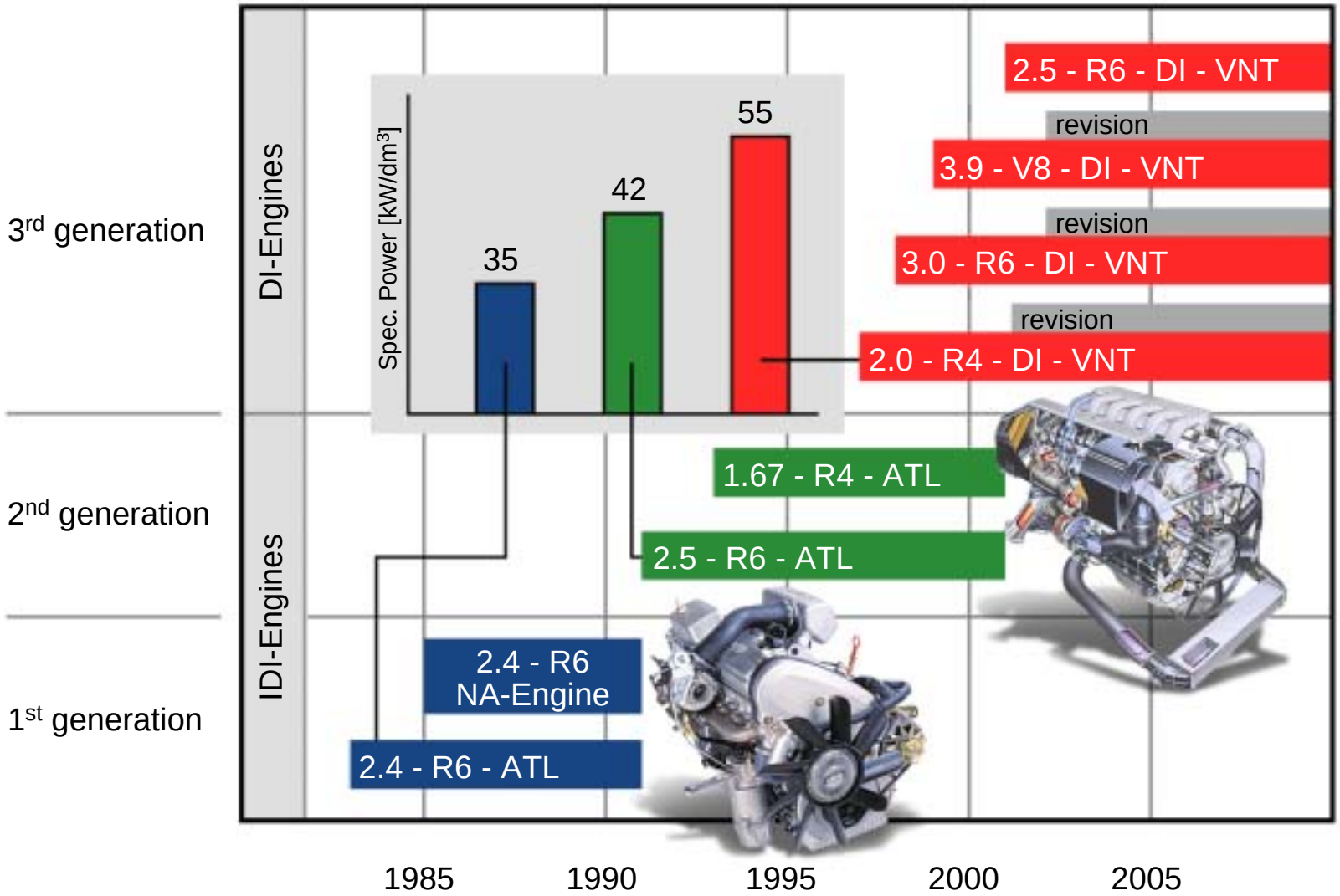
Recent Developments in BMW´s Diesel Technology

DEER Conference 2003 – Newport, USA August 2003

BMW Group

Recent Developments in BMW´s Diesel Technology

BMW Diesel History



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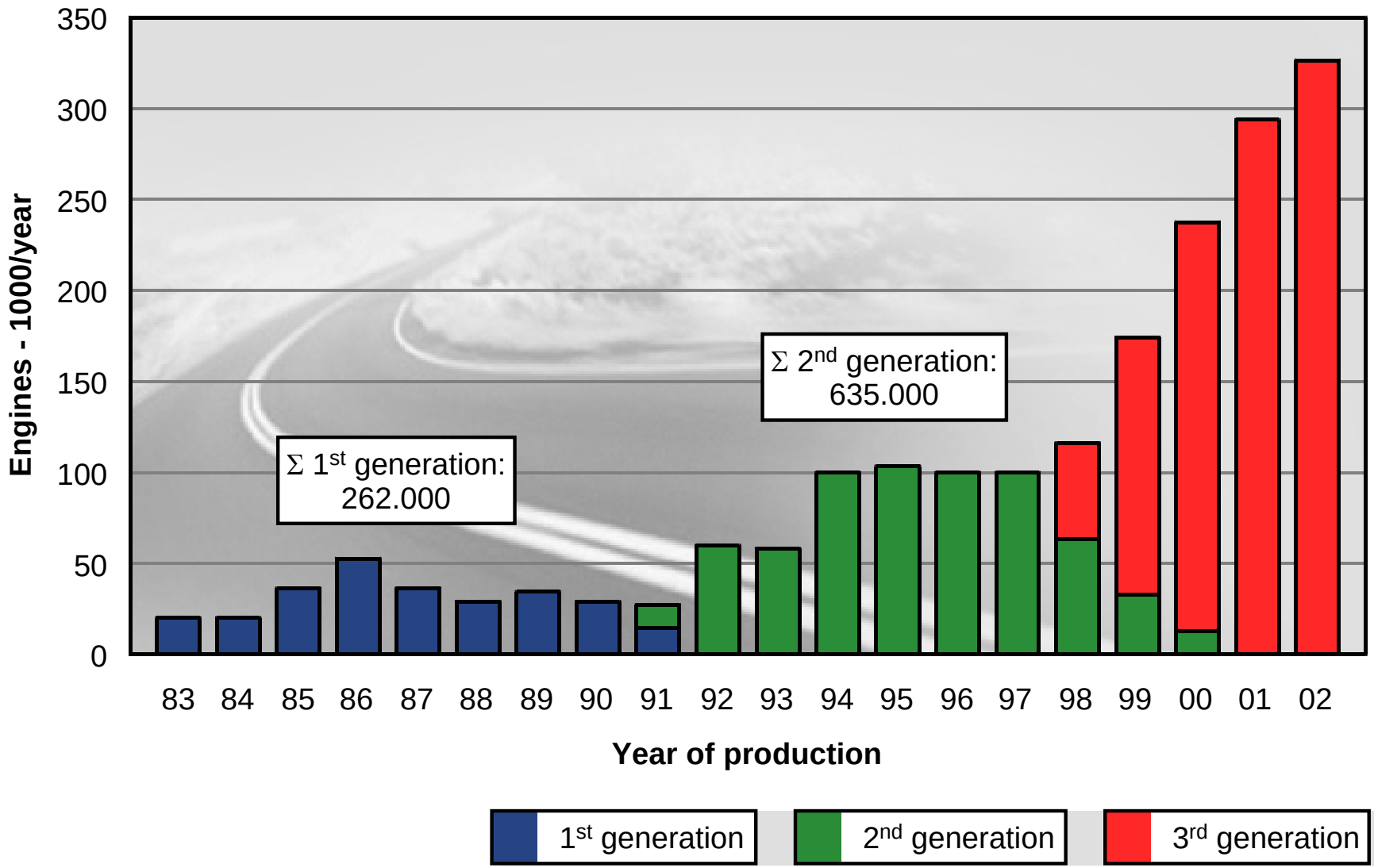
BMW Diesel Production



