Idaho National Laboratory

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

INL's ARRA / TADA Light-Duty Electric Drive Vehicle and Charging Infrastructure Data Collection Activities

Jim Francfort

DOE Review Meeting @ NREL
Golden, Colorado
June 9, 2011

This presentation does not contain any proprietary or sensitive information

Presentation Outline

- INL and AVTA (DOE) Participants and Goals
- Vehicle Testing Experience
- INL data handling experiences and methods
- ARRA and TADA data collection projects
- EV Project what is it about
- EV Project data collection parameters
- EV Project results to date
- Ford PHEV data collection results to date
- Other data collection activities

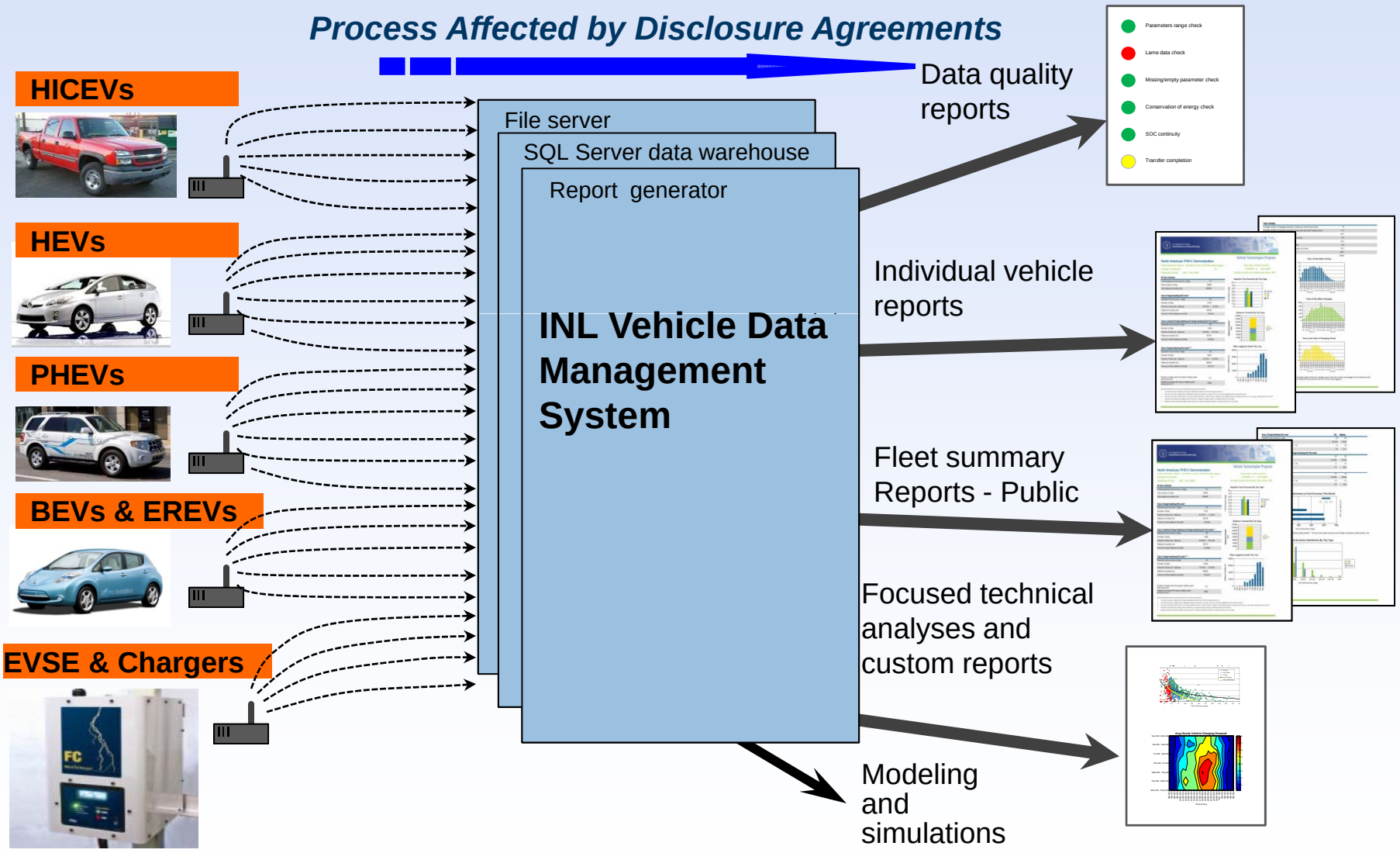
AVTA Participants and Goals

- **Participants**
  - **The Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program (EERE)**
  - **The Idaho National Laboratory (INL) conducts the AVTA per DOE guidance**
  - **100+ fleets and organizations as testing partners**
  - **Some of these testing activities are also conducted with ECOtality North American**
- **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 Testing Experience

- **Plug-in hybrid electric vehicles: 14 models, 430 PHEVs, 5 million test miles**
- **Extended Range Electric Vehicles: 1 model, 150 EREVs, 400,000 test miles**
- **Hybrid electric vehicles: 19 models, 50 HEVs, 6 million test miles**
- **Micro hybrid vehicles: 3 models, 7 MHVs, 200,000 test miles**
- **Neighborhood electric vehicles: 24 models, 372 NEVs, 200,000 test miles**
- **Battery electric vehicles: 47 models, 1,300 BEVs, 5 million test miles (includes 500+ USPS BEVs)**
- **Urban electric vehicles: 3 models, 460 UEVs, 1 million test miles**
- **18 million test miles accumulated on 2,300 electric drive vehicles representing 110 models**

INL Vehicle Data Management Process



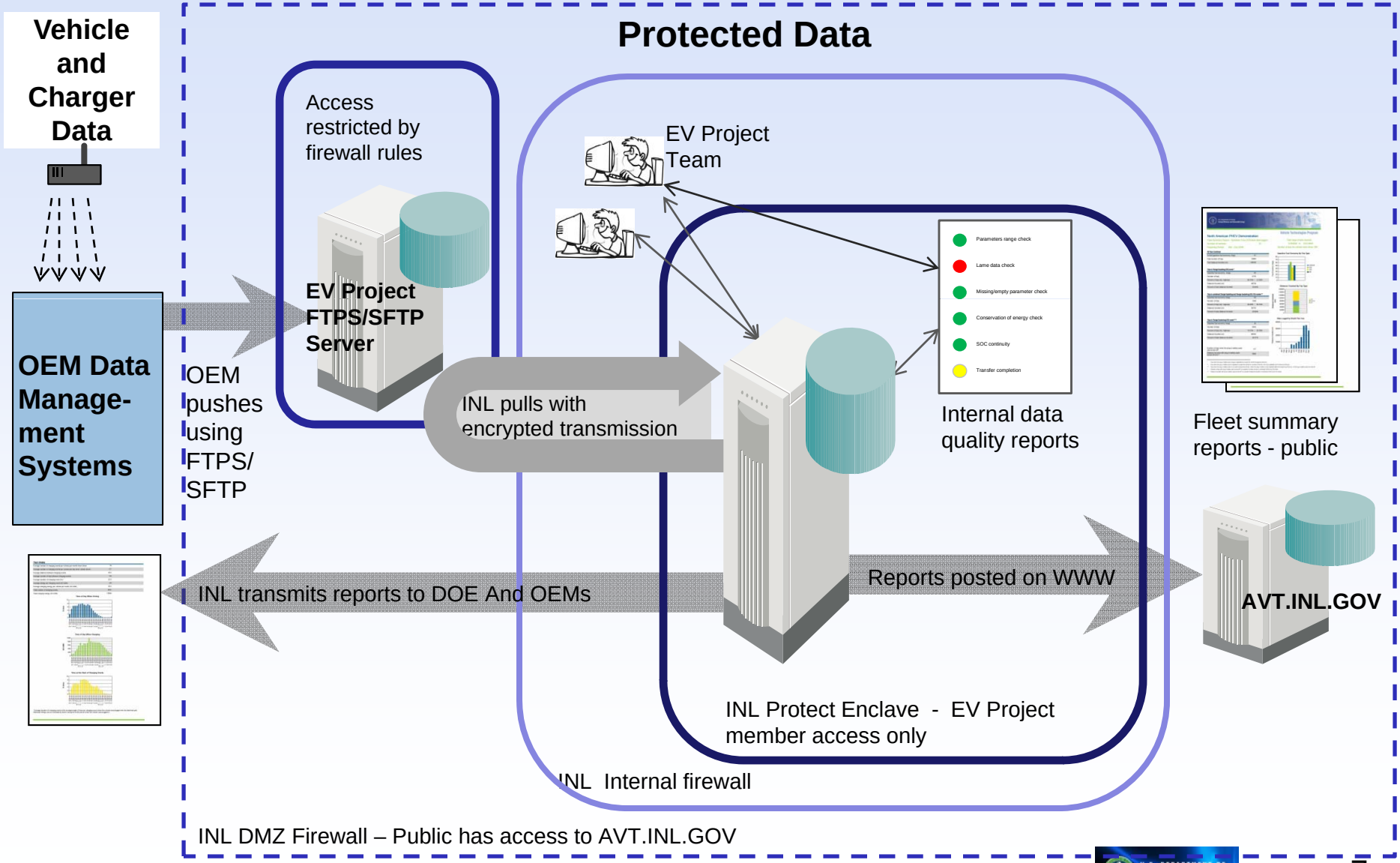
Vehicle and Infrastructure Data Sources

Vehicle time-history data (second-by-second)	HEV: 12 vehicle models, 1 data logger
	HICE: 1 vehicle model, 1 data logger
	Conversion PHEVs: 8 vehicle models, 3 data loggers
	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

