

ADVANCED VEHICLE TESTING & EVALUATION

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VSS029

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OVERVIEW - NEW AGREEMENT

TIMELINE

Project Start; 10/01/2011 Project End; 9/30/2016 Percent Complete; 10%

BUDGET

Total Project; \$33,088,218
DOE Share; \$26,400,000
Cost Share; \$ 6,688,218
Current Auth; \$ 6,351,700

BARRIERS

Vehicle Availability
Vehicle Reliability
Infrastructure Requirements

PARTNERS

EZ Messenger Total Transit Idaho National Laboratory Argonne National Laboratory

Relevance



OBJECTIVES

- Disseminate vehicle and infrastructure testing results to industry and other DOE programs
- Provide benchmark data for advanced technology vehicles
- Develop lifecycle cost data for production vehicles that are utilizing advanced power trains
- Provide fleet operations data to the Idaho National Laboratory database

Relevance



MILESTONES

Advanced Technology Vehicles on test (2012)

	BEV	2
•	PHEV	6

◆ HEV 7

◆ ICE 8

 Advanced Technology Vehicles to be tested in 2013 (difference is those to be started)

◆ BEV 12

◆ PHEV 22

◆ HEV 19

◆ ICE 8



PROCEDURE DEVELOPMENT

- Administrative Procedures For Control Of Test Conduct
- Vehicle Specifications Defining Key Vehicle and Performance And Safety Parameters
- Battery Test Procedures Defining Implementation Of Standard Test Requirements
- Develop Interim Component Durability Test Procedures



BASELINE TESTING

- Benchmark Performance
 - Acceleration
 - Maximum speed
 - Braking
 - Driving cycle range
 - With accessory loads
 - Without accessory loads



ACCELERATED TESTING

◆ Fixed Route Mileage Accumulation

Cycle	Urban	Highway	Charge	Reps	Total	Reps	Miles
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	(%)	(%)
10	1	0	4	60	600	37%	11%
20	1	1	8	30	600	19%	11%
40	4	0	12	15	600	9%	11%
40	2	2	12	15	600	9%	11%
40	0	4	12	15	600	9%	11%
60	2	4	12	10	600	6%	11%
80	2	6	12	8	640	5%	12%
100	2	8	12	6	600	4%	11%
200	2	18	12	3	600	2%	11%
Total	2,340	3,100	1,344	162	5,440		
Average	43%	57%	8.3	18			



FLEET TESTING

- Production Vehicles
- ◆ 195,000 Miles
- On-Board Data Logger with Automatic Data Upload
- ◆ Fuel And Maintenance Logs
- ◆ Interim Component Durability Testing



BATTERY TESTING

- Hybrid Vehicles
 - ◆ C₁ capacity
 - Hybrid pulse power characterization
- ◆ Plug-In Hybrid Vehicles
 - ◆ C₃ capacity
 - Hybrid pulse power characterization
- **◆** Battery Electric Vehicles
 - ◆ C₃ capacity
 - Electric vehicle power characterization

Accomplishments



2012 BASELINE TESTS

- ◆ 2012 Honda Civic CNG
- ◆ 2013 Chevrolet Volt
- ◆ 2013 Chevrolet Malibu ECO
- 2013 VW Jetta TDI



2011 Chevrolet Volt – VIN 0815

Advanced Vehicle Testing - Baseline Testing Results



Vehicle Features

Base Vehicle: 2011 Chevrolet Volt VIN: 1G1RD6E48BUI00815 Class: Compact Seatbelt Positions: 4 Type²: Multi-Mode PHEV (EV,

Series, and Power-split)

Mote

Type: 12-pole permanent magnet AC synchronous Max. Power/Torque: 111 kW/370 Nm

Max. Motor Speed: 9500 rpm Cooling: Active – Liquid cooled

Generator Type: 16-pole permanent magnet AC

synchronous
Max. Power/Torque: 55 kW/200 Nm
May. Generator Speed: 6000 rnm

Max. Generator Speed: 6000 rpm Cooling: Active – Liquid cooled

VEHICLE SPECIFICATIONS¹

Battery

Manufacturer: LG Chem
Type: Lithium-ion
Cathode/Anode Material:
LiMn₂O₄/Hard Carbon
Number of Cells: 288
Cell Config.: 3 parallel, 96 series
Nominal Cell Voltage: 3.7 V
Nominal System Voltage: 355.2 V
Rated Pack Capacity: 45 Ah
Rated Pack Energy: 16 kWh
Weight of Pack: 435 lb
Pack Location: Underneath vehicle
center
Cooling: Active—Liquid cooled

Engine

Model: DOHC I-4 Output: 63 kW @ 4800rpm Configuration: Inline 4-Cylinder Displacement: 1.4 L Fuel Tank Capacity: 9.3 gal Fuel Type: Premium Gasoline

