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

Plug-in Electric Vehicle (PEV) Real-World Data from DOE's AVTA (IWC, Tempe, AZ)

Jim Francfort – Idaho National Laboratory

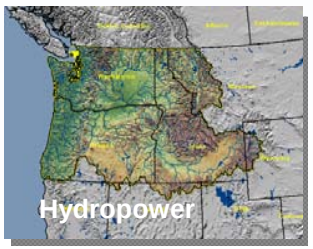
EPRI – Infrastructure Working Council
Tempe, AZ
December 2011

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
- ChargePoint American results
- Hymotion Prius results
- Other vehicle and EVSE testing
- Summary

Idaho National Laboratory

- 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



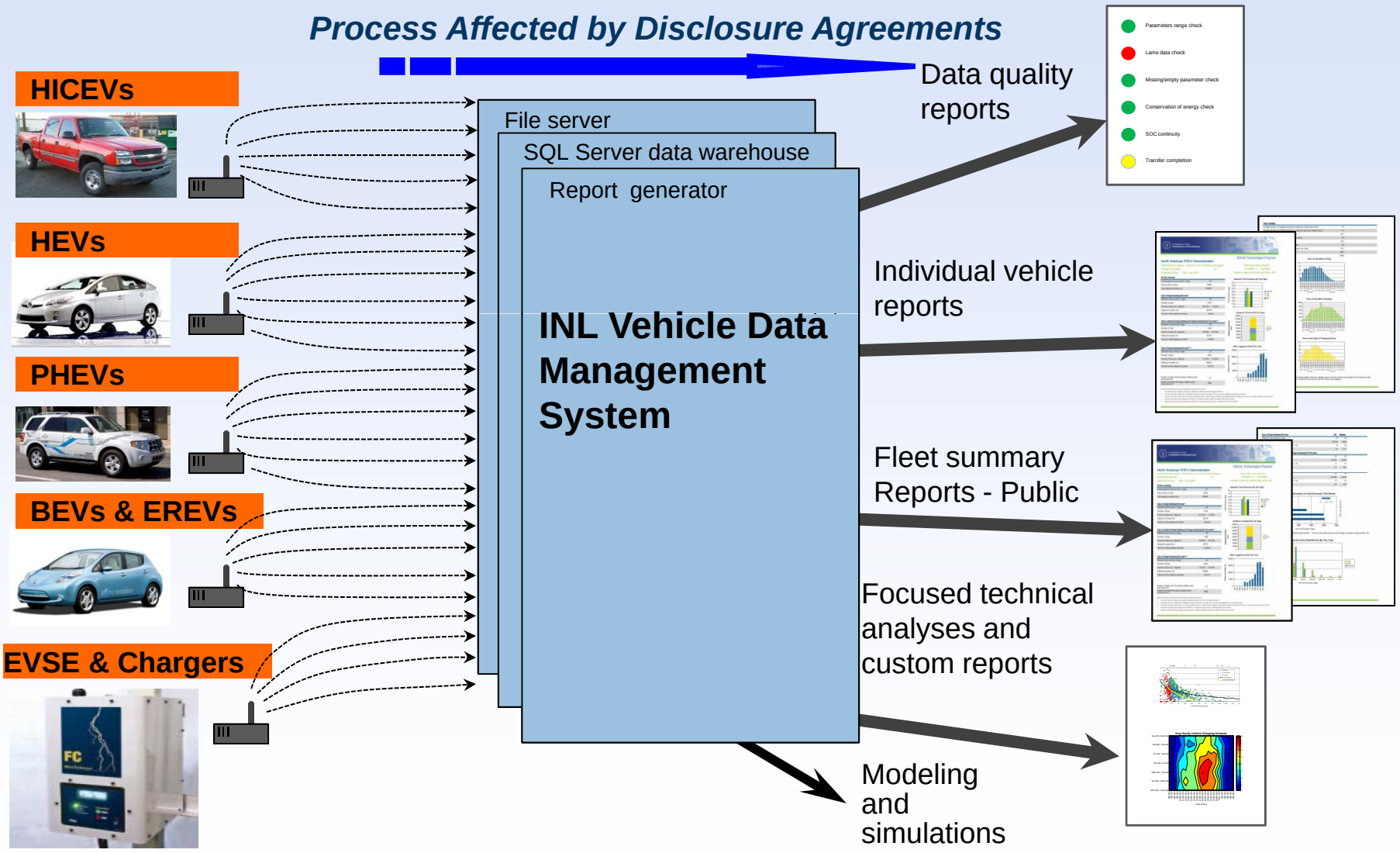
AVTA Participants and Goals

- **Participants**
  - **The Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program (EERE)**
  - **The Idaho National Laboratory (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

- **24 million test miles accumulated on 5,500 electric drive vehicles representing 111 models**
- **Plug-in hybrid electric vehicles: 14 models, 430 PHEVs, 4 million test miles**
- **Extended Range Electric Vehicles: 1 model, 125 EREVs, 250,000 test miles**
- **Hybrid electric vehicles: 19 models, 50 HEVs, 6 million test miles**
- **Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 300,000 test miles**
- **Neighborhood electric vehicles: 24 models, 372 NEVs, 200,000 test miles**
- **Battery electric vehicles: 47 models, 4,000 BEVs, 12 million test miles**
- **Urban electric vehicles: 3 models, 460 UEVs, 1 million test miles**
- **4,000 EVSE and first hydrogen generation/dispensing station in United States**

INL Vehicle Data Management Process



Example: Vehicle/Infrastructure Data Sources

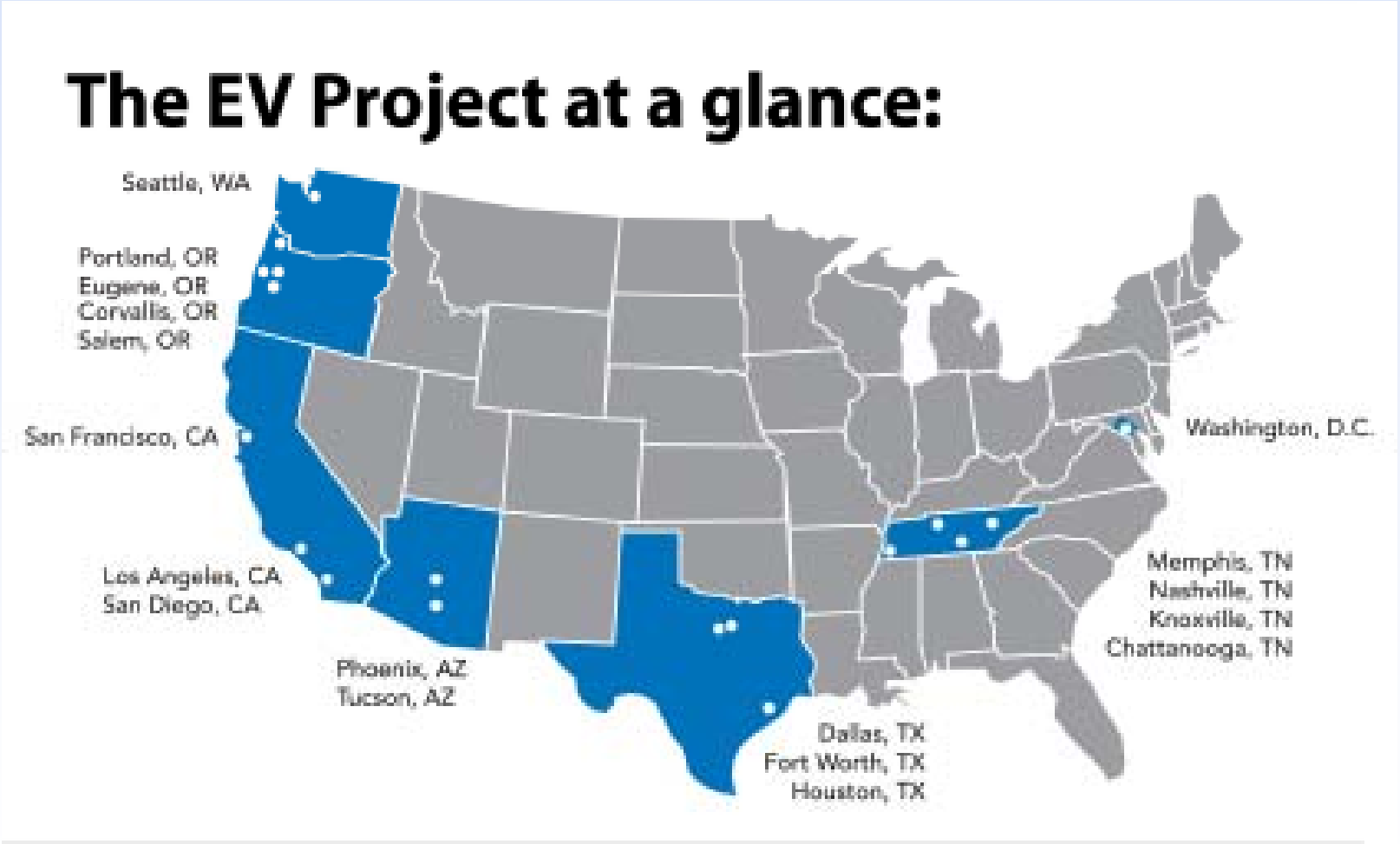
Vehicle time-history data (second-by-second)	HEV: 12 vehicle models, 1 data logger
	HICE: 1 vehicle model, 1 data logger
	Conversion PHEVs: 8 vehicle models, 3 data loggers
	Ford Escape PHEV, Ford wireless logger
	Chrysler Ram PHEV, Chrysler wireless logger
Vehicle event data (key-on, key-off)	**Nissan** 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
- INL can bin data results into usable information formats for analysis in research partnerships
- No raw data can be shared by INL

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



EV Project Residential Infrastructure

- **Deploy 8,300 battery electric vehicles with data loggers**
  - **5,700 Nissan Leaf BEVs**
  - **2,600 Chevrolet Volt EREVs**
- **Install 8,300 level 2 residential EVSE with data loggers**

EV Project Commercial Infrastructure

- **Install ~5,000 level 2 EVSE with data loggers**
  - **Retail locations**
  - **Municipal locations**
  - **Employer locations**
- **Deploy 200+ Dual Port DC Fast Chargers with data loggers**

EV Project – 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 – 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

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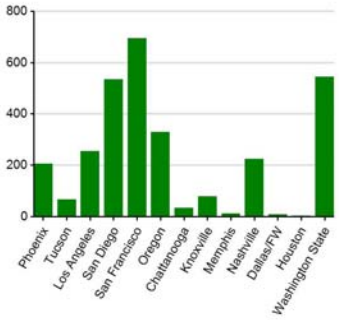
EV Project Overview Report

THE EV Project

Project to Date through September 2011

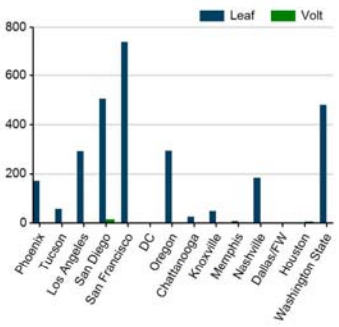
Charging Infrastructure Region[1]	Number of EV Project Charging Units Installed To Date	Number of Charging Events Performed	Electricity Consumed (AC MWh)
Phoenix, AZ Metropolitan Area	204	14,240	89.96
Tucson, AZ Metropolitan Area	65	4,414	26.10
Los Angeles, CA Metropolitan Area	254	14,686	105.56
San Diego, CA Metropolitan Area	535	41,549	316.48
San Francisco, CA Metropolitan Area	695	33,442	255.84
Washington, D.C. Metropolitan Area	0	0	0.00
Oregon	328	19,452	133.75
Chattanooga, TN Metropolitan Area	35	1,366	10.68
Knoxville, TN Metropolitan Area	78	3,320	24.45
Memphis, TN Metropolitan Area	13	554	4.06
Nashville, TN Metropolitan Area	223	9,204	62.07
Dallas/Ft. Worth, TX Metropolitan Area	10	97	0.41
Houston, TX Metropolitan Area	5	29	0.10
Washington State	545	35,609	243.33
Total	2,990	177,962	1272.79

Charging Unit Installation to Date by Region



Vehicles Region[1]	EV Project Nissan Leafs Enrolled to Date[2]	EV Project Chevrolet Volts Enrolled to Date[2]	Distance Driven (mi)
Phoenix, AZ Metropolitan Area	170	—	451,536
Tucson, AZ Metropolitan Area	57	—	128,033
Los Angeles, CA Metropolitan Area	292	0	592,152
San Diego, CA Metropolitan Area	504	15	1,365,134
San Francisco, CA Metropolitan Area	739	—	1,506,394
Washington, D.C. Metropolitan Area	—	0	0
Oregon	294	—	639,452
Chattanooga, TN Metropolitan Area	25	—	42,756
Knoxville, TN Metropolitan Area	48	—	105,405
Memphis, TN Metropolitan Area	8	—	11,910
Nashville, TN Metropolitan Area	184	—	269,630
Dallas/Ft. Worth, TX Metropolitan Area	—	1	
Houston, TX Metropolitan Area	—	5	3,102
Washington State	480	—	1,057,463
Total	2,801	21	6,174,051

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.

[1] Regions: Oregon region includes the Greater Corvallis, Eugene, Portland, and Salem Metropolitan Areas
Washington region includes the Greater Seattle and Olympia Metropolitan Areas

[2] Vehicle enrollment numbers refer to the EV Project only. Numbers do not reflect total regional or national vehicles sales or production.

