Allison Transmission, Inc.

2010 U.S. DOE HYDROGEN PROGRAM AND VEHICLE TECHNOLOGIES PROGRAM ANNUAL MERIT REVIEW AND PEER EVALUATION PRESENTATION

June 7-11, 2010

Electric Drive Component Manufacturing Facilities

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Allison Transmission, Inc., on June 10, 2010

Project ID #ARRAVT023

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Started on January 1, 2010
- Finishing December 31, 2013
- 16% complete today

Budget

- Total project funding
  - DOE to fund $62,800,000
  - Allison funds > $62,800,000
  - DOE funds to be received in the first and second quarter of 2010 total $ 6,115,000

Barriers

- System affordability to the Enduser
- Speed of hybrid integration into vehicle platforms
- System control optimization
- Electrical component and communication interfaces

Key Suppliers

- Delphi Electronics
  - Power electronics and energy storage
- Remy, Inc.
  - Motor-generator

Objectives/Relevance

- **Expand U.S. production capacity for the hybrid supply chain through commercializing a fuel-efficient, cost-effective, fast-to-market hybrid propulsion system for commercial-duty trucks**
  - Will enable expansion of the U.S. hybrid supply chain
    - Will create or maintain direct jobs during the course of the Project
  - Will utilize existing commercial sub-components whenever possible
    - Avoids unnecessary cost in the final product in production
    - Enhance the product family's speed-to-market by quickly applying proven, reliable, known technology
  - Will quickly commercialize and begin production

Objectives/Relevance – Benefits

- Enable development of greater U.S. manufacturing capacity for, and expertise in the production of, essential hybrid technology
- Improve fuel economy by 25% to 35% over commercial trucks with conventional propulsion
  - Savings are dependent on vocation and duty cycle
- Reduce U.S. petroleum consumption as well as greenhouse gas emissions and other air pollutants from commercial trucks

Objectives/Relevance –
Allison Transmission, Inc., Background

- Allison is the world's leading producer of hybrid propulsion systems for city transit bus & coach markets
  - Product sales commenced in October 2003
    - Family of purpose-built hybrid electric drive systems for busses
  - As of January 1, 2010, these Allison hybrid products have
    - Over 192,777,500 miles in service
    - Over 10,247,300 gallons of fuel saved to date
    - Over 101,410 metric tons of CO_2 emissions avoided to date

Objectives/Relevance -
Allison Transmission, Inc., Background

• Allison is the world's highest volume supplier of commercial-duty, fully automatic transmissions in addition to its leadership in transit bus hybrid propulsion system production

• Allison products today are specified by over 270 of the world's leading vehicle manufacturers

- over 100 Allison product models are used in 2,500 vehicle configurations

• Allison products are used in a variety of market sectors including On-Highway, Off-Highway, and Military

• Allison has regional headquarters with dedicated support staff in China, The Netherlands, Brazil, India, Japan, and Indianapolis, Indiana … and a presence in 80 countries with an independent network of more than 1,500 distributor and dealer locations globally

Objectives/Relevance -
Allison Transmission, Inc., Markets Served

On-Highway

- School Bus / Shuttle Bus
- Transit Bus
- Motorhome
- Truck RV
- Distribution
- Rugged Duty
- Emergency Vehicles

Objectives/Relevance -
Allison Transmission, Inc., Markets Served

Military

Off-Highway

Aftermarket

Allison Transmission PARTS

Objectives/Relevance -

Allison Serves World-class Customers Including…

Objectives/Relevance –
Allison Current Hybrid Technology

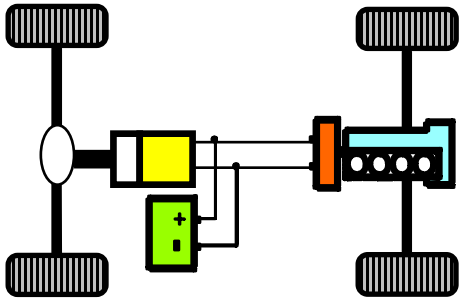
- Kinetic energy recovery to use less fuel & reduce emissions
- Captures the energy otherwise wasted as a vehicle decelerates
- Reuses the energy to propel or reaccelerate the vehicle, or to power accessories
- System components:
  - generator
  - energy storage
  - motor
  - power electronics
  - component and system electronic controllers