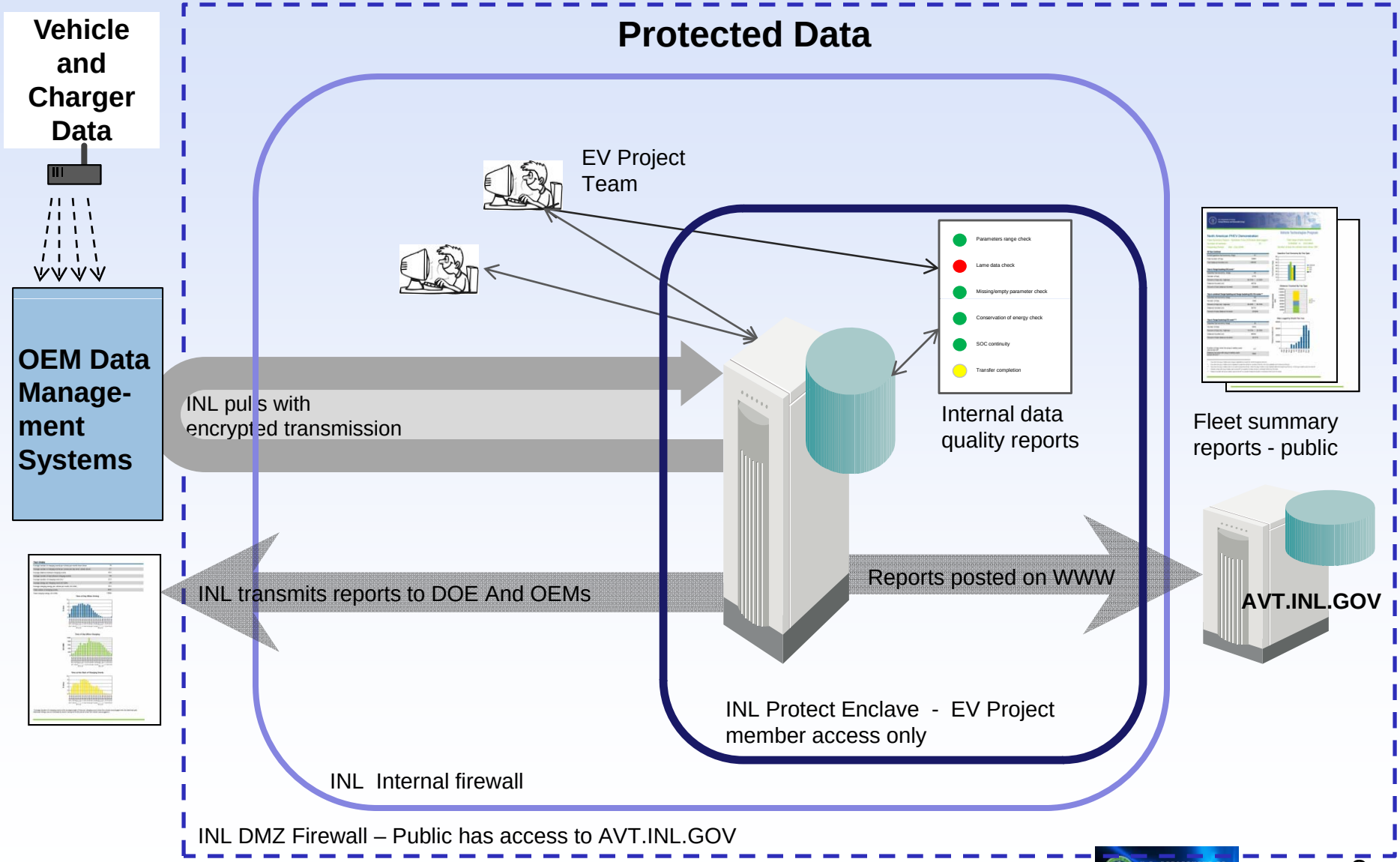
INL Data Management System - Push

(Nissan, GM, Chrysler, Coulomb)



INL Data Management System - Pull

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



Data Collection: Harder Than You'd Think…..

- Field data collection and processing is deceivingly complex due to remoteness and the many technical, environmental and human variables
  - 60 mpg PHEV in charge depleting mode and 130 mpg in charge sustaining mode - 6,000 foot mountain
  - 84 hour trips - So quiet, does it shut itself off?
  - <-10 to >140 degrees F
  - Internet companies don't trust the internet for data transfers
  - Firmware, software and component upgrades
  - GPS and the advanced metal bucket technology
  - Work rules and the girlfriend factor (110 mph)
  - Is a Key-On event for rolling up a window or moving a vehicle ten feet considered a trip event?
    - 53-foot rule, 40% reduction result and 0.1% impact

Data Collection: Harder Than You'd Think…..

- **All companies have data collection launch issues, regardless of company size. Examples:**
  - **Data from a conversion company in 2007: time stamps go backwards occasionally**
  - **Data from partner in 2011: time stamps go backwards occasionally**
  - **Start-up conversation company in 2008: "I wish we had more QA resources"**
  - **Partner in 2011: "We allocated resources for sending the data, but not for looking at the data**

Quality Control Accomplishments

- **INL has identified and/or assisted with root cause analysis of numerous vehicle data issues, including:**
  - **Control software version differences cause unexpected differences in vehicle operation**
  - **Logger resets during driving or charging, resulting in missing data or split events**
  - **Split or missing driving and charging events due to bugs in logger trigger programming or post-processing algorithms**
  - **Missing records to indicate Key On, Key Off, Start of Charge, or End of Charge**
  - **Odometer and cumulative fuel consumed rolls backward or resets to zero**
  - **Number of parameters logged and other data formatting changes from month to month as vehicle software updates are made**

INL Data Security Accomplishments

- **Internal servers “Franc” and “Fort” in protected enclave are fully operational**
- **External server “AVT-EXT” is fully operational, loaded with software for multiple secure file transfer and encryption protocols**
- **Instituted security and export control policies per lab-wide procedures**
  - **Project data and information considered Official Use Only / Proprietary or CRADA-Protected**
  - **Guidelines documented specific to each project**

Data Security and Protection

- All raw vehicle and EVSE data, and personal information protected by NDAs (Non Disclosure Agreements) or a CRADA (Cooperative Research And Development Agreement), resulting in:
  - Limitations on how the proprietary data can be distributed, stored, and used
  - No raw data can or will be distributed by INL
  - Raw data, in both electronic and printed formats, cannot be shared with DOE in order to avoid exposure to FOIA
- Vehicle and EVSE data collection would not occur unless the above limitations are strictly adhered by INL
- INL can bin data results into usable information formats for analysis in research partnerships (electric utilities and DOE labs?)
- No raw data will be shared by INL

