



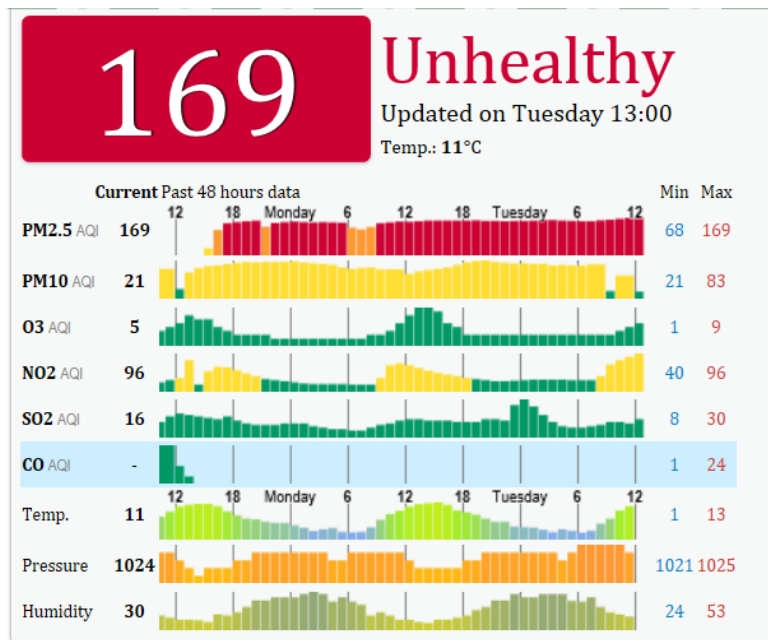
VERT Workshop

Teheran / January 23, 2018

J. Gieshoff, Umicore AG&Co.KG

Air Quality in Tehran

Dec 19, 2017



Sources of Emissions

Air pollution emissions in Tehran falls into two major groups, the **stationary** (industrial commercial, residential) and **mobile** (traffic) sources;

the **share of mobile** sources (as a total tonnage) is **89%**.

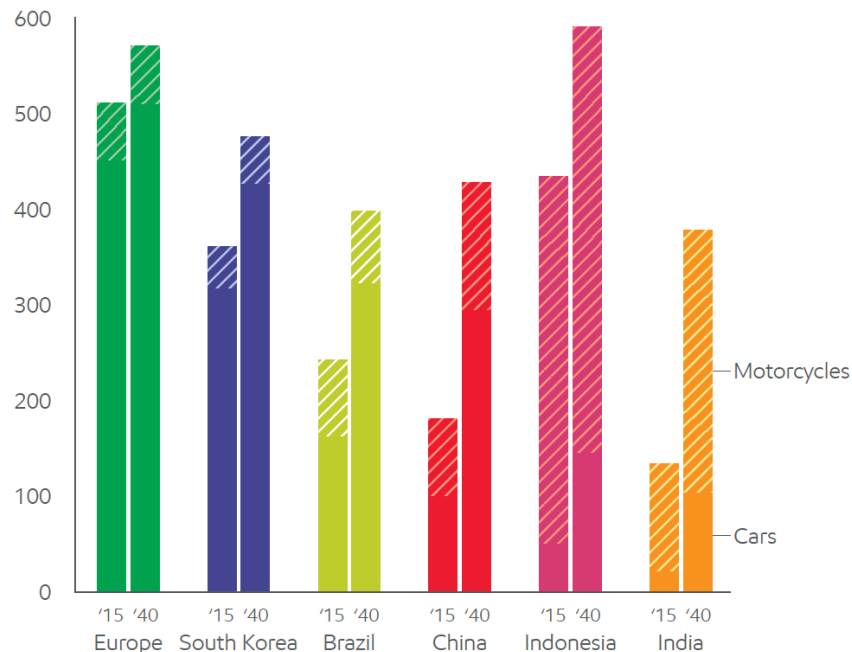
Vehicles are the main emissions source in this city.

<http://www.ess.co.at/WEBAIR/TEHRAN/tehran.html>

Growth in Vehicle Population Expected... And the majority will (still) use internal combustion engines

Access to personal mobility increases

Vehicles per thousand people



http://cdn.exxonmobil.com/~media/global/files/outlook-for-energy/2017/2017_outlook_for_energy.pdf

