

Euro4, Euro5 and EEV

MAN Engine Technology for Today and Tomorrow



New emission standard Euro5 / EEV

Overview



- Introduction of MAN Group
- Once and Today: A Comparison
- Development of exhaust gas stages
- NOx or PM: How to influence the Combustion
- Combustion with reduced NOx amount: The MAN way
- Euro 5 Concept for D0834
- Euro 5 Concept for D0836
- Euro 5 Concept for D20/26
- Advantages for the Customer
- Strategy for future technology
- Summary

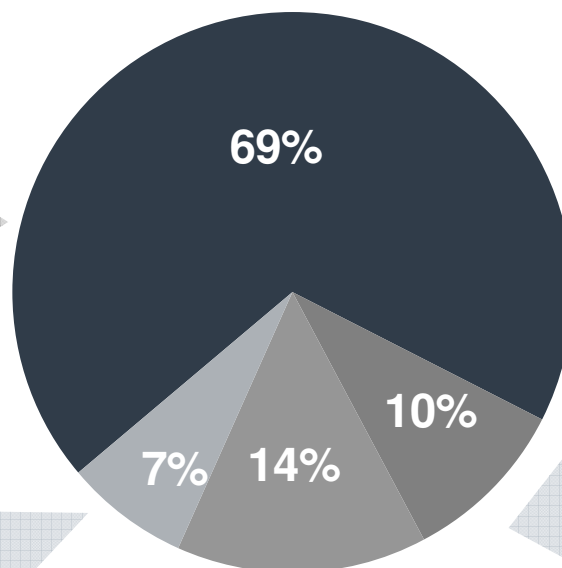
Sales in 2007: €15.5 billion (*No. 375 in Fortune 500*)



Commercial Vehicles



Turbomachinery
(plus industrial cooperations and financial services)