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EV Project – Overview Report

- Vehicles and charging infrastructure deployed to date (Sept 2011)
- Charging infrastructure
  - 2,990 units installed
  - 177,962 charging events
  - 1,273 AC MWh
- Vehicles
  - 2,822 Leafs & Volts enrolled
  - 6.2 million miles
- Results provided nationally & regionally

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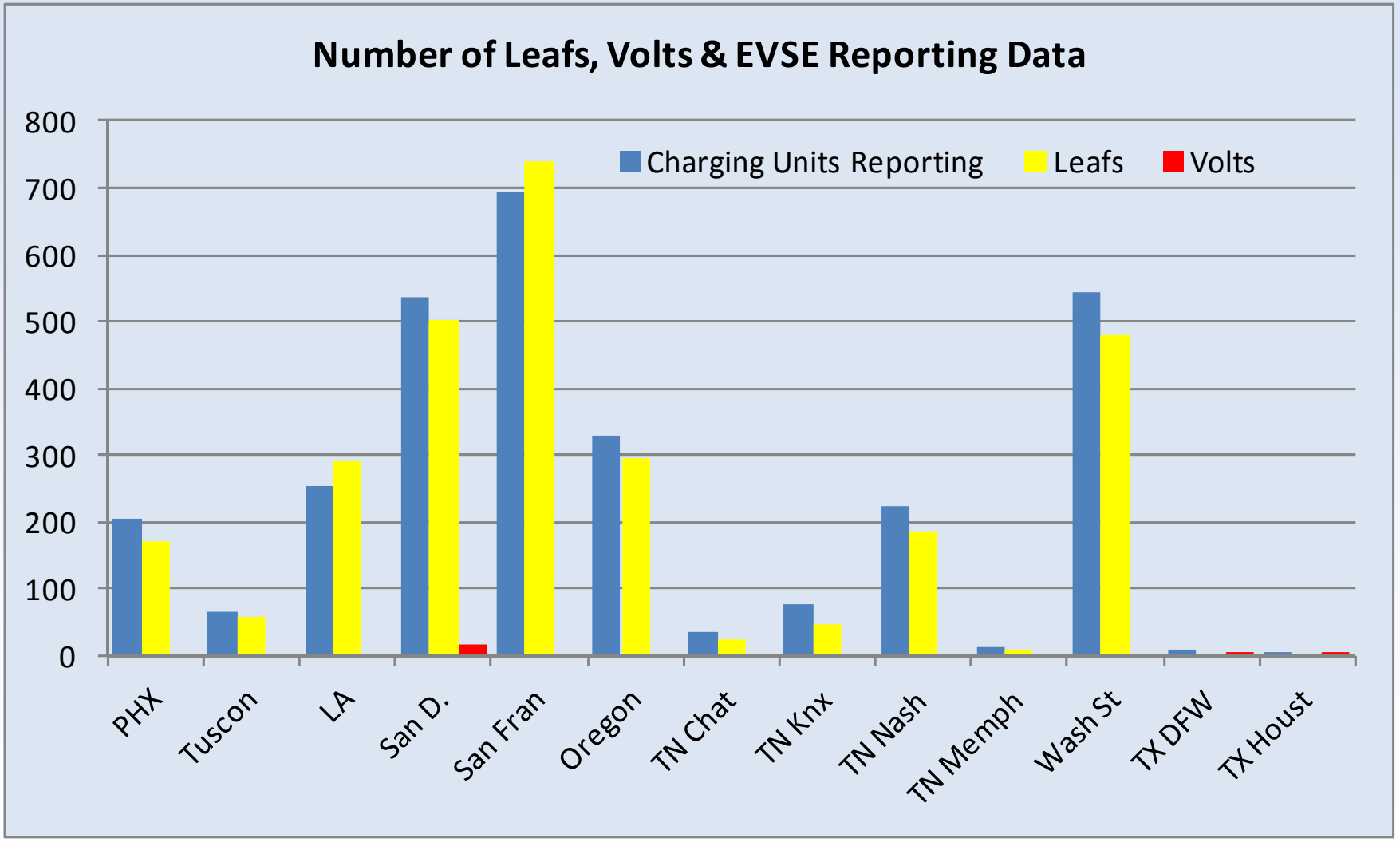
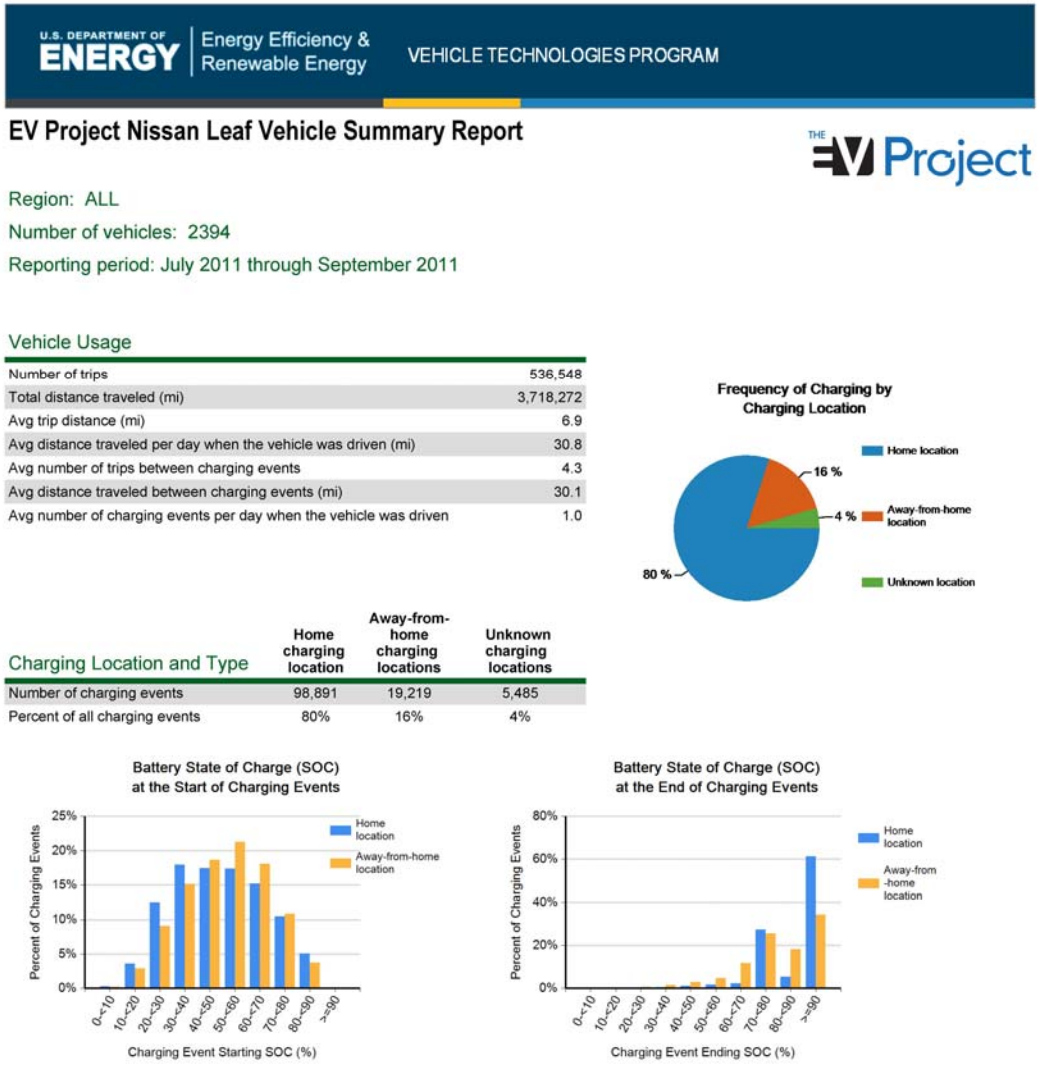
EV Project – # EVSE & Vehicles 3rd Quarter





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EV Project Nissan Leaf Vehicle Summary Report

THE EV Project

Region: ALL

Number of vehicles: 2394

Reporting period: July 2011 through September 2011

Vehicle Usage

Number of trips	536,548
Total distance traveled (mi)	3,718,272
Avg trip distance (mi)	6.9
Avg distance traveled per day when the vehicle was driven (mi)	30.8
Avg number of trips between charging events	4.3
Avg distance traveled between charging events (mi)	30.1
Avg number of charging events per day when the vehicle was driven	1.0

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	98,891	19,219	5,485
Percent of all charging events	80%	16%	4%

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

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

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EV Project – Nissan Leaf Usage Report

- July - Sept 2011 only
- See following slides
- 1 page nationally
- Plus 1 additional page for each region with more than 10 vehicles
- Subset of 2,394 vehicles as this report requires matching Leaf and charging data

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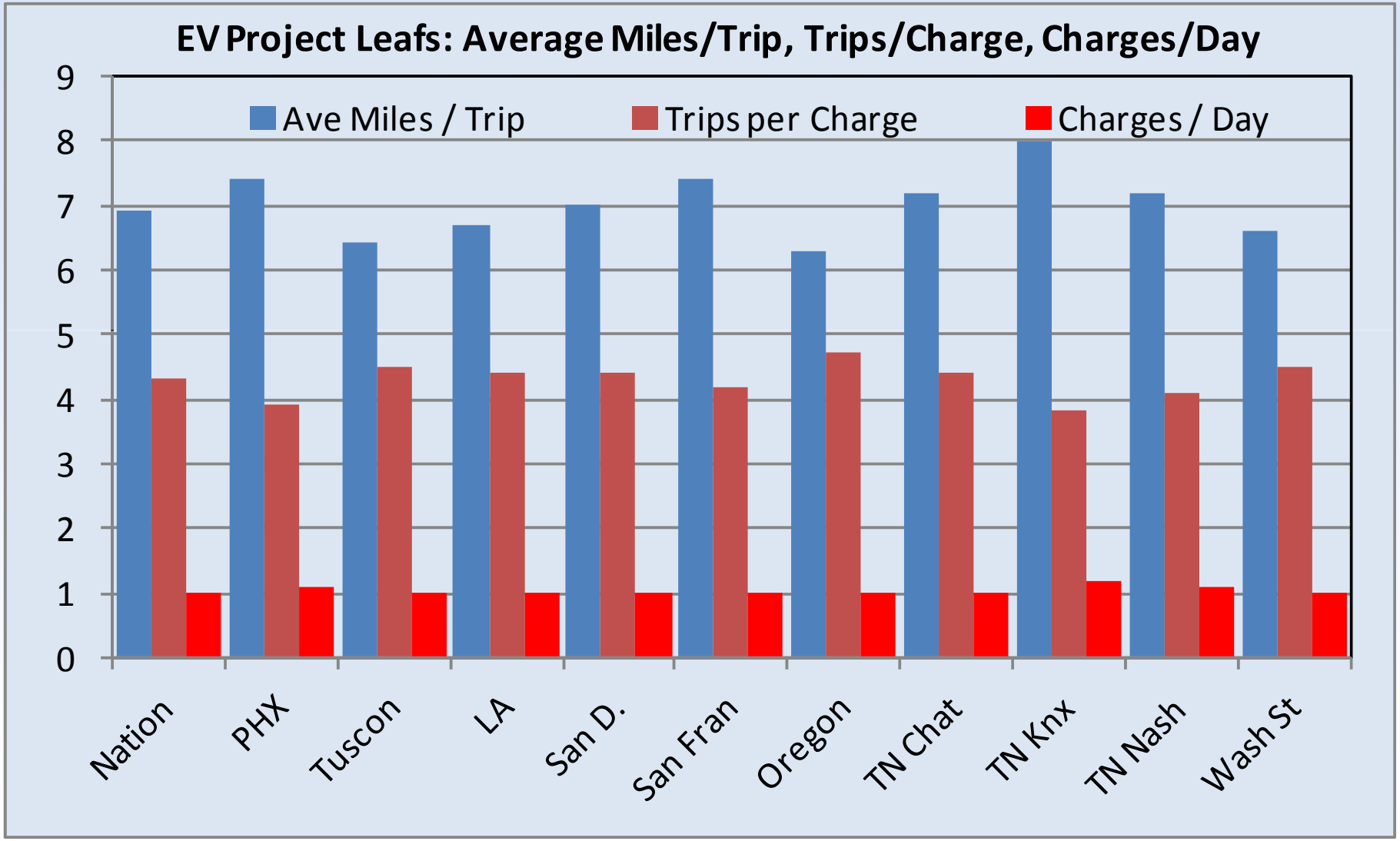
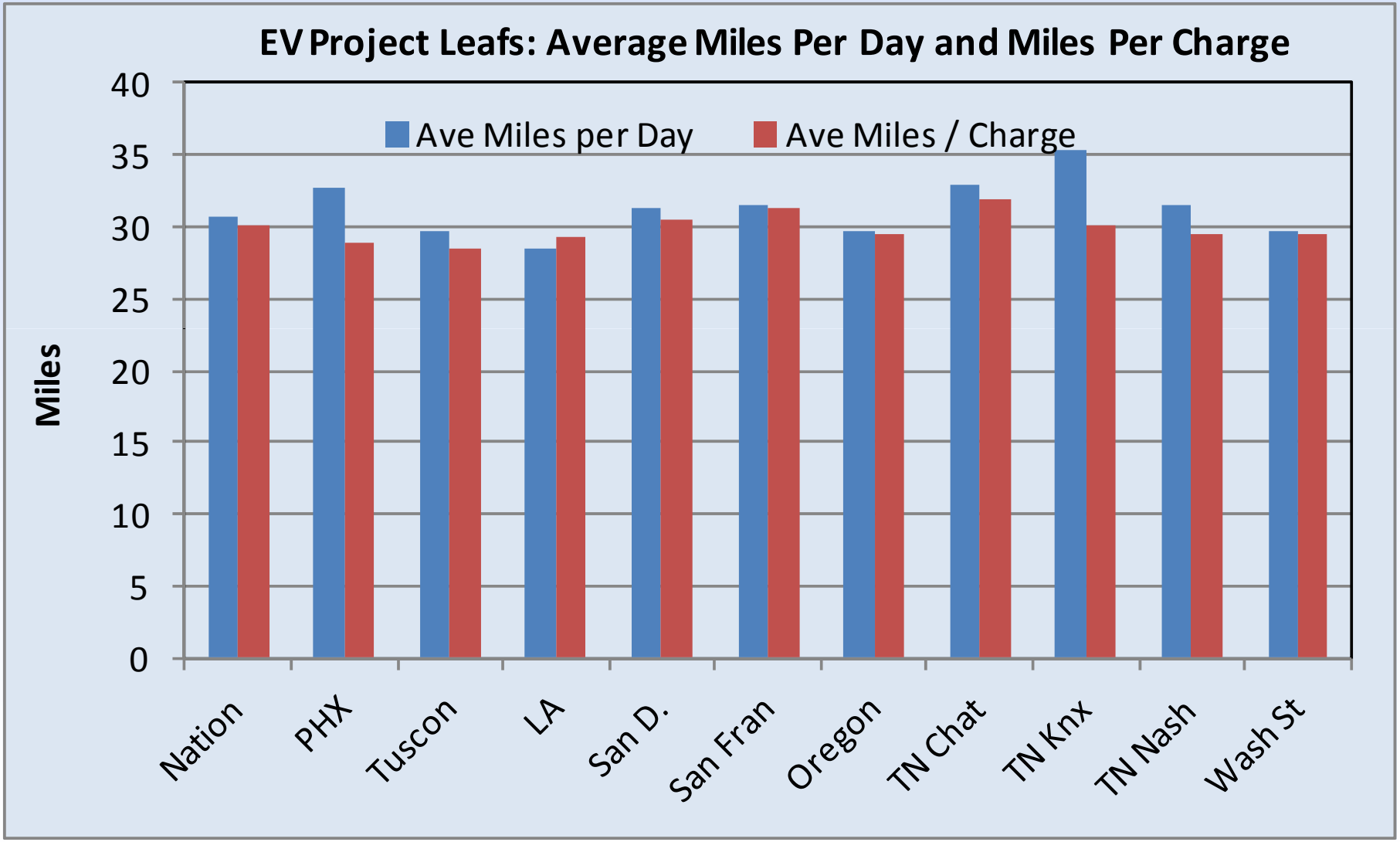
EV Project – Nissan Leaf Usage Report

- **Vehicle Usage – 3st quarter 2011**
  - **Number of Trips** — **536,548**
  - **Total distance traveled (miles)** — **3,718,272 mi**
  - **Ave trip distance** — **6.9 mi**
  - **Ave distance per day when driven** — **30.8 mi**
  - **Ave # trips between charging events** — **4.3**
  - **Ave distance traveled between charging events** — **30.1 mi**
  - **Ave # charging events per day when a vehicle was driven** — **1.0**
  - **Vehicle petroleum used** — **0 gallons**