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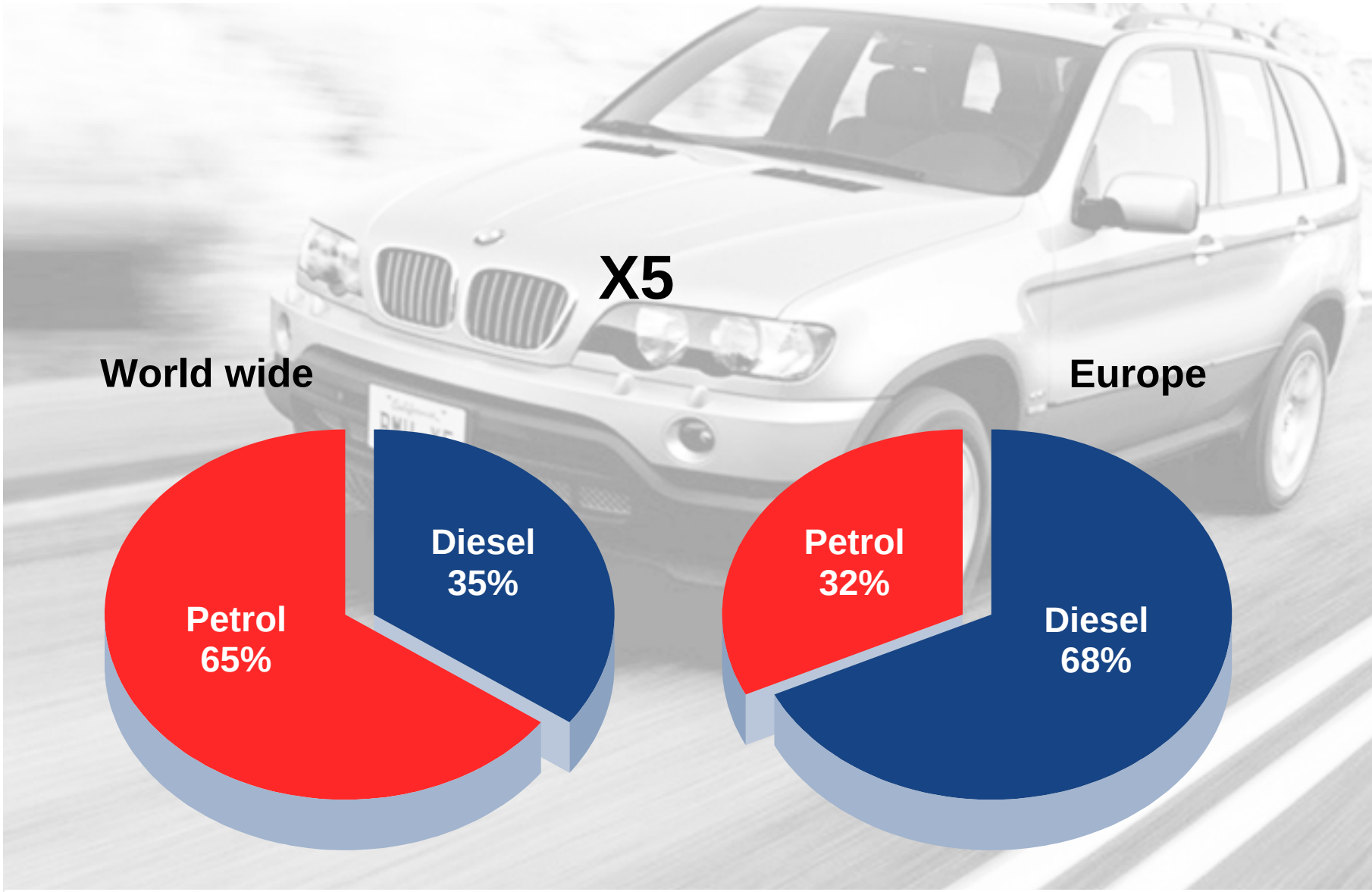
BMW Market Share 04/2003



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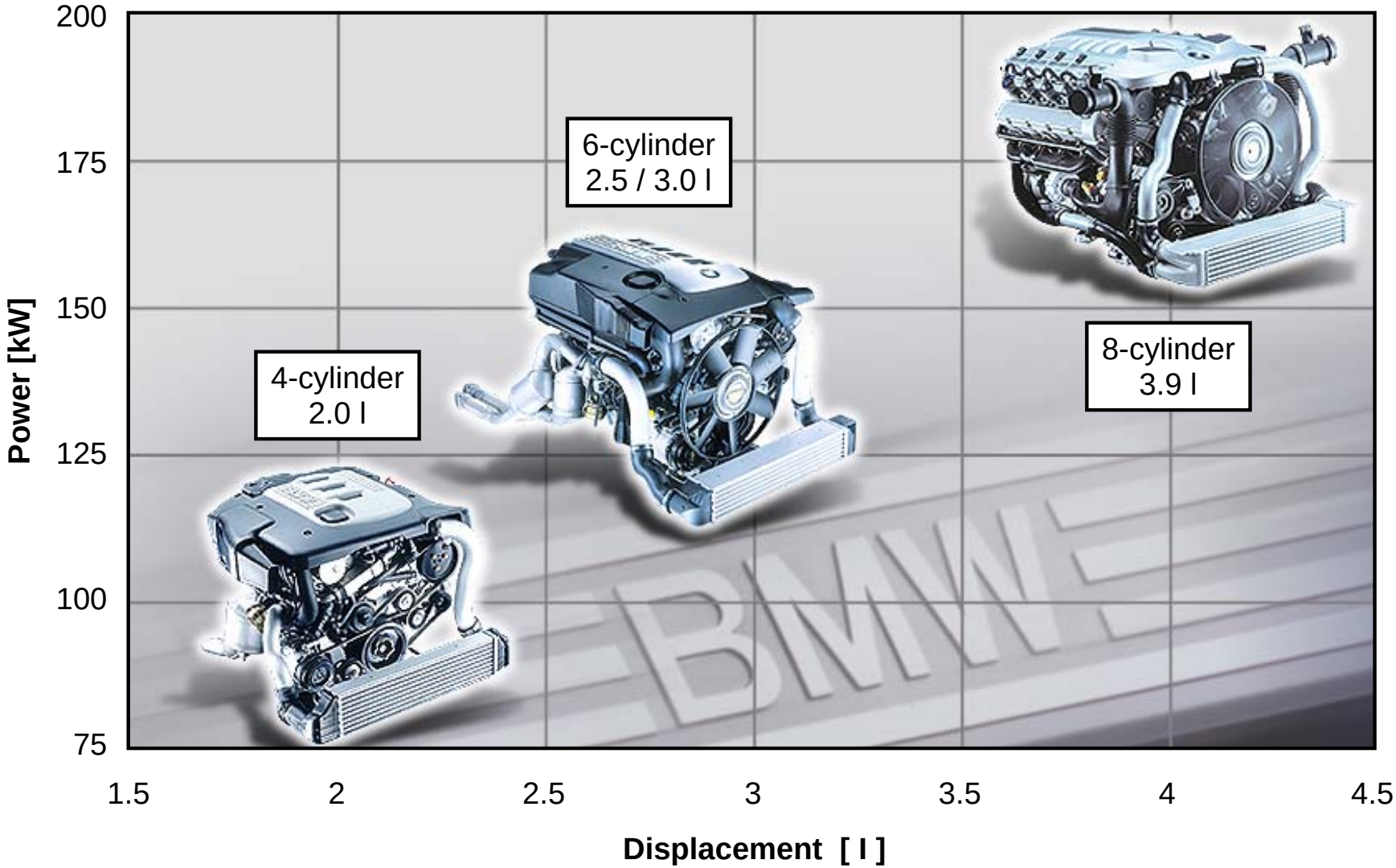
BMW Diesel Engine Family