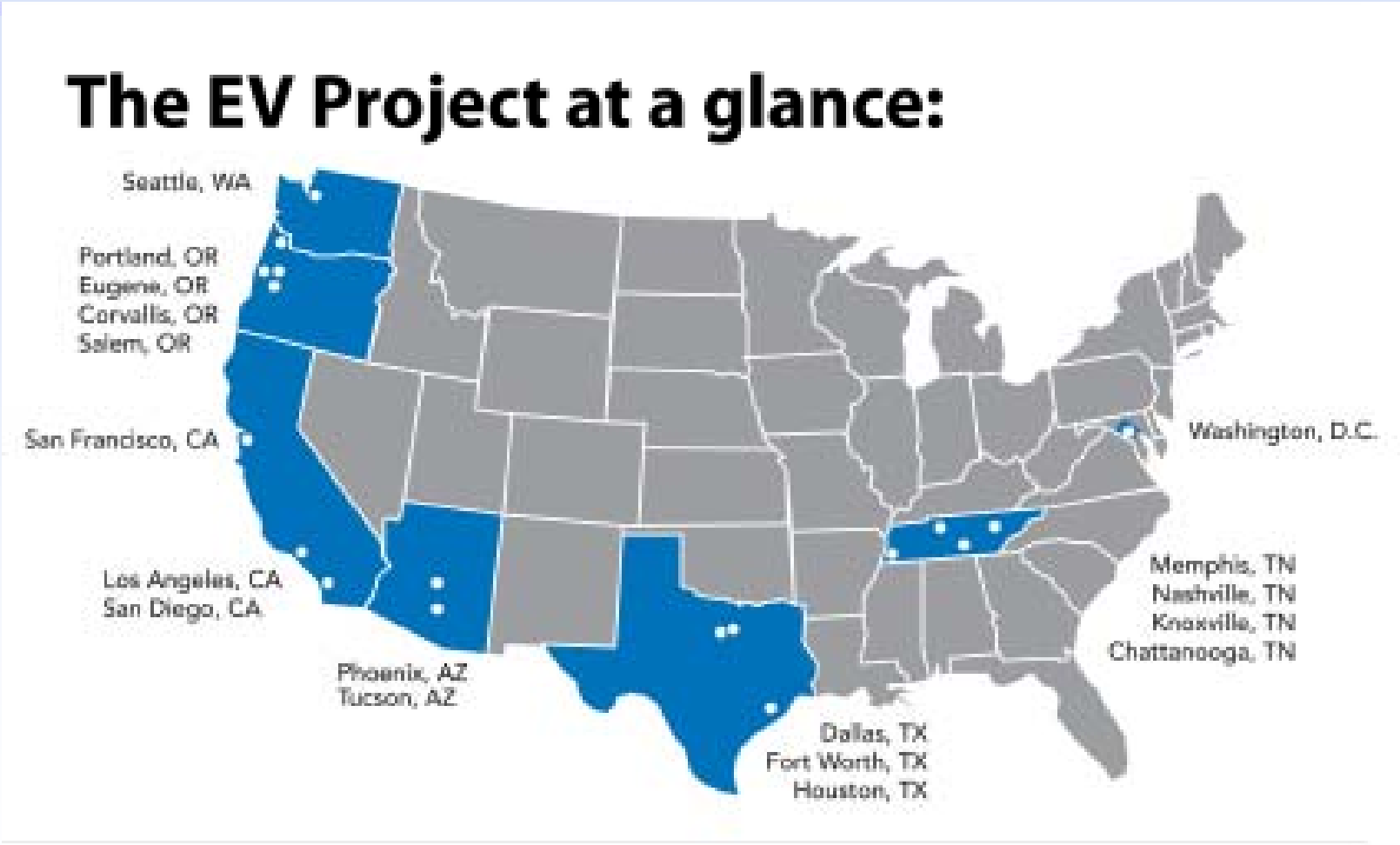
INL ARRA / TADA Data Collection Support

- **INL tasked with data collection, analysis and reporting for charging infrastructure and light-duty vehicle ARRA and other DOE funded demonstrations:**
  - **EV Project: 8,300 Leaf EVs and Volt EREVs, and 14,000 ECOtality / Blink Level 2 EVSE and fast chargers. Data logging (DL) on all 23,000 pieces of equipment**
  - **140 Chrysler Ram Pickup and minivan PHEVs with DL**
  - **150 General Motors EREV Volts with DL**
  - **21 Ford Escape PHEV SUVs with DL**
  - **4,000 Level 2 EVSE deployed by Coulomb with DL**
- **INL, and OEM and EVSE partners collecting real-time data**

The EV Project

- **$230 million project**
  - **$115 million ARRA grant from DOE**
  - **$115 million match**
- **Purpose: To plan, build, study, and evaluate mature electric vehicle charging infrastructure in six states plus the District of Columbia**
- **Product: Lessons learned**
- **Largest data collection effort**

The EV Project Locations



EV Project Micro-Climate Plan

Structured program to make regions “plug-in ready”

1) Community Planning

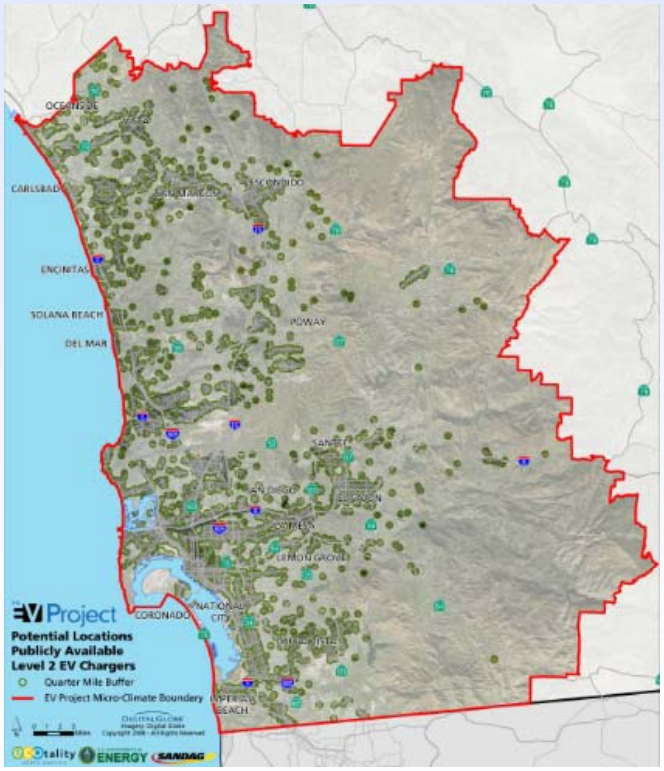
- **Deployment Guidelines & Stakeholder Organization**
- **Long Range Plan (10 years)**
- **Micro-Climate Plan (1-3 years)**

2) Road Mapping

- **1-3 year action plan**
- **Systematic GIS mapping**

3) Infrastructure Implementation

- **Deployment of EV charge stations**
- **Targets scalable national accounts**
- **Implement sustainable business models**



EV Micro-Climates©

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EV Project Residential Infrastructure

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

EV Project Commercial Infrastructure

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

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EV Project Data Collection & Reporting

Vehicle Data

EV & EREV

Nissan GDC
GM OnStar

INL

EVSE Data

EVSE

ECOtality Data Center

INL

MATCH

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

?

?

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

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blink

EV Project & Overall Data Collection Rational

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

EV Project & Overall Data Rational – cont'd

- **Quantified testing results that avoid subjective reporting results**
  - **No "best" or "worst" results**
  - **Only "highest" or "lowest", or "longest" or "shortest" achieved by reporting testing numbers**
  - **Minimize subjective and maximize quantitative measurements**

EV Project – Eleven Infrastructure 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 – Seven 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)
- Fuel consumption (some vehicles)
- Recorded for each key-on and key-off event

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EV Project Nissan Leaf Vehicle Summary Report

THE EV Project

Region: All

Number of vehicles: 35

Reporting period: January 2011 through March 2011

Vehicle Usage

Number of trips	3,364
Total distance traveled (mi)	21,706
Avg trip distance (mi)	5.8
Avg distance traveled per day when the vehicle was driven (mi)	32.5
Avg number of trips between charging events	3.3
Avg distance traveled between charging events (mi)	21.5
Avg number of charging events per day when the vehicle was driven	1.5

Charging Location and Type

	Home charging location	Away-from-home charging locations		
	AC level 2 charging	AC level 2 charging	DC fast charging	Non-EV Project charging[1]
Total number of charging events	800	0	0	208
Percent of all charging events	79%	0%	0%	21%
Total time plugged-in (hr)	8,126	0	0	–
Percent of all time plugged-in at EV Project charging units	100%	0%	0%	–
Total electricity consumed (AC MWh)	5.25	0	0	–
Percent of all electricity consumed from EV Project charging units	100%	0%	0%	–

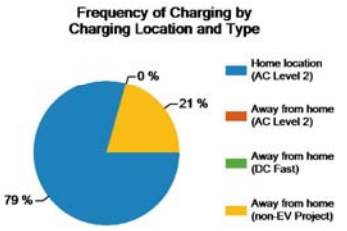
Charging Completeness

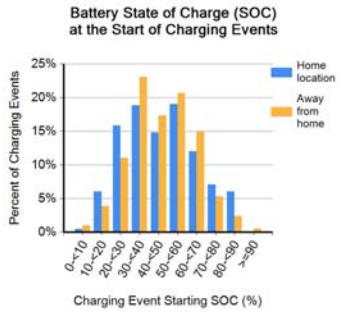
	Home charging location	Away-from-home charging locations		
	AC level 2 charging	AC level 2 charging	DC fast charging	Non-EV Project charging[1]
Number of complete charging events[2]	199	0	0	54
Percent of charging events of the same type and location	43%	0%	0%	26%
Number of partial charging events[3]	268	0	0	154
Percent of charging events of the same type and location	57%	0%	0%	74%

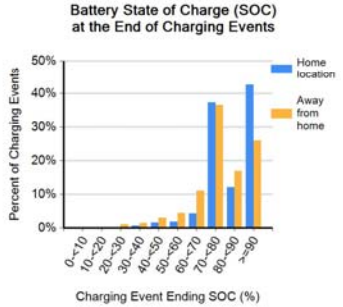
[1] Charging level, time plugged-in, and electricity consumed are not available from Non-EV Project charging units. Charging level could be AC level 1, AC level 2, or DC fast charging.

