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Lehrstuhl für
Verbrennungskraftmaschinen
Prof. Dr. Rudolf Flierl

diesel-CNG-mixed combustion

Benefits of simultaneous Combustion of Diesel and Compressed natural Gas

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Gliederung des Vortrags

1 Gas-Diesel-Combustion

- Motivation
- System
- Targets

2 Results of Diesel-CNG-Mixed Combustion of a Euro3-Nfz-Engine

3 Results of a modern Commonrail-V6-Engine

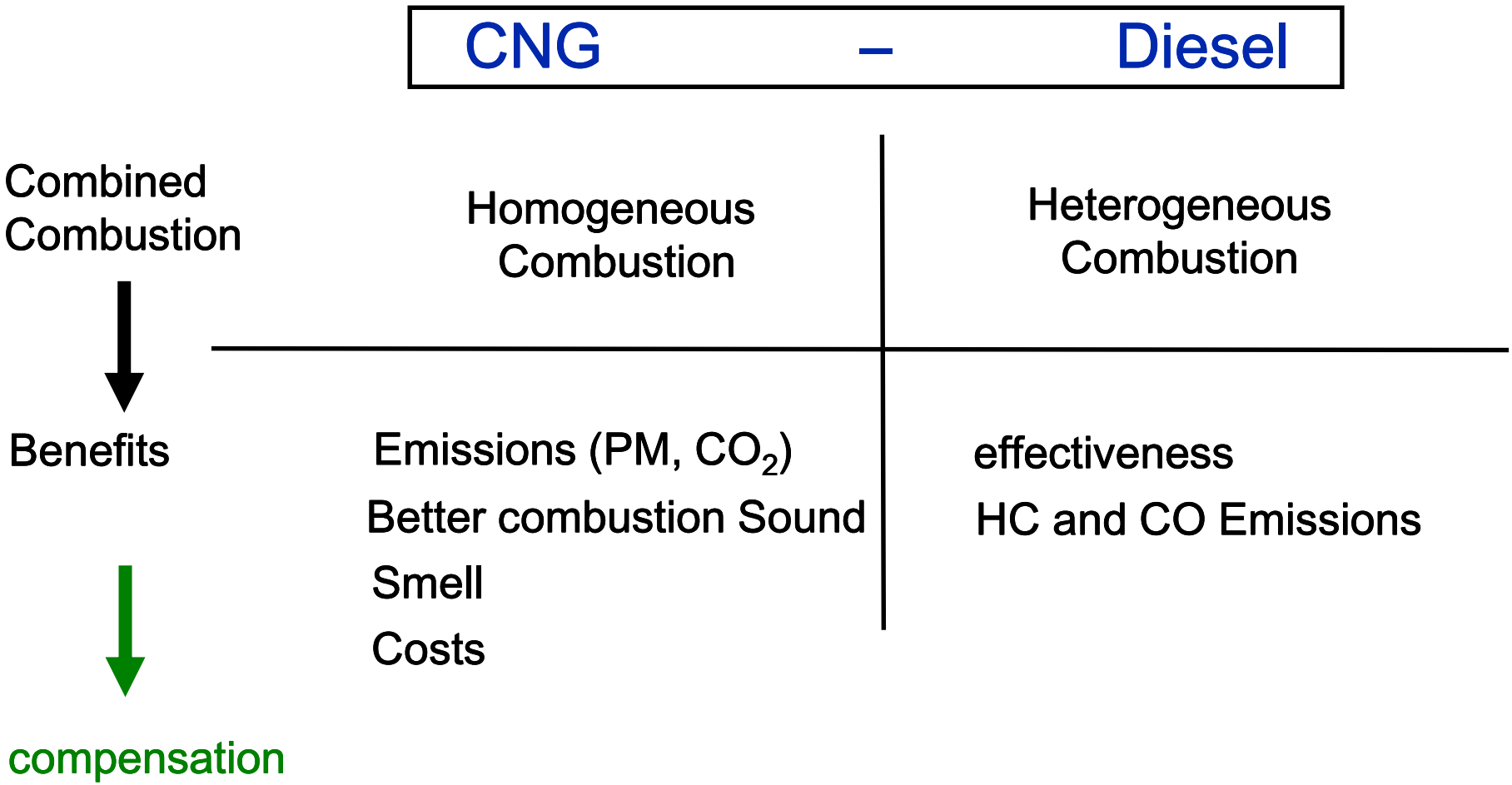
4 Outlook

Diesel-CNG-Mixed Combustion