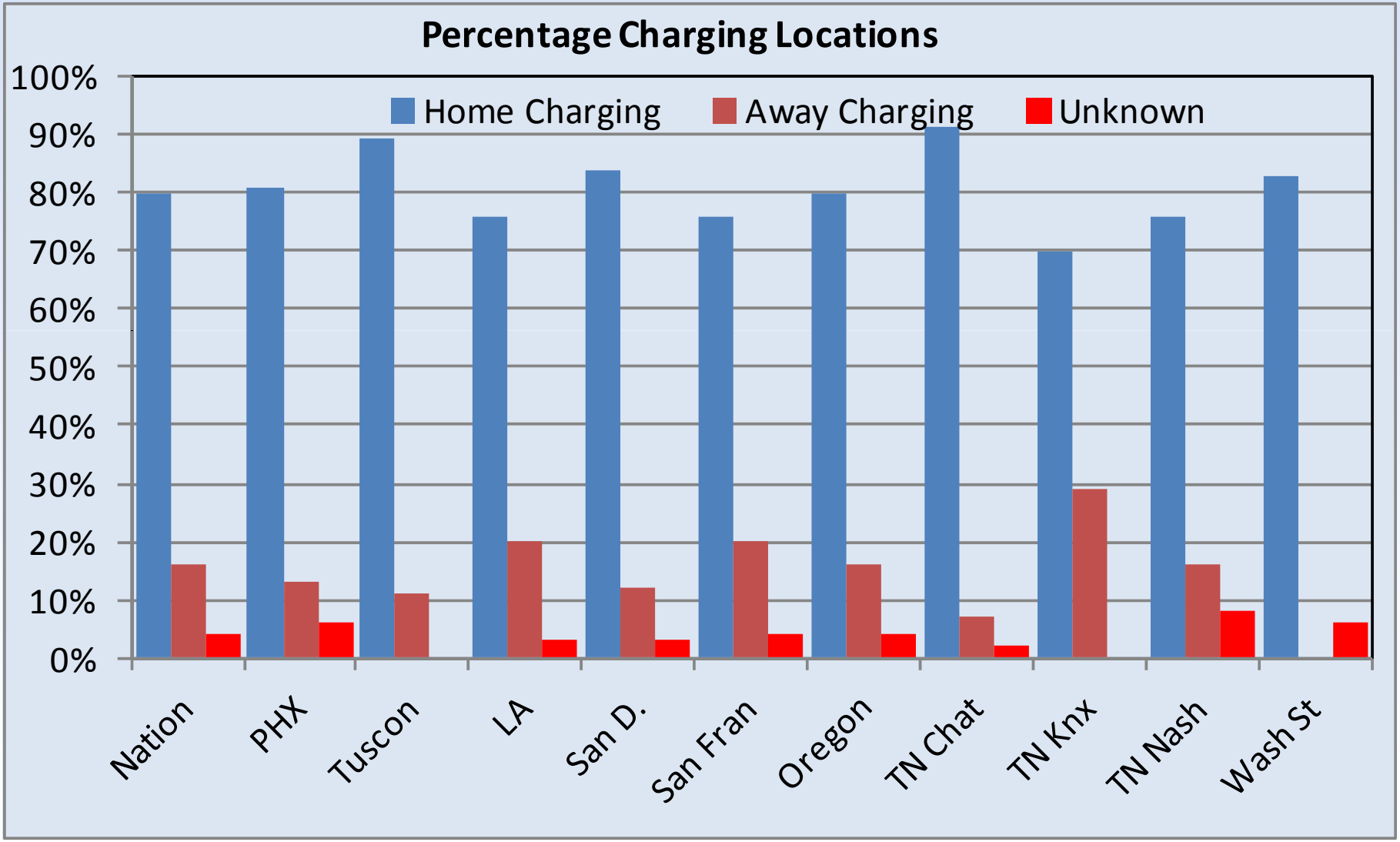
EV Project – Nissan Leaf Usage



EV Project – Nissan Leaf Usage

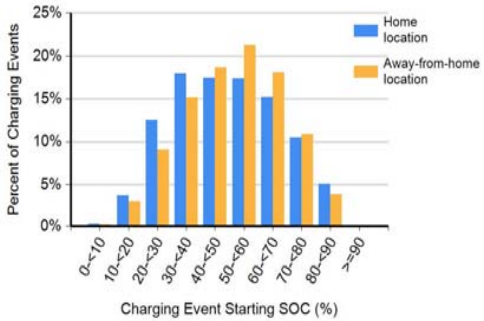


EV Project – Nissan Leaf Usage



EV Project – Nissan Leaf Usage

National



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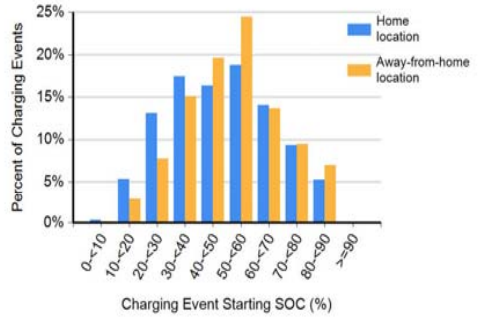

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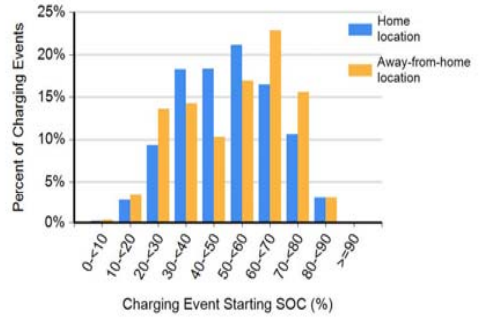

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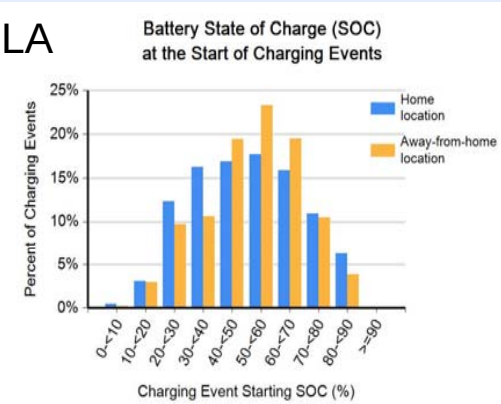

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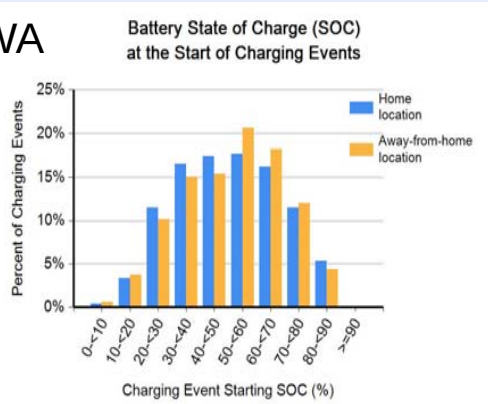

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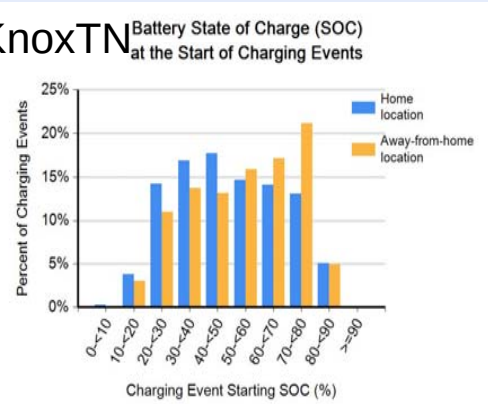

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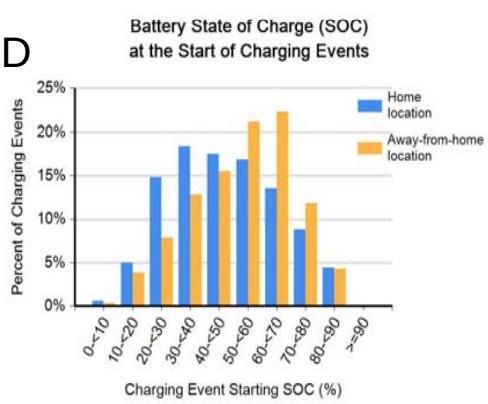

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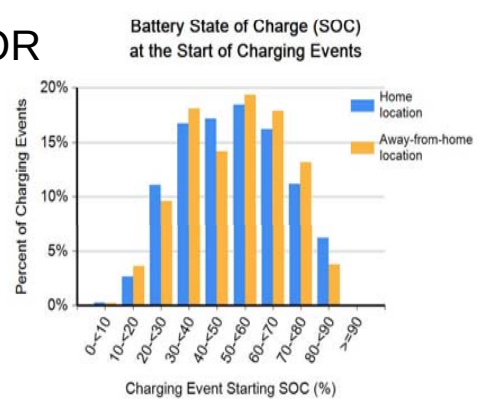

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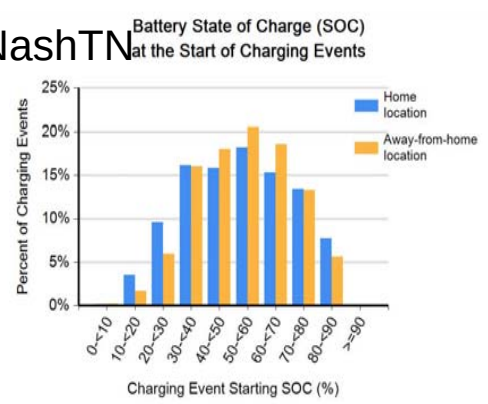
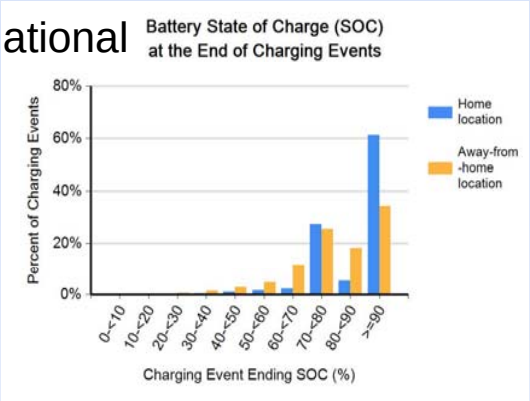


EV Project – Nissan Leaf Usage

National



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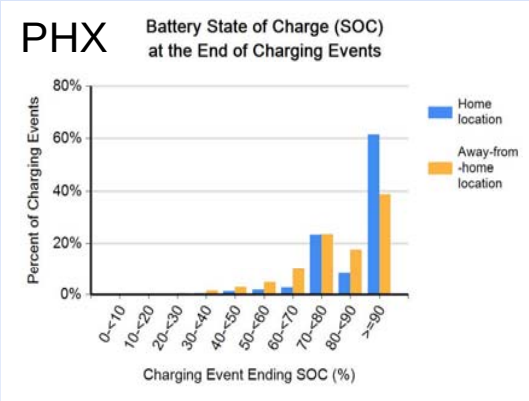

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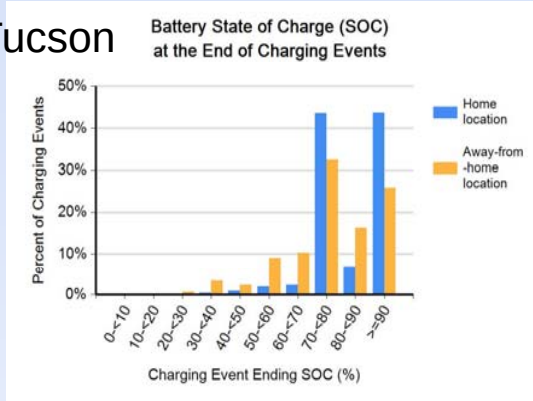

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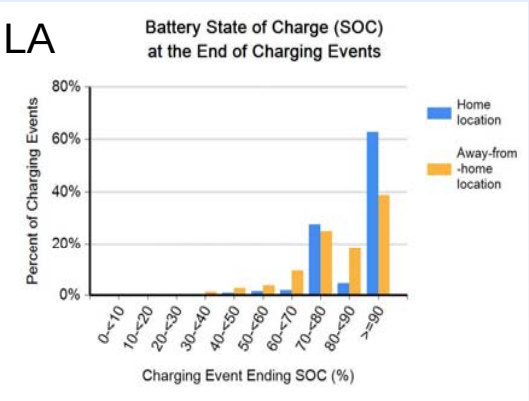

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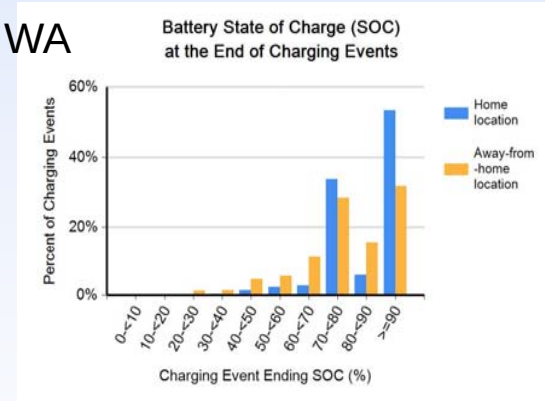

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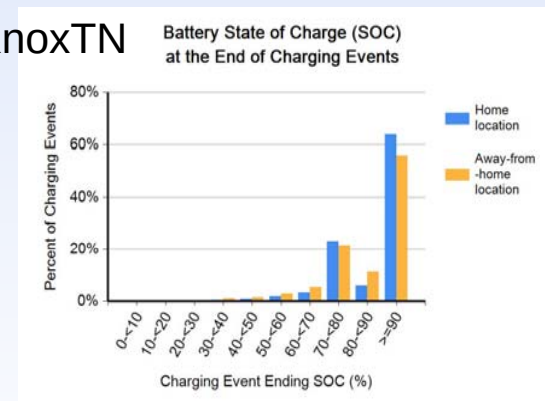

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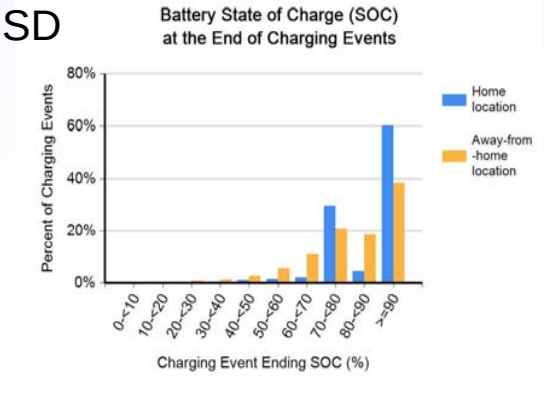

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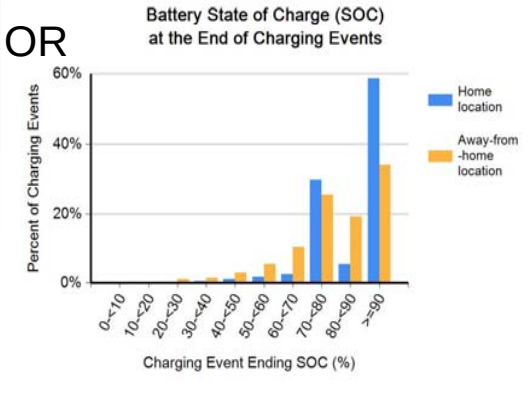

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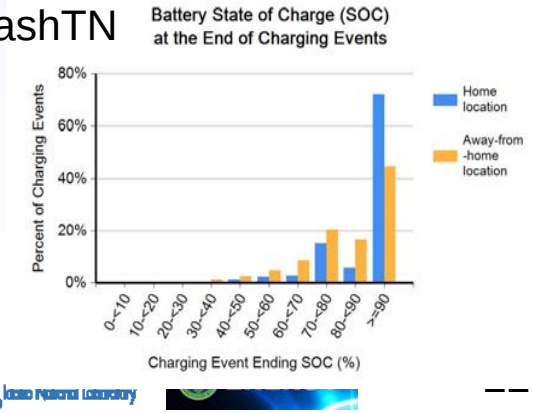