Emission Control Catalysts for Improving the Air Quality

$\lambda = 1$ - Concepts

-“Standard“ Petrol Powered Vehicles-

CO, HC, NO_x

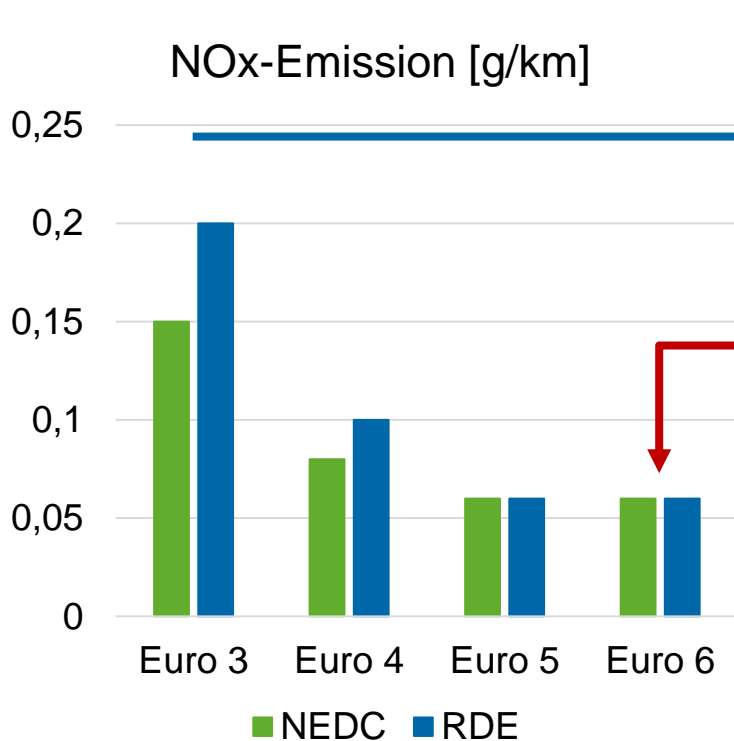
Three-Way Catalyst

Particulate Mass and Number

Gasoline Particulate Filter
(GPF)

Petrol powered cars

Comparison Test Cycle vs Real Driving Emissions



<http://www.eea.europa.eu/publications/air-quality-in-europe-2016>

Enforcing stringent emission limits will help to improve air quality

Gaseous Emissions (incl. NOx) are not the major topic for gasoline powered vehicles

Focus on **particulate number** as new topic in the European legislation for DI-engines to improve urban air quality

Proposed Solution:

Coated Gasoline Particulate Filter (GPF)

Proof-of-Concept: Durability Run Coated Gasoline Particulate Filter (GPF)

Original Exhaust Gas Line

Close-coupled (CC) TWC

- TWC 1.24L 80g/ft³

Redesigned Exhaust Gas Line

CC TWC + UF Filter

- CC TWC 1.24L 64g/ft³
- GPF 1.68L 10g/ft³

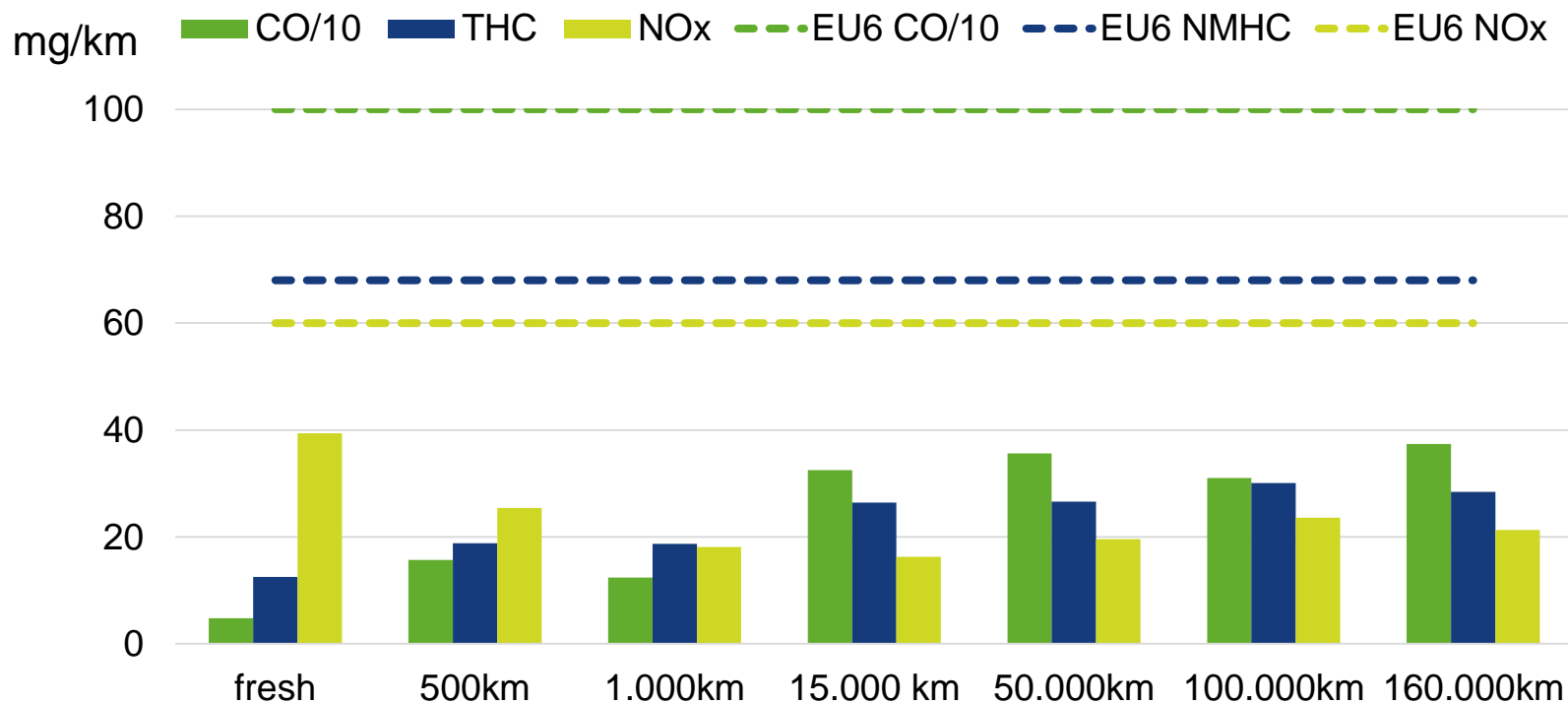
@ equal precious metal costs



Audi 2.0L TFSI, EU4 (DI-Engine)

