Idaho National Laboratory Testing of Advanced Technology Vehicles

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Idaho National Laboratory
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VSS021

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This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Idaho National Laboratory

Timeline

The Advanced Vehicle Testing Activity (AVTA) is an annually funded DOE activity

Barriers

Barriers addressed

- High risk to develop and purchase plug-in electric vehicles (PEV) and charging infrastructure
- PEV infrastructure requirements and impacts are not yet understood
- Development of codes and standards for products and testing is required

Budget

FY 2013 project funding
- $1.8 million

FY 2014 project funding
- $1.05M

Partners

- Intertek Testing Services – AVTA testing partner
- NETL, ORNL, ANL
- Ford, GM, OnStar, Chrysler, Nissan, ECOtality, Intertek, ChargePoint, EPRI, AeroVironment, NYC TLC via vehicle and infrastructure demos
- Idaho National Laboratory – Lead

Objectives

AVTA's objective is to support DOE's goal of petroleum reduction and energy security by:

- Performing low-cost testing and demonstrations of advanced technology vehicles and fueling infrastructure to:
  - Identify the real-world potential of the technology for petroleum displacement
  - Verify return on investment of DOE-funded technology development
- Providing results and lessons learned to a broad range of stakeholders, including:
  - DOE modelers and target setters to improve model validity
  - R&D organizations to reduce risk of product development decisions
  - Electric utilities, policy makers, and government agencies to guide their infrastructure requirements planning and impact assessment
  - Standards development organizations to support the development of codes and standards
  - Fleet managers and private consumers to assist them in making vehicle and infrastructure purchase, deployment, and operating decisions that minimize the overall cost of ownership

FY13 & FY14 Milestones

Date	Milestone	Status
9/30/2013	Test two new HEV models.	Complete
9/30/2013	Collect data on all Nissan Leaf taxi cabs deployed	Complete
9/30/2013	Collect data on 100+ Volts and 100+ Rams for 1+ million miles	Complete
12/31/2013	Post testing reports and fact sheets on AVTA website, report status	Complete
3/3/1/2014	Post testing reports and fact sheets on AVTA website, report status	Complete
6/30/2014	Post testing reports and fact sheets on AVTA website, report status	On-Track
9/30/2014	Post testing reports and fact sheets on AVTA website, report status	On-Track

Approach/Strategy

- AVTA testing procedures are established for each new technology based on:
  - Existing standard test procedures
  - Recommendations from fleet managers and subject matter experts from industry and other national laboratories
- AVTA test procedures are published and strictly followed to reduce testing uncertainties
- Depending on technology and capabilities, vehicles and EVSE are tested via:
  - Laboratory bench testers (battery packs, EVSE)
  - Closed test tracks and dynamometers
  - On-road captive fleet testing
  - Vehicle and infrastructure demonstrations by independent fleets and private consumers
- Different test methods are used to balance testing control / repeatability, sample size, and costs

Approach/Strategy continued

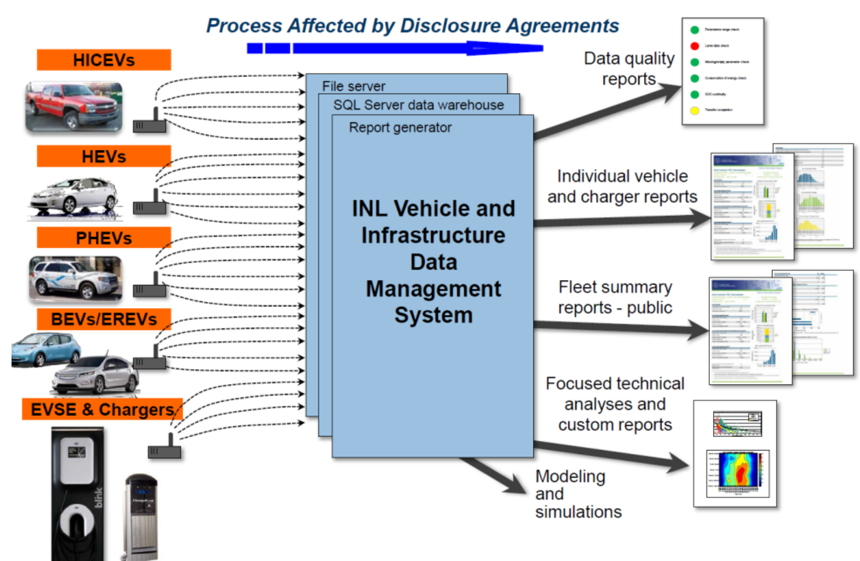
- Vehicle testing results are published to document:
  - Real-world vehicle fuel economy and electricity consumption as a result of driver behavior and external conditions
  - Traction battery pack capacity reduction as a result of vehicle use and conditions
  - Vehicle life-cycle costs
- EVSE testing results are published to document efficiency of charging infrastructure technologies as a result of power level and product design
- Vehicle and infrastructure demonstration results are published to document
  - Vehicle fuel economy and electricity consumption as a result of driving and charging behavior
  - Infrastructure use and electricity demand

Approach/Strategy continued

- Testing and demonstration results are presented in numerous ways, including:
  - To auto and electric utility industry representatives via DOE technical team meetings (VSATT, GITT, EESTT, MTT)
  - Direct meetings with auto OEMs, federal/state/local agencies, NGOs and universities
  - Conferences, Clean Cities webinars, and other public venues
  - Via the EERE VTO and INL websites
- Publication of testing and demonstration results addresses barriers by
  - Lowering or avoiding cost by improving the product development process and helping end consumers make wise purchase, deployment, and operating decisions
  - Verifying results of DOE-funded technology development to prevent waste and drive future decisions
  - Helping infrastructure planners define infrastructure deployment requirements
  - Providing input to codes and standards development and validation process

