The Mercedes-Benz OM 651 Four-Cylinder Diesel Engine for Worldwide Use

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Summary

The four-cylinder diesel engine, with the in-house code OM 651, was launched for the first time in 2008 in the C-Class. Since then, it has been used in almost all Mercedes-Benz passenger car and van variants – an unprecedented range of deployment and the highest production volume for a single assembly within the Mercedes-Benz Cars Group.

The basic design of the major assembly was planned for a wide array of applications, with the objective of using a high number of shared parts. This article presents the most significant basic engine layouts, describing the technological modules from the initial design and also the characteristics of the variants – from the transverse configuration in Mercedes front-wheel architecture and hybridization in the powertrains of the E- and S-Classes to commercial vehicle applications. It also deals with the changes to exhaust gas aftertreatment in Europe (EU6), the variant for the USA (BIN5), and the special emissions requirements for commercial vehicles. The article makes particular reference to the development issues relating to variation in major assemblies, cost efficiency and premium standards in product characteristics, as well as setting out an intended path forwards. It closes with a description of the OM 651 Eco, the latest evolution in the lifecycle of the major assembly range.

With this current incarnation of the Mercedes-Benz four-cylinder diesel engine, the E-Class E220 BlueTec and the variants of the transverse assembly, such as the GLA200 CDI and 220 CDI on the basis of the Euro 6 emissions standard, and the US versions – the GLK250 and E250 BlueTec – based on the bin emissions standard, are achieving top marks in fuel efficiency in the competitive environment while simultaneously offering excellent performance and the high level of comfort typical for the brand.

1 Requirement Profile / Range of Applications of the Four-Cylinder Diesel Engine Major Assemblies at Mercedes-Benz

The four-cylinder diesel engine segment is of particular significance for Mercedes-Benz because the requirements for major assemblies are shaped not only by the passenger car applications, but traditionally also count appreciable quantities in the commercial vehicle sector among their range of applications.

The increasing trend towards downsizing in recent years means that traditional six-cylinder engine line-ups are being replaced by four-cylinder versions offering just as much power and torque. This trend will continue over the years to come.

The range of applications of the current-generation four-cylinder diesel engine has been continually expanded since its introduction in the C- and E-Classes and now covers all Mercedes-Benz vehicle classes except the SL, as well as the Viano, Vito and Sprinter commercial vehicles.

With an output range of 70–150 kW and torque of up to 500 Nm, it is used in vehicles in a weight range from 1350 kg as a front-wheel-drive, over the transverse engine variant for the current A-Class to current hybrid applications in the S300 BlueTEC and the Sprinter, handling traction weights of up to seven metric tons, encompassing 4x2 and 4x4 drive train variants as well as left- and right-hand-drive vehicles.

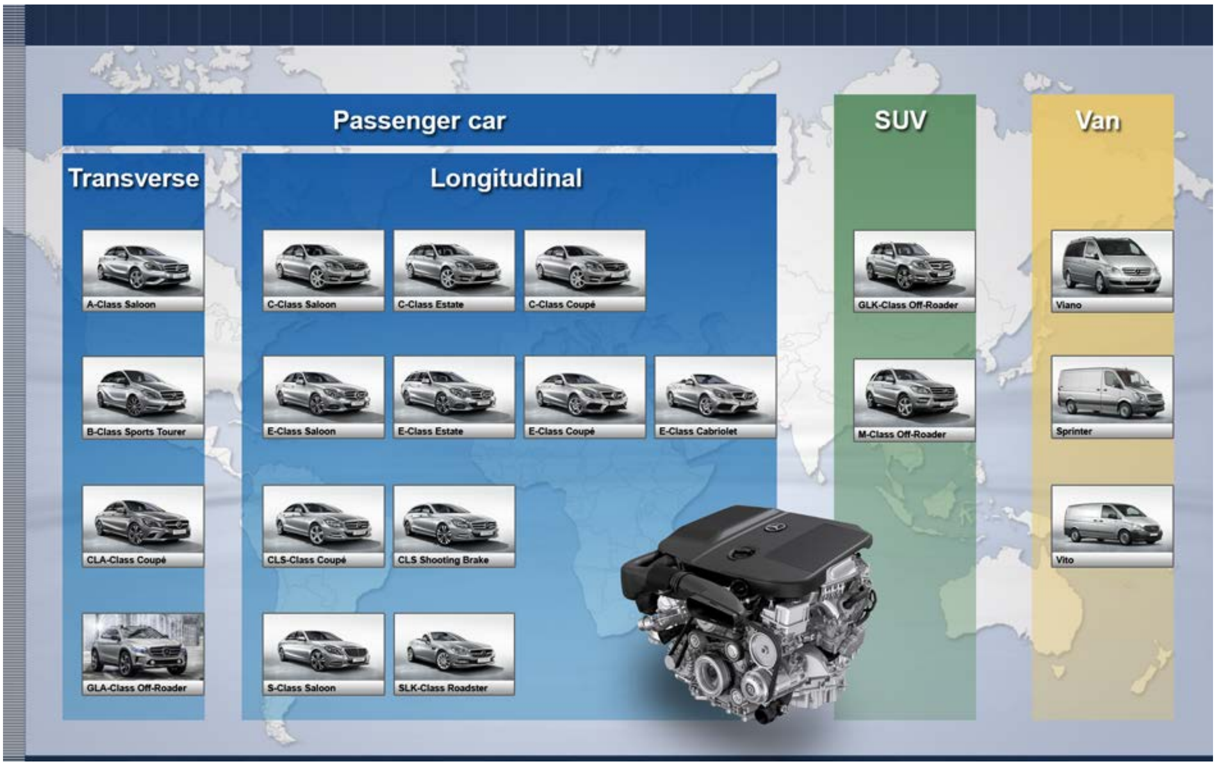

Fig. 1: Vehicle classes with the OM 651 four-cylinder diesel engine

Owing to the fact that the engine is now used worldwide, all known emissions standards must be complied with, from Euro 1 to BIN 5, as well as commercial vehicle approvals and fuel compatibility requirements of up to 500 ppm.

The OM 651 engine is applied in 20 vehicle categories, with a production volume of 760,000 engines per year. Eighteen engine hardware structure variants cover 1,014 functional variants with various emissions, drive and country versions.

The portfolio of the Mercedes-Benz four-cylinder engine illustrates the complexity of use in the reference segment, in which gaining dominance requires both special measures in engine design and suitable methods over the course of development.

The design of the current Mercedes-Benz OM 651 four-cylinder engine dates back to 2005. The following development targets were the priority at the time:

- A shared engine design for longitudinal and transverse installation, as well as for application in commercial vehicles
- Maximum torque of 500 Nm
- Maximum output of 150 kW
- Same agility as a six-cylinder engine with greater displacement
- Compliance with EU5 emissions limits, including dynamometer approvals for commercial vehicle applications without active denoxification
- Potential untreated emissions in view of EU6
- Significant reduction in fuel consumption over the predecessor engine
- Optimization and standardization of modules and assembly processes with the goal of increasing quality at the same time as improving the cost situation

These requirements have been added to over the lifecycle to date, with the introduction of the EU6 emissions standards for longitudinal installation and the front-wheel-drive platform of Mercedes-Benz passenger cars, as well as BIN5 for the current variants on the US market; the hybrid combination as the E300 and S300 BlueTec Hybrid; and the expanded CO_2 requirements that have led to the development of the Eco stage, as shown in Figure 2.