Objectives/Relevance –

Allison Current Hybrids Incorporate Two Popular Technologies

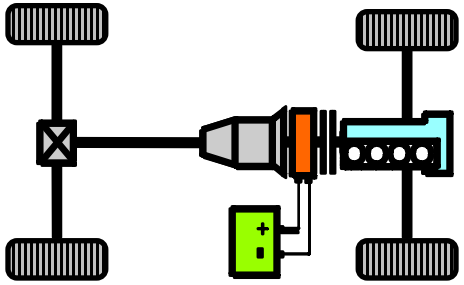
Series Hybrid

- Engine and generator are one unit (a genset)
- An electric motor is the drive motor
- Advantage in high stop/start duty cycles under 50 kph, all-electric mode and ease of packaging



Parallel Hybrid

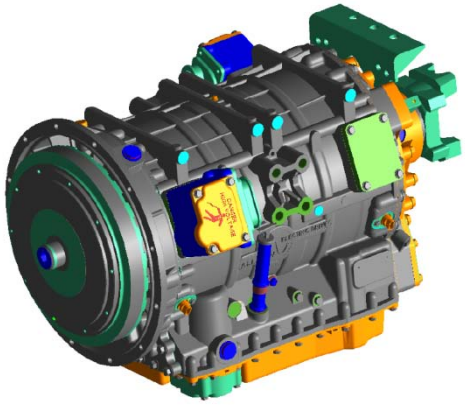
- Mechanical connection between engine and electric motor
- Motor is also used as a generator to capture energy to store in battery
- Advantage is versatility within the drive cycle:
  - High stop/start duty cycles, as well as,
  - Higher speed operation within cities & between suburbs and city center

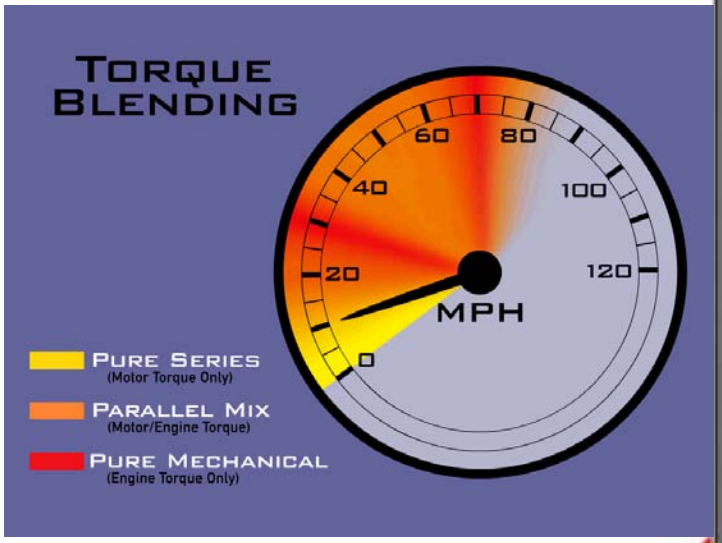


Objectives/Relevance –

Allison Current Hybrids Incorporate Two Popular Technologies

- Allison combines both Series and Parallel Systems into a single device, the E^P40 or E^P50
- Concentric electric motors provide electrically-variable drive ratios
- Gear range packs nested inside of the electric motors provide efficient operation across a wide range of vehicle speeds and loads
- Operation is pure electric power, engine power, or a blend of both power sources





Objectives/Relevance –

Production of E^{P}40 & E^{P}50 for Transit Buses & Coaches Began in October 2003 at Allison … as of January 1, 2010

- Global System Deliveries > 2,900
- Cities Worldwide > 140
- States in the US 36 of 50

