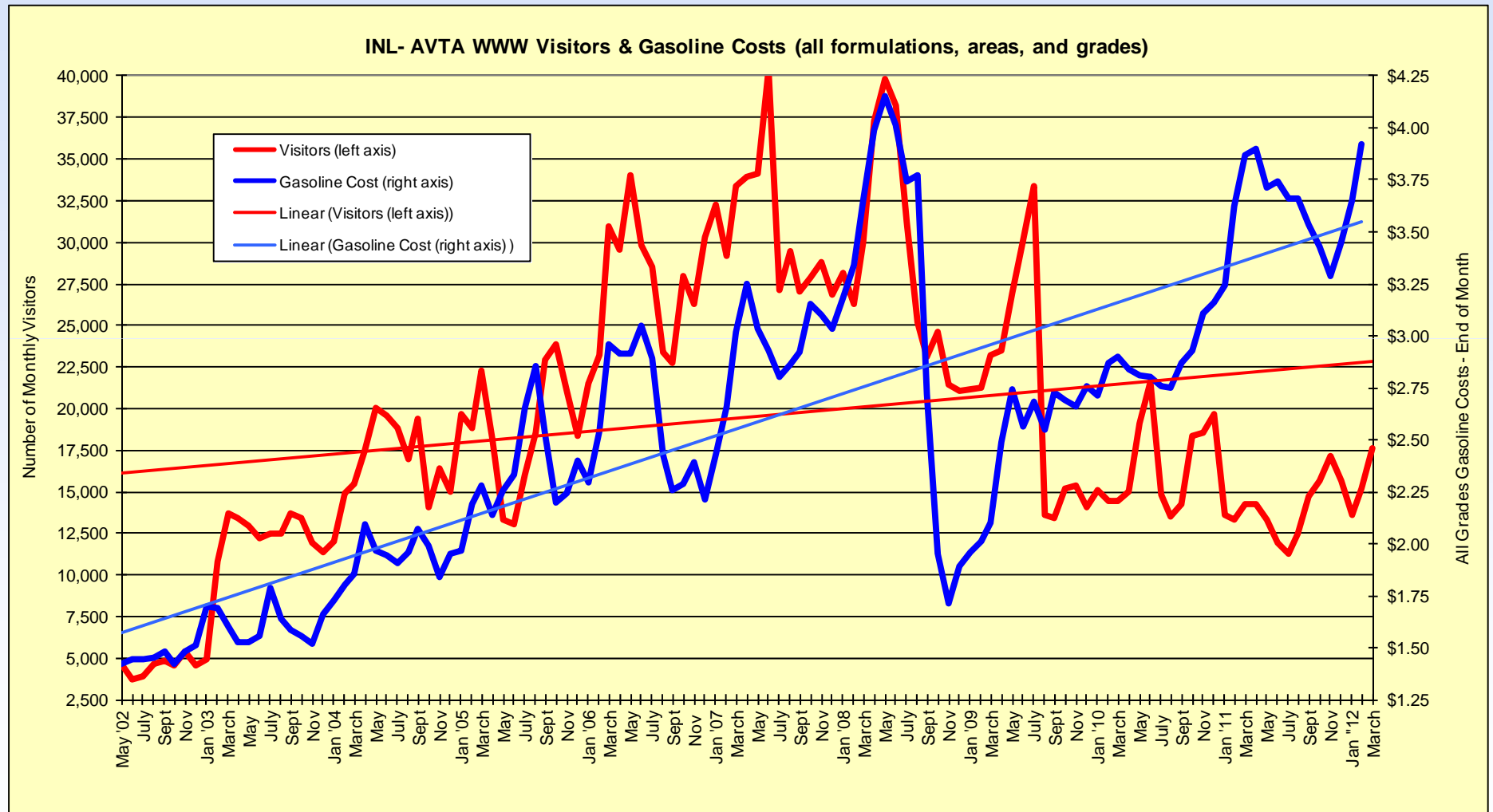
- Conducting mass impacts on fuel efficiency for HEV, ICEV and BEV technologies
- Fast charge study compares Fast vs Level 2 charging impacts on battery life in vehicles and laboratory tests
- Seven conductive Level 2 EVSE recently benchmarked
- Developing wireless charging test program
- 20 Lithium PHEV Escape Quantum conversions – same format as Ford Escapes
- DOD support, including JBLM and Andrews AFB
- Five USPS electric long life vehicles (ELLV) conversions track, dynamometer, and fleet tested



Summary – Based on Early Data

- **Most residential Level 2 EV Project charging occurs off-peak to date**
- **EV Project vehicles connected much longer than needed to recharge - opportunities to shift charging times even further**
- **Significant EV Project charge-starts occur at the midnight+ start of super off-peak kWh rates**
- **EV Project is accumulating 100,000 miles of data per day. Significant opportunities to fully understand how the public uses public versus non-public infrastructure**
- **Today's grid-connected electric drive technologies result in 29% to 100% reductions in petroleum use**
- **INL needs to complete collect data before reporting seasonal trends and behaviors**

Public Interest



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-12-25426