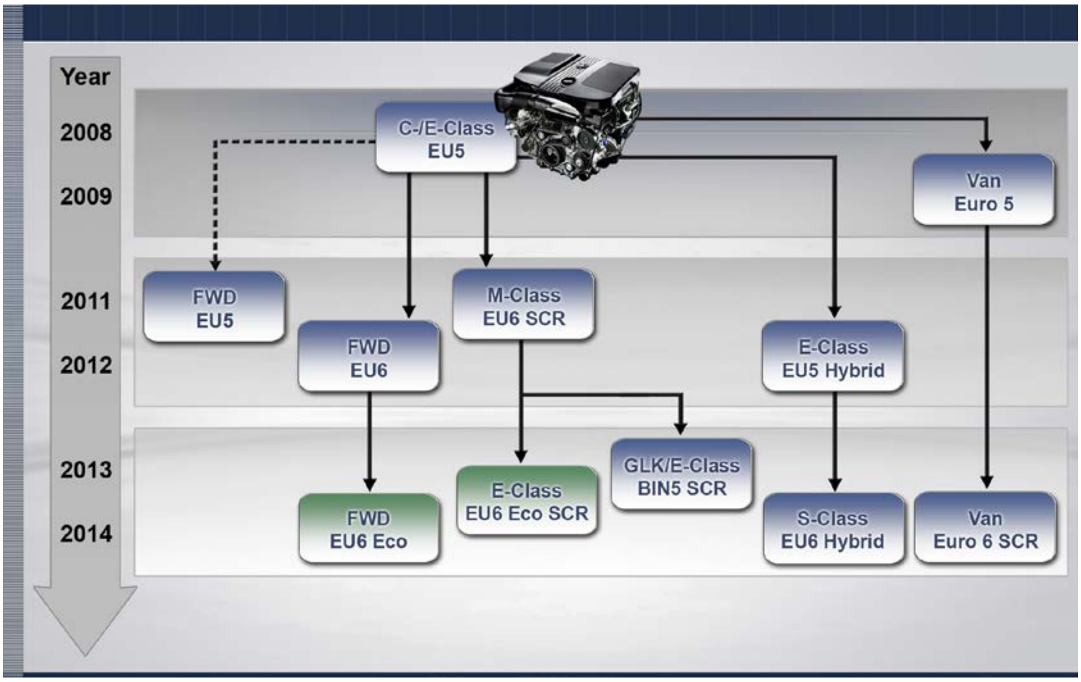

Fig. 2: Major assembly variants over the lifecycle to date

2 Technical Description of the Basic Major Assembly

2.1 Main Dimensions/Basic Engine Design

The basic dimensions of the OM 651 four-cylinder diesel engine were defined by the requirements of the use profile, which covers both the commercial vehicle applications that have been described and their optimal design for starting torque and fulfillment of emissions standards and is suitable for compact applications in the A- and B-Classes in the passenger car segment.

On the basis of a configuration of 150 kW for the top-of-the-line version for passenger car application, i.e. with a power density of 70 kW/l, and the resultant requirements concerning thermal loads, the actual dimension of a 94 mm gap between cylinders, a standard bore of 83 mm and standard displacement of 2.15 l in the initial design were selected (Figure 3).

A stroke of 99 mm represents a decidedly long-stroke design.

A peak pressure of 200 bar and compression of 16.2 contributed to a thermodynamically optimal design.

For the 80 kW and 100 kW variants used in the new A- and B-Classes from 2011 on, a variant with 1.8 l displacement and a reduced stroke of 83 mm, with no difference in bore, was developed for the 80 and 100 kW power bands (250 and 300 Nm respectively).

		Transverse			Longitudinal			Van
Displacement	Ltr	**1.8**		**2.2**				
Cylinder spacing	mm	**94**						
Stroke	mm	**83**		**99**				
Bore	mm	**83**						
Stroke/bore ratio	-	**1.00**			**1.19**			
Rated output	kW	**80**	**100**	**125**	**100**	**125**	**150**	**120**
Max. torque	Nm	**250**	**300**	**350**	**360**	**400**	**500**	**360**

Fig. 3: Main dimensions of the OM 651 major assembly variants

The skirted crankcase is made of cast iron. The low cylinder head threaded connection enables the cylinder head to be tightened with distortion minimized for the bore, positively influencing the configuration of the piston ring pre-stress. The control drive of the four-valve cylinder head is provided by a combined gear and short chain drive at the transmission end, making it possible not only for the engine to have a short installed length but also for sports car applications in the SLK to be served with flat hood contours in the conventional drive layout.

2.2 Technology Portfolio

Lanchester Balancer

Due to the necessary all-wheel-drive capability, a high position for the balancer shafts was chosen, underneath the crankshaft and conrod module. Drive is provided via idler gears by the crankshaft, with contra-rotation of the left-hand shaft taking place via an additional gear level, which also drives the oil pump and high-pressure pump. To reduce noise, the gear drive is helically geared and has tensioned idler gears. The Lanchester shafts themselves are mounted on anti-friction bearings to minimize drive output, with two needle bearings and one grooved ball bearing.

Turbocharging and Air Ducting

Two different turbocharging concepts are used to cover the broad range of outputs and applications.

Single-stage turbocharging with variable turbine geometry and electric actuation is used for passenger car types up to an output of 100 kW.

For the 125 kW and 150 kW output levels in EU6 types and for BIN5 applications, two-stage turbocharging is used. Both the high-pressure turbocharger used here and the low-pressure turbine are wastegate turbos, with a compressor bypass with an actively engaged flap on the air side. When the wastegate valve opens once the engine is in the full-load range, this flap reduces pressure loss and protects the high-pressure turbocharger from being overloaded.

The result of this turbocharging is greater performance thanks to the increased turbo configuration options at the low-pressure level, as good response characteristics can be achieved at low engine speeds with the small high-pressure turbine. Due to the high levels of turbocharging that can consequently be attained, longer gear ratios can be used more easily and fuel consumption reduced as a result, in addition to the thermodynamic benefits of improved EGR compatibility at partial load and optimal positions of the center of gravity for combustion.

Variable Oil Circuit

The OM 651 uses a vane cell oil pump. The control variable for the delivery volume is the oil pressure in the main oil duct of the crankcase. This needs-based pressure control makes it possible to react to the various volumetric flow requirements arising as a result of the different operating temperatures and engine speeds and the switching state of the piston-cooling units. The oil pump is completely integrated in the crankcase.

Switchable Coolant Pump/Thermal Management

Optimal control of the flow of substances during the cold-start and warm-up phases, as well as minimization of the drive output necessary to achieve it, is now standard in major assembly design and development for achieving fuel efficiency targets. The foremost objective in this respect is reducing fuel consumption under all operating conditions, in addition to reducing raw emissions and accelerating the response of oxidation catalysts.

The core components used in the OM 651 are a switchable coolant pump, coolant temperature control dependent on the characteristics map, and switchable piston-cooling units. Reduction of the raw HC and CO emissions after the engine starts by means of the fastest possible warm-up of the combustion chamber is a priority here. Consequently, coolant is not required until the optimal temperature levels have been reached.

Constant monitoring of the temperature level and regulation of the substance flows both protect components from excessive temperatures and optimize the temperature level of the EGR path and engine oil, soot buildup and oil dilution.