Objectives/Relevance –
Allison Current Hybrid Technology

- Total accumulated kilometers …… > 310,000,000
- Total accumulated miles …… > 192,800,000
- Liters of diesel fuel saved …….. > 38,750,000
- Gallons of diesel fuel saved …….. > 10,200,000
- Metric tons of CO_2 avoided …… > 101,000

- Fuel economy improvement is a function of the duty cycle; particularly the frequency of stopping and starting
- Fuel economy improvement versus a non-hybrid bus is typically in the range of 20-30%, and greater

Objectives/Relevance –

Allison Hybrid Benefits Also Include Reduced Engine Wear and Reduced Service Brake Wear

- Today a large U.S. transit property might annually incur typical service brake expenses of:
  - 2 rear brakes changes / year @ $ 800 / brake job
  - 1 front brakes change / year @ $ 500 / brake job

= $2,100 / bus / year

- Non-hybrid busses may need a brake job after approximately 50-70,000 miles in service
- In Louisville, E^{P}40-equipped busses reach 170,000 miles

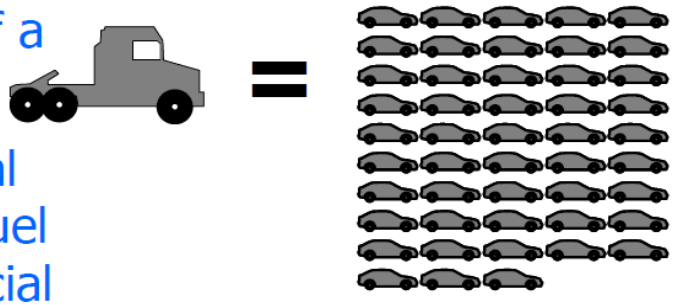
Objectives/Relevance –
E^P40-equipped Bus Deployments Near Washington, D.C.

- Washington Metropolitan Area Transit Authority (WMATA)
  - of 1,500 total bus population
  - 251 are E^P40-equipped
- Philadelphia has 119
- Baltimore has 57
- Boston has 50 on order

Objectives/Relevance –
Fuel Efficiency & Commercial Trucks from SAE

Why Class 8 Vehicles Are A Good Target For Hybrid Technology – Energy Security

- **48 cars:** The number it takes to match the annual fuel use of a typical line-haul truck [1]



- **One fourth**: Portion of total on-highway transportation fuel that is used in U.S. commercial trucks and buses [2]
- **39 Billion:** Gallons per year of diesel fuel used by U.S. commercial trucks [3]

Sources:

[1] Calculated assuming 12,500 miles / year per car and 25 mpg versus 120,000 miles / year per truck and 5.5 mpg plus 1500 hours of overnight idling of the diesel engine

[2] U.S. Energy Information Administration (www.eia.doe.gov)

[3] American Trucking Associations Fuel Facts (www.truckonline.com)

SAE

3

Objectives/Relevance –
Benefits of Hybridizing an Allison Commercial Truck Transmission

- US Economy creates a "Cause and Effect" relationship:
  - US economy produces an amount of cargo and goods to deliver every year
  - US economy prescribes the needed ton-miles/year of cargo to be transported
  - The US trucking industry must deliver these ton-miles/year of cargo or the US economy will suffer
  - "Efficiency" is how well fuel is used within the desired time allotted to move the cargo and make the deliveries
- Must look at Fuel Efficiency from this broad standpoint:
  - The overall ton-miles must get done in the allotted time
  - How can we reduce both fuel & the number of trucks needed to get this work done?
- **To get the necessary work done, but minimize the carbon footprint:**
  - **Maximize utilization of each vehicle built**
  - **Maximize fuel efficiency of each vehicle built**

Objectives/Relevance –
Benefits of Hybridizing an Allison Commercial Truck Transmission

- It is axiomatic in business that: ***time = money!***
- In the trucking industry, a key aspect is:

  Vehicle utilization = “work done per day” (or month, or year)

Rationale:

- Fleet is paying for each truck & driver, each and every day
- Fleet usually earns money according to the amount of work done
- Fleet must maximize the work done per vehicle per driver per day

Objectives/Relevance –
Benefits of Hybridizing an Allison Commercial Truck Transmission

- Allison fully automatic transmissions are characterized by fuel efficient productivity enabling Endusers to perform their work effectively within each workday of operation
  - Allison transmissions shift between gear ranges without interrupting the power to the vehicle wheels
    - Any interruption of power during shifts wastes the kinetic energy of the vehicle
    - Interrupted power during shifts creates inefficient vehicle and fuel use
  - Regardless of the source of the power, Allison transmissions shift without interrupting the power from the prime mover, whether the prime mover is conventional or a hybrid
    - Engine
    - Energy Storage (i.e. batteries)
    - Or a blend of both

Approach -
ARRA DOE Grant Summary

- American Reinvestment and Recovery Act
- DOE Grant Award No. DE-EE0002025
- Quickly bring to production commercial truck hybrids from US manufacturing base & expand production capabilities
- Awarded in August 2009
- Under contract in December 2009
- Contract period January 1, 2010 – December 31, 2013
- Cost-share program with
  - $62.8 Million DOE-funded
  - Over $62.8 Million Allison-funded
  - Funding through December 2013

Approach –

Allison Already Understands & Serves Many Vocations That Would Benefit from a Hybrid Propulsion System

Approach -
Allison Commercial Truck Hybrid Characteristics

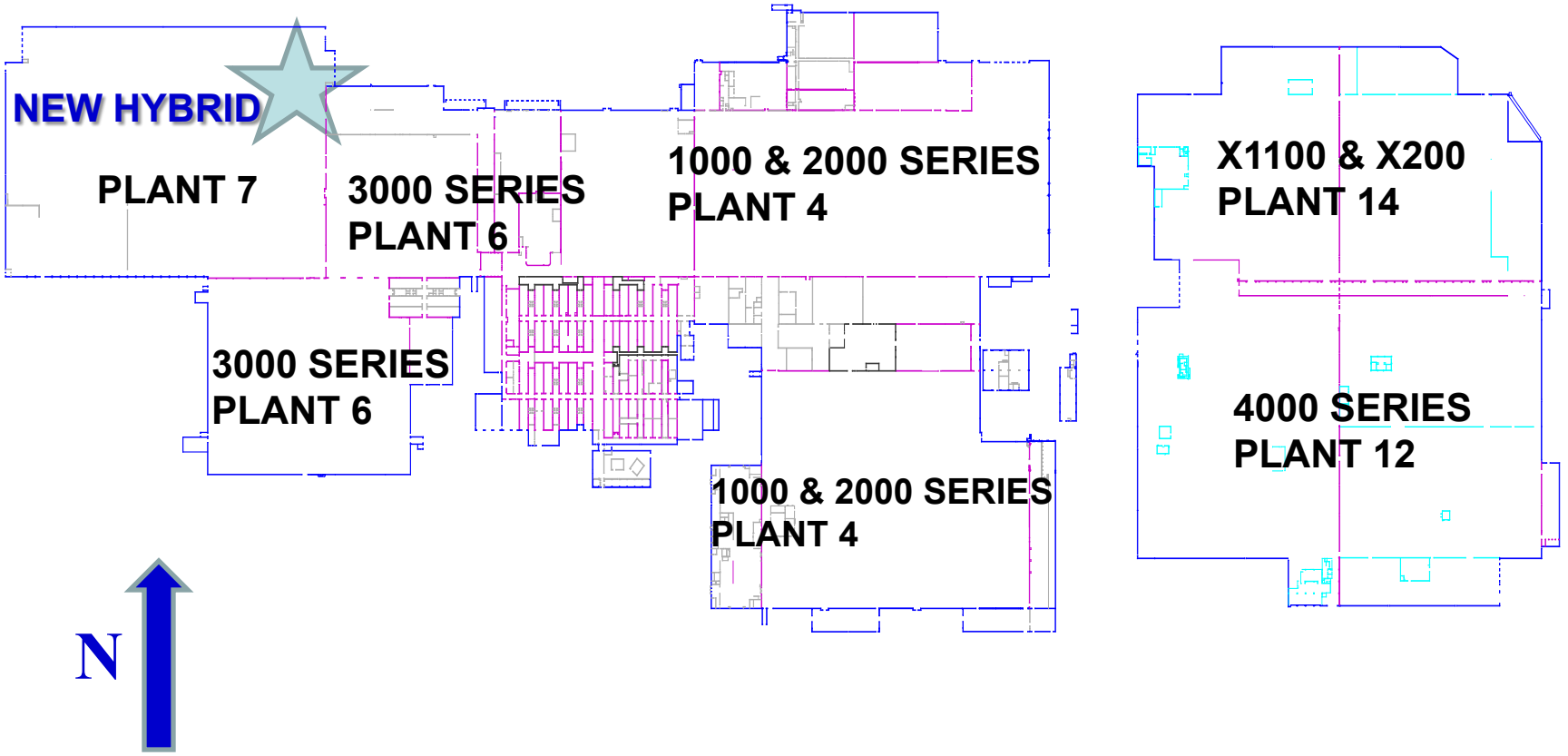
- Combines 7 years of Allison's hybrid transit bus market experience with Allison's commercial truck market knowledge
- To put into production an affordable parallel hybrid system
  - Motor can add torque through path into an existing Allison six-speed transmission
    - No change to current production Allison products
  - Motor is used as generator for regeneration mode during deceleration to capture & store vehicle energy
- Permanent magnet motor-generator
- Lithium-ion energy storage system
  - Modular for cost avoidance
  - Modular for optimization for Enduser needs