[2] Complete charging events end with battery state of charge at 90% to 100% (for charging events with SOC reported)

[3] Partial charging events end with battery state of charge below 90% (for charging events with SOC reported)







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EV Project – Nissan Leaf Usage Report

- 1 of 3 report types produced to date
- See next slides for details
- Initially, all reports produced quarterly

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EV Project – Nissan Leaf Usage Report

- **Vehicle Usage – 1st quarter 2011**
  - **Number of Trips** **3,364**
  - **Total distance traveled (miles)** **21,706 mi**
  - **Ave trip distance** **5.8 mi**
  - **Ave distance per day when driven** **32.5 mi**
  - **Ave # trips between charging events** **3.3**
  - **Ave distance traveled between charging events** **21.5 mi**
  - **Ave # charging events per day when a vehicle was driven** **1.5**

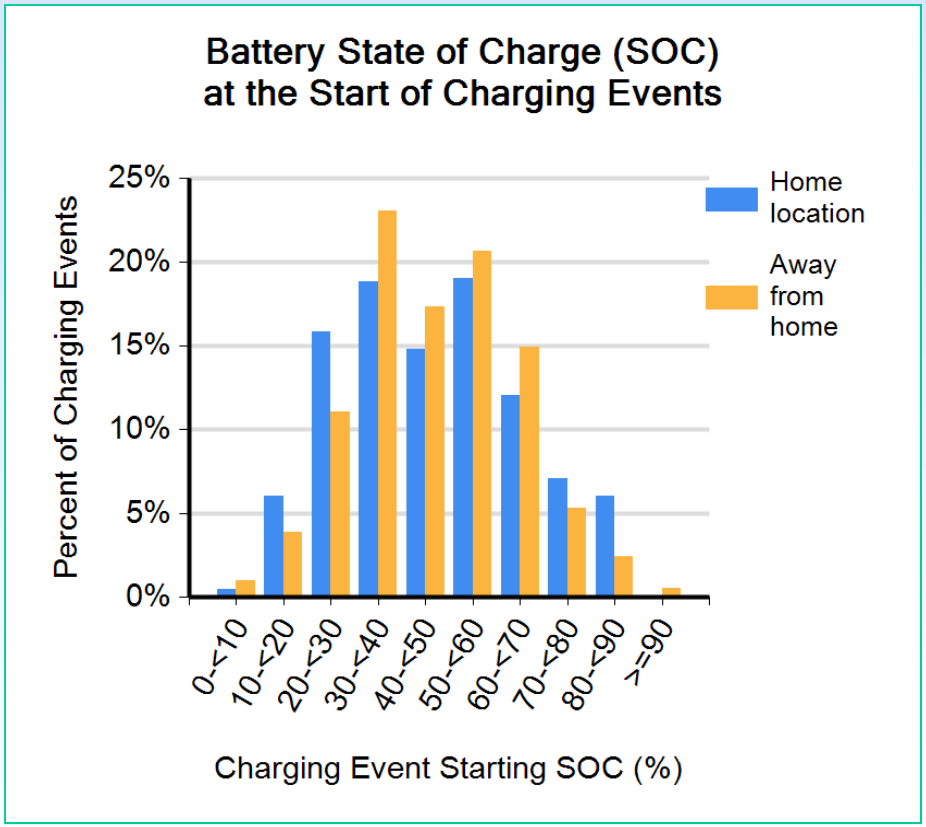
- **This report requires matching Leaf and charging data**

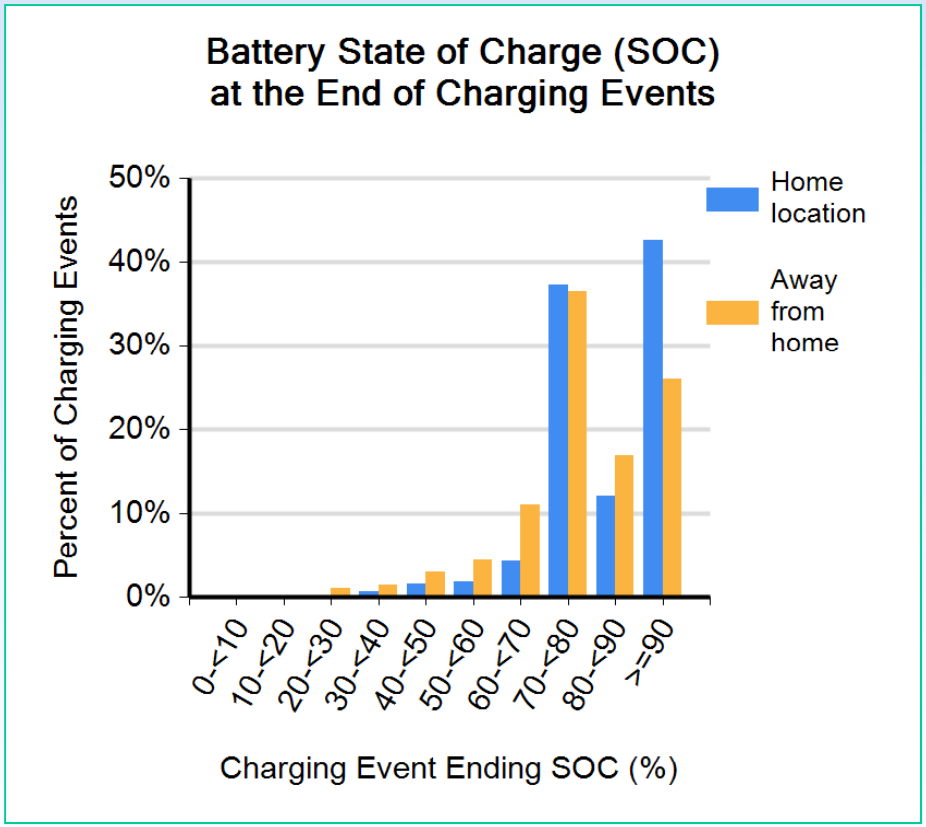
EV Project – Nissan Leaf Usage cont'd

	Level 2 Home Location
• Charging Location and Type	
– Total number of charging events	800
– Total time plugged in	8,126 hr
– Percent of all time plugged in at EV Project units	100%
– Total electricity consumed	5.25 AC MWh
• Charging Completeness	
– Number of complete charging events (SOC reported)	199
– Number of partial charging events (SOC reported)	268

- This report will also include Away-from-home charging locations: EV Project Level 2 and DC fast charging as well as non-EV Project charging

EV Project – Nissan Leaf Usage – cont'd





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EV Project Overview Report

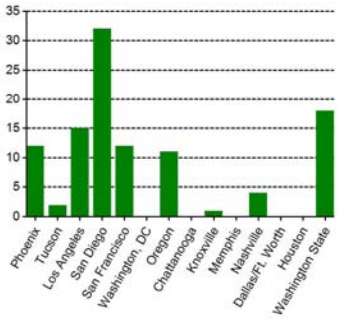
THE EV Project

Project to Date through March 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	12	143	0.74
Tucson, AZ Metropolitan Area	2	40	0.28
Los Angeles, CA Metropolitan Area	15	249	1.61
San Diego, CA Metropolitan Area	32	483	3.23
San Francisco, CA Metropolitan Area	12	85	0.55
Washington, D.C. Metropolitan Area	0	0	0.00
Oregon	11	210	1.28
Chattanooga, TN Metropolitan Area	0	0	0.00
Knoxville, TN Metropolitan Area	1		
Memphis, TN Metropolitan Area	0	0	0.00
Nashville, TN Metropolitan Area	4	44	0.36
Dallas/Ft. Worth, TX Metropolitan Area	0	0	0.00
Houston, TX Metropolitan Area	0	0	0.00
Washington State	18	322	2.02
Total	107	1,582	10.13

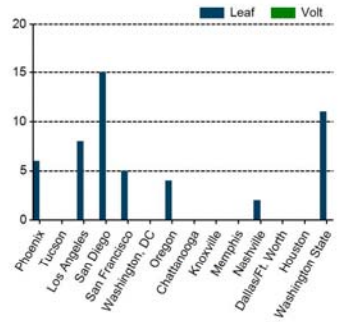
Charging Unit Installation to Date by Region



Vehicles

Region[1]	EV Project Nissan Leafs Enrolled to Date[2]	EV Project Chevrolet Volts Enrolled to Date[3]	Number of Trips	Distance Driven (mi)
Phoenix, AZ Metropolitan Area	6	—	929	5,689
Tucson, AZ Metropolitan Area	0	—	0	0
Los Angeles, CA Metropolitan Area	8	0	656	6,018
San Diego, CA Metropolitan Area	15	0	2,095	15,349
San Francisco, CA Metropolitan Area	5	—	246	2,702
Washington, D.C. Metropolitan Area	—	0	0	0
Oregon	4	—	662	3,368
Chattanooga, TN Metropolitan Area	0	—	0	0
Knoxville, TN Metropolitan Area	0	—	0	0
Memphis, TN Metropolitan Area	0	—	0	0
Nashville, TN Metropolitan Area	2	—	238	1,813
Dallas/Ft. Worth, TX Metropolitan Area	—	0	0	0
Houston, TX Metropolitan Area	—	0	0	0
Washington State	11	—	1,517	9,528
Total	51	0	6,343	44,467

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.

[3] Enrollment of EV Project Chevrolet Volts is expected to begin in the second quarter of 2011.

