2011 DOE Vehicle Technologies Program
Electric Drive Component Manufacturing Facilities - Allison Hybrids to Serve Commercial Trucks

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Overview – Allison Transmission, Inc.
Electric Drive Component Manufacturing Facilities

Timeline
- Started on January 1, 2010
- Finishing December 31, 2013
- 32% complete as of February 28, 2011

Budget
- Total project cost is $149,000,000
  - DOE to fund $62,800,000
  - Allison funds $86,200,000
  - DOE funds received 1Q2010 through 1Q2011 = $20,025,085
  - DOE funding anticipated for 2Q-4Q2011 = $17,448,151

Barriers
- System affordability to Enduser
- Time to integrate hybrids into individual vehicle platforms
- System control optimization
- Electrical component and communication interfaces

Key Suppliers
- Delphi Electronics
  - Power electronics and energy storage system
- Remy, Inc.
  - Motor-generator
Relevance – Objectives

Electric Drive Component Manufacturing Facilities

• Expand U.S. production capacity for the hybrid supply chain through commercializing a fuel-efficient, cost-effective, fast-to-market parallel hybrid propulsion system for commercial-duty trucks
  • Plan to enable expansion of the U.S. hybrid supply chain
  • Plan to use existing commercial sub-components whenever possible
  • Plan to quickly establish manufacturing facilities and commercialize to begin production in December 2012
  • Plan to produce “H 3000” and “H 4000” Allison Hybrid family for commercial trucks
Relevance – Benefits

Electric Drive Component Manufacturing Facilities

• Plan to enable development of greater U.S. manufacturing capacity for, and expertise in the production of, essential hybrid technology
  ➢ Plan to create or maintain direct jobs during course of the project
• Plan to improve fuel economy (mpg) by 25% to 35% over commercial trucks with conventional propulsion
  ➢ Savings are dependent on vocation and duty cycle
• Plan to reduce U.S. petroleum consumption as well as greenhouse gas emissions and other air pollutants from commercial trucks
Relevance – Benefits
Plan to apply known benefits of Allison’s H 40/50 EP hybrids for transit buses to commercial trucks

• Washington Metropolitan Area Transit Authority (WMATA)
  • Total fleet is 1,512 of which
  • 399 are H 40 EP-equipped

• Philadelphia has 370

• Baltimore has 169
Relevance – Benefits
Examples of commercial markets served by Allison

Current On-Highway Markets Served by Allison

- School Bus / Shuttle Bus
- Transit Bus
- Motorhome
- Truck RV
- Distribution
- Rugged Duty
- Emergency Vehicles
Relevance – Benefits
Example Markets for Allison H 3000 and H 4000 Hybrids
• **Identified Barrier #1: System Affordability**
  - Plan to leverage proven, reliable, known technology
  - Both in-house and with Key Suppliers
  - Are using more than 20 years of experience with hybrids
  - Successful hybrid installations for 13 bus OEMs over past 9 years
  - Our understanding of installation cost avoidance, duty cycle specifics, brake wear savings, and fuel savings is intended to drive down overall cost of ownership
• Identified Barrier #2: Time required to integrate hybrids into individual vehicle platforms
  ➢ Plan to leverage Allison’s overall 60 years of vehicle integration expertise
  ➢ Allison’s “Process of Concurrent Engineering” is intended to drive speed into programs
  ➢ Concurrent engineering is planned to reduce time
    ➢ Plan to continue concurrent design work with OEM
    ➢ Plan for joint validation between OEM, End User and Allison
Relevance – Overcoming Barriers

Electric Drive Component Manufacturing Facilities

• Identified Barrier #3: System control optimization
  ➢ Allison has knowledge gained from integrating with 250 commercial vehicle OEMs
    ➢ Managed 10,000 calibrations in CY2010
    ➢ Able to operate behind approximately 500 combinations of engine brands, models and ratings
    ➢ Have optimized controls for 13 OEMs of hybrid transit buses

• Identified Barrier #4: Electrical component and communication interfaces
  ➢ Allison has incorporated our decades of vehicle integration and durability experience into our design and test standards in order to mitigate system interface challenges
Hybridize existing fully-automatic Allison transmissions

