Engine downsizing – Fuel Consumption and Emissions Challenges
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2016-11-15
• Introduction
• Global Powertrain Technology Trends
• Geely Global Powertrain Strategy
• Summary
• Strong global focus on emissions and CO2
  – China are showing leadership by introducing toughest legislation
• Powertrain technology is key to meet the requirements
• Vehicle measures are needed as well as powertrain measures
  – SUV trend is increasing the challenge – increased energy required to propel the large, heavy vehicles with large wheels
• Significant OEM challenges in new technology
  – major investments in development and production
  – timing is critical
  – quality is critical
• Geely is expanding into a multi brand global OEM
  – Strong on Chinese home market
  – Strong in EU and US markets
  – Global brands Volvo, Geely and LYNK&CO
Well known facts:

- More and more stringent emissions levels
- Real Driving Emissions legislation in EU/CN
- New driving cycles
- Electrification growing
- …

The pressure is increasing on powertrain – need to balance cost of PT technology, aftertreatment systems and electrification
Global Fleet Average Fuel Consumption

Well known facts:

• More and more stringent fleet fuel consumption legislation
• Massive fines or illegal to sell vehicles
• Real World driving fuel consumption scrutinized

The OEMs need to find cost-effective solutions to the CAFE legislation – not really customer driven

To meet the global demands the OEMs are:

- Optimizing the Internal Combustion Engines:
  - Fewer cylinders
  - smaller displacement & turbocharging
  - direct injection

- Optimizing the transmissions
  - more gears for conventional automatics and manuals
  - dual clutch transmissions

- Introducing electrification on a wider scale
  - Start / stop, Mild hybrid (BSG, 48 V), HEV, PHEV

*All OEMs are on the same roadmap – timing and cost effectiveness are crucial*
Real Driving Emissions:
- Driving style is very important for the actual load
- With aggressive downsizing the engine is close to full load

Engine technology and aftertreatment system needs to be chosen carefully for RDE compliance

Source: AVL 2015 International Vienna Engine Symposium, RDE- Challenges and Solutions
Geely Global Powertrain Strategy

- Geely must provide a wide range of solutions for the global markets
  - Current powertrains will be further optimized for cost and quality
  - New modular powertrains are developed to meet the future demands and will be rolled out step by step starting in 2017
- Electrification will gradually take over as prime driver with ICE used in sweet spot, and Geely has developed a flexible modular powertrain platform
  - Electrification as required by market needs (48V, HEV, PHEV, BEV)
  - Same industrial footprint as conventional powertrain
- Multiple Transmission technologies in parallel
  - New generation automatic transmission
  - Dual Clutch Transmission, DCT
  - Optimized manual transmissions
  - DCT with built in electric motor
• Internal Combustion Engines will still be dominant for the coming 10-15 years, but the gradual shift to electrification has started
• ICE is not stand alone any more – system optimization with electrification
• Concentrate on three main engine families developed and built in-house
  – 2.0 4-cylinder
  – 1.5 3-cylinder
  – 1.0 3-cylinder
Real Driving Emissions Technologies

Engines are developed for Real Driving Emissions:

- High pressure Gasoline Direct Injection
  - Central injector location
  - Multiple injection strategy for cold start and catalyst heating
  - Particulate Number reduction by spray shape optimization
- High tumble to ensure fast and complete combustion
- Rightsizing – balanced displacement/vehicle weight ratio
- Minimized Scavenging
- Large lambda 1 window
  - Integrated exhaust manifold
  - Optimized cooling system
- Exhaust Aftertreatment
  - Capable of CN/EU/US emissions
No new engine architecture needed to reach 40+ % of thermal efficiency since the new base engines are very competitive

- Advanced boosting systems with/without electric support
- External cooled EGR system (long route / short route)
- Higher pressure GDI (350+ bar)
- Miller cycle with/without 2-stage Variable Valve Lift
- Cylinder deactivation for 4-cylinder
- Exhaust heat recovery systems

Source: internet and internal
• There is a strong global focus on emissions and CO2
• Powertrain technology is key to meet the requirements
• Choice of technology vs. cost is critical for OEM’s business case
• Creating a set of modular powertrain components is critical for managing the transition into electrification

**Geely is well prepared for future emissions and CO2 legislation!**
THANKS