Advancing Transportation Through Vehicle Electrification - PHEV

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Chrysler Group, LLC
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Project ID # ARRAVT067

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## Overview

### Timeline
- **Project Start:** September, 2009
- **Project Complete:** August, 2013
- **15% Complete**

### Budget
- **Total Project Funding**
  - DOE: $48,000,000
  - Chrysler: $49,408,996
- **Funding received FY09:** $0
- **Funding for FY10:** $3.3M

### Barriers
- **Battery performance across extreme ambient conditions**
- **Thermal management integration**
- **Charger technology**
- **Understanding customer usage of the PHEV technology**

### Development Partners & Key Suppliers
- Behr America
- Electrovaya
- Hitachi
- Delphi
- Eetrex
- Continental
- CASCO Products
- EPRI
- Austin Energy
- ERCOT
- Michigan State University
- University of Michigan
- Sacramento Municipal Utility District (SMUD)
- NextEnergy
- UC Davis

### Demonstration Partners
- Sacramento Municipal Utility District (SMUD)
- State of Colorado, DOT
- State of North Dakota
- New York State Energy Research and Development Authority (NYSERDA)
- Commonwealth of Massachusetts
- Austin Energy
- State of Michigan
- City of Kansas City, Missouri
- Clark Co., NV
- City of Yuma, AZ
- Hawaii State Energy Office (in cooperation with US Military)
- City and County of San Francisco
Objectives

- Demonstrate 140 pickup trucks in diverse geographies and climates, spanning from North Dakota to Arizona & Hawaii to Massachusetts, and across a range of drive cycles and consumer usage patterns applicable to the entire NAFTA region.

- Verify plug-in charging mode performance based on charger and battery model.

- Verify AC power generation mode.

- Prove product viability in “real-world” conditions.

- Develop bi-directional (communication and power) charger interface.

- Quantify the benefits to customers and to the nation.
Phase I: PHEV Development – 2009/10
- ✓ Supplier selection and component sourcing
- ✓ Perform Vehicle packaging
- ✓ Procure Instrumentation equipment
- ✓ Conduct design and performance standardization
- ✓ Simulate key systems prior to vehicle builds
- ✓ Order carrier vehicles for Ram Truck as well as HV Battery Packs, Chargers and Power Panels for Bench Testing
- ✓ Procure all components required for the 12 Development vehicles and build 12 trucks
- ✓ Finalize part and tooling costs and lead times for all components
- ✓ Kick off tool orders for components and builds
- ✓ Determine the material required date (MRD) for the parts
Phase I
PHEV Development
Aug ‘09 to Sep. ‘10

Phase II
Build 12 development vehicles for system and supplier validation
Build and Launch Prep
Oct. ’10 to Feb ‘11

Pre-Demo builds: Ensure that all pre-build requirements for the Demo fleet are established and executed
Oct. - Dec. ‘10

Build the Demo fleet of 140 trucks and ensure that all customers are prepared to receive fleet vehicles
Jan. – Feb. ‘11

Phase III
Demo Phase
Mar ‘11 to Aug ‘13

Ongoing Vehicle Operations: Ensure the vehicles are utilized and function as intended

Ongoing Development of smart grid, bi-directional chargers, and renewables with partners.

System monitoring and customer usage data will be collected on an ongoing basis.

Approach

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Data Recording Process:

Data Recording Module (DRM) compresses the data captured from the vehicle. Monitors all CAN buses, has diagnostic capabilities as well as CAN Calibration Protocol (CCP) functionality.

DRM will upload the recorded files wirelessly (cell phone or wi-fi) to a server.

A secure server stores collected data.

Website customer charge input and adjustment. Utility Cost Rate Schedule displayed for optimum charge.

Website management to view status of a specific vehicle as well as transmitted data sets to Chrysler and DoE.
Technical Approach

**RAM CREW 1500**

- The only plug-in hybrid truck available in the marketplace
- Does not compromise any of the standard pickup volume or utility
- Maintains trailer tow and gradeability advantage of standard truck
- Only full size truck with Advanced Technology Partial Zero Emissions
- Features the unique utility and functionality of on-board AC power
- Is a low cost alternative to aftermarket commercial grade diesel generators
- Eliminates the need for a separate generator fuel supply

