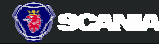


Reducing emissions at source: Engineering global products for local needs

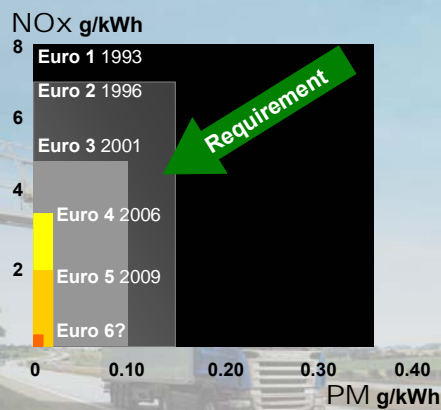
Dr. Greger Juhlin
Manager
Emissions and Performance
Scania Engine Development

1



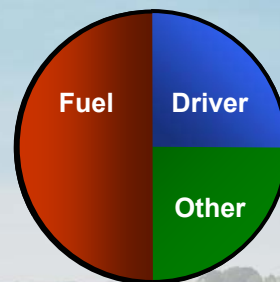
Drivers and challenges

Emission legislation



Fuel economy

Long-haulage



CO₂ = Fuel Consumed

to give the customer the lowest operating cost

2

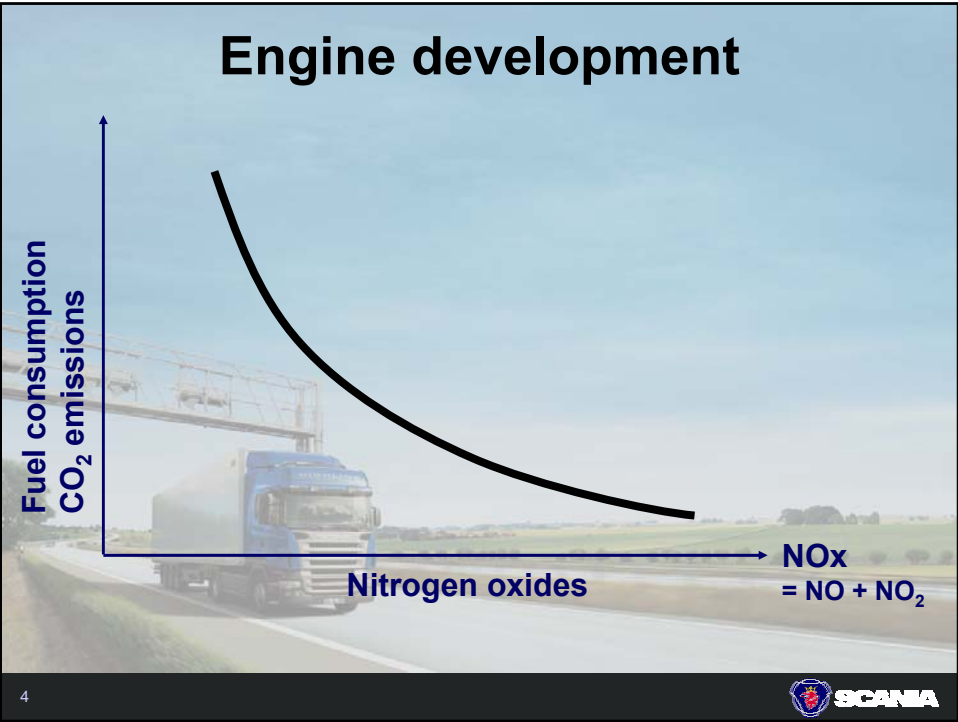




Development challenges

Nitrogen Oxides (NOx) and Particulate Matter (PM)