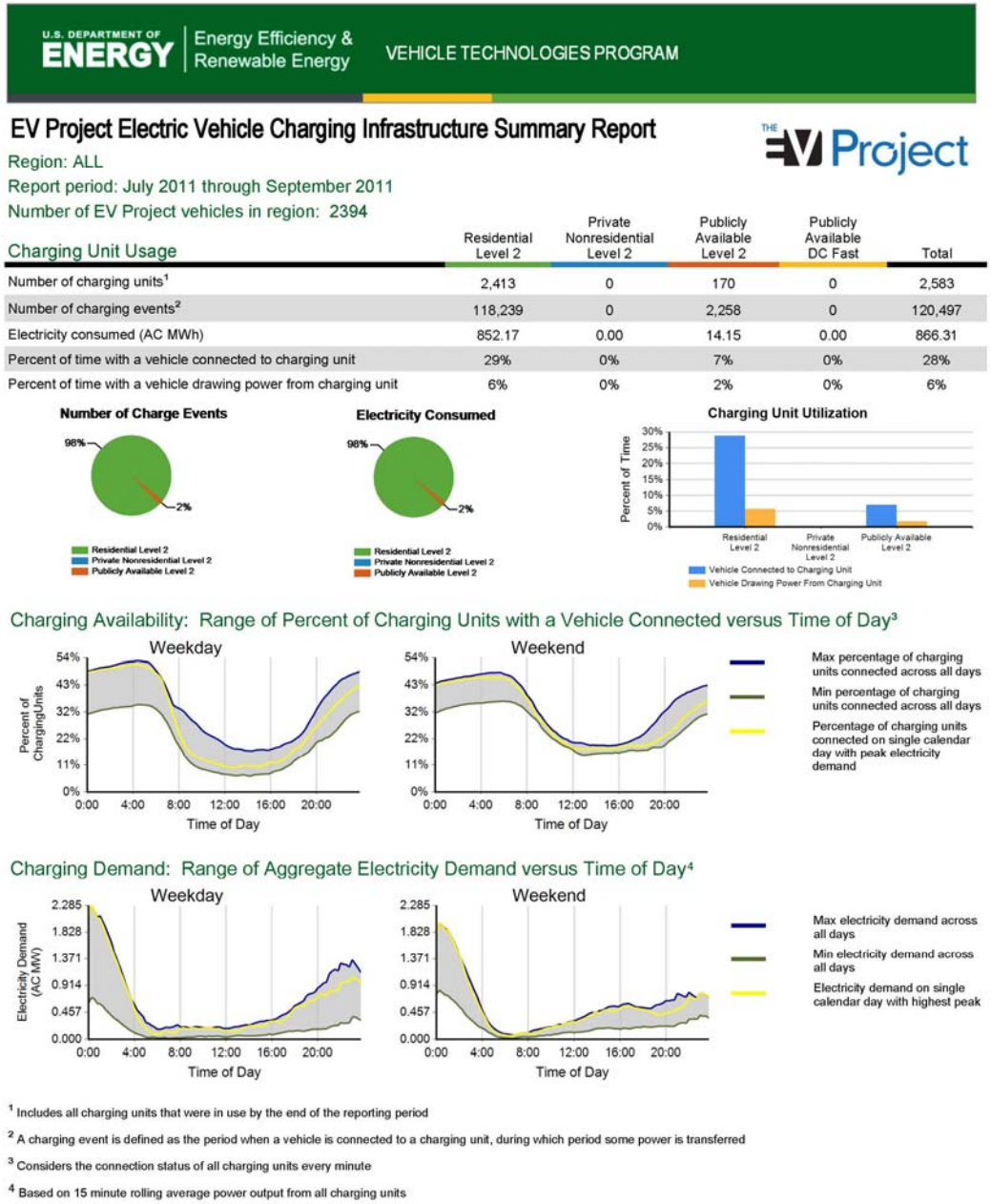

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EV Project Electric Vehicle Charging Infrastructure Summary Report

THE EV Project

Region: ALL
Report period: July 2011 through September 2011
Number of EV Project vehicles in region: 2394

Charging Unit Usage	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units[1]	2,413	0	170	0	2,583
Number of charging events[2]	118,239	0	2,258	0	120,497
Electricity consumed (AC MWh)	852.17	0.00	14.15	0.00	866.31
Percent of time with a vehicle connected to charging unit	29%	0%	7%	0%	28%
Percent of time with a vehicle drawing power from charging unit	6%	0%	2%	0%	6%

Charging Availability: Range of Percent of Charging Units with a Vehicle Connected versus Time of Day[3]

Charging Demand: Range of Aggregate Electricity Demand versus Time of Day[4]

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

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

[3] Considers the connection status of all charging units every minute

[4] Based on 15 minute rolling average power output from all charging units

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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

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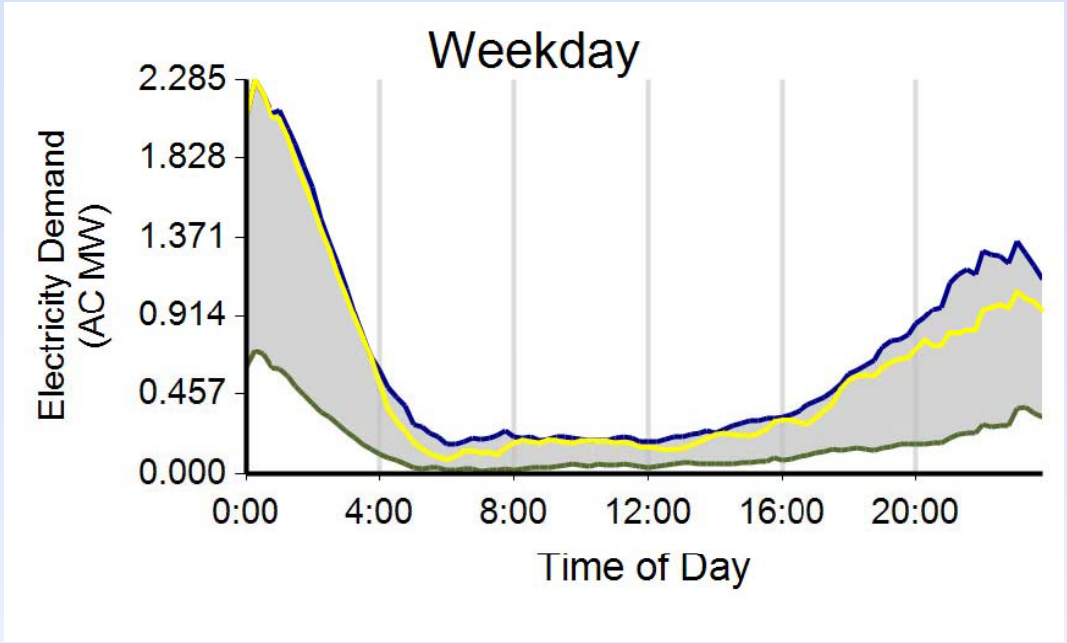
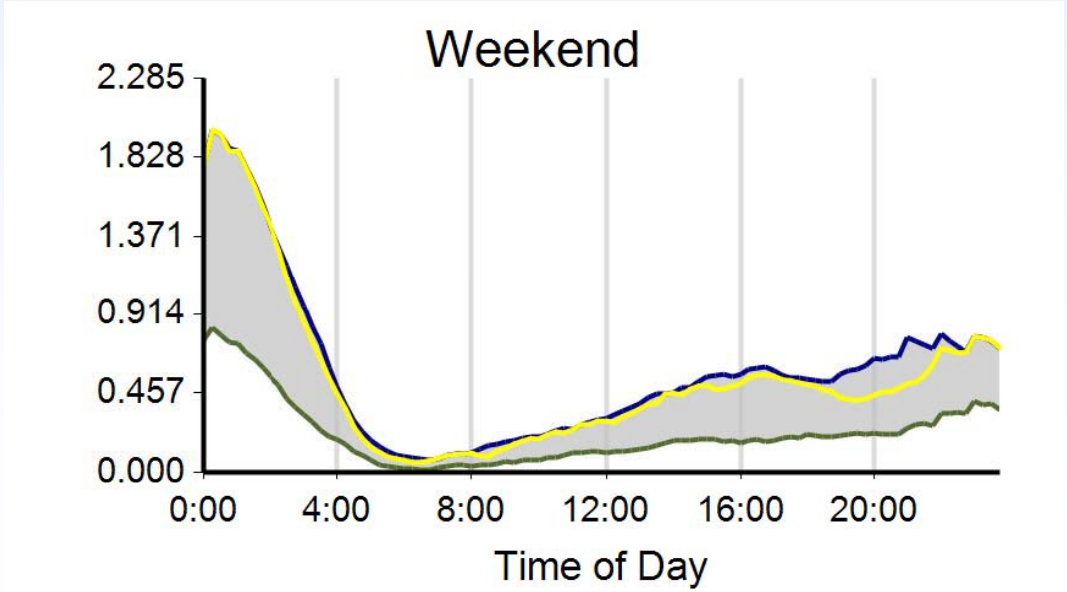
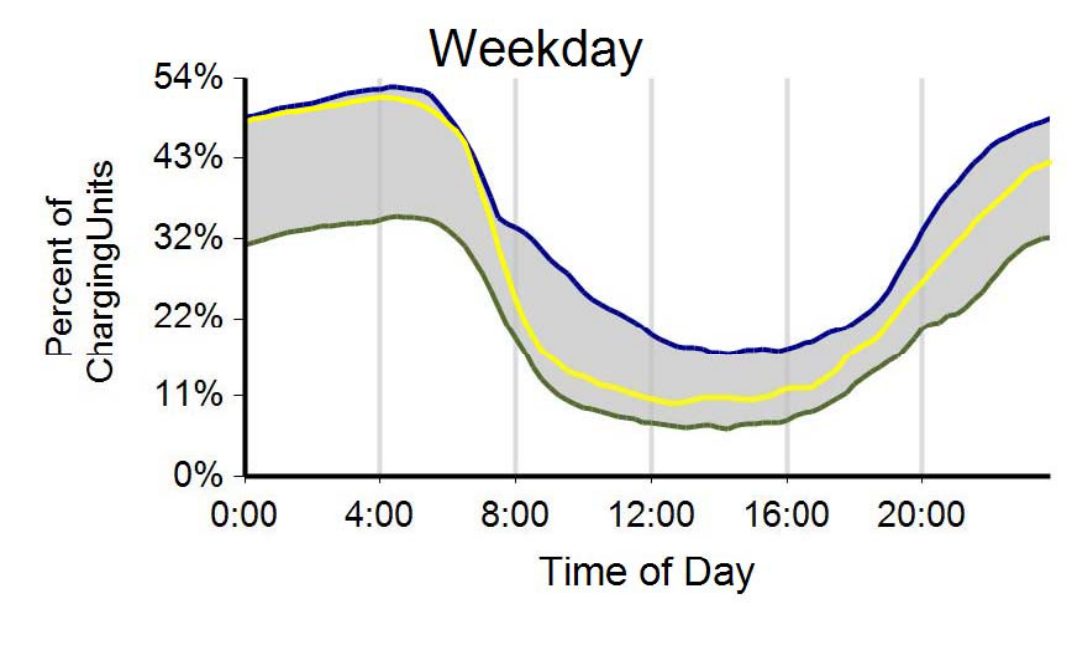
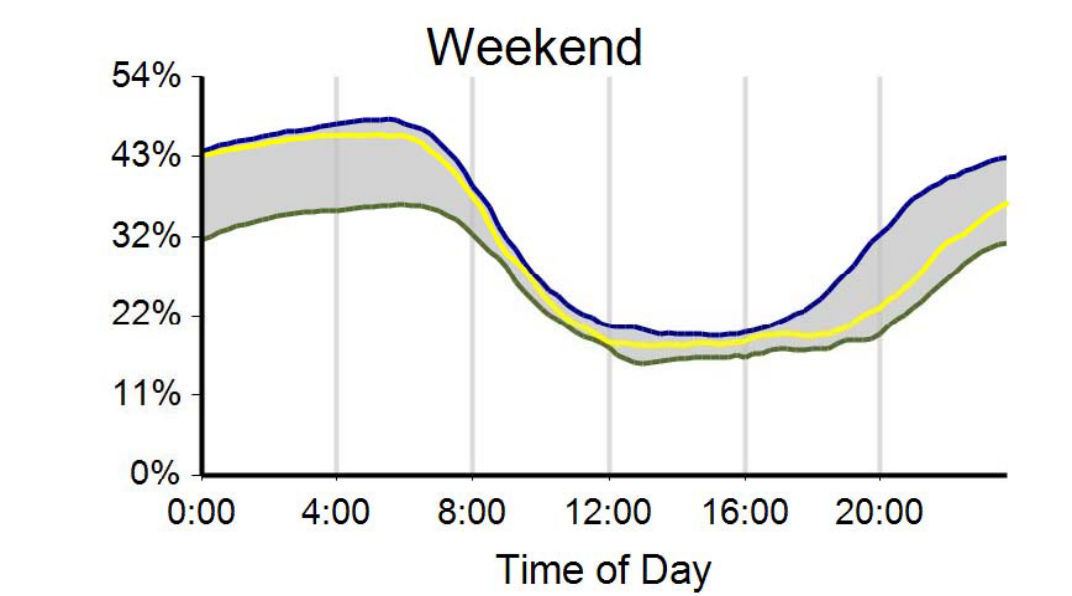




EV Project – EVSE Infra. Summary Report

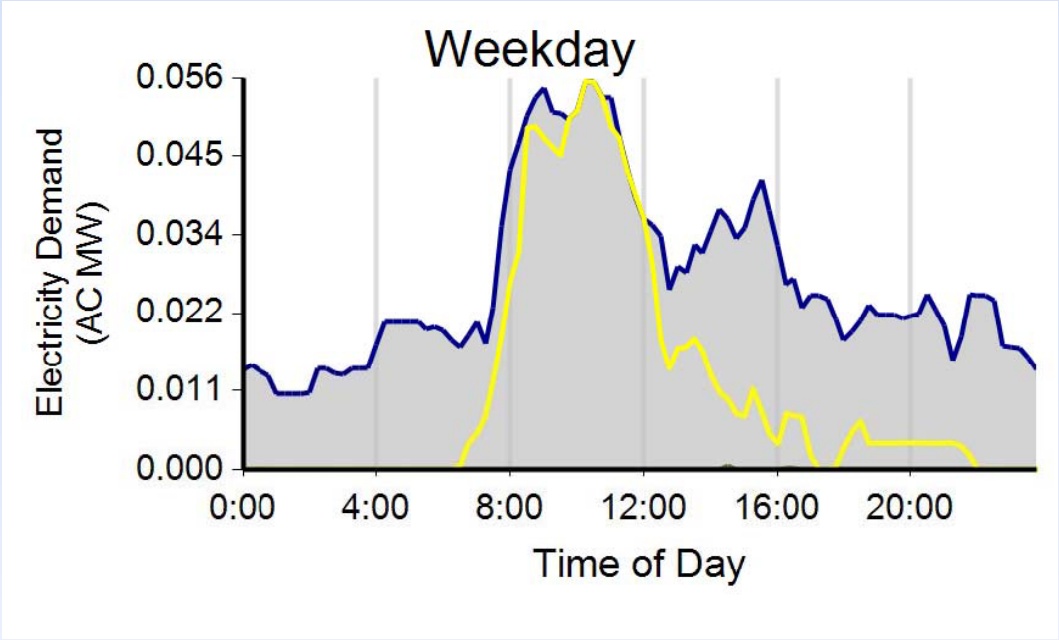
- **National data. All 2,413 R2 EVSE. July-Sept 2011**
- **Power demand range for any time during reporting quarter**
- **Yellow line is daily profile for the day with quarterly peak demand**
- **Both graphs in AC MW**
- **Based on 15 minute rolling average MW demand**