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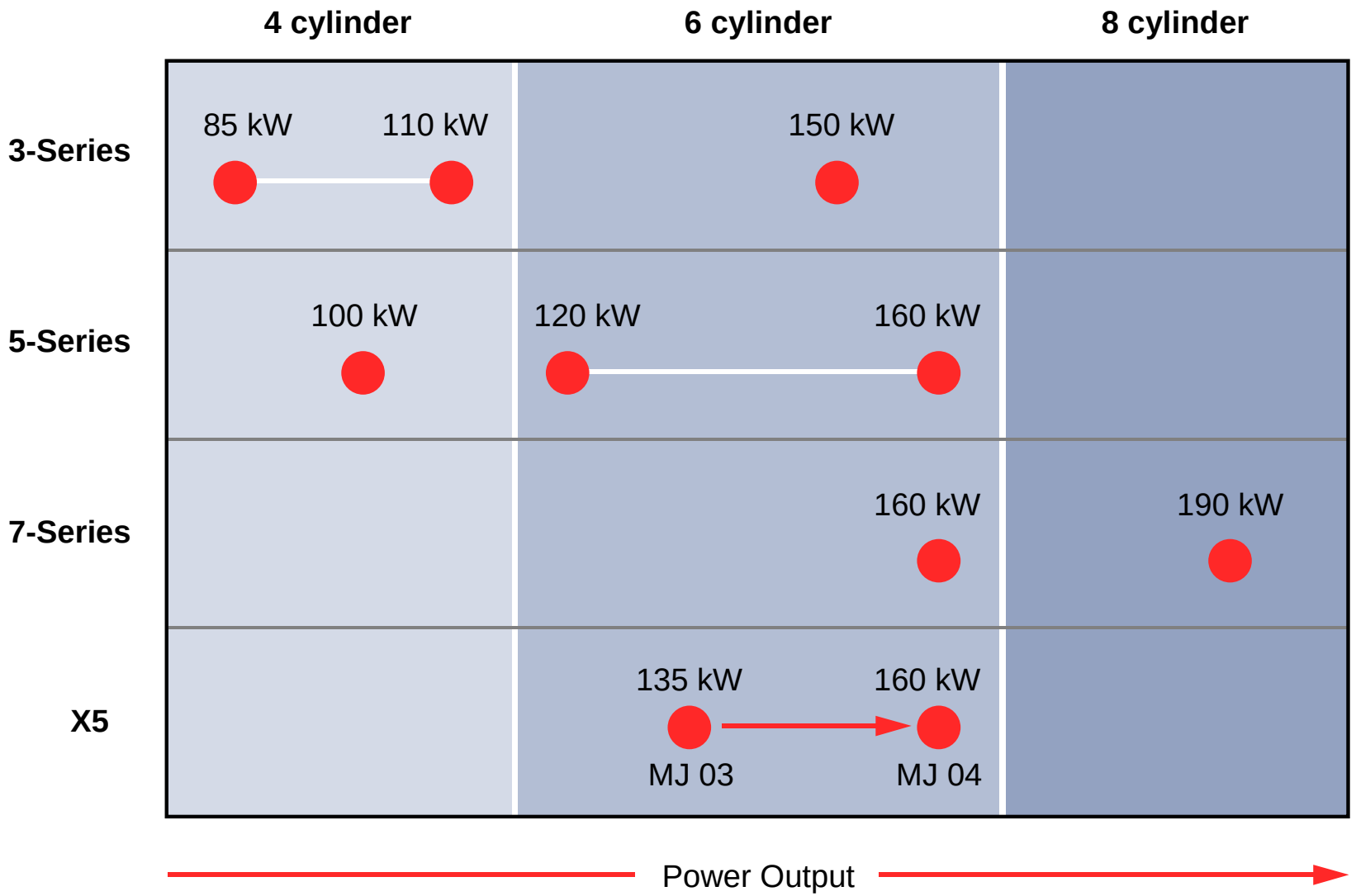
BMW Diesel Product Range



Recent Developments in BMW´s Diesel Technology

Key Technologies

Core engine

- Durability for cylinder pressures up to 180 bar
- High thermal resistance
- Low friction

Injection system

- High hydraulic performance
- Sophisticated application strategy

BMW Diesel-Development

Combustion concept

- Combustion chamber layout
- Port design for efficient swirl generation

Air management

- VNT-Turbochargers
- Optimised intake / exhaust system with intercooling

Outstanding performance
Low consumption and emissions

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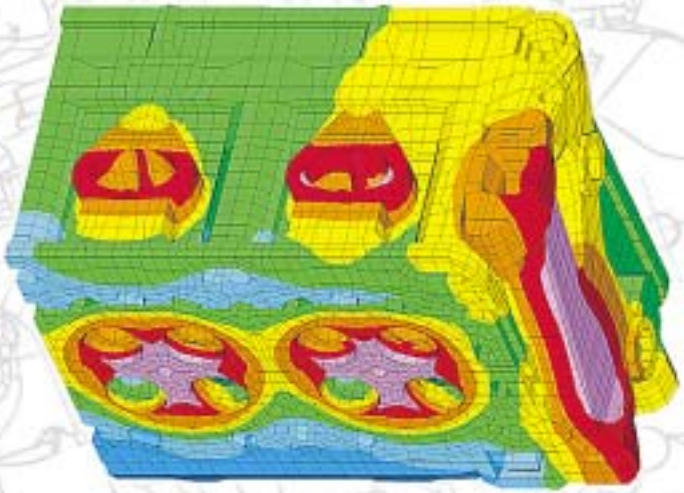
Core Engine Design

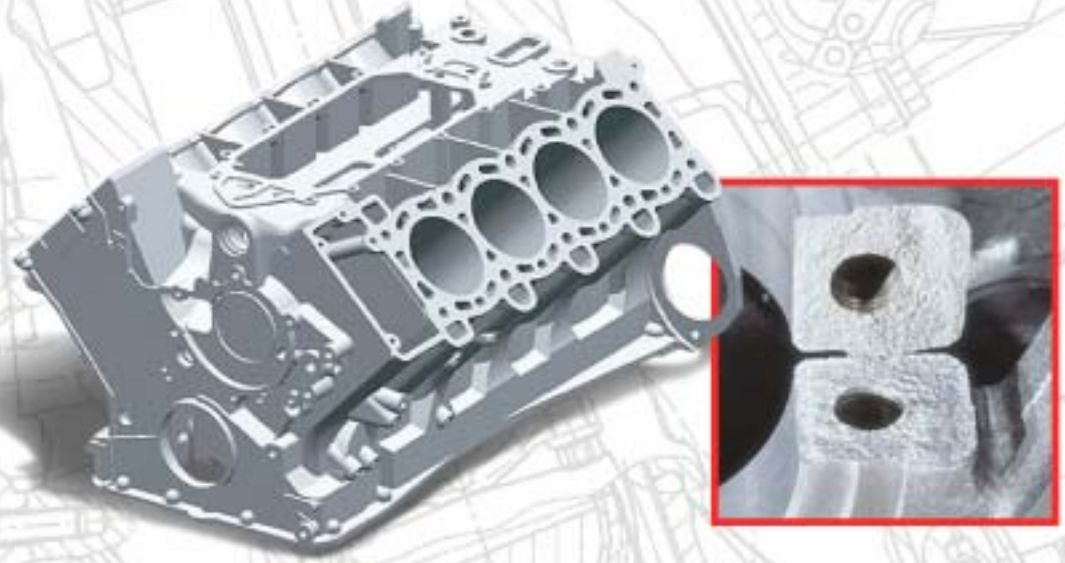
Cylinder head

- Aluminium alloy with specific thermal treatment
- Design based on sophisticated simulation methods
  - Mould filling
  - Residual stress simulation
  - Strength and fatigue analysis



Crank case

- Material GGV-500
- Cracked main bearing walls
- Two main bearing bolts



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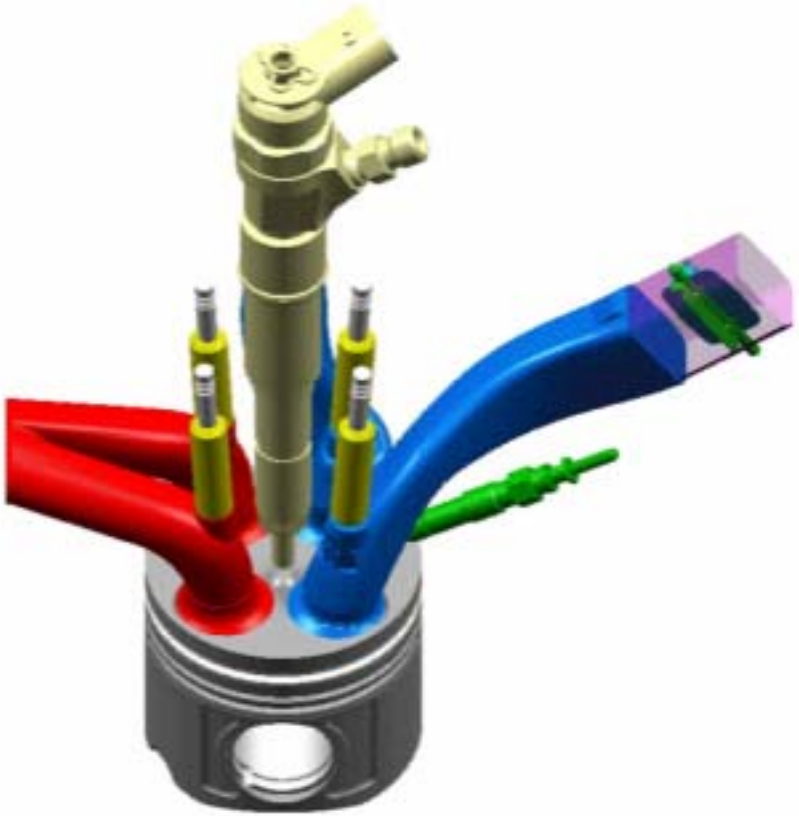
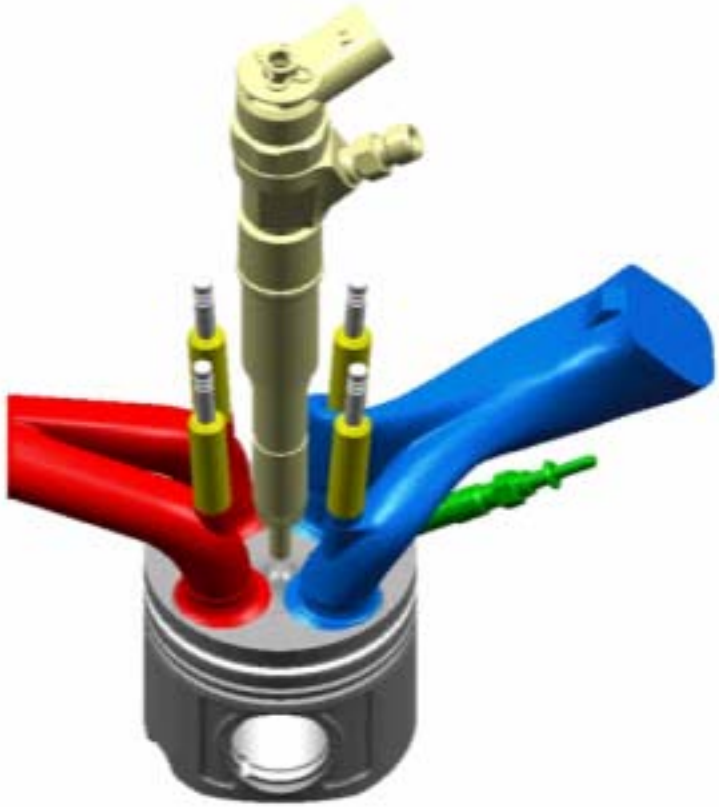
Combustion Chamber and Port Design