Approach/Strategy continued

- AVTA is conducted primarily by INL and Intertek Testing Services North America, with dynamometer testing by ANL and ORNL
- Testing activities, from individual EVSE tests to large-scale vehicle and infrastructure demonstrations, are made possible by contributions from a multitude of partners – hundreds of organizations and thousands of individual participants to date
- Test methods, quality and efficiency of data collection, and cost of testing have been continuously improving since 1993



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Vehicle Testing Accomplishments

59 AVTE Vehicles Tested This Year

Purchase Vehicle (4 of each model)

↓ *Baseline Traction Battery Testing*

Install On-Board Data Logger (all cars)

↓ *4,000 Miles for Break-In*

Track Performance and Coast Down Testing (one each model)

↓

Dynamometer Testing (one each model)

↓

Data Collection During Fleet Operation (all cars)

↓ *Traction Batteries or Components* — *3 Interim Tests*

End-of-test Component and Performance Evaluation

EV end-of-test: 60,000 Miles
PHEV end-of-test: 195,000 Miles
HEV, ICE end-of-test: 195,000 Miles

Vehicle Testing Accomplishments (cont.)

- HEV Models: 2 completed, 4 begin AVTE fleet testing *(FY 13 Milestone)*

Vehicle	Baseline track and dyno testing	Battery Test	Fleet mileage accumulation	Vehicle sample size	Miles target (per vehicle)
2011 Honda CRZ (parallel mild HEV)	Prior year	2/2 Tests Complete	Complete	2	160,000
2011 Hyundai Sonata Hybrid (parallel full HEV)	Prior year	2/2 Tests Complete	Complete	2	160,000
2013 Chevrolet Malibu Eco (BAS mild HEV)	Complete	2/5 Tests Complete	46% Complete	4	195,000
2013 Honda Civic Hybrid	Complete	2/5 Tests Complete	24% Complete	4	195,000
2013 Ford C-Max Hybrid	Complete	1/5 Tests Complete	6% Complete	4	195,000
2014 Volkswagen Jetta Hybrid	Complete	1/5 Tests Complete	5% Complete	4	195,000

- PHEV Models: 1 continue, and 4 begin AVTE fleet testing

Vehicle	Baseline track and dyno testing	Battery Test	Fleet mileage accumulation	Vehicle sample size	Miles target (per vehicle)
2011 Chevrolet Volt	Prior year	2/5 Tests Complete	33% Complete	2	195,000
2013 Chevrolet Volt	Complete	2/5 Tests Complete	27% Complete	4	195,000
2013 Toyota Prius Plug-In	Complete	2/5 Tests Complete	25% Complete	4	195,000
2013 Ford C-Max Energi	Complete	1/5 Tests Complete	5% Complete	4	195,000
2013 Ford Fusion Energi	On Schedule	1/5 Tests Complete	2% Complete	4	195,000

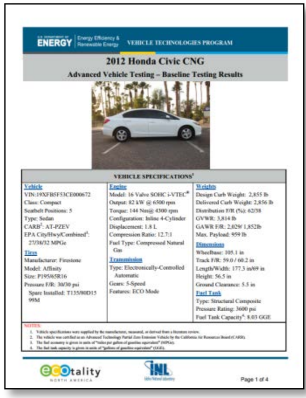
Vehicle Testing Accomplishments (cont.)

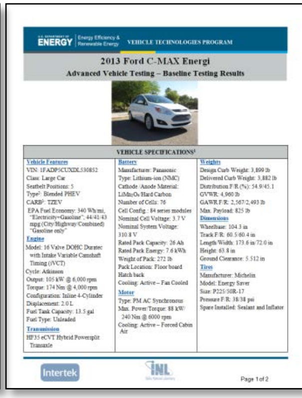
- BEV Models: 1 continuing, 4 begin AVTE fleet testing

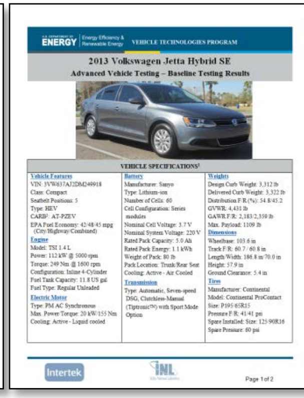
Vehicle	Baseline track and dyno testing	Battery Test	Fleet mileage accumulation	Vehicle sample size	Miles target (per vehicle)
2011 Nissan Leaf	Prior year	2/5 Tests Complete	51% Complete	2	60,000
2012 Mitsubishi i	Complete	1/5 Tests Complete	14% Complete	2	60,000
2013 Nissan Leaf	Complete	1/5 Tests Complete	6% Complete	4	60,000
2013 Ford Focus EV	On Schedule	1/5 Tests Complete	1% Complete	4	60,000
2014 Smart ED	On Schedule	0/5 Tests Completed	0% Complete	1	60,000

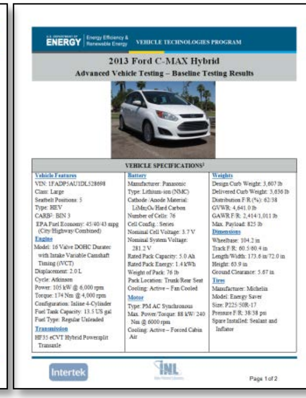
- ICE Models: 2 begin AVTE fleet testing