Industrial Services



Diesel Engines

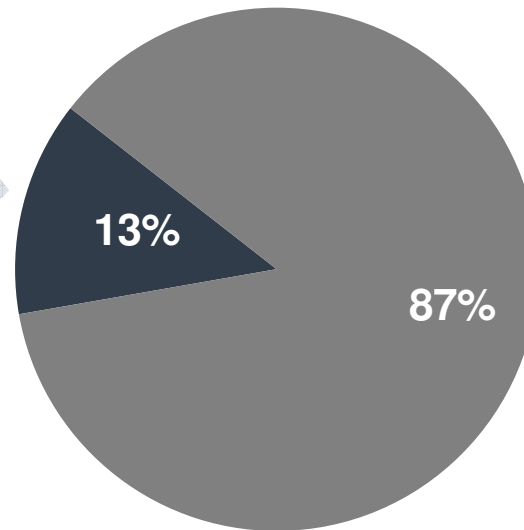
MAN Nutzfahrzeuge Group



Sales in 2007: €10.4 billion



Buses & Coaches



■ Buses and Coaches
■ Trucks



Trucks

Truck Division



Light/Medium Range



Heavy Range



Special-purpose Vehicles

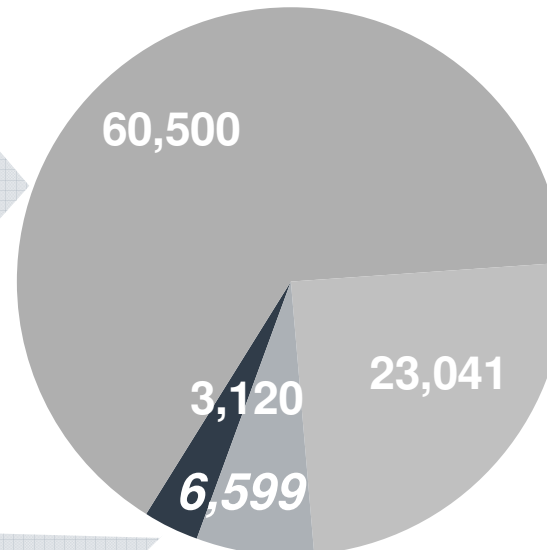
Truck Production in 2007



Total: 93,260 units



TGA



TGL



TGM



TGX/TGS



Special-purpose Vehicles

Bus Division



Coaches



Coaches / Inter-city Buses



City Buses



Chassis

Components



Axles



Engines



Pressings



Transfer Cases

Product Innovations



Optimised Tractors for Europe



**D20 Common-Rail
Euro 4 with PM-Kat®**



NEOPLAN Starliner



TGL



D 08



TGX/TGS



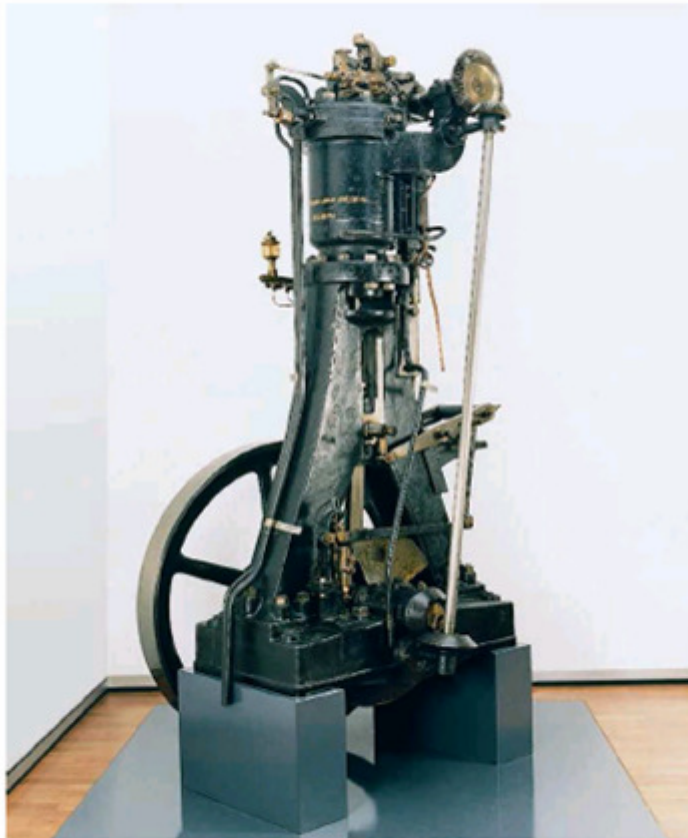
MAN PriTarder

New emission standard Euro5 / EEV

Once and Today: A Comparison



1897



Displacement 20 ltr., 15 kW (20 HP) 4,5 to

2007

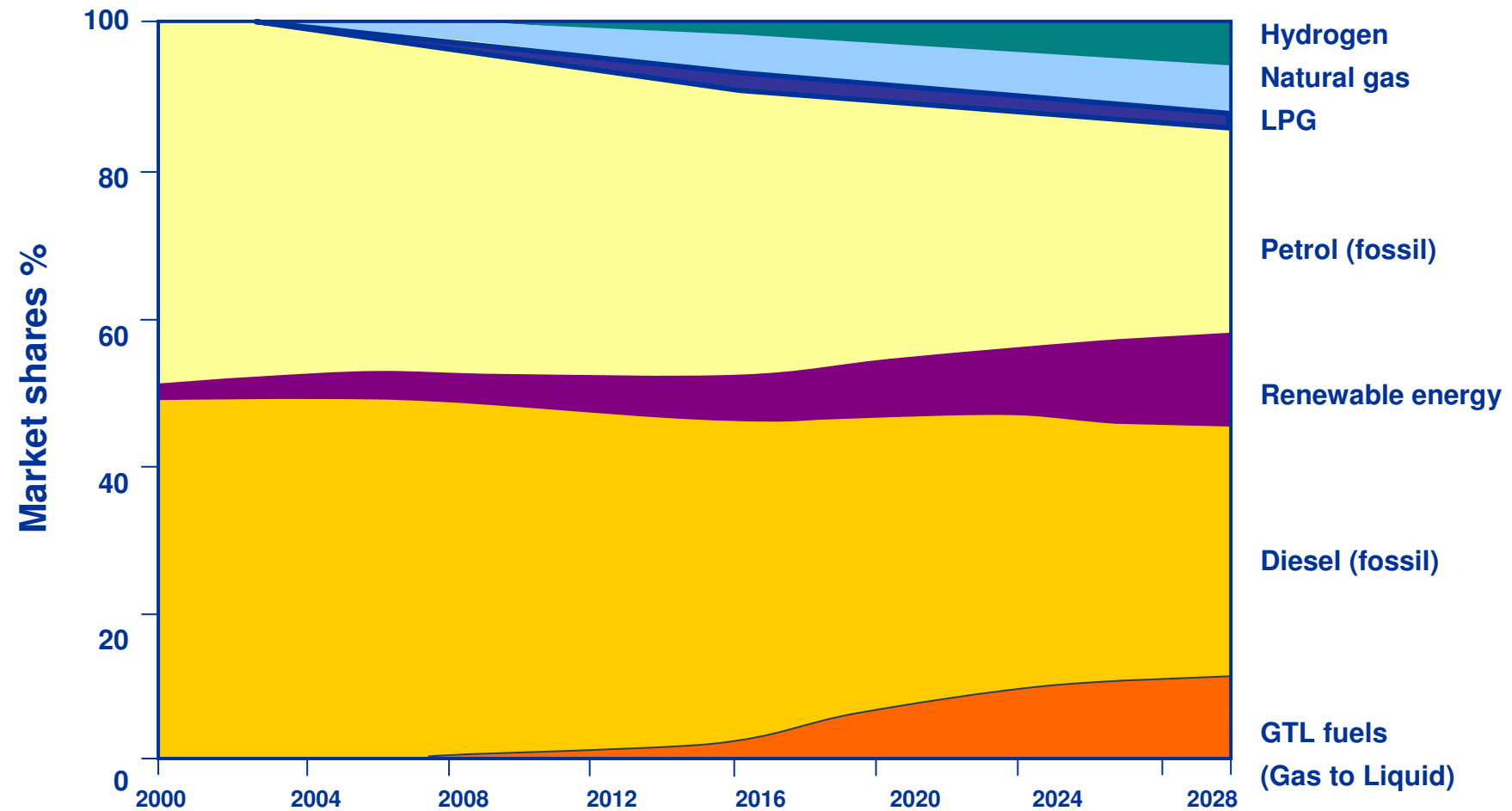
Engine D0834 LFL



Displacement 4,6 ltr., 151 kW (206 HP) 480 kg

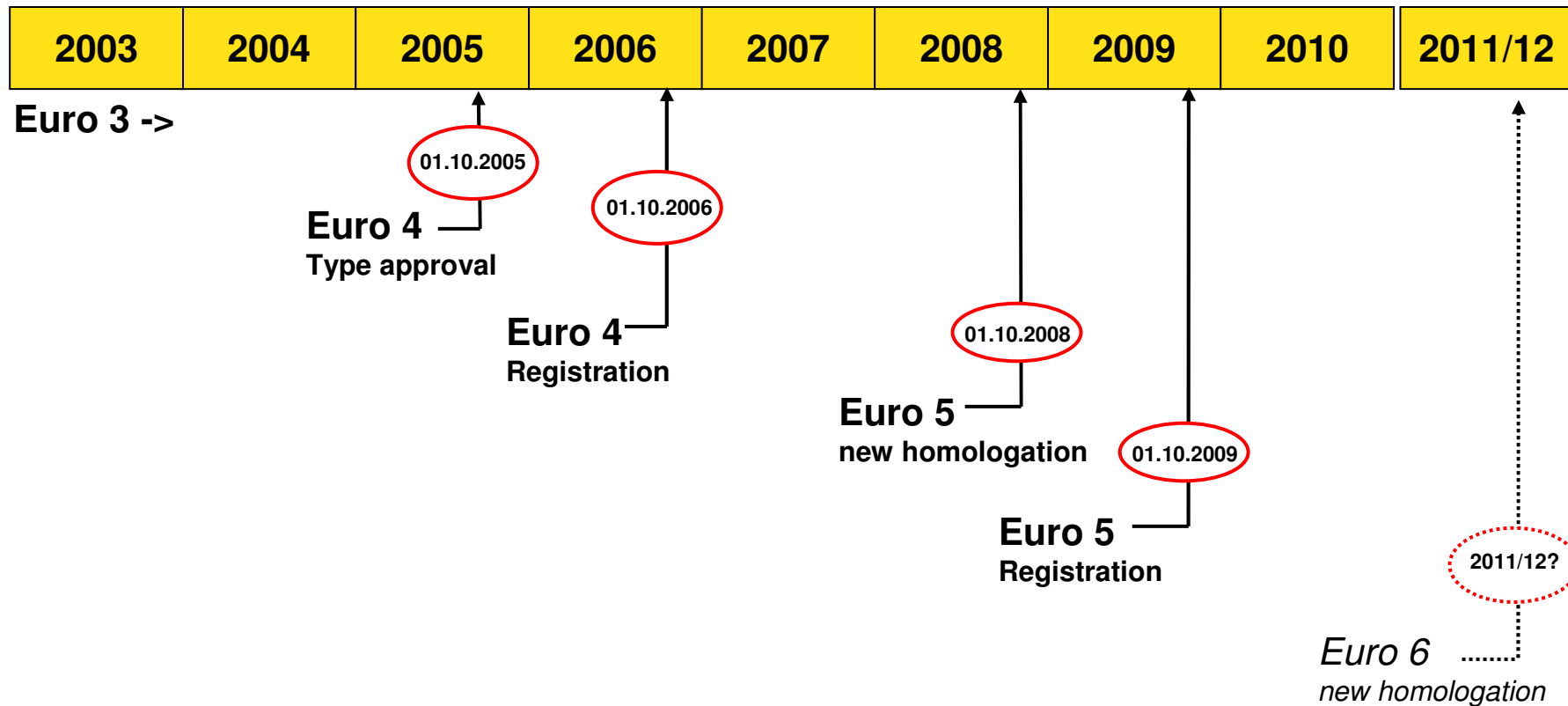
New emission standard Euro5 / EEV

Energy Mix of the future



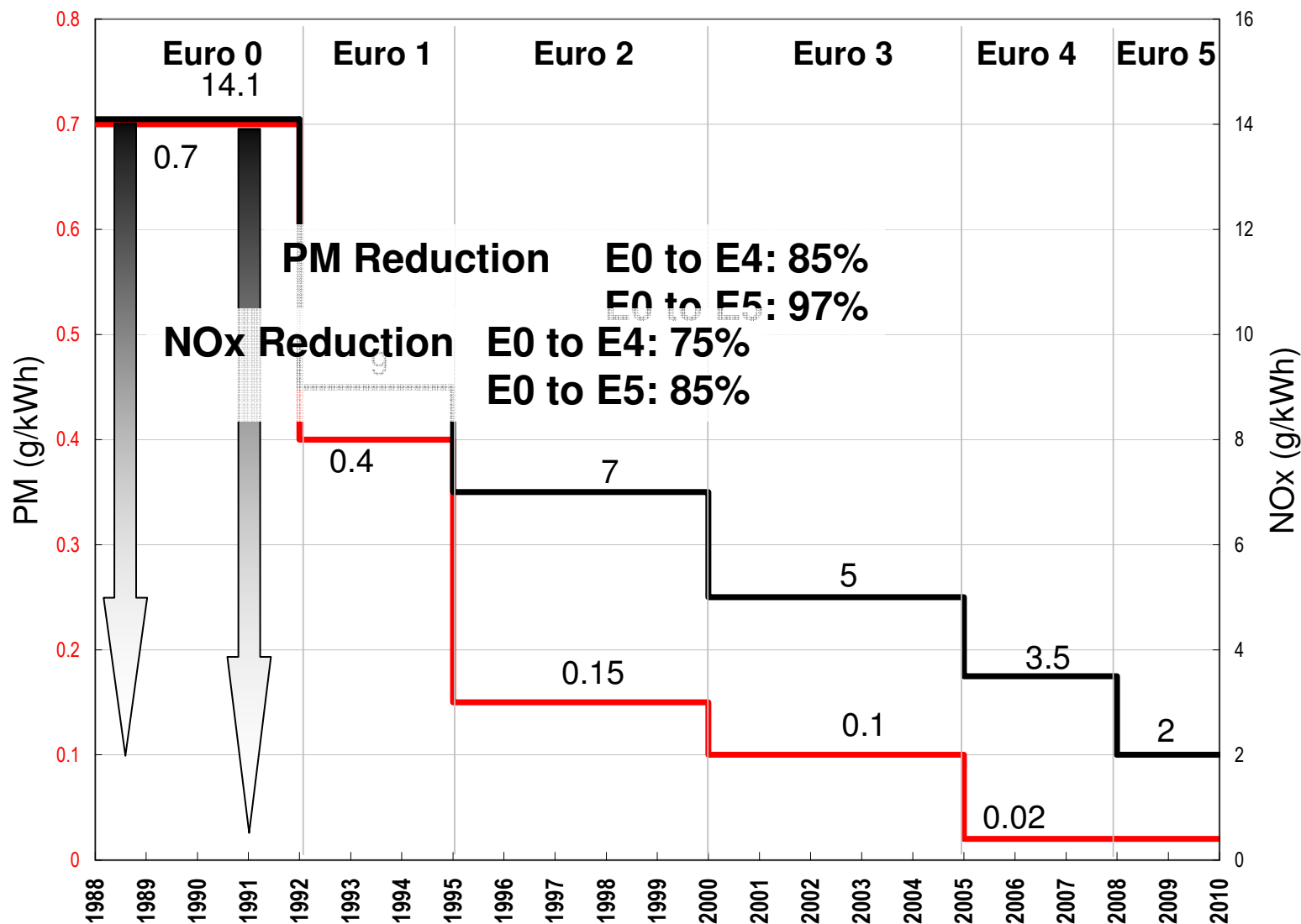
Development of the Euro-Stages

Timeline



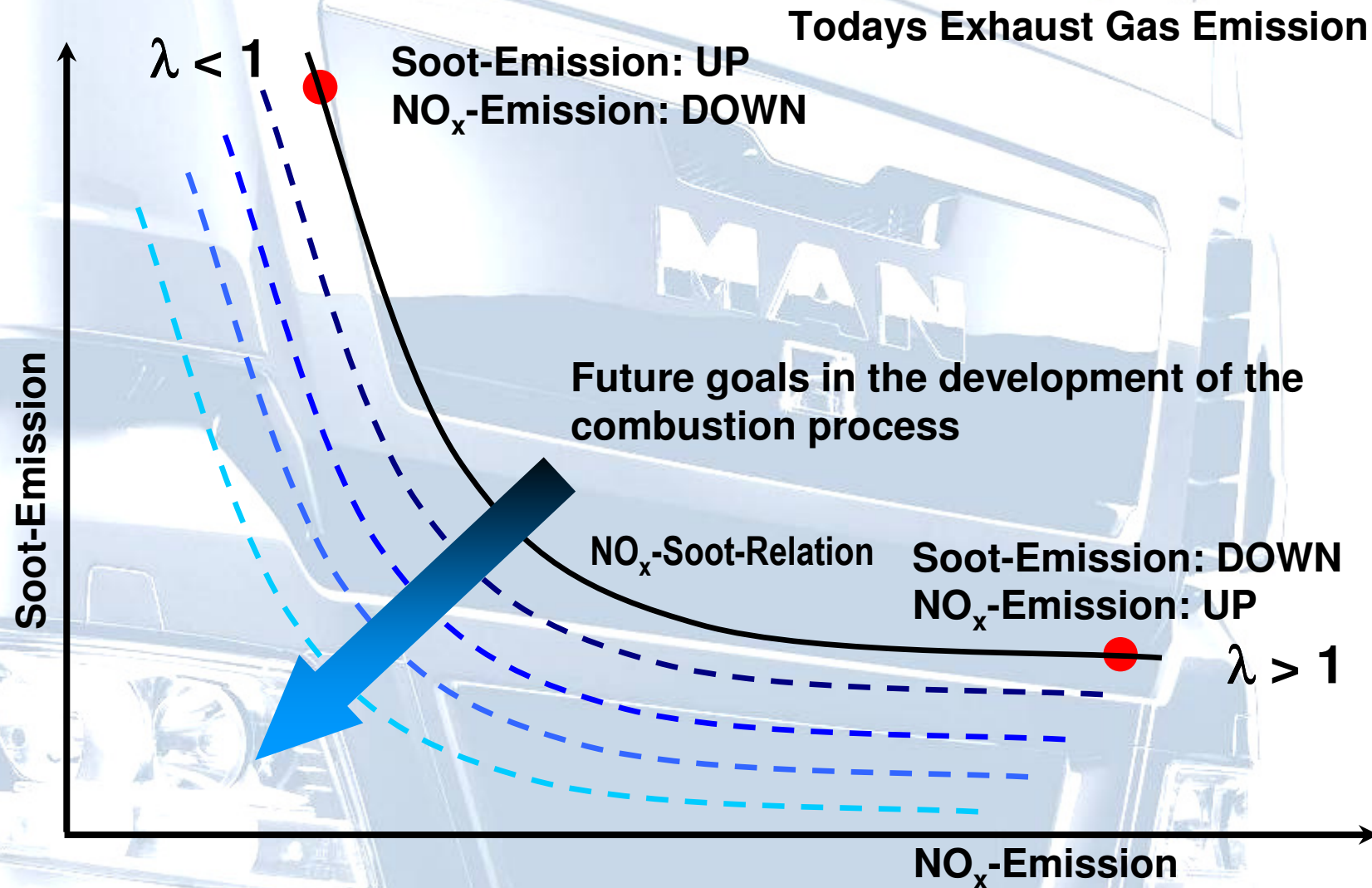
Development of the Euro-Stages

What it means in terms of NO_x and PM



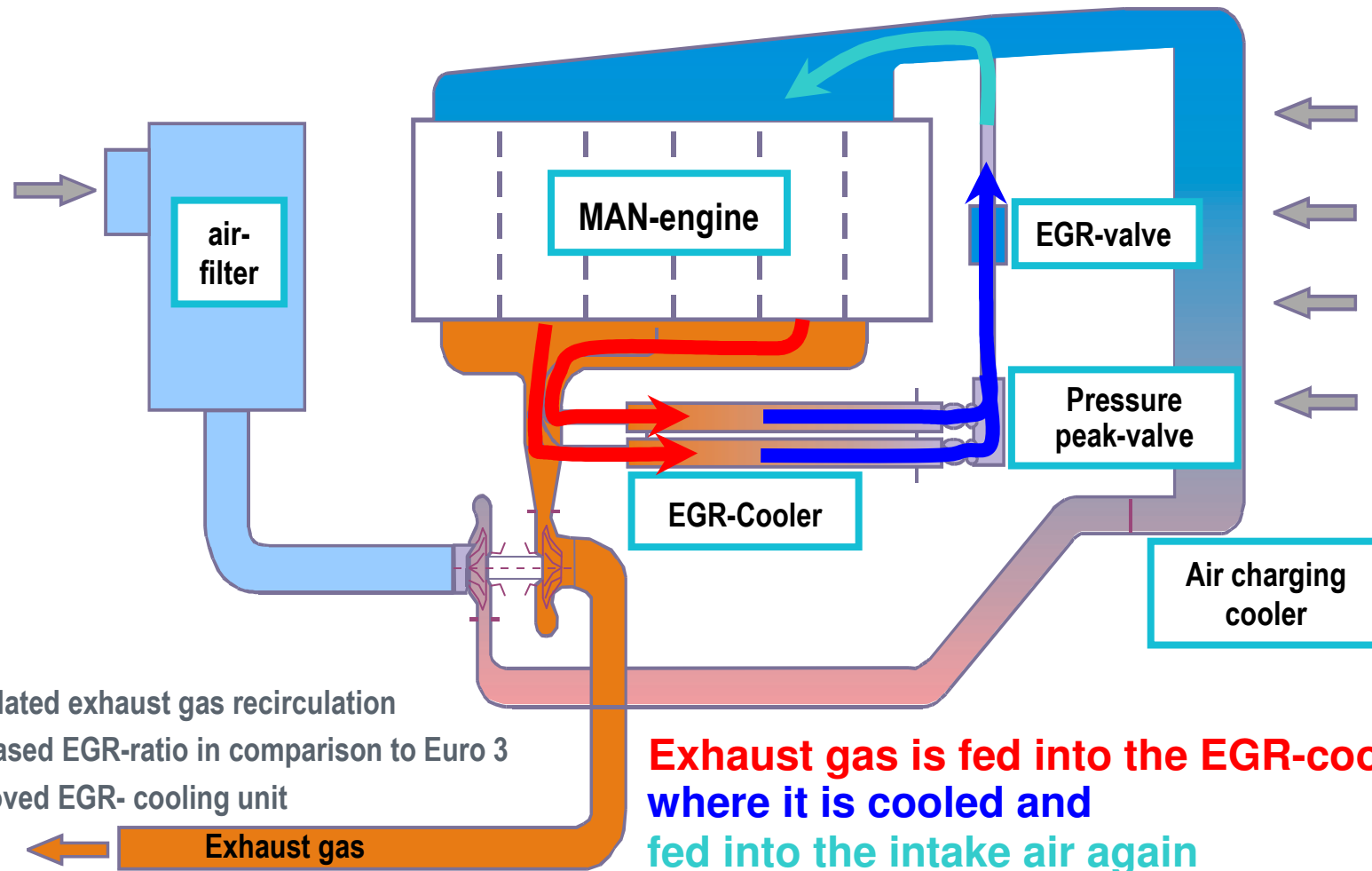
MAN's engine technology:

Soot – NO_x - Tradeoff



MAN's engine technology:

EGR function schematic



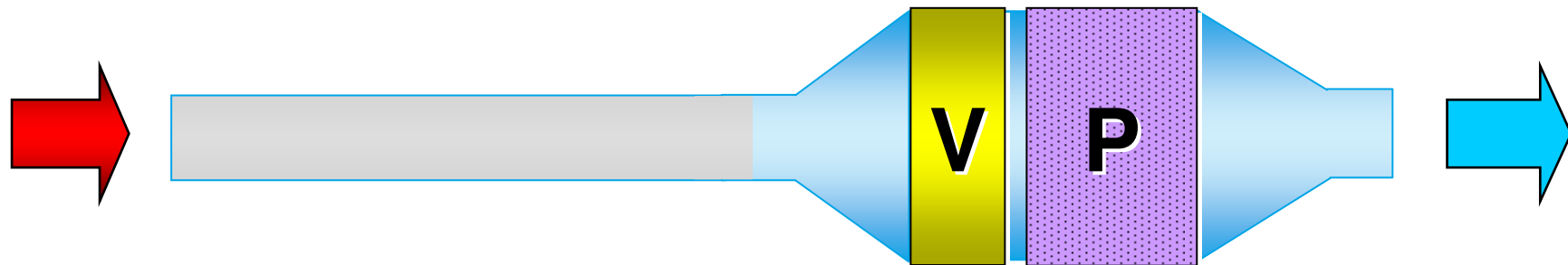
- Regulated exhaust gas recirculation
- increased EGR-ratio in comparison to Euro 3
- improved EGR-cooling unit

Exhaust gas is fed into the EGR-cooler where it is cooled and fed into the intake air again

Effect: Lower combustion temperature and thus less NOx

MAN's engine technology:

Catalyzer Chemistry



PM = Particulate matter

V

Pre-oxidation Pt,Pd,Rh cat: $2\text{NO} + \text{O}_2 \Rightarrow 2\text{NO}_2$

P

Soot particle separator: $\text{C} + 2\text{NO}_2 \Rightarrow \text{CO}_2 + 2\text{NO}$
 $\text{C} + \text{O}_2 \Rightarrow \text{CO}_2$

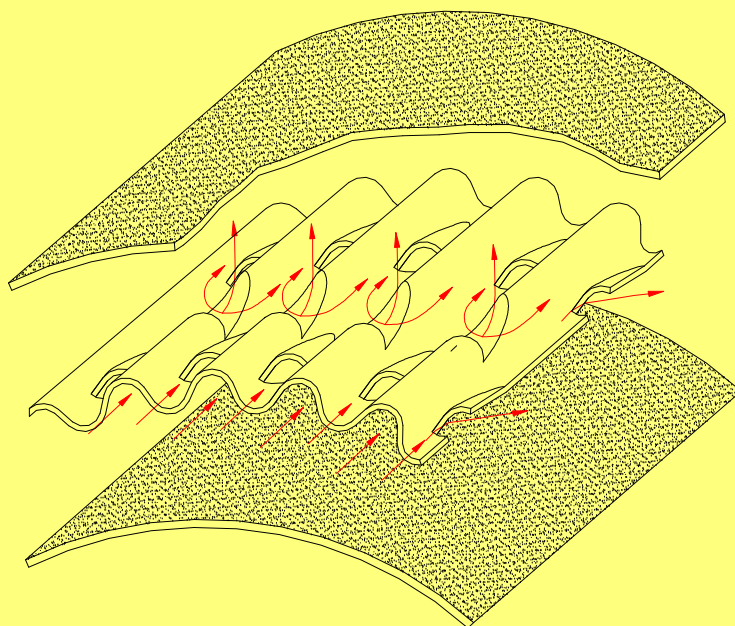
MAN's engine technology:

PM-Catalyzer Type BC

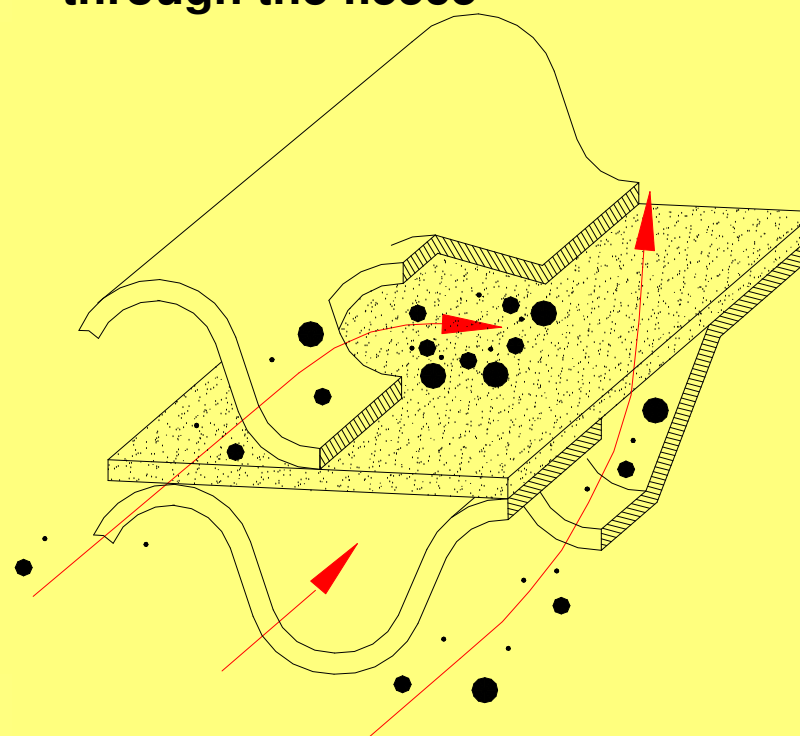


ETITEC

Composition of the **BC-Type**



Particle separation during flow through the fleece

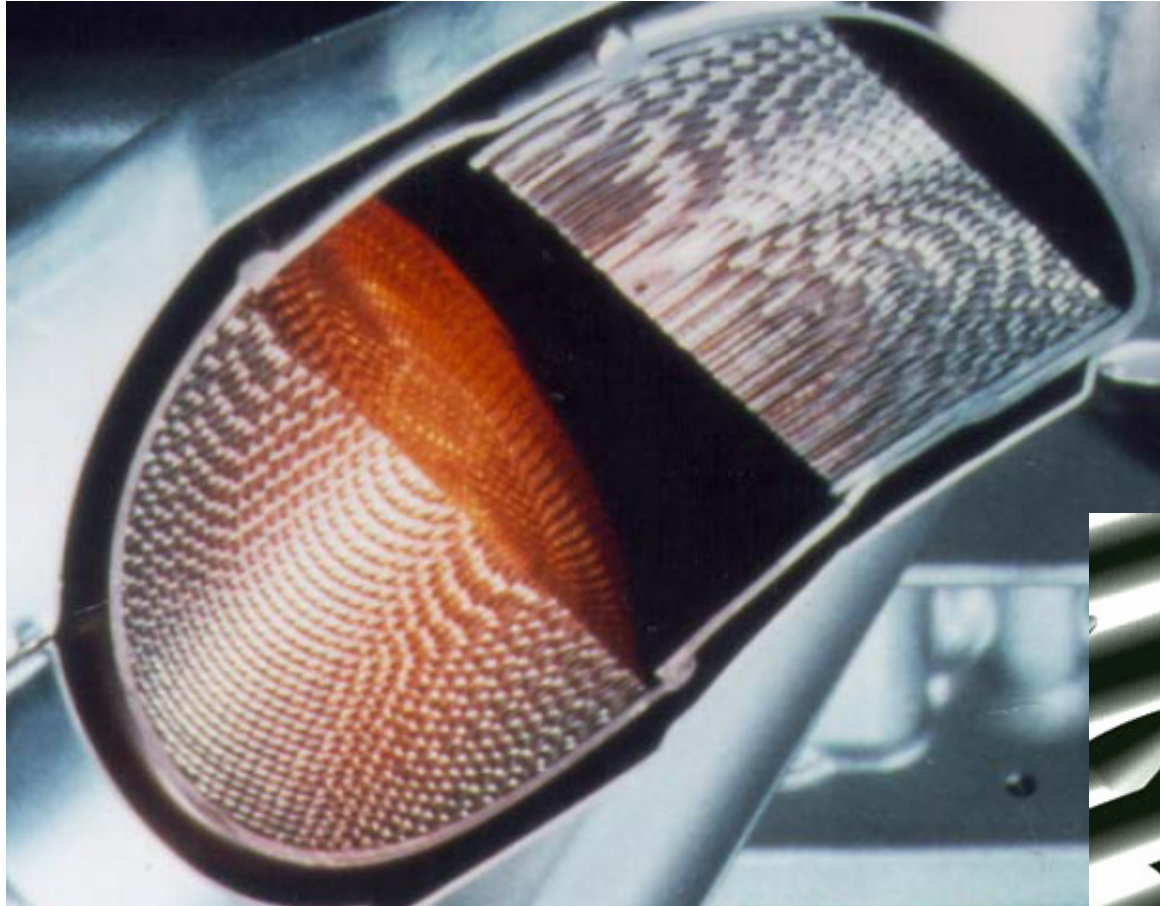


cardiagn.com

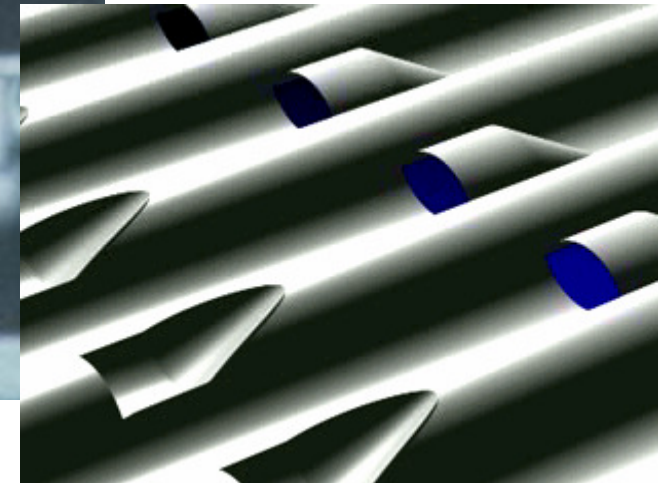
As a result of the open structure, the PM-Kat cannot be mechanically blocked in normal use!

MAN's engine technology:

PM-Catalyzer



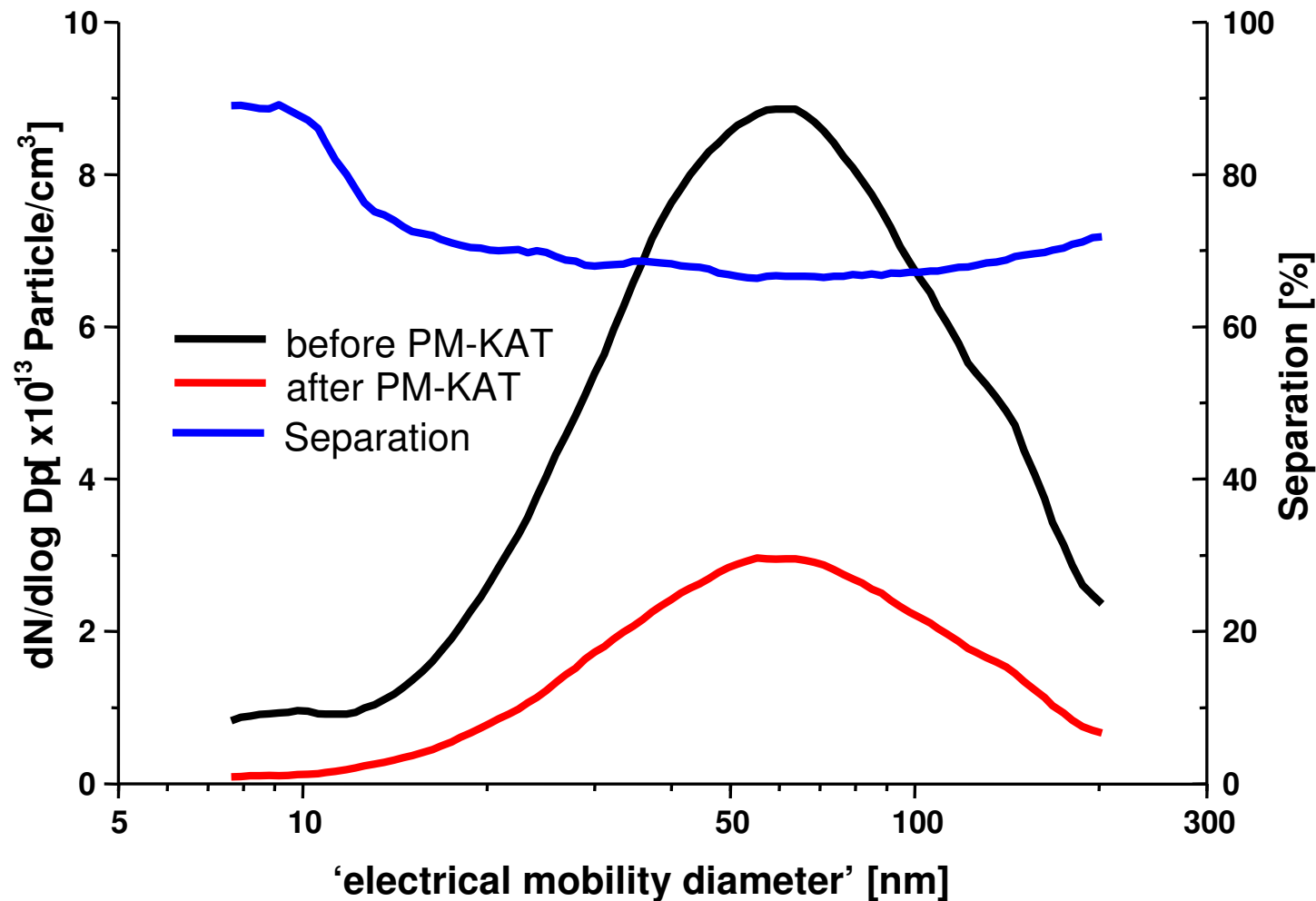
Catalyzer element cut open



Detail: Open Cell Structure

MAN's engine technology:

Separationrate as function of the particle size



From Euro 4 to Euro 5

Overview

- **Common Rail System 2nd generation**
- **Exhaust-gas recirculation system**
- **2-stage turbo charging**
- **Indirect inter- and main charge air cooling**
- **PM-Kat**