6-Cylinder Engine

- Swirl port from the top
- Tangential port with swirl flap from the side



8-Cylinder Engine

- Inlet ports coming from one side

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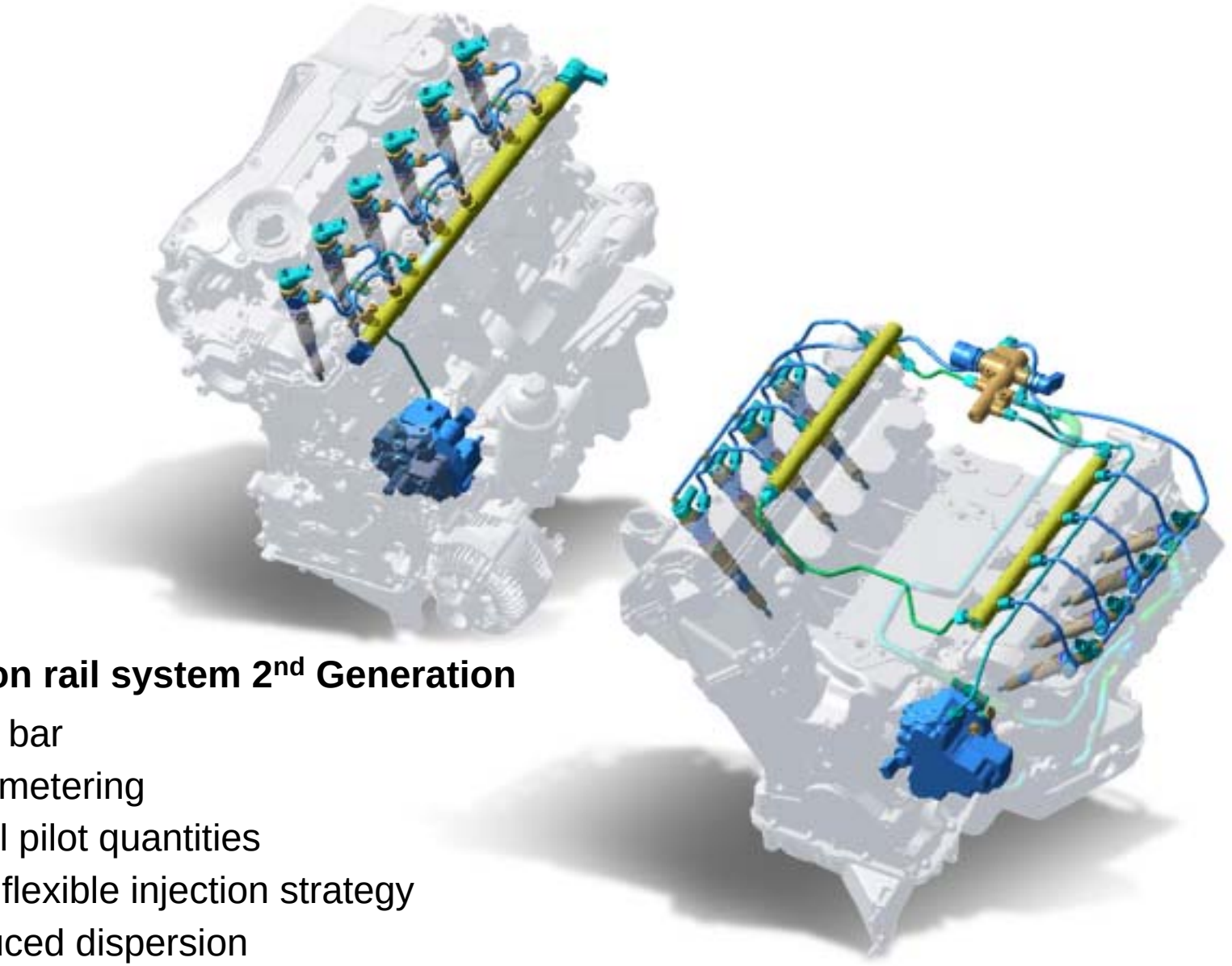
Fuel Injection System



Common rail system 2nd Generation

- 1600 bar
- Fuel metering
- Small pilot quantities
- High flexible injection strategy
- Reduced dispersion

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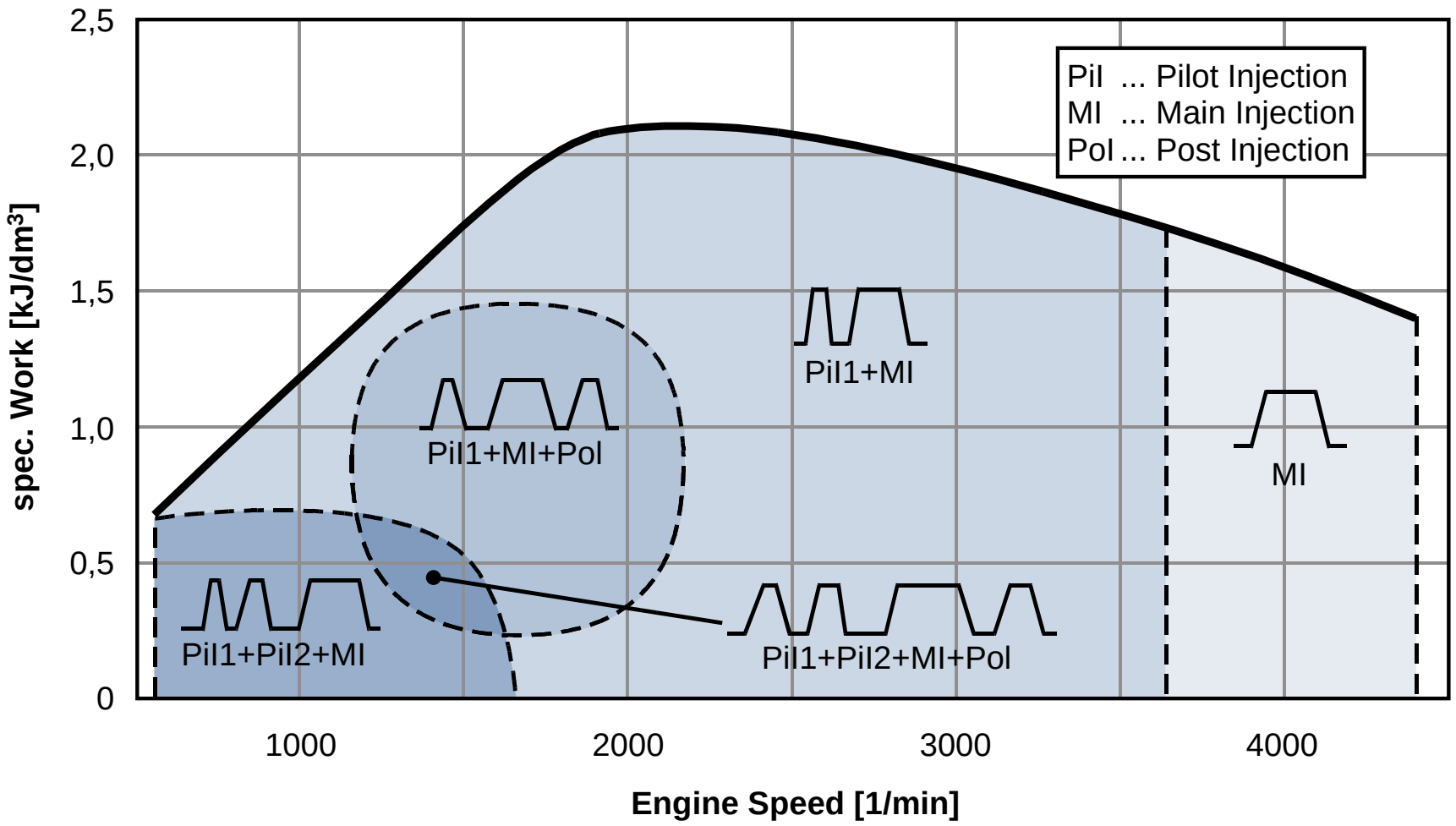
Injection Strategy