3




Engine development

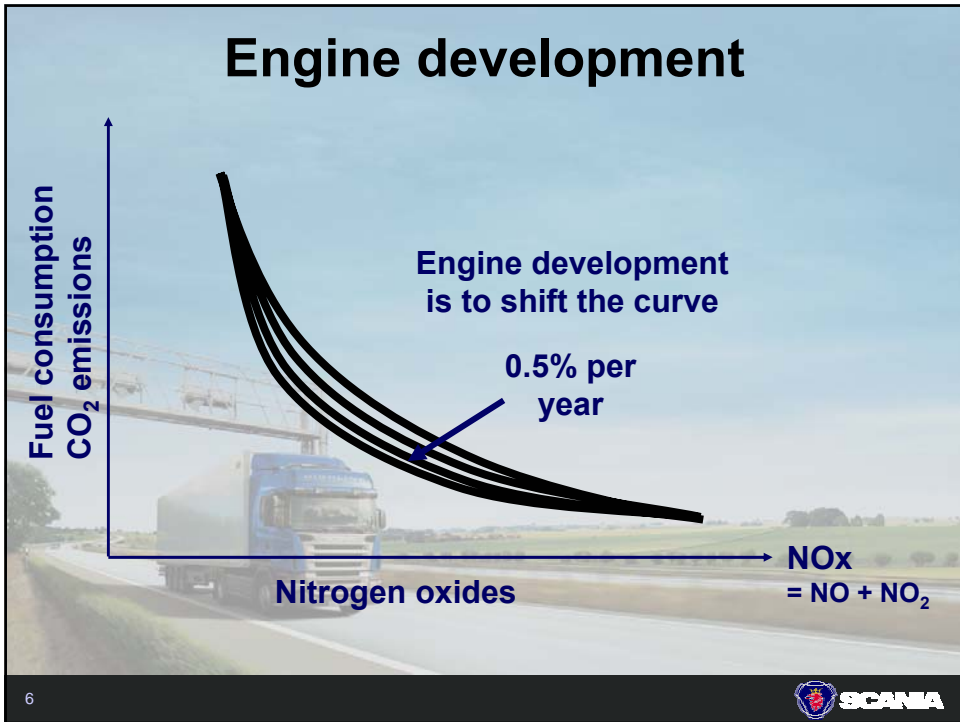
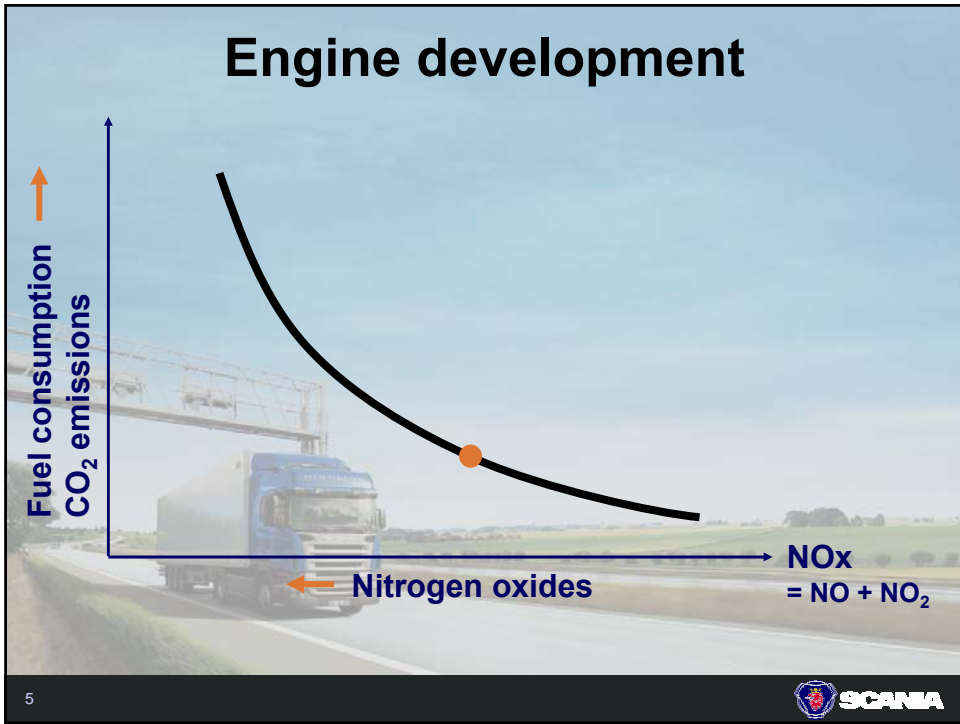
Fuel consumption
CO₂ emissions