Weight

Design Curb Weight: 3,7811b
Delivered Curb Weight: 3,7701b
Distribution F/R (%4): 61/39
GVWR: 4,5481b
GAWR F/R: 2,515/2,0331b
Max. Payload: 7501b
Performance Goal: 24001b
Dimensions
Wheelbase: 105.7 in
Track F/R: 61.2 / 62.1 in
Length/Width: 177.1 in/70.4 in

Height: 56.6 in Ground Clearance: 6.0 in Performance Goal: ≥6.0 in

Tires
Manufacturer: Goodyear
Model: Assurance
Size: P215/55R17
Pressure F/R: 35/35 psi
Spare Installed: N/A - Tire

sealant and inflator





Accomplishments



2012 FLEET TESTS

- ◆ 2 Honda CR-Z HEV
- 2 Hyundai Sonata HEV
- 2 Chevrolet Volt PHEV (MY 11)
- 2 Nissan Leaf BEV (MY 11)
- 4 Honda Civic CNG
- 4 VW Jetta TDI
- ◆ 4 Chevrolet Volt PHEV (MY 13)
- 4 Chevrolet Malibu ECO



VEHICLE SPECIFICATIONS

WEIGHTS

GAMR: 3164 bs GAWR F/R: 1797/1378bs

Payload 5 954 bs

DIMENSIONS

Length: 160.6 In

Height: 54.9 in

Tire Mfg: Dunlop

Spare Installed: Yes

Displacement: 1.5 L Ruel Tank Capacity: 10.6 call

TIRES

ENGINE

Model: 1.5 L 14

Track E.R - 59 6/59 Lin

Ground Clearance: 5.3 In

Performance Goal: 5.0 in

Tire Model: SP Sport 1000m

The Size: 195 / 55 R16 86V

The Pressure F/R: 30/30 psi

Output⁶: 122 hp @ 6000 rpm

Ruel Type: Unleaded Gasoline

Gaiffattation: Trilling Batt edition:

8. C ombined: engine (\$65 ner) + electric motor

Design Curb Weight: 2650 lbs

Performance Goal: 400 bs

Delivered Curb Weight?: 2615 bs

Distribution F/R® (%): \$8.6/41.4

VEHICLE FEATURES Başe Vehicle: 2011 Honda CRZ EX VIN: JHMZF1C648S002982

Seatbelt Postions: Two Standard Features: Air Conditioning Power Lodks Power Steering Power Brakes

Power Windows Cruise Control Front Disc Brokes Roar Disc Brakes Front Wheel Drive Regenerative Broking

Anti-Line (Oraketa) Traction Control Air Sags AN/PM Starce with CO player State of Charge Meter

BATTERY

Manufacturer: Renasonic Type: Rickel-Yeld Hydride Number of Modules: 84 Weight of Redc 65 lbs Rack(s) Location: Behind the rear arkigo tays under the turk fuer Nominal Module Voltage: 1.2 V Nominal System Voltage: 100.8 V Nominal Pack Capacity: 5.75 Ah Electric Motor: 10 kW

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of ormancenumbers based on "Nor mail" mode. diudes a cost down at the end of the cycle.

This which meats all HEV America Minimum Requirements I lated on back of this sheet

PERFORMANCE STATISTICS

Acceleration 0-60 mph Measured: 10.9 seconds Performance Goal: 13.5 seconds

Maximum Speed⁶ At V₆ Mile: 79.3 mph In 1 Mile: 108.0 mph Performance Goal: 70 mph in one mile

Driving Cycle Range w/o Accessories⁶

Amn - cute Out: 3,175 4t1^{2,7} Amn - cute In: 3,377 4t1^{2,7} Cycle Fuel Economy: 44.4 mpg Driving Range: 471 miles³

Driving Cycle Range

w/Accessor Ama Hours Out: 5,553 Abril Ama--curs in: 5.7% Ahr² Cycle Fuel Economy: 35.8 mpg Driving Range: 379 miles²

Braking From 60 mph⁶ Controlled Dry: 116.8 feet

Gradeability (Calculated) Maximum Speed @ 3%: 82.6 mph

Maximum Speed @ 6%: 82.3 mph Maximum Grade: 51.7 %

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Collaborations



NATIONAL LABORATORIES

- ◆ Idaho National Laboratory
 - Procedure development
 - Data collection & analysis
 - Reporting
- Argonne National Laboratory
 - Procedure development
 - Chassis Dynamometer testing
 - Fuel Economy

Collaborations



INDUSTRY PARTNERS

- **◆ EZ Messenger**
 - Document delivery fleet
 - Mileage accumulation
 - ◆ Route design
- **♦** Total Transit
 - **♦** Taxi service
 - Mileage accumulation



