



ADVANCED VEHICLE TESTING & EVALUATION

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ECOTALITY NORTH AMERICA

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VSS029

OVERVIEW

TIMELINE

Project Start; 10/1/05
Project End; 3/31/12
Percent Complete; 80%

BUDGET

Total Project; \$13,197,679
DOE Share; \$10,659,094
Contractor; \$2,538,585
CY 2010; \$1,362,845

BARRIERS

Vehicle Availability
Vehicle Reliability
Infrastructure Requirements

PARTNERS

Roush Industries
EZ Messenger
Idaho National Laboratory
Argonne National Laboratory

OBJECTIVES

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

MILESTONES

◆ 2010 (Completed)	
◆ Vehicles Purchased	19
◆ Tests Initiated	36
◆ Tests Completed	19
◆ 2011 (Scheduled)	
◆ Vehicles Purchases	10
◆ Tests Completions	75
◆ Contract Termination	

PROCEDURE DEVELOPMENT

- ◆ Administrative Procedures For Control Of Test Conduct
- ◆ Vehicle Specification Defining Key Performance And Safety Parameters
- ◆ Vehicle Test Procedures Defining Tests Verifying Vehicle Specification Requirements
- ◆ Battery Test Procedures Defining Implementation Of Standard Test Requirements

Approach

BASELINE TESTING

- ◆ Benchmark Performance
 - ◆ Acceleration
 - ◆ Maximum Speed
 - ◆ Driving Cycle Range (ANL Dynamometer)
 - ◆ Without Accessory Loads
 - ◆ With Accessory Loads
 - ◆ Braking
 - ◆ Gradeability

HEVAmericA
 U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY



2011 Honda CRZ Hybrid Electric Vehicle

VEHICLE SPECIFICATIONS	PERFORMANCE STATISTICS
VEHICLE FEATURES Base Vehicle: 2011 Honda CRZ EX Hybrid VIN: JHMZF1C64B9002982 Seatbelt Positions: Two Standard Features: Air Conditioning Power Steering Power Windows Cruise Control Front Disc Brakes Rear Disc Brakes Front Wheel Drive Regenerative Braking Anti-Lock Brakes Traction Control Air Bags AM/FM Stereo with CD player State of Charge Meter ¹	WEIGHTS Design Curb Weight: 2650 lbs Delivered Curb Weight ² : 2815 lbs Distribution F/R ³ (%): 58.6/41.4 GVWR: 3164 lbs GAWR F/R: 1797/1378lbs Payload ⁴ : 564 lbs Performance Goal: 400 lbs DIMENSIONS Wheelbase: 95.9 in Track F/R: 59.6/59.1 in Length: 160.6 in Width: 68.5 in Height: 54.9 in Ground Clearance: 5.3 in Performance Goal: 5.0 in TIRES Tire Mfg: Dunlop Tire Model: SP Sport 1000m Tire Size: 195 / 55 R 16 86V Tire Pressure F/R: 30/30 psi Spare: Installed: Yes ENGINE Model: 1.5 L I4 Output ⁵ : 122 hp @ 6000 rpm Configuration: Inline Four-cylinder Displacement: 1.5 L Fuel Tank Capacity: 10.6 gal Fuel Type: Unleaded Gasoline
BATTERY Manufacturer: Panasonic Type: Nickel-Metal Hydride Number of Modules: 84 Weight of Pack: 65 lbs Pack(s) Location: Behind the rear package trays under the trunk floor Nominal Module Voltage: 1.2 V Nominal System Voltage: 100.8 V Nominal Pack Capacity: 5.75 Ah Electric Motor: 10 kW	Acceleration 0-60 mph⁶ Measured: 10.9 seconds Performance Goal: 13.5 seconds Maximum Speed⁶ At 1/4 Mile: 79.3 mph In 1 Mile: 108.0 mph Performance Goal: 70 mph in one mile Driving Cycle Range w/o Accessories⁶ Amp-Hours Out: 3,475 Ah ²⁷ Amp-Hours In: 3,327 Ah ²⁷ Cycle Fuel Economy: 44.4 mpg Driving Range: 471 miles ³ Driving Cycle Range w/Accessories⁶ Amp-Hours Out: 6,563 Ah ² Amp-Hours In: 6,731 Ah ² Cycle Fuel Economy: 35.8 mpg Driving Range: 379 miles ³ Braking From 60 mph⁶ Controlled Dry: 116.8 feet Gradeability (Calculated)⁶ Maximum Speed @ 3%: 82.6 mph Maximum Speed @ 6%: 82.3 mph Maximum Grade: 51.7 %
TEST NOTES: 1. Energy transfer display and SOC Meter. 2. Total battery discharge over SAE E24 drive cycle. 3. Values calculated based on fuel economy and fuel tank size. 4. Air Conditioning on maximum with full blower. 5. Payload does not include driver weight. 6. Performance number based on "Normal" mode. 7. Includes a coastdown at the end of the cycle. 8. C combined-engine (SAE net) + electric motor 9. Fuel tank approximately 5/8ths full.	

