



ELECTRIC DRIVE VEHICLE DEMONSTRATION AND VEHICLE INFRASTRUCTURE EVALUATION

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Electric Transportation Engineering Corp.

MAY 16, 2013

ARRAVT066

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OVERVIEW

TIMELINE

Project Start; 1 Oct 2009
Project End; 31 Dec 2013
Percent Complete; 83%

BUDGET

Total Project; \$225,403,708
DOE Share; \$100,196,560
Contractor; \$110,503,708
ORNL FWP; \$ 6,800,000
INL FWP; \$ 7,803,440

BARRIERS

Slow Deployment of Vehicles
Permitting Requirements
Utility Demand Charges

PARTNERS

Nissan North America
General Motors/OnStar
Thousands of PEV drivers & hosts
10 Electric Utilities
2 Universities

OBJECTIVES

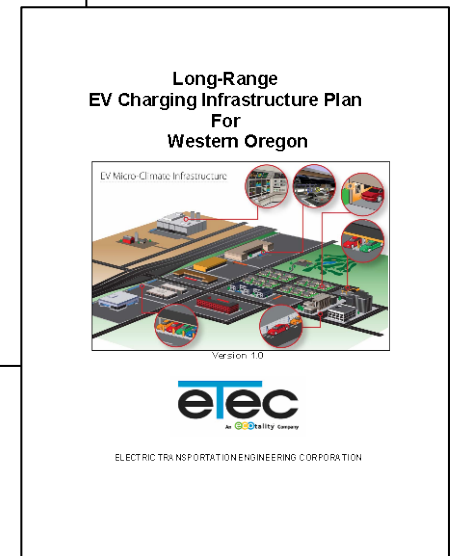
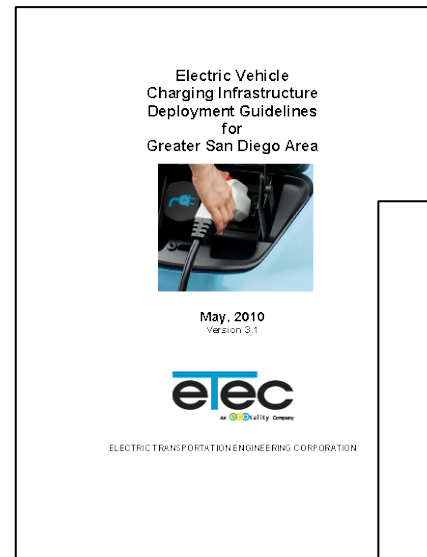
- ▣ Establish mature charge infrastructures in diverse geographies
- ▣ Deploy grid-connected vehicles to utilize infrastructure
- ▣ Collect data characterizing infrastructure & vehicle utilization
- ▣ Evaluate means to improve infrastructure effectiveness
- ▣ Evaluate means to increase vehicle utilization
- ▣ Identify and resolve barriers to infrastructure deployment
- ▣ Develop models to support future infrastructure deployment