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Characteristics Diesel Electronic Control Units

					730d 740d
Start of Production		**1989**	**1993**	**1998**	**2002**
ECU-Type		DDE1	DDE2	DDE4	DDE5
Data Length	bit	8	16	16	32
Computer Performance	MIPS	<1	1	4	40
Number of Transistors	Mio	<1	<1	<1	7
Memory	kByte	33	64	256	1000
Number Labels for Calibration		500	1500	4500	7800*
Number of ECU - Pins		55	55	121	154

* With Master / Slave ECU´s: 15600 Labels for Calibration

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Spontaneous Glow System

- Pre Glow Phase < 3 sec
- Reduction Power Consumption
- ECU Mounted to the Engine

Previous Engine
12V Glow Plug

New Engine
6V Glow Plug

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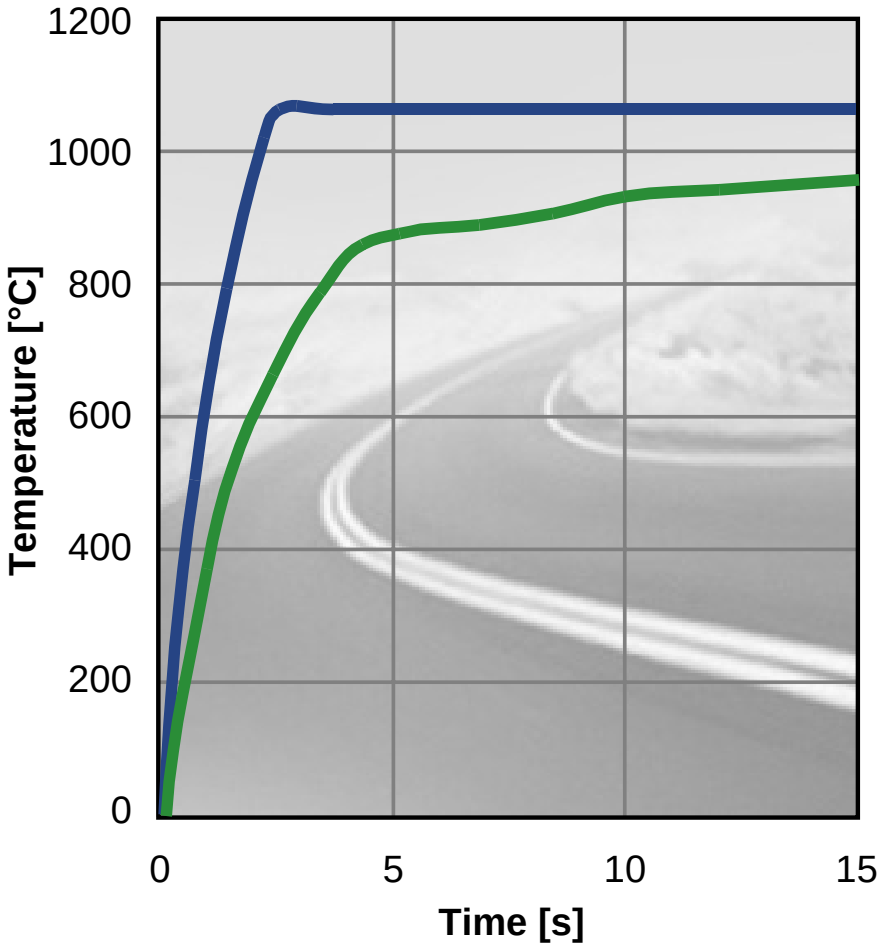
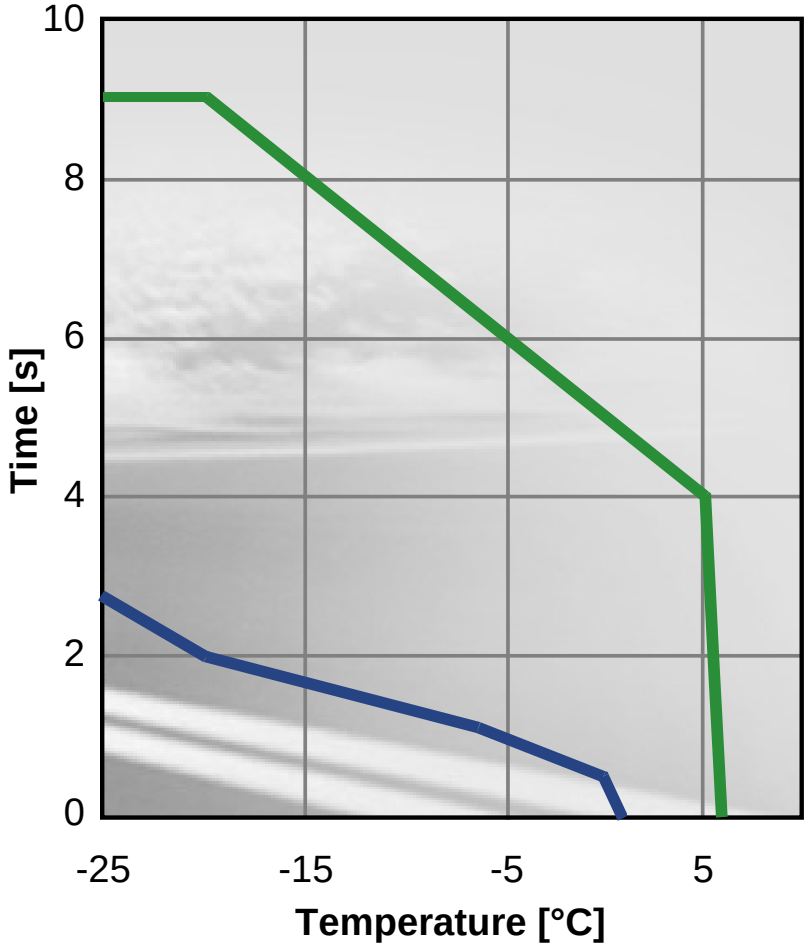
Spontaneous Glow System

Temperature Glow Plugs



Pre Glow Time



New Engine

Previous Engine

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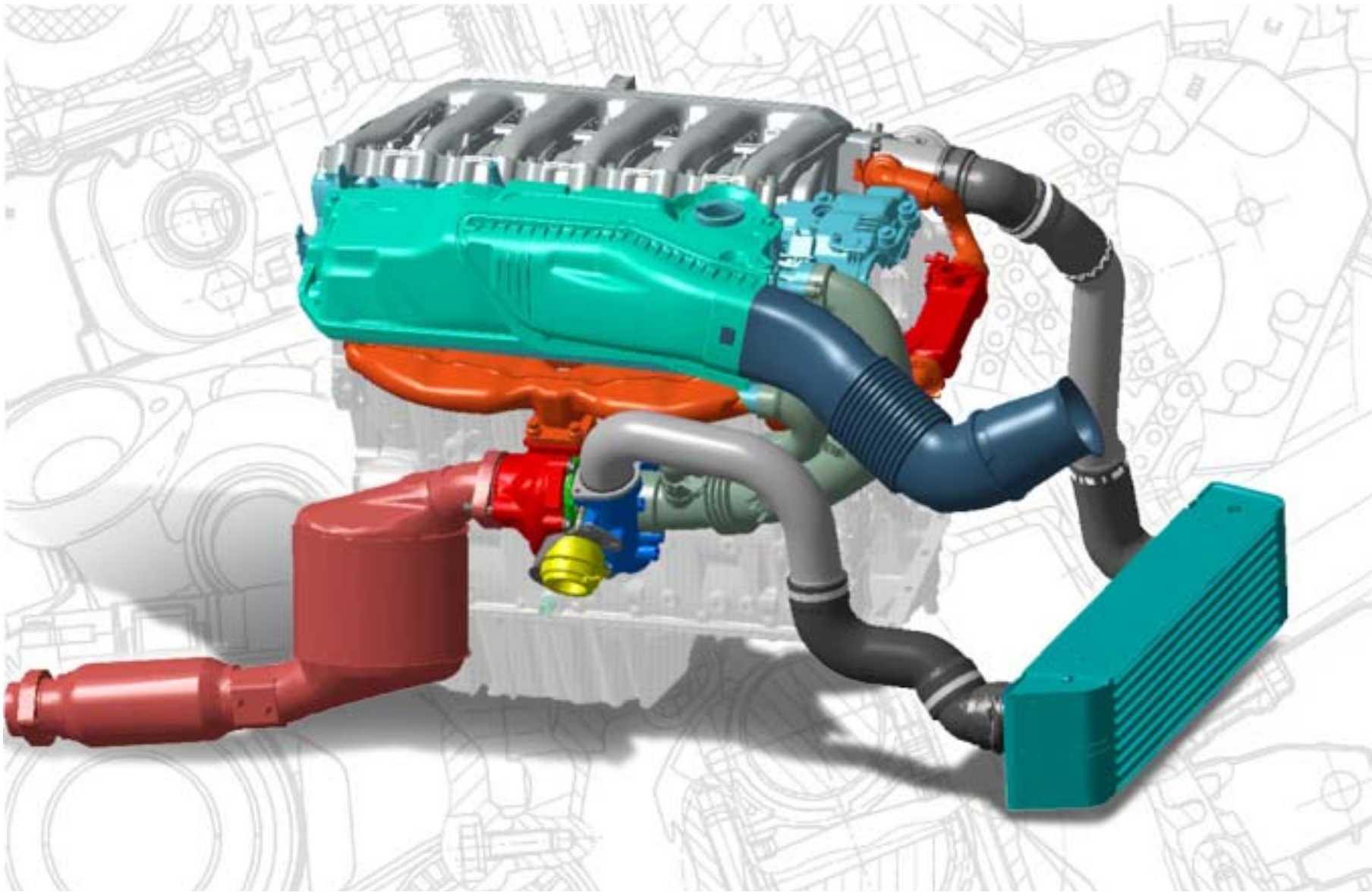
Air Management