Durability Run

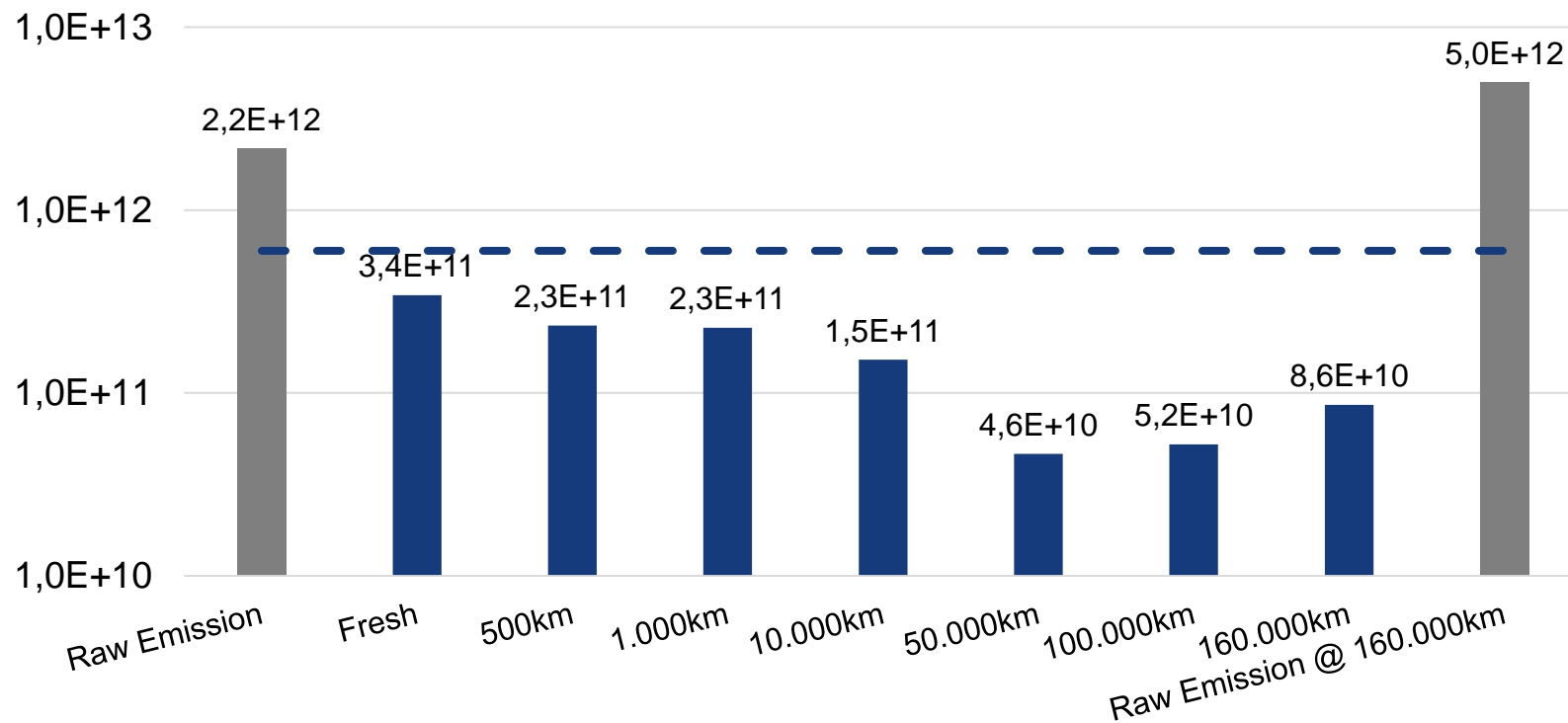
-Test Results / NEDC / Gaseous Emissions-



Durability Run

-Test Results / NEDC / Particulate Number [# / km]-

Log. Scale



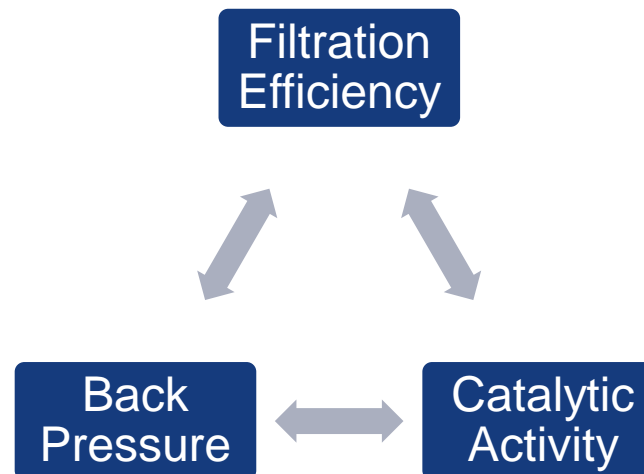
Summary GPF

-“Standard“ Petrol Powered Vehicles-

Particulate Emission Reduction of DI-powered gasoline engines can be achieved by applying a Gasoline Particulate Filter (GPF)