MILESTONES

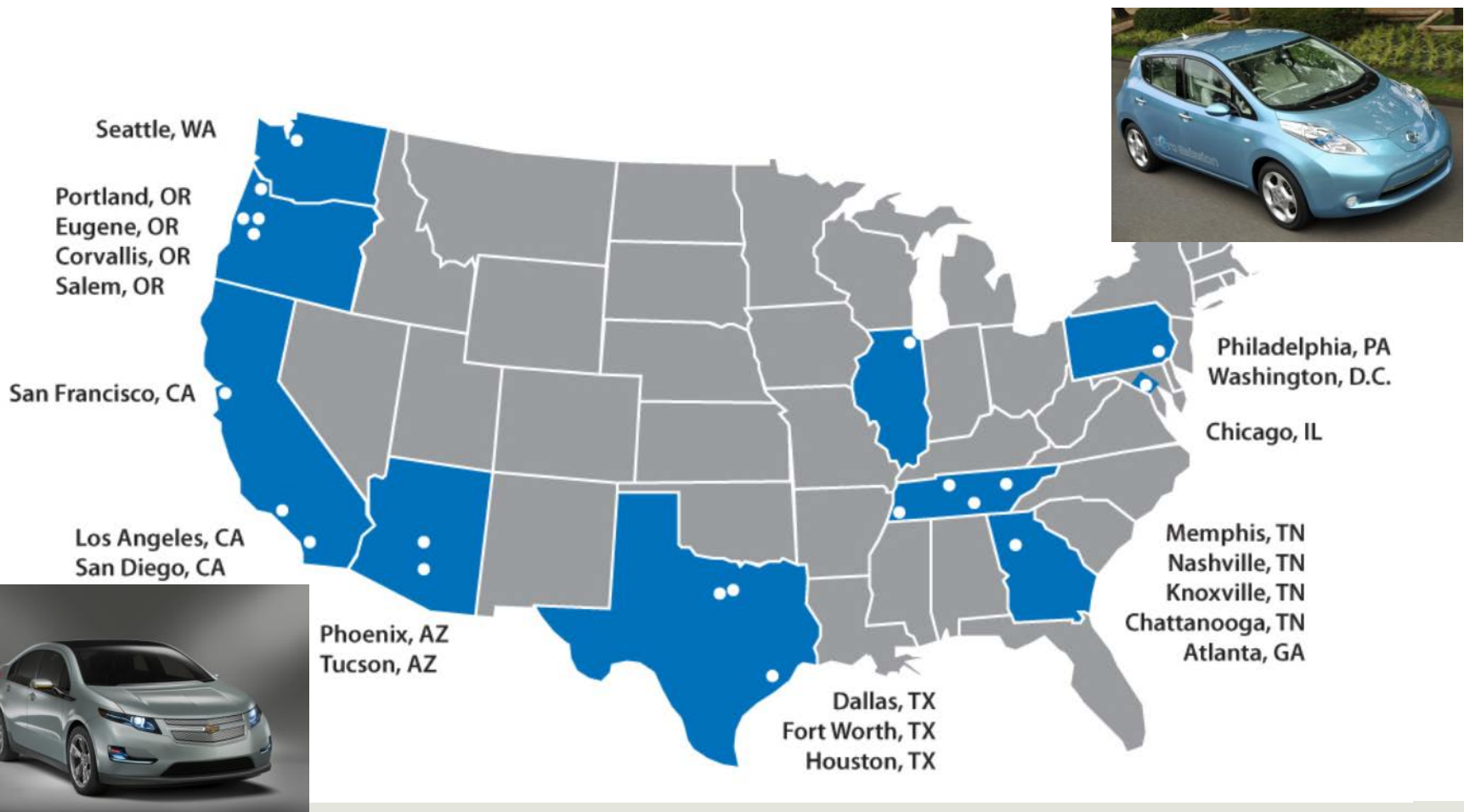
- ▣ Project initiation 10/01/09 (complete)
- ▣ Complete EV Micro-Climate Plans 08/30/10 (complete)
- ▣ Initial residential infrastructure 12/01/10 (complete)
- ▣ Initial vehicle deliveries 12/01/10 (complete)
- ▣ Initial commercial infrastructure 06/06/11 (complete)
- ▣ Initial DC fast charge infrastructure 10/24/11 (complete)
- ▣ Residential I/S deployment complete 04/30/13
- ▣ Commercial I/S deployment complete 09/30/13
- ▣ Data collection complete 12/31/13

INFRASTRUCTURE PLANNING

- Organize regional stakeholders
 - Government
 - Utilities
 - Employers
- Develop long-range Plan
 - Deployment area
 - Vehicle penetration
 - Infrastructure requirements
- Develop EV Micro-Climate
 - Initial deployment



INFRASTRUCTURE DEPLOYMENT



INFRASTRUCTURE DEPLOYMENT

- ▣ **Develop mature infrastructures**
 - ▣ Install residential EVSE for Leaf & Volt Vehicles
 - ▣ Install level 2 commercial EVSE
 - ▣ Install DC fast charge in cities and on transportations routes

- ▣ **Utilize Certified Contractor Network**
 - ▣ Develop permitting and installation experience
 - ▣ Create jobs



DATA COLLECTION

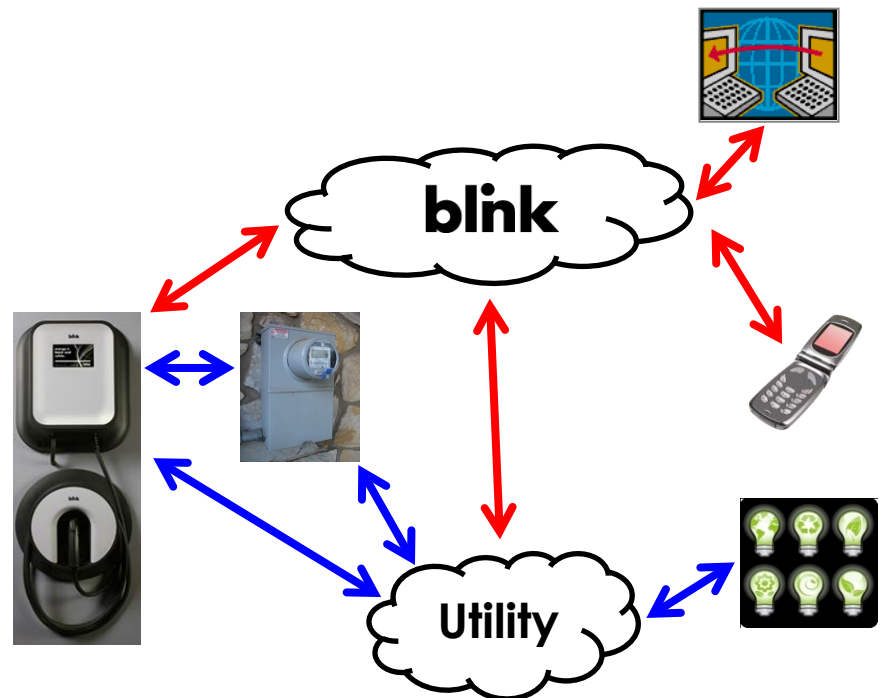
- ▣ **Collect vehicle data using vehicle telematics system**
 - ▣ **Vehicle Data Set at each “Key Event”**
 - ▣ Vehicle Identification
 - ▣ Time & Date
 - ▣ Odometer
 - ▣ Location (GPS Coordinates)
 - ▣ Indicated Battery State-of-Charge