Future Work



Continuous Improvement

- Update test procedures
- Develop new test procedures for new technologies
- Develop test procedures for interim component durability testing
- Electronic transmission of test data
- Initiate vehicle fueling infrastructure testing and evaluation
- Identify & expand test fleet operators



Future Work



Ongoing Testing

- Over 150 vehicles scheduled for testing
- ◆ A dozen fueling infrastructure evaluations





2012 SUMMARY

- 4 new models started in vehicle testing (16 vehicles)
- 4 different advanced vehicle technologies
- New data collection tools selected and implemented
- Electronic test data transfer implemented
- ◆ All Test Results Posted To AVTA Website



TECHNICAL BACKUP SLIDES

vss029

HEV Fleet Testing - Summary Fact Sheet



Advanced Vehicle Testing Activity

2010 Toyota Prius

Fleet Performance

Operating Cost:

Purchase Cost: \$29,174 (7/09)*
Kelley Blue Book: \$8,944 (1/12)
Sale Price: In Operation
Maintenance Cost: \$0.03/mile
Operating Cost: \$0.12/mile**
Total Ownership Cost: \$0.32/mile

Operating Performance:

Total miles driven: 136,181 Cumulative MPG: 45.6

Major Operations & Maintenance

Events: None

*Purchase includes dealer price with options plus taxes. It does not include title, license, registration, extended warranty or delivery fee costs.

**Operating costs includes insurance, fuel, and registration costs

Description:

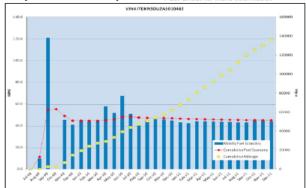
This vehicle is operated throughout the valley of Phoenix, Arizona by EZ Messenger, a legal document courier business. It is operated five days a week, transferring documents between courts, law offices, and medical facilities on city streets and urban freeways.

Vehicle Specifications

Engine: 1.8 L 4-cylinder Electric Motor: 60 kW Battery: NiMH Seatbelt Positions: Five Payload: 885 lbs Features:

Regenerative braking Traction control

See HEVAmerica Baseline Performance Fact Sheet for more information



Monthly MPG = (miles driven)/(gallons of fuel purchased). Monthly variation in reported MPG may occur due to the difference in fuel tank level at the beginning and end of the month.

ENERGY

Energy Efficiency & Renewable Energy EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov/informationcenter



VEHICLE TECHNOLOGIES PROGRAM

2013 Chevrolet Volt - VIN 3929

Advanced Vehicle Testing - Beginning-of-Test Battery Testing Results





VEHICLE DETAILS AND BATTERY SPECIFICATIONS¹

Vehicle Details

Base Vehicle: 2013 Chevrolet Volt VIN: 1G1RA6E40DU103929

Propulsion System: Multi-Mode PHEV (EV, Series, and

Power-split)

Engine: DOHC I-4, 1.4 L, 63 kW @ 4800 rpm

Number of Electric Machines²: 2

Motor: 111 kW (peak), AC induction, Air cooled

Generator2: 55 kW (peak), DC Permanent Magnet, Liquid

cooled

Peak Electric Drive and Engine Power: 111 kW

Battery Specifications Manufacturer: LG Chem

Type: Lithium-ion Number of Cells: 288 Nominal Cell Voltage: 3.7 V Nominal System Voltage: 355.2 V Rated Pack Capacity: 45 Ah Rated Pack Energy: 16.5 kWh

Maximum Cell Charge Voltage³: 4.15 V Minimum Cell Discharge Voltage³: 3.00 V Thermal Management: Active – Liquid cooled

BATTERY LABORATORY TEST RESULTS SUMMARY

Vehicle Mileage and Testing Date

Vehicle Odometer: 4,007 mi Date of Test: December 13, 2012

Static Capacity Test

Measured Average Capacity: 46.5 Ah Measured Average Energy Capacity: 16.6 kWh

HPPC Test

CD Available Energy Margin⁴: 1.1 kWh CS Available Energy Margin⁴: 0.89 kWh

Constant-Power Discharge Test

Capacity Discharged: 46.7 Ah Energy Discharged: 16.7 kWh

NOTES:

- 1. Vehicle details and battery specifications were either supplied by the manufacturer or derived from a literature review.
- 2. Not all electric machines (EMs) always provide traction power; one of the EMs is a traction motor while the main role of the other is to act as a generator.
- 3. Maximum cell charge voltage and minimum cell discharge voltage are based on similar battery chemistries from the same battery manufacturer.
- 4. Available energy at the DOE maximum PHEV power performance goals.