Nitrogen oxides

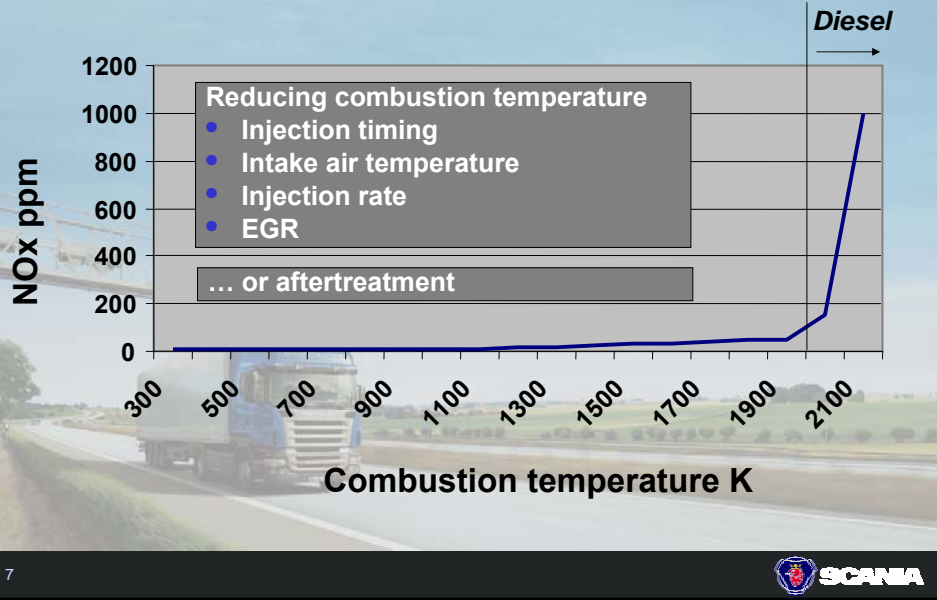
NOx
= NO + NO₂

4





How to reduce NOx



How to reduce PM

Traffic-related particulates

- Tyres
- Road surface
- Brakes
- Exhaust

Exhaust particulates

- Soot
- Hydrocarbon
- Lubrication oil
- (Sulphur)

- **Increased injection pressure**
- **Controlled boost pressure**
- **Combustion chamber design**
- **Aftertreatment**
 - Oxicat
 - Particulate trap

