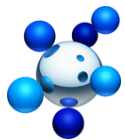


# ***The Potential of GTL Diesel to Meet Future Exhaust Emission Limits***

*Paul Schaberg, Sasol Technology*

*12<sup>th</sup> Diesel Engine-Efficiency and Emissions Research Conference,  
Detroit, August 20-24, 2006*

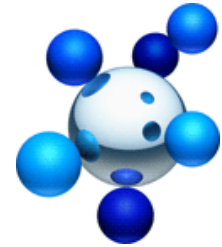


**SASOL**  
*reaching new frontiers*



DAIMLERCHRYSLER

## Co-authors



DaimlerChrysler AG  
Hans-Otto Herrmann  
Stefan Keppeler  
Walter Friess

DAIMLERCHRYSLER

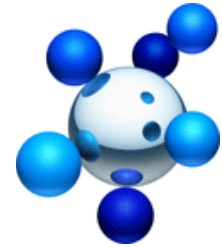
SasolChevron Consulting Ltd  
Mark Schnell



Sasol Technology  
Johan Botha



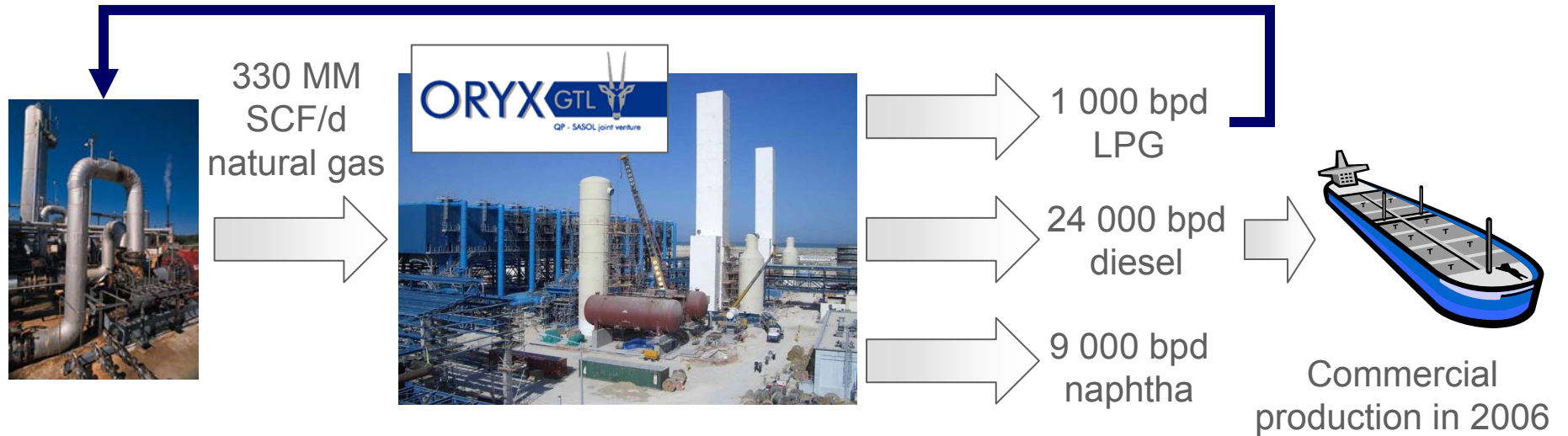
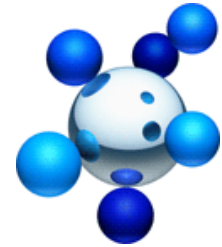
## ***Presentation overview***



- *Status and availability of GTL diesel fuel*
- *Impact of GTL diesel fuel on performance and emissions*
  - *Without engine modifications*
  - *With software adaptation*
  - *With hardware adaptation*
- *GTL Demonstration Vehicle*
- *Conclusions*