- Plan to refurbish facility in Indianapolis, IN, for sub-assembly and test of hybridization module, assembly of module onto an existing transmission and test of the completed system
- Plan to leverage existing Allison plant capacities and create additional capacity for annual plant capacity of 20,000 commercial-duty hybrid systems with production start December 2012

- Plan to use many production-ready components to lower the system costs and to accelerate the speed to market
  - Base Allison transmissions (3000 and 4000 Series) do not change
  - Base transmission controller also serves as hybrid controller

- Create a commercial truck Allison hybrid, the value proposition for which is commercially competitive with conventional drive systems
New Allison hybrid systems plan to incorporate
  • State-of-the-art motor-generator, ESS and power electronics from U.S. suppliers
  • Allison’s proven expertise in design, manufacture, and sale of over 4,000 hybrid propulsion systems for transit buses since October 2003
    • As of 01/01/2011 Allison estimates our hybrid system accomplishments are
      • Over 520,000,000 km in service
      • Savings of over 65,000,000 liters of diesel fuel
      • Avoidance of over 170,000 metric tons of CO₂
  • Allison may be viewed as holding a unique position as
    • Leader in the design and manufacture of commercial-duty fully-automatic transmissions and pre-eminent supplier of commercial, heavy-duty fully-automatic transmissions to the North American medium- and heavy-duty work truck market
    • Available factory space for new hybrid family in Speedway, IN, located adjacent to conventional (base) transmission
Kinetic energy is the force acting on a vehicle causing its motion.

A driver slows a conventional vehicle with the service brakes or other motion-retarding device.

- As conventional vehicle slows down or comes to a stop, the energy of motion is transformed by the vehicle’s braking system into heat.
- The heat is dissipated – wasting the original kinetic energy.

Allison hybrids are “kinetic energy recovery systems with regenerative braking” enabled by a motor-generator electric machine.

Existing productivity and fuel efficiency benefits of a fully-automatic Allison transmission plan to be even further improved with hybridization.
Approach – Technical

Allison Commercial Truck Hybrid Characteristics

- Parallel hybrid system was chosen
  - Supplies a blend of two paths of power to assist with vehicle propulsion
    - From the conventional diesel engine, and
    - From the stored energy in the batteries
- Permanent magnet motor-generator with engine disconnect clutch is planned to be added between engine and conventional transmission
  - No change is required to current Allison conventional products
  - Generator mode is used during regeneration mode when vehicle decelerates to absorb and enable vehicle energy storage in battery
  - Motor mode uses battery energy for later assisting vehicle propulsion
- Hybrid system also includes the energy storage system, inverter, DC-to-DC converter, and hybrid system controller
Approach – Technical

Allison Commercial Truck Hybrid Characteristics

• Energy storage system is Lithium-ion chemistry
  • Modular for flexibility in vehicle integration
• Inverter for managing the flow of power
• Optional DC-to-DC converter
• High-voltage connections for vehicle accessories
• Goal is to provide 25-35% fuel economy improvement
  • Actual “mpg” improvement has expected dependence on operating factors including vocation and duty cycle
• Hybrid System Controller
  • No change is required to an already-planned controller common with all Allison conventional transmissions
• Plant planned capacity of 20,000 units annually
• Hybrid input module will be assembled and tested
• Hybrid module will be assembled to base Allison transmission
• “Dress” of the combined assembly follows final test
Approach – Program Timeline in CY2011
Planned Transition from “Concept” to “Design” Validation

- **1Q2011**: Concept Validation, CV Gate Review April 2011
- **2Q2011**: DV Long-lead Components Production Release May 2011, 100% Plant RFQs are submitted
- **3Q2011**: Plant Chillers & Coolers Installed, CV Gate Review
- **4Q2011**: DV Full Production Release July 2011, Support Supplier DV, Integration & Test
- **CY2012**: OEM Vehicle Testing