Benefits of simultaneous Combustion of Diesel and Compressed natural Gas

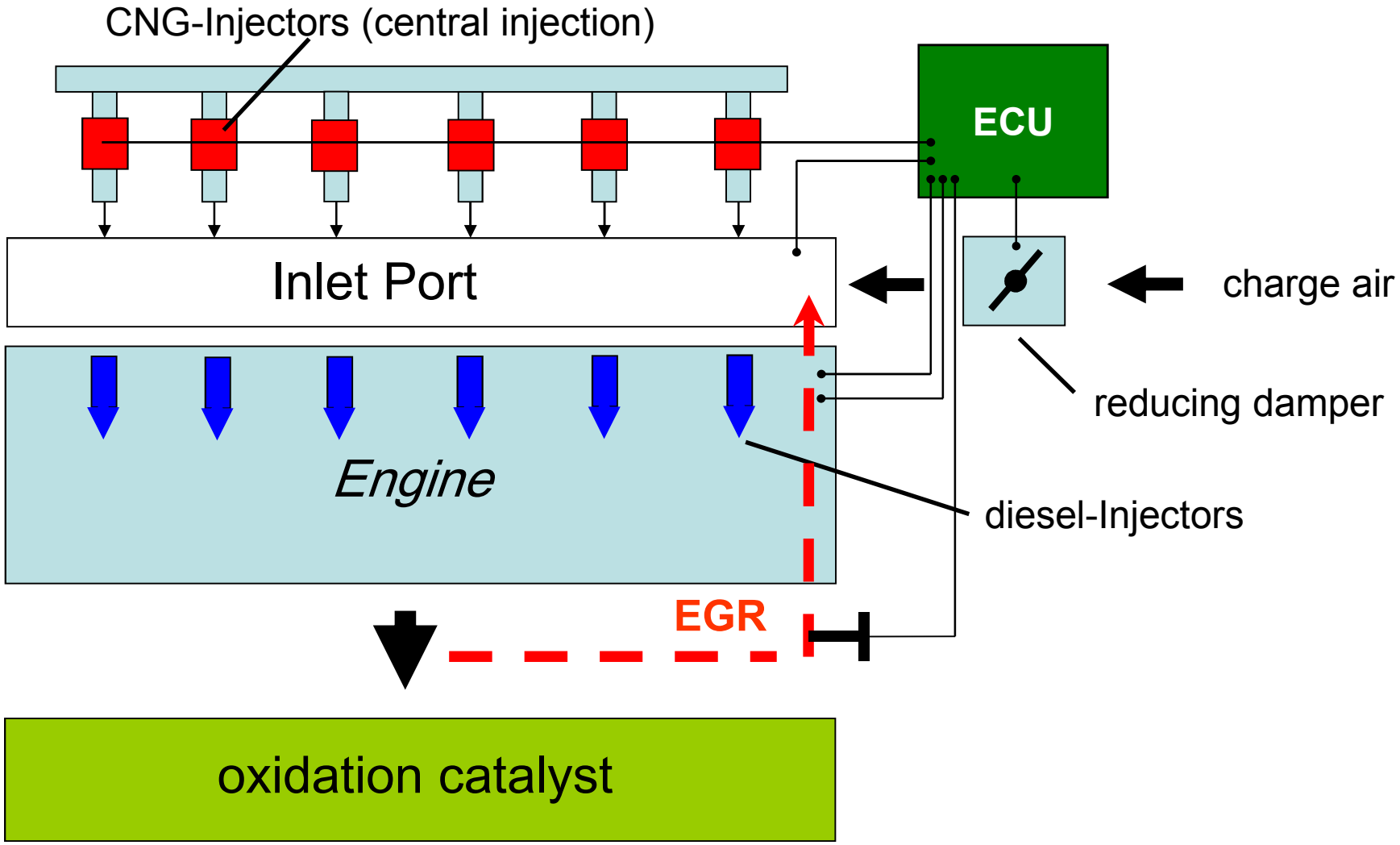
Diesel-CNG-Mixed Combustion

Motivation



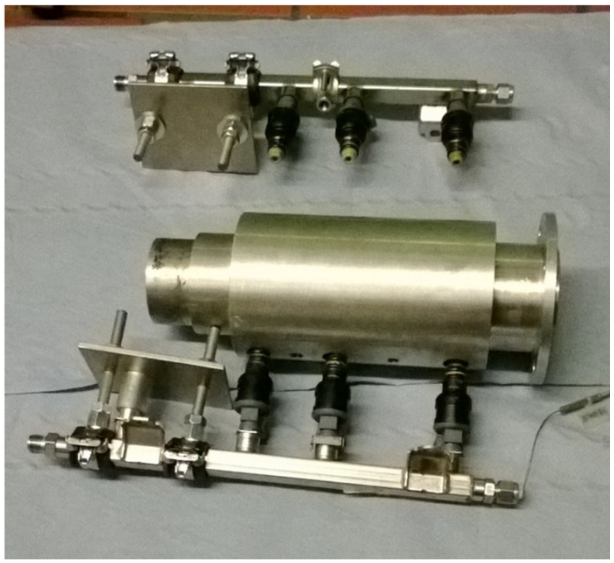
Diesel-CNG-Mixed Combustion

System



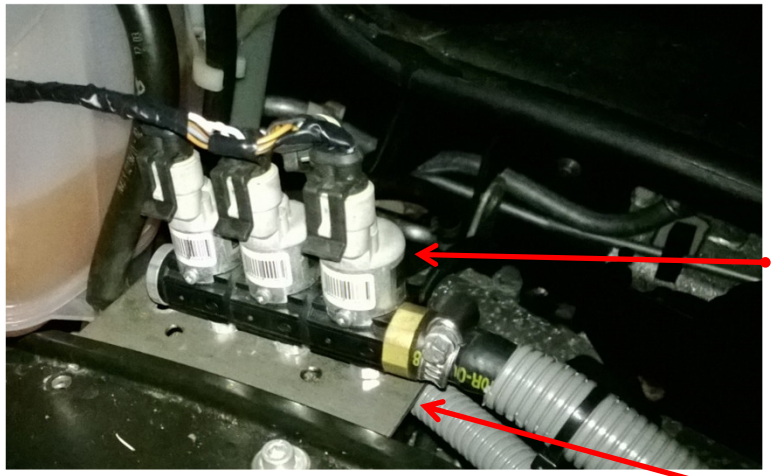
Diesel-CNG-Mixed Combustion

Injector flange



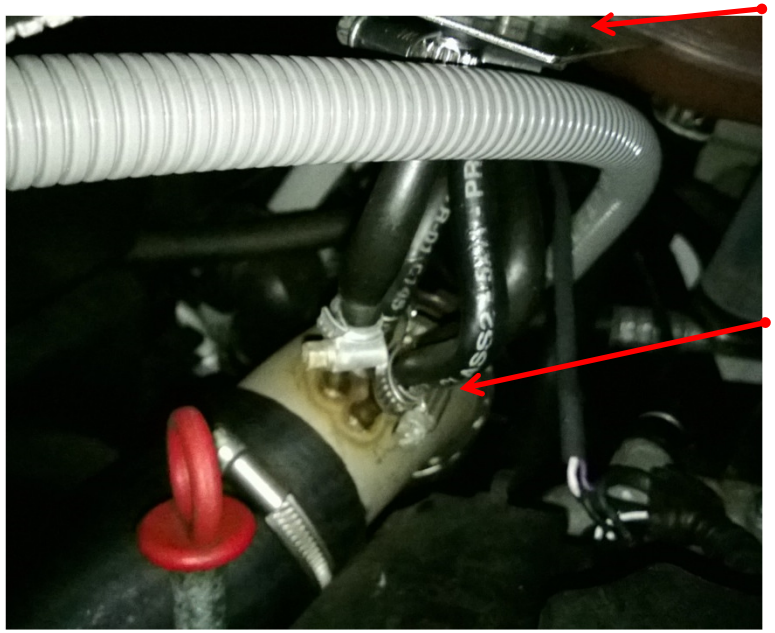
Diesel-CNG-Mixed Combustion

installation example for a central inection into the inlet system



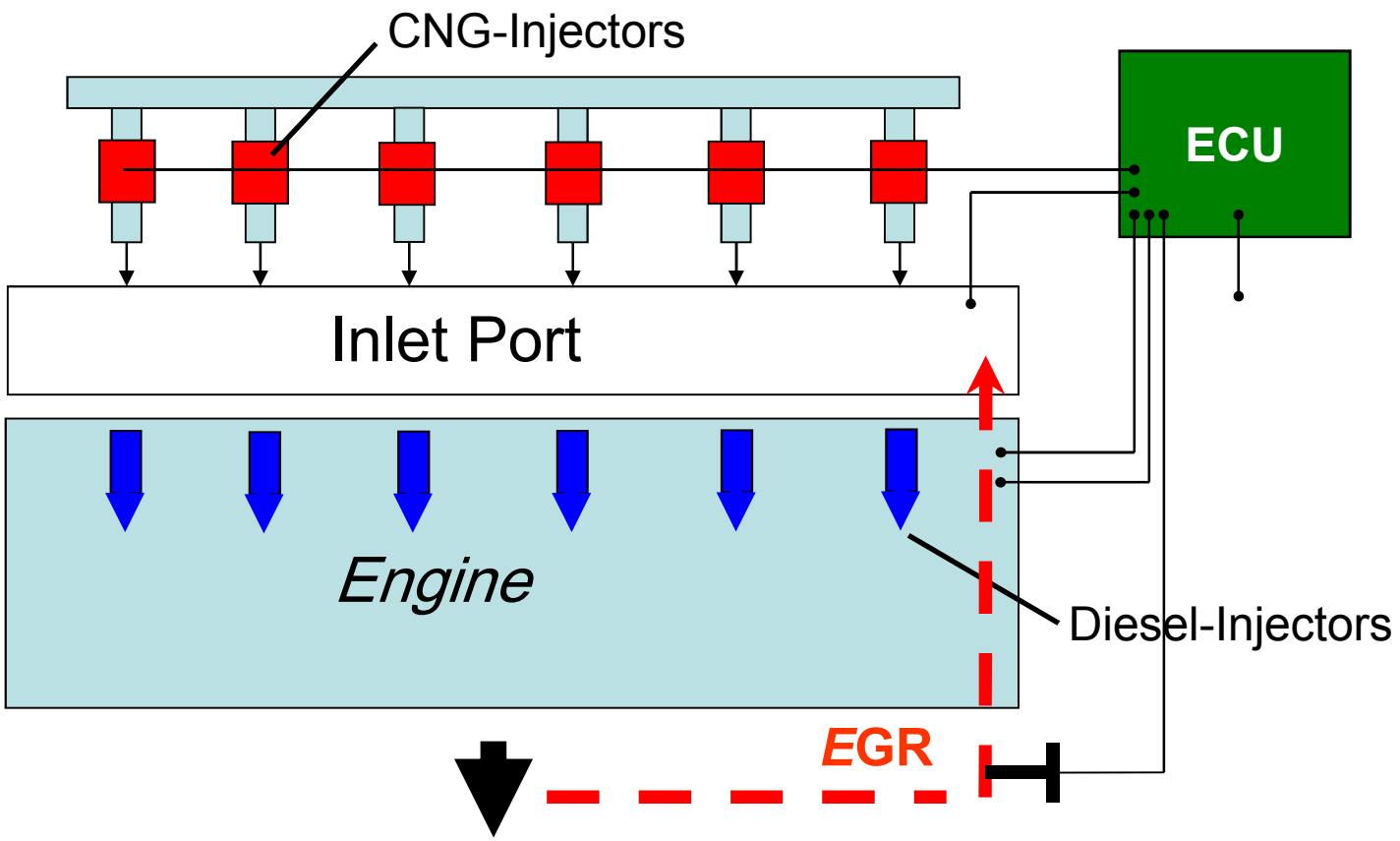
CNG-injector

injector installation platform