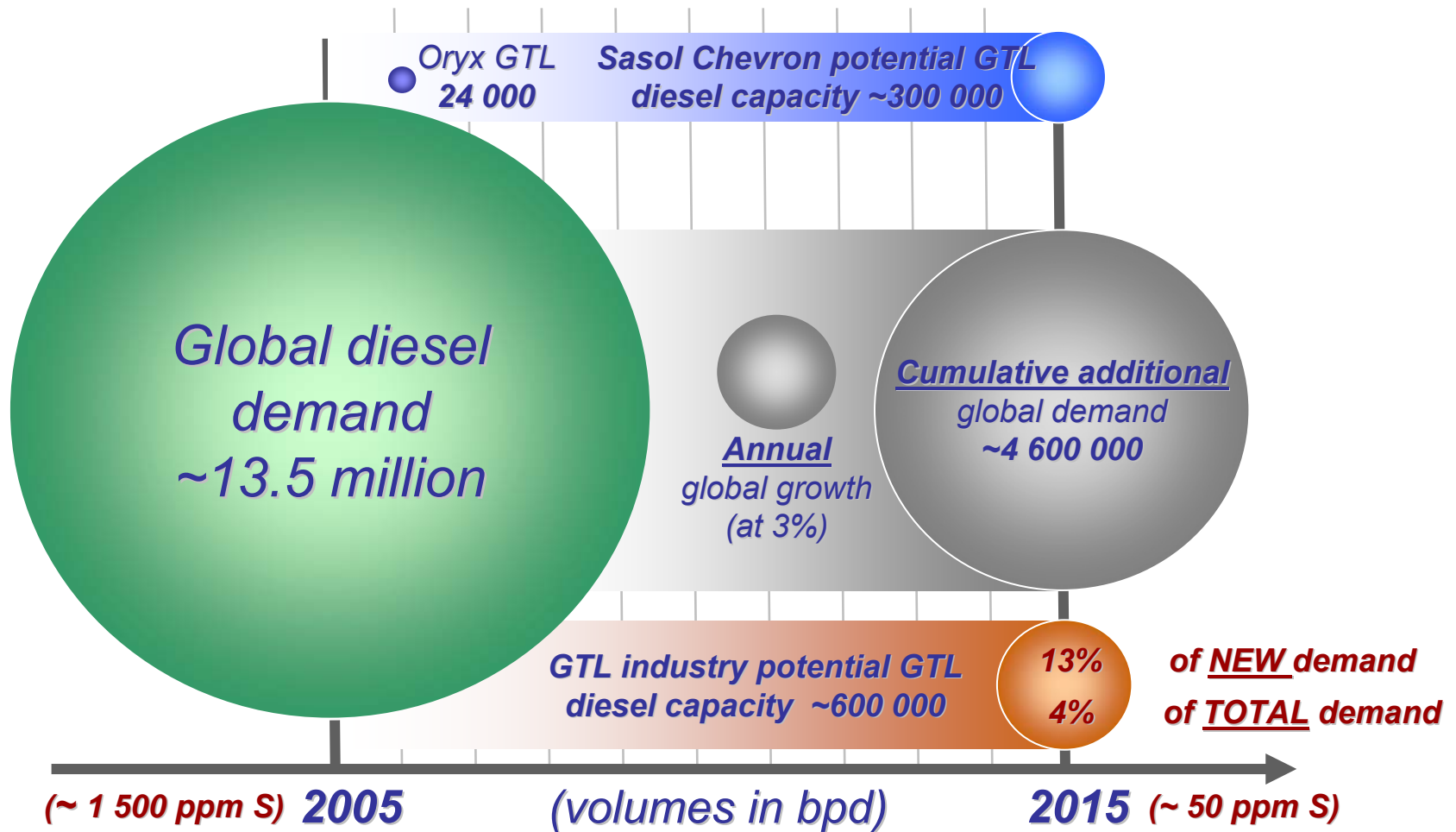
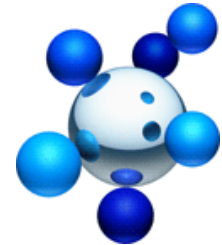
# GTL diesel fuel production

## Oryx GTL, Qatar

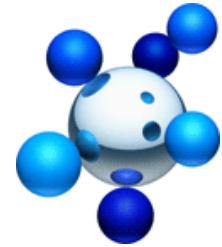


# GTL diesel Fuel

## Meeting diesel demand growth



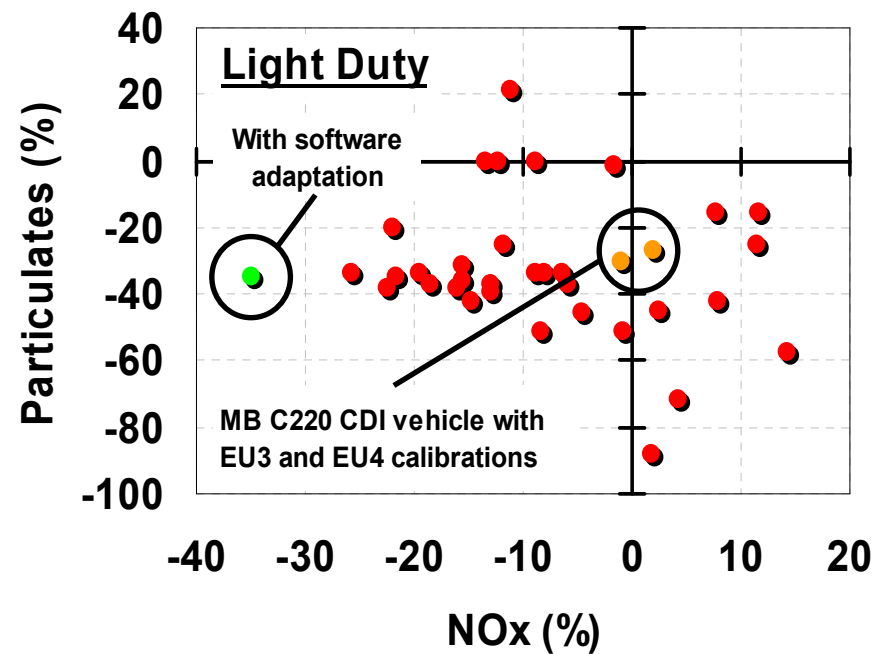
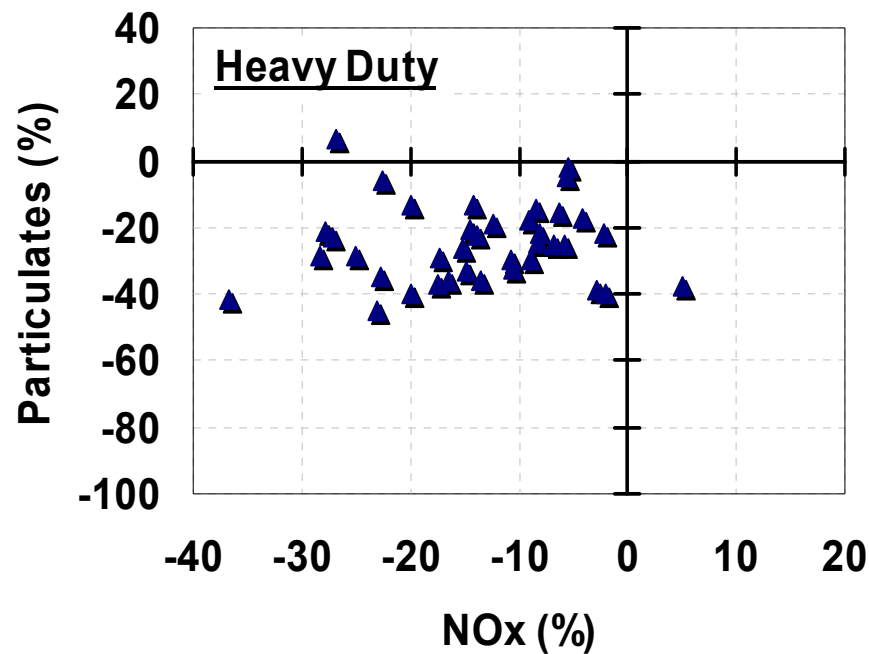
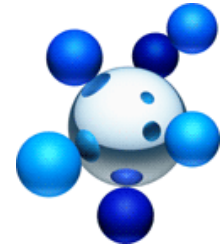
# ***Properties of SasolChevron GTL diesel fuel***



