

2012 DOE Vehicle Technologies Program

Electric Drive Component Manufacturing Facilities - Allison Hybrids to Serve Commercial Trucks

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U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

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Overview – Allison Transmission, Inc.

Electric Drive Component Manufacturing Facilities

Timeline

- Started on January 1, 2010
- Finishing December 31, 2013
- 55% complete as of EOY 2011

Budget

- Total project cost is \$149,000,000
 - DOE to fund \$62,800,000
 - Allison funds \$86,200,000
 - DOE funds received through 4Q2011 = \$35.1M
 - DOE funding anticipated for 1Q-4Q2012 = \$22.1M

Barriers

- System affordability to end user
- 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 vehicles**
 - 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 vehicles



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 vehicles 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 vehicles

Relevance – Benefits

Plan to apply known benefits of Allison's H 40/50 EP hybrids for transit buses to commercial vehicles

- Washington Metropolitan Area Transit Authority (WMATA)
 - Total fleet is 1,512 of which
 - 502 are H 40/50 EP-equipped
- Philadelphia has 449
- Baltimore has 211



** Data above as of February 1, 2012

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



Relevance – Overcoming Barriers

Electric Drive Component Manufacturing

- **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

Relevance – Overcoming Barriers

Electric Drive Component Manufacturing

- **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 CY2011
 - 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

Approach – Overall

Electric Drive Component Manufacturing Facilities

- **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
 - *Plant will be production ready 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**



Approach – Uniqueness

Electric Drive Component Manufacturing Facilities

- **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 5,000 hybrid propulsion systems for transit buses since October 2003
 - As of 01/01/2012 Allison estimates our hybrid system accomplishments are
 - Over 492,800,000 miles in service
 - Savings of over 26,200,000 gallons of diesel fuel
 - Avoidance of over 259,200 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