Approach -
Allison Commercial Truck Hybrid Characteristics

- Integrated engine disconnect clutch
  - Disconnects engine during electronic-PTO mode
  - Enables engine to be started with motor-generator
- Optional DC-to-DC converter for alternator replacement
- High-voltage connections available for vehicle accessories
- Expected performance of 25-35% fuel consumption reduction (or greater depending on duty cycle) combined with commercial viability for both the Enduser & Allison

Approach –

Groundbreaking for the New Allison Commercial Truck Hybrid is in Indianapolis in June 29, 2010



Approach – Program Management

- Allison is using the "Allison Transmission Process of Concurrent Engineering" (POCE) to speed this project into production
  - POCE is the Program Management philosophy
  - POCE assures appropriate & timely cross-functional involvement
    - Enables Enduser satisfaction
    - Enables cost avoidance
    - Enables a highly manufacturable, low-cost, reliable product
  - Process accelerates progress through four major steps culminating in the launch into full-rate production
    - Concept Validation (CV)
    - Design Validation (DV)
    - Process Validation (PV)
    - Factory Validation (FV)

Approach –
Program Management

- Allison is tracking project expenditures against project accomplishments utilizing the Project Systems module of its enterprise-wide SAP Business Systems software
- All project-related, commercial, manufacturing process-related, and technical risks will be mitigated by the use of Allison's POCE in combination with the Key Suppliers' concurrent engineering process deliverables, expertise, and core competencies

Approach –
Program Management Team is Fully Staffed

Position Description	Functional Department
Program Director	Advanced Hybrids
Launch Manager	Operations
Systems Manager	Information Technology
Total Manufacturing Integration Engineer	Manufacturing Engineering
Facilities Project Management	Facilities
Purchasing Program Manager	Purchasing
Service Engineer	Service
Legal Counsel	Legal
Business Development Director	Business Planning
Materials Planner	MC/PC & PDC
Applications Representative	Applications Engineering
North America Product Strategist	MSS - Market Development
Transmission System Controls Engrg Representative	Product Controls Engineering
Financial Analyst	Budget & Forecasting
Program Quality Manager	Quality Systems
Program Engineering Manager	Product Engineering
Manufacturing Engineering Manager	Manufacturing Engineering
Program Analyst	Hybrid Programs
Global Business Development & Forecasting	Global Market Development
Contract Administrator	Contract Administration