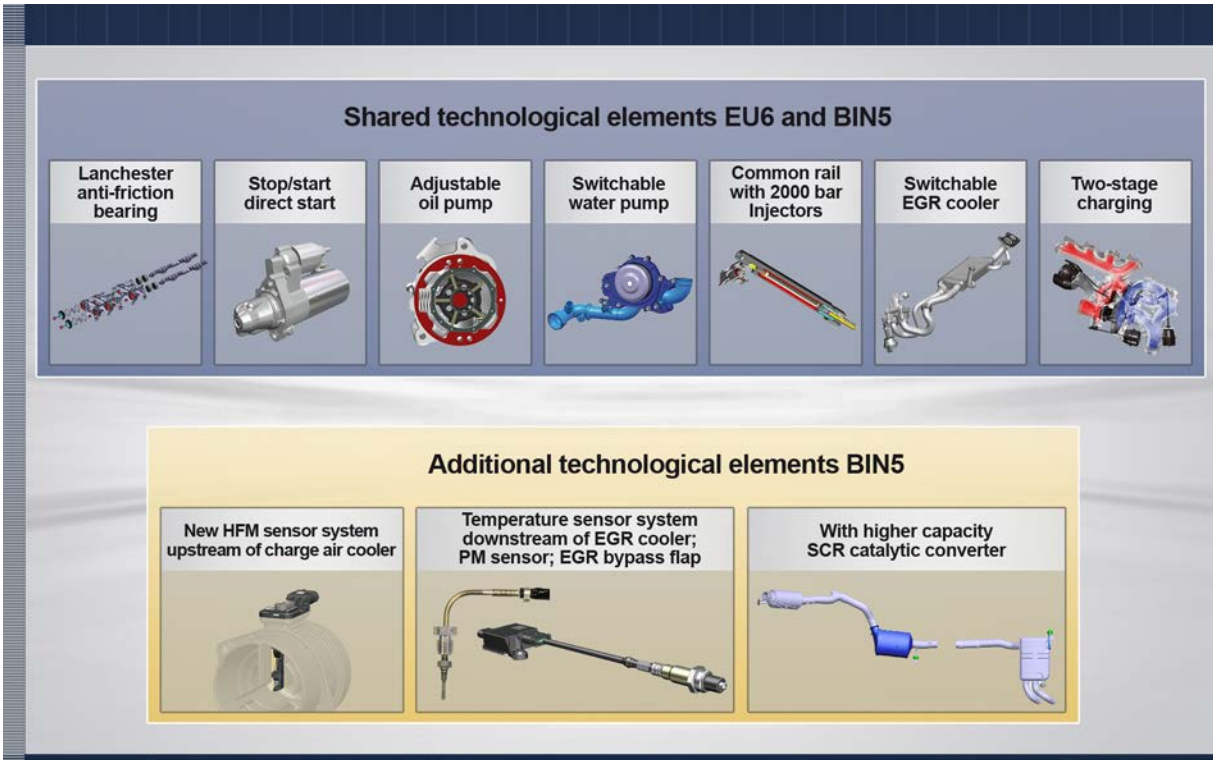

Fig. 4: Technological Elements, OM 651 Euro 6 and BIN5

Switchable Piston Cooling

The piston-cooling units are actuated via a separate oil duct, which is switched using an electric valve. After a cold start and during warm-up, the heat-up behavior improves markedly due to the deactivation of the piston-cooling units. Owing to the reduced heat dissipation, the critical raw HC and CO emissions drop appreciably in the phase before high conversion rates are achieved by the oxidation catalyst – a phase that is extremely significant in terms of emissions. The exhaust enthalpy is also increased.

Fuel Injection

Due to the diverse array of requirements, markets and emissions standards covered by the major assembly, a modular design is used for fuel injection. Various components from Bosch and Delphi are combined such that the system best attuned to the respective requirements is used in each case. Mercedes-Benz is the prime contractor.

Depending on emissions requirements, the system pressures used are between 1800 bar and 2000 bar. For average specific outputs in van applications, Bosch CRI2-18 solenoid injectors are used. For higher outputs and more critical installation conditions in longitudinal and transverse configurations in passenger cars, Delphi DFI1 injectors with pressures of between 1800 and 2000 bar (depending on emissions requirements) are employed.

For applications subject to BIN5 emissions legislation in heavy-duty vehicles, Bosch CRI3-20 piezo injectors are used. These have been operated successfully in the US market for years. They are especially suitable for the diesel fuel used there, with lower lubricity and oxidation stability.

All systems are combined with an extremely robust Delphi CP3.4 twin-plunger high-pressure pump, which covers the entire pressure and volume range of the different applications and is likewise suitable for worldwide fuel qualities.

Output and Torque Values

The following chart shows the output and torque values of the Mercedes-Benz four-cylinder major assembly range.

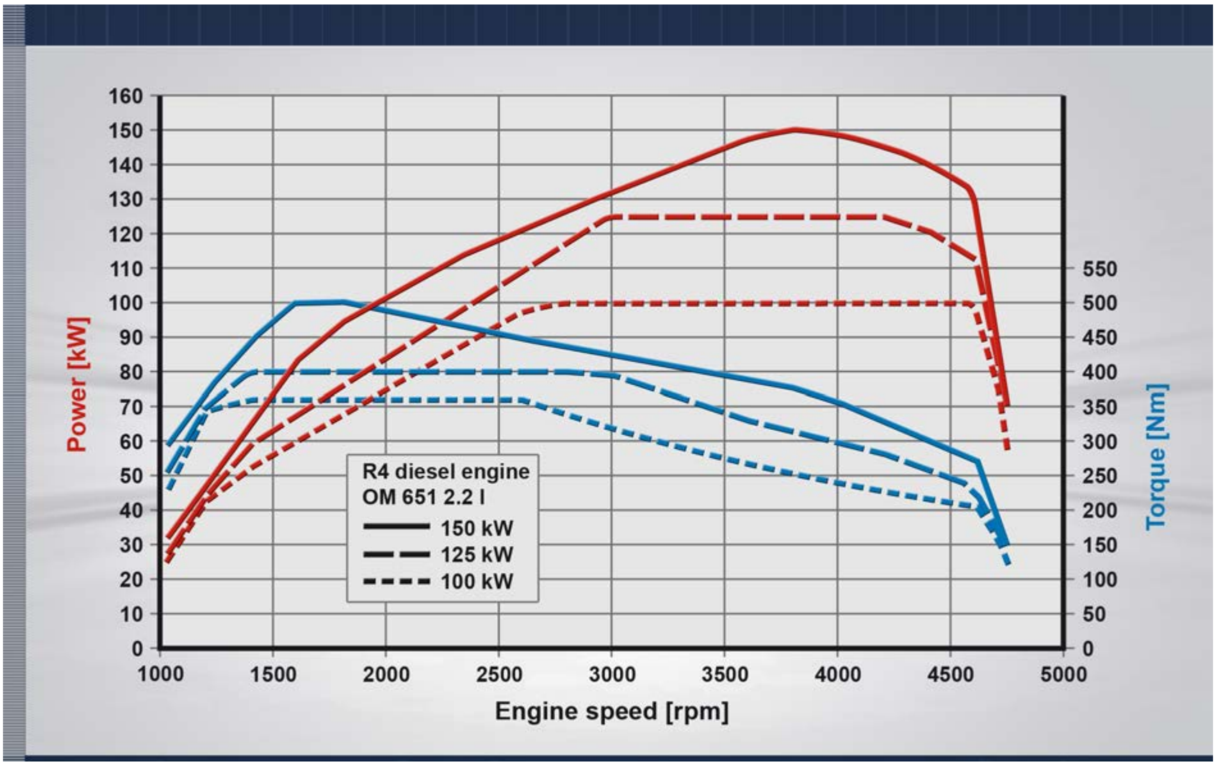

Fig. 5: Output and torque curves for main OM 651 variants

This output range encompasses the main configurations at 100 kW (200 CDI), 125 kW (220 CDI) and 150 kW (250 CDI), whereby the two lower output levels with single-stage turbocharging are used for transverse engines and the longitudinal engines are used above an output of 125 kW and 400 Nm with two-stage turbocharging. Even in today's competitive environment, with a torque of 500 Nm, the peak type still achieves a peak value.

3 Technical Adjustments

Development Premises for Implementing Global Emissions Requirements

The most significant modifications to diesel powertrains, which are currently offered in various vehicle classes and regions of the world, concern exhaust gas aftertreatment to fulfill a diverse set of emissions requirements and sharply fluctuating fuel qualities.

The vehicle load mentioned at the outset has a significant influence on the effort required to comply with the limits. The lightest vehicle weighs 1350 kg, while the heaviest traction weights in the Van segment can reach up to approximately 7 metric tons.

The applications cover everything, from EU1 limits for the so-called “rest of world” countries and commercial vehicle approvals based on engine dynamometer certifications to the strictest approvals under the EPA/CARB regulations. There is a conflict here between solutions that provide the best possible standardization and cost optimization. The standardized solutions are accompanied by high unit costs under the most challenging standards. The cost-optimized solutions, on the other hand, produce a high degree of type variation, and the capacities necessary for this entail high development costs.