DATA COLLECTION

- **Collect EVSE charge data using cellular/internet based network**
 - Unique ID Identifying the EVSE unit
 - Unique ID for Charging Event
 - Connect and Disconnect Times
 - Start and End Charge Times
 - Maximum Instantaneous Peak Power
 - Total energy (kWh) per charging event
 - Rolling 15-Minute Average Power
- **All data merged and stored at INL for analysis**

SMART GRID INTEGRATION

- ▣ Smart Grid studies
 - ▣ TOU rate effectiveness
 - ▣ Off peak price elasticity
 - ▣ Distribution transformer loading
 - ▣ Sub-meter vs. Utility Meter
 - ▣ Utilize communication strategies to alter EVSE operation – Demand Response demonstration



HARDWARE DEPLOYMENT

- ▣ **7,871 Level 2 residential EVSE installed concurrent with vehicle sales as of 03/15/13**
 - ▣ **5,775 Leaf**
 - ▣ **1,996 Volt**
- ▣ **3,481 Level 2 commercial EVSE installed as of 03/15/12**
 - ▣ **1,340 sites**
- ▣ **73 DC fast chargers installed as of 03/15/13**



NETWORK IMPLEMENTATION

- ▣ **Communications Network Established**
 - ▣ Internet residential network
 - ▣ M2M cellular commercial network
- ▣ **Web portals established**
 - ▣ Residential vehicle owner
 - ▣ Charging Site Host
 - ▣ Electric utility
- ▣ **Mobile application established**
 - ▣ SMS notifications
 - ▣ Charger location mapping



MAPPING IMPLEMENTATION

blink Why Blink Changers Network Mobile BlinkMap Membership Search

Total Chargers: 3160 Link API Access

User Login

Legend Layers Filters Map Satellite

Search

Charging Locations (9)

1. **McDonald's #2637 - Mahogany Way - Antioch CA**
2424 Mahogany Way
Antioch, CA 94509
2. **McDonald's #12565 - Main Street - Oakley CA**
914 Main Street
Oakley, CA 94561
3. **McDonald's #16318 - Bailey Rd - Bay Point CA**
220 Bailey Road
Bay Point, CA 94565
4. **McDonald's #24982 - Contra Costa Blvd - Pleasant Hill CA**
1690 Contra Costa Blvd.
Pleasant Hill, CA 94523
5. **McDonald's #23782 - Deer Valley Rd - Antioch CA**
3450 Deer Valley Road
Antioch, CA 94509
6. **McDonald's #19235 - Lone Tree Way - Antioch CA**
4440 Lone Tree Way
Antioch, CA 94509
7. **McDonald's #26922 - Balfour Rd - Brentwood CA**
2351 Balfour Rd
Brentwood, CA 94513
8. **Concord Hilton**
1970 Diamond Blvd.
Concord, CA 94520
9. **McDonald's #1353 - Clayton Rd. - Concord CA**
4550 Clayton Road
Concord, CA 94521

McDonald's #16318 - Bailey Rd - Bay Point CA
220 Bailey Road
Bay Point, CA 94565

Level 2 Chargers
2 Ready / 1 Busy / 0 Unavailable
Blink Plus: \$1.00 per 1 hour
Blink Basic: \$1.50 per 1 hour
Blink Guest: \$2.00 per 1 hour

Map data ©2013 Google - Terms of Use Report a map error

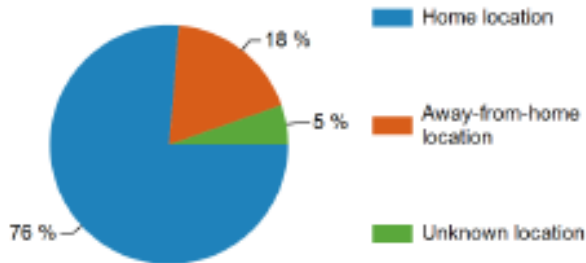
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DATA COLLECTION (12/31/12)