Approach – Technical

Allison Commercial Truck Hybrid Characteristics

- 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*

Approach – Hybrid Factory

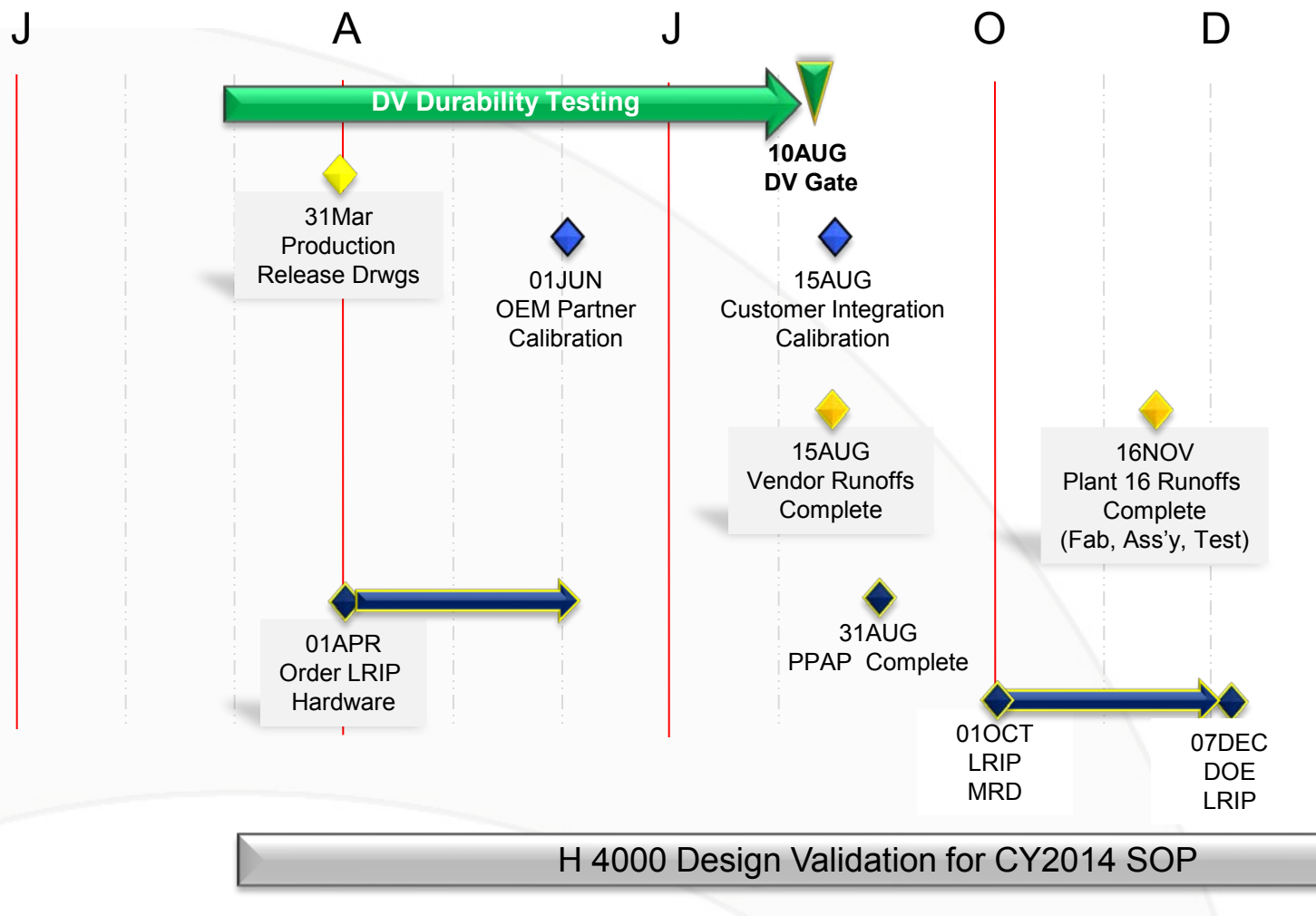
Manufacture, Assemble and Test



Plant planned capacity of 20,000 units annually

Approach – Program Timeline in CY2012

Planned Transition from H 3000 “Design” to “LRIP” & H 4000



Technical Accomplishments and Progress Through CY2011

- August 2009 - DOE Grant awarded and under contract December 31, 2009
- 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
- December 2010 - Demonstration of product in vehicle for Allison Leadership
- April 2011 - Passed CV “Gate” Review in Allison’s Process of Concurrent Engineering
- July 2011 - Design Validation (DV) drawings released
- August 2011 - 100% of plant assembly, test, and fabrication RFQs submitted
- September 2011 - Source selection of purchased components complete
- December 2011 – Plant 16 Facilities work complete
- \$ 35.1 million of \$62.8 million of Grant spent (through EOY 2011)



Technical Accomplishments, Progress and Plan

Hybrid Plant Refurbishment

- **Completed through CY2011**
 - Roof replacement 100% complete per plan
 - Concrete floor replacement 100% complete per plan
 - Air handler replacement 100% complete per plan
 - Air compressors and air dryer 100% complete per plan
 - Includes plant chillers and coolers replacement
 - Cooling Tower
 - Set in-place on the roof of plant
 - Cooling tower pumps are 100% complete per plan
 - Completion of refurbishment and painting per plan
 - Break Mall/Restroom refurbishment 100% complete

Allison Hybrid Plant Progress

Plant Air Handler Replacement

Eight New Air Handling Units for CY2011 Installation



Allison Hybrid Plant Progress

Plant Cooling Towers



Allison Hybrid Plant Progress



Technical Accomplishments and Progress

Planned activity through CY2012

- DOE Annual Merit Review and FY “Kickoff” Review
- Design Validation (DV) testing and validation of LRIP configuration
- DV “Gate” Review to be held
- Customer Integration Calibration complete for OEM public road use
- 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 Allison Plant 16
- All machinery and equipment runoff
- LRIP build begins in plant November 2012

Technical Accomplishments and Progress

Beyond CY12

- H 3000 production
- Run-at-rate confirmations in plant and at suppliers
- Production and Factory Validation (PV and FV) refinements as needed
- H 4000 Design Validation (DV) hardware available
- H 4000 DV hardware test and validation activities
- “Gate” Reviews per Allison’s Process of Concurrent Engineering
- Continue OEM integration work

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 2013)

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 vehicles
- **Relevance:**
 - Plan to increase domestic manufacturing capacity for hybrids
 - Plan to provide high-value hybrid system for commercial vehicles
 - 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 2013)