Euro 5 features

Common Rail System

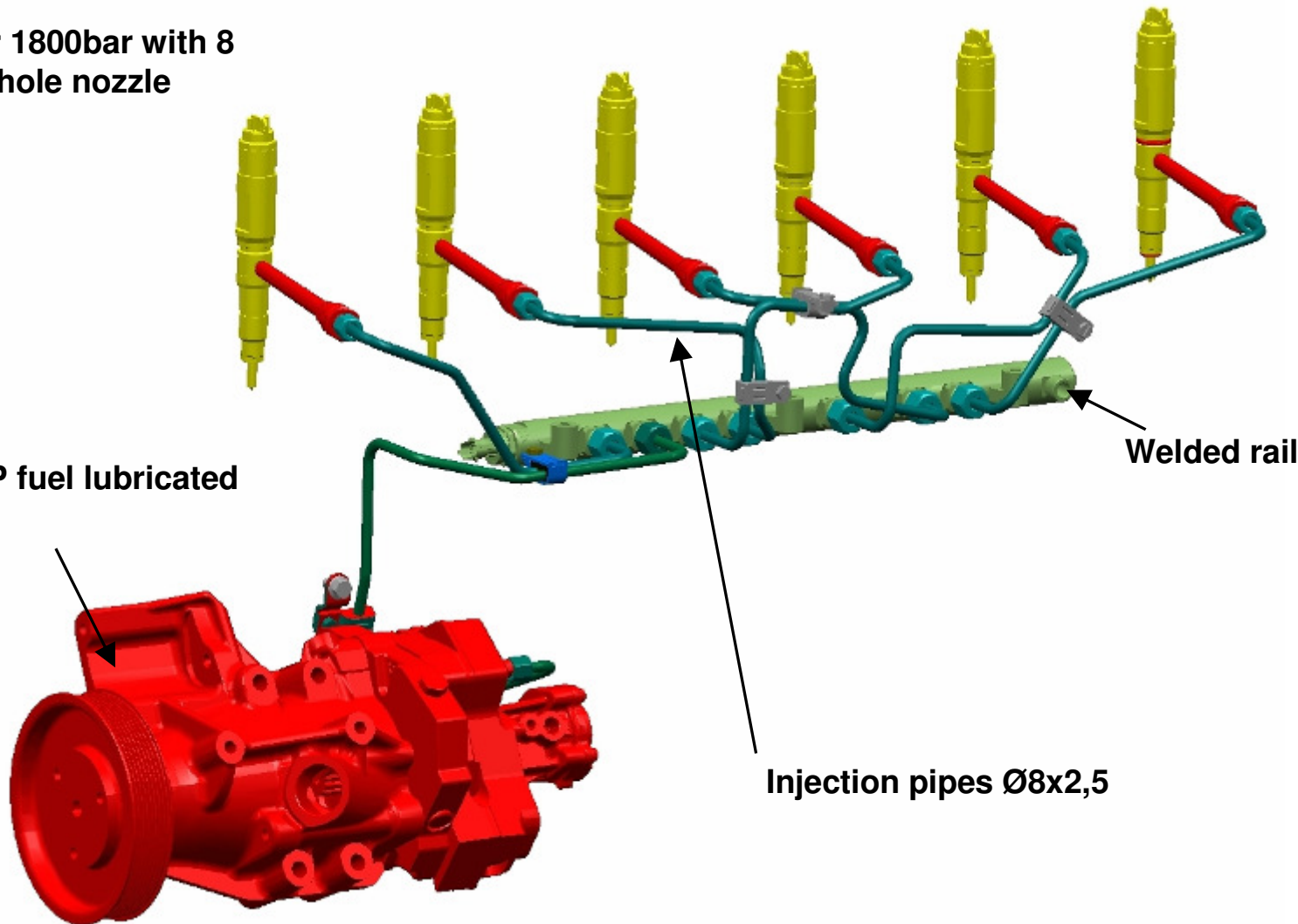


Injector 1800bar with 8
pinhole nozzle

HDP fuel lubricated

Welded rail

Injection pipes Ø8x2,5

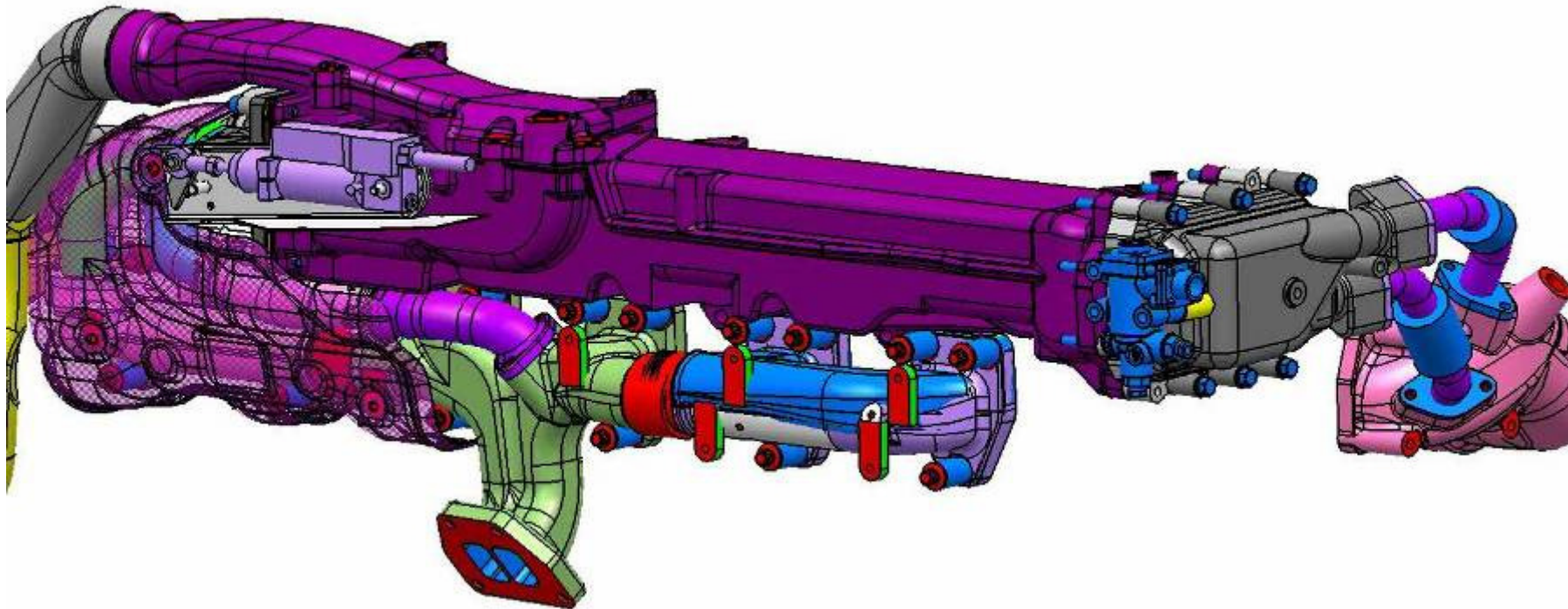


Euro 5 features

Exhaust-gas recirculation system

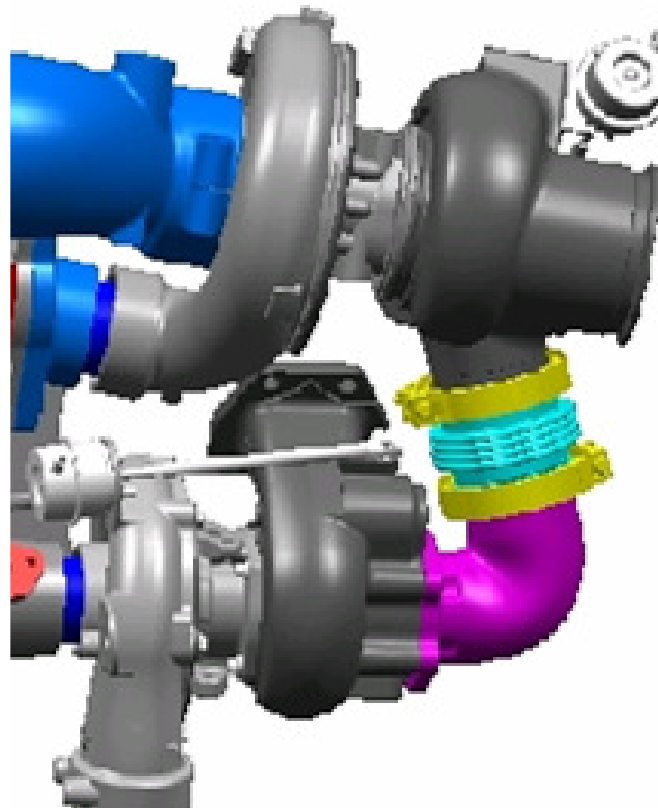


- Dual exhaust system
- Water cooled EGR-module



Euro 5 features

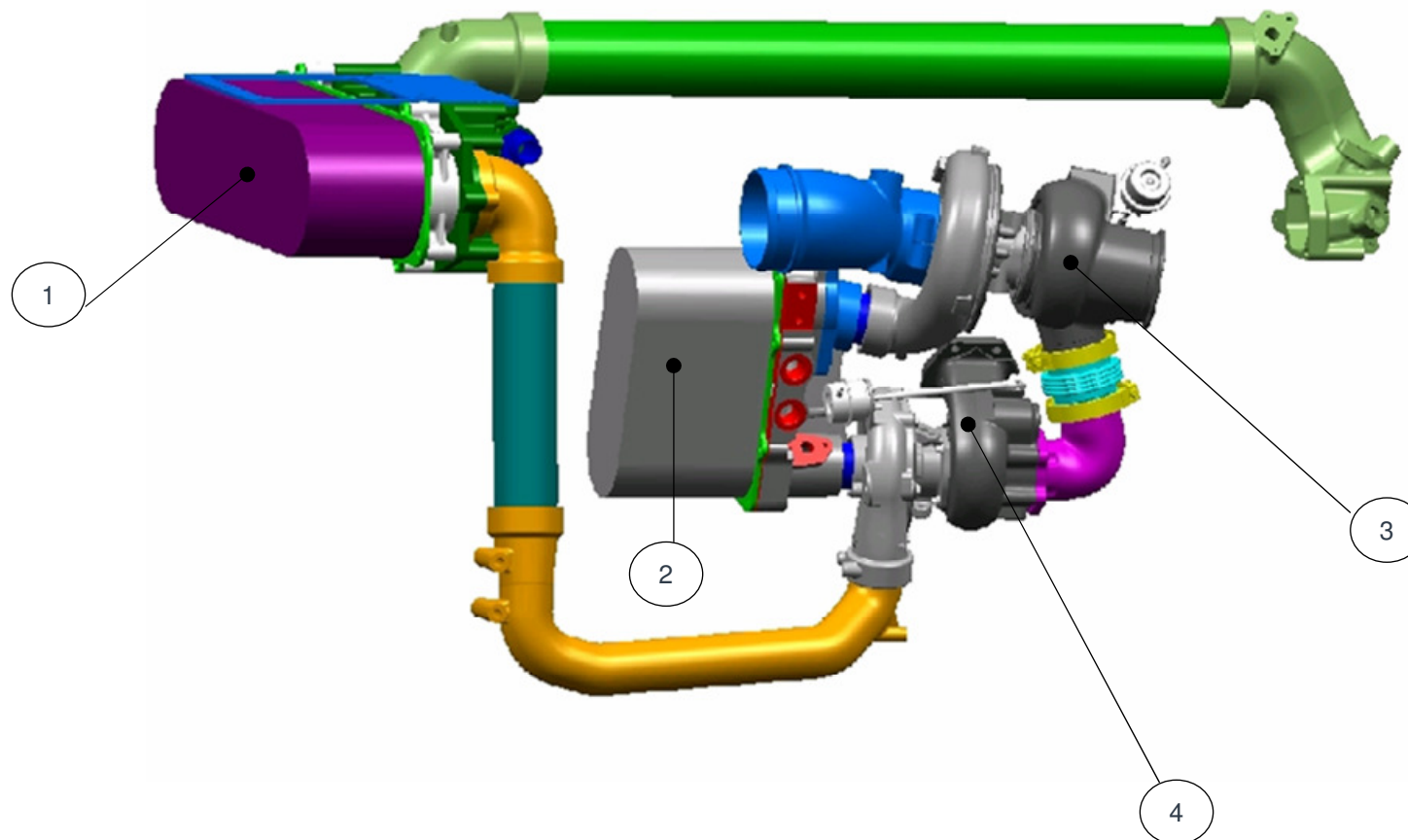
2-stage turbo charging



Coolant systems Euro 5 / EEV



Euro 5 EEV NT Coolant circuit

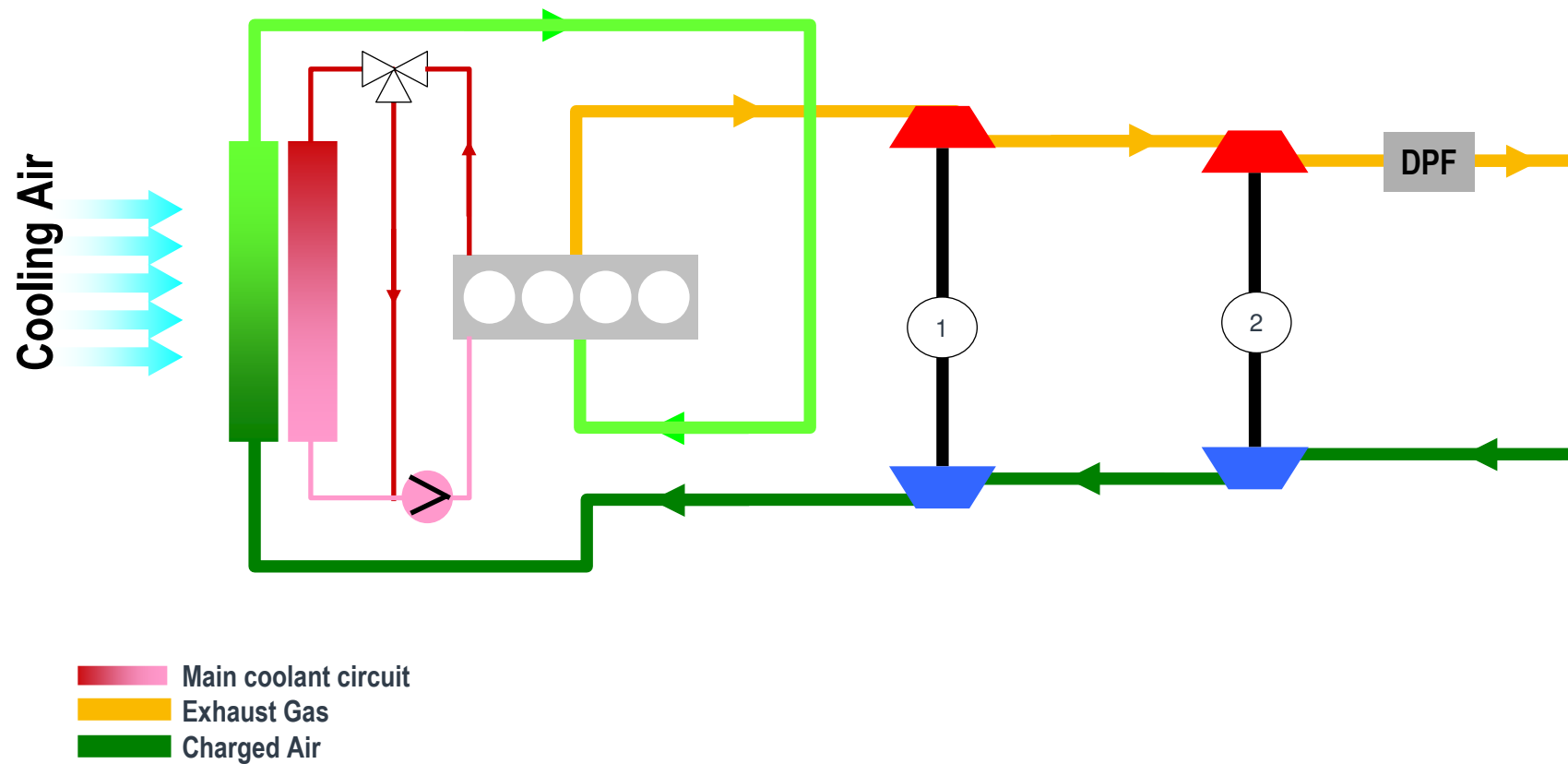


Concept D0834 LOH Euro 5 / EEV

Coolant systems



D0834 cooling circuit Euro 5



Concept D0834 LOH Euro 5 / EEV

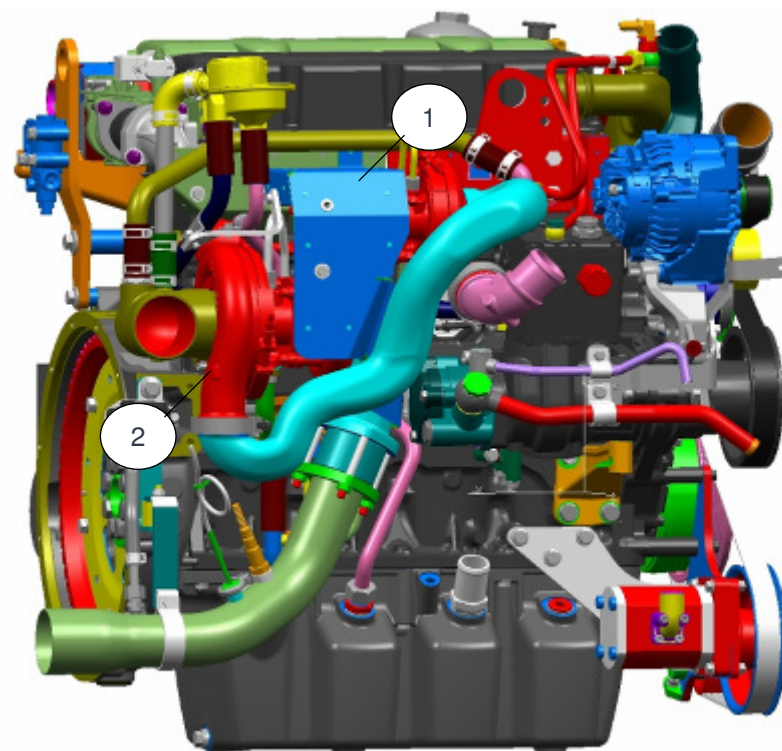
Comparison to Euro 4



D0834 LOH 52/53 Euro 4



D0834 LOH 60/61 Euro 5 / EEV

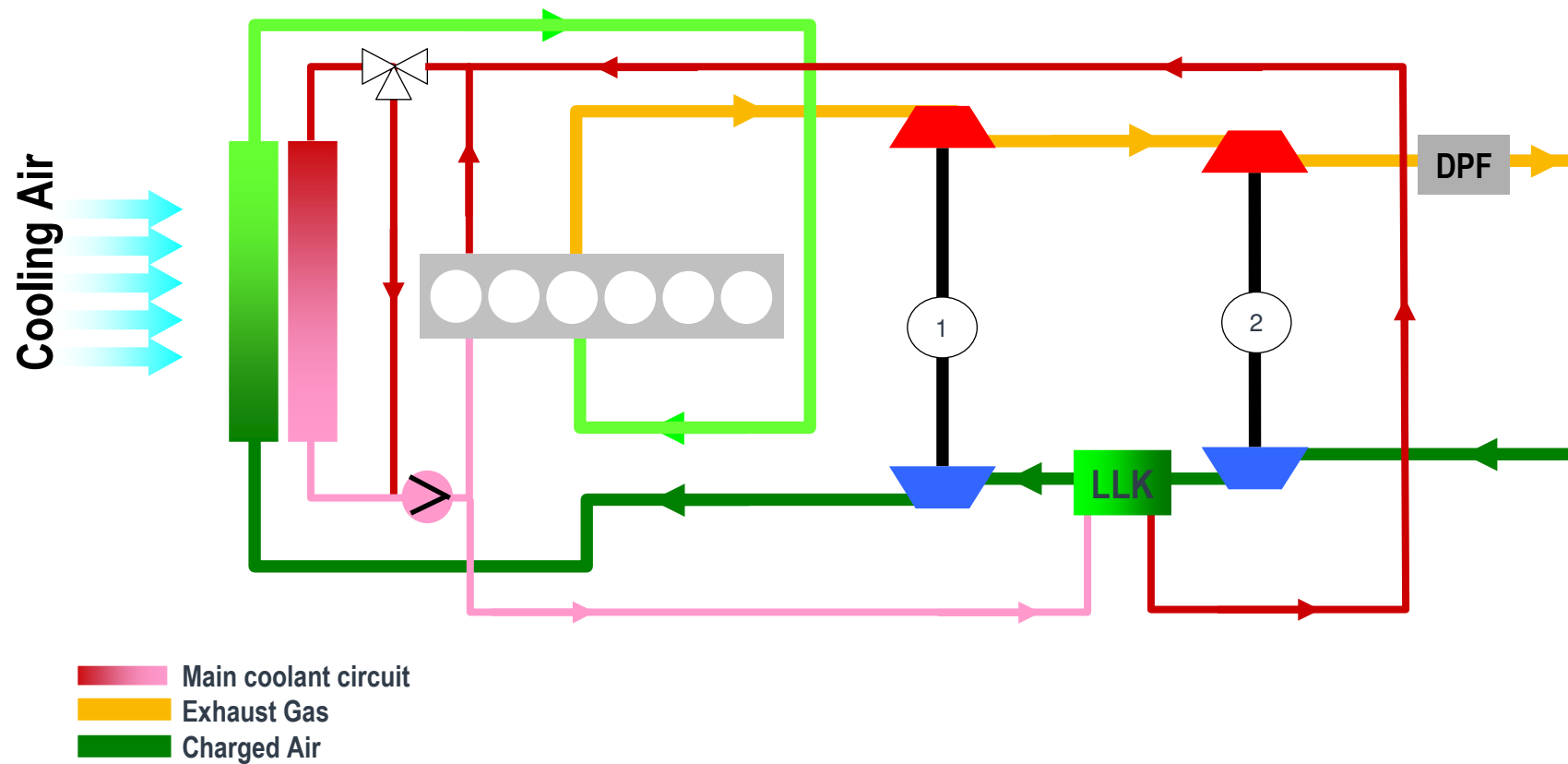


Concept D0836 LOH Euro 5 / EEV

Coolant systems



D0836 cooling circuit Euro 5



Concept D0836 LOH Euro 5 / EEV

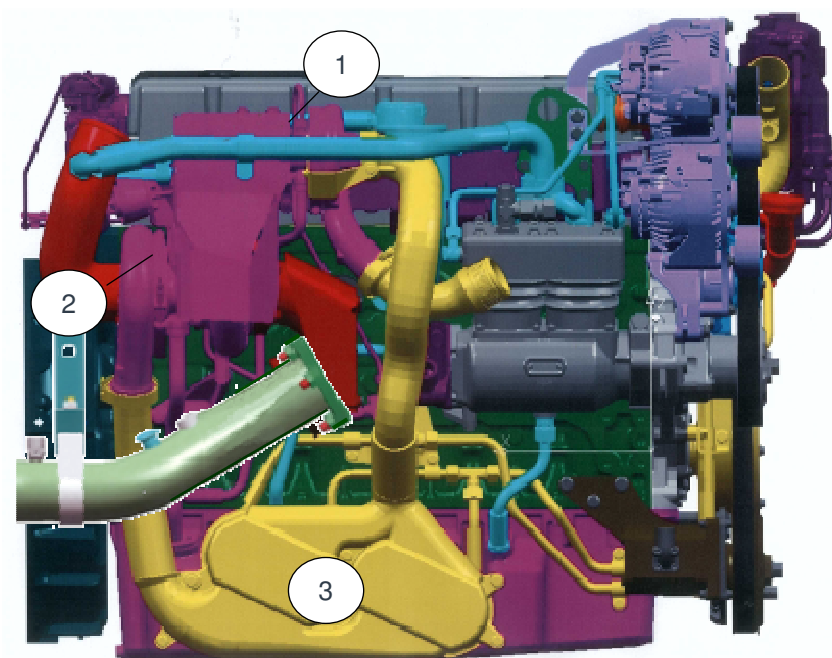
Comparison to Euro 4



**D0836 LOH 55/56 (SAE 1)
Euro 4**



**D0836 LOH 64/65 (SAE 1)
Euro 5 / EEV**