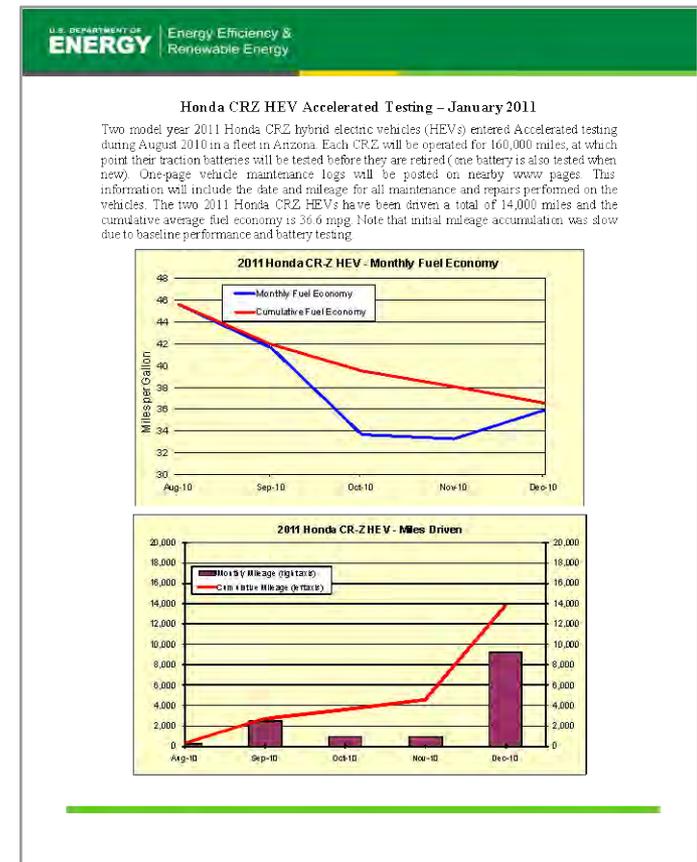
ACCELERATED TESTING

Cycle (mi)	Urban (10 mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Reps (%)	Miles (%)
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			

Approach

FLEET TESTING

- ◆ Production Vehicles
- ◆ 160,000 Mile Test Duration
- ◆ EZ Messenger Delivery Fleet
- ◆ On Board Data Logger
- ◆ Fuel And Maintenance Logs



BATTERY TESTING

- ◆ Hybrid Vehicles
 - ◆ C₁ Capacity
 - ◆ Hybrid Pulse Power Characterization
 - ◆ Vehicle New & End Of Test
- ◆ Start-Stop – C₁ Capacity
- ◆ Battery Electric Vehicles
 - ◆ C₁ Capacity

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2008 Chevrolet Tahoe-5170
Hybrid PBT Battery Test Results



Battery Specifications	Vehicle Specifications
Manufacturer: Cobasys	Manufacturer: Chevrolet
Type: Nickel-Metal Hydride	Model: Tahoe
Number of Modules: 240	Year: 2008
Weight of Pack: 145 lbs	Number of Motors ¹ : 2
Module Weight: 0.55 lbs	Motor Power Rating ² : 60 kW
Nominal Module Voltage: 1.2 V	VIN #: 1GNFC13568R215170
Nominal System Voltage: 288 V	
Nominal Pack Capacity: 6.5 Ah	

Battery Lab Test Results

HPPC Test	Static Capacity Test
Peak Pulse Discharge Power @ 10s ³ : 28.0 kW	Measured Average Capacity: 4.77 Ah
Peak Pulse Discharge Power @ 1s ³ : 37.1 kW	Measured Average Energy Capacity: 1750 Wh
Peak Pulse Charge Power @ 10s ³ : 24.7 kW	
Peak Pulse Charge Power @ 1s ³ : 32.8 kW	Vehicle Mileage and Testing Date
Maximum Cell Charge Voltage: 1.49 V	Vehicle Odometer: 543 mi
Minimum Cell Discharge Voltage: 1.0 V	Date of Test: April 16, 2008

Analysis Notes:
1. Motor refers to any motor capable of supplying traction power.
2. Motor power rating refers to the manufacturer's peak power rating for the motor(s) supplying traction power.
3. Calculated value based on selected battery voltage limits and at 50% SOC.