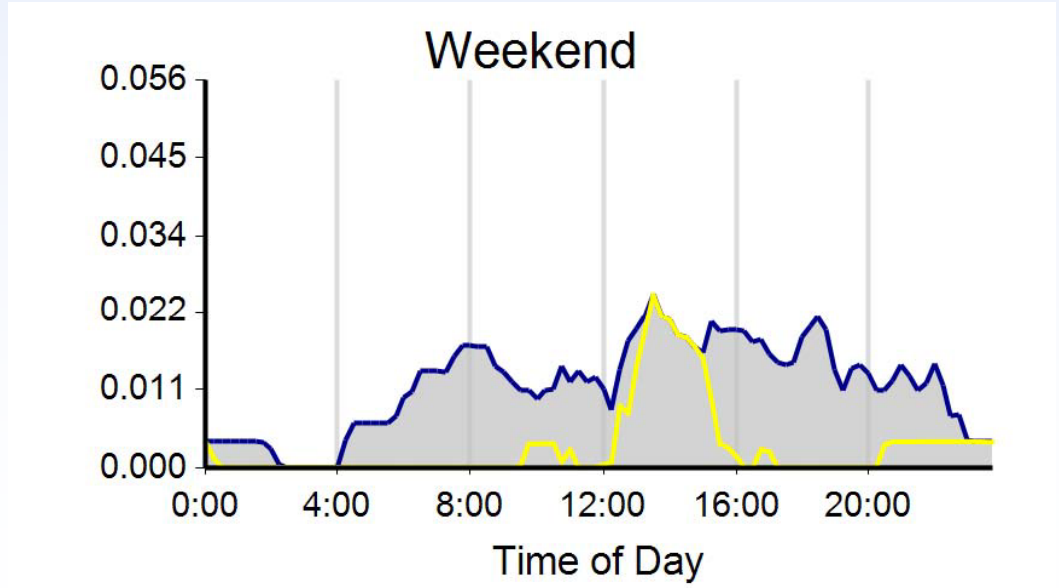




EV Project – EVSE Infra. Summary Report

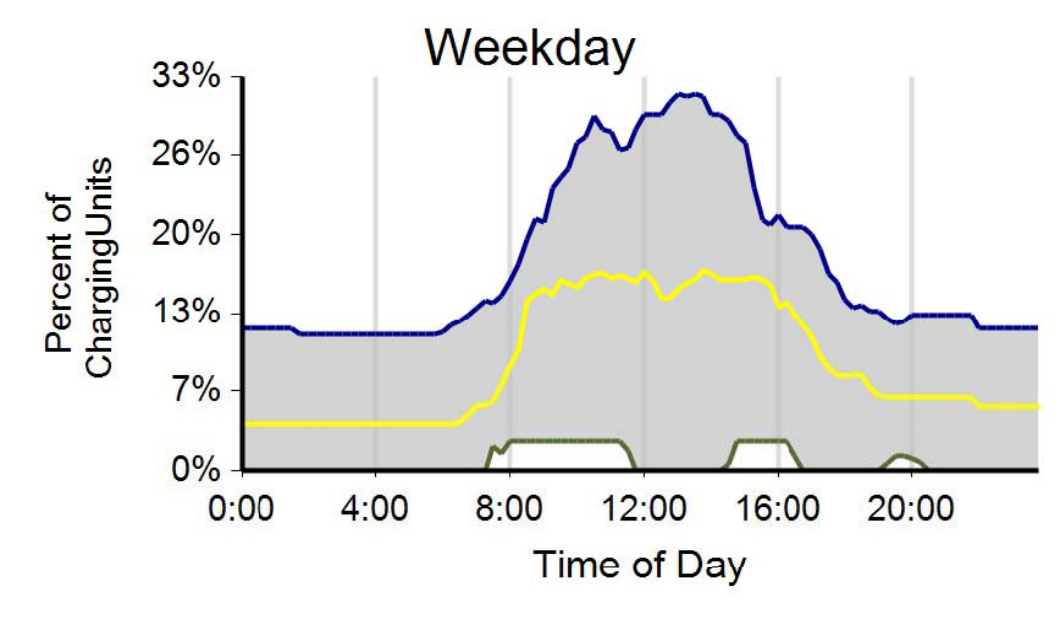
- National data. All 2,413 R2 EVSE. July-Sept 2011
- Range of charging units with a vehicle connected
- Yellow line is for day with peak power demand
- Both graphs percent of charging units

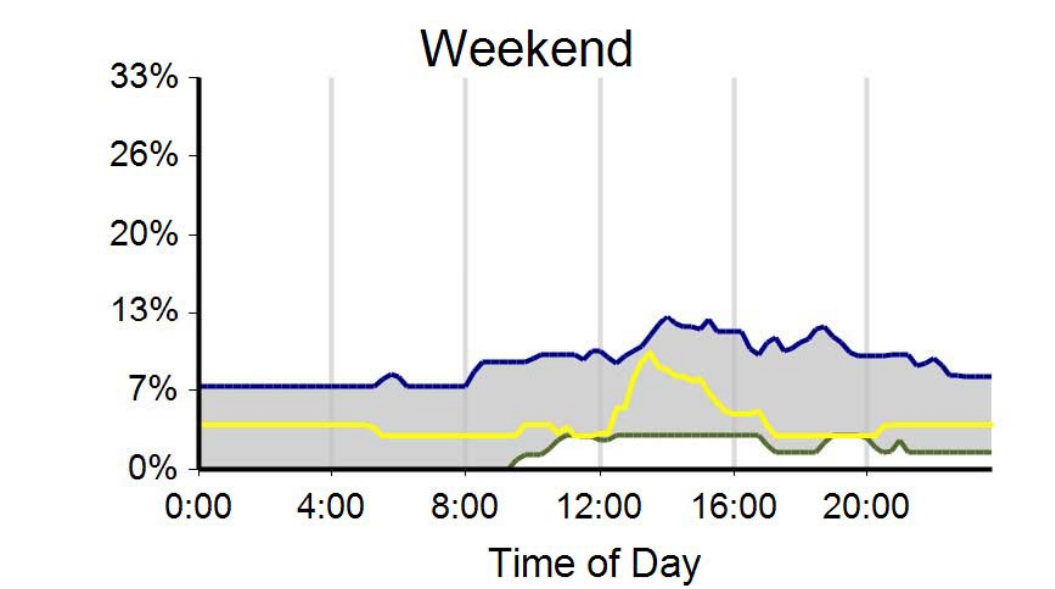




EV Project – EVSE Infra. Summary Report

- National data. All 170 P2 EVSE. July-Sept 2011
- Power demand range for any time during reporting quarter
- Yellow line is daily profile for the day with quarterly peak demand
- Both graphs in AC MW
- Based on 15 minute rolling average MW demand



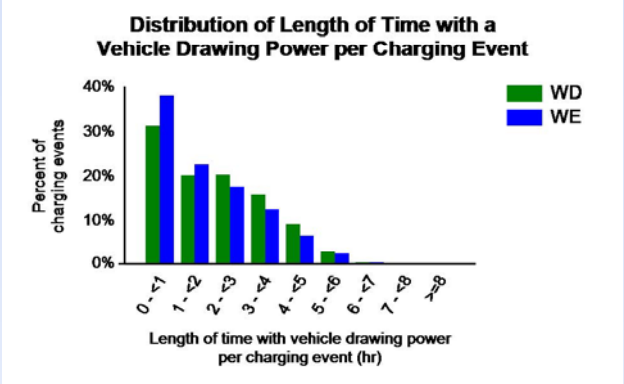


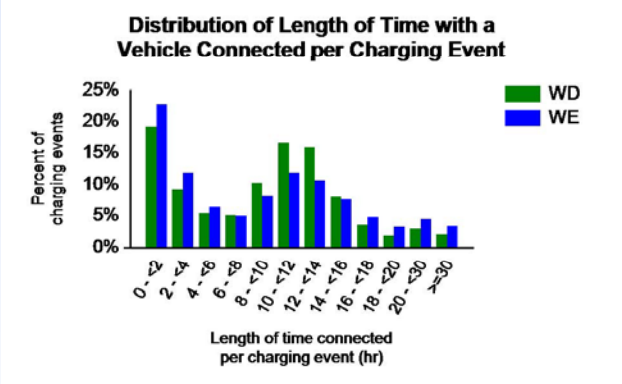
EV Project – EVSE Infra. Summary Report

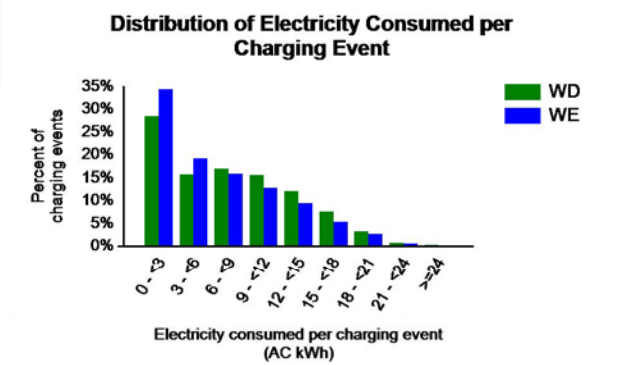
- National data. All 170 P2 EVSE. July-Sept 2011
- Range of charging units with a vehicle connected
- Yellow line is for day with peak power demand
- Both graphs percent of charging units

EV Project – EVSE Infra. Summary Report

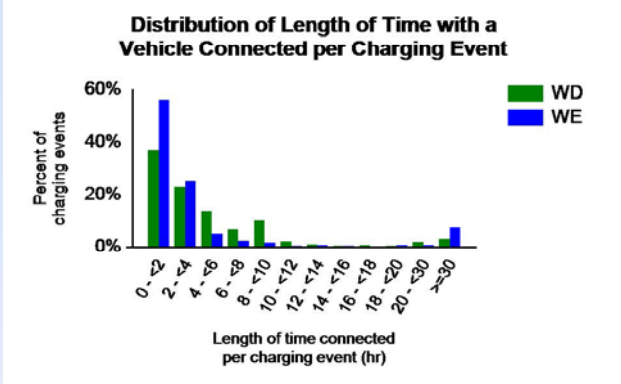
Residential Level 2 EVSE

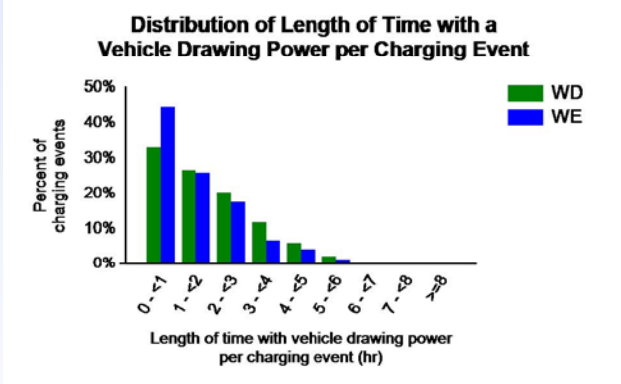


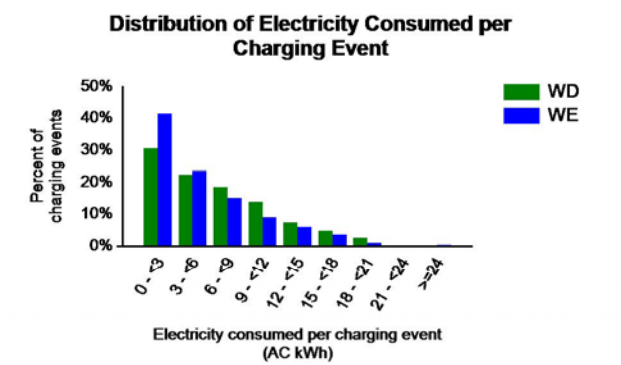




Public Level 2 EVSE





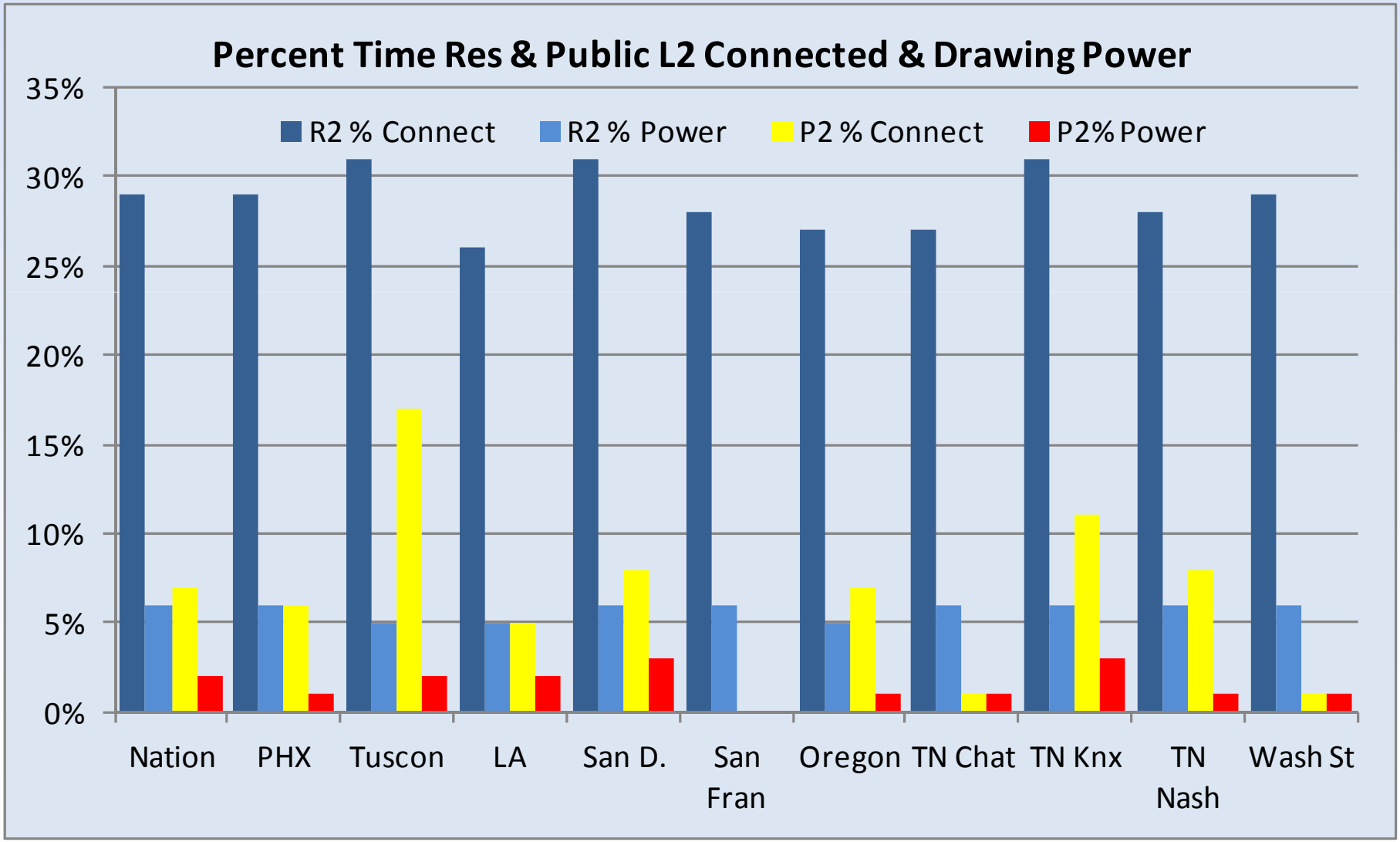


EV Project – EVSE Infra. Summary Report

- National Data – 3rd quarter 2011
  - Ave time vehicle connected R2 WD 9.9 hours
  - Ave time vehicle connected R2 WE 10.0 hours
  - Ave time vehicle drawing power R2 WD 2.0 hours
  - Ave time vehicle drawing power R2 WE 1.8 hours
  - Ave energy per charge event R2 WD 7.5 AC kWh
  - Ave energy per charge event R2 WE 6.5 AC kWh
  - Ave time vehicle connected P2 All 6.8 hours
  - Ave time vehicle drawing power P2 All 1.7 hours
  - Ave energy per charge event P2 All 6.3 AC kWh