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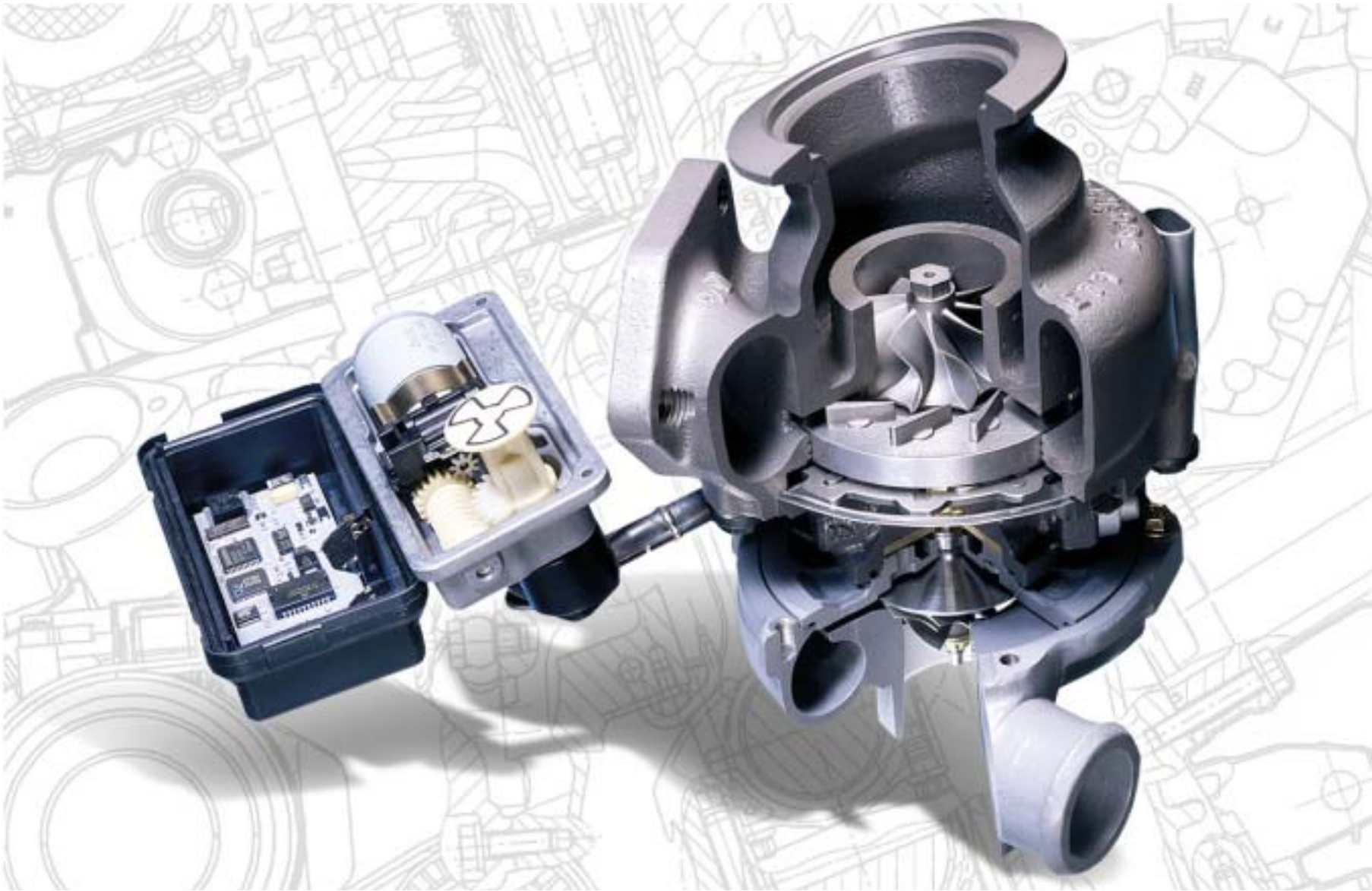
Air Management



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Improvements DI 1st to 2nd Generation

			1st gen.	2nd gen.
Base Engine:	Cylinder pressure	bar	160	180
	Compression Ratio		18:1	17:1
Injection System:	Rail pressure	bar	1350	1600
	Number of Injection		3	4
	Min. Pilot quantity	mm^3/cyc	1.6	1.0
	Fuel metering		without	with
Turbocharging:	Max. Boost pressure	bar	2.1	2.3
	Pressure ratio		2.48	2.72
	Max. Turbine Eff.	%	64	70
	Max. Compressor Eff.	%	59	63

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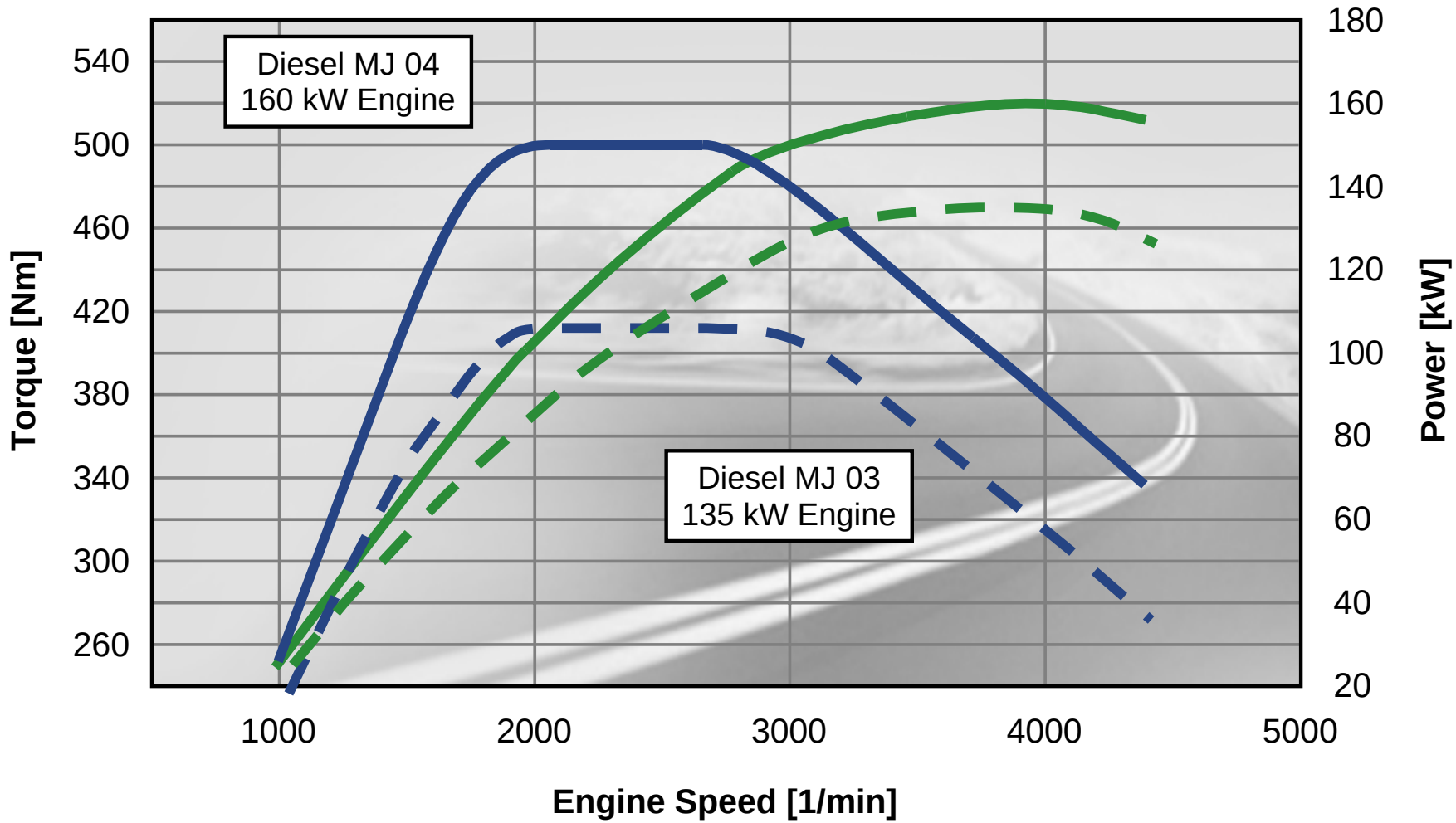
Engine Performance 6-Cylinder in X5