- ▣ Vehicle data
 - ▣ 68 million miles
 - ▣ Distance between charges (Q4)
 - ▣ Volt 28.2 miles
 - ▣ Leaf 26.3 miles

Frequency of Charging by Charging Location



EV Project Overview Report

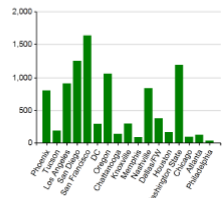
Project to date through December 2012

Charging Infrastructure

Region*	Number of EV Project Charging Units Installed To Date	Number of Charging Sites Permitted	Electricity Consumed (kWh)
Phoenix, AZ Metropolitan Area	805	115,241	84,362
Tucson, AZ Metropolitan Area	192	29,534	206,49
Los Angeles, CA Metropolitan Area	915	144,605	1,234,79
San Diego, CA Metropolitan Area	1,259	307,768	2,747,30
San Francisco, CA Metropolitan Area	1,535	357,471	3,421,99
Washington, D.C. Metropolitan Area	256	47,314	303,91
Orlando	1,065	190,005	1,407,54
Charlotte, TN Metropolitan Area	141	18,424	151,47
Knoxville, TN Metropolitan Area	296	34,947	297,91
Memphis, TN Metropolitan Area	94	14,410	110,51
Nashville, TN Metropolitan Area	840	133,645	1,117,49
Dallas/Ft. Worth, TX Metropolitan Area	377	39,571	299,88
Houston, TX Metropolitan Area	170	29,910	195,90
Washington State	1,200	210,343	2,145,72
Chicago, IL Metropolitan Area	91	5,897	36,49
Atlanta, GA Metropolitan Area	138	5,026	40,31
Philadelphia, PA Metropolitan Area	37	1,971	13,57
Total	9,546	1,726,832	14,461,55



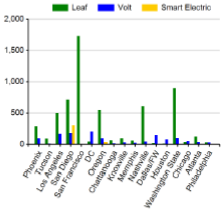
Charging Unit Installation to Date by Region



Vehicles

Region*	EV Project Nissan Leaf Enrolled To Date*	EV Project Chevrolet Volt Enrolled To Date*	EV Project Smart Electric Drive Enrolled To Date*	Distance Driven (mi)
Phoenix, AZ Metropolitan Area	285	92	—	3,755,236
Tucson, AZ Metropolitan Area	86	7	—	963,036
Los Angeles, CA Metropolitan Area	497	165	—	5,392,618
San Diego, CA Metropolitan Area	711	176	300	10,693,987
San Francisco, CA Metropolitan Area	1,730	—	—	14,811,493
Washington, D.C. Metropolitan Area	38	198	—	1,842,936
Orlando	549	94	30	5,929,677
Charlotte, TN Metropolitan Area	61	11	—	413,119
Knoxville, TN Metropolitan Area	93	24	—	1,229,962
Memphis, TN Metropolitan Area	54	22	—	453,532
Nashville, TN Metropolitan Area	606	40	—	4,576,940
Dallas/Ft. Worth, TX Metropolitan Area	18	146	—	1,476,969
Houston, TX Metropolitan Area	5	74	—	933,736
Washington State	893	98	—	8,419,419
Chicago, IL Metropolitan Area	29	47	—	210,772
Atlanta, GA Metropolitan Area	120	28	—	264,476
Philadelphia, PA Metropolitan Area	23	27	—	121,916
Total	57,97	1,249	330	61,204,462

Vehicle Enrollment to Date by Region



Note: EV Project charging data may be used by other participants in the EV Project. Likewise, EV Project data may be used by other EV Project participants. Therefore, EV Project data may be used by other EV Project participants. EV Project data may be used by other EV Project participants. EV Project data may be used by other EV Project participants.

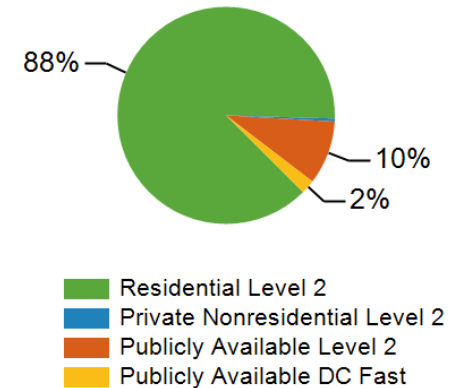
* Region*: Oregon region includes the Greater Corvallis, Eugene, Portland, and Salem Metropolitan Areas.
Washington region includes the Greater Seattle and Olympia Metropolitan Areas.

* Vehicle enrollment numbers are based on EV Project data. Numbers do not reflect total regional or national sales or production.