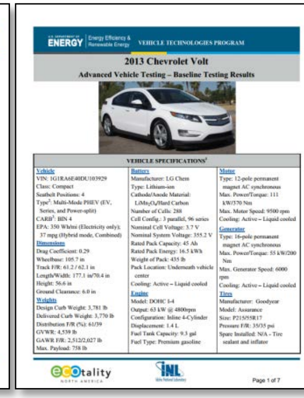
Vehicle	Baseline track and dyno testing	Component Test	Fleet mileage accumulation	Vehicle sample size	Miles target (per vehicle)
2012 Honda Civic CNG	Complete	2/5 Tests Complete	24% Complete	4	195,000
2013 Volkswagen Jetta TDI	Complete	NA	22% Complete	4	195,000

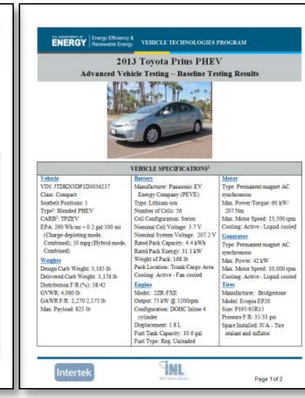

2012 Honda Civic CNG
Advanced Vehicle Testing – Baseline Testing Results


2013 Ford C-MAX Energi
Advanced Vehicle Testing – Baseline Testing Results


2013 Volkswagen Jetta Hybrid SE
Advanced Vehicle Testing – Baseline Testing Results


2013 Ford C-MAX Hybrid
Advanced Vehicle Testing – Baseline Testing Results

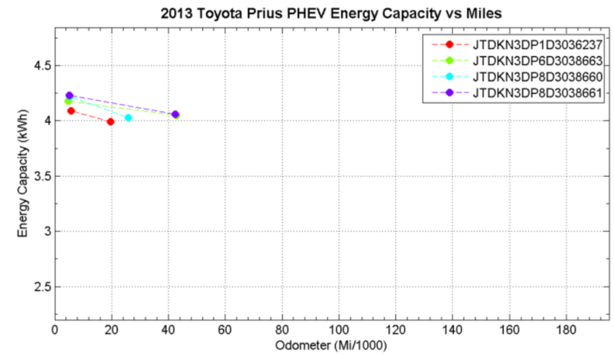

2013 Chevrolet Volt
Advanced Vehicle Testing – Baseline Testing Results

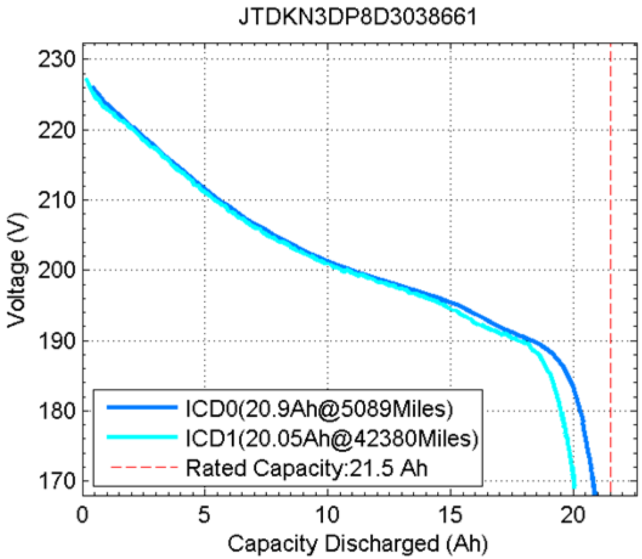

2013 Toyota Prius PHEV
Advanced Vehicle Testing – Baseline Testing Results

Battery Testing Accomplishments

Traction battery capacity testing at beginning, 3 interim points and completion of fleet mileage accumulation

- Battery testing results-to-date published for
  - (4) 2013 Chevrolet Malibu Eco
  - (4) 2013 Chevrolet Volt
  - (4) 2013 Toyota Prius Plug-In
  - (3) 2013 Ford C-Max Energi
  - (4) 2013 Ford C-Max Hybrid
  - (2) 2012 Mitsubishi i
  - (4) 2013 Nissan Leaf
  - (4) 2013 Ford Focus EV
  - (4) 2013 Honda Civic Hybrid
  - (4) 2013/2014 VW Jetta Hybrid
- Five battery test points through operation allow linkages between battery changes and operating conditions, vehicle usage
- Leverages vehicle testing program's fleet mileage accumulation