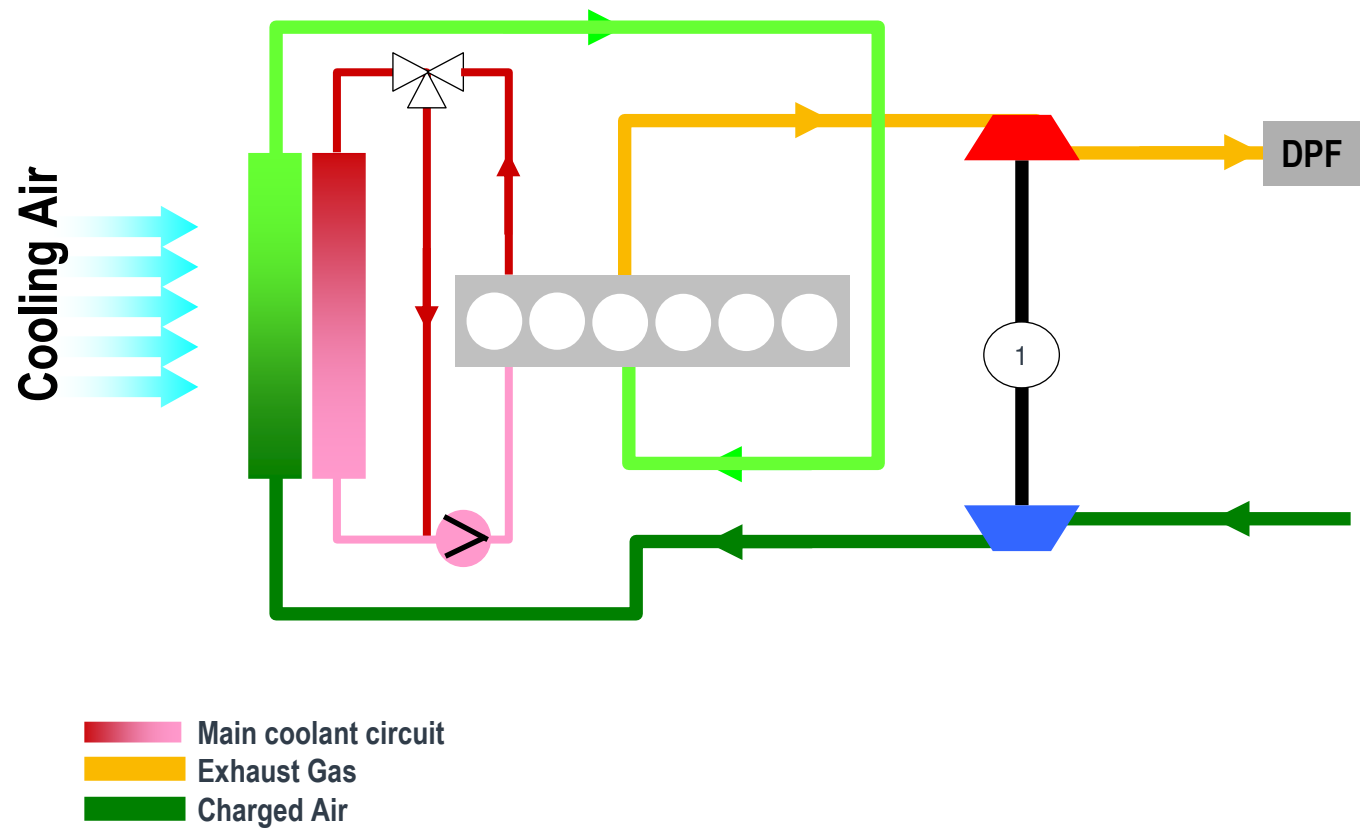


Concept D20 / 26 LOH Euro 4 / EEV

Coolant systems Euro 4



Euro 4 Coolant circuit

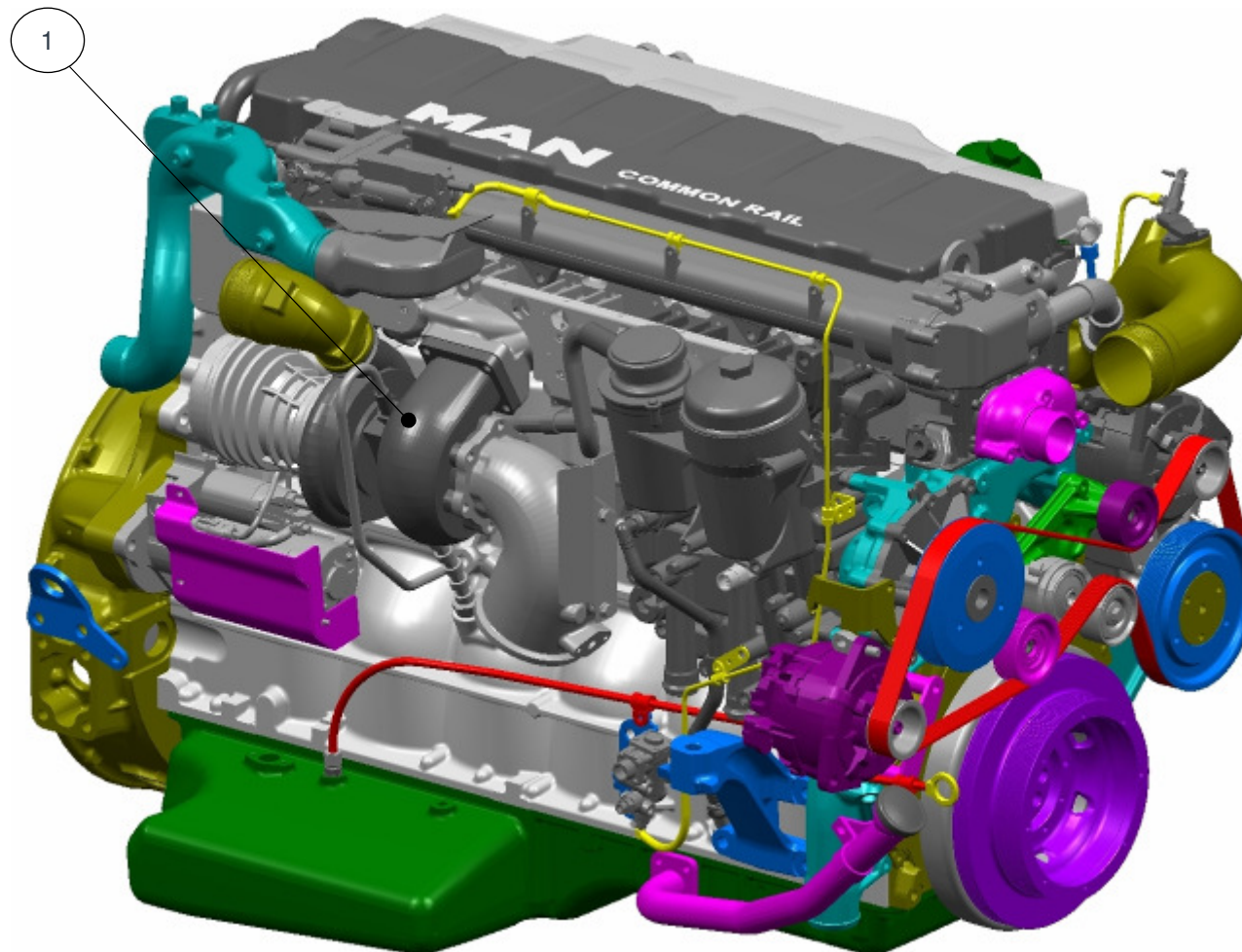


Concept D20 / 26 LOH Euro 4 / EEV

Coolant systems Euro 4



Euro 4 Coolant circuit

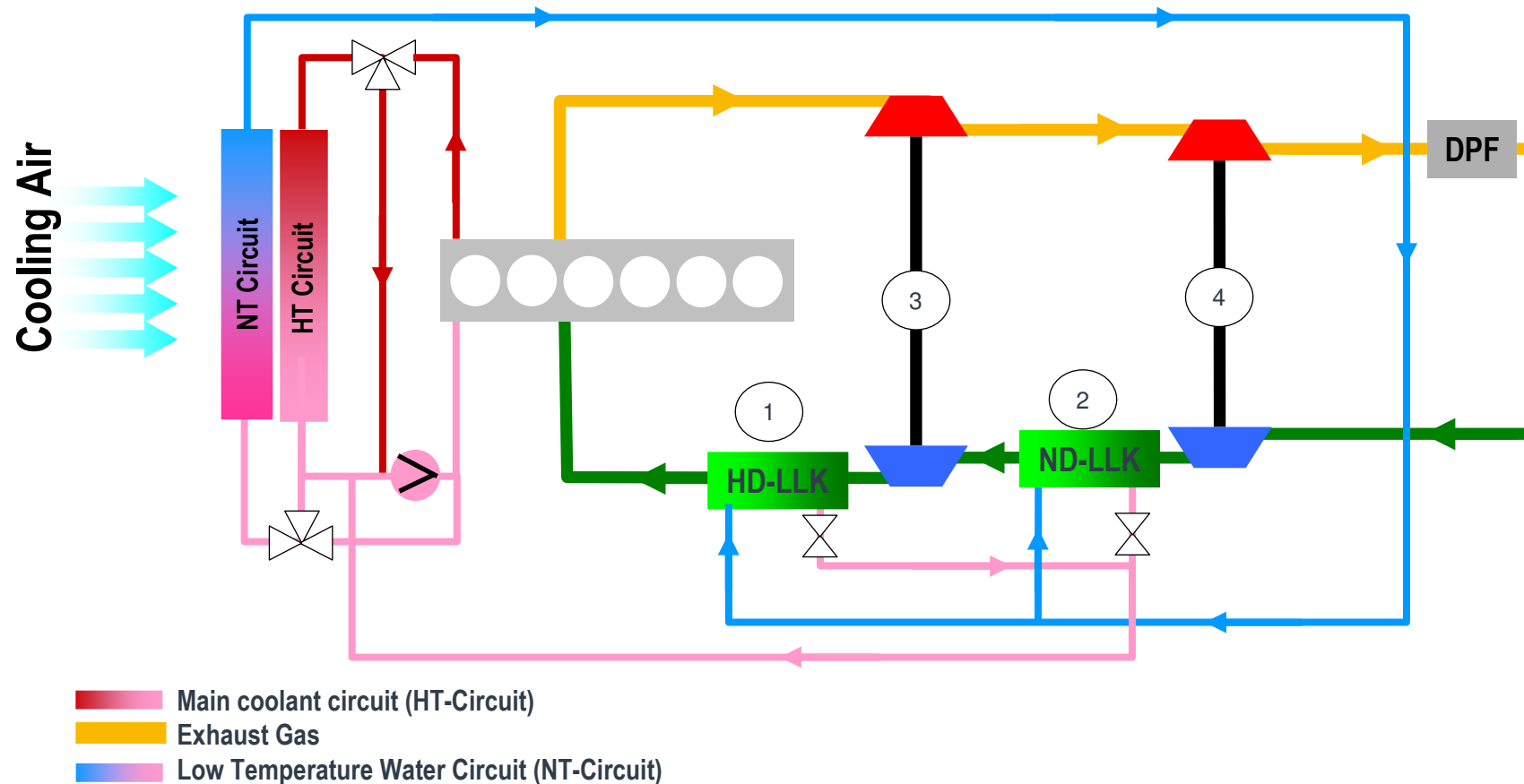


Concept D20 / 26 LOH Euro 4 / EEV

Coolant systems Euro 5 / EEV



Euro 5 EEV NT Kühlkreislauf / Euro 5 EEV NT Coolant circuit

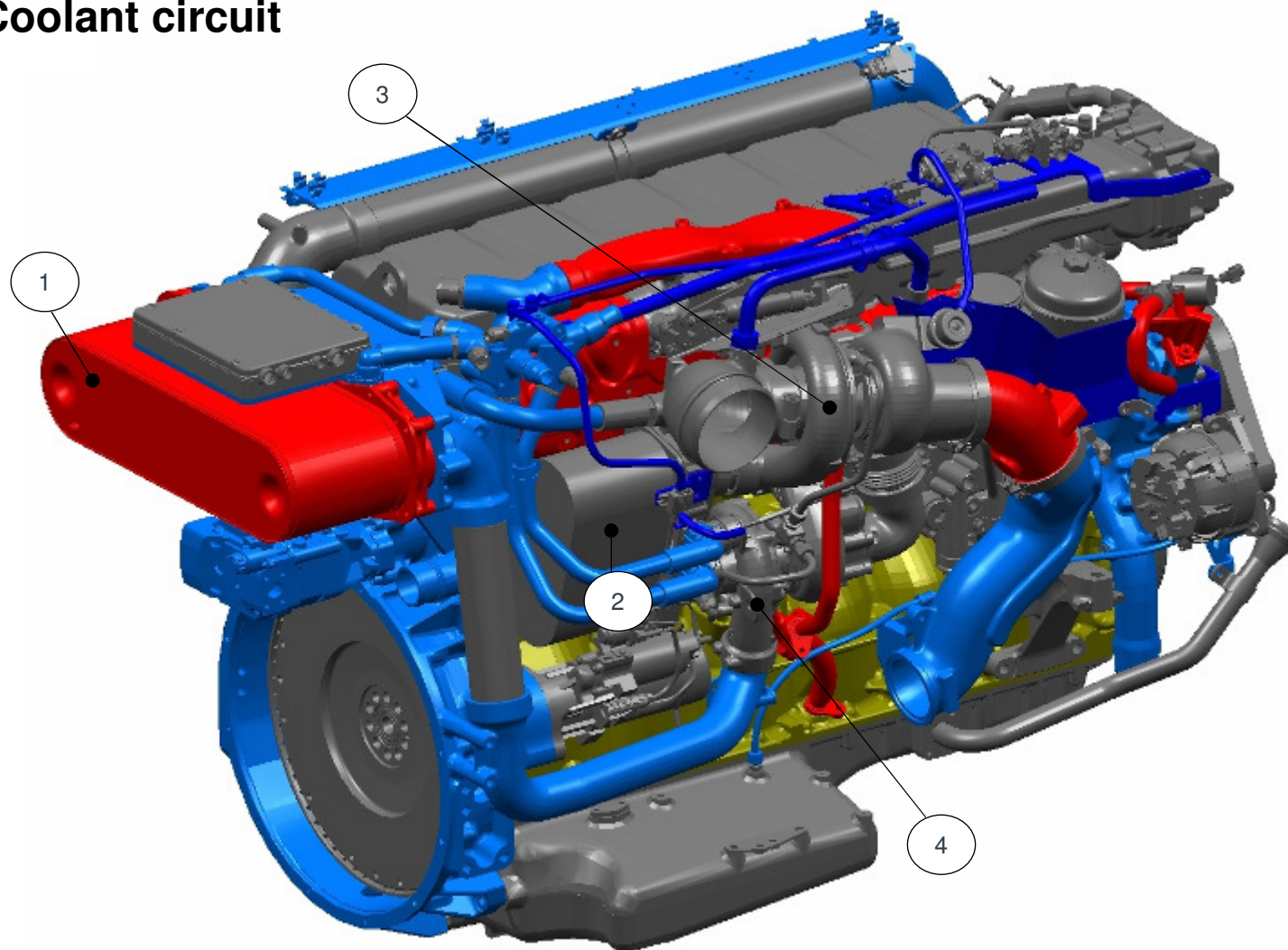


Concept D20 / 26 LOH Euro 4 / EEV

Coolant systems Euro 5 / EEV



EEV NT Coolant circuit

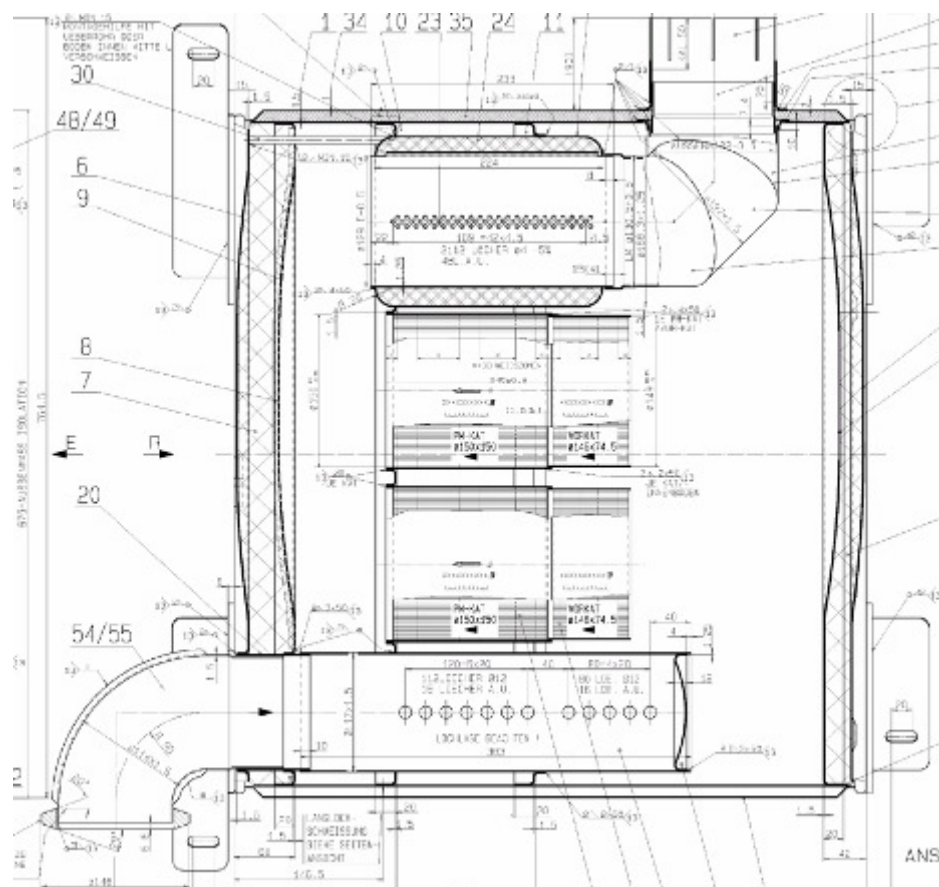
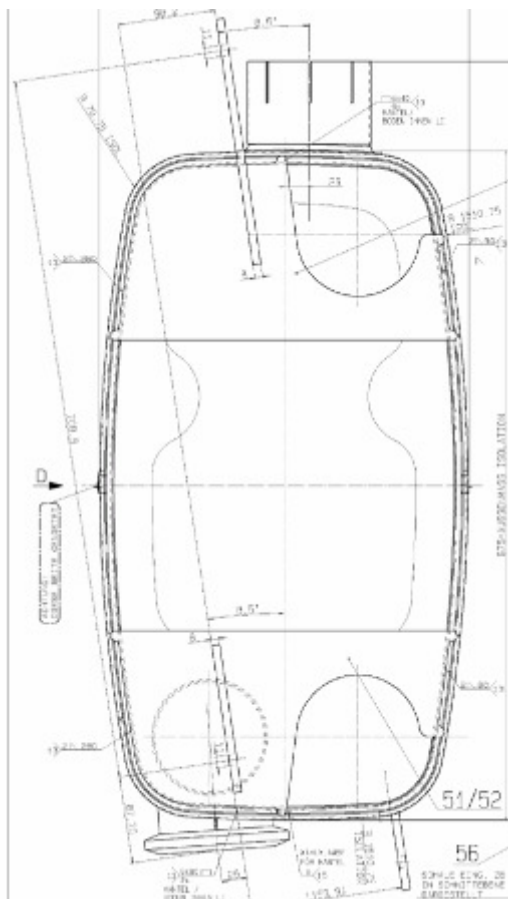


Concept D20 / 26 LOH Euro 4 / EEV

Exhaust System Euro 4



D2066 LOH 01/02/03/04 Euro4

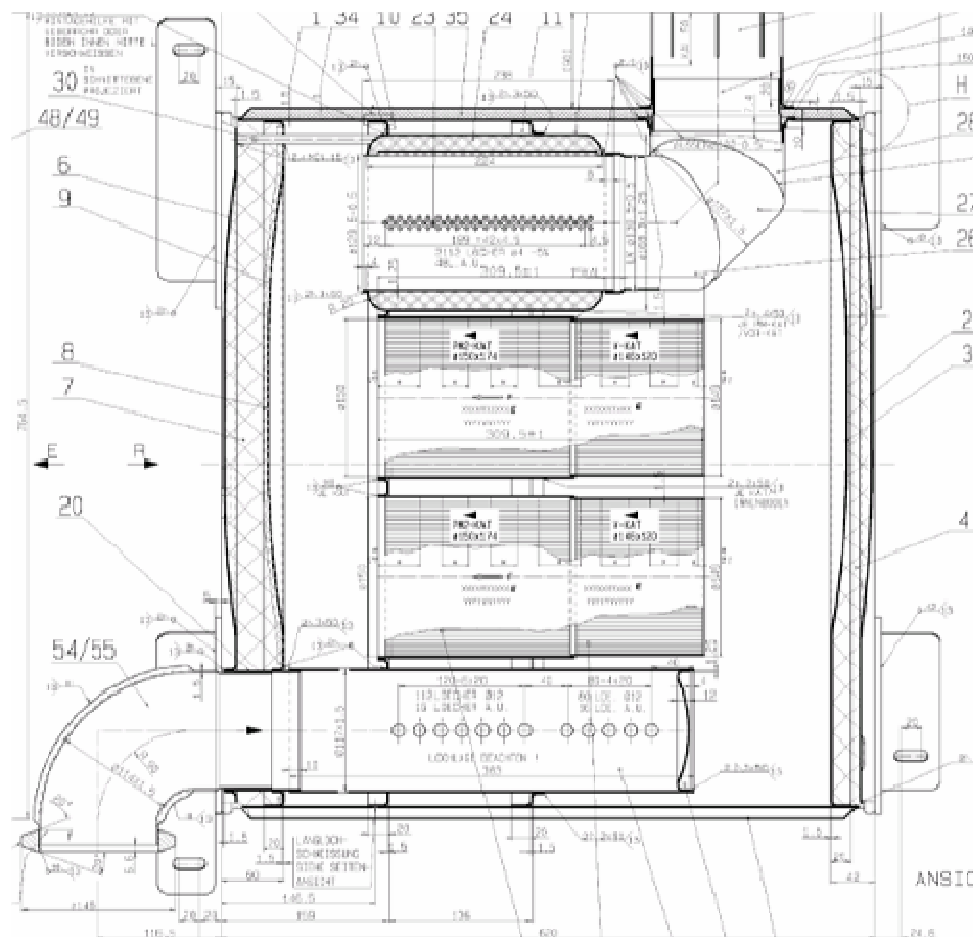
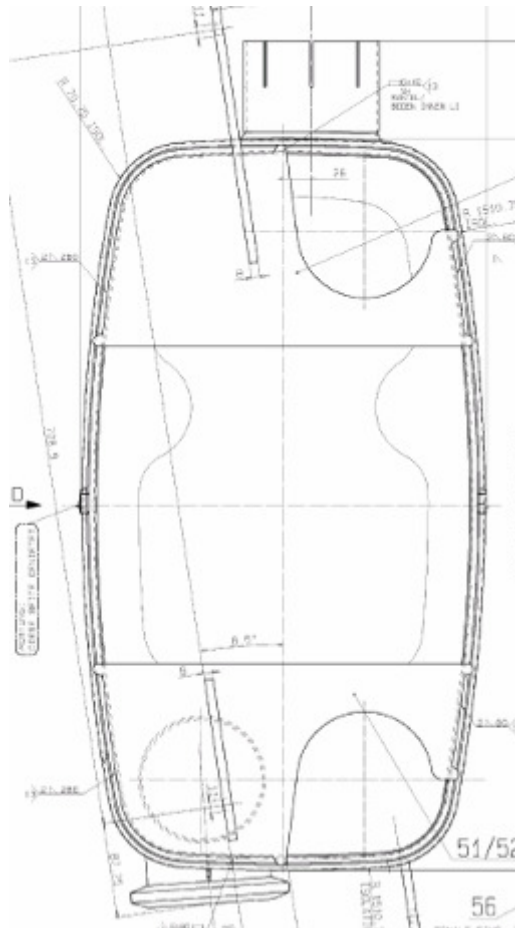


Concept D20 / 26 LOH Euro 4 / EEV

Exhaust System Euro 5 / EEV



D2066 LOH 26/27/28 EEV



MAN's engine technology:

How to achieve Euro 4 limits



Combustion chamber and injection:

- Compression ratio raised from 19:1 to 20,5:1