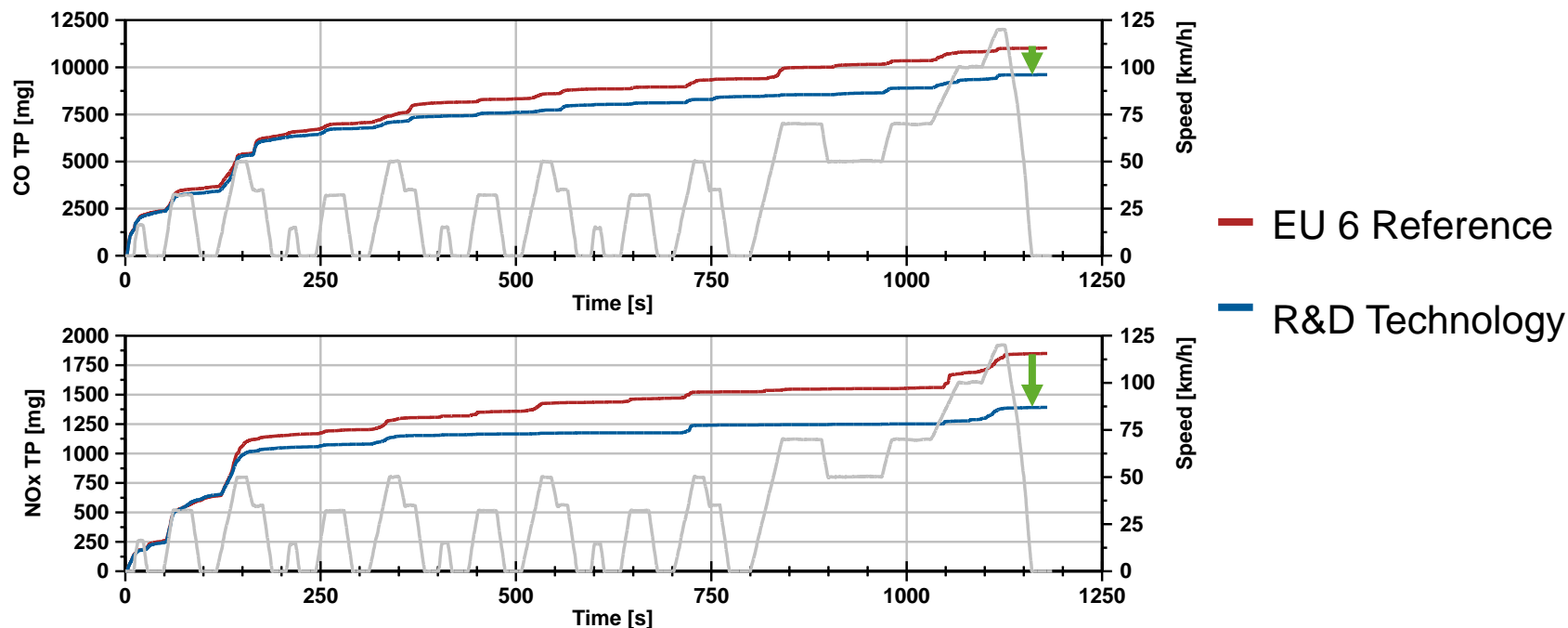
Market Introduction will take place in Europe within the next months to cope with the challenging PN-limits in Europe.

Development Criteria for GPF



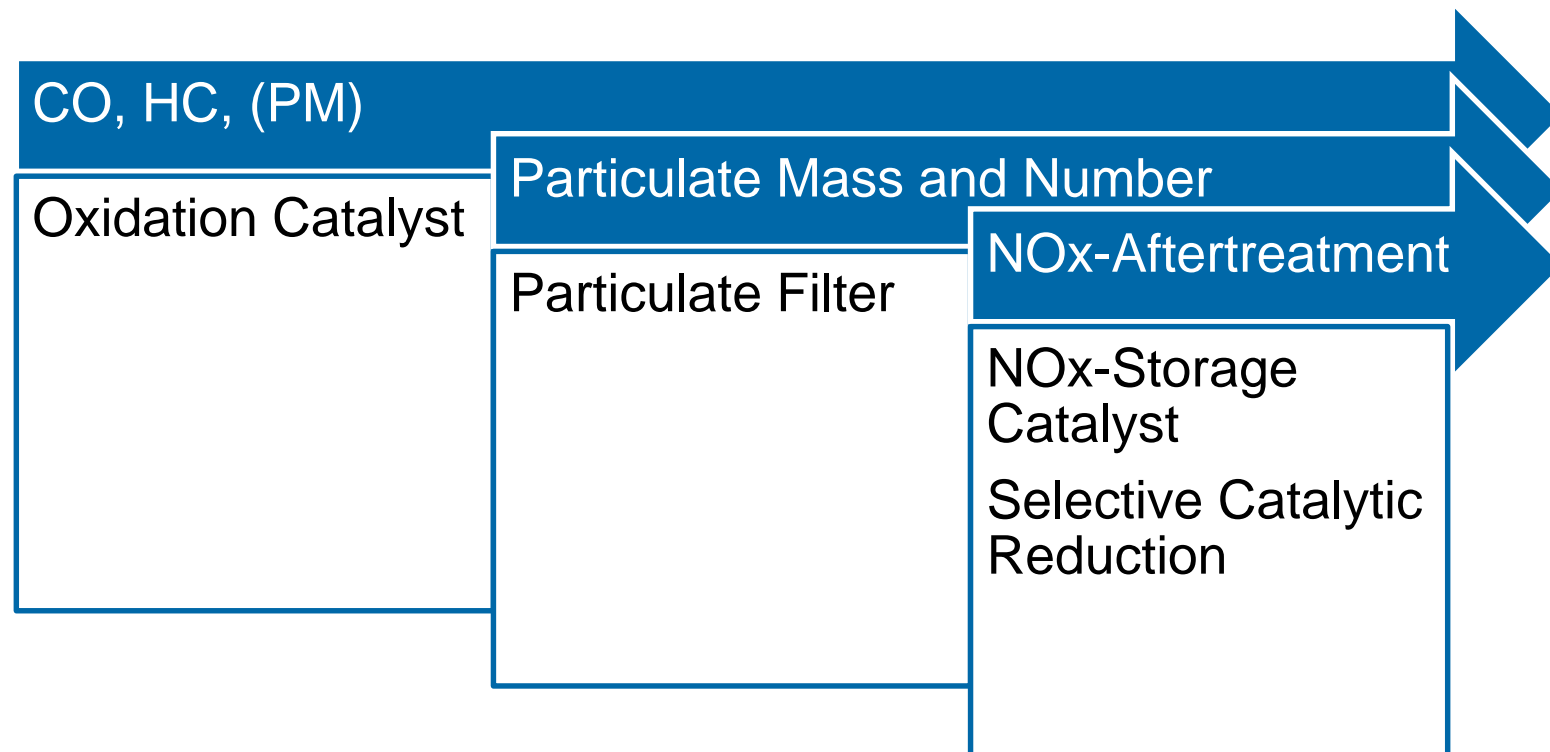
And ... the TWC is still not a commodity....