Support Supplier DV
Technical Accomplishments and Progress Through CY2010

- May 2009 – Concept Validation (CV) Phase began
  - Configured and scaled proven technologies to meet Customer needs
  - Selected Key Suppliers of hybrid components (Delphi and Remy)
  - Performed required analyses and design for manufacturability
  - Created the drawing sets for the product and for the factory
- August 2009 – DOE Grant awarded and under contract December 2009
- April 2010 – Concept Validation drawings released for prototype hardware
- June 2010 – CV concept hardware available
- June 2010 – Appropriations Request approved for plant capital equipment
- July 2010 – Final Assembly Manufacturing Line and Final Test RFQs sent
- September 2010 – Start of CV durability test validation
- September 2010 – 100% of long lead suppliers selected
- December 2010 – Demonstration of product in vehicle for Allison Leadership
Technical Accomplishments, Progress and Plan

Hybrid Plant Refurbishment

• Completed through CY2010
  ➢ Roof replacement 100% complete per plan
  ➢ Concrete floor replacement 100% complete per plan
  ➢ Air handler replacement 50% complete per plan
  ➢ Air compressors and air dryer 70% complete per plan
    • Includes plant chillers and coolers replacement

• Plan highlights for CY2011
  ➢ Completion of refurbishment and painting per plan
  ➢ Completion of equipment procurement per plan
  ➢ Start of factory equipment installation per plan
Allison Hybrid Plant Progress

Plant Air Handler Replacement

Eight New Air Handling Units for CY2011 Installation
Allison Hybrid Plant Progress

Plant Cooling Tower #6 (Example Shown)
Technical Accomplishments and Progress
Planned activity through CY2011

- February 2011 – Non-long-lead (“other”) supplied parts bid lists completed
- April 2011 – Planned CV “Gate” Review in Allison’s Process of Concurrent Engineering
- May 2011 – Design Validation (DV) long lead drawings planned completion
- June 2011 – 100% of Plant sub-assembly lines and fabrication RFQs planned to be submitted by this date
- July 2011 – DV “other” drawings planned to be finished
- August 2011 – Quotes planned to be issued to all other suppliers
- January – September 2011 – All sources of supply planned to be selected
- January – September 2011 – Advanced Purchasing Quality Process planned start of execution for 100% of suppliers
Technical Accomplishments and Progress
Beyond FY11

• DOE Annual Merit Reviews and FY “Kickoff” Reviews CY2012 and CY2013
• Design Validation (DV) hardware available
• DV “Gate” Review to be held
• Production and Factory Validation (PV and FV) refinements
• All suppliers under contract for Delivery Schedule Agreements
• “Advanced Purchasing and Quality Process” completed and parts PPAPed
• All run-offs of equipment at machinery and equipment suppliers completed
• All machinery and equipment installed in plant and run-off
• Run-at-rate confirmations in plant and at suppliers
• PV and FV “Gate” Reviews per Allison’s Process of Concurrent Engineering
• Production builds begin in plant December 2012
Summary Slide

• Fuel-efficient, fast-to-market hybrid propulsion system for commercial-duty trucks

• Relevance:
  • Increased domestic manufacturing capacity for hybrids
  • Cost-efficient, affordable hybrid propulsion for Endusers
  • Jobs maintained or created during

• Approach: POCE and SAP Control

• Key Suppliers: Delphi, Remy

• Project timeline and deliverables tracking to budget and schedule

• Allison is well-prepared and in cadence with Key Suppliers for work through this Fiscal Year and next (FY 2011)
Key Suppliers

• Delphi Electronics, Kokomo, Indiana
  • Purchased Engineering Services
  • Power Electronics
    • Inverter
    • Converter
  • Energy Storage System
  • Transmission/Hybrid Control Module

• Remy, Inc., Pendleton, Indiana
  • Motor-generator
  • Hybrid module sub-assembly
Summary

Electric Drive Component Manufacturing Facilities

• On budget and on plan to put into production a fuel-efficient, fast-to-market Allison hybrid propulsion system for commercial-duty trucks

• Relevance:
  • Plan to increase domestic manufacturing capacity for hybrids
  • Plan to provide high-value hybrid system for commercial trucks
  • Maintained or created jobs during course of Project

• Approach:
  • Plans to refurbish existing plant, use existing base transmission and leverage known technology scaled for commercial-duty truck applications

• Key Suppliers: Delphi and Remy

• Funding:
  • Allison is well-prepared and in cadence with Key Suppliers for work through this Fiscal Year and next (FY 2012)