Even though production material costs for volume types usually have a large amount of leverage on profitability in an economic viability analysis, topics such as the breadth of mechanical and functional validation from the specific conditions, such as fuel quality or height validation, must also be taken into account.

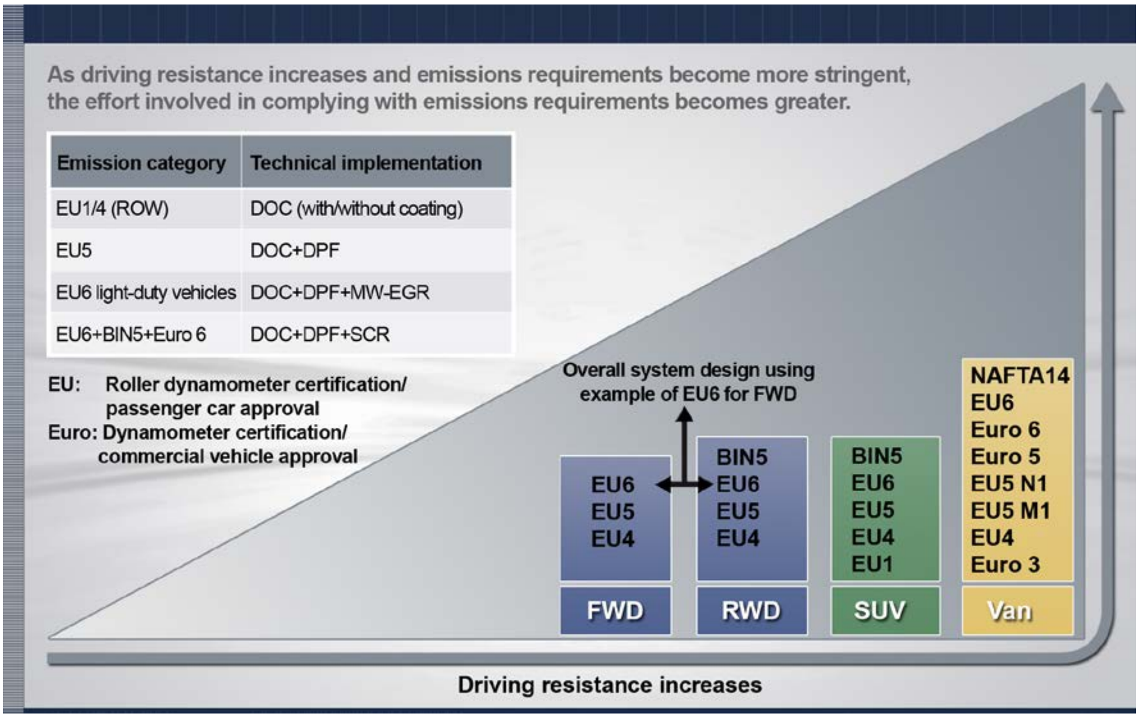

Fig. 6: Emissions variants

The Mercedes engineers decided to employ various approaches to optimization in this respect.

1. EU4/EU1 variants are achieved by simplification in the EGA, based on the Euro 5 type, resulting in the omission of the DPF.
2. EU6, EPA/CARB and commercial vehicle approvals for rear-wheel-drive types from Euro 6 are SCR types.
3. In the case of vehicles using Mercedes Front Wheel Architecture, Euro 6 emissions requirements can be complied with in-engine. This represents an optimal compromise for these types between costs and low fuel consumption and, depending on the segment, achieves high unit figures.

3.1 EU 6 for All RWD Applications

In the EU5 variants, an oxidation catalyst and particulate filter are used for exhaust treatment.

In order to achieve the much lower EU6 limits, an SCR catalytic converter is used in RWD vehicles alongside the oxidation catalyst and particulate filter to reduce nitric oxide emissions. Among other things, this technology enables the emissions limits to be adhered to while keeping fuel consumption to a minimum, as there is no need for additional regenerative combustion for a NO_x storage catalytic converter.

The effectiveness of the emission-reducing components in the exhaust gas system is ensured by the use of temperature, pressure and nitric oxide sensors in the exhaust gas system, combined with complex monitoring functions in the engine control unit (onboard diagnostics). The sensor values are compared with values modeled specifically for this purpose.

3.2 EU 6 for All FWD Applications

In 2011, the OM 651 was introduced in transverse configuration for the first time as a variant with 1.8 l displacement, starting in the B-Class under the EU5 emissions standard. In addition to the changes to the short-stroke drive unit, the modifications from the longitudinal versions covered the design of the engine peripherals for pure and clean air routing, the hot end with the exhaust manifold, the turbocharger arrangement and position of the oxidation catalyst and changes to the major assembly setup and belt drive.

In the Mercedes-Benz front-wheel-drive architecture for the A- and B-Class and in the CLA and GLA, the OM 651 is used in the 100 kW position in combination with a six-speed manual transmission and the 7G-FDCT transmission; in the 125 kW position solely in conjunction with the 7G-FDCT transmission.

In contrast to the RWD configuration, the 125 kW version is designed with a single-stage VNT turbocharger.

As previously with the RWD applications, the foremost consideration in the design of the exhaust gas aftertreatment under the EU6 emissions standard for the 125 kW type was again omitting active regenerative combustion for fuel efficiency reasons and, instead, fulfilling the EU6 limits with in-engine multi-way exhaust gas recirculation measures alone.

The following measures were implemented to achieve the EU6 limits:

- Expansion of high-pressure EGR by means of a low-pressure EGR path including exhaust flap
- Evolution of the air path model to enable the combustion chamber conditions to be described more precisely both statically and dynamically in terms of O_2 concentration
- Optimization of mixture formation through use of 8-hole injection nozzles in conjunction with modifications to the tangential inlet duct

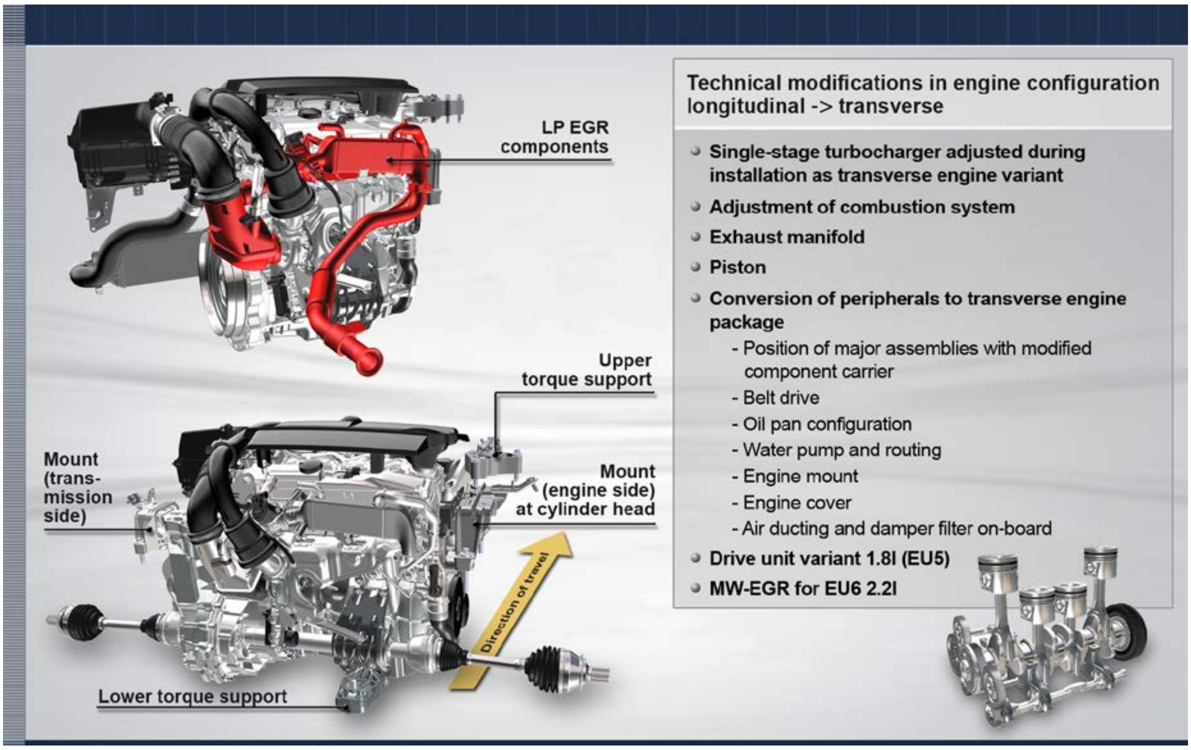

Fig. 7: Change scopes – FWD versions of OM 651

For the current roll-out of the EU6 emissions standard at the output level of the previous 1.8 l 100 kW type, fundamental consideration has been given to efficient implementation from the existing portfolio for an optimal solution, with priority given to efficient reduction of fuel consumption in a trade-off with product costs and development efficiency.