- R: residential, P: public, WD: weekday, WE: weekend, All: weekday/end combined

EV Project – EVSE Infra. Summary Report



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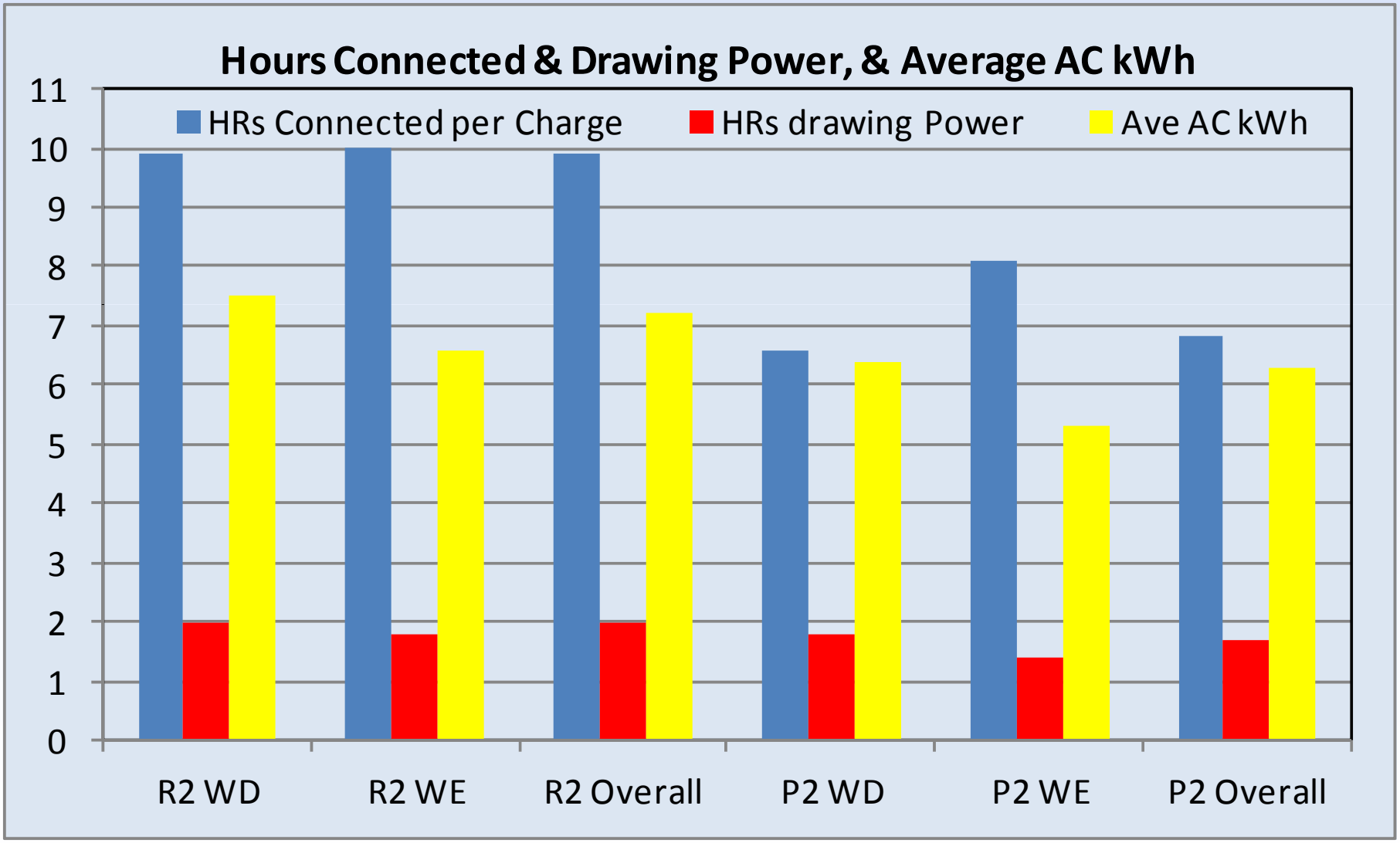

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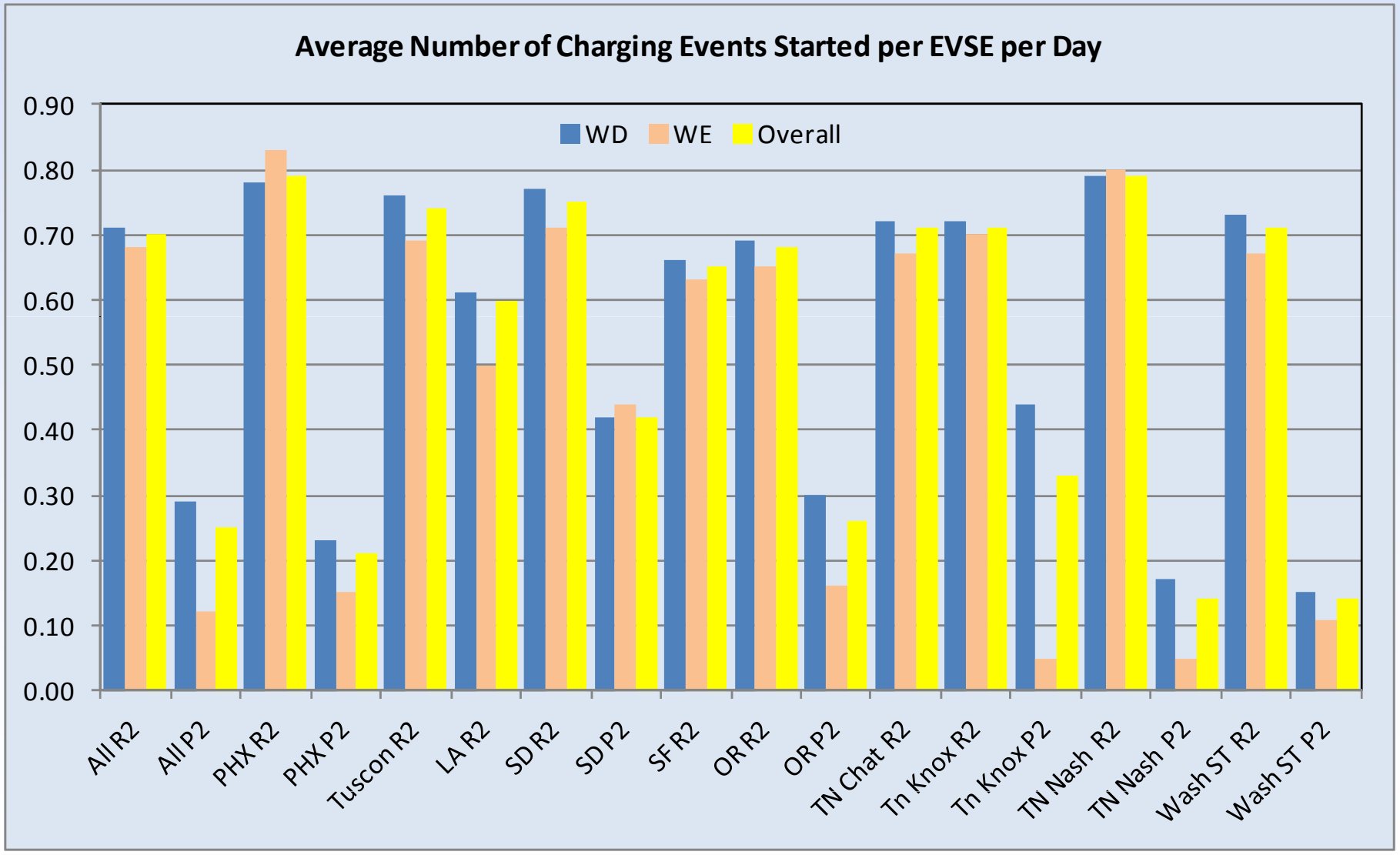

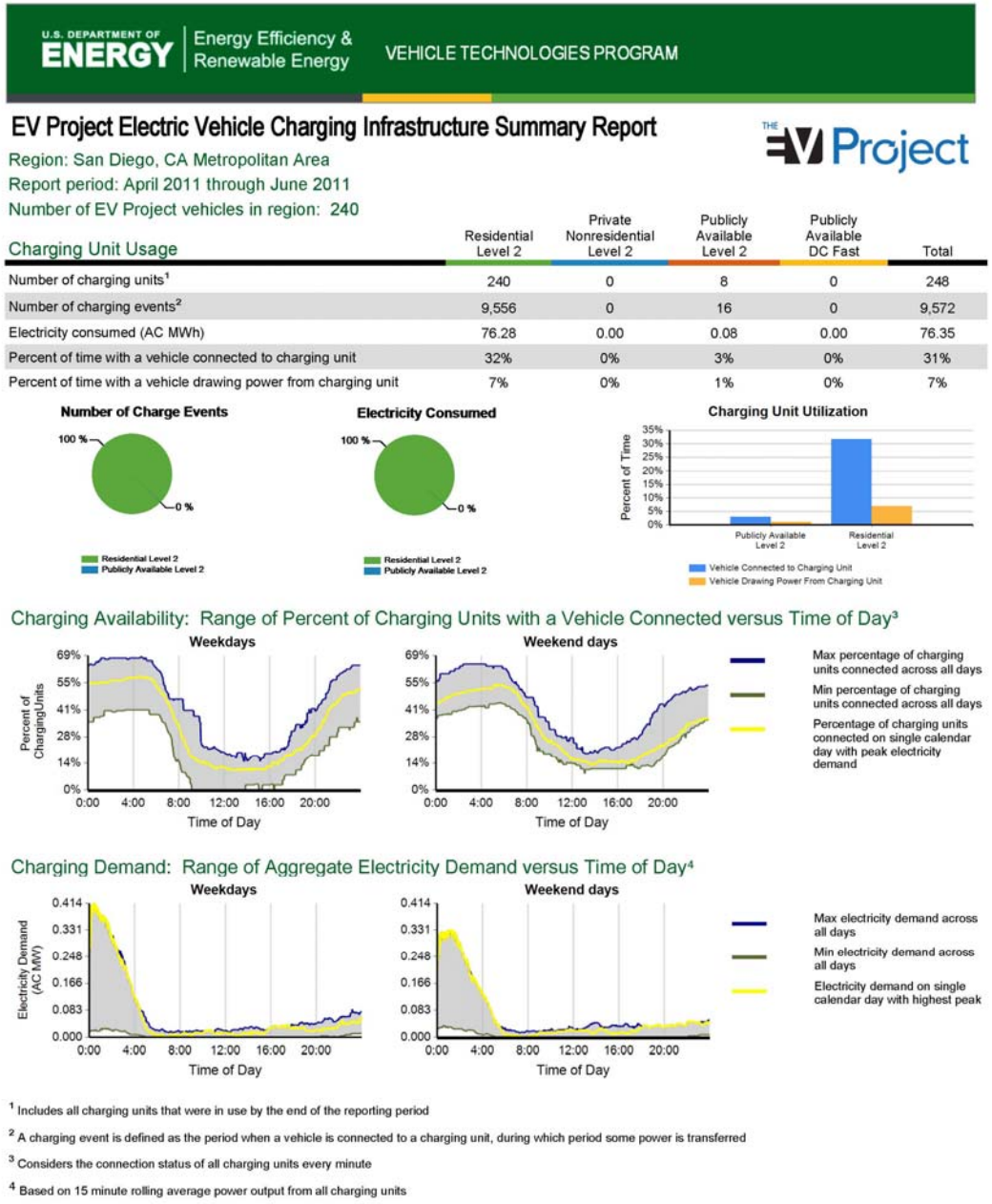

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy | VEHICLE TECHNOLOGIES PROGRAM

EV Project Electric Vehicle Charging Infrastructure Summary Report

THE EV Project

Region: San Diego, CA Metropolitan Area
Report period: April 2011 through June 2011
Number of EV Project vehicles in region: 240

Charging Unit Usage	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units[1]	240	0	8	0	248
Number of charging events[2]	9,556	0	16	0	9,572
Electricity consumed (AC MWh)	76.28	0.00	0.08	0.00	76.35
Percent of time with a vehicle connected to charging unit	32%	0%	3%	0%	31%
Percent of time with a vehicle drawing power from charging unit	7%	0%	1%	0%	7%

Number of Charge Events

Electricity Consumed

Charging Unit Utilization

Charging Availability: Range of Percent of Charging Units with a Vehicle Connected versus Time of Day[3]

Charging Demand: Range of Aggregate Electricity Demand versus Time of Day[4]

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

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

[3] Considers the connection status of all charging units every minute

[4] Based on 15 minute rolling average power output from all charging units

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EV Project – Other Reports to date include

- Infrastructure reports by each utility service area are produced by overlaying GIS service area data with EV Project data
- Various billing support reports
- Shown - San Diego infrastructure report

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U.S. DEPARTMENT OF ENERGY

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

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

Chrysler RAM PHEV Fleet

Number of vehicles: 37
Reporting period: July 11 - Aug 11
Date range of data received: 7/1/2011 to 8/31/2011
Number of vehicle days driven: 615

All Trips Combined

Overall gasoline fuel economy (mpg)	16
Overall AC electrical energy consumption (AC Wh/mi)[1]	162
Overall DC electrical energy consumption (DC Wh/mi)[2]	94
Overall DC electrical energy captured from regenerative braking (DC Wh/mi)	53
Total number of trips	3,443
Total distance traveled (mi)	13,911

Trips in Charge Depleting (CD) mode[3]

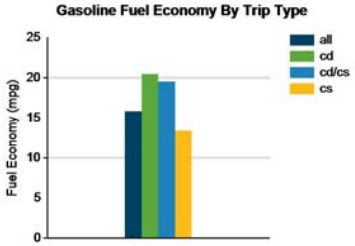
Gasoline fuel economy (mpg)	20
DC electrical energy consumption (DC Wh/mi)[4]	282
Number of trips	1,310
Percent of trips city | highway	98% | 2%
Distance traveled (mi)	3,779
Percent of total distance traveled	27%

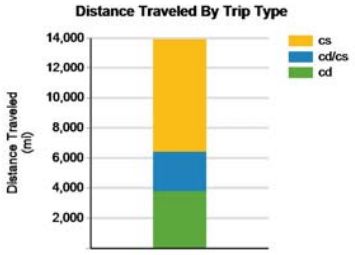
Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes[5]

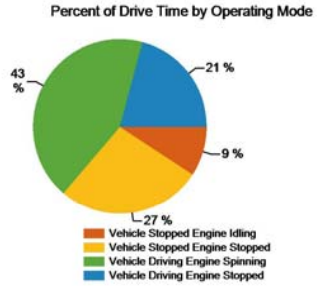
Gasoline fuel economy (mpg)	20
DC electrical energy consumption (DC Wh/mi)[6]	121
Number of trips	175
Percent of trips city | highway	86% | 14%
Distance traveled CD | CS (mi)	1,232 | 1,433
Percent of total distance traveled CD | CS	9% | 10%

Trips in Charge Sustaining (CS) mode[7]

Gasoline fuel economy (mpg)	13
Number of trips	1,958
Percent of trips city | highway	98% | 2%
Distance traveled (mi)	7,505
Percent of total distance traveled	53%







Notes: 1 - 9. Please see http://avt.inl.gov/pdf/phev/chryslerreportnotes.pdf for an explanation of all PHEV Fleet Testing Report notes.