New Technologies help to improve air quality



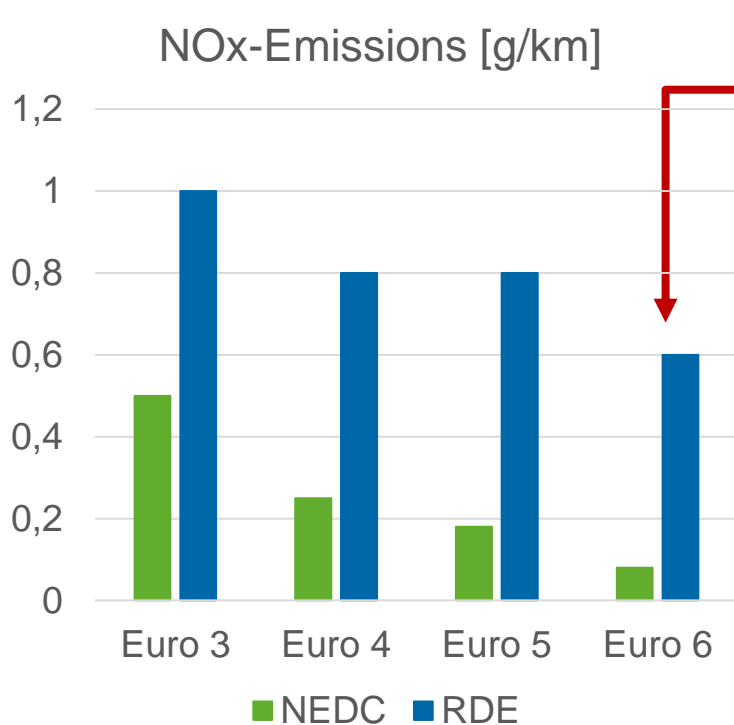
$\lambda > 1$ - Concepts for Passenger Cars

-Diesel And Lean Gasoline Powertrains -



Diesel powered passenger cars

Comparison Test Cycle vs Real Driving Emissions



NOx-Emissions are the major topic for diesel powered vehicles in Europe.

Reduction of particulate matter (in mass as well as in number) has been achieved through the implementation of diesel particulate filters (DPF)

Question:

How can we reduce NOx-emissions to improve urban air quality under various test conditions

Proof-of-Concept for EU 6d

A System Design Study

System “SCR”



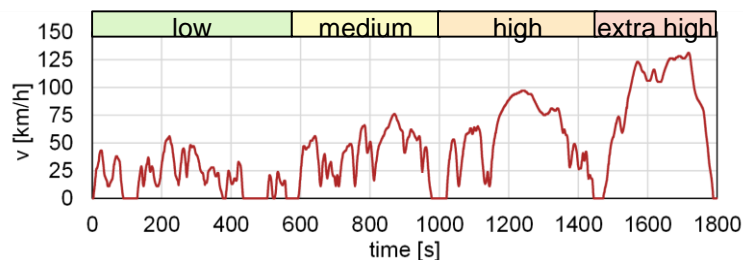
Boundary Conditions

- 2,0l EU6 HP&LP-EGR Engine
- High Dynamic Engine Bench
- Aged Catalysts
- NOx-Storage Catalyst (NSC)
 - Catalyst Volume: 1.65 L
- Selective Catalytic Reduction (SCR)
 - Catalyst Volume: 3.8 L
 - Aqueous Urea Dosing starting at 160°C