In deciding on technology for the roll-out of the further Euro 6 variants for light-duty vehicles, the primary aspect is the trade-off between emissions, consumption and costs. To reach the EU6 targets, the 1.8 l and 2.2 l displacement options were evaluated, along with a combined high- and low-pressure EGR, each with and without active NO_x exhaust gas aftertreatment.

Figure 8 shows the "raw" NO_x trade-off for both displacement variants. Starting from the EU5 type of the 1.8 l engine, the addition of multi-way exhaust gas recirculation initially improves fuel efficiency, although this deteriorates beyond the basic level as a result of the drop in nitric oxide in-engine to the target level. Operation at low air/fuel ratios also creates an increase in particulate matter, which would impair efficiency further via the Ki factor.

With active NO_x aftertreatment, it would be possible to maintain the good basic consumption of the engine with MW-EGR, however this would come with the high costs of the additional EGA technology.

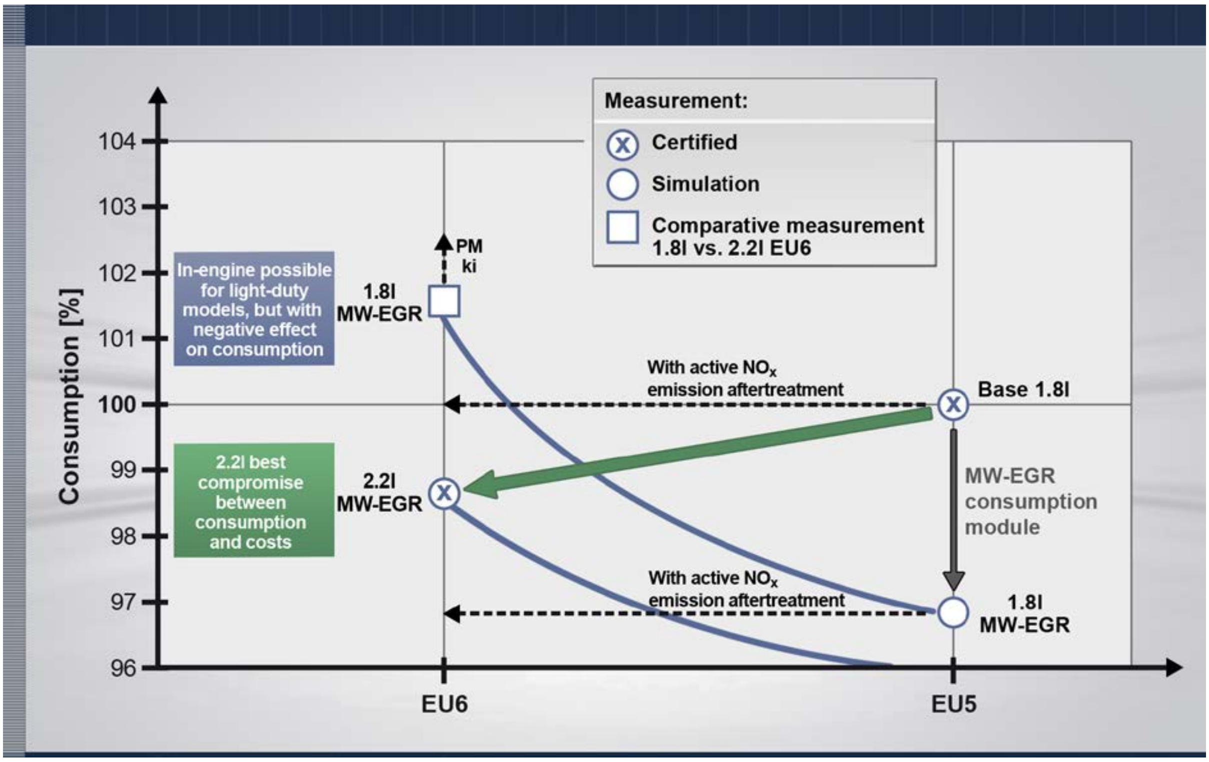

Fig. 8: Development options for the EU6 OM 651 in the trade-off with emissions requirements

The higher-displacement 2.2 l engine is capable of achieving the target emissions with a high air/fuel ratio and neutral particulate emissions with an improvement in consumption relative to the 1.8 l EU5 basis. This solution is also attractive from a cost perspective thanks to the omission of exhaust gas aftertreatment affecting NO_x.

This is possible through the utilization of the degree of freedom afforded by the greater cylinder displacement and a combustion process adjusted to suit the emissions targets, as well as a modified turbocharger. For this purpose, the swirl ratio was increased in comparison with the base version, a high-EGR-compatible piston recess developed and the injection nozzles adjusted accordingly. The turbocharger was optimized especially for operation with multi-way EGR and the highest levels of turbocharging at low loads/engine speeds.

3.3 BIN5 for the CDN/USA Market

The basic engine corresponds to the EU6 SCR major assembly, used first in the M-Class in 2011, then in the model refinement of the GLK and currently in the E-Class.

In comparison with the Euro 6 variants, a larger catalytic converter is used in the BIN5 variants. The basic design and layout of the catalytic converter units in the respective vehicle applications are the same as in the EU6 version.

A particulate sensor is also required for diagnostics regarding particulate filter efficiency. In the USA, in contrast to Europe, compliance with the limits must be verified in three different test cycles. The legal requirements concerning monitoring of the emission-reducing components are higher overall than with the EU6 variants and thus require greater outlay for development and validation.

3.4 Commercial Vehicle Application in the Sprinter

One particular challenge for use in the Sprinter comes in the form of the emissions concept for the various applications. Almost all conceivable emissions requirements worldwide need to be fulfilled, from US applications with highly complex exhaust gas aftertreatment and heavy-duty emissions specifications with full-load EGR to standard European passenger car emissions requirements and ROW applications. The variation in the Sprinter vehicle types extends far beyond that of passenger cars. Consideration must be given to vehicle weights of approximately two to seven metric tons, up to six different axle variations and a wide range of transmission variants. These conditions were taken into account right from the planning phase for the OM 651, and a comprehensive parts commonization strategy was implemented.

The basic engine is identical to the passenger car variant. With regard to the configuration of the combustion chamber, the broad range of applications was considered conceptually. The combustion process functions optimally at both partial and full loads, and thus offers the ideal basis for efficient emissions reduction in all operating ranges. Consequently, the only measures needed for the Sprinter emissions concept were modification of the low-pressure turbocharger and integration of an EGR pre-cooler.

Due to the high passenger car output requirements, the charging assembly is widely splayed. However, heavy-duty application in the Sprinter requires a well-coordinated configuration in the intermediate range of the two turbochargers at the highest possible efficiency levels and good controllability in conjunction with EGR. It was also observed that in contrast to passenger car application, the intermediate range for vans is entered considerably more frequently due to the higher engine speed and load level in customer operation. The exhaust gas recirculation tract is fitted with a two-stage EGR cooler for use in the Sprinter (Fig. 9). The exhaust gas is first extracted from the exhaust manifold and then cooled by the pre-cooler. Only then is the exhaust gas cooled by the main cooler or routed to the air ducting via a bypass, depending on the operating state. The additional pre-cooler increases the overall cooling capacity to the level necessary with regard to emissions and ensures adherence to the maximum permissible component temperature on the EGR valve for operation with full-load EGR.