- *Clear, almost odourless liquid*
- *Highly paraffinic (total aromatic content <1%, polycyclic aromatic content < 0.05%)*
  - *Density ~ 0.77 kg/l*
  - *H/C ratio ~ 2.10 mol/mol*
  - *Energy content ~ 47.1 MJ/kg*
  - *Cetane number >>70*
- *Very low sulphur (< 1ppm)*
- *Good thermal stability*



# Impact of GTL diesel fuel on performance and emissions : Review



*Potential reductions in all regulated emissions (HC, CO, NO<sub>x</sub>, PM), as well as in CO<sub>2</sub> and other unregulated emissions*

# Impact of GTL diesel fuel on engine performance and emissions



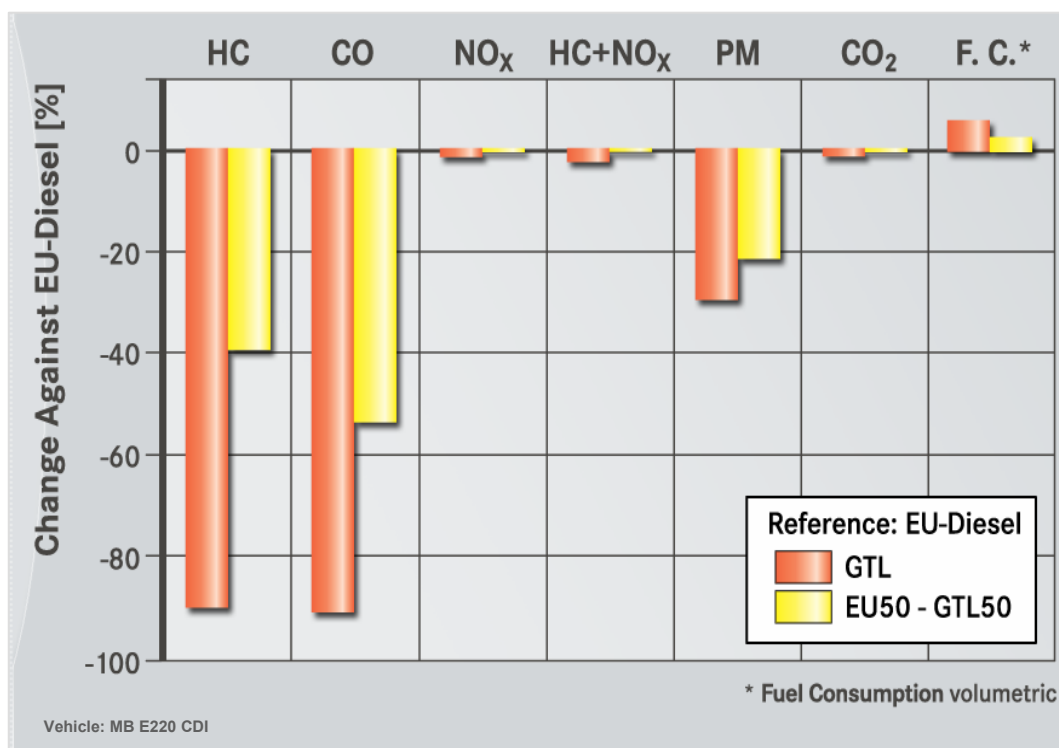
No engine modifications



- HC reduction potential 90%
- CO reduction potential 90%
- PM reduction potential 35%



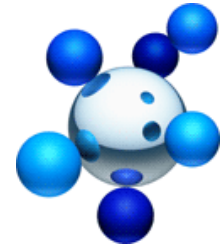
- Limited NO<sub>x</sub>-reduction
- Slightly reduced power
- Higher volumetric fuel consumption



***GTL diesel fuel offers high emission reduction potential for non-adapted engines. These benefits can be utilized in existing vehicle fleet.***