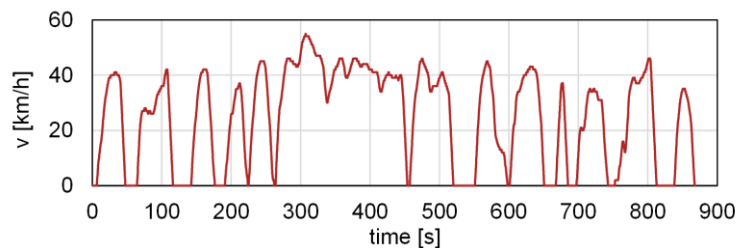
A System Design Study / EU 6d

Applied Test Cycles on the Engine Bench

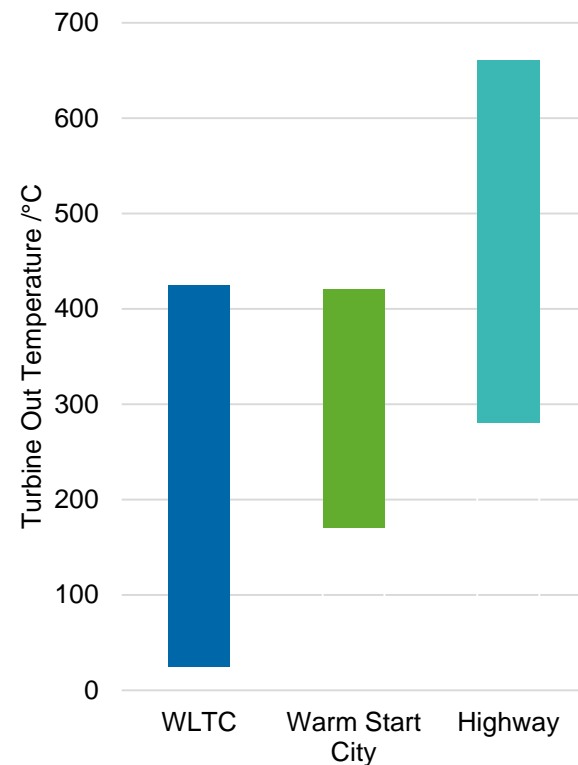
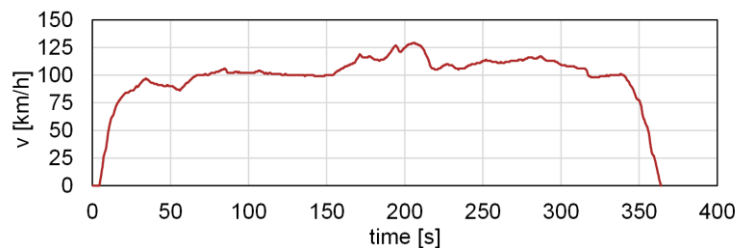
WLTC