- Optimization of combustion chamber
- Use of improved injection nozzles (7-hole) for optimised combustion
- Injection pressure was raised to 1600 bar
- Useage of postinjection to reduce formation of soot

Useage of an optimized EGR-system:

- EGR-rates of up to 20 %
- Lower temperatures of the recirculated exhaust gas
- The formation of NO_x is in-line with E4 regulations

Useage of the PM-catalyzer to reduce the soot output

- Maintenance free, price-winning system that keeps the PM output in-line with E4 regulations

MAN's engine technology:

How to achieve Euro 5 limits



Injection:

- Usage of 2nd generation CommonRail system
- Use of improved injection nozzles (8-hole) for optimised combustion
- Injection pressure was raised to 1800 bar (for E6 pressure of up to 2400 bar is planned)

Further optimized EGR-system:

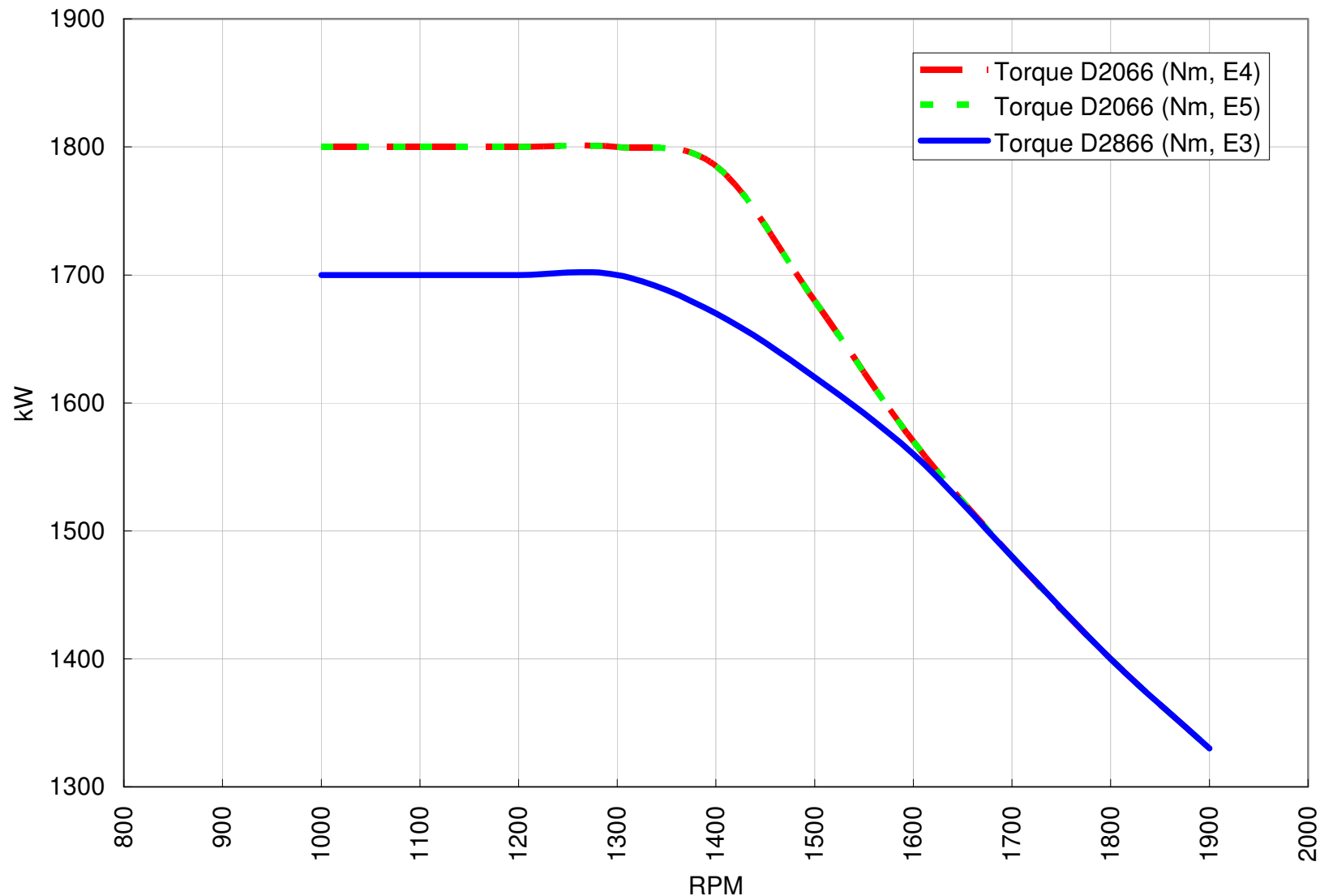
- EGR-rates of up to 30 %
- Double-fold exhaust system to achieve high EGR-rates
- Lower temperatures of the recirculated exhaust gas due to a better cooling unit
- The formation of NO_x is in-line with E5 regulations