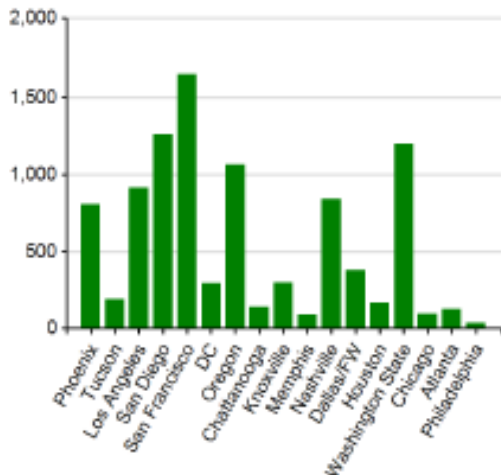
DATA COLLECTION (12/31/12)

- ▣ Charge data
 - ▣ Over 1,600,000 charge events
 - ▣ 14.1 GWh of electrical energy consumed

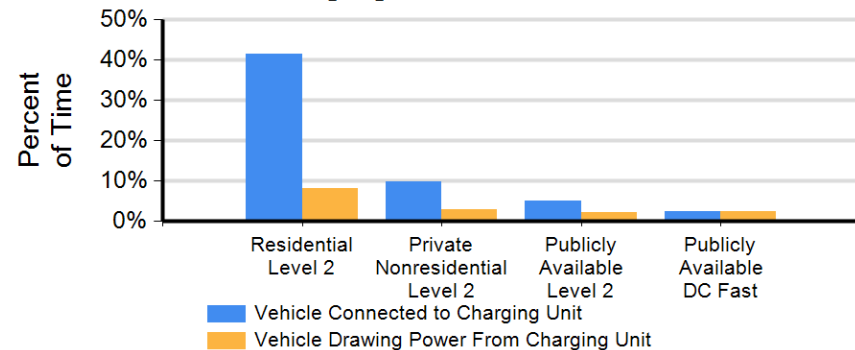
Number of Charge Events



Charging Unit Installation to Date by Region



Charging Unit Utilization



EVSE ACCESS FEES

- Introduced across network of publicly accessible chargers in August 2012
- Time-based fees
- Encourage the widespread use of commercial EVSE
- Demonstrate value to charger hosts
- Evaluate business model sustainability



BARRIER IDENTIFICATION

- ▣ ADA requirements
- ▣ Charge station signage
- ▣ Installation costs
- ▣ Utility demand charges
- ▣ Residential metering
- ▣ Cluster overloading
- ▣ Fast charge connector standard



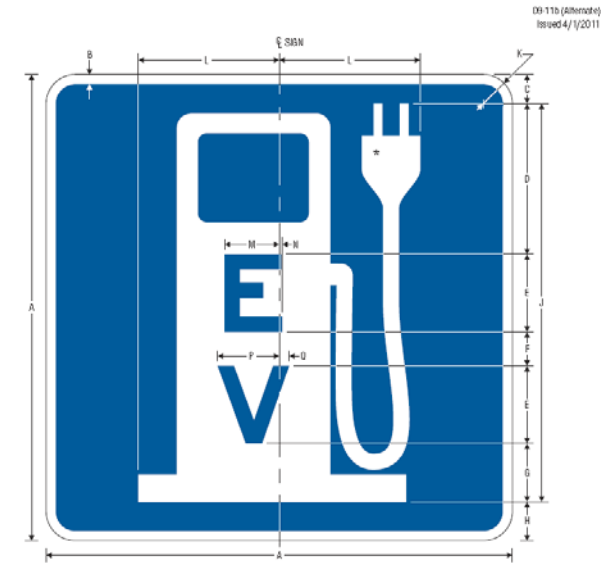
SMART GRID EVALUATION

- ▣ Collaboration with San Diego Gas & Electric
 - ▣ Sub-meter vs. Utility Meter
 - ▣ Impact of EV Charging on Distribution Infrastructure
 - ▣ Utilize communication strategies to alter EVSE operation – Demand Response demonstration



SIGNAGE

- Coordinate efforts with OR & WA State DOTs and FHWA
- Signage white paper posted
- Enforcement still a barrier to ICE-ing



D9-11b (All verticals)
Electric Vehicle Charging (Alternative Symbol)

	A	B	C	D	E	F	G	H	J	K	L	M
24	24	0.5	1.5	7.75	4 E(m)	1.75	3	2	20.5	1.5	7.25	2.814
30	30	0.75	1.875	9.625	5 E(m)	2	4	2.5	25.625	1.875	9.063	3.518