# Impact of GTL diesel fuel on engine performance and emissions



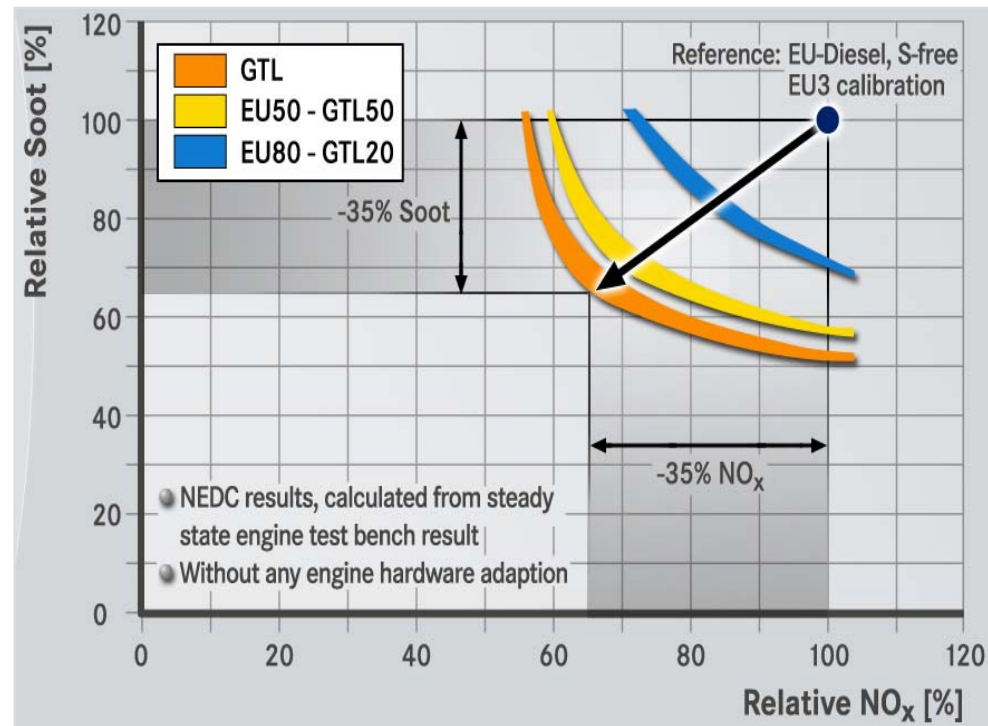
## Software adaptation only



- Simultaneous particulate and NO<sub>x</sub> reduction of up to 35%



- Must still meet emission limits with conventional diesel
- Higher volumetric fuel consumption



*Software adaptation would facilitate NO<sub>x</sub> reduction from engines operated with GTL diesel fuel. However, potential is limited by certification requirements.*

# Impact of GTL diesel fuel on engine performance and emissions



Hardware and software adaptation

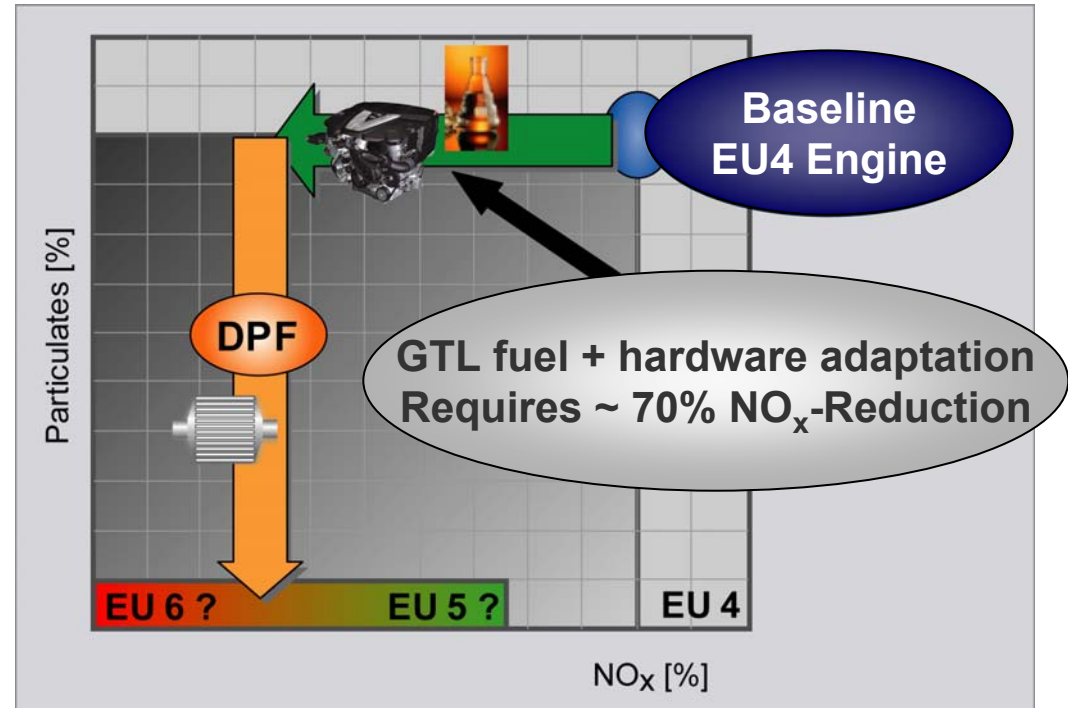


- Potential to reduce all engine-out emissions
- No power loss
- Reduced overall cost



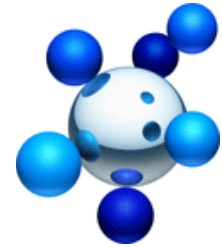
- Dedicated engine
- Requires new standard to utilize full potential

Project Target: 0.08 g/km NO<sub>x</sub> (NEDC) without active NO<sub>x</sub> aftertreatment



Hardware adaptation offers maximum potential to reduce emissions at lower cost. This scenario requires dedicated GTL engines.

# ***Engine and vehicle data***



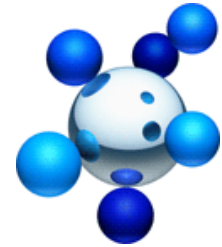
## **Vehicle details : Mercedes Benz E320 CDI**

<i>Model year</i>	: 2005
<i>Gearbox</i>	: 7-speed automatic transmission
<i>Emission status</i>	: EU 4 (baseline)
<i>Emission test cycle</i>	: New European Driving Cycle NEDC 2000
<i>Vehicle weight class</i>	: 4000 lbs

## **Engine details : Mercedes Benz OM642**

<i>Configuration</i>	: 3 litre, 6 cylinders, 72 degree V
<i>Compression ratio</i>	: 18:1 (baseline)
<i>Fuel management</i>	: Common rail, direct injection, piezo injectors, 1600 bar peak pressure
<i>Air management</i>	: VGT turbocharged, intercooled
<i>Emission control</i>	: Cooled EGR, inlet swirl control, closed coupled DOC, DPF
<i>Rated torque</i>	: 510 Nm from 1600 to 2800 rev/min
<i>Rated power</i>	: 165 kW at 3600 rev/min