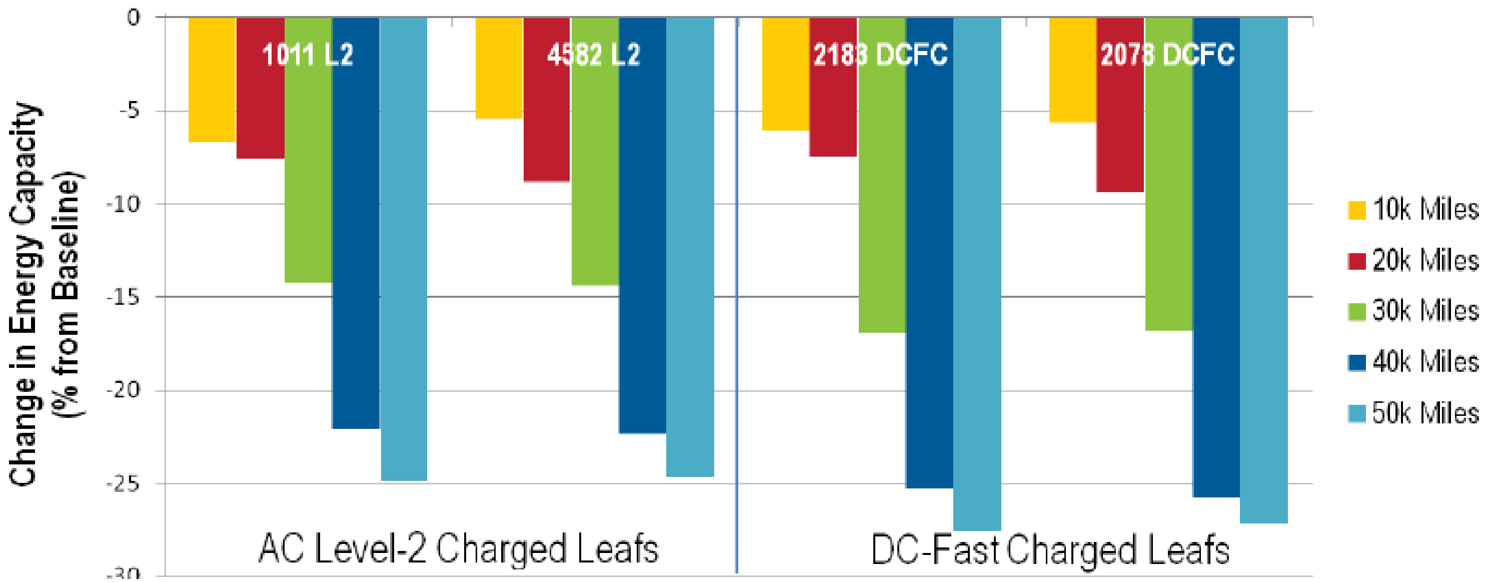


Battery Testing Accomplishments (cont.)

DC Fast Charging Effect on Battery Life and Vehicle Performance

This project is fully detailed in VSS131

- Baseline laboratory and track testing of 4 vehicles/battery packs competed, lab cycling of 2 packs underway
- Battery tests performed after 10,20,30,40, and 50k miles of on-road testing
- Project results will provide the public with unprecedented understanding of the impact of high charge power on battery life



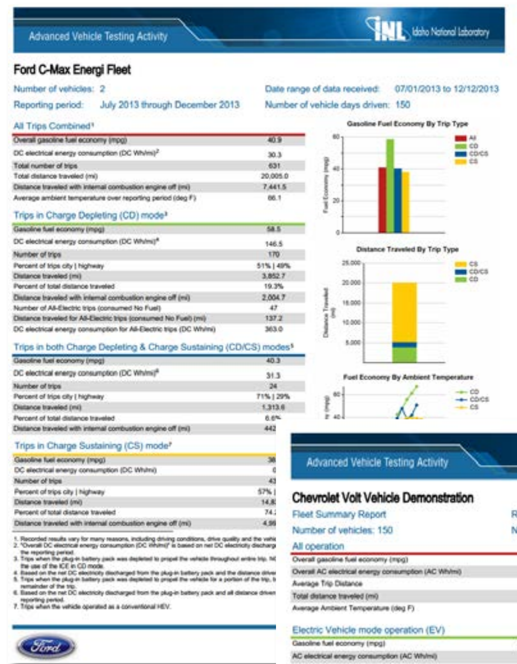
Vehicle Demonstration Accomplishments

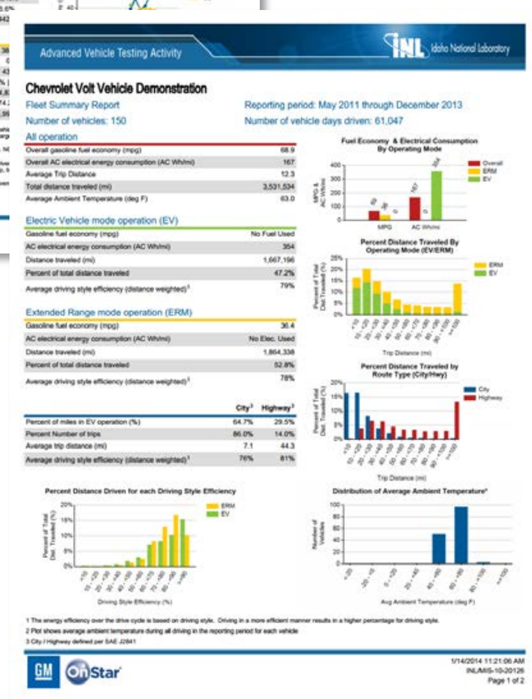
2013 Ford C-Max Energi Fleet Demo

- Quarterly and summary results-to-date INL reports published online
- Reporting Metrics
  - 2 Vehicles
  - 20,050 Miles @ 41 MPG
    - 3853 Charge Depleting Trip Miles (20%) @ 59 MPG

2011 Chevrolet Volt Fleet Demo

- Quarterly and summary results-to-date INL reports published online
- Reporting Metrics *(FY13 Milestone)*
  - 150 Vehicles
  - 3,531,534 Miles
    - 1,667,196 EV Miles (47%)