Part of the inletsystem – point of central CNG-injection

System



Diesel-CNG-Mixed Combustion

Targets

- **maximise energetic CNG percentage**
- **maximise power efficiency**
- **solid design endurance**
- **maximum reduction of CO2 Emission**
- **Reduce Soot-Emissions**

CR-V6-diesel engine
-
diesel-CNG-mixed combustion

CR-V6-diesel engine with CNG-Diesel

variation: energetic CNG-ratio

VKM

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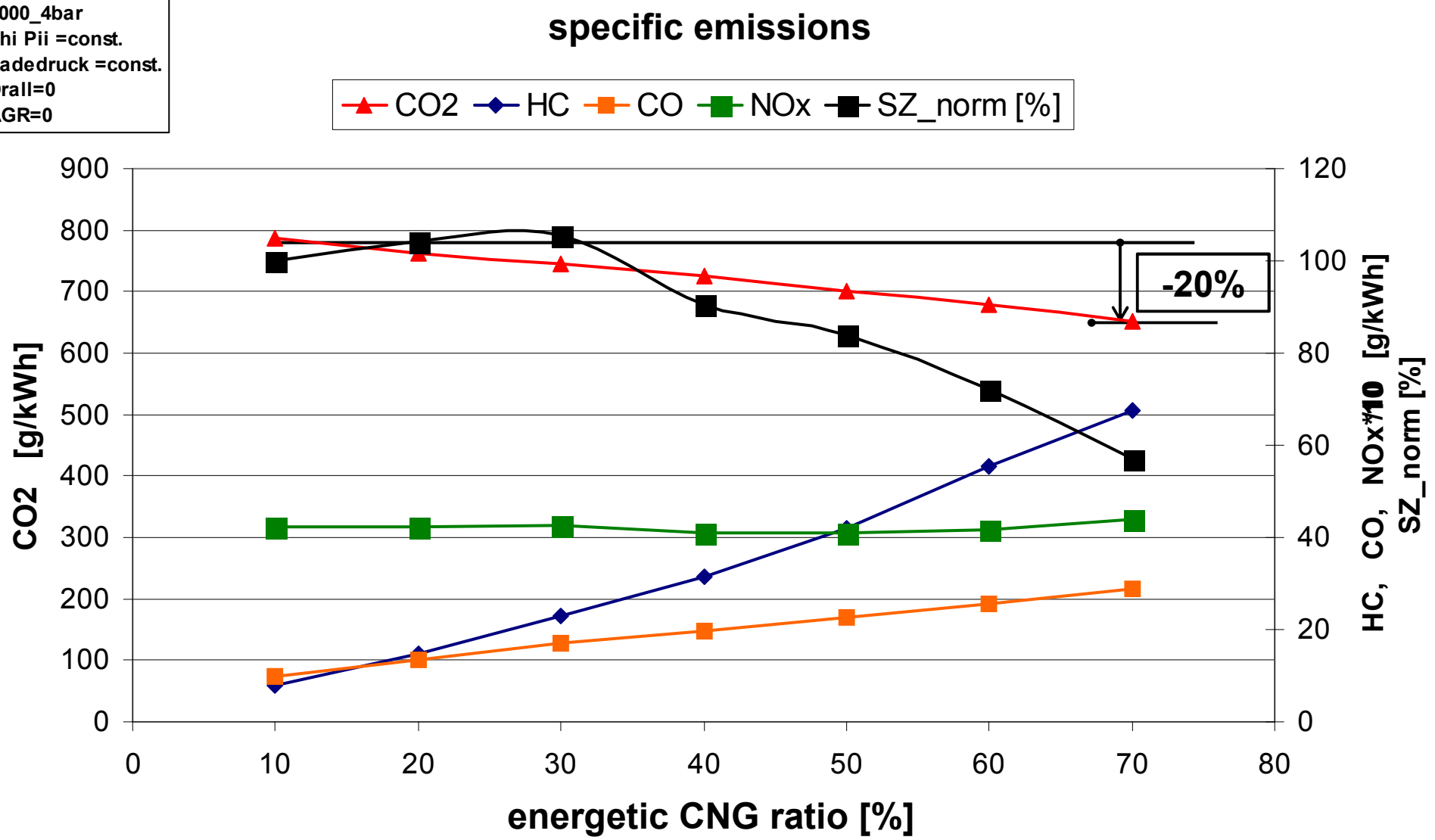
V6 CR-Diesel
2000_4bar
phi Pii =const.
Ladedruck =const.
Drall=0
AGR=0