Warm Start
City Driving

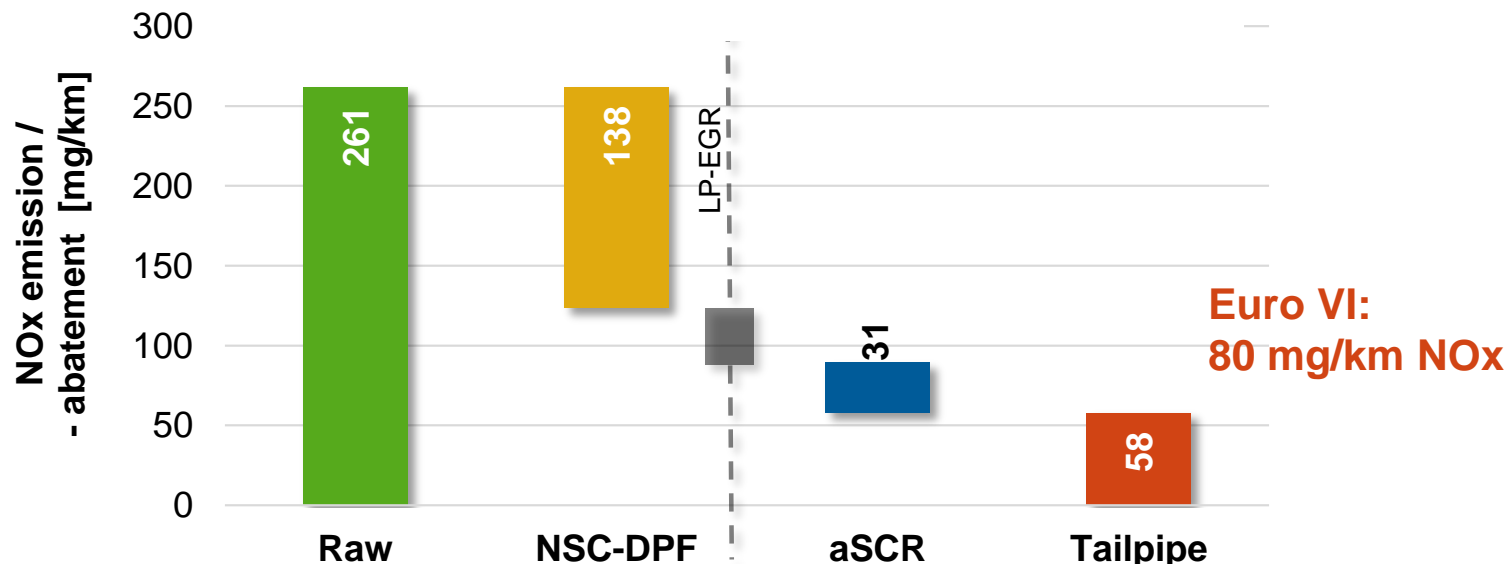


Highway



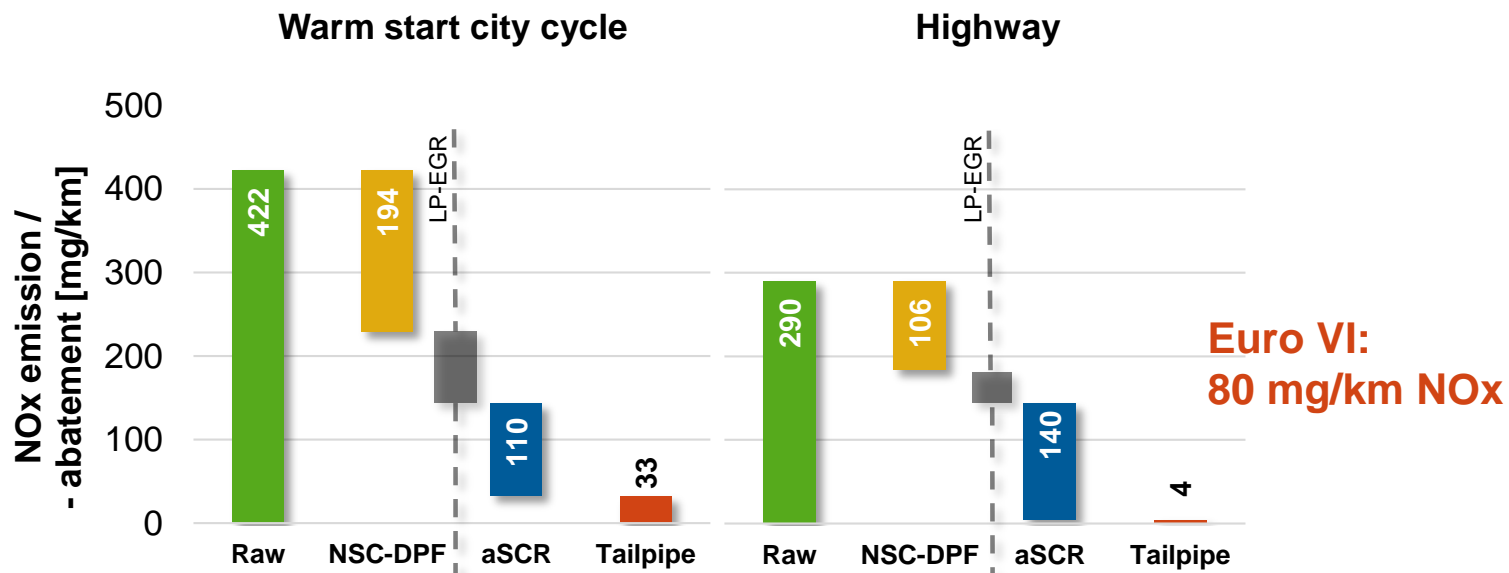
Test Result / NOx-Emission

WLTC – SCR System



Test Result / NOx-Emission

Warm Start City and Highway Driving / SCR System



Summary and Outlook

Within the EU 6d legislation PM and PN are addressed by coated filters with an active regeneration strategy

The improvement of the air quality with respect to NO_x can be solved by using a NSC combined with a coated filter and an active SCR catalyst using urea injection.

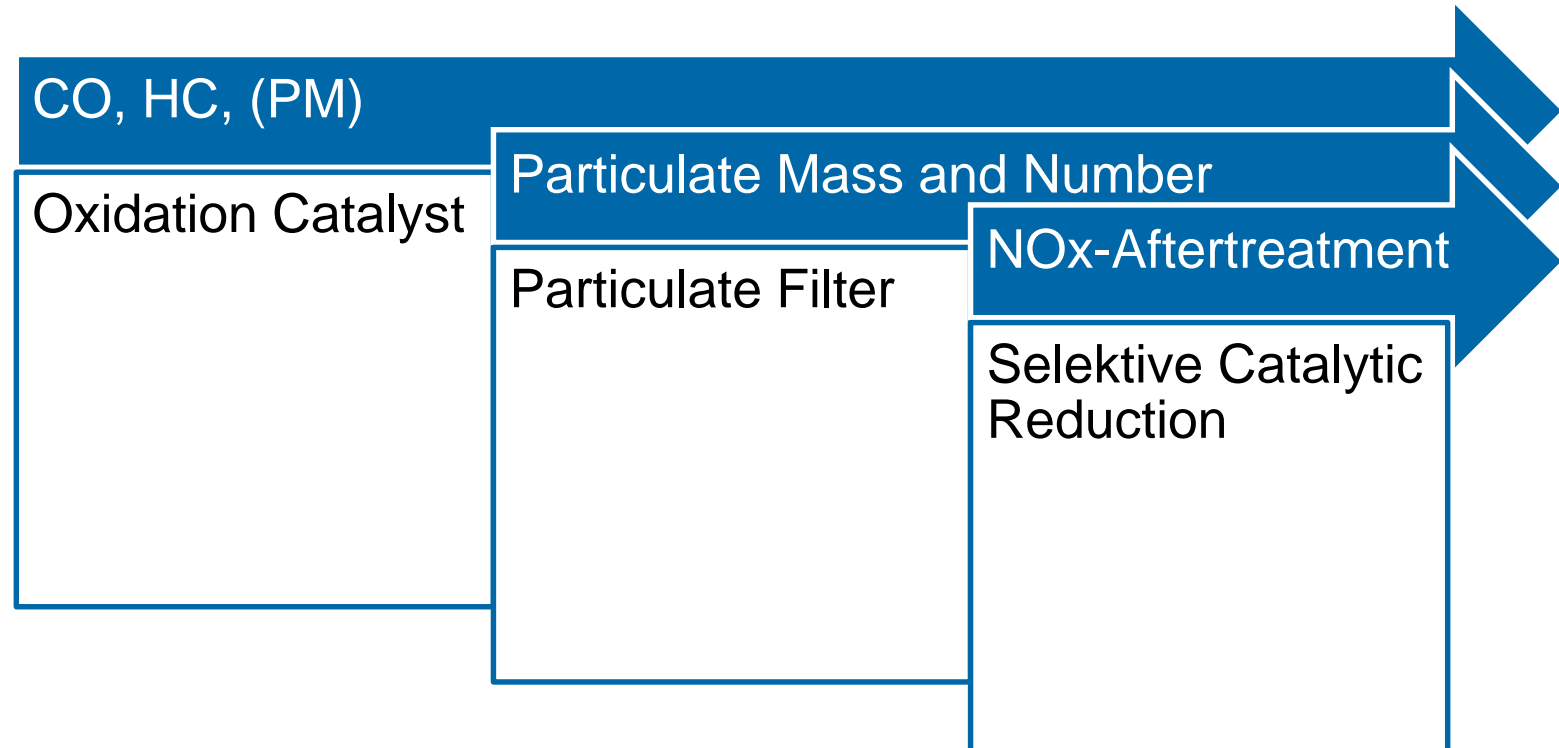
The technologies are developed and in commercial use.