Also modified for the Sprinter were the belt drive, the oil pan and several interface-specific components, such as the air ducting to the vehicle-mounted air filter, engine mount and two-mass flywheel.

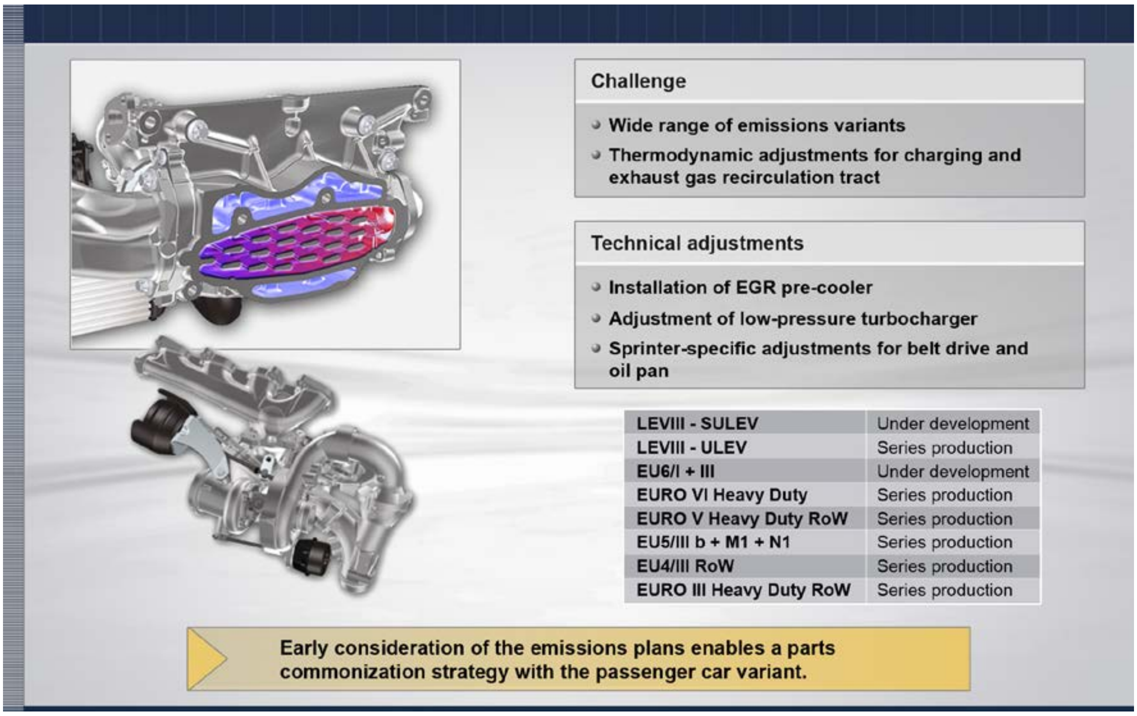

Fig. 9: Specific adjustments to OM 651 for use in the Sprinter

3.5 Hybrid Applications in the S300 BlueTec Hybrid

Today, there is a range of highly efficient diesel drives and hybrid drives with gasoline engines, including the premium segment of the luxury class. With the introduction of the diesel hybrid system in the E300 BlueTEC HYBRID in 2012, Mercedes-Benz achieved another milestone in the development of the automobile.

The OM 651 is combined in the powertrain of the diesel hybrid system with the 7G-TRONIC PLUS automatic transmission, which was completely revised for the hybrid application. The objective of the hybrid development was a highly efficient powertrain achieving the best possible fuel consumption without compromising installation space in the overall vehicle.

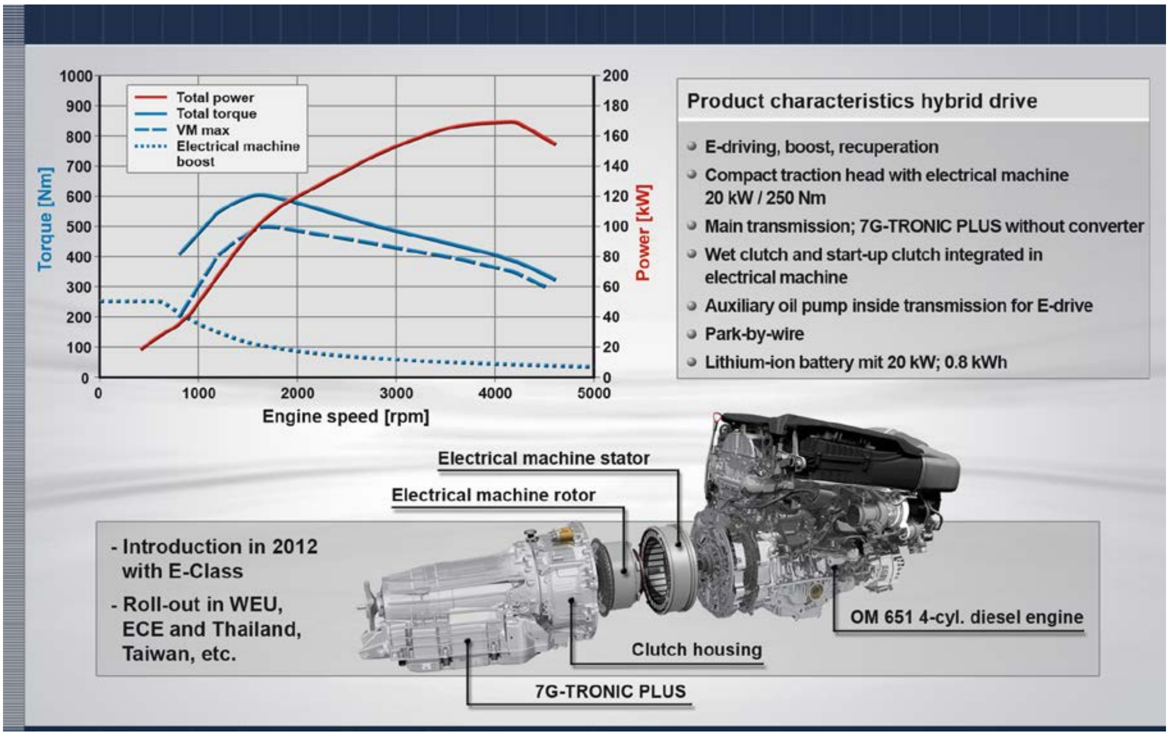

Fig. 10: Use of the OM 651 in hybrid applications

The hybrid system in the diesel hybrids in the E- and S-Classes (Fig. 10) originates from the parallel hybrid modular system that was subsequently fitted to further model series and engine line-ups with tiered electric outputs. It involves a P2 configuration. The system-specific characteristic is the additional clutch integrated between the combustion engine and electric motor. It decouples the combustion engine during purely electric driving while also offering the option to start up using the combustion engine with the performance of a wet start-up clutch. The clutch replaces the converter in this instance and, thanks to full integration in the converter housing, places no additional demands on installation space.

Owing to its configuration of the components, the P2 concept enables all hybrid functions, such as electric driving, recuperation, boost and start/stop. In the development targets for the diesel hybrid system, particularly high value was placed on reducing consumption.

Consequently, with a fuel economy figure of 107 g/km CO_2 in the E-Class, a new benchmark was set in the premium segment of the luxury automobile class.

The system captivates customers with its efficiency and modularity and thereby enables hybrid driving at the premium level with top-class fuel consumption, with limitless options for vehicle configuration.

The second-generation Mercedes-Benz hybrid system can very easily be adapted to other engines. Thanks to the variation in the length of the electrical machine, the assembly plan for the power electronics and the battery cells with identical system architecture, the degree of hybridization can range from consumption-optimized full hybrids to performance-optimized plug-in hybrids.