Turbo charger and cooling system

- Double turbo charger
- Elaborate cooling system with air-water-intercooling for both turbos

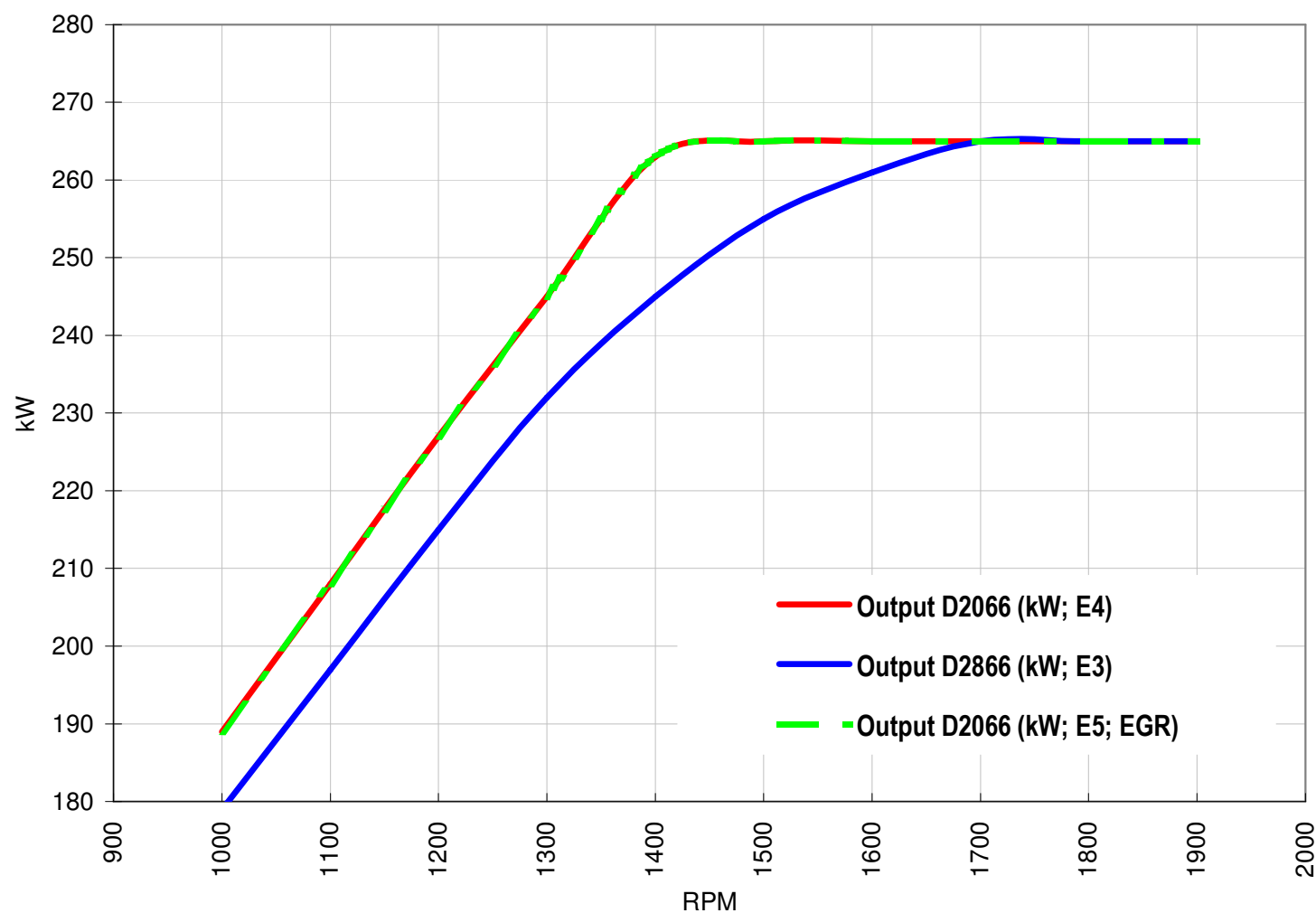
MAN's engine technology:

Comparison of old and new engine generation



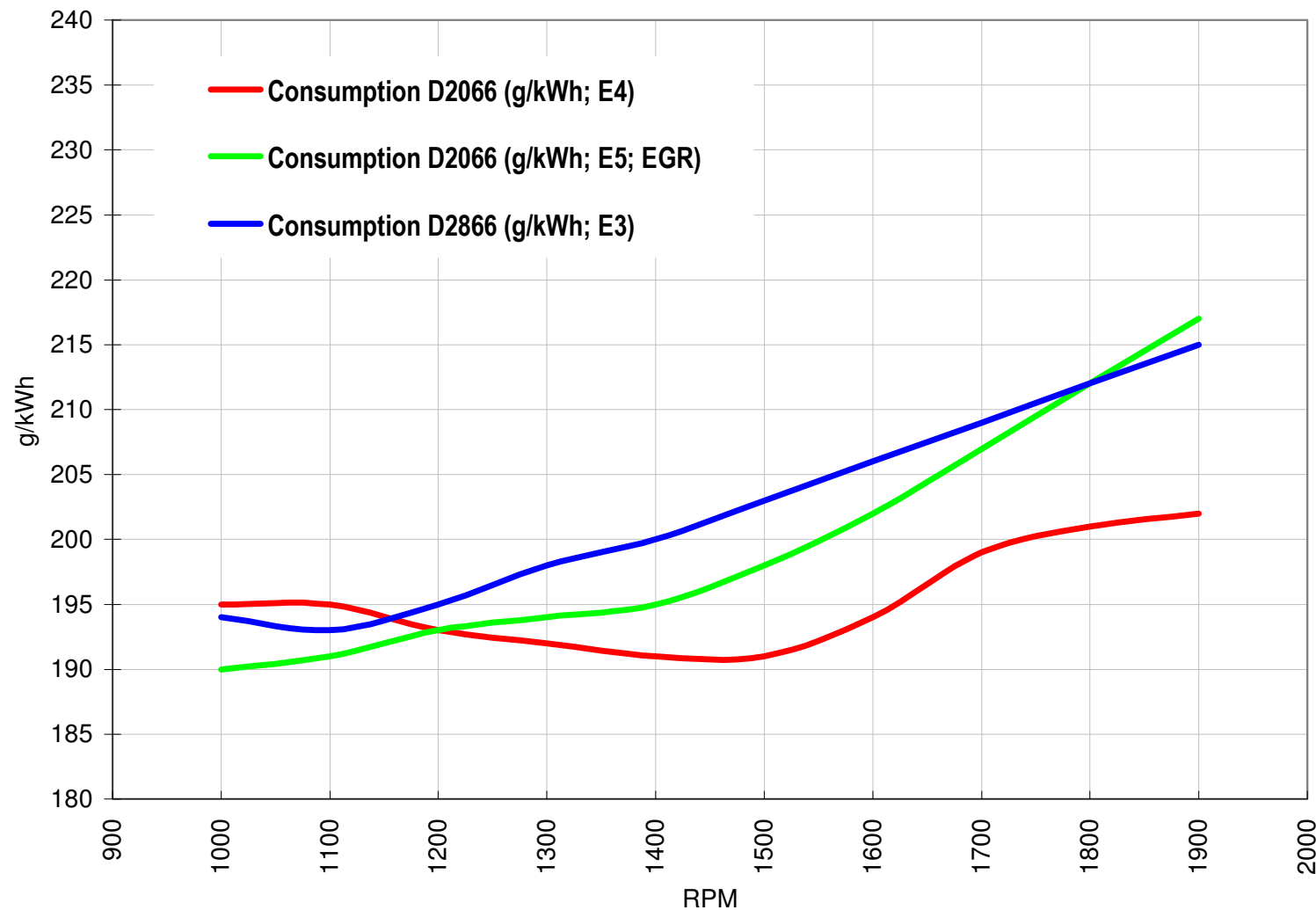
MAN's engine technology:

Comparison of old and new engine generation



MAN's engine technology:

Comparison of old and new engine generation



Euro 4/5 Technology with MAN PM-KAT[®]

Advantages for the customer



- Lower weight and reduced installation space (compared to SCR-solution)
- No increased consumption compared to Euro3 (D28)
- Robust and maintenance-free system
- No reduction-agent necessary ⇒ no urea heating or separate tank is needed
- No complex metering system needed



Overview

MAN Euro5 / EEV Engines



Engine Type	Rated Power kW / HP	Charging	Intermediate Cooling	Exhaust Norm	Exhaust Treatment	Cooling Concept
D0834LOH60	132 / 180	2-stage	without	Euro 5	Oxi-Cat	conventional
D0834LOH61	132 / 180	2-stage	without	EEV	PM-Cat	conventional
D0836LOH65	184 / 250	2-stage	with	Euro 5	Oxi-Cat	conventional
D0836LOH64	213 / 290	2-stage	with	Euro 5	Oxi-Cat	conventional
D0836LOH61	184 / 250	2-stage	with	EEV	CRT-Filter	conventional
D0836LOH60	213 / 290	2-stage	with	EEV	CRT-Filter	conventional
D2066LOH26	235 / 320	2-stage	with	EEV	PM-Cat	NT-Cooling
D2066LOH27	265 / 360	2-stage	with	EEV	PM-Cat	NT-Cooling
D2066LOH28	294 / 400	2-stage	with	EEV	PM-Cat	NT-Cooling
D2066LUH46	206 / 280	2-stage	with	EEV	CRT-Filter	conventional
D2066LUH47	235 / 320	2-stage	with	EEV	CRT-Filter	conventional
D2066LUH48	265 / 360	2-stage	with	EEV	CRT-Filter	conventional
D2066LUH32	235 / 320	2-stage	with	Euro 5	PM-Cat	conventional
D2066LUH33	265 / 360	2-stage	with	Euro 5	PM-Cat	conventional
D2066LUH34	294 / 400	2-stage	with	Euro 5	PM-Cat	conventional
D2676LOH26	324 / 440	2-stage	with	EEV	PM-Cat	conventional
D2676LOH27	353 / 480	2-stage	with	EEV	PM-Cat	conventional
D2676LOH28	371 / 505	2-stage	with	EEV	PM-Cat	conventional

Strategy for future technology

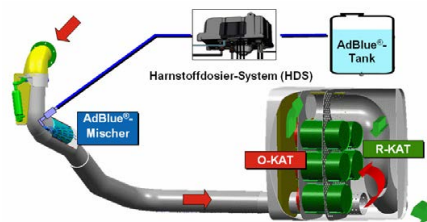
US2010 / Euro6



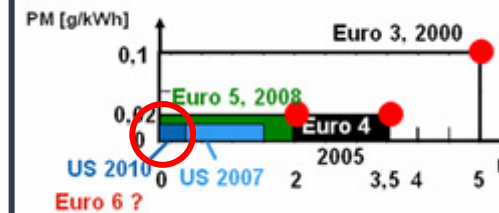
EPA 2007

EGR-Technology
+
2-stage turbo charge
with
Charge air intercooling
+
Filter (PM-KAT®/CRTec®)

Euro 5



MAN AdBlue®



EPA 2010

Euro 6

Strategy for future technology

US2010 / Euro6



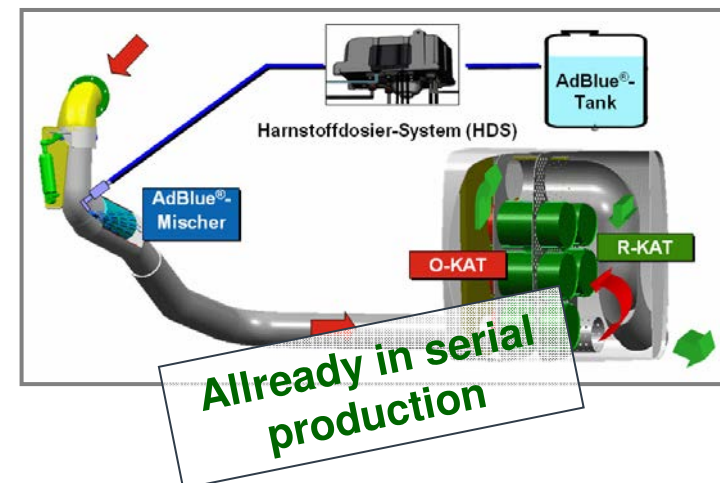
2 stage turbo charging
with intercooling



AGR+PM-KAT[®]/CRTec[®]



MAN AdBlue[®]



***MAN has already developed the principal key technology
in compliance with the requirements for EPA 2010 and Euro 6!***

New emission standard Euro5 / EEV



Thank you for your
attention !