CR-V6-diesel engine with CNG-Diesel

Variation: combustion-air ratio VTG+DK vs DK

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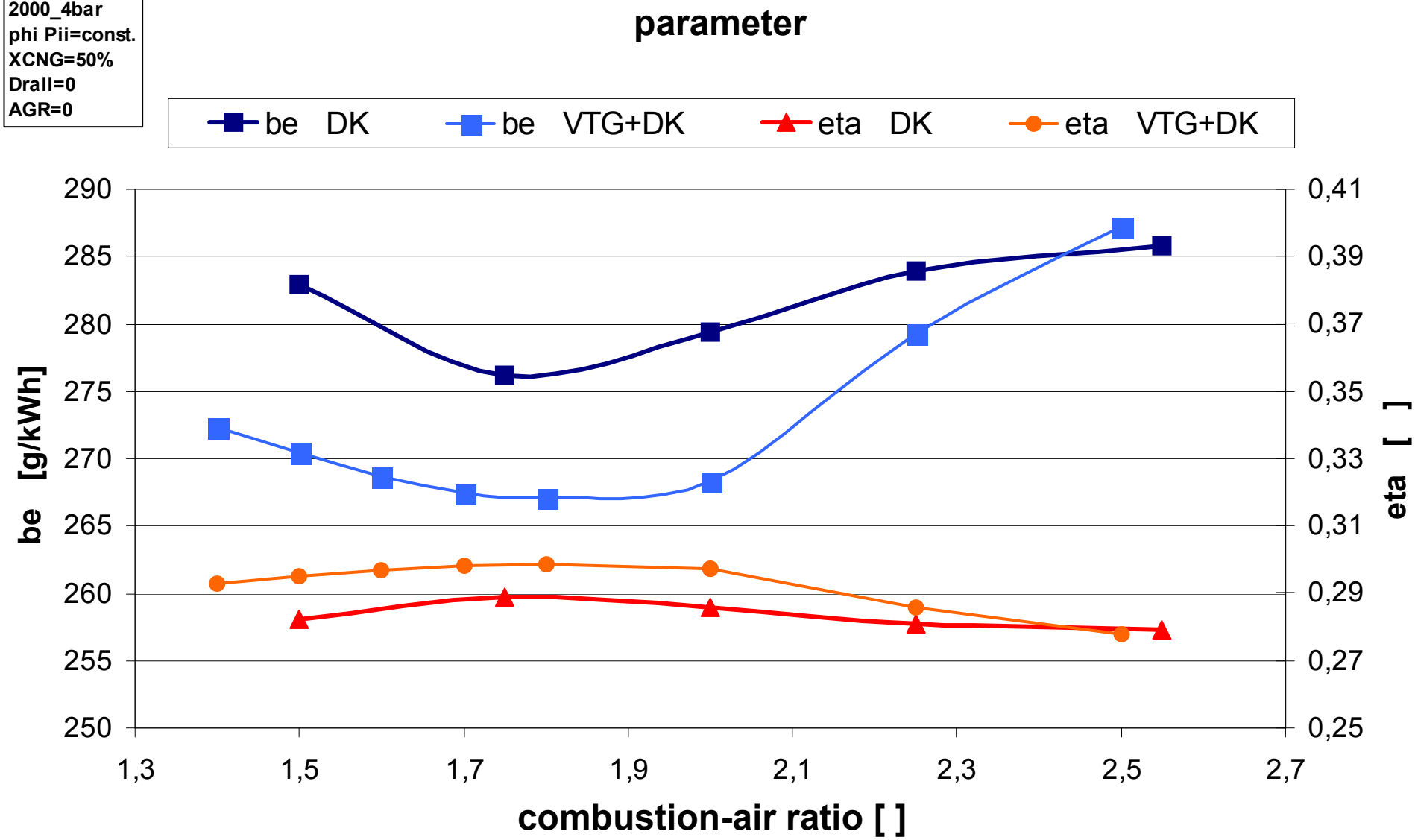
V6 CR-Diesel
2000_4bar
phi Pii=const.
XCNG=50%
Drall=0
AGR=0