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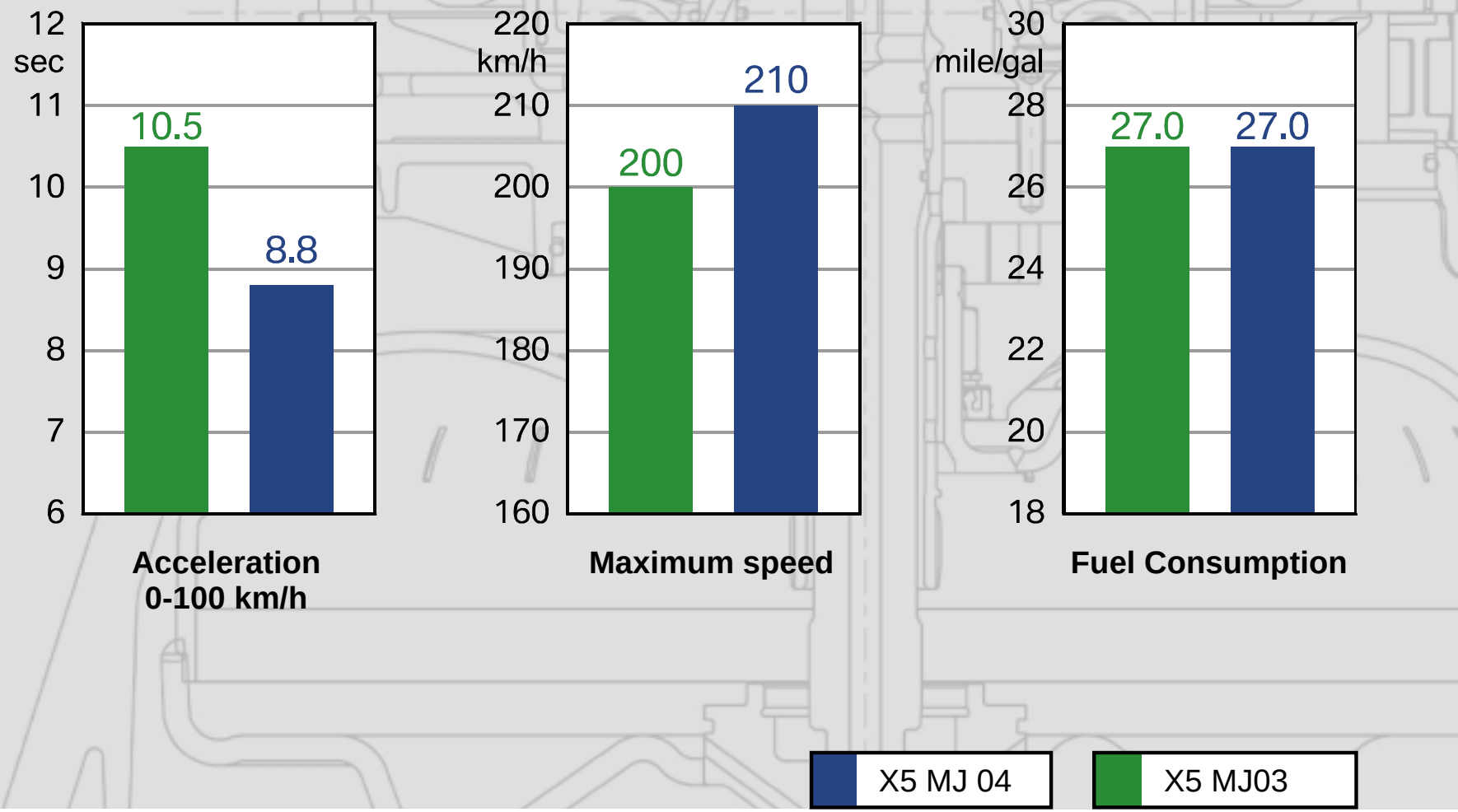
Performance / Fuel Consumption - X5 AT



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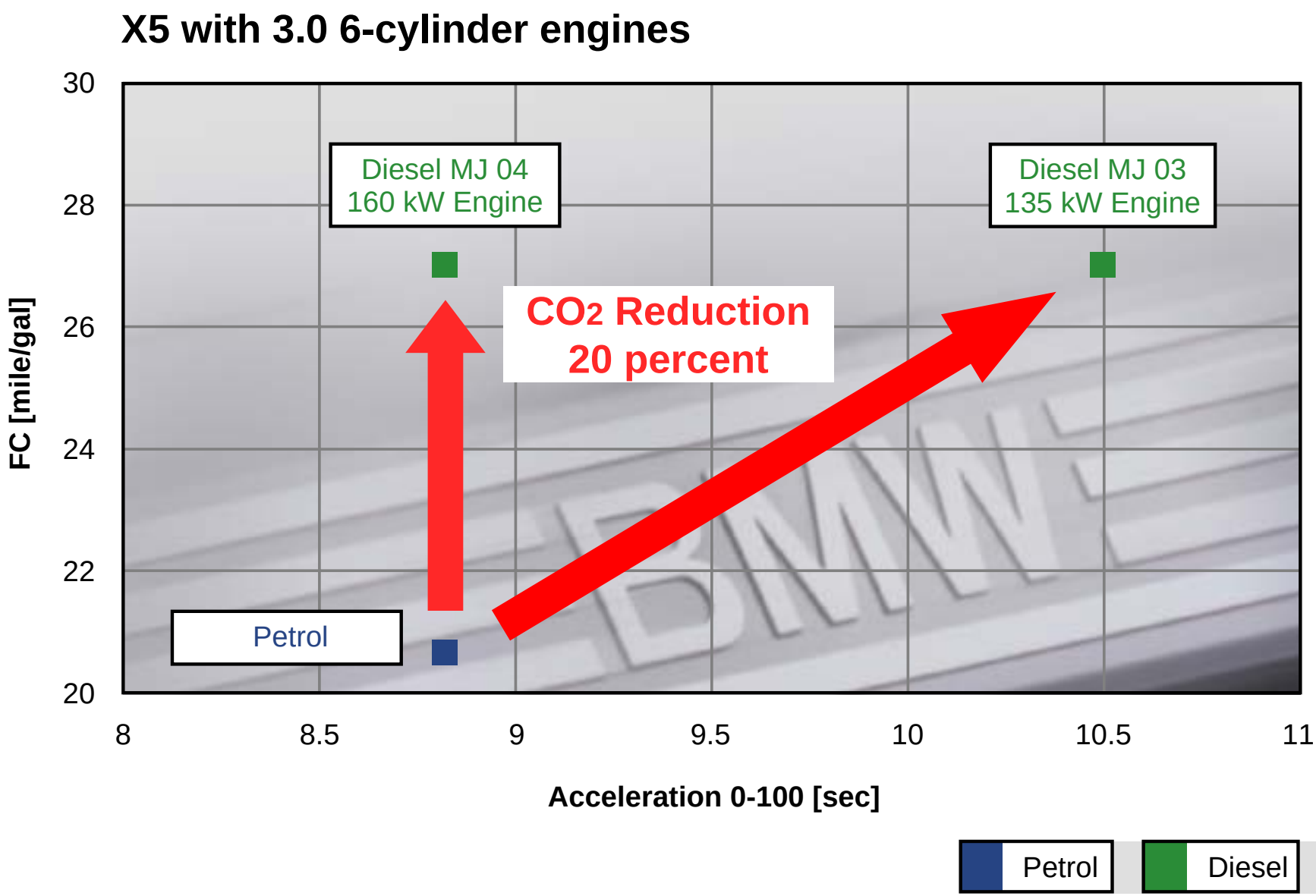
Fuel Consumption in X5 AT – Comparison Diesel / Petrol