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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Chevrolet Volt DOE ARRA Project

- July – Sept 2011
- 110 Chevy Volts
- 208,165 test miles
- All trips, 74.8 mpg, 185 AC Wh/mi
- EV mode, 369 AC Wh/mi no gasoline, 50.3% all miles
- Extended range mode, 37.2 mpg
- Average trip distance 7.4 miles city and 45.6 miles highway driving

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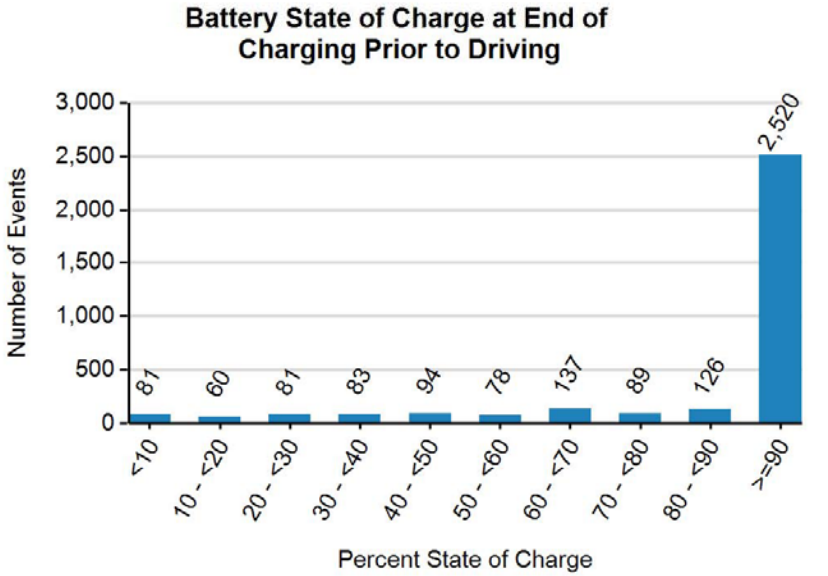
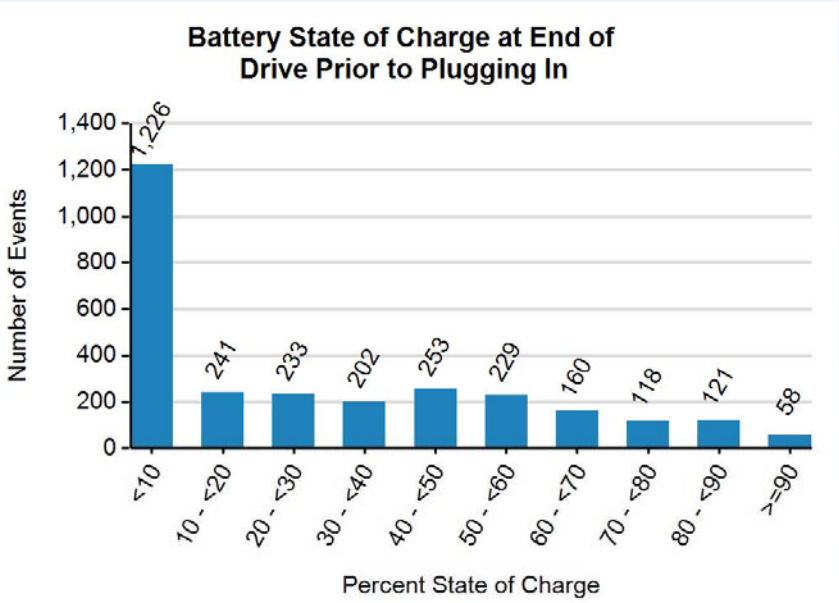
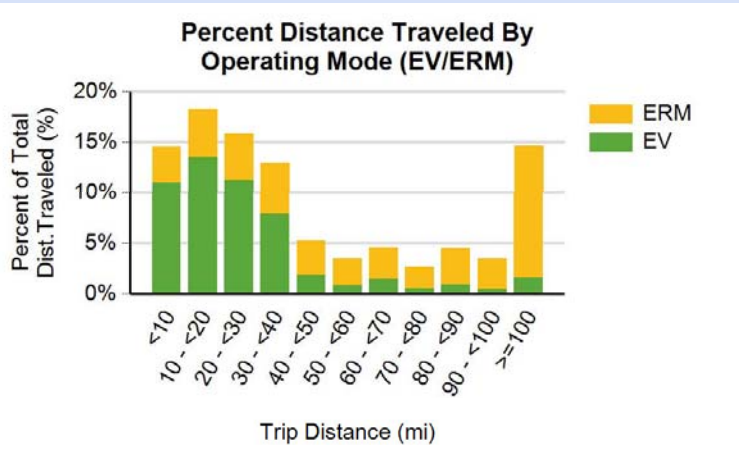
Chevrolet Volt DOE ARRA Project

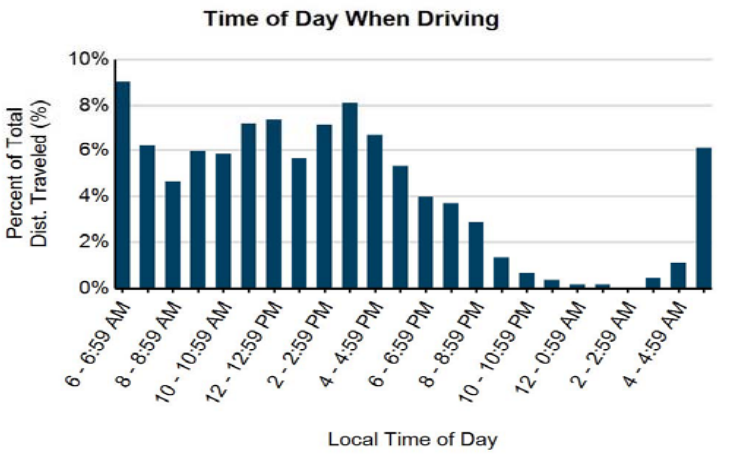
- 110 Volt 3rd quarter report
  - Average charging events per month 17
  - Average # charging events per vehicle day 1.3
  - Average miles per charging event 44 miles
  - Average trips between charging events 3.3
  - Average time connected per event 3.4 hours
  - Average energy per charge event 7.1 AC kWh
  - Average charging energy per vehicle month 119 AC kWh

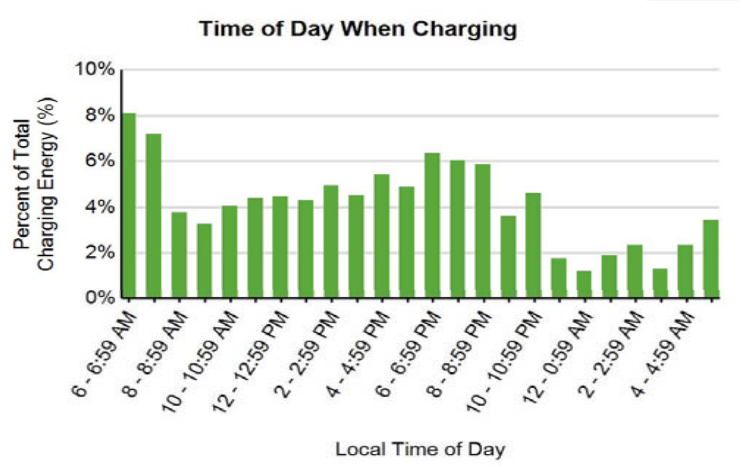
Chevrolet Volt DOE











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

Ford Escape Advanced Research Fleet

Number of vehicles: 21 | Date range of data received: 11/01/2009 to 10/31/2011

Reporting period: Nov 09 - Oct 11 | Number of vehicle days driven: 6,973

All Trips Combined

Overall gasoline fuel economy (mpg)	38
Overall AC electrical energy consumption (AC Wh/mi)[1]	101
Overall DC electrical energy consumption (DC Wh/mi)[2]	66
Total number of trips	31,451
Total distance traveled (mi)	394,564

Trips in Charge Depleting (CD) mode[3]

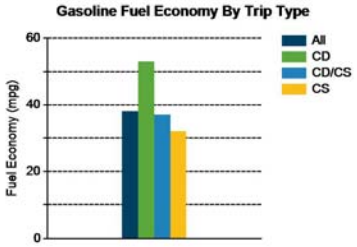
Gasoline fuel economy (mpg)	53
DC electrical energy consumption (DC Wh/mi)[4]	165
Number of trips	18,056
Percent of trips city | highway	100% | 0%
Distance traveled (mi)	106,042
Percent of total distance traveled	27%

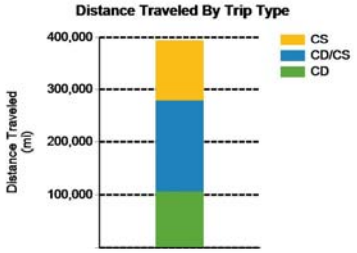
Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes[5]

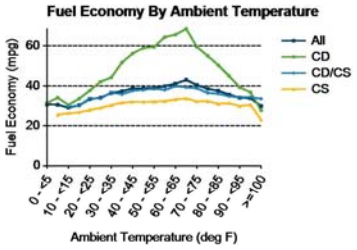
Gasoline fuel economy (mpg)	37
DC electrical energy consumption (DC Wh/mi)[6]	54
Number of trips	6,015
Percent of trips city | highway	0% | 100%
Distance traveled (mi)	172,376
Percent of total distance traveled	44%

Trips in Charge Sustaining (CS) mode[7]

Gasoline fuel economy (mpg)	32
Number of trips	7,371
Percent of trips city | highway	100% | 0%
Distance traveled (mi)	116,146
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

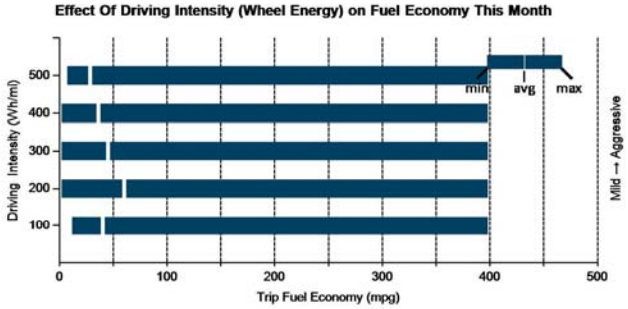
- 21 Ford Escape PHEVs
- 395,000 test miles and 31,000 trips
- All trips, 38 mpg, 101 AC Wh/mi & 66 DC Wh/mi
- Charge Depleting (CD), 53 mpg & 165 DC Wh/mi
- Charge Sustaining (CS), 32 mpg
- Plugging in = 66% increase in overall MPG when comparing CD to CS trips

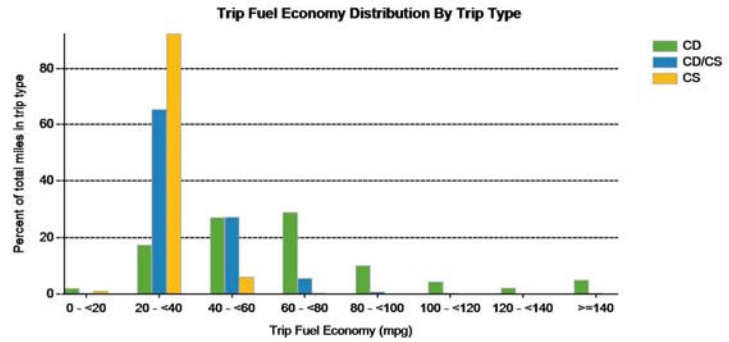
VEHICLE TECHNOLOGIES PROGRAM

Trips in Charge Depleting (CD) mode	City	Highway
Gasoline fuel economy (mpg)	49	58
DC electrical energy consumption (DC Wh/mi)	166	164
Percent of miles with internal combustion engine off	38%	12%
Average trip driving intensity (Wh/mi)	269	306
Average trip distance (mi)	4	18

Trips in Charge Depleting and Charge Sustaining (CD/CS) mode		
Gasoline fuel economy (mpg)	43	36
DC electrical energy consumption (DC Wh/mi)	75	51
Percent of miles with internal combustion engine off	30%	5%
Average trip driving intensity (Wh/mi)	279	326
Average trip distance (mi)	9	40

Trips in Charge Sustaining (CS) mode		
Gasoline fuel economy (mpg)	30	32
Percent of miles with internal combustion engine off	23%	4%
Average trip driving intensity (Wh/mi)	266	321
Average trip distance (mi)	4	38



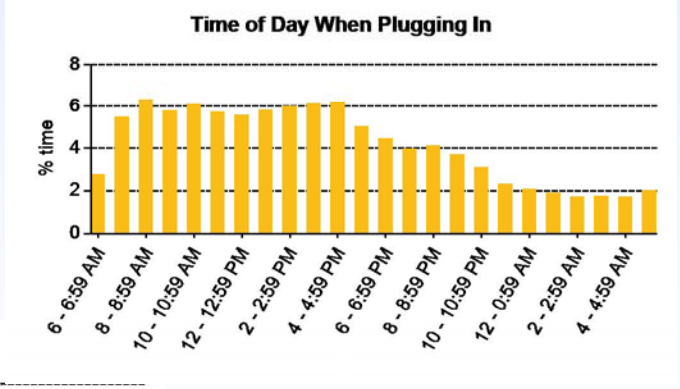


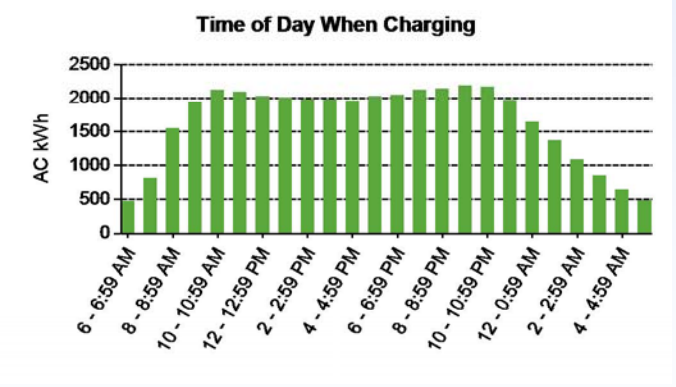
Ford Escape Adv. Research Vehicle

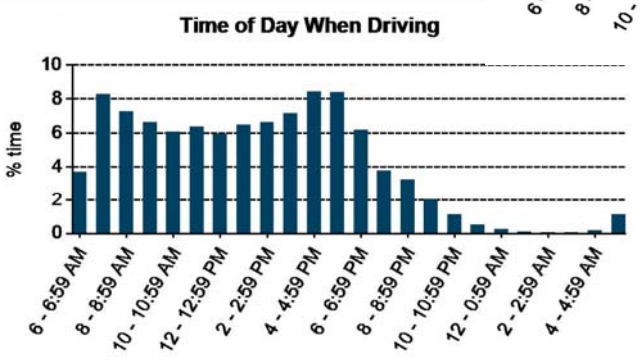
- CD city, 49 mpg, 166 DC Wh/mi
- CD highway, 58 mpg, 164 DC Wh/mi
- CS city, 30 mpg
- CS highway, 32 mpg
- Plugging in = 63% increase in city MPG and 81% increase in highway MPG (compare CD to CS)
- City - 38% CD and 23% CS miles engine off
- Highway - 12% CD and 4% CS miles engine off

Ford Escape Advanced Research Vehicle

- **18.9 miles per charge event**
- **1.5 trips per charge event**
- **3.0 charge events per vehicle day**
- **6.1 average hours plugged in per charge**
- **1.4 average hours drawing power per charge event**
- **1.9 kWh average energy per charge event**
- **44 average charge events / vehicle / month when driven**







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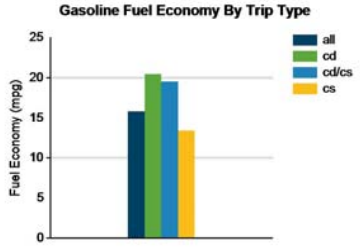