8

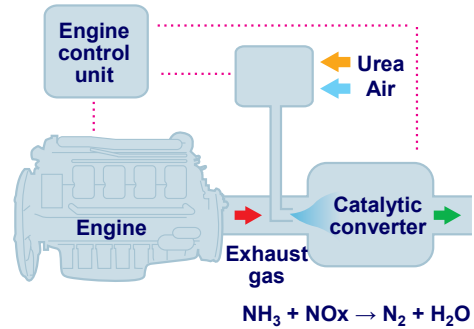
Technical solutions

Recirculated and cooled exhaust gas



Cooled EGR*

* Exhaust gas recirculation



SCR**

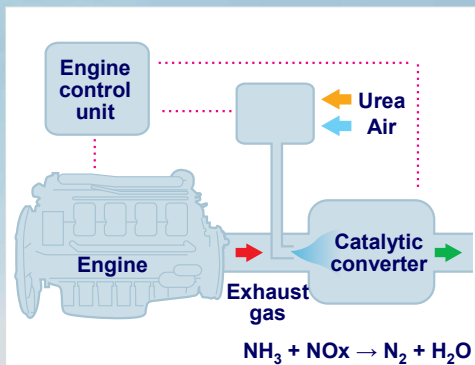
** Selective catalytic reduction

9



Technical solutions – SCR

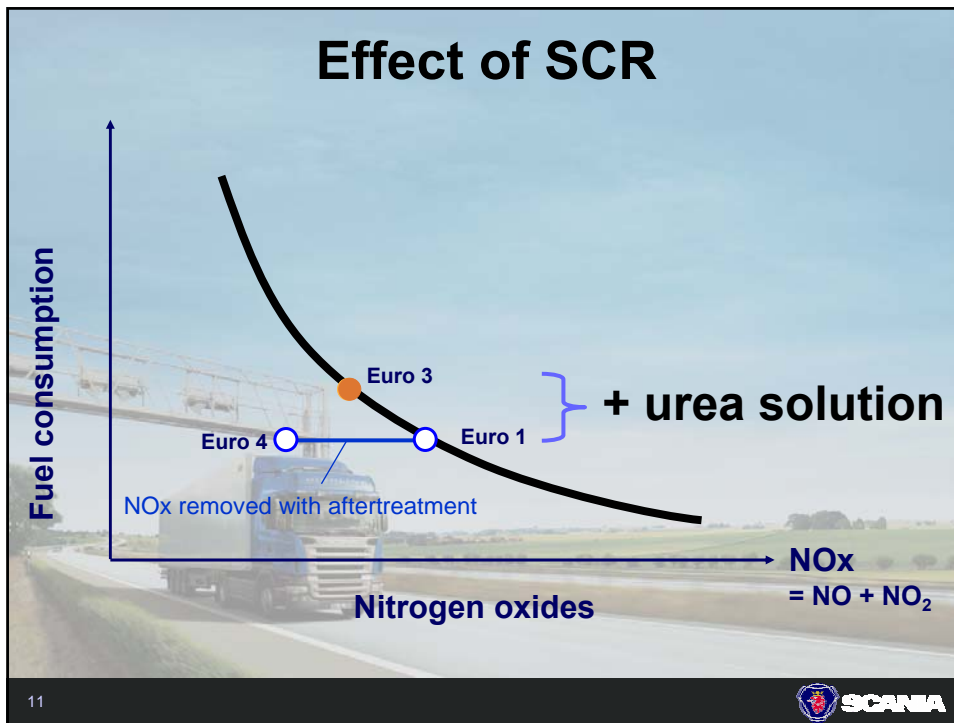
- **Active aftertreatment**
- **New technology for automotive use**
- **Relies on added reagent**
 - Requires extra tank and filling
 - Infrastructure for urea solution lacking
 - Operating cost dependent on price of urea solution
 - Chassis installation affected
- **Relies on high exhaust temp.**
 - Works best under higher load, e.g. long-haulage



SCR

10





Cheating and tampering

- **Adaptation of emissions directive for Euro 4 and 5**
(11 Feb 2005)
- **Prevents cheating with emission levels**
e.g. by not filling urea solution
- **Compliance ensured**
 - System functionality checked
 - NOx sensing in exhaust
 - Non-compliance logged up to 12 months
- **Torque reduced by at least 40 percent**
 - Activated when stationary

500 hp
2,400 Nm

→

300 hp
1,440 Nm

Implementation
2006/2007

12

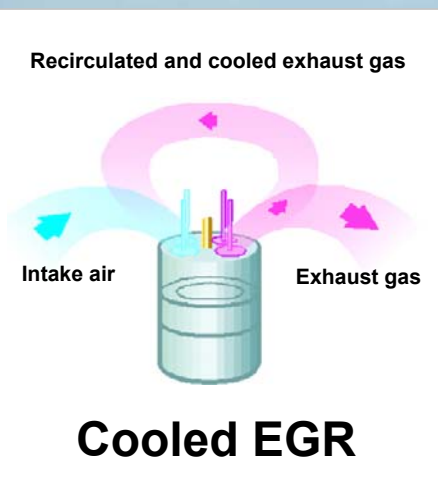
New operational factors with SCR

- Environmental performance
- Build-up of supply infrastructure for urea solution
- Misuse and tampering
 - NOx control from October 2007
- Purity of urea solution
- Warranty