4 Latest Development: OM 651 Eco

The next stage of development of the OM 651, the OM 651 Eco will be used for the first time beginning in September 2013 in the E220 BlueTEC, as well as in transverse configuration in the GLA220 CDI.

The revisions are focused on two key areas:

1. Reduction in the dissipative losses of the basic engine through revision of selected mechanical components of the basic engine, reduction in friction/power loss and use of new-generation low-friction oil.
2. Thermodynamic revision of the consumption process and optimization of fuel injection.

The basic engine revisions concern the use of clearance-optimized pistons with reduced piston ring stress and DLC coating, mounting of the camshaft on anti-friction bearings at the drive end of the chain drive, a vacuum pump with reduced friction loss and an optimized belt drive, which did not require deflection due to the conversion to electric power steering in the RWD applications.

On the basis of intensive simulations and investigations into the vibratory excitations on the crank assembly in conjunction with the 8-counterweight crankshaft, a reduction in the degree of compensation of the Lanchester by 15% meant that a further decrease in power loss in the basic drive unit was achieved without negatively affecting the vibration characteristics for customer operation.

The thermodynamic revision involved modification of the injection parameters and air path coordination in conjunction with the use of combustion regulation.

The use of low-friction oil with additional fuel economy potential of 1-1.5% and an unchanged HTHS figure of 3.5 completes the measures implemented on the engine.

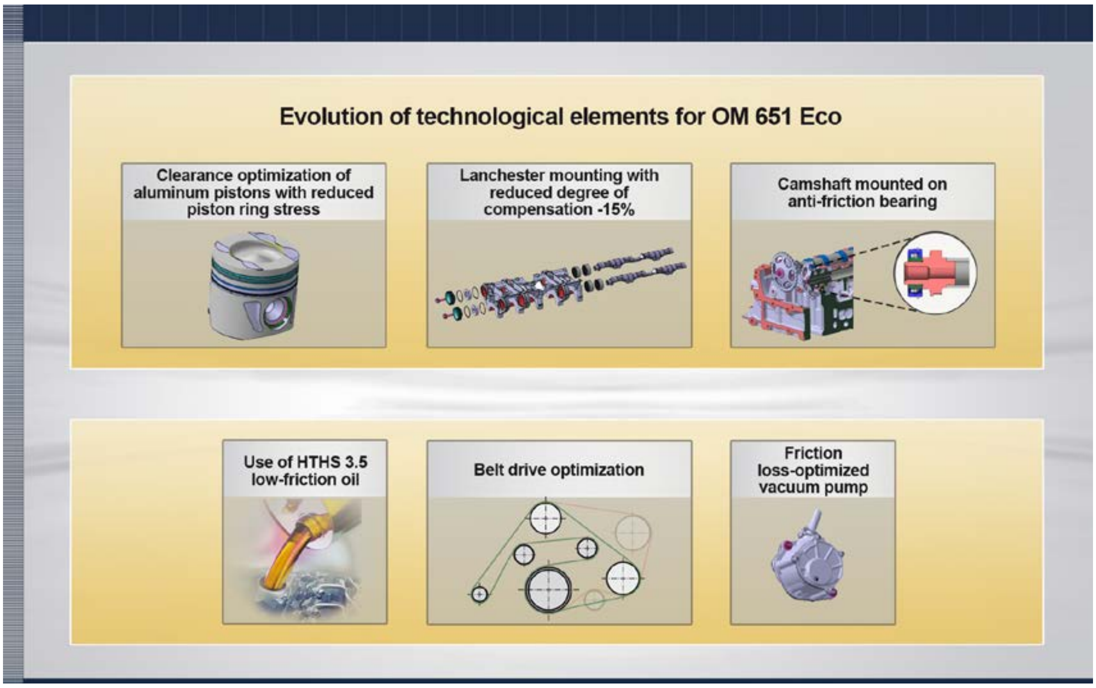

Fig. 11: Technological elements of the OM 651 Eco

The positive effects of the revision can particularly be seen in the following map of differences from the previous basic version for the single-stage turbocharger variants in transverse applications.

The specific BEFF fuel consumption was improved by up to 10% in the lower engine speed range and up to approximately 300 Nm, resulting in a notable consumption benefit in the NEDC of 5-7% from engine-related measures only.

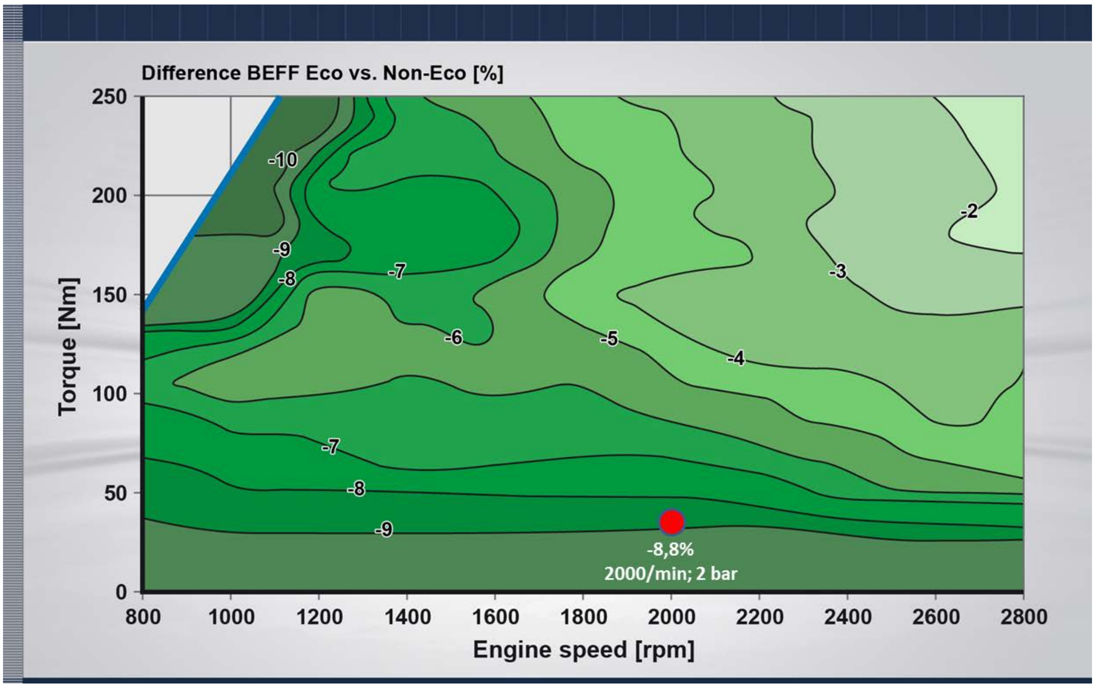

Fig. 12: Consumption map – differences between basic engine and Eco

5 Vehicle Results with the Current OM 651 Eco Powertrains

The following illustrations provide an overview of the improvements in fuel consumption and performance achieved by the various types.

5.1 E220 BlueTec for EU6 and BIN5

With the use of the new OM 651 Eco engine, excellent figures are already being achieved at the basic level in the new E-Class in conjunction with the 7G-TRONIC PLUS automatic transmission and stop/start system as standard in the form of the E220 BlueTEC with a value of 117 g/km CO_2, equating to 4.5 l/100 km.

The special E220 BlueTEC Blue EFFICIENCY model, featuring additional measures such as the use of low rolling-resistance tires, reduced weight and optimized aerodynamic details, not only achieves a further reduction in fuel consumption of roughly 10% from the predecessor model to 114 g/km CO_2, but also a new best-in-class figure in the reference segment.

The GLK250 Bluetec, also available since March 2013 and producing 150 kW, and the E250 BlueTEC for BIN5, offered on the Canadian and US markets from September 2013, also attain excellent consumption figures – 32 mpg and 45 mpg respectively for highway driving – which, for example in combination with the 80 l tank in the E-Class, enable a range of up to 900 miles.