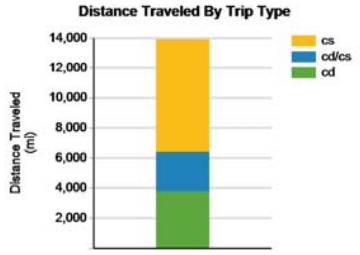

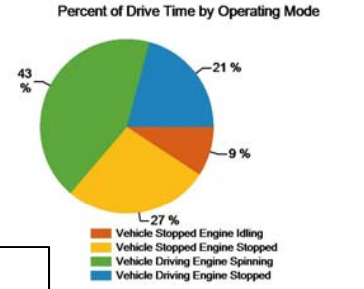

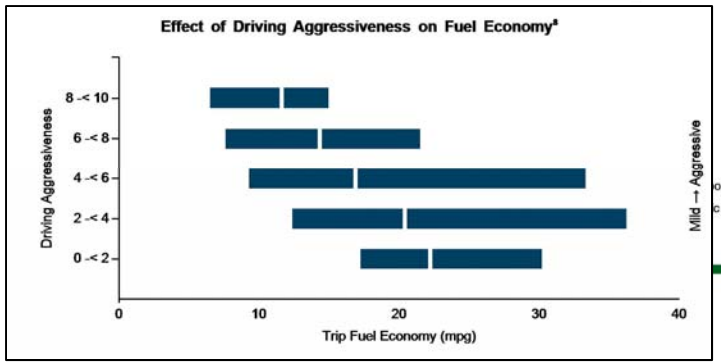

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Chrysler Ram PHEV Project

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- All trips, 18 mpg, 115 AC Wh/mi & 69 DC Wh/mi
- CD, 23 mpg & 248 DC Wh/mi
- CS, 17 mpg
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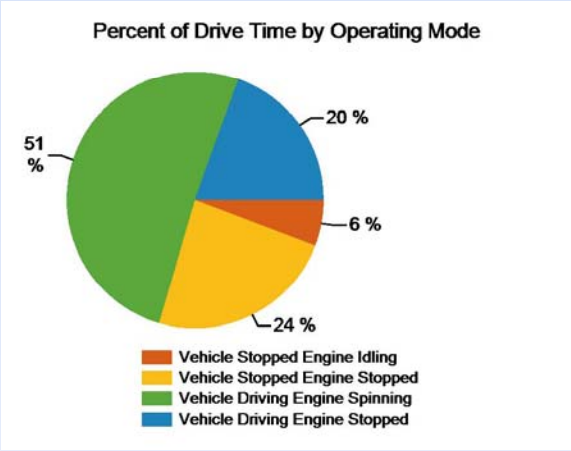
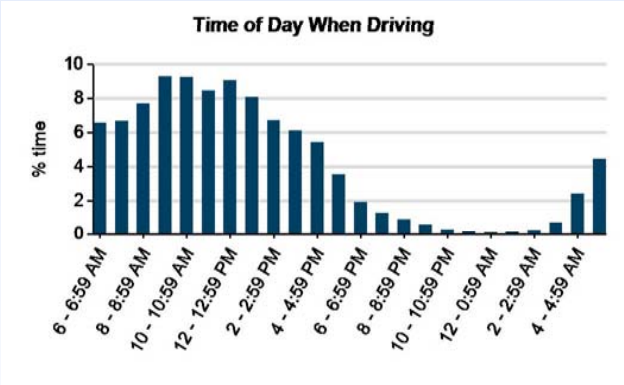
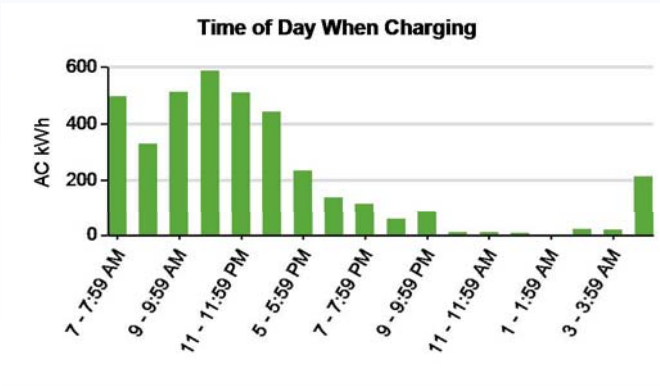
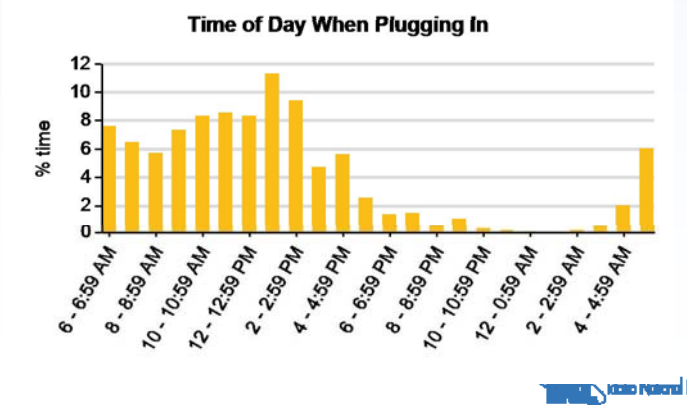
Chrysler Ram PHEV Pickups





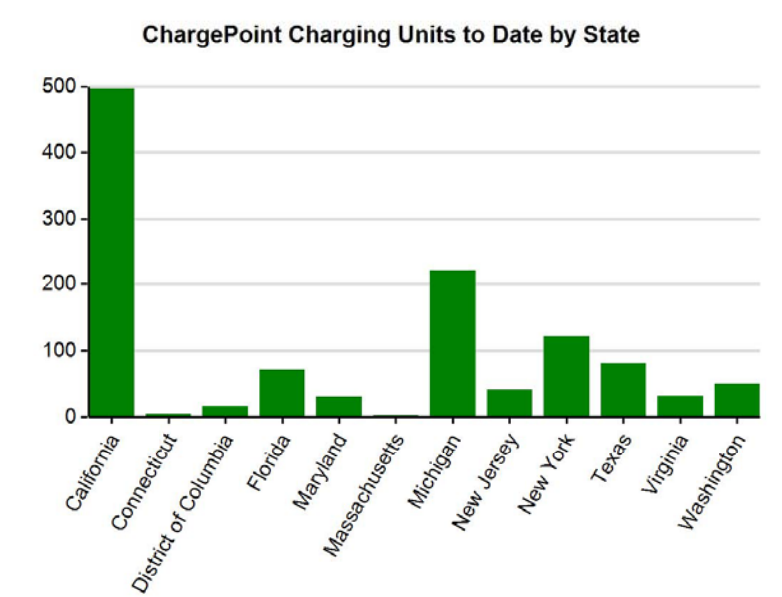
- 44% of Ram driving and stopped time, gas engine is stopped
- 54.4 miles per charge event
- 8.5 trips per charge event
- 0.64 charge events per vehicle day
- 1.9 average hours per charge event
- 6.3 kWh average energy / charge
- 240 L1 and 1,029 L2 charge events
- 14% at L1 & 86% at L2 total energy
- 29.8 hrs at L1 & 2.3 hrs at L2 to charge from 20% to 100% SOC

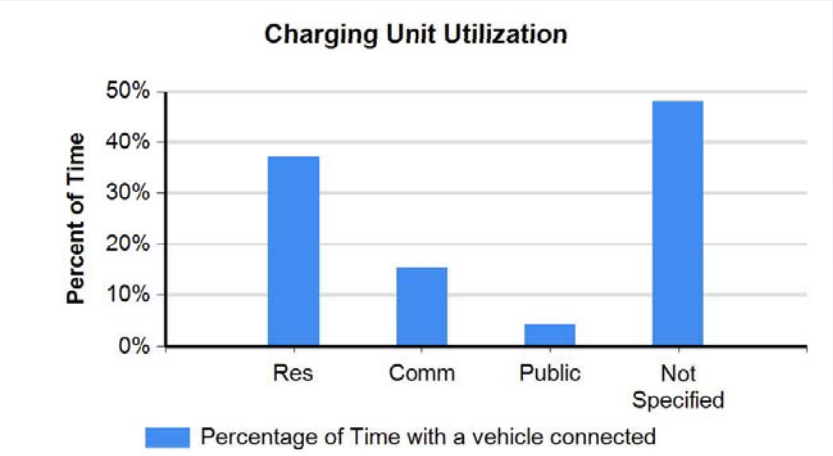




ChargePoint America (Coulomb) Project

- 893 EVSE installed (May – August 2011)
- 39,000 charge events
- 237 AC MWh consumed
- 444 Residential, 37% of time a vehicle is connected
- 83 Private commercial, 15% of time a vehicle is connected
- 365 Public, 4% of time a vehicle is connected
- 1 Not specified, 48% of time a vehicle is connected





U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

North American PHEV Demonstration

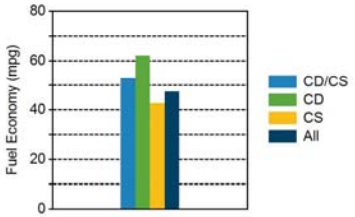
Vehicle Technologies Program

Fleet Summary Report: Hymotion Prius (V2Green data logger)
Number of vehicles: 184
Reporting Period: Apr 08 - May 11

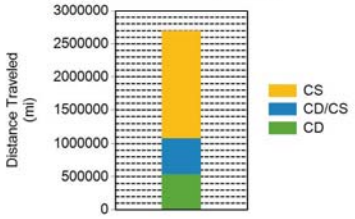
Date range of data received:
4/18/2008 to 5/31/2011
Number of days the vehicles were driven: 1132

All Trips Combined	
Overall gasoline fuel economy (mpg)	47
Overall AC electrical energy consumption (AC Wh/mi) [1]	53
Overall DC electrical energy consumption (DC Wh/mi) [2]	38
Total number of trips	287,310
Total distance traveled (mi)	2,691,319
Trips in Charge Depleting (CD) mode [3]	
Gasoline fuel economy (mpg)	62
DC electrical energy consumption (DC Wh/mi) [4]	142
Number of trips	116,236
Percent of trips city / highway	87% / 13%
Distance traveled (mi)	534,289
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	20,745
Percent of trips city / highway	47% / 53%
Distance traveled (mi)	541,395
Percent of total distance traveled	20%
Trips in Charge Sustaining (CS) mode [7]	
Gasoline fuel economy (mpg)	43
Number of trips	150,320
Percent of trips city / highway	77% / 23%
Distance traveled (mi)	1,619,064
Percent of total distance traveled	60%
Number of trips when the plug-in battery pack was turned off by the vehicle operator [8]	12479
Distance traveled with plug-in battery pack turned off by the vehicle operator (mi) [9]	274,084

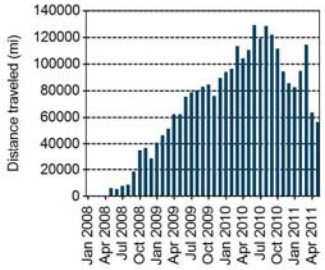
Gasoline Fuel Economy By Trip Type



Distance Traveled By Trip Type



Miles Logged by Month This Year



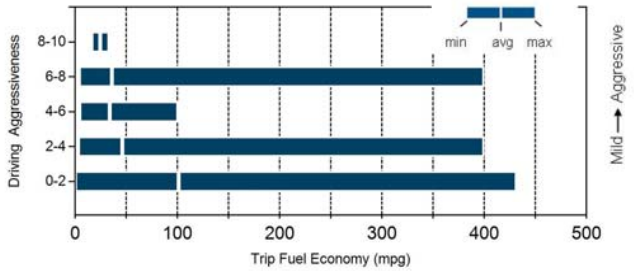
Notes: 1 - 9. Please see http://avt.inl.gov/pdf/phev/ReportNotes.pdf for an explanation of all PHEV Fleet Testing Report notes.

Hymotion Prius PHEV Conversion

- 3.3 million total 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
- Only 20% miles in CD trips
- 60% miles in CS trips

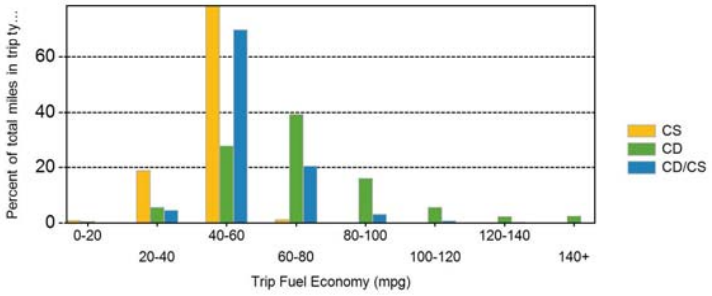
Trips in Charge Depleting (CD) mode	City	Highway
Gasoline fuel economy (mpg)	60	66
DC electrical energy consumption (DC Wh/mi)	165	109
Percent of miles with internal combustion engine off	32%	15%
Average trip aggressiveness (on scale 0 - 10)	1.8	1.8
Average trip distance (mi)	3.0	15.1
Trips in both Charge 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



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 trips 37% miles with engine off
- CS trips 30% miles with engine off

Ongoing INL Data Collection Projects

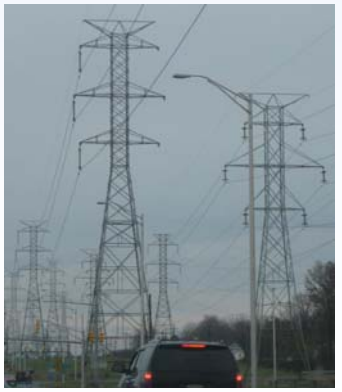
- 20 Lithium PHEV Escape Quantum conversions – same format as Ford Escapes
- Development of vehicle-based battery test-bed mule for testing emerging battery technologies
- Conducting mass impacts on fuel efficiency for HEV, ICEV and BEV technologies
- Developing fast charge study
  - Comparison of Fast versus Level 2 charging impacts on battery life in six-vehicle fleet and laboratory tests

Ongoing INL Data Collection Projects

- **Initiated wireless and conductive charging infrastructure testing projects**
  - **Wireless EVSE energy efficiencies will be benchmarked**
  - **Cyber security testing of EVSE is being initiated**
  - **Five conductive Level 2 EVSE recently benchmarked and reports are being prepared**
    - **EVSE AC W consumption pre, post, and during charge**
    - **Efficiency during steady state charge**
    - **Unit specifications and features**







Federal Fleet Data Collection Projects

- **Five USPS electric long life vehicles (ELLV) conversions track, dynamometer, and fleet testing (with data loggers)**
  - **Stop & Go Trips (>5 stops/mile)**
    - **467 DC Wh/mi**
    - **0.2 mile average trip distance**
    - **5.3 mph average speed**
    - **32.2 average stops per mile**
    - **15% regenerative braking energy recovery**
  - **All trips 1.43 AC / DC Wh/mi ratio = 668 AC Wh/mi for above Stop & Go Trips**

Summary – Based on Early Data

- **Leafs: 31 miles per day, 30 miles per charge, 1 charge per vehicle day, 4.3 trips per charge, and 7.5 kWh per charge**
- **Most residential L2 EV Project charging occurs off-peak**
- **EV Project vehicles connected 5X's longer than needed to recharge - opportunities to shift charging times**
- **San Diego: significant charge-starts occur at the midnight start of super off-peak kWh rates**
- **EV Project – accumulating ½ million test miles per week**
- **1% of 2009 generation would charge 20 million PEVs (U.S. Min/Max average daily demand delta is 44%)**
- **Today's grid-connected electric drive technologies result in 35% to 100% reductions in petroleum use**
- **EV Project plan did not include an earthquake, tsunami, fires, or reductions in economic activity and vehicle sales**
- **INL needs to collect data before reporting it**

Acknowledgement

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More Information

http://avt.inl.gov

INL/CON-11-24174