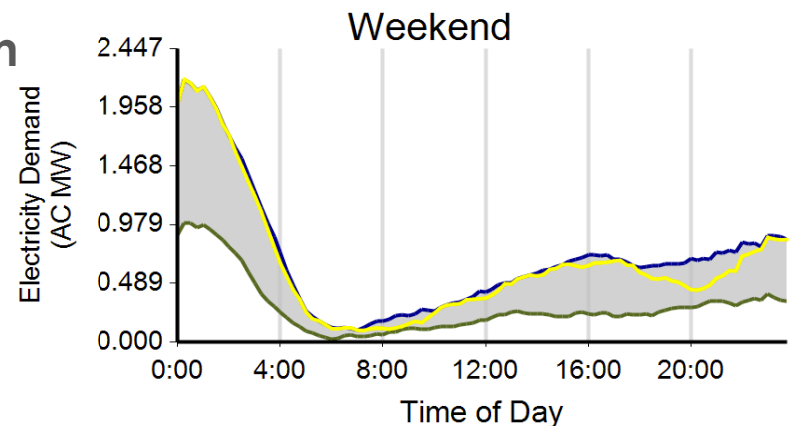
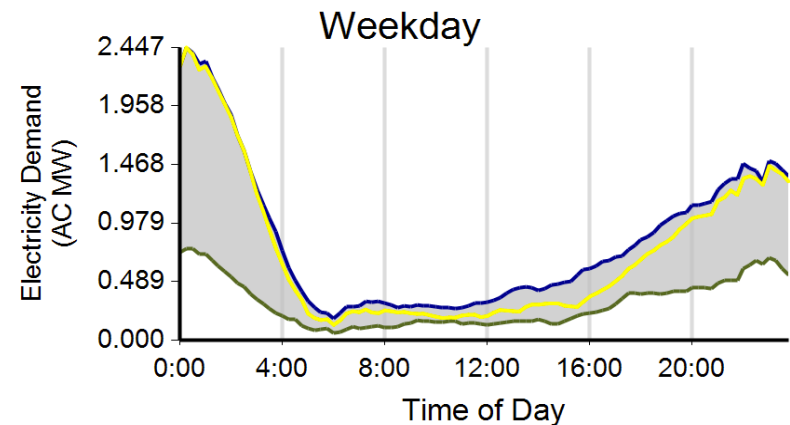
	N	P	Q
24	0.148	3.174	0.507
30	0.185	3.968	0.635

* See page IA-13.2 for symbol design

COLORS: LEGEND, BACKGROUND — BLUE (RETROREFLECTIVE)
SYMBOL, BORDER — WHITE (RETROREFLECTIVE)

DEMAND RESPONSE





- ▣ **Utility Data Generation**
 - ▣ Load Duration
 - ▣ Energy Use
 - ▣ EV Project Data
 - ▣ 10-Year Projections
- ▣ **Demand Response**
 - ▣ EVSE Control
 - ▣ User Transparency Evaluation
- ▣ **GIS Based Data**
 - ▣ Distribution Effects
 - ▣ Clustering



INFORMATION DISSEMINATION

- EV Project Information Dissemination Plan
- Posted on EV Project website at <http://theevproject.com/documents.php>

EV Micro-Climate Plans

-  [EV Micro-Climate Plan for Central Puget Sound & Olympia Areas, Washington \(October 2010\)](#)
-  [EV Micro-Climate Plan for Arizona \(November 2010\)](#)
-  [EV Micro-Climate Plan for Northwestern Oregon \(November 2010\)](#)
-  [EV Micro-Climate Plan for San Diego Region, California \(February 2011\)](#)

Lessons Learned Reports

-  [First Responder Training \(March 2011\)](#)
-  [Accessibility at Public EV Charging Locations \(October 2011\)](#)
-  [Battery Electric Vehicle Driving and Charging Behavior Observed Early in The EV Project \(April 2012\)](#)
-  [Signage \(April 2012\)](#)
-  [A First Look at the Impact of Electric Vehicle Charging on the Electric Grid in The EV Project \(May 2012\)](#)
-  [DC Fast Charge-Demand Charge Reduction \(May 2012\)](#)
-  [The EV Micro-Climate Planning Process \(May 2012\)](#)
-  [Greenhouse Gas \(GHG\) Avoidance and Fuel Cost Reduction \(June 2012\)](#)
-  [Regulatory Issues and Utility EV Rates \(March 2013\)](#)
-  [Electric Vehicle Public Charging - Time vs. Energy \(March 2013\)](#)

Presentations

-  [Technologies required to fully integrate electric vehicles and the smart grid \(June 2011\)](#)
-  [Clean Cities Webinar \(June 2012\)](#)
-  [Battery Power Conference \(September 2012\)](#)
-  [EUEC 2013 Session E8 \(January 2013\)](#)
-  [Information Dissemination Peer Review \(March 2013\)](#)

SUMMARY

- ▣ EV Project Hardware continues to be deployed
- ▣ Data Collection continues at a rate of 1,000,000 miles and 46,000 charge events per week
- ▣ Barriers Identified – Many Addressed
- ▣ Information Being Disseminated