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EV Project – Overview Report

- 2 of 3 report types produced to date
- Charging infrastructure
  - # units installed
  - # charging events
  - AC MWh consumed
- Vehicles
  - # enrolled
  - # trips
  - Distance driven
- Results provided by EV Project region

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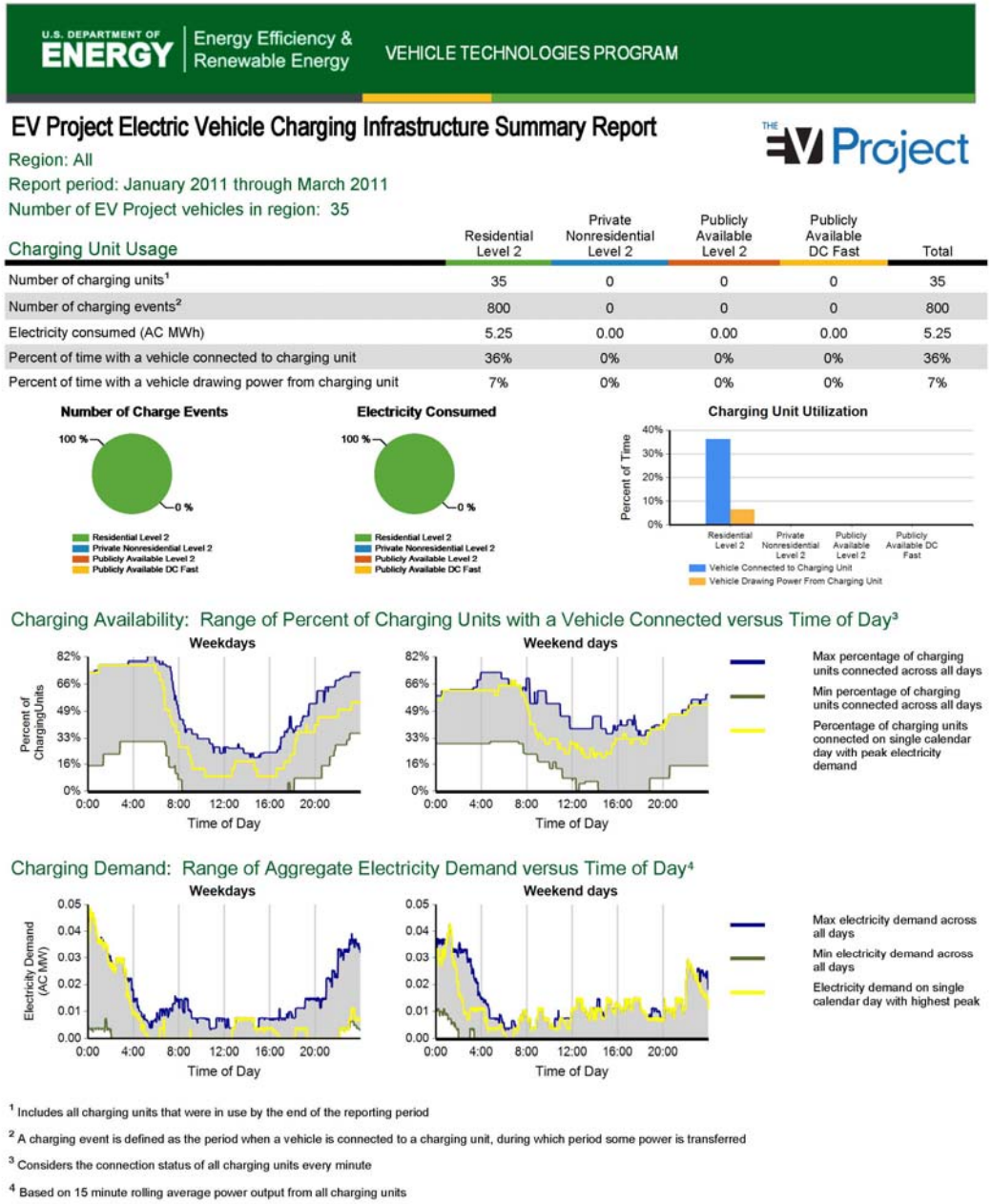

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EV Project Electric Vehicle Charging Infrastructure Summary Report

THE EV Project

Region: All
Report period: January 2011 through March 2011
Number of EV Project vehicles in region: 35

Charging Unit Usage	Residential Level 2	Private Nonresidential Level 2	Publicly Available Level 2	Publicly Available DC Fast	Total
Number of charging units[1]	35	0	0	0	35
Number of charging events[2]	800	0	0	0	800
Electricity consumed (AC MWh)	5.25	0.00	0.00	0.00	5.25
Percent of time with a vehicle connected to charging unit	36%	0%	0%	0%	36%
Percent of time with a vehicle drawing power from charging unit	7%	0%	0%	0%	7%

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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1 of 2

EV Project – EV Charging Infrastructure Summary Report

- 3 of 3 report types produced to date
- Charging unit usage
- Percent charging units with a vehicle connected by time of day
- Range of aggregate electricity demand versus time of day
- See next 2 slides