### Hybrid Drive System

**Technology**
- Next Generation Lithium Ion Battery

**Charge Times**
- 2-4hrs at 220V
- 6-8 hrs at 110V
- Full Hybrid system function w/o Plug-in

**Fuel Economy (City)**
- Charge Depleting 32MPG

**Electric Drive Range (City)**
- 20 miles equivalent Range
- 655 miles

**Transmission**
- Advanced Technology Plug-in Hybrid

**Brakes**
- Regenerative Brake System

### Auxiliary Power

- 4.8kW Continuous Through:
  - **Power Panel**
  - Pickup Bed
  - 2 – 120V, 20A duplex
  - 1 – 240V, 20A plug

**Cabin Receptacle**
- Center Console
- 1 – 120v, 20A plug

**Power On-The-Fly**
- 120V / 240V, 60Hz AC

**Silent Mode**
- 120V / 240V, 60Hz AC

### Exterior Dimensions

**Vehicle Length**
- 227.5”

**Overall Height**
- 74.8”

**Body Width**
- 79.4”

**Ground Clearance**
- 7.7” @ Curb Weight

**Approach / Departure**
- 19.2° / 21.9°

**Breakover**
- 15.2°

**Track**
- 68.1” Front
- 67.5 Rear

**Turning Diameter**
- 45.3’ Curb to Curb

**Wheelbase**
- 140”

### Capacities / Weights

**Curb**
- 5,900 lbs

**Fuel Tank Capacity**
- 26 gallons

**GCWR**
- 12,100 lbs

**GVWR**
- 7,200 lbs

**Payload**
- 1,300 lbs

**Towing Capacity**
- 6,000 lbs

**Cargo Box**
- 5’7” with two-tier loading

### Safety

**Electronic Stability Program**
- Traction Control
- ABS
- Brake Assist
- Electronic Roll Mitigation
- Hill Start Assisted
- Trailer Sway Control

**Air Bags**
- Advanced Multistage Front
- Supplemental Side Curtain
- Supplemental Front and Rear Curtain

### Wheels / Tires

**Wheels**
- 17” x 7.0” Aluminum Wheels

**Tires**
- P265/70R17 BSW All Season Tires
- Full Size Spare Tire

### Interior Dimensions

**Passenger Volume**
- 126.9 Cubic Feet

**Seating Capacity**
- 6 Passenger 3F/3R
PHEV Grant External Stake Holders
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<tr>
<th>Partner</th>
<th>Central Location</th>
<th>Demonstration Fleet Quantity</th>
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<td><strong>GRNAD TOTAL</strong></td>
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Partner and Vehicle Allocation

The cumulative mileage for the entire 140 Vehicle fleet is estimated to be 6,525,000 miles.

**Annual Ambient Cold Temperature Profiles**

Shows the cumulative number of days the demonstration vehicles will be deployed in Colder ambient temperature per year. The total estimated mileage accumulation for the cold temperature zone over three years of the demonstration program will be at least 2,925,000 miles. Of the total cold zone miles, approximately 1,023,750 miles will be driven in sub freezing (less than 32 deg F) temperatures.

**Annual Ambient Hot Temperature Profiles**

Shows the cumulative number of days the demonstration vehicles will be deployed in Hot ambient temperatures per year. The total estimated the mileage accumulation for the hot temperature zone over three years of the demonstration program will be at least 3,600,000 miles. Of the total hot zone miles, approximately 800,000 miles will be driven in greater than 90 deg F.
Technical Accomplishments Phase I

- Program Kick-Off

- Packaged and Designed PHEV Components

- Virtual modeling and simulation of PHEV technology

- Bench Testing of new PHEV components, software and calibrations

- Updated current HEV vehicle with PHEV Technology
  1. Updated to latest Li-Ion Battery
  2. Updated controls for battery thermal module
  3. Updated controls and calibration for PHEV
  4. Updated thermal system for PHEV
  5. Instrumented vehicle for PHEV testing & validation
Future Work

Phase I: PHEV Development
- Complete Hot Weather Validation of vehicle software, calibration and component
- Complete vehicle durability and validation
- Calibration/Controls Development
- Charging system / basic grid interface
- HMI
  - Hybrid Human Machine Interface (HMI) Display
  - Plug-In Charging HMI display
  - Power Panel HMI Display
  - Functional objective verification
- Fuel reduction
  - Emissions abatement
  - Driveability
  - Towing

Phase II: Build and Launch Prep
- Site preparation
- Customer/Dealer training
- Vehicle Prep and Delivery
- Build the 140 truck demonstration fleet

Phase III: PHEV Vehicle Demonstration
Summary

• Successful Kick-Off of DoE PHEV Project
• Management process established
• Virtual modeling and simulation of PHEV technology
• Designs and packaging completed for Development Vehicle Builds
• Built 12 PHEV Vehicles for vehicle validation and testing
• On track to meet program milestones and project deliverables