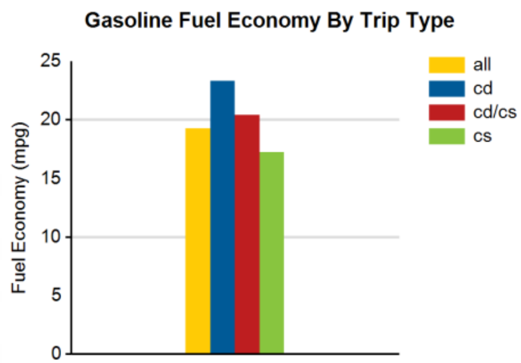




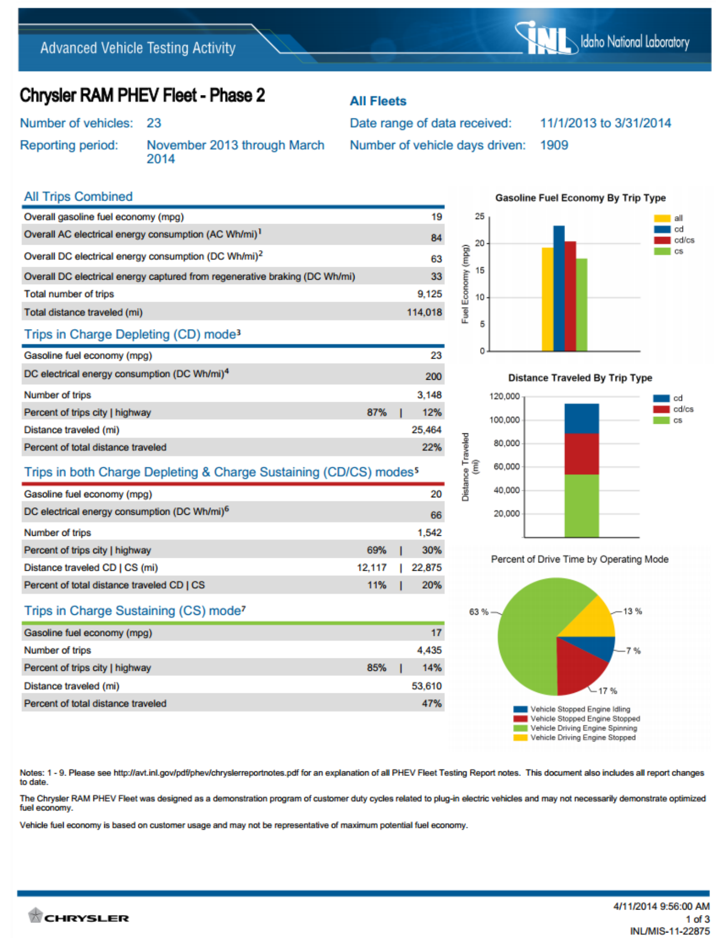
Vehicle Demonstration Accomplishments

Chrysler Ram PHEV Demo

- Monthly and summary results-to-date INL reports published online



- Phase 1 data reporting – previous years
  - July 2011 – September 2012
  - 111 Vehicles/1,039,138 Miles
  - *(FY13 Milestone)*
- Phase 2 data reporting
  - November 2013 – March 2014
  - 23 Vehicles/114,018 Miles



Advanced Vehicle Testing Activity

Chrysler RAM PHEV Fleet - Phase 2

Number of vehicles: 23
Reporting period: November 2013 through March 2014

All Fleets
Date range of data received: 11/1/2013 to 3/31/2014
Number of vehicle days driven: 1909

All Trips Combined	
Overall gasoline fuel economy (mpg)	19
Overall AC electrical energy consumption (AC Wh/mi)[1]	84
Overall DC electrical energy consumption (DC Wh/mi)[2]	63
Overall DC electrical energy captured from regenerative braking (DC Wh/mi)	33
Total number of trips	9,125
Total distance traveled (mi)	114,018

Trips in Charge Depleting (CD) mode[3]		
Gasoline fuel economy (mpg)		23
DC electrical energy consumption (DC Wh/mi)[4]		200
Number of trips		3,148
Percent of trips city | highway	87%	12%
Distance traveled (mi)		25,464
Percent of total distance traveled		22%

Trips in both Charge Depleting & Charge Sustaining (CD/CS) modes[5]		
Gasoline fuel economy (mpg)		20
DC electrical energy consumption (DC Wh/mi)[6]		66
Number of trips		1,542
Percent of trips city | highway	69%	30%
Distance traveled CD | CS (mi)	12,117	22,875
Percent of total distance traveled CD | CS	11%	20%

Trips in Charge Sustaining (CS) mode[7]		
Gasoline fuel economy (mpg)		17
Number of trips		4,435
Percent of trips city | highway	85%	14%
Distance traveled (mi)		53,610
Percent of total distance traveled		47%

Gasoline Fuel Economy By Trip Type

Distance Traveled By Trip Type

Percent of Drive Time by Operating Mode

Vehicle Stopped Engine Idling
Vehicle Stopped Engine Stopped
Vehicle Driving Engine Spinning
Vehicle Driving Engine Stopped

Notes: 1 - 9. Please see http://avt.inl.gov/pdf/phev/chryslerreportnotes.pdf for an explanation of all PHEV Fleet Testing Report notes. This document also includes all report changes to date.

The Chrysler RAM PHEV Fleet was designed as a demonstration program of customer duty cycles related to plug-in electric vehicles and may not necessarily demonstrate optimized fuel economy.

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

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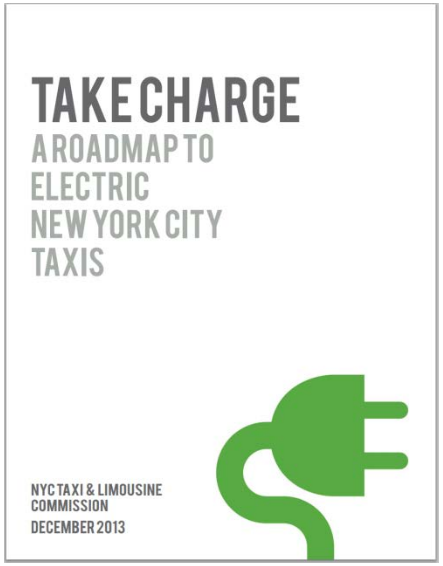
Vehicle Demonstration Accomplishments

NYC EV Taxi Pilot

- INL Data collection from
  - Nissan
    - Vehicle driving and charging data from 6 2012 Nissan Leaf Taxis *(FY 13 Milestone)*
  - New York City Taxi & Limousine Commission (NYC TLC)
    - Taxi meter data
- INL merges, analyzes data, providse monthly reporting to Nissan, NYC Taxi and Limousine Commission
- NYC Taxi and Limousine Commission released <u>Take Charge: A Roadmap to Electric New York City Taxis</u> leveraging demonstration reporting