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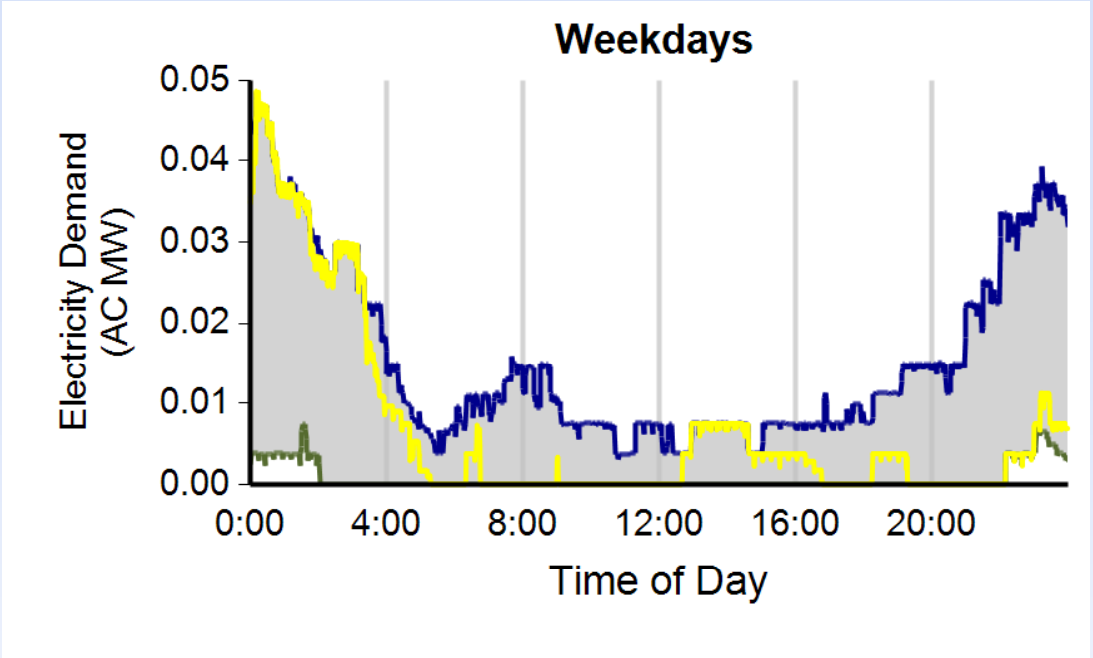
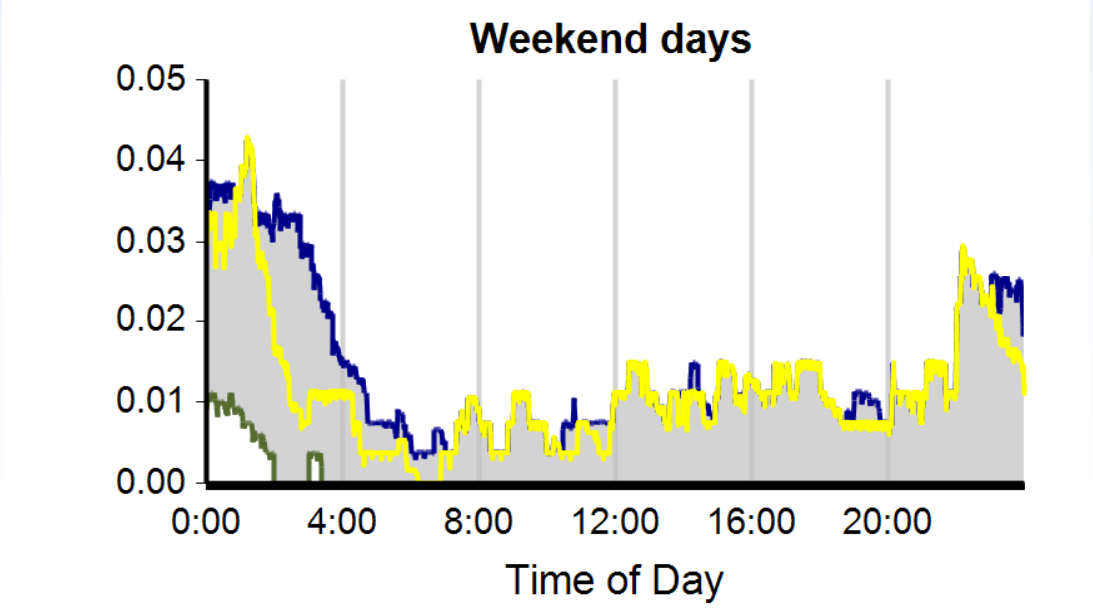
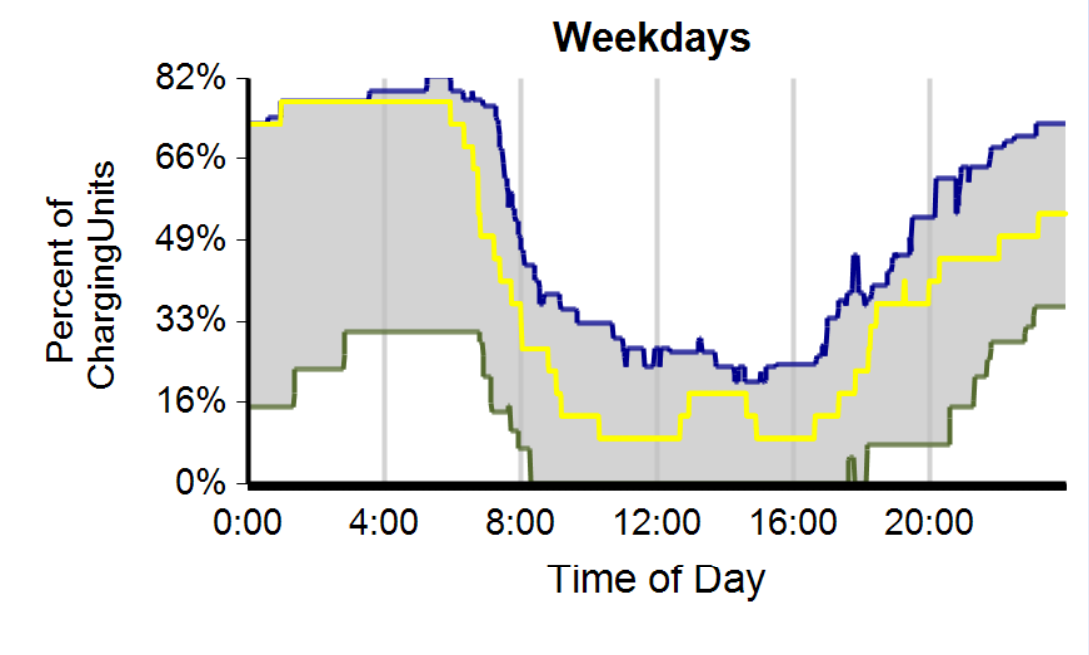
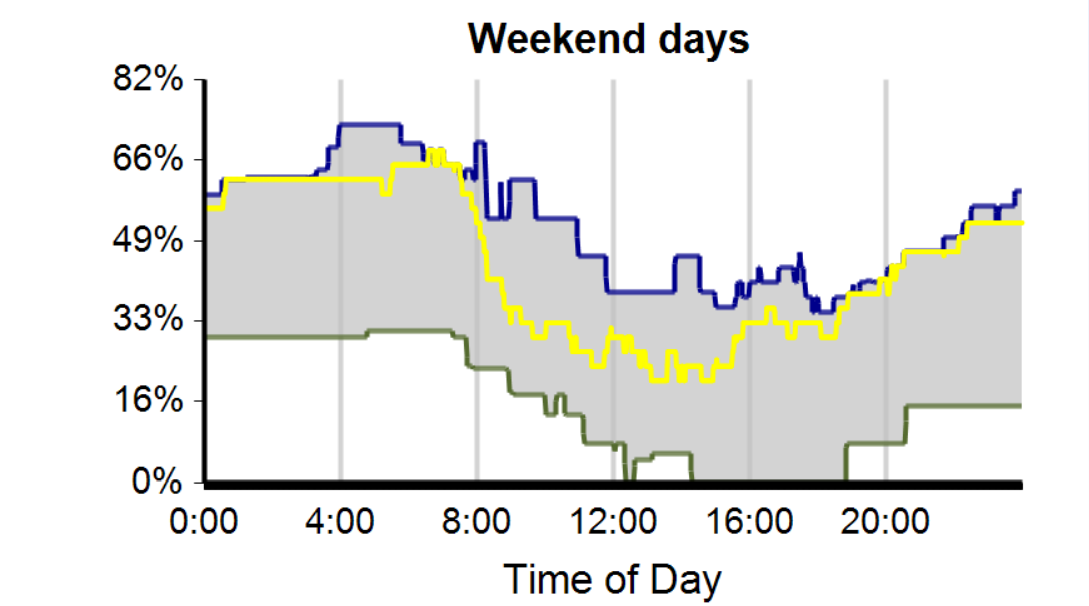




EV Project – EV Charging Infrastructure Summary Report – cont'd

- 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 – EV Charging Infrastructure Summary Report – cont'd

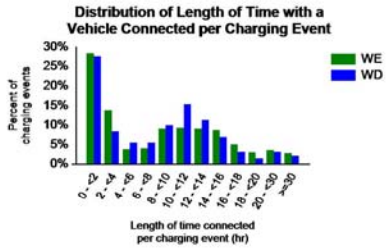
- Range of charging units with a vehicle connected
- Yellow line is for day with peak power demand
- Both graphs percent of charging units

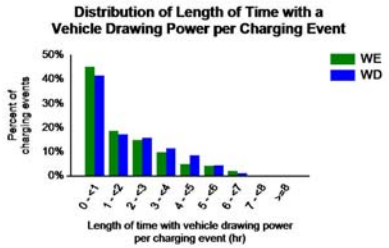
Residential Level 2 Electric Vehicle Supply Equipment (EVSE)

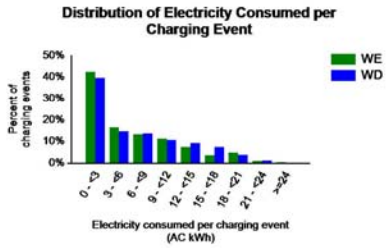
EVSE Usage	Weekday	Weekend	Overall
Number of charging events	593	207	800
Electricity consumed (AC MWh)	4.01	1.24	5.25
Percent of time with a vehicle connected to EVSE	36%	38%	36%
Percent of time with a vehicle drawing power from EVSE	7%	7%	7%
Average number of charging events started per EVSE per day	0.9	0.8	0.9
Average number of distinct vehicles charged per EVSE per day (EV Project vehicles only)	1.0	1.0	1.0

Vehicles Charged	Nissan Leaf	Chevrolet Volt	Non-EV Project vehicles
Percent of charging events	100%	0%	0%
Percent of electricity consumed	100%	0%	0%

Individual Charging Event Statistics	Weekday (WD)	Weekend (WE)	Overall
Average length of time with vehicle connected per charging event (hr)	9.8	11.1	10.2
Average length of time with vehicle drawing power per charging event (hr)	1.9	1.8	1.9
Average electricity consumed per charging event (AC kWh)	6.8	6.0	6.6



