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# Overview

## Timeline

<table>
<thead>
<tr>
<th>Start:</th>
<th>October 1, 2009</th>
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<tbody>
<tr>
<td>Finish:</td>
<td>September 30, 2012</td>
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## Risks and Barriers

- Functional
- Financial
- Marketing
- Purchasing

## Budget

- Total Project Funding
  - DOE: $62.5M
  - Ford: $62.5M
- Funding received in FY10 = $8.6M
- Funding received in FY11 = $28.7M
- Funding received in FY12 = $3.3M

## Partners

No official partners identified in grant
Hybrid Electric Vehicle (HEV)
• Combines an internal combustion engine with an electric motor and battery
• Electric power is used for vehicle launch and lower-speed operation
• Internal combustion engine takes over for higher demand operation and charges the battery

Plug-in Hybrid Electric Vehicle (PHEV)
• Combines HEV technology with a high-voltage storage battery like that used in a Battery Electric Vehicle (BEV)
• Ford’s PHEV is a blended PHEV – optimally first using the battery charge and then operating in regular hybrid mode
• Offers consumers the best possible fuel economy, smallest battery and most affordable solution.
Relevance – Fuel Economy Leadership

<table>
<thead>
<tr>
<th>ESCAPE HEV</th>
<th>FUSION / MKZ HEV</th>
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<tr>
<td><strong>CITY MPG</strong></td>
<td><strong>CITY MPG</strong></td>
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<tr>
<td>34</td>
<td>41</td>
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<tr>
<td><strong>HIGHWAY MPG</strong></td>
<td><strong>HIGHWAY MPG</strong></td>
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<tr>
<td>31</td>
<td>36</td>
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**CMax (HEV/PHEV)**

FHEV will be 47 city mpg / 44 highway mpg

PHEV will be > 100 mpge

The HF35 is a key contributor to Ford’s Fuel Economy Leadership going forward.
As part of our overall transformation, Ford Motor Company is committed to bringing hybrid and plug-in hybrid vehicles to market quickly and affordably. The HF35 transaxle program is a major catalyst in support of this strategy.
The HF35 Strategy takes advantage of a known, robust transaxle design.
The HF35 is Ford’s third generation Powersplit transaxle, and the 1st internally manufactured – taking advantage of evolutionary design of a robust product.
The cost of the HF35 is mitigated with the utilization of components common with other Ford transaxle products.
Ford’s 1st flexible transaxle assembly process for gas and hybrid models enables nimble response to customer demand fluctuations.
## Approach – Phased Project Plan

<table>
<thead>
<tr>
<th>Months</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<td>J A S O N D</td>
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### Project Milestones/Events

<table>
<thead>
<tr>
<th>Phase I Completion</th>
<th>Phase 2 Health Check</th>
<th>Phase 3 Health Check</th>
<th>Phase 4 Completion</th>
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<tbody>
<tr>
<td>MBJ1</td>
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### Project Phases

**Phase I**
- MBJ1
- MBJ2

**Phase II**
- MBJ3
- MBJ4

**Phase III**
- MBJ5
- MBJ6

**Phase IV**
- MBJ7
- MBJ8

### Manufacturing Timeline

- **2009**
  - X0 Prototype Procurement
  - M1 Prototype Procurement
  - VP Prototype Procurement
- **2010**
  - M1 Build
  - VP Build
  - M1 Testing
  - VP Testing
  - VP Prototype Procurement
- **2011**
  - VP Level Design Freeze
  - Failure Mode Analysis and Update
  - Site Facility Preparation
  - PSW Component Procurement
- **2012**
  - PP Build Avail. (External)
  - Regular Production

**Key Events**
- X0 Build
- X0 Testing
- VP Prototype Procurement
- M1 Build
- M1 Testing
- VP Testing
- VP Prototype Procurement
- M1 Testing
Milestones Completed in Phase I (Period ending September 2009):

- <Unit PTC> Program Target Compatibility GPDS Milestone – September 2009 (Go / No Go Decision Point)
- Long Lead Funding Approved – September 2009
- Component Sourcing Agreements Signed – September 2009
- First Phase I (X0) Transaxle Available – September 2009

