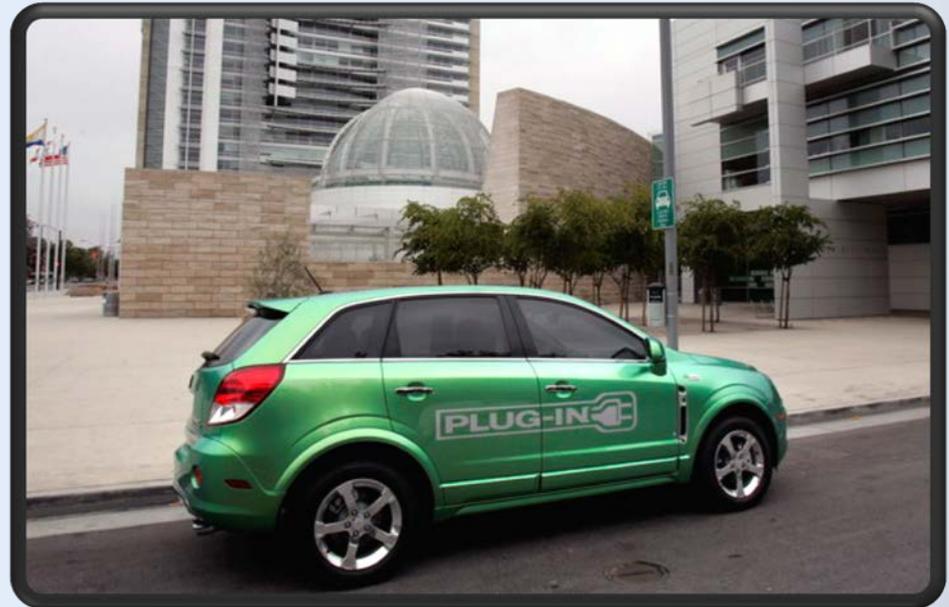


2012 DOE Vehicle Technologies Annual Merit Review

Plug-in Hybrid (PHEV) Vehicle Technology Advancement and Demonstration Activity

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General Motors LLC
May 17, 2012



Project ID #: VSS018

Overview

Timeline

- Project Start: September 30, 2008
- Project End: December 31, 2012
- Percent Complete: 84%

Budget

- Project Funding: \$54 M
 - DOE Share: \$9.3 M
 - MEDC Share: \$2 M
 - GM Share: \$72.9 M

Barriers

- High cost of advanced technology
 - Drive cost down
- Infrastructure
 - Interface and interaction with electric power grid

Partners

- Michigan Economic Development Corporation (MEDC) - Funding
- University of Michigan Advanced Battery Coalition for Drivetrains – Research



Objectives

- Overall Program Objective
 - Develop components and subsystems required for a plug-in hybrid electric vehicle (PHEV) and fully integrate them in a production-intent vehicle
 - Incorporate advanced lithium-ion battery technology
 - Feature high tech E85-capable Flex Fuel engine technology
 - Balance fuel economy, emissions, vehicle performance and battery life trade offs
 - Achieve battery cell performance and life requirements
- Phase 1 – Development of Year 1 Mule Vehicles
 - Achieve performance targets and proceed to Phase II
 - Hot weather, cold weather and altitude development
- Phase 2 – Development of Year 2 Integration Vehicles
 - Merge developed components and subsystems with production intent hardware content
 - Produce and refine calibrations/software with Integration level vehicles
- Phase 3 – Battery Thermal Development of Alpha Module
 - Development of a new thermal management design (thermal, vibration, aging, sealing evaluations)
- Phase 4 – Battery Thermal Development of Mule Module
 - Further development and refinement of the new thermal management design (thermal, vibration, aging, sealing evaluations)



Milestones

- 65% program review and ride milestone achieved and demonstrated to the DOE
 - May 26, 2011
- Integration vehicle builds completed
- Battery module concept work initiated with FEV, Inc
 - January 5, 2012
- Initial concepts review
 - January 20, 2012
- Concept selection complete
 - January 27, 2012
- Onsite DOE Technical Review
 - April 3, 2012



Approach/Strategy

- Hot Weather, Altitude and Cold Weather Development Trips
- Integration Vehicle Build
 - Integration vehicles produced
 - Significant technology improvements
- Argonne National Lab
- Module Thermal Development
 - Total temperature of the module
 - Internal heat temperature difference of the module
 - Maximum & minimum cell temperature
 - Module temperature at beginning & end of test
 - Heat capacity of the battery coolant
 - Thermal interface material evaluation
- Module Vibration Development
 - Verification of structural integrity of the module to vibration
- Module Aging Evaluations
 - Verification of seal integrity after thermal aging of the:
 - Heater seal
 - Hose to outlet/inlet interface
 - Heat sink to outlet interface
- Module Sealing Evaluations
 - Determine sealing capability with coolant of the:
 - Heater seal
 - Hose to outlet/inlet interface
 - Heat sink to outlet interface

Technical Accomplishments & Progress

- Two physical builds completed producing vehicles for internal deployment at General Motors
 - 50+ vehicles built
 - 180,000+ miles driven
- Charge depleting (CD) and charge sustaining (CS) hybrid functionality has been successfully completed and demonstrated to the DOE
- Cold weather testing was performed and exceeded technical specification using both gasoline and alcohol fuels
- Module concept definition and development progressing on time to a successful completion



Collaboration & Coordination w/Other Institutions

- University of Michigan Advanced Battery Coalition for Drivetrains
 - Cooperative agreement between U of M and GM
 - Five year development agreement
 - Within Vehicle Technology scope as it related to alternative energy resources and efficient hybrid vehicles

- FEV, Inc
 - Collaboration of design and development of new thermal management system



Future Work

- **Module concept detailed engineering**
 - Feasibility study
 - Detailed design
 - 3D CAD Modeling
 - CAE Analysis
 - DFMEA
 - Manufacturing Plan
 - Physical property build
 - Development testing
 - Design refinement



Project Summary

- Production-intent program, building on proven GM 2-Mode strong hybrid technology
- On track to meet new program milestones and project deliverables
- Development Phases on track to a successful completion