CR-V6-diesel engine with CNG-Diesel

Variation: combustion-air ratio - VTG and DK

VKM

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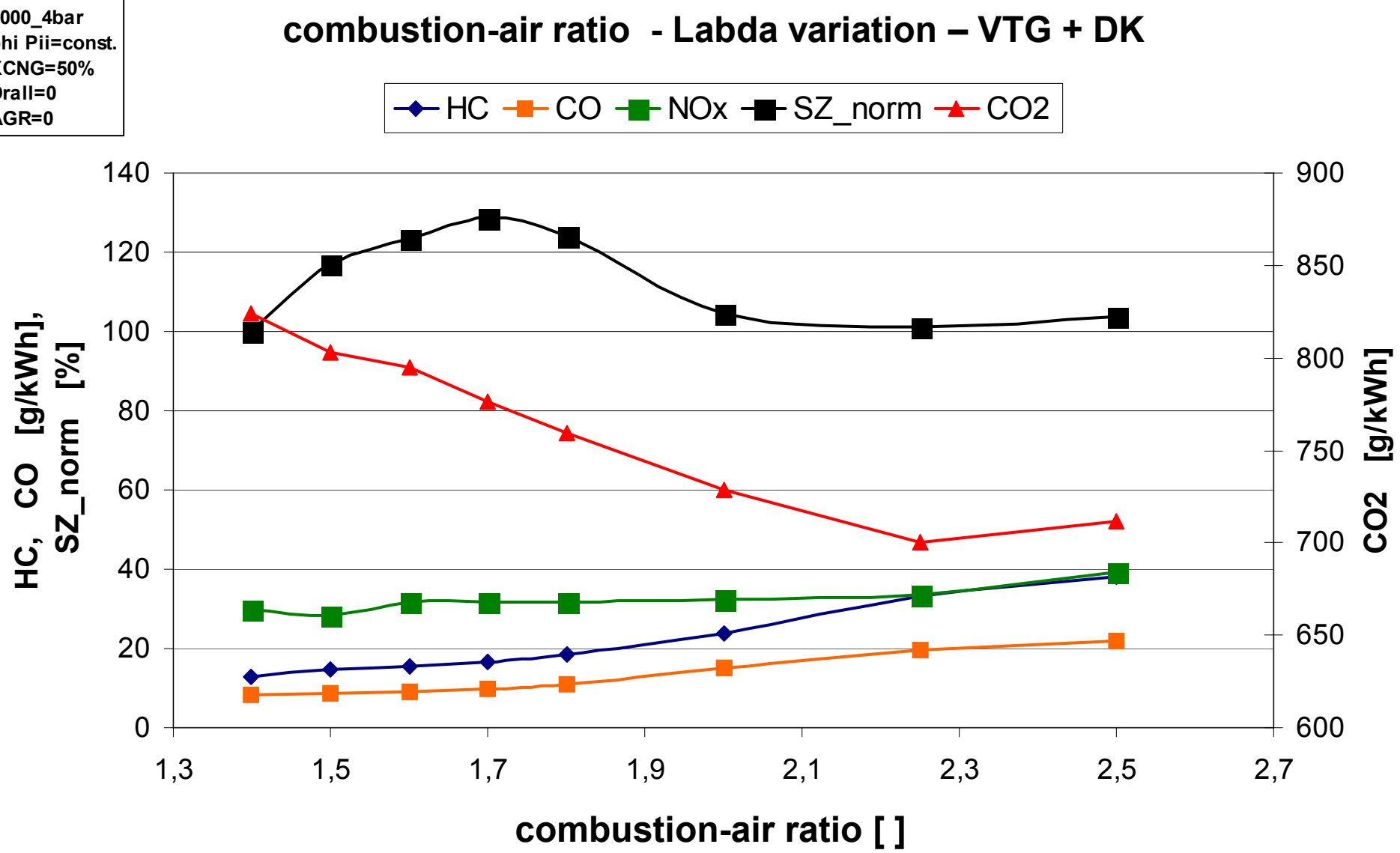
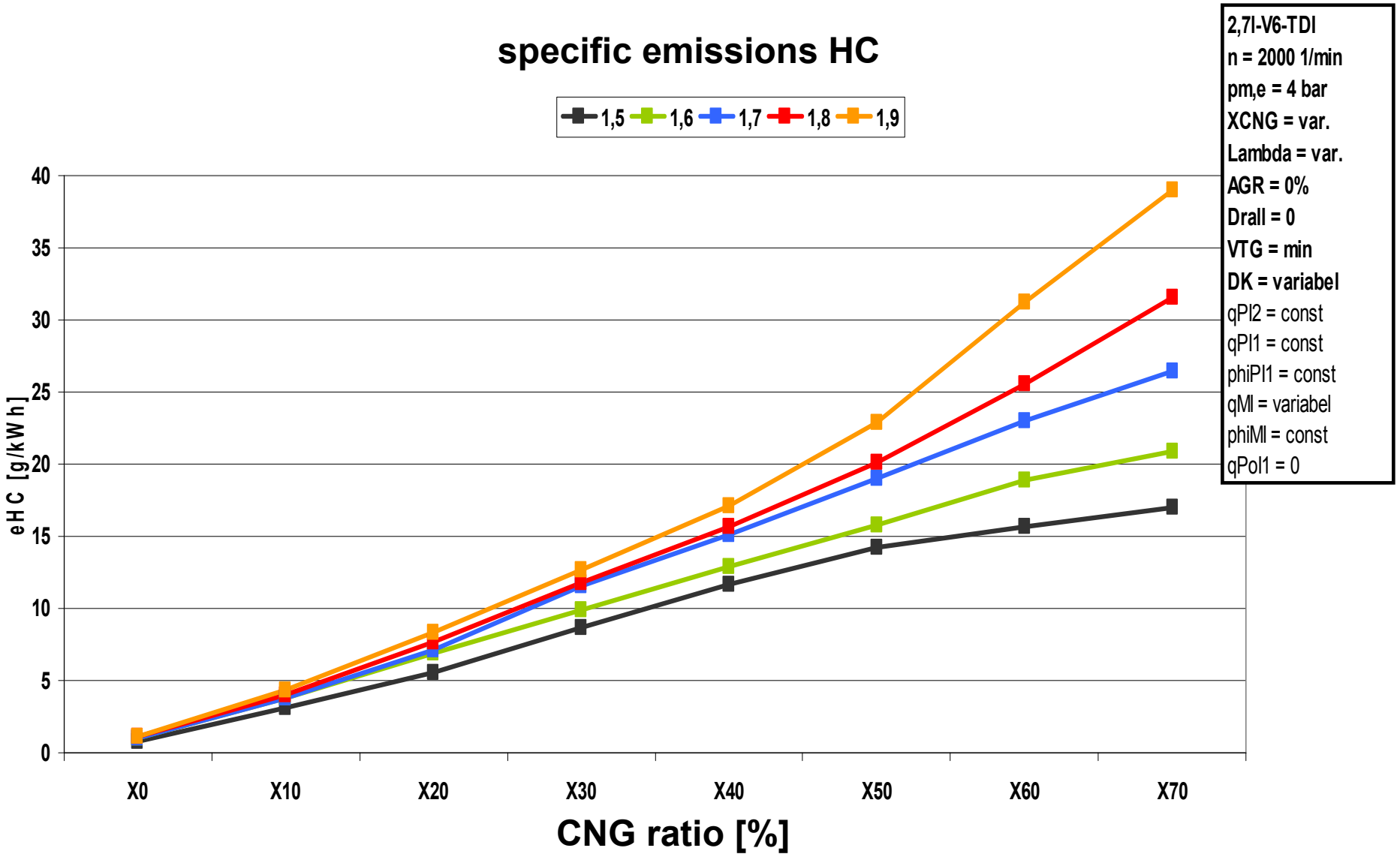
V6 CR-Diesel
2000_4bar
phi Pii=const.
XCNG=50%
Drall=0
AGR=0



CR-V6-diesel engine with CNG-Diesel

HC-emissions: combustion-air ratio variation



CR-V6-diesel engine with CNG-Diesel

pilot injection 1: injected fuel quantity variation

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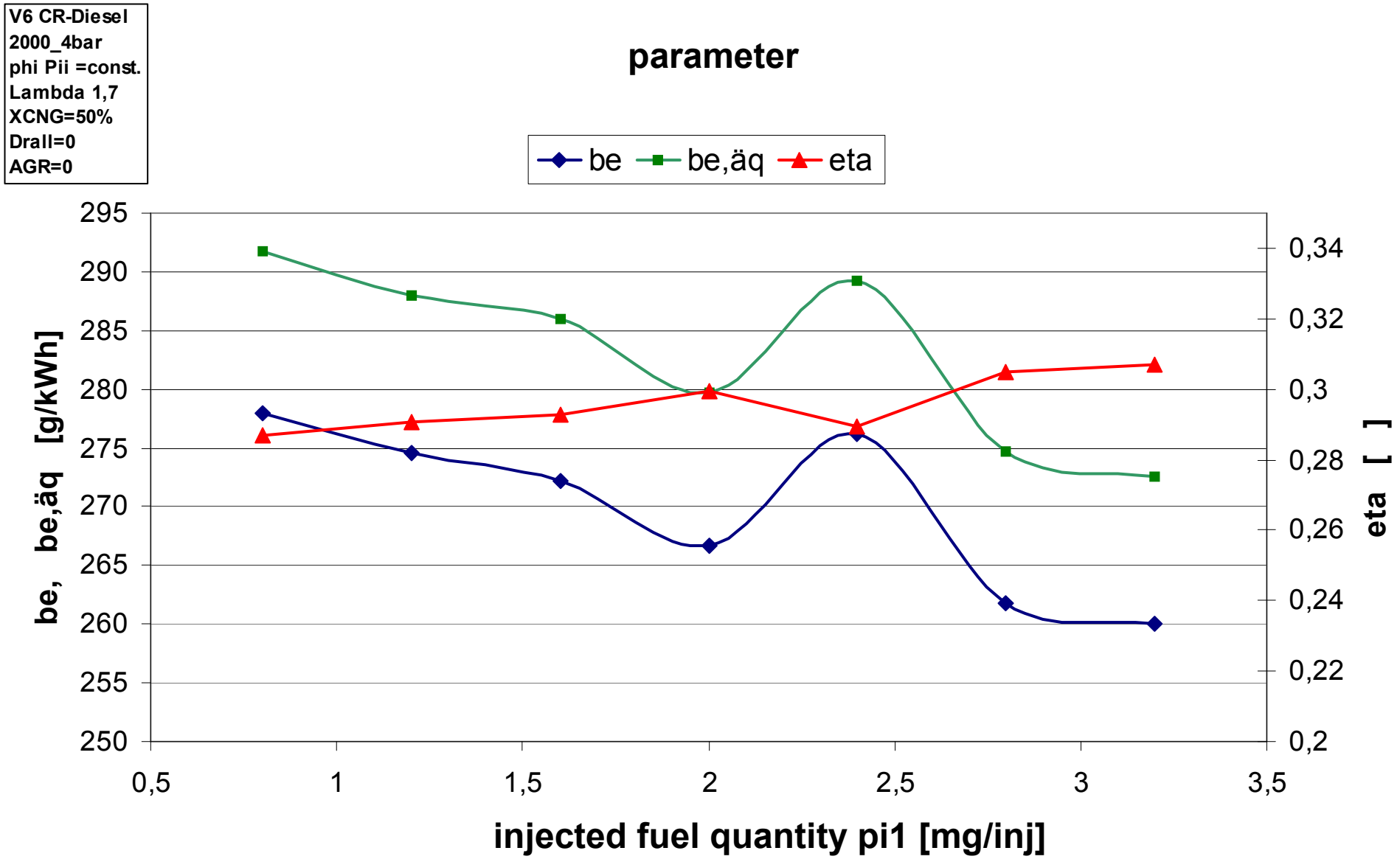