13



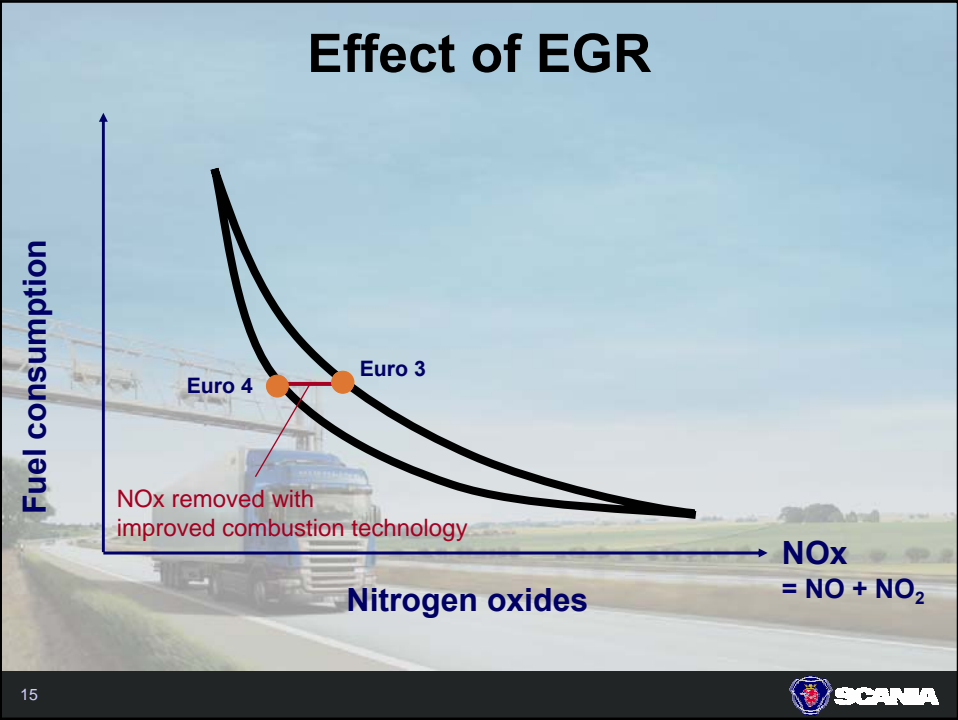
Technical solutions – EGR



- Refined combustion
- High injection pressure
 - Reduces particulates
 - Improves fuel efficiency
- Tried-and-proven since decades
- Just fill standard diesel
- Works at any load
 - Operational in urban stop-and-go traffic

14





Scania Technical Centre

- 1,800 engineers (900 powertrain)
- 40 engine test cells
- 20 km test tracks

17

One combustion chamber

Year	Displacement (litre)	Power Output (kW)	Engine Type
2005	9	230, 270, 310	9-litre
2000	11	340, 380	11-litre
1995	12	360, 400, 420	12-litre
2000	12	420, 470	12-litre turbocompound
1995	16	500, 560, 580, 620	16-litre V8

18

Euro 4

Inline engines

- Trucks and buses
- Scania EGR
- Scania high-pressure injection
- Scania venturi or turbocompounding
- Oxicat

V8 engines

- Trucks
- Scania SCR

Particulates 0.02 g/kWh
NOx 3.5 g/kWh

3000 units sold



19



First step to Euro 5

Scania's first Euro 5 truck engines

- Mainly trucks for long-haulage
- 420 and 500 hp
- Benefit from incentives
- Scania SCR
- Available in 2006

Scania's first Euro 5 city bus engine

- Scania EGR
- Particulate trap to secure environmental performance
- 270 hp
- Available in 2006

Particulates 0.02 g/kWh
NOx 2.0 g/kWh



20

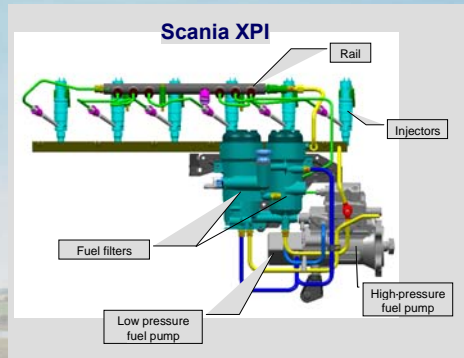


Euro 5 (2008/09)

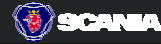
All truck and bus engines

- Scania EGR
- Scania XPI
- Variable turbo geometry
- Increased swept volume
- Oxicat

Particulates 0.02 g/kWh
NOx 2.0 g/kWh



21



Euro 6 (2011/12 ?)

New world standard based on EPA 10 ?