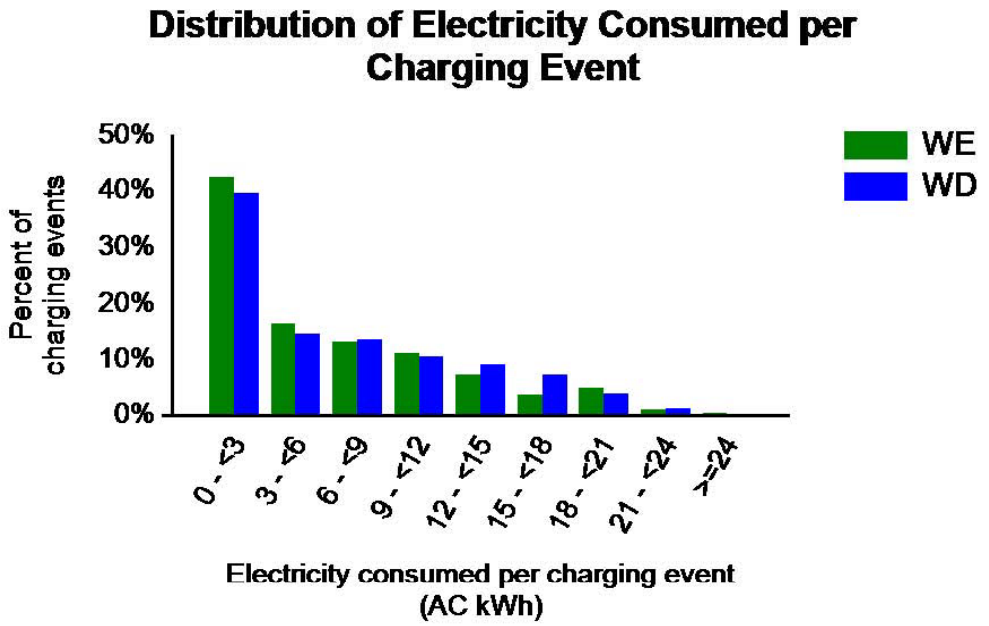


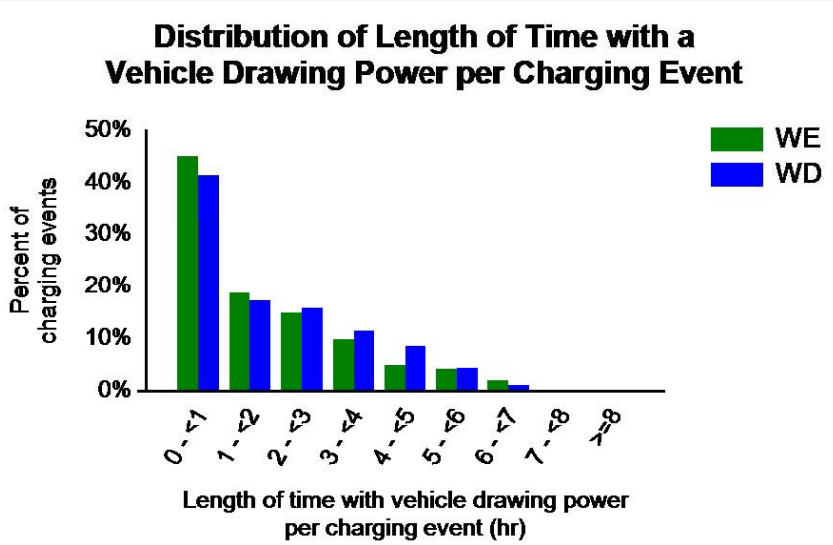


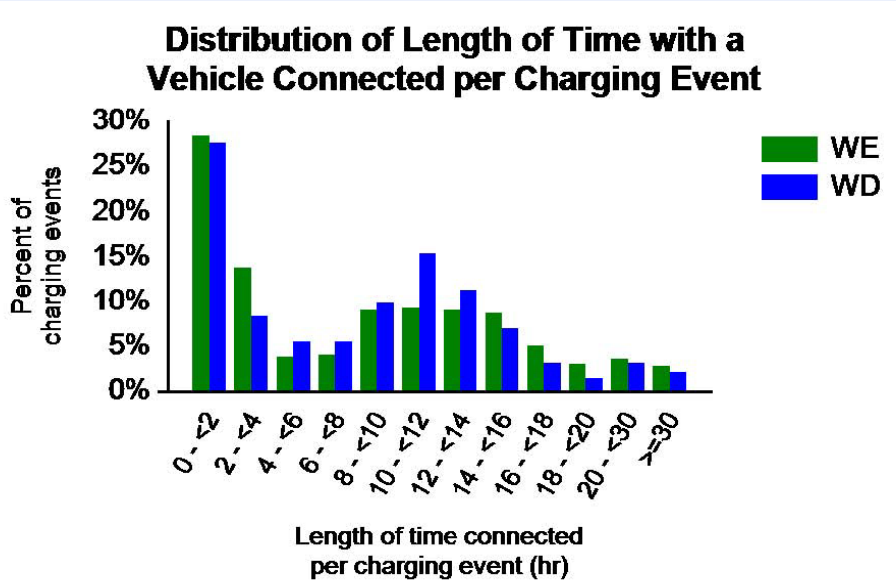
EV Project – EV Charging Infrastructure Summary Report – cont'd

- Page 2 of 1 of 3 report types produced to date
- To be produced for each "charger" type
- Detailed charging event breakdowns
- Graphs on next page
- Data shown for residential Level 2 EVSE

EV Project – EV Charging Infrastructure Summary Report – cont'd







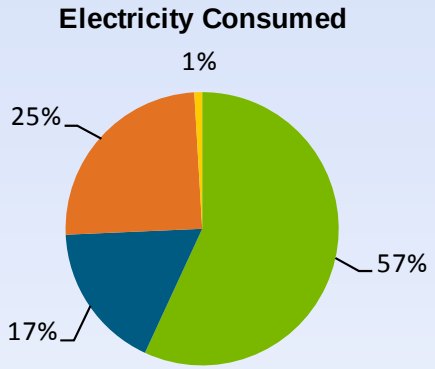
EV Project – Number of Units

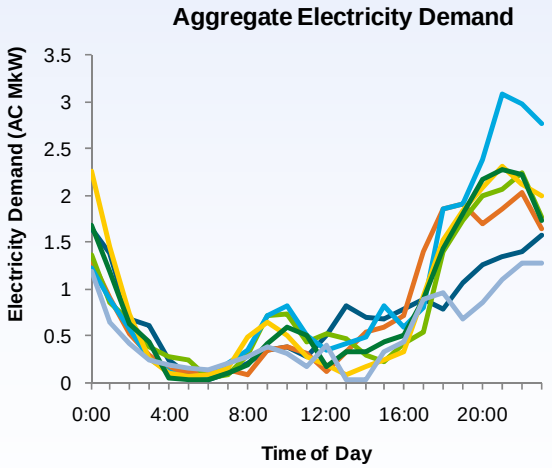
1st Quarter 2011 Report Leaf and EVSE Units	
Number of Leafs	50
Number of Blink EVSE	107

June 7, 2011 Leaf and EVSE Units with Data	
Number of Leafs	761
Number of Blink EVSE	784

Future EV Project Activities - Infrastructure Usage Report

- 117 metrics and plots, including:
  - Charging unit utilization
  - Aggregate charging demand vs. time of day and day of the week
  - Individual charging event metrics
    - How often, how long, how empty, how full
  - Reporting by various subgroups





EV Project Data Collection Summary

- **Utilize a systematic process for planning and installing charging infrastructure**
  - **Document travel patterns**
  - **Document charging patterns**
- **Provide feedback on infrastructure deployment decisions**
- **Successful grid-connected electric drive vehicle deployment is dependent on successful infrastructure deployment**
- **Future charging infrastructure deployments must be based on real-world travel and charging patters**

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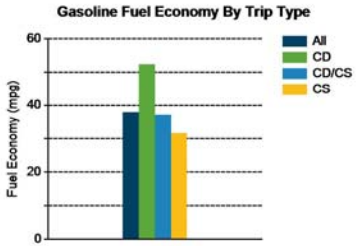
Ford Escape Advanced Research Fleet

Number of vehicles: 21
Reporting period: Nov 09 - Apr 11
Date range of data received: 11/01/2009 to 04/30/2011
Number of vehicle days driven: 5,425

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	23,548
Total distance traveled (mi)	299,960

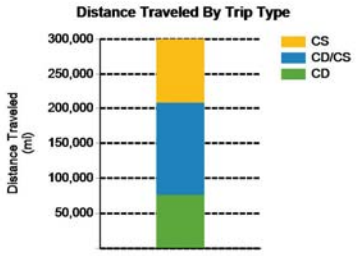


Trips in Charge Depleting (CD) mode[3]

Gasoline fuel economy (mpg)	52
DC electrical energy consumption (DC Wh/mi)[4]	170
Number of trips	13,205
Percent of trips city | highway	84% | 16%
Distance traveled (mi)	75,997
Percent of total distance traveled	25%

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

Gasoline fuel economy (mpg)	37
DC electrical energy consumption (DC Wh/mi)[6]	55
Number of trips	4,506
Percent of trips city | highway	38% | 62%
Distance traveled (mi)	131,484
Percent of total distance traveled	44%



Trips in Charge Sustaining (CS) mode[7]

Gasoline fuel economy (mpg)	32
Number of trips	5,831
Percent of trips city | highway	65% | 35%
Distance traveled (mi)	92,478
Percent of total distance traveled	31%

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

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

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

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1 of 2

Ford Escape PHEV 3-Page Report

- Reports 300,000 test miles and 24,000 trips
- Report by charge mode:
  - Charge depleting (CD)
  - Charge sustaining (CS)
  - Mixed (CD/CS)
- All trips, 38 mpg, 101 AC Wh/mi & 66 DC Wh/mi
- CD, 52 mpg & 170 DC Wh/mi
- CD/CS, 37 mpg & 55 DC Wh/mi
- CS, 32 mpg
- Plugging-in = 63% improvement in MPG