TECHNICAL BACKUP SLIDES

ARRAVT066

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

EV Project Overview Report

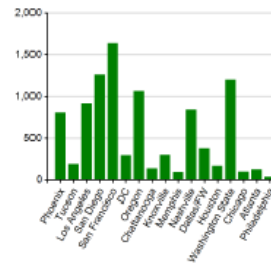
Project to date through December 2012



Charging Infrastructure

Region*	Number of EV Project Charging Units Installed To Date	Number of Charging Events Performed	Electricity Consumed (AC kWh)
Phoenix, AZ Metropolitan Area	305	115,241	843.62
Tucson, AZ Metropolitan Area	192	29,534	205.49
Los Angeles, CA Metropolitan Area	915	144,905	1,234.79
San Diego, CA Metropolitan Area	1,259	307,763	2,747.50
San Francisco, CA Metropolitan Area	1,636	357,471	3,421.99
Washington, D.C. Metropolitan Area	296	47,274	309.97
Oregon	1,056	180,005	1,407.54
Chattanooga, TN Metropolitan Area	141	18,424	151.47
Knoxville, TN Metropolitan Area	296	34,947	297.91
Memphis, TN Metropolitan Area	94	14,410	110.51
Kashville, TN Metropolitan Area	840	133,545	1,117.49
Dallas/Ft. Worth, TX Metropolitan Area	377	39,571	239.83
Houston, TX Metropolitan Area	170	20,910	136.90
Washington State	1,200	270,343	2,145.72
Chicago, IL Metropolitan Area	97	5,697	36.49
Atlanta, GA Metropolitan Area	128	5,026	40.31
Philadelphia, PA Metropolitan Area	37	1,971	13.97
Total	9,546	1,729,532	14,461.99

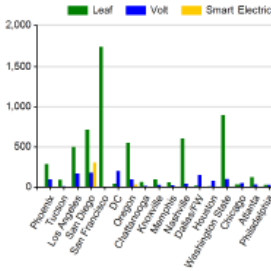
Charging Unit Installation to Date by Region



Vehicles

Region*	EV Project Nissan Leafs Enrolled to Date*	EV Project Chevrolet Volts Enrolled to Date*	EV Project Smart Electric Drivers Enrolled to Date*	Distance Driven (mi)
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Tucson, AZ Metropolitan Area	35	7	—	953,036
Los Angeles, CA Metropolitan Area	497	165	—	5,262,618
San Diego, CA Metropolitan Area	711	176	300	10,693,987
San Francisco, CA Metropolitan Area	1,730	—	—	14,817,493
Washington, D.C. Metropolitan Area	33	198	—	1,842,935
Oregon	549	94	30	5,609,617
Chattanooga, TN Metropolitan Area	61	11	—	613,119
Knoxville, TN Metropolitan Area	93	24	—	1,229,962
Memphis, TN Metropolitan Area	54	22	—	453,532
Kashville, TN Metropolitan Area	605	40	—	4,576,940
Dallas/Ft. Worth, TX Metropolitan Area	19	145	—	1,476,969
Houston, TX Metropolitan Area	5	74	—	503,736
Washington State	393	98	—	8,419,419
Chicago, IL Metropolitan Area	29	47	—	210,772
Atlanta, GA Metropolitan Area	120	28	—	264,476
Philadelphia, PA Metropolitan Area	23	27	—	121,316
Total	5,759	1,249	300	61,204,452

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 Coosville, Eugene, Portland, and Salem Metropolitan Areas
Washington region includes the Greater Seattle and Olympia Metropolitan Areas

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

Overview Report
Fourth Quarter-2012

EV Project Electric Vehicle Charging Infrastructure Summary Report

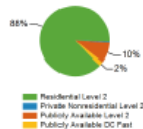


Region: ALL
Report period: October 2012 through December 2012
Number of EV Project vehicles in region: 4783

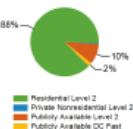
Charging Unit Usage

	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units*	4,819	78	1,988	54	6,939
Number of charging events [†]	341,828	1,699	36,990	8,089	388,606
Electricity consumed (AC MWh)	2,827.92	14.83	311.16	88.39	3,212.30
Percent of time with a vehicle connected to charging unit	42%	10%	5%	2%	31%
Percent of time with a vehicle drawing power from charging unit	8%	3%	2%	2%	6%