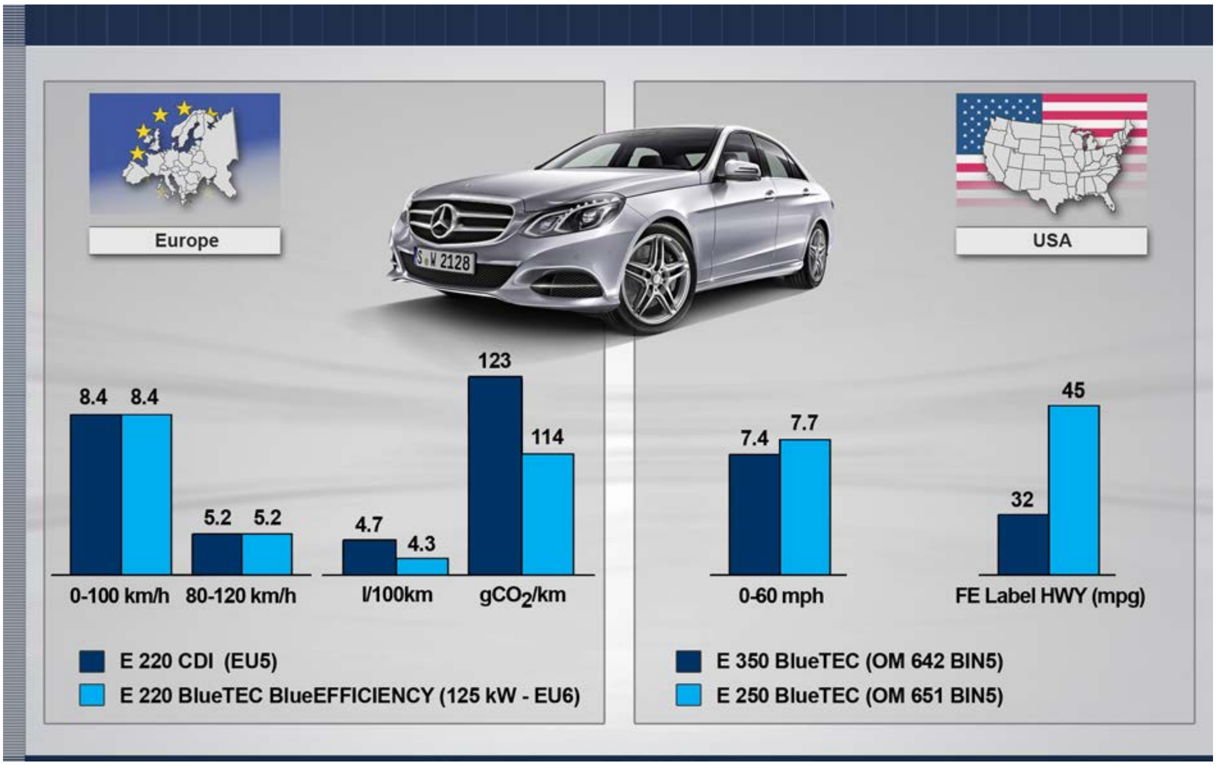

Fig. 13: Performance/consumption of OM 651 Eco in comparison with predecessor

5.2 GLA200 and 220 CDI

In the front-wheel-drive architecture, the OM 651 Eco for the first time is available in the recently unveiled GLA200 CDI along with either a six-speed manual transmission or a seven-speed DCT.

The GLA220 is offered exclusively as a 4x4 version in conjunction with the seven-speed dual-clutch transmission.

At 114 g CO_2/km, the fuel economy figures for the GLA200 CDI, just as the 129 g CO_2/km for the GLA220 CDI 4Matic, represent the absolute best scores in the reference segment for compact SUVs.

With acceleration of 0–100 km/h in 8.3 seconds and 80–120 km/h in 5.6 seconds, the GLA220 CDI also offers a very sporty performance.

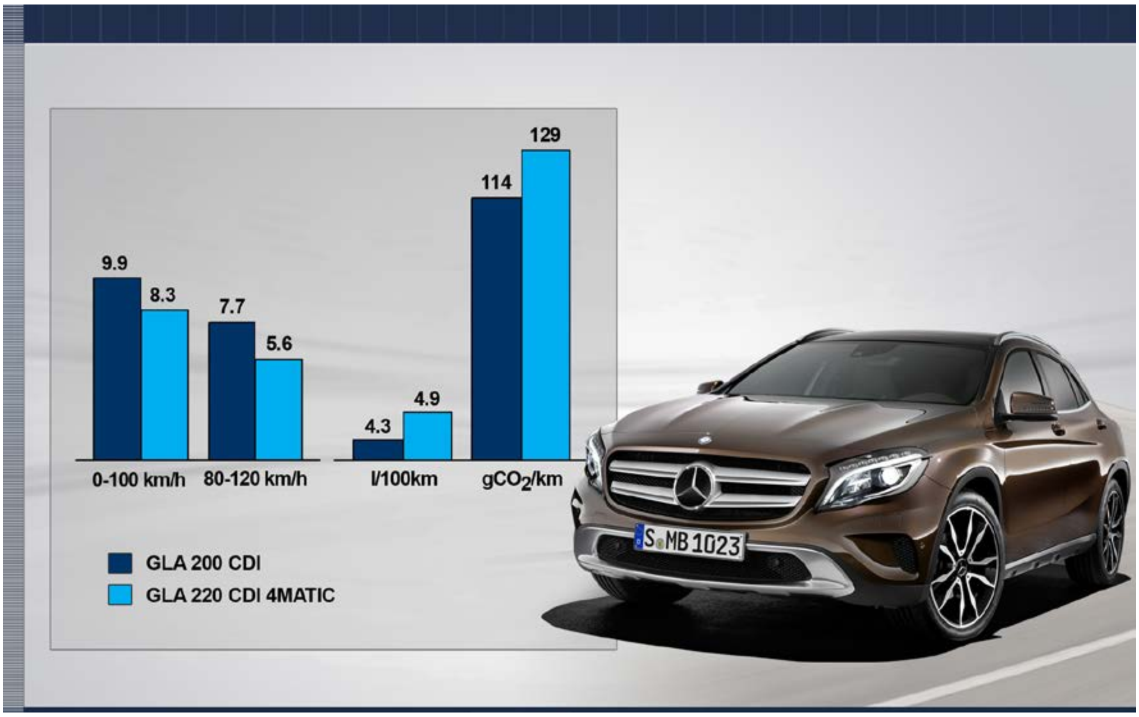

Fig. 14: Performance and consumption of OM 651 Eco in the new GLA200/220 CDI

6 Summary

With its standard basic engine and functional architecture, the Mercedes-Benz four-cylinder diesel engine line-up offers an unprecedented range of applications for both passenger cars and vans. The vehicle applications extend from the A-Class, in the A200, to the Sprinter with weights of up to seven metric tons, and from the SLK250 CDI to the S300 BlueTEC Hybrid.

All drive configurations come into play, from manual transmissions to torque converter automatic transmissions, as 4x2 or all-wheel-drive and as left-hand or right-hand drive.

This applies to worldwide use in all emissions certifications to the point of the latest LEV legislation.

Mastering this variation in drives requires not only a standard basic architecture and parts commonization strategy, but also efficient process planning in the development stages and intelligent start-up control during production in order that necessary evolution in both functional development and production can be achieved with high capacity utilization.

The success of the current generation of the OM 651 for BIN5 since the beginning of 2013 on the US market in the GLK and now in the E250 BlueTec is a testament to this development strategy, receiving a very positive market response. The same applies to the latest development in the form of the OM 651 Eco, which is available for the first time beginning in September 2013 in longitudinal configuration in the E-Class, with the best fuel economy level in the reference segment of premium manufacturers in the Euro 6 emissions level in Europe, followed by the transverse variants, which start with the new GLA200 and roll-out across all variants in 2014, thereby making the Mercedes-Benz four-cylinder diesel engine range an even more attractive proposition.

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