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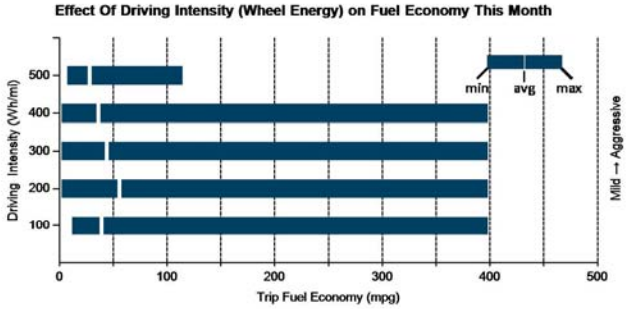
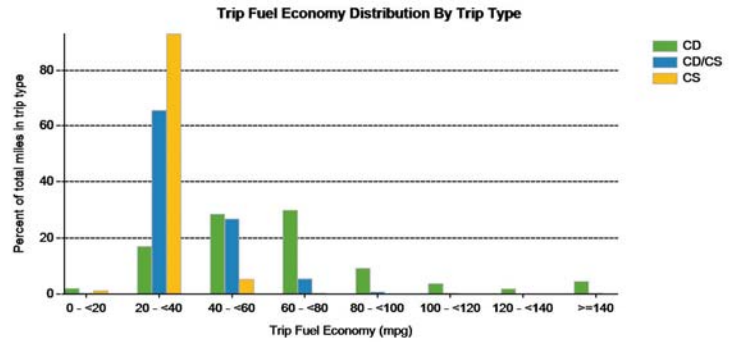
VEHICLE TECHNOLOGIES PROGRAM

Trips in Charge Depleting (CD) mode	City	Highway
Gasoline fuel economy (mpg)	48	57
DC electrical energy consumption (DC Wh/mi)	171	169
Percent of miles with internal combustion engine off	37%	13%
Average trip driving intensity (Wh/mi)	265	305
Average trip distance (mi)	3	17

Trips in Charge Depleting and Charge Sustaining (CD/CS) mode		
Gasoline fuel economy (mpg)	43	36
DC electrical energy consumption (DC Wh/mi)	79	52
Percent of miles with internal combustion engine off	30%	5%
Average trip driving intensity (Wh/mi)	277	325
Average trip distance (mi)	9	41

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





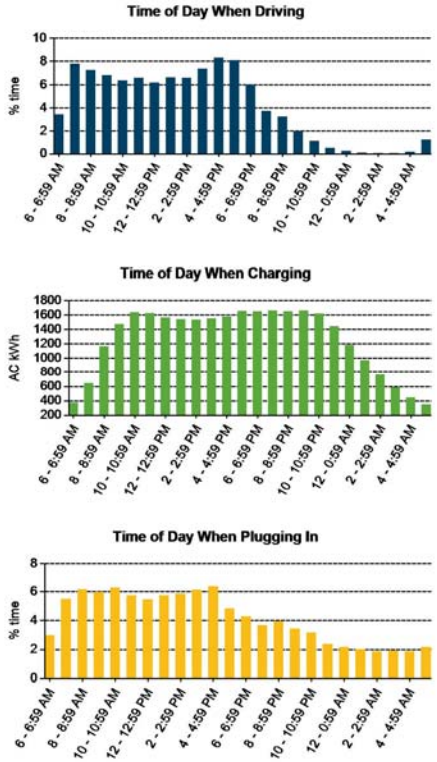
Ford Escape PHEV 3-Page Report

- Report fuel use by highway/city cycles and driver style
- CD city, 48 mpg, 171 DC Wh/mi
- CD highway, 57 mpg, 169 DC Wh/mi
- CS city, 30 mpg
- CS highway, 32 mpg
- Plugging-in = 60% improvement in city MPG and 78% improvement in highway MPG

VEHICLE TECHNOLOGIES PROGRAM

Plug-in charging

Average number of charging events per vehicle per month when driven	47
Average number of charging events per vehicle per day when driven	3.2
Average distance driven between charging events (mi)	17.5
Average number of trips between charging events	1.4
Average time plugged in per charging event (hr)	6.2
Average time charging per charging event (hr)	1.3
Average energy per charging event (AC kWh)	1.8
Average charging energy per vehicle per month (AC kWh)	82.9
Total number of charging events	17,110
Total charging energy (AC kWh)	30,276

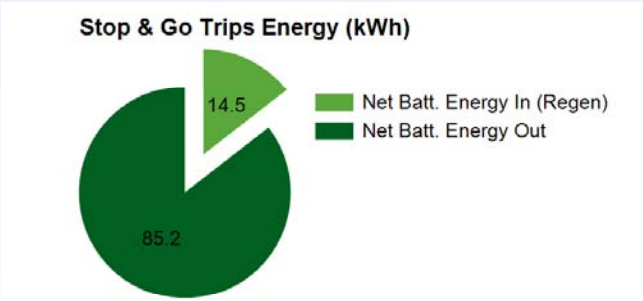


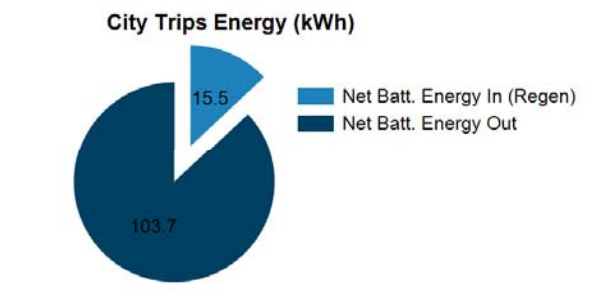
Ford Escape PHEV 3-Page Report

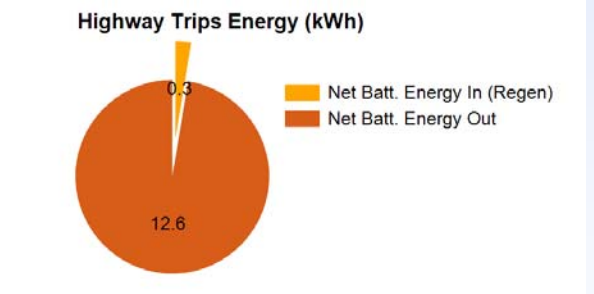
- Report charging stats, time of day driving, and charging profiles
- 30,276 AC kWh used
- 17,110 charging events
- Ave 3.2 charging events per day when driven
- 17.5 miles between charge events
- 1.4 trips between charge events
- 1.3 hours per charge
- 6.2 hours time plugged in per charge
- 1.8 AC kWh per charge

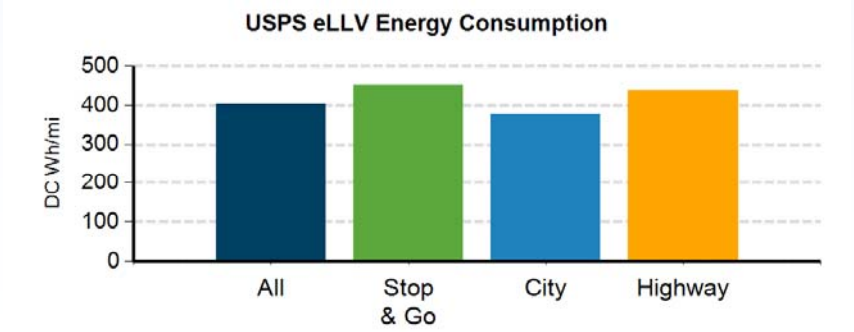
Other INL Data Collection Projects

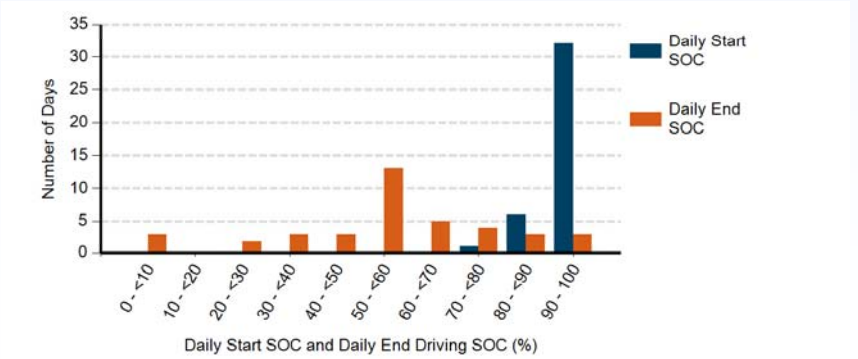
- **Five USPS electric long life vehicle (ELLV) conversions**
  - **ELLVs required five customized onboard data loggers**
  - **Testing to USPS and AVTA test procedures and cycles**
  - **All five subjected to baseline performance (track and dynamometer testing)**
  - **All five in Washington DC area delivery routes with data loggers**











Other INL Data Collection Projects – cont'd

- 140 Ram PHEV pickups – same report format as Ford Escape PHEVs
- Federal fleet vehicle use profiles
- Mass change impacts on ICEV, HEV, and BEV fuel use
- Development of vehicle-based battery test-bed mule
  - Street legal, includes real world impacts of power electronics, and motor energy and power demands, ambient and mission impacts
  - First lithium battery pack being installed

Other INL Data Collection Projects – cont'd

- Coulomb EVSE data collection will be same parameters as the EV Project, but no vehicle data will be collected
- Coulomb reports 525 EVSE installed to date
- Nissan Leaf fast charge study
  - Comparison of fast versus Level 2 charging impacts on battery life
- 20 Lithium PHEV Escape Quantum conversions (SCAQMD) – same report format as Ford Escape PHEVs

Vehicles INL Declined Testing Opportunities

Acknowledgement

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

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More Information

http://avt.inl.gov

INL/MIS-11-22237