Accomplishments and Progress – 2010 Q1-Q2

- Allison Hybrid Program Team formed
  - Team created & is tracking to Master Timing Schedule
- Product Engineering team has completed "Concept Validation" design release
  - Eliminated any change to existing Allison commercial transmissions
    - Just adding a hybrid input module and hybrid system components
  - Combined reliable, proven technologies in a package scalable for commercial truck use
  - Chose key suppliers
    - Contracts completed with key suppliers

Technical Accomplishments and Progress – 2010 Q1-Q2

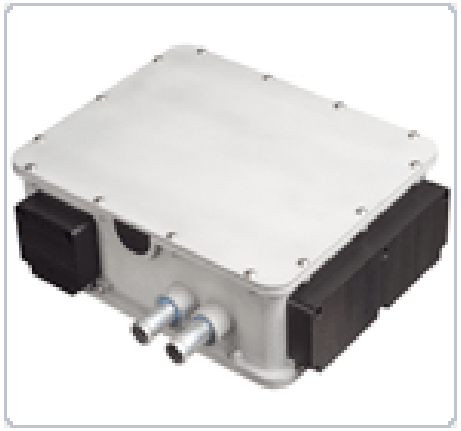
- Component fabrication & testing are underway
  - Energy storage system reliability validation
  - Power electronics & motor-generator validation
  - "First Pours" on main housing and valve bodies
- "Manufacturing Technical Specification" has been created defining the factory requirements for production
- "Product Technical Specification" has been created defining the features and performance of the products
- Approval granted at "Concurrent Review #1 Signoff"
  - occurred April 23, 2010

Key Suppliers

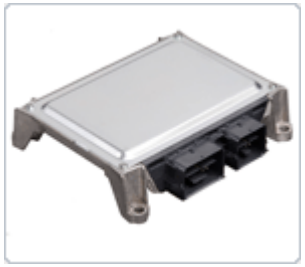
- Delphi Electronics, Kokomo, Indiana
  - Selected to provide the power electronics, hybrid control module & energy storage system
- Remy Inc., Anderson, Indiana
  - Selected to provide the motor-generator module
- Both firms are established, proven suppliers in the maturing hybrid component industry

Key Suppliers –
Delphi Examples of Hybrid/Electronic Products

Multiple Cell 320 VDC Battery Pack System (ESS)



Delphi Traction Inverter



Delphi Battery Management Controller

Delphi DC-to-DC Converter (Optional)

Key Suppliers –
Remy, Inc., Example of Electric Machine

High Voltage Electric Motor-generator

Future Work

- Activities for next fiscal year (FY 2011)
  - Complete component testing and fabrication
  - Receive longest-lead critical purchased components
  - Complete first combination and integration of the Power Electronics and Energy Storage System
  - Complete “Hardware Assembly POCE” Review
  - Complete “First Generation” of hardware test validation

Future Work –

Allison Also Continues with Many Other Self-funded Fuel Efficiency Enhancement Projects, Examples Include:

- "Flybus" Hybrid Demo Program
  - Supporting a PTO-driven hybrid with Torotrak
- "Allison Optimized" for current production programs
  - Load-based shifting selects between "Economy" & "Performance" shift schedules given vehicle payloads & grades on which the vehicle operates
  - Reduced engine load at full stop
  - Acceleration-based shifting to control torque
  - Reduced internal parasitic losses

Summary Slide

- **Fuel-efficient, fast-to-market hybrid propulsion system for commercial-duty trucks**
- Relevance:
  - Job creation
  - Increased domestic manufacturing capacity for hybrids
  - Cost-efficient, affordable hybrid propulsion for Endusers
- Approach: POCE and SAP Control
- Key Suppliers: Delphi, Remy
- Project timeline & deliverables tracking to budget & schedule
- Allison is well-prepared and in cadence with Key Suppliers for work through this Fiscal Year and next (FY 2011)