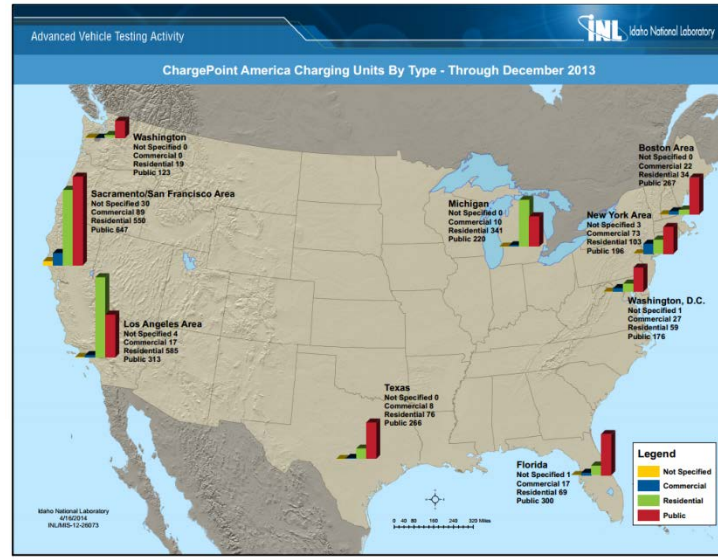
Credit: NYC Taxi & Limousine Commission

Photo Credit: Nissan North America

Infrastructure Demonstration Accomplishments

ChargePoint America

- Provides information about ARRA funded infrastructure deployment and usage
- 4,647 AC L2 Ports in 9 regions in Dec 2013
- INL published quarterly reports and maps online from 5/2011 through 12/2013

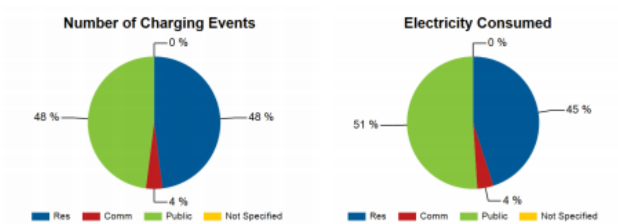


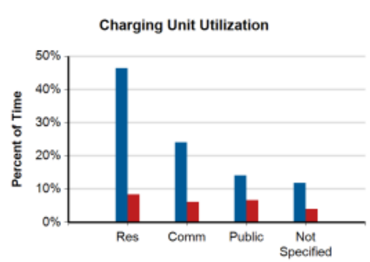
ChargePoint® America Vehicle Charging Infrastructure Summary Report

Report period: October 2013 through December 2013

Region: All

Charging Unit Usage - By Type	Residential	Private Nonresidential	Publicly Accessible	Not Specified	Total
Number of charging units[1]	1,683	197	2,098	28	4,006
Number of charging events[2]	137,286	11,047	136,450	1,123	285,906
Electricity consumed (AC MWh)	992.74	91.46	1,117.79	9.87	2,211.85
Percent of time with a vehicle connected	46%	24%	14%	12%	28%
Percent of time with a vehicle drawing power	8%	6%	7%	4%	7%





Public infrastructure utilization varies geographically due to:
- Vehicle population
- Travel needs and routines
- Local culture

Infrastructure Demonstration Accomplishments

NYSERDA EVSE Demonstration Program

- INL collecting data from EVSE deployed in New York State
- Developing reporting in conjunction with NYSERDA and Energetics
  - Public reporting
  - Build on EV project reporting
  - Current data 228+ EVSE, 345 ports.
- Diverse EVSE and attributes
  - 6+ EVSE Mfg.
  - 4+ Data providers
  - Location type, access type, signage
  - Truck Charging

Photo Credit - NYSERDA

Demonstration Accomplishments

Results from infrastructure and vehicle demos requested by a multitude of organizations, including:

- Electric utilities seeking input on rate design, advice filings to PUCs
- EVSE manufacturers seeking insights into valued product features, business model development
- Federal, state, and local agencies involved in infrastructure planning, such as DOT, California air quality management districts, DOE Clean Cities coalitions
- Auto manufacturers seeking to validate travel and charging behavior assumptions
- Universities and private research organization collaboration

Codes and Standards Support Accomplishments

Provide input from testing & evaluation to support standards development

- NFPA PEV Battery Hazards Project
  - Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results technical report published
- NIST U.S. National Work Group on Measuring Devices for Electric Vehicle Fuel and Sub-Metering
- SAE J2894 Power Quality Requirements for Plug-In Electric Vehicle Chargers committee
- SAE J2954 Wireless Charging of Electric and Plug-in Hybrid Vehicles
  - Support test procedure development
    - Test results using draft procedures
    - System tolerance,response to debris
    - Evaluated mock floor pan fixture, compare open air, on-vehicle

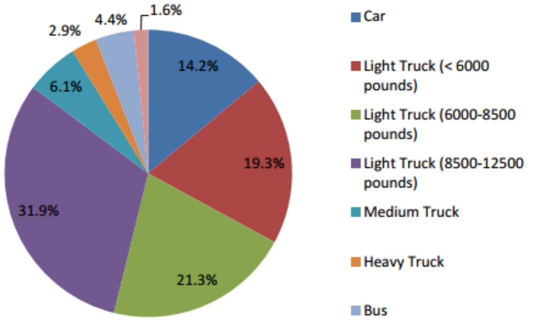
Federal Fleet Outreach Accomplishments

FEMP fleet PEV suitability project

- Collected usage data from conventional vehicles in federal fleets
- Reporting results of analysis as it applies for each fleet's mission
  - Golden Gate NRA, Fort Vancouver NRA reports completed
  - Agency Analyses in progress: (3) NPS, (3) NASA, (2) VA, (1) DHS, and (1) NIH