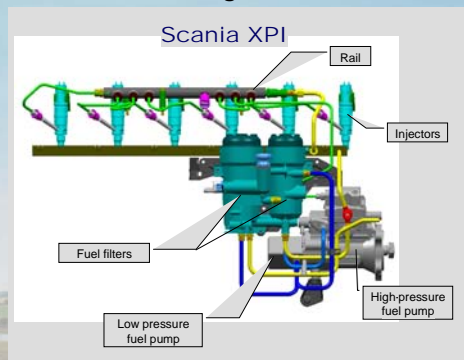
Assuming

- Japanese, US and European norms harmonised
- World-harmonised test cycle

Technologies

- Scania XPI, EGR, VTG, SCR ...

Particulates 0.013 g/kWh
NOx 0.27 g/kWh

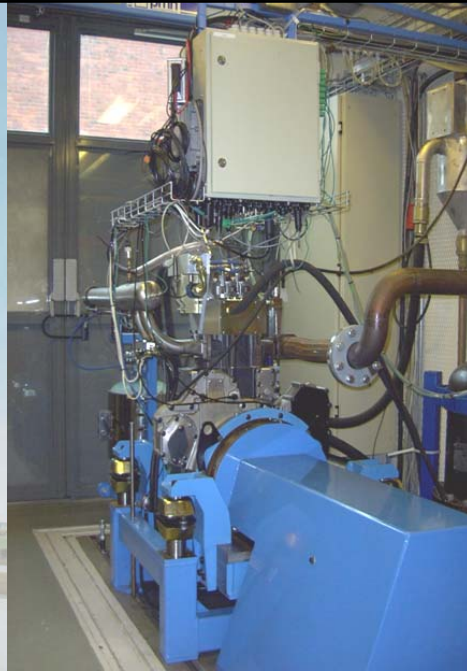


22

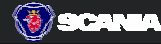


Scania HCCI

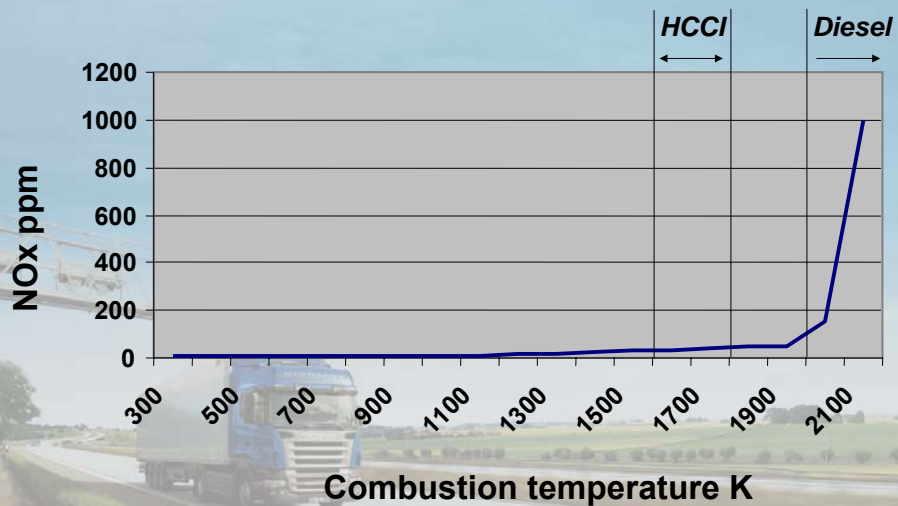
- Homogeneous charge compression ignition
- Technology mature around 2015
- High efficiency
- Cold combustion gives low NOx
- Premix prevents formation of particulates
- High EGR rate
- Tricky combustion control
- High noise level
- High strength required



23



NOx formation during combustion



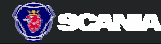
24



Cold combustion

- **HCCI a possibility**
- **Mixed mode combustion has high potential**
 - Low load
 - Pre-mix
 - Homogeneous combustion
- **EGR is a key technology**

25



Summary

- **Overall aim is to avoid the formation of emissions**
- **EGR main route for Euro 4 and 5**
- **SCR on some Euro 4 and Euro 5 incentive engines**
- **EGR is a key technology for the future**
 - Diesel-combustion, HCCI, or mixed-mode

26