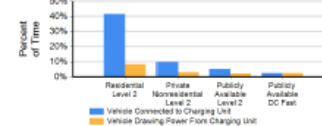
Number of Charge Events



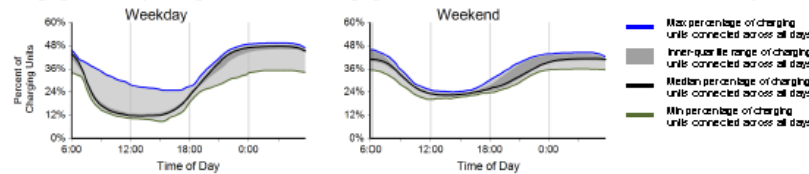
Electricity Consumed



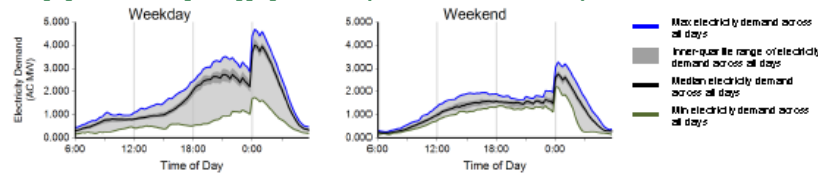
Charging Unit Utilization



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



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



* Includes all charging units that were in use by the end of the reporting period
[†] A charging event is defined as the period when a vehicle is connected to a charging unit, during which period some power is transferred
[‡] Considers the connection status of all charging units every minute
[§] Based on 15 minute rolling average power output from all charging units
 Note: throughout this report, weekdays are defined as the period from Monday 6:00 AM until Saturday 6:00 AM. The weekend is defined as the period from Saturday 6:00 AM until Monday 6:00 AM.

Charging Summary
Fourth Quarter-2012

LEAF

EV Project Nissan Leaf Vehicle Summary Report

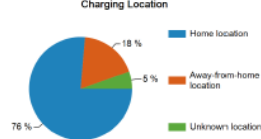


Region: ALL
 Number of vehicles: 3762
 Reporting period: October 2012 through December 2012

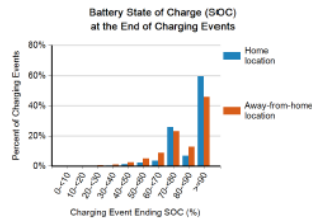
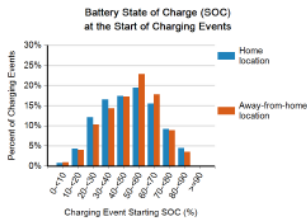
Vehicle Usage

Number of trips ¹	969,863
Total distance traveled (mi)	6,724,952
Avg trip distance (mi)	6.9
Avg distance traveled per day while the vehicle was driven (mi)	29.2
Avg number of trips between a charging event	3.8
Avg distance traveled between a charging event (mi)	26.3
Avg number of charging events per day while the vehicle was driven	1.1

Frequency of Charging by Charging Location



Charging Location and Type	Home charging locations ²	Away-from-home charging locations ³	Unknown charging locations ⁴
Number of charging events	195,303	46,749	13,741
Percent of all charging events	76%	18%	5%



1 A trip is defined as all the driving done between consecutive "key-on" and "key-off" events when some distance was traveled.
 2 Charging events at the "home charging location" refer to charging events performed at the location where the vehicle owner's home charging unit is installed.
 3 Charging events at "away-from-home charging locations" refer to charging events performed at any location other than the vehicle's "home charging location."
 4 Charging events at "unknown charging locations" were performed when the vehicle's location relative to its "home charging location" is not known, due to OBD data anomalies.

VOLT

EV Project Chevrolet Volt Vehicle Summary Report

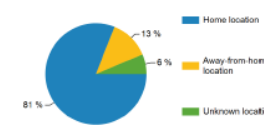


Region: ALL
 Number of vehicles: 1021
 Reporting period: October 2012 through December 2012

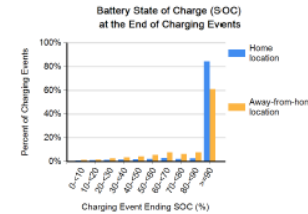
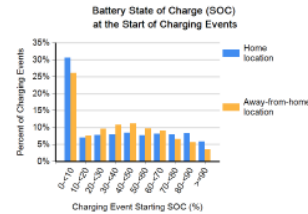
Vehicle Usage

Overall the location only (mi/gal)	1.26
Overall the electrical energy consumption (kWh/mi)	2.29
Number of trips ¹	369,118
Total distance traveled (mi)	3,001,976
Avg trip distance (mi)	8.1
Avg distance traveled per day while the vehicle was driven (mi)	40.5
Avg number of trips between a charging event	3.5
Avg distance traveled between a charging event (mi)	28.2
Avg number of charging events per day while the vehicle was driven	1.4

Frequency of Charging by Charging Location



Charging Location and Type	Home charging locations ²	Away-from-home charging locations ³	Unknown charging locations ⁴
Number of charging events	86,264	13,547	6,698
Percent of all charging events	81%	13%	6%



1 A trip is defined as all the driving done between consecutive "key-on" and "key-off" events when some distance was traveled.
 2 Charging events at the "home charging location" refer to charging events performed at the location where the vehicle owner's home charging unit is installed.
 3 Charging events at "away-from-home charging locations" refer to charging events performed at any location other than the vehicle's "home charging location."
 4 Charging events at "unknown charging locations" were performed when the vehicle's location relative to its "home charging location" is not known, due to OBD data anomalies.