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2010 PROCEDURES

- ◆ Update Battery Test Procedures To Clarify Test Conditions
- ◆ Modify Baseline Test Procedures To Reflect New Test Facility
- ◆ Update Accelerated Test Procedures To Incorporate Driver Requirements
- ◆ Collaborate With INL To Develop Test Procedures For USPS Electric Vehicles

2010 BASELINE TESTS

- ◆ 2010 Honda Insight
- ◆ 2010 Toyota Prius
- ◆ 2010 Ford Fusion
- ◆ 2010 Mercedes S400
- ◆ 2011 Honda CRZ
- ◆ 2010 Smart For Two
- ◆ 2010 VW Golf Diesel
- ◆ 2010 Mazda 3
- ◆ 2010 EVI E-Mega
- ◆ 2010 Ford Escape

Accomplishments

2010 ACCELERATED TESTS

◆ 2010 Ford Escape PHEV



Test Date	Cycle (mi)	Urban (10 mi)	Highway (10 mi)	Charge (Hr)	Repetitions (N)	Total (mi)	Repetitions (%)	Miles (%)	Cumulative (mi)	Electricity (kwh)	Fuel (E-85)	MPG
	10	1	0	4	60	600	37%	11%	600			
Testing now	20	1	1	8	30	600	19%	11%	1200			
1/24-2/14/11	40	4	0	12	15	612.8	9%	11%	1812.8	186.12	3.200	191.5
8/24-9/15/10	40	2	2	12	15	620	9%	11%	2432.8	171.74	7.300	84.9
12/3/10- 1/7/11	40	0	4	12	15	632.6	9%	11%	3065.4	200.02	9.700	65.2
11/17-12/2/10	60	2	4	12	10	624.2	6%	11%	3689.6	124.16	11.800	52.9
9/16-9/27/10	80	2	6	12	8	664.1	5%	12%	4353.7	89.50	13.600	48.8
8/16-8/23/10	100	2	8	12	6	603	4%	11%	4956.7	64.01	13.700	44.0
8/1-8/3/10	200	2	18	12	3	557.2	2%	10%	5513.9	31.53	15.280	36.5
	Total	16	43	96	162	5514						

2010 FLEET TESTS

- ◆ 2010 Honda Insight
- ◆ 2010 Toyota Prius
- ◆ 2010 Ford Fusion
- ◆ 2010 Mercedes S400
- ◆ 2011 Honda CRZ
- ◆ 2010 Smart For Two
- ◆ 2010 VW Golf Diesel
- ◆ 2010 Mazda 3

Two of Each Vehicle

2010 BATTERY TESTS

◆ Initial Tests

- ◆ 2010 Honda Insight
- ◆ 2010 Toyota Prius
- ◆ 2010 Ford Fusion
- ◆ 2010 Mercedes S400
- ◆ 2011 Honda CRZ
- ◆ 2010 Smart For Two
- ◆ 2010 VW Golf Diesel
- ◆ 2010 Mazda 3

◆ Test Reports

- ◆ Initial & Final Test Data
 - ◆ 2007 Nissan Altima
 - ◆ 2007 Toyota Camry
 - ◆ 2006 Lexus 400h
- ◆ Final Test Data
 - ◆ 2006 Honda Civic
 - ◆ 2005 Ford Escape
 - ◆ 2005 Honda Accord
 - ◆ 2004 Toyota Prius

2010 SPECIAL TESTS

- ◆ Start-Stop Fuel Economy Study
 - ◆ Dynamometer Testing
 - ◆ Fuel Economy Test Cycles
 - ◆ USA, Europe, Japan
 - ◆ Fleet Testing Validation
 - ◆ With & Without Start-Stop Enabled
 - ◆ Real World Validation
- ◆ USPS Long-Life Vehicle Prototypes

NATIONAL LABORATORIES

- ◆ Idaho National Laboratory
 - ◆ Procedure Development
 - ◆ Data Collection & Analysis
- ◆ Argonne National Laboratory
 - ◆ Procedure Development
 - ◆ Dynamometer Testing

INDUSTRY PARTNERS

- ◆ Roush Industries
 - ◆ Vehicle Development
 - ◆ Regulatory Compliance Analysis
 - ◆ Special Testing
- ◆ EZ Messenger
 - ◆ Mileage Accumulation
 - ◆ Route Design

CONTRACT CLOSEOUT

- ◆ 2011 Testing
 - ◆ Grid-Connected Vehicle Testing
 - ◆ Industrial Equipment Using Advanced Batteries
 - ◆ Fast Charge Test Procedures
- ◆ Work Completion
 - ◆ Testing Complete 12/31/2011
 - ◆ Fleet Testing Wrap Up
 - ◆ Reporting Closeout



SUMMARY

- ◆ 175 Separate Testing Tasks Completed
- ◆ Ten Million Fleet Test Miles Accumulated
- ◆ Vehicles Using With Six Different Fuels Tested
- ◆ \$2.5 Million Cost Share Provided
- ◆ All Test Reports Posted To AVTA Website