# Hardware optimization strategy

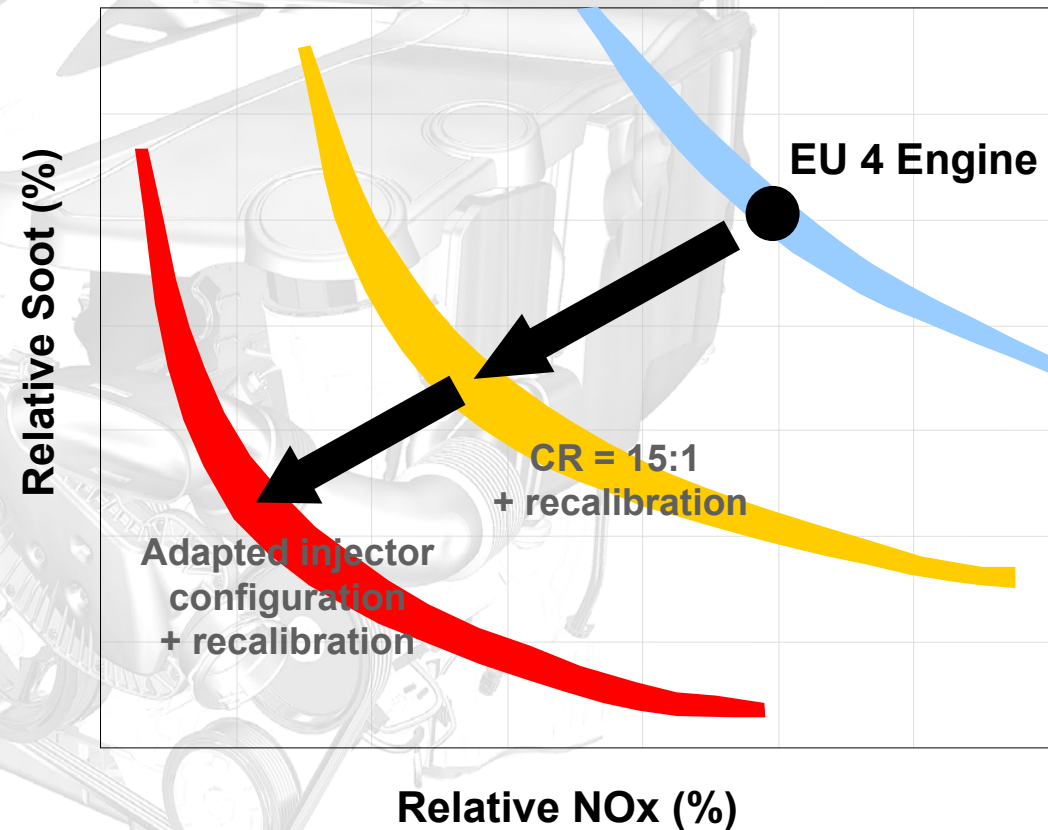


**Two-step hardware optimization strategy:**

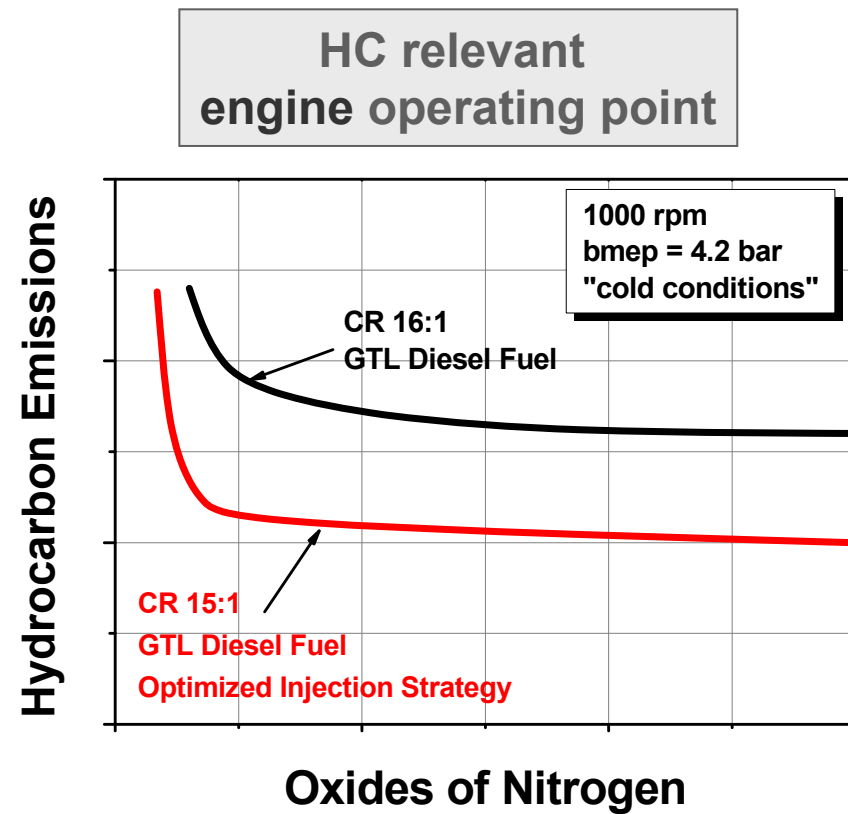
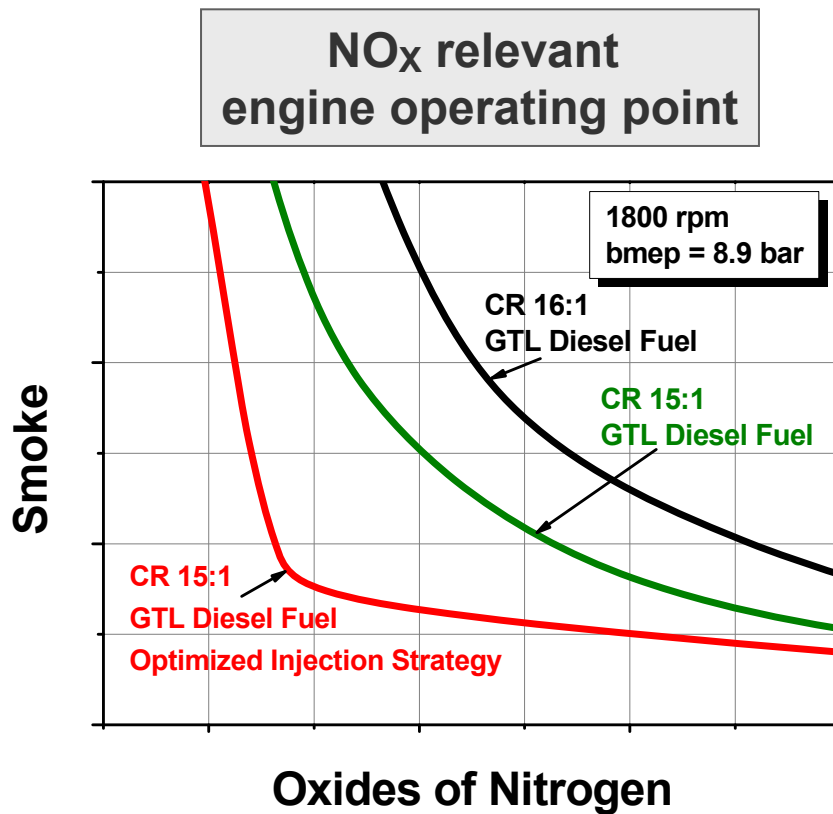
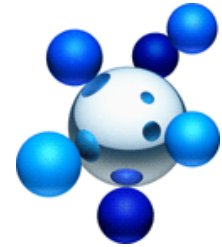
**Step 1:** Reduction of compression ratio (CR=15:1)