Extension of this study using RDE-cycles is on the way

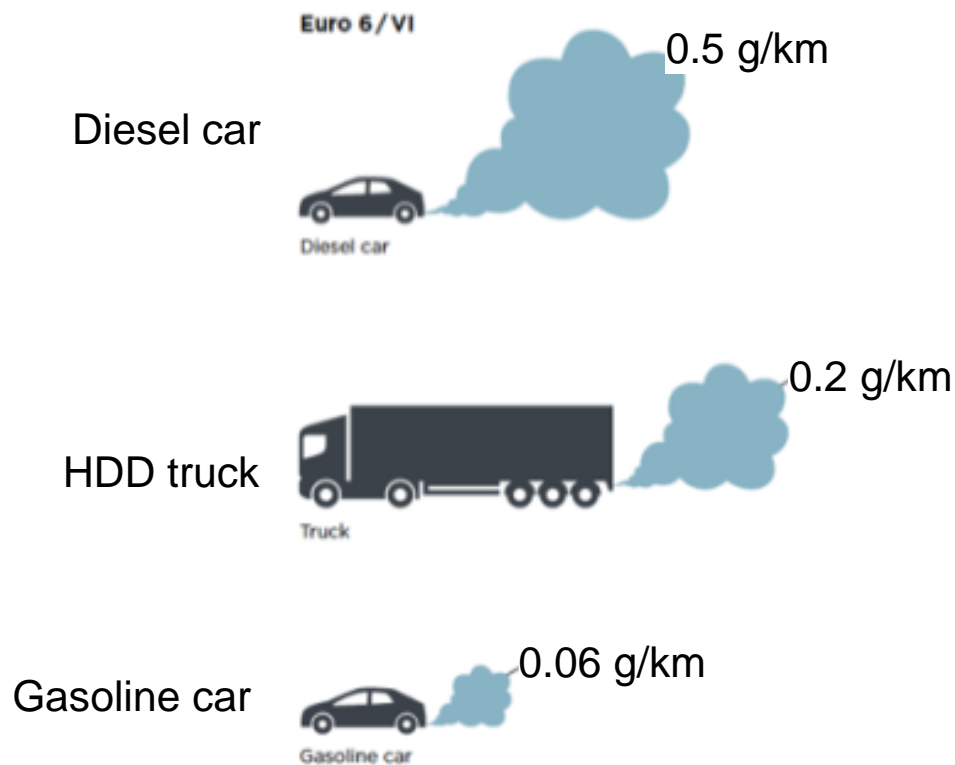
As a first step towards a cleaner urban air diesel passenger cars can be equipped with a DOC and (SCR or DOC) coated filter combined with an active SCR catalyst.

This approach can be designed to be more tolerant towards higher fuel sulfur levels.

$\lambda > 1$ - Concepts for Heavy Duty Diesel -Diesel Powertrains -

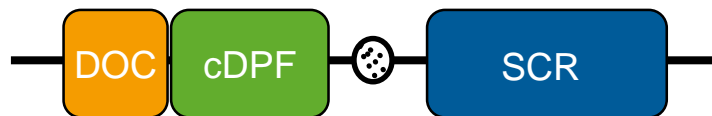


Real World Emissions - Euro 6 / VI -HDD vs Diesel and Gasoline Passenger Car-



System Configuration of HDD

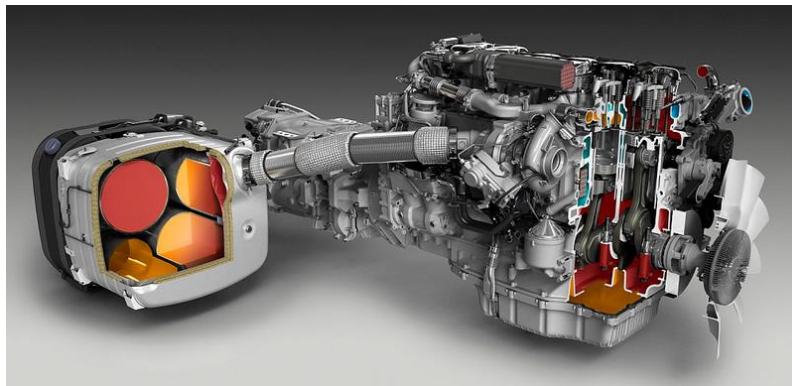
System Layout



Challenges for HDD

- Durability/Robustness
- Fuel Quality (esp sulfur level)

Scania Euro VI Layout



<http://www.greencarcongress.com/2011/04/scania-20110402.html>

And what else should be
considered

Important Parameters for Emission Control

Vehicle and Engine

- Exhaust Gas Temperature, Composition and Mass Flow

Coating

- Active Component, Washcoat Loading, Washcoat Composition

Substrate

- Material, Volume, Cell Density and Wall Thickness

Converter / Canning

- Fluid Dynamics

Fuels and Lube Oil

- Catalyst Poisons

Motor Management

- Possibilities

Maintenance and Inspection

materials for a better life

Clean air is our business

Thank you very much for your
attention!