DoD / DOE MOU

- Microclimate base study – Electric Vehicle Preparedness
  - Joint Base Lewis McChord
  - Candidate bases for evaluation
  - Vehicle data logging, PEV suitability
  - Infrastructure support analysis



- Purpose is to reduce fleets' risk with advanced vehicle and infrastructure purchase, deployment, and operating decisions

Address Previous Year Review Comments

- …The reviewer observed that the presenter noted a lack of confidence in understanding the lifecycle performance of EV batteries under normal driving conditions. The reviewer suggested that if this was true, that the INL study ought to identify specific areas of concern and suggest specific pathways to resolve the concerns.
  - Updated testing procedures incorporate continuous data logging through the life of a test vehicle. This information, combined with five laboratory battery tests throughout the vehicle life allow battery performance changes at mileage intervals to be linked to conditions the vehicle was subjected to (i.e. heat, fast charge, frequent charging, little charging, etc). Additionally, performance changes in real-world operating conditions through the duration of vehicle testing (EV range, fuel economy, etc) can also be better attributed to battery degradation. The results of this testing feed into battery technical working groups including the national labs, DOE, and vehicle OEMs via U.S. Advanced Battery Consortium. USABC's feedback is considered while continuously improving testing methods to ensure the data products are providing value.
- The reviewer indicated that a more targeted effort in bringing this voluminous data stream down to a digestible level across this vehicle class is warranted. The reviewer added that stating that continuation of objectives reinforces no change other than collecting more extensive data.
  - While the volume of data has been emphasized, the accuracy and usefulness of the information presented as a result of the collection and analysis activities is the most important deliverable. One example of efforts to make the information products useful and accessible include providing numerical reporting in addition to figure-based fact sheets, such that the information may be used more efficiently as inputs for further analysis. The objective of continuing and broadening data collection efforts is focused on producing testing and demonstration results from technologies that are continuously changing with advances in technology and standards.

Address Previous Year Review Comments

- This reviewer pointed out that there was good data collection activity. However, the reviewer noted that limited sample sizes could limit the strength of some conclusions.
  - The focused data collection and analysis activity that monitors vehicle performance, usage, and sub-system performance through vehicle life are limited in sample size due to costs. While the typical sample size of four vehicles for this element of the project may not be statistically representative of the average vehicle of the same year/make/model, it does allow for investigation of sub-system attributes and changes through time, benchmarking of technology capabilities through track and dynamometer testing on standardized cycles, while tracking of operating costs and fuel-efficiency are use-dependent.
  - Complementary demonstration activities that capture both the average and distribution of operational parameters are better suited to showing the range of results from a large sample size, where the costs are not proportional to the number of vehicles participating.

Collaboration

Photo: Argonne

- Intertek Testing Services – AVTA testing partner
- ANL & ORNL – AVTA vehicle dynamometer testing
- Vehicle and infrastructure demonstrations
  - Ford, GM, OnStar, Chrysler, Nissan
  - ChargePoint, NYSERDA, NYC Taxi & Limousine Commission
  - AeroVironment, EPRI, Oregon State, Washington State
- Testing to support codes and standards development
  - DOT, NFPA, SAE, NIST

Photo: Intertek

- Federal fleet outreach activities
  - FEMP, GSA, DOE Clean Cities, US Park Service
  - US Army, Navy, Air Force, Marine Corps
- University
  - University of California Davis – Ram PHEV demo
  - Colorado State – PHEV utility

Photo: Oregon DOT

Remaining Challenges and Barriers

- Vehicle technologies constantly evolving
- Charging infrastructure technologies advancing, changing i.e. wireless
- Standards evolving to meet technology needs
- Vehicle interaction with grid has many uncertainties

- Each of these challenges are opportunities for testing, evaluation, and demonstration projects to provide key input for modeling, developers, and decision makers

Future Work

- Continuously expand advanced vehicle testing to include a wider selection of technologies and increased data collection sophistication and analysis
  - 12V system accessory load monitoring for AVTE test vehicles
- Leverage vehicle testing program resources to allow low-cost EVSE/vehicle interoperability testing (standards validation and compliance)
  - SAE Interoperability study
  - EVSE travel corridor study on the I-5
- Increase value of test results by
  - Continued collaboration with industry and other labs through DOE tech teams
  - Expanded outreach to federal fleet managers through continued collaboration with FEMP, GSA, and Clean Cities by leveraging results of vehicle and infrastructure testing
- Expansion of vehicle and infrastructure demonstrations into new regions and/or unique applications
  - New York State Energy Research & Development Agency infrastructure demo – 325+ EVSE in NY
  - DC Fast Chargers load leveling with integrated energy storage
  - XL Hybrid fleet demo: data collection and reporting
  - EVSE travel corridor study on the I-5
  - Multiple OEM PEV demo and analysis
  - DoD V2G PEV pilot study data collection, analysis, and reporting support
- Continue to provide testing and data collection services to DOE for future DOE-funded technology demonstrations, including:
  - EPRI / VIA Motors PEV demo
  - Support ESIF grid related research by leveraging INL infrastructure data archives and project data

Summary

- AVTA performs low-cost testing and demonstrations for a broad range of advanced technology vehicles and fueling infrastructure to
  - Identify the real-world potential of the technology for petroleum displacement in a wide array of usage scenarios
  - Verify return on investment of DOE-funded technology development
- Results and lessons learned are provided to a broad range of stakeholders to:
  - Reduce risk of development, deployment, and ownership decisions
  - Guide infrastructure requirements planning and impact assessment
  - Support the development of codes and standards
- To date, results clearly show ***how the vehicles are used*** matters to petroleum displacement
- Therefore, AVTA will continue to emphasize technology evaluation across a wide range of usage patterns and customer applications