**Step 2:** Adaptation of injector parameters

*Due to availability of a DPF, main focus of engine optimization was reduction of nitrogen oxide emissions*

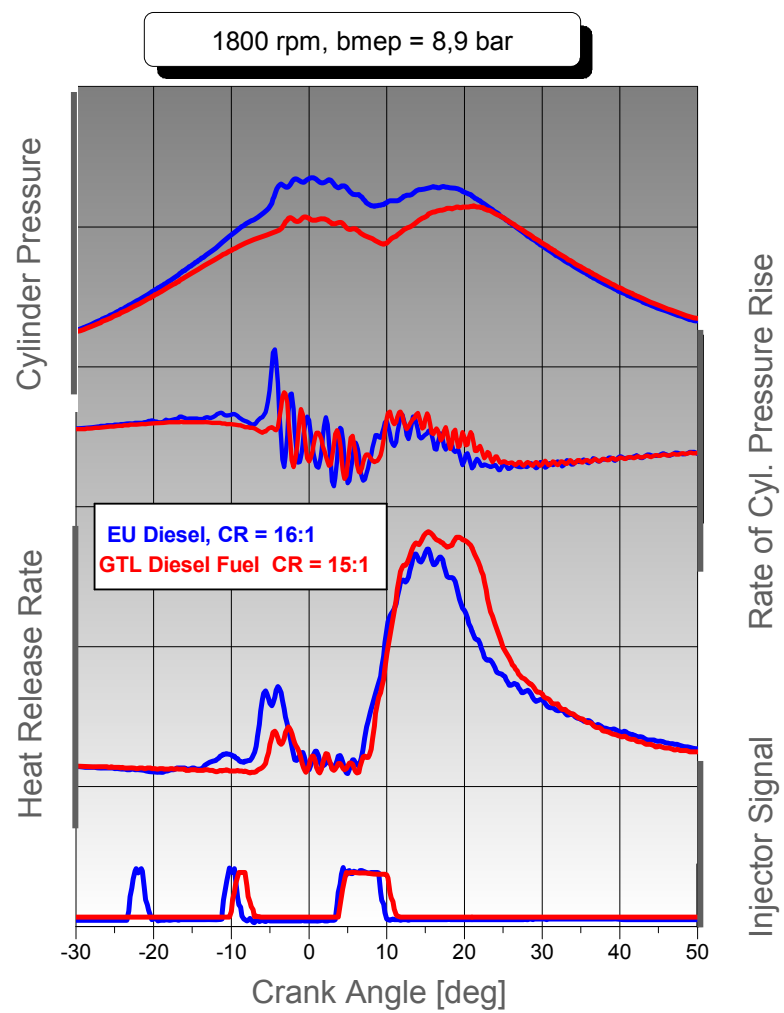
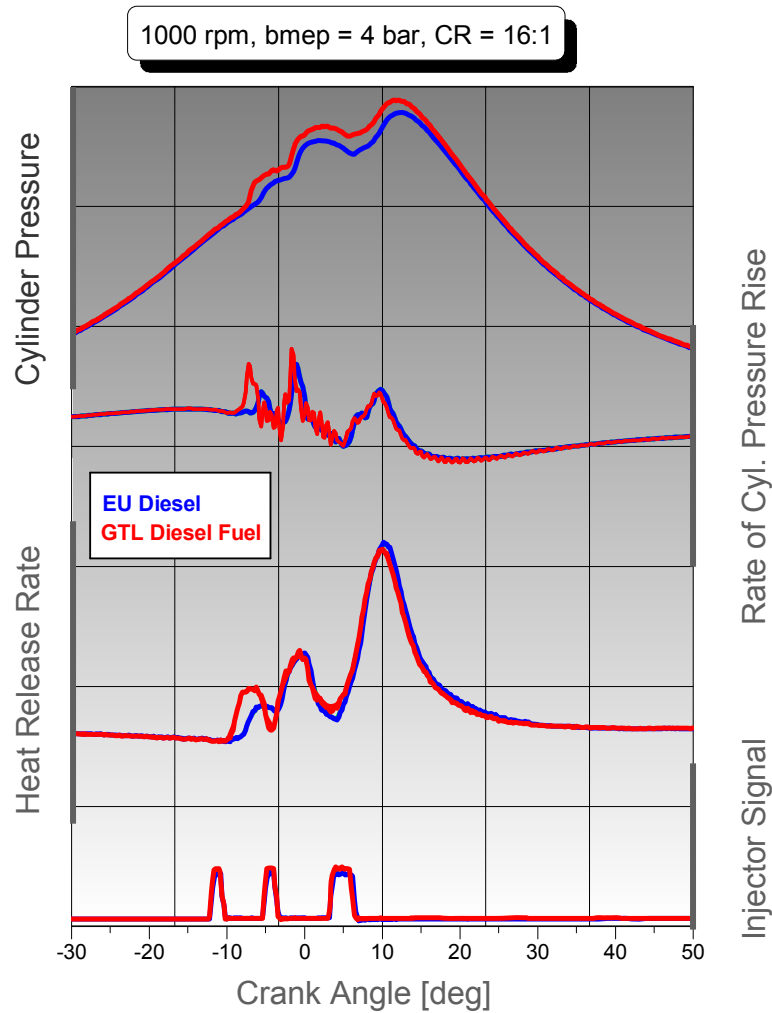
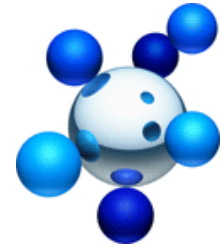