The objective of Phase I is to finalize the initial design and deliver the first functional prototype transaxle for testing.
Milestones Occurring in Phase II  
(Period ending May 2010):

- Phase II (M1) Level Design Freeze – October 2009
- Production Equipment Design Orders Initiated – October 2009
- <Unit PA> Program Approval GPDS Milestone – February 2010 (Go / No Go Decision Point)
- Component Commercial Pricing Agreements Signed – February 2010
- First Phase II (M1) Transaxle Available (Internal) – February 2010
- Production Equipment Build Orders Initiated – February 2010
- First Phase II (M1) Transaxle Available (External shipped to build site) – May 2010

✓ = Completed

The objective of Phase II is to refine the Phase I design and address any failure modes found during Phase I testing.
Milestones Occurring in Phase III (Period ending May 2011):

- Machine Tryout Parts Ordered – June 2010
- Phase III (VP) Level Design Freeze – July 2010
- Production Equipment Run-off's Initiated – November 2010
- Final Data Judgment GPDS Milestone – December 2010 (Go / No Go Decision Point)
- First Phase III (VP) Transaxle Available (Internal) – January 2011
- First Phase III (VP) Transaxle Available (External) – May 2011

 ✓ = Completed

The objective of Phase III is finalize design refinements and build confirmation prototypes
Milestones Occurring in Phase IV
(Period ending June 2012):

- Production Equipment Delivery Completed – July 2011
- Production Equipment In-Plant Runoffs Completed – September 2011
- 1st Production HF35 Build at Transaxle Assembly Plant – October 2011
- <FEC> Final Engineering Confirmation GPDS Milestone – December 2011
  (Go / No Go Decision Point)
- HF35 Production Validation (PV) Testing Sign-off – January 2012
- 1st Production HF35 Build at Vehicle Assembly Plant – January 2012
  - Transaxle OK-to-Buy – April 2012
  - <MP1> Mass Production 1 GPDS Milestone – June 2012

The objective of Phase IV is to deliver production level transaxles to the vehicle assembly plant and complete product launch.
This picture shows our new HF35 hybrid transmission (near) trailing our existing 6F35 gas transmission into our flexible final test stand in production. True “batch of one” process capability!
Flexible Assembly System – Conveyor Selection and Pallet Design

The conveyor system selected provides access to (3) sides of the product during assembly as well as future flexibility for changeover and / or expansion.

The pallet design is flexible for both gas and hybrid versions of Ford’s FWD transaxles.
Technical Accomplishments and Progress

Rotor Magnetization

Rotors queued up for processing

Rotors entering bearing press after magnetization

The Traction and Generator Rotors are carryover design, magnetized internally at Ford for the 1st time during the assembly process.
Major Milestones

June 2012

• <MP1> Mass Production 1 GPDS Milestone
  • Complete HF35 pre-production builds
  • Complete production validation
  • Achieve “OK to Build” for HF35 transaxle
No partners were officially identified for the DOE grant awarded to Ford

The ultimate success of the project will be a reflection of new and existing relationships that are furthered as a result of this project. These include but are not limited to:

Production Component Suppliers

• Toshiba, Weber Automotive, Auma-Bocar, Systrand, Yazaki NA, …

Machine Tool Suppliers

• Kuka AT, Magnetic Instrumentation, Cinetic, WMA Inc., …

Community

• United Auto Workers
• State of Michigan
• City of Sterling Heights, Michigan
Summary

• The HF35 project facilitates the launch and commercialization of hybrid electric vehicles via U.S. design and production of a world-class HEV/PHEV transaxle system

• Our approach leverages robust design evolution, common components, and a flexible assembly system at a world class Ford manufacturing facility.

• We have accomplished or exceeded all objectives for Phase I, II, and III of the project
  • Lessons learned through prototype testing and simultaneous engineering have been applied to the design leading into Phase IV

• We are in mid-Phase IV of the project, and are on target to accomplish all objectives for this Phase
  • All pre-production builds have been completed, road tested, and shipped to the vehicle plant customer to support their pre-production build activities

• We are well positioned for the scope of work to be completed in time

• We remain confident in the execution and ultimate success of the HF35 project