The powertrain system

ENGINE
TRANSMISSIONS
DRIVELINE
ELECTRIFIED PROPULSION
INTEGRATED CONTROLS

Global Powertrain
The overarching driver for powertrain technology change over the next 5+ years is CO₂. This is driven by regulation and increasingly customer preference.

- Brazil: 135 g/km
- China: 117 g/km
- EU: 95 g/km
- US: 101 g/km
FCA was compliant in 2012 but had negative credit generation due to model mix.

We purchased credits and will continue to do so when appropriate to provide time to understand and decision the complex business cases associated with new technologies.

FCA is focused on:

- Developing and producing increasingly more fuel-efficient vehicles which customers want to buy.
- Fully complying with the GHG regulation.
Meeting CO$_2$ and other regulatory requirements is not enough. We must meet the market needs of our customers and ensure the ongoing benefit of the enterprise.
CO₂ emissions are:
• A function of both vehicle and powertrain characteristics
• Directly proportional to Vehicle Demand Energy (VDE)
• Dependent on driving cycle

VDE = f(Aerodynamic drag, Tire drag, Weight)

*VDE also includes brake drag, bearing friction and other spin losses. Weight included in VDE through the energy required to accelerate the vehicle.
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- The European drive cycle has more dependence on weight for both the city and the highway cycles.

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FCA Powertrain technology usage

We simulate combinations of powertrain and VDE technologies to identify the best "Bang-for-the-Buck" which satisfies the "Synthesis of requirements" for the FCA fleet.

Axles & Drivelines
High efficiency axles and driveline disconnect solutions

Transmissions
Wide ratio spread and increased speeds for FWD and RWD transmissions

Engines
Improvement of internal combustion engines with technologies

Advanced Technologies
Multi-Air, DDCT, Start/Stop, Diesel Multi-Jet, Compressed Natural Gas (CNG)

Thermal Management
"Waste heat" recovery, intelligent thermostat, bypass system, etc.

Electrified & Hybrid Systems
HEV, PHEV, BEV, ReEV, Fuel Cell
More costly technologies will be required to meet the regulatory CO$_2$ requirements in the 2016+ timeframe.
Technology assessment
Best Bang-for-the-Buck

FCA technology selection is based on incorporating the best value considering cost and customer acceptance.
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Technology assessment
Best Bang-for-the-Buck

Diesel provides about the same Bang-for-the-Buck as CNG and hybrid technology when assessed on a fuel consumption rather than CO$_2$ basis.
We focused on transmissions first – moving from 4, 5, and 6 speeds to 8 and 9 speeds gaining efficiency, performance, and refinement.

The 8 and 9 speed transmissions provide:
- 6-10% improvement in fuel economy over their 4, 5, and 6 speed predecessors
- Simplified manufacturing and supply base with greater scale
Global FCA transmission portfolio trends

Automated transmissions with more speeds grow in all regions

**NAFTA**
8 and 9 speed transmissions become main stream

**LATAM**
Manual transmissions remain primary but automatics increase significantly

**EMEA**
Manual transmissions remain primary but automatics increase significantly

**APAC**
Automatic transmissions and DDCTs become the primary technologies
The Pentastar family replaced Seven V-6 Engines (four families) and provided significant CO₂ reduction with improvements in performance and refinement.

More than 3 Million Pentastar Engines produced since 2010 CY.

Three-time “Ward’s 10 Best Engines” winner.

The Pentastar engine family provided improvements in power and a 7% improvement in fuel efficiency across the fleet.
Consolidation and improvement actions are also being applied on Large and Specialty Engines

- These applications have more fragmented usage and are dominated by special work and performance market requirements
- Same approach to consolidation:
  - Shared technologies with other engine families
  - Common engine package for full-size truck, large SUV and large sedan/coupe
- The technologies and benefits will be more substantial than cylinder deactivation was in 2003
Portfolio consolidation
Small gasoline engines

Displacement per Cylinder

Power

 Macedo 4x4

- Turbo charged
- Naturally aspirated
Portfolio consolidation
Small gasoline engines

The portfolio will be consolidated with the introduction of a new family of engines.

- Turbo charged
- Naturally aspirated
Portfolio consolidation
Small gasoline engines

The new family of engines will be available in many power levels but will share cylinder geometry and combustion system architecture for maximum efficiency.
New small engine family technology

The new gasoline engine family will incorporate numerous technologies

- Integrated Water/Air Charge Cooler
- MultiAir Valvetrain
- Direct Fuel Injection
- Belt Starter / Generator
- Variable Displacement Oil Pump
- Low-Friction Silent Chain
- Lightweight Crankshaft
- Crankshaft Offset from Cylinder Bores
- Aluminum Block
- Low-Friction Roller Bearing Camshaft
- Twin-Scroll Turbocharger
- Integrated Exhaust Manifold
- Close-Coupled Catalyst
- Cooled EGR
- Stop/Start Starter
- Low-Friction Roller Bearing Balance Shaft
- Variable Flow Water Pump + Electric Auxiliary Water Pump
- Integrated Water/Air Charge Cooler
- MultiAir Valvetrain
- Direct Fuel Injection
- Belt Starter / Generator
- Variable Displacement Oil Pump
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Global Powertrain
Global FCA gasoline engine portfolio trends

The portfolio is transforming to smaller displacements with greater technology content for improved efficiency

NAFTA
Reduced vehicle demand energy enables smaller engines

LATAM
CO₂ regulations drive higher content engines

EMEA
Positioning the portfolio to meet 2020 CO₂ requirements

APAC
Regional CO₂ and displacement regulations drive smaller engines with higher technology content
Diesels are not just for Europe anymore

**NAFTA**
Diesel mix remains constant

**EMEA**
Diesel share grows in C and higher segments

**LATAM**
Diesel grows in SUV and pickup segments

**APAC**
Diesel growth in Indian market
The FCA strategy is to introduce electrification for regulatory compliance and where market-based customer demand is forecast.

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- **Leverage Start/Stop technology**
- **Belt Starter Generator (BSG)**
- **Plug-in Hybrid Electric Vehicle (PHEV)**
- **Maximize economies scale**

**ZEV mandate regulation**

**Market opportunity**

**Broad market penetration**
The overarching driver for powertrain technology change over the next 5 years is CO₂ reduction – driven mainly by regulation but increasingly by customer preference.

FCA and the industry in general have made great strides in improving the efficiency of the internal combustion engine. Much more progress will come as gasoline and diesel engine technologies converge. FCA will start the global roll out of a new small gasoline engine family in 2015 which incorporates these new and emerging technologies.

Diesel, a Fiat core technology, will increase outside of Europe. The RAM 1500 and Grand Cherokee applications in NAFTA are two recent examples.

CNG can play a significant role in reducing emissions and dependence on oil. Although widespread usage is not expected to develop in the U.S. primarily due to the lack of a public distribution infrastructure, CNG remains strong in other global markets.
FCA has established a leadership position in transmission technology. Much of the work is behind us but we will continue to improve efficiency and extend 8 and 9 speed applications on a global scale.

Electrification has been over-blown by the media. With the exception of a relatively small group of early adopters, the market continues to be primarily driven by regulatory requirements. FCA will launch a PHEV minivan in 2016 to comply with ZEV requirements. Several mild hybrid applications will come to market shortly thereafter.

Despite the strong regulatory push by CARB’s ZEV mandate, fuel cells still are not commercially viable for mainstream automobiles. The technology is too expensive and the infrastructure to create and distribute hydrogen with a net CO₂ footprint reduction is not in place.
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