# Impact of compression ratio on emissions

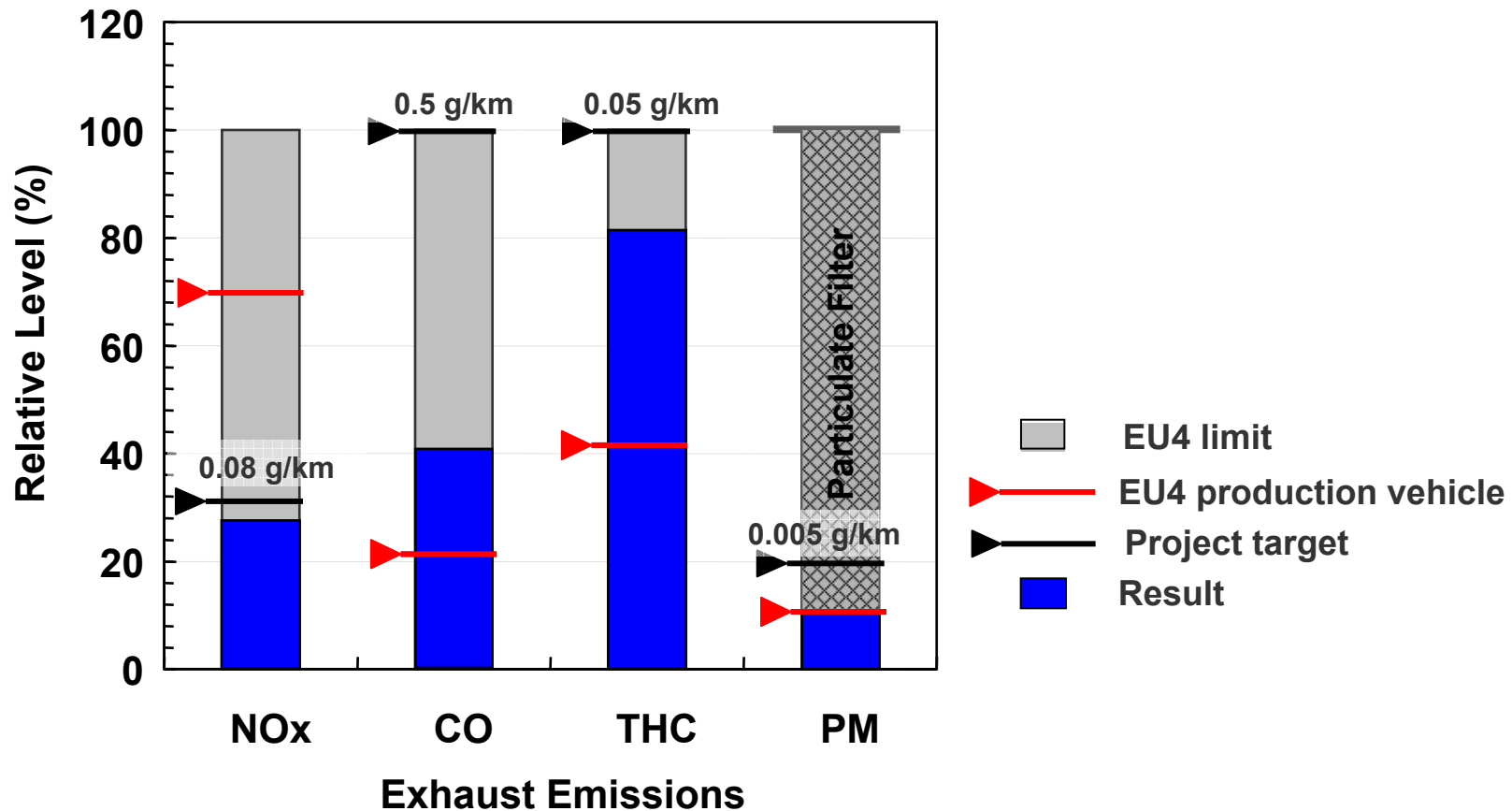
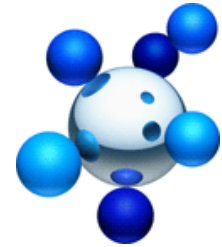