CR-V6-diesel engine with CNG-Diesel

pilot injection 1: injected fuel quantity variation

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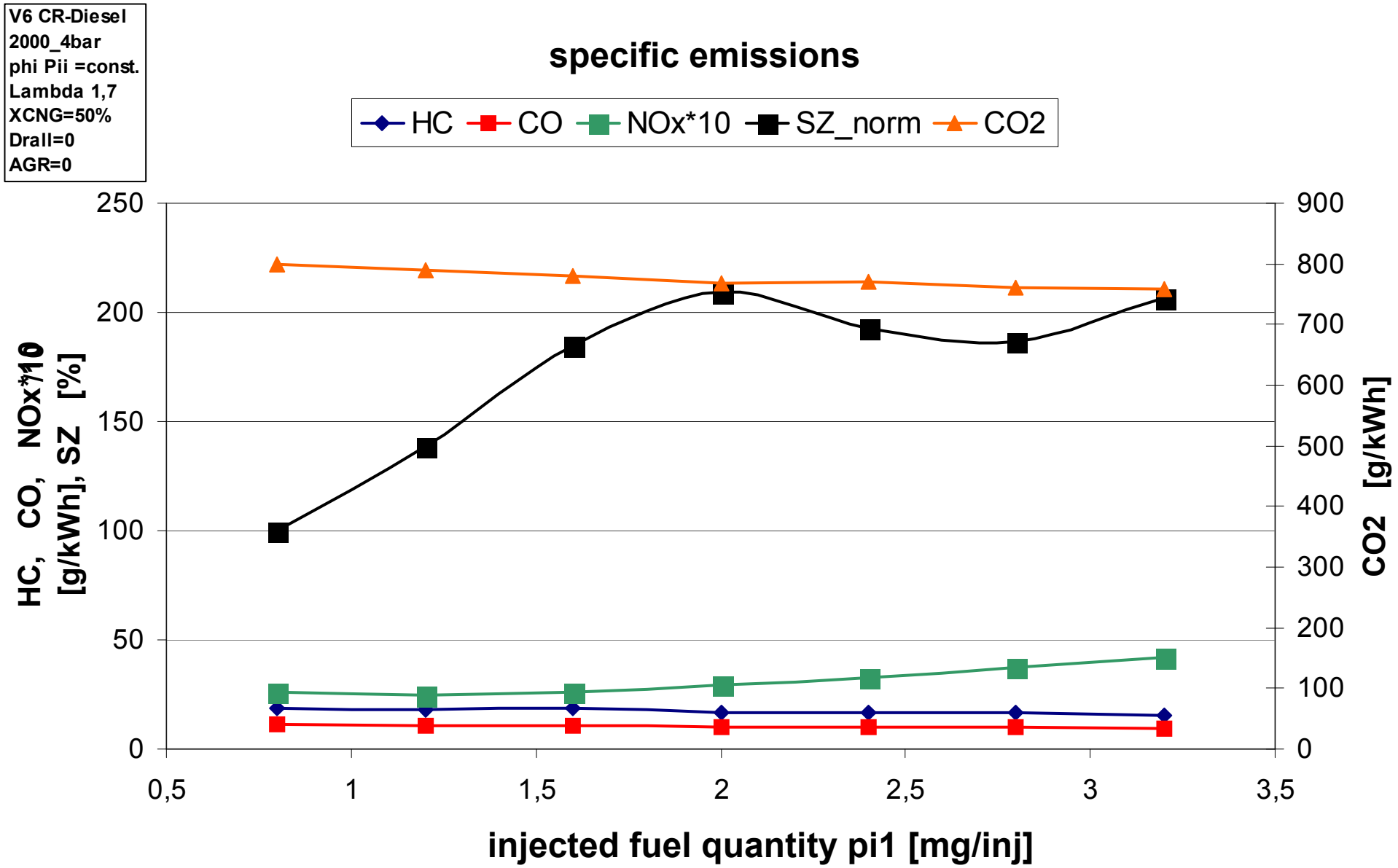

CR-V6-diesel engine with CNG-Diesel

pilot injection 1: fuel injection timing variation

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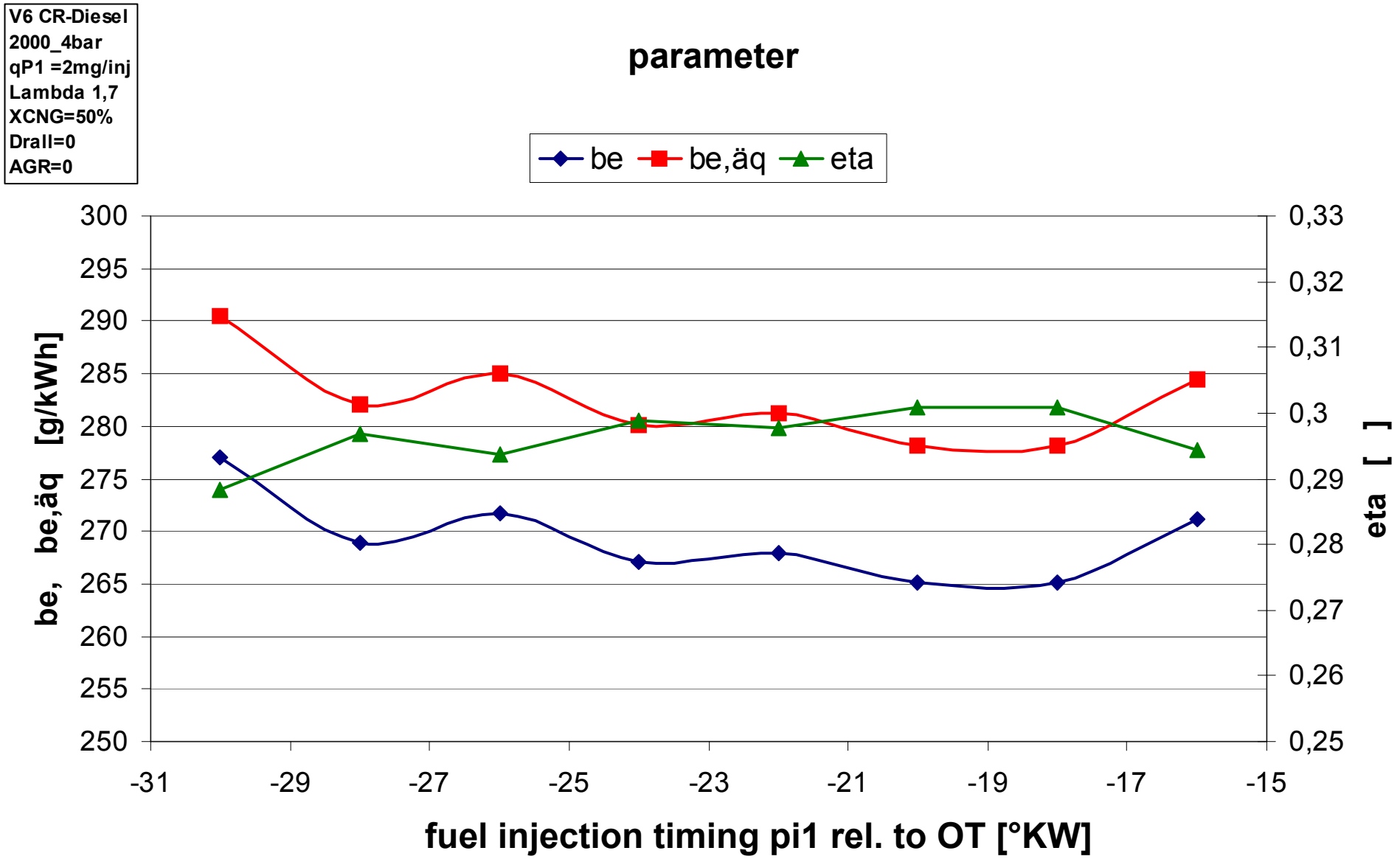