Summary continued

- AVTA is a very low-cost activity for the testing performed and results published
  - Testing and infrastructure demonstrations are made possible by contributions from a multitude of partners – hundreds of organizations and thousands of individual participants to date
  - Every testing regime has at least 20% cost share; most testing cost-share is 50% or higher
- Before a vehicle testing regime or demonstration is initiated, the AVTA determines the technical and economic value of testing partnerships to ensure that the maximum value to DOE and taxpayers are achieved
- A broad range of stakeholders, including taxpayers, receive independent information on emerging technologies

Reviewer-Only Slides

Publications and Presentations

Select Reports

- Schey, S., Francfort, J., *AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for the National Park Service: Fort Vancouver National Historic Site*, Idaho National Laboratory technical paper INL/EXT-14-31608, Mar 2014.
- Schey, S., Francfort, J., *AVTA Federal Fleet PEV Readiness Data Logging and Characterization Study for the National Park Service: Golden Gate National Recreation Area*, Idaho National Laboratory technical paper INL/EXT-14-31368, Mar 2014.
- Sathaye,N., Schey,S., Francfort,J., *Electric Vehicle Preparedness Task 1: Assessment of Data and Survey Results for Joint Base Lewis McChord,* Idaho National Laboratory technical paper INL/EXT-13-29359, Jun 2013.
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- Sathaye,N., Schey,S., Francfort,J., *Electric Vehicle Preparedness - Task 2: Identification of Joint Base Lewis McChord Vehicles for Installation of Data Loggers ,* Idaho National Laboratory technical paper INL/EXT-13-29329, Jun 2013.
- Gray, T., Diez,J., Wishart, J., Francfort, J., *Electric Ground Support Equipment Advanced Battery Technology Demonstration Project at the Ontario Airport*, INL technical paper INL/EXT-13-29680, Jul 2013.
- Newnham, R., Sun, S., Karner, D., *Energy Storage for DC Fast Chargers Development and Demonstration of Operating Protocolsfor 20-kWh and 200-kWh Field Sites*, INL technical paper INL/EXT-13-28684, Apr 2014.

Select Summary Reports and Fact Sheets

- Ford C-Max Energi Fleet Report Summary
- Chrysler RAM PHEV Fleet Summary Report
- Chevrolet Volt Vehicle Demonstration Report Summary Report
- ChargePoint America Vehicle Charging Infrastructure Summary Report
- INL Hybrid Shuttle Buses Fact Sheet
- US Drive Report: DC Fast Charge Effects on EV Battery Performance

Publications and Presentations Continued

<u>Select Summary Reports and Fact Sheets (Continued)</u>

AVTE Vehicle Baseline Testing Reports

AVTE Battery Testing Reports

AVTE Interim Component Durability Reports

AVTE Maintenance History Fact Sheets

AVTE Fleet Testing Fuel Economy Fact Sheets

AVTE Fleet Testing Summary Fact Sheet

<u>Select Presentations</u>

- Francfort, J., PEV Infrastructure Deployments, Costs, and Drivers, AABC Conference, Atlanta, GA, February 2011, INL/CON-13-30486
- Francfort J., Plug-in Electric Vehicle Operations and Charging Profiles, Defense Energy Summit, Austin, TX, November 2013, INL/CON-13-30604
- Francfort, J., White House, DOE, DOT, SAE - Vehicle Data Jam, White House DataJam Meeting, Detroit, MI, April 2013, INL/MIS-13-28858
- Francfort, J., Shirk,M., EV 101 & INL's EV and Charging Infrastructure Experience, Jackson, WY, September, 2013, INL/MIS-13-30197
- Francfort, J., Shirk,M., Smart,J., McGuire, P., INL's EV and Charging Infrastructure Activities, US-Shanghai PEV Exchange, Idaho Falls, ID, September, 2013, INL/MIS-13-30240
- Francfort, J., NJ Transit Meadows Maintenance Complex and Rail Operations Center: Potential Electric Drive Vehicle Replacements, November, 2013, INL/MIS-13-30670
- Francfort, J., Smart, J., Trends Observed in Plug-in Electric Vehicle Infrastructure Demonstrations, March, 2014, INL/MIS-14-31406
- Shirk, M., DC Fast, Wireless, and Conductive Charging Evaluation Projects at Idaho National Laboratory, SAE Hybrid Symposium, San Diego, CA, February 2014, INL/CON-13-30492
- Carlson, R., Idaho National Laboratory Testing of Wireless Charging Systems in support of SAE J2954, June, 2013, INL/MIS-13-29235

Critical Assumptions and Issues

- Information on fuel efficiency and operating modes, such as all-electric and blended charge-depleting, beyond single, composite numbers such as ‘window sticker’ fuel economy, can be used by an informed consumer to affect purchasing, operating, and utilization behavior to minimize their energy consumption and maximize their return on investment on advanced vehicle purchases
  - Pairing individual usage needs with technology capabilities while understanding limitations can result in choices that drastically affect the petroleum reduction potential of a given technology.
- Funding agencies need technical reporting to quantify the success of project goals from advanced technology vehicle deployments and to guide future investments
  - Field testing results routinely vary from manufacturer or technology developer statements of capability.
  - Data collection and reporting can capture the distribution of results and help both the funding agency and the developer understand the causality.
- Modeling can be used to accelerate technology development, supporting DOE goals, given data sources to build powerful, accurate methods based on a wide variety of conditions
  - Field testing, lab testing, and large scale demonstrations give both precise data from controlled experiments, and valuable information on the distributions of outcomes from ‘real-world’, unguided technology usage.
  - Simple models with narrow assumptions are limited in their predictive power, thus the need for many sources of data.