*GTL diesel fuel + compression ratio reduction offers significant improvement potential for NO<sub>x</sub> at higher load, while maintaining low HC emissions at low temperature operating conditions*

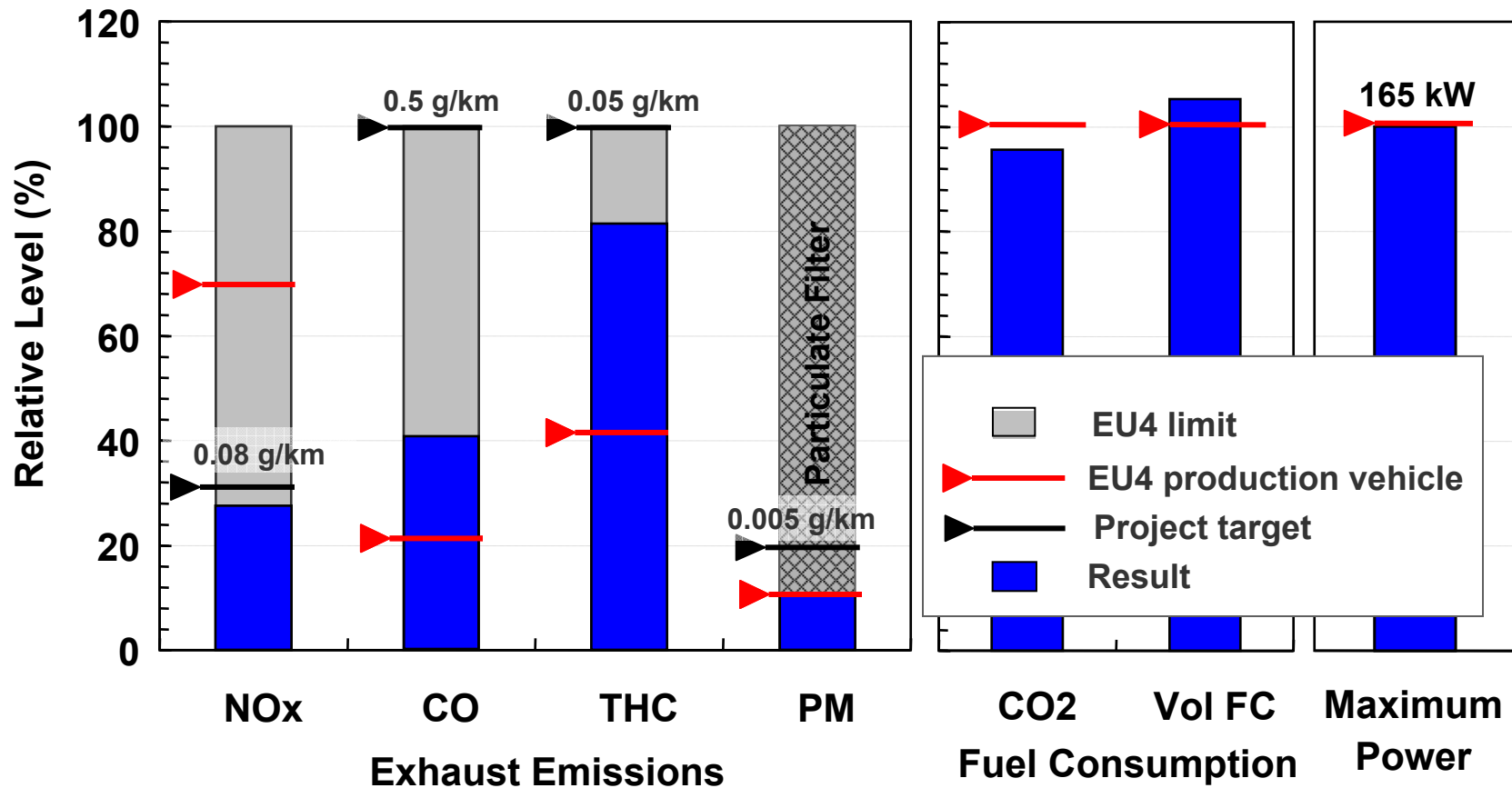
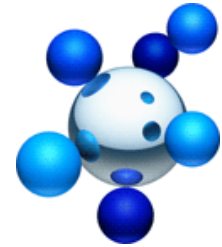
# Impact of GTL diesel fuel on combustion parameters



# GTL Demonstration Vehicle Emissions and performance



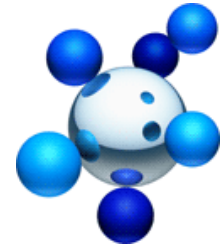
# GTL Demonstration Vehicle Emissions and performance



*Project emission targets were achieved without compromising maximum power or energy efficiency.*



# Conclusions



- *GTL diesel fuel is an enabler for cost-efficient reductions in exhaust emissions*
- *Engine efficiency and performance need not be compromised by the adaptation for GTL diesel fuel.*
- *The results corroborate that clean fuels are one means to comply with future, more stringent emission regulations in a cost-effective manner.*
- *Potential future development of such dedicated “GTL diesel engines” will be determined by the widespread availability and the cost of GTL diesel fuels. Also, a standard for such fuels would have to be developed.*

DAIMLERCHRYSLER