CR-V6-diesel engine with CNG-Diesel

pilot injection 1: fuel injection timing variation

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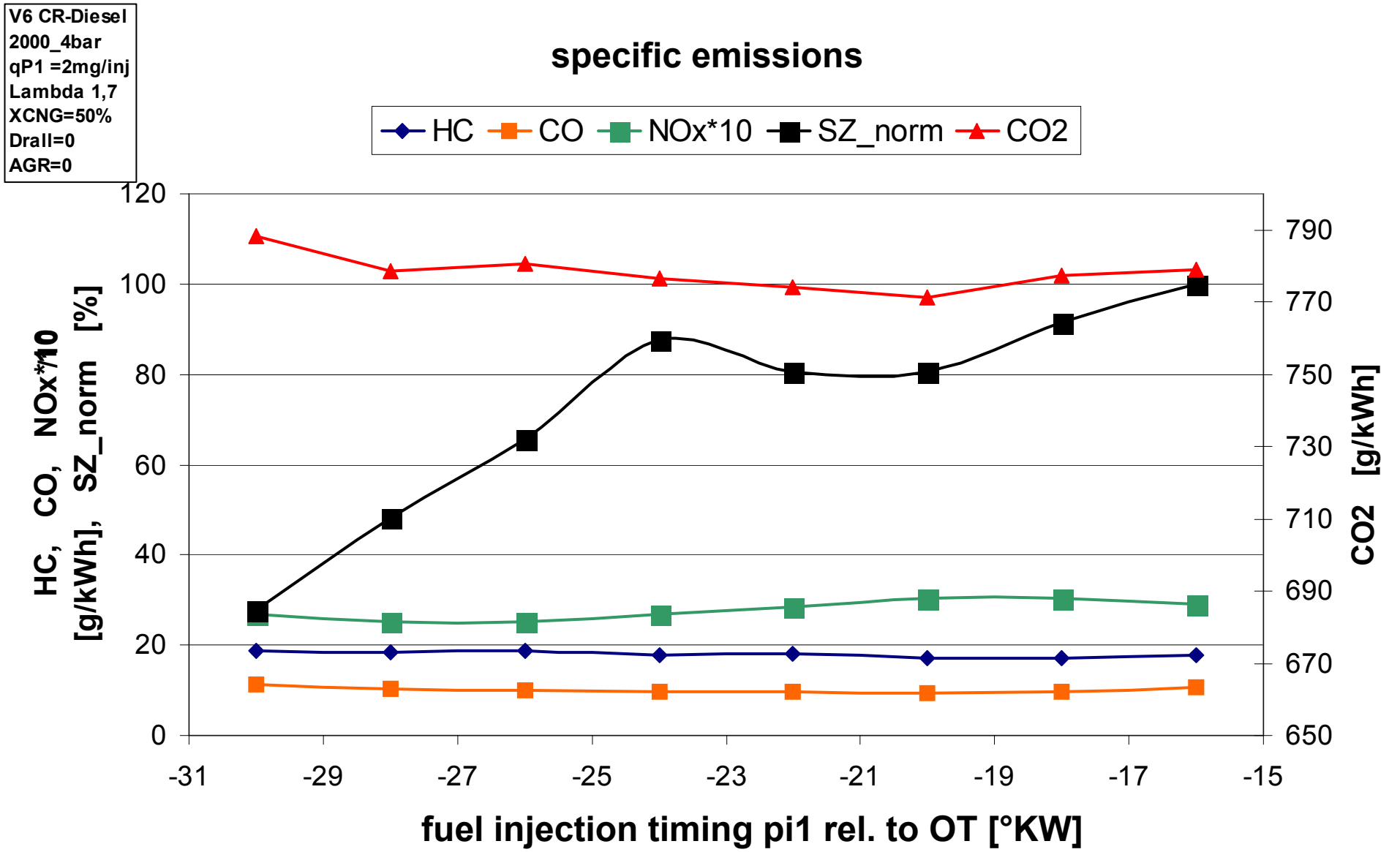