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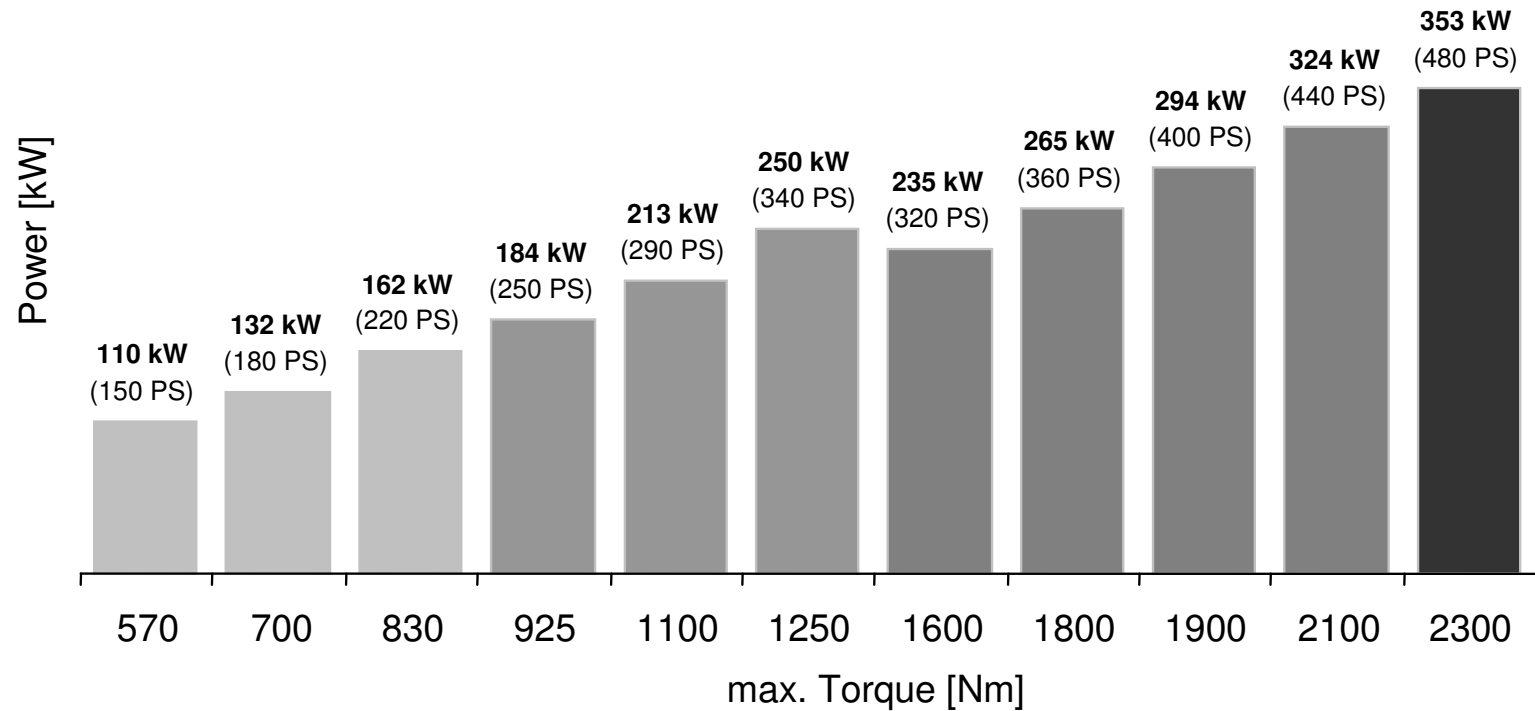


Outlook into the future:

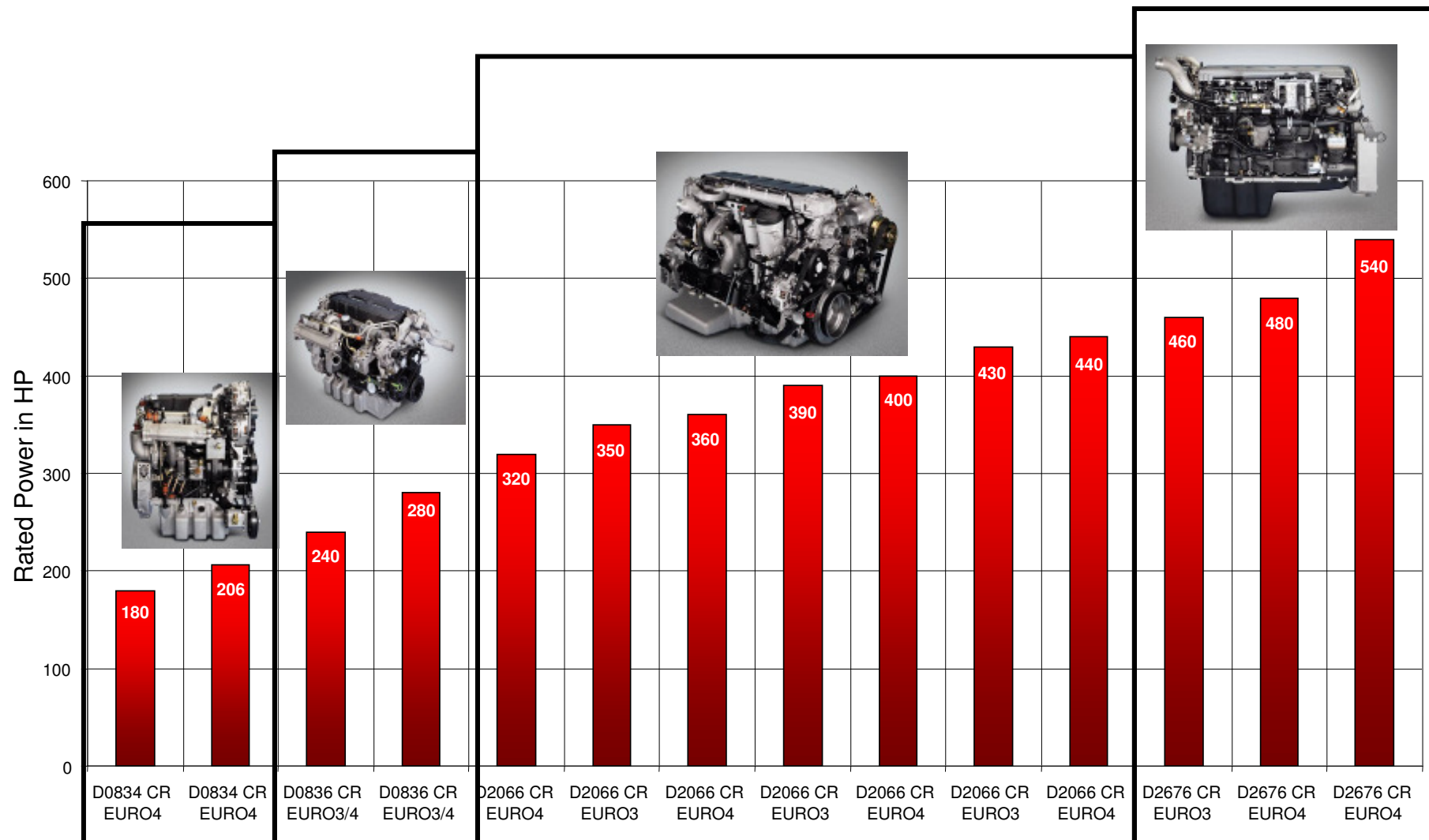
Euro 5 engines from 2009 onwards



EGR + MAN PM-CAT®



MAN's engine technology: Engine lines and power output



How to comply with the Euro4 : MAN-Exhaustfilter obtains Environmental Award

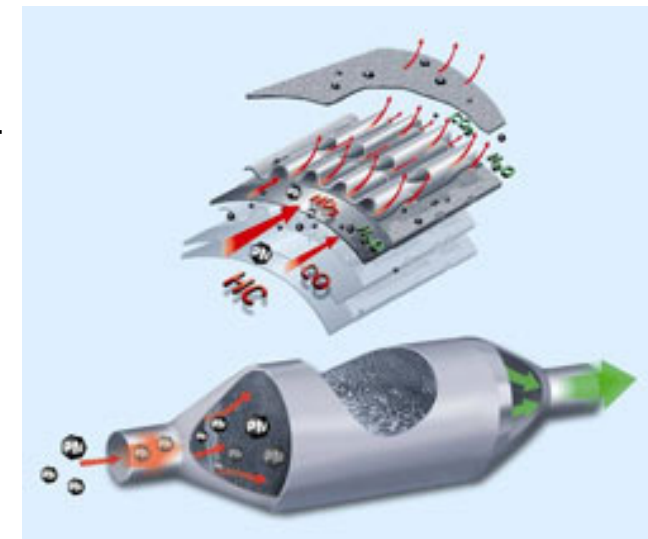


Clean, cleaner, MAN PM-KAT®! The innovative dieselfilter for particulate matter for commercial vehicles was awarded the renowned “BDI-Umweltpreis für die Industrie 2005/2006” (Federal Association of German Industry – Environmental Award for the Industry 2005/2006)

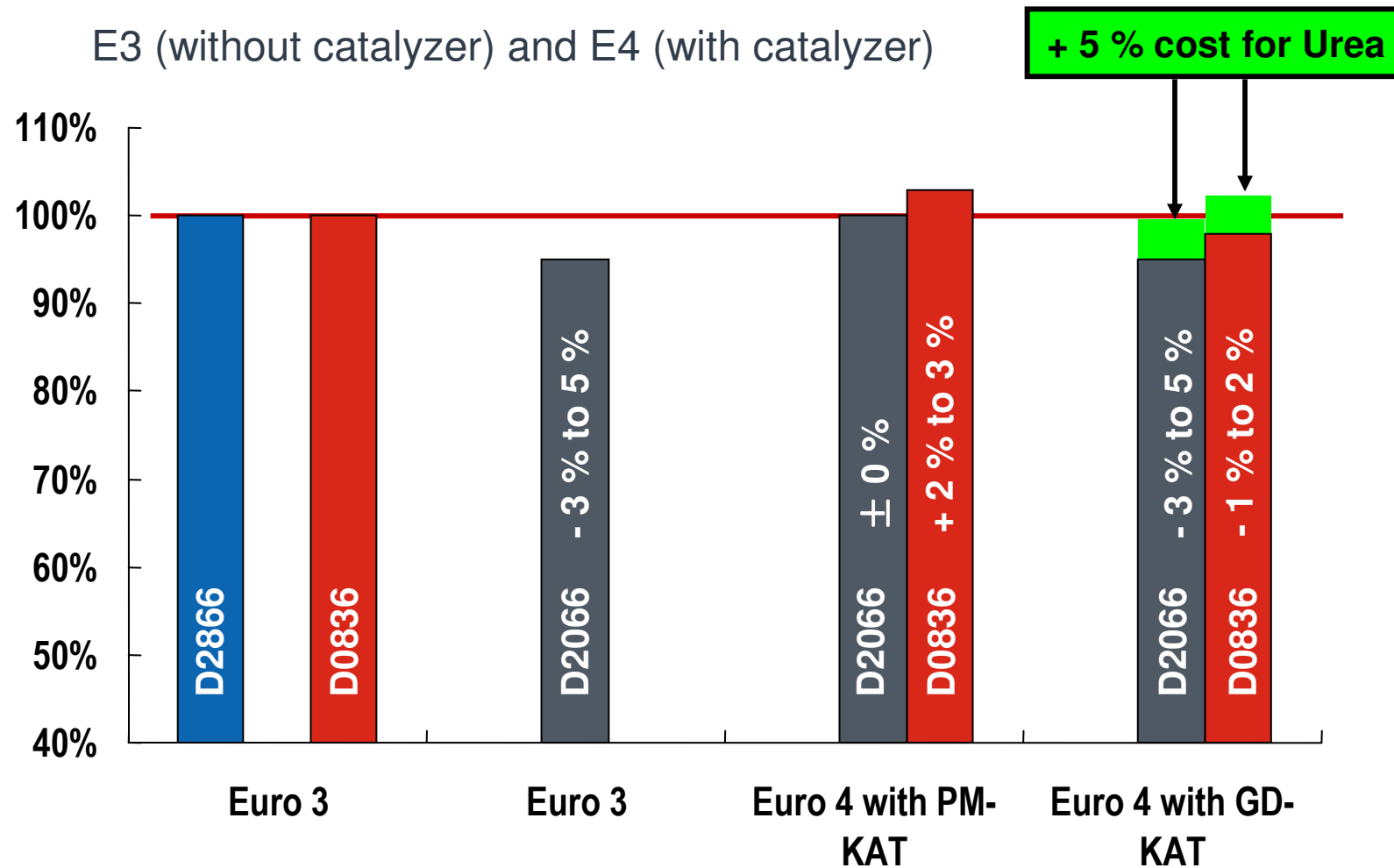
A high ranking jury consisting of leading characters from industry, science, politics and environmental associations was convinced: Within the category “Environment-friendly products” the MAN PM-KAT® is outstanding.

Thereby this filter – that is used by MAN serially for trucks and busses since the end of 2004 – is nominated as German contribution for the European Environmental Competition. The patented filtering concept – that was developed together with the catalyzer experts from EMITEC – retains up to 90% of the particulate matter which is deemed especially hazardous.

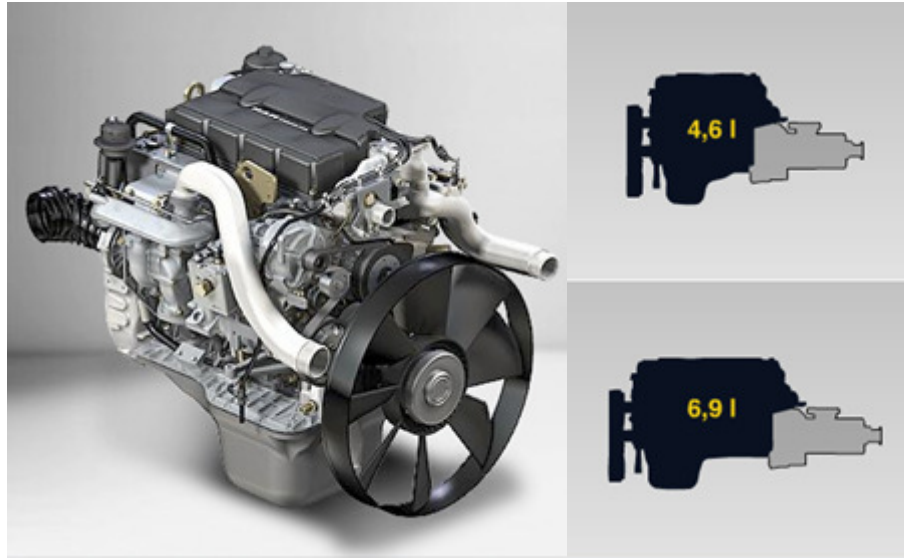
In contrast to conventional diesel filters, the MAN PM-KAT® is absolutely maintenance free. It cannot clog and runs without any additives. A distinct advantage over competitor's products!



How to comply with Euro4: Comparison fuel consumption D2066



MAN's New Engine Technology: D08 CR – Technical information and customer's benefits



Engine line D0834/36

Diesel engine with direct injection with 4,6 respectively 6,9 l swept volume

Common-Rail-Injection with EDC7 engine management system

Several models with cooled external EGR

The 206 HP 4 Cylinder engine comes with twin turbochargers

→ Customers benefit's:

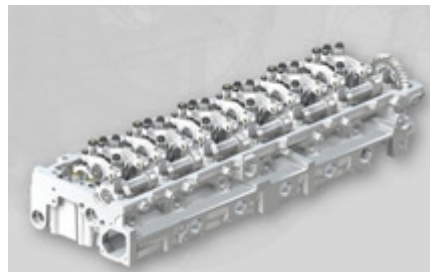
- Engines with high output in power and torque
- Long intervals between oil-changes of up to 80.000 km (long distance transport)
- Favourable torque curve and start trait
- Quiet engine (esp. at partial load)
- Low fuel consumption – highly environmental friendly



MAN's New Engine Technology: D20 CR – Technical information and customer's benefits



First time ever in a commercial vehicle: Oil pump as a Trochoid-Pump



Cylinderhead in one piece

Engine line D2066 CR

Economical 10,5-l-engines with state-of-the-art technology – Especially the Common-Rail-Injection guarantees low consumption combined with high performance

The D2066 CR offers fuel economy of up to 5 % compared to the older D28

Lowest engine mass in the 430 HP category (967 kg dry weight) – hence biggest payload advantage

Long intervals between oil-changes of up to 120.000 km (long distance transport)

Use of cooled external EGR in all D20 models

Approx. 1,5 Mio km until major engine overhaul is necessary

→ Customers benefit's:

Low fuel consumption

Big payload advantage due to low engine weight

Very little downtime due to long maintenance intervals