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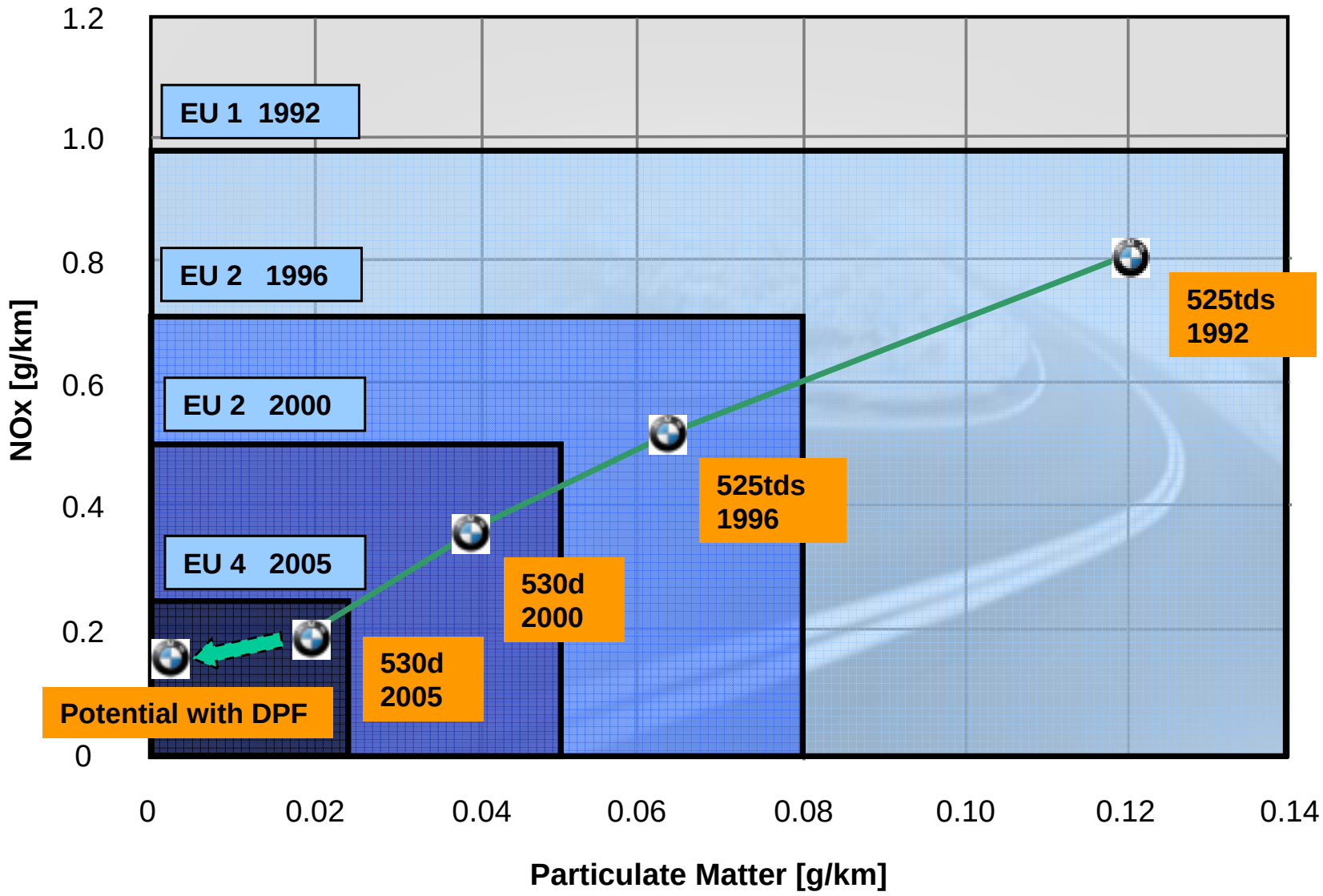
NOx- and PM-Reduction for BMW 5 Series Diesel cars



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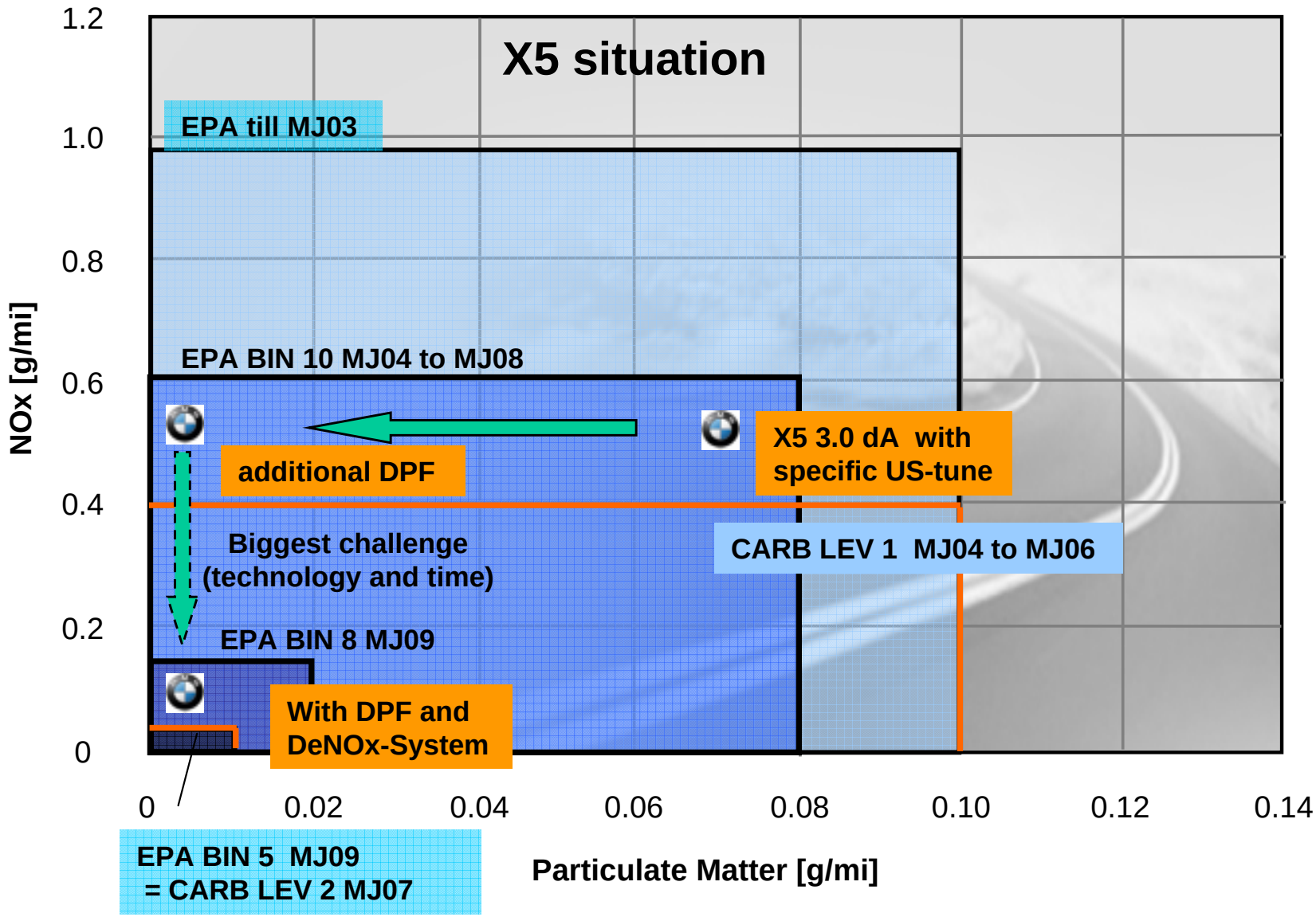
Emission Legislation in USA



Conclusion

Diesel engines could play a major role in saving crude oil and reducing CO2-emissions in USA too

- **Modern BMW Diesel technology offers powerful, clean and economic engines for the new decade**
- **Improved combustion systems combined with filter technologies can virtually remove PM-emissions**
- **The 2007 US NOx-limits are the biggest challenge**
  - Technology for highly efficient NOx-aftertreatment
  - Time scale for 2007 very demanding
- **The introduction of diesels with durable and enabling emission control technologies should be supported by:**
  - Better fuel quality similar to ECE 2005+
  - Slightly legislation adaptations to take account of the specific diesel advantages (long term emission stability, CO2)

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