CR-V6-diesel engine with CNG-Diesel

particle size distribution: energetic CNG-ratio variation

VKM

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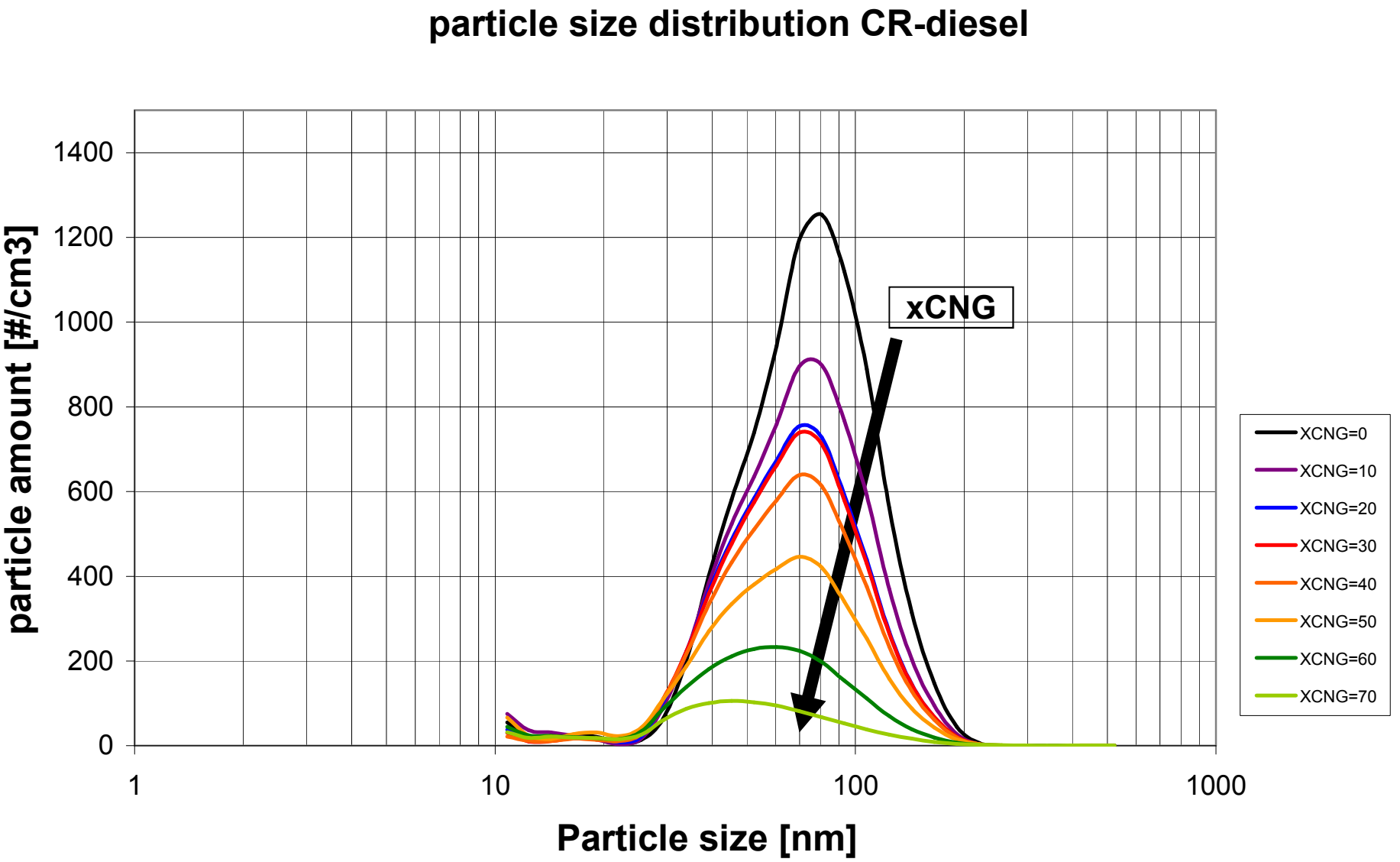


CR-V6-diesel engine with CNG-Diesel

abstract

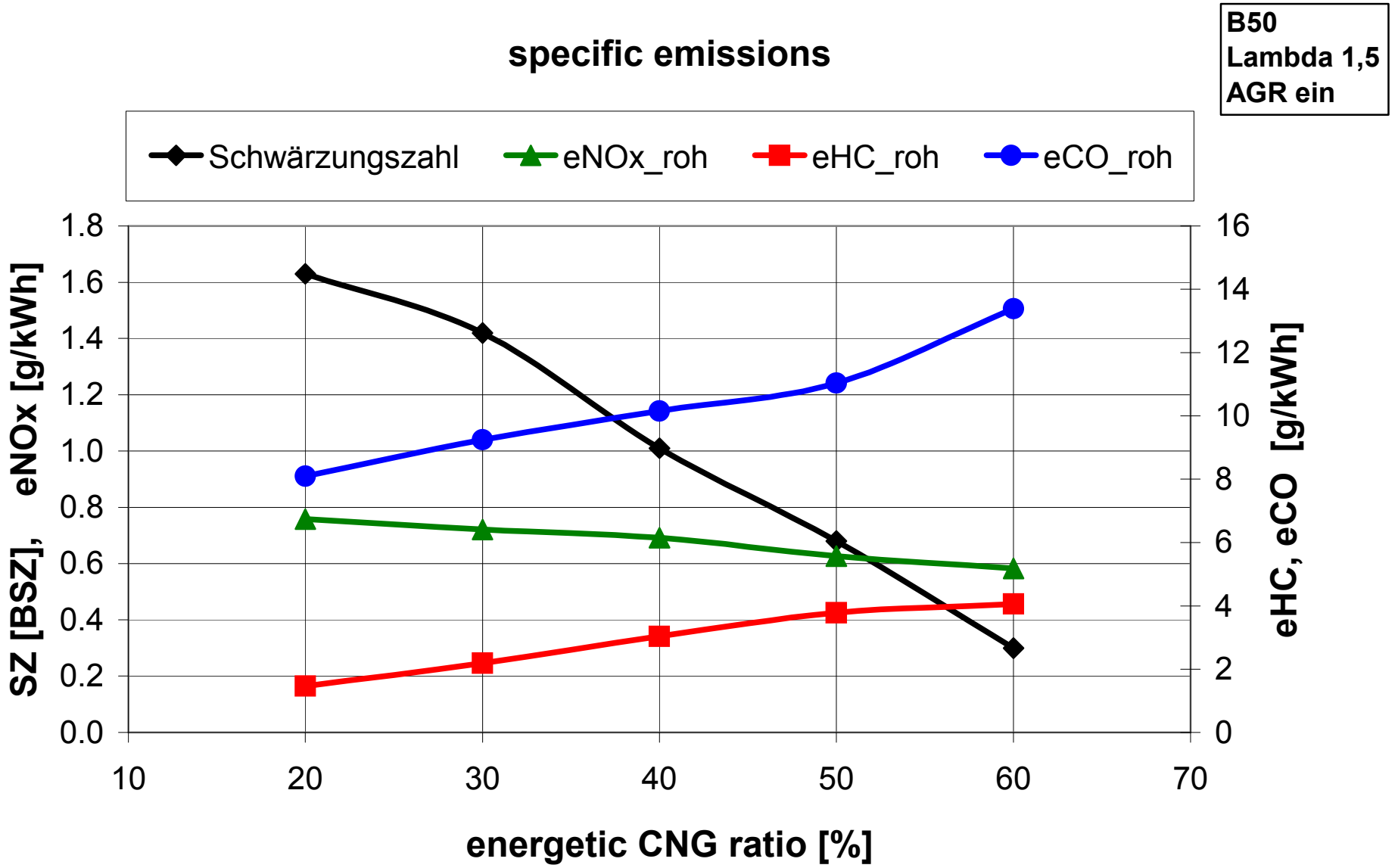
- **energetic CNG-ratio up to > 55% possible**
- **soot emission reduction: 30 % – 40 %**
- **NO_x-emissions: constant level**
- **rise of HC- und CO-emission can be managed by oxidation catalyst**
- **particale amount linearly dependent on energetic CNG-ratio (particle size distribution nearly constant)**
- **only low loss of real efficiency (~1 abs-%)**
- **fuel cost reduction potential**
- **CO_2-reduction potential up to 23%**

Thank You.

Results of CNG-Diesel-Mixed Combustion of an Euro3-Utility Vehicle

CNG-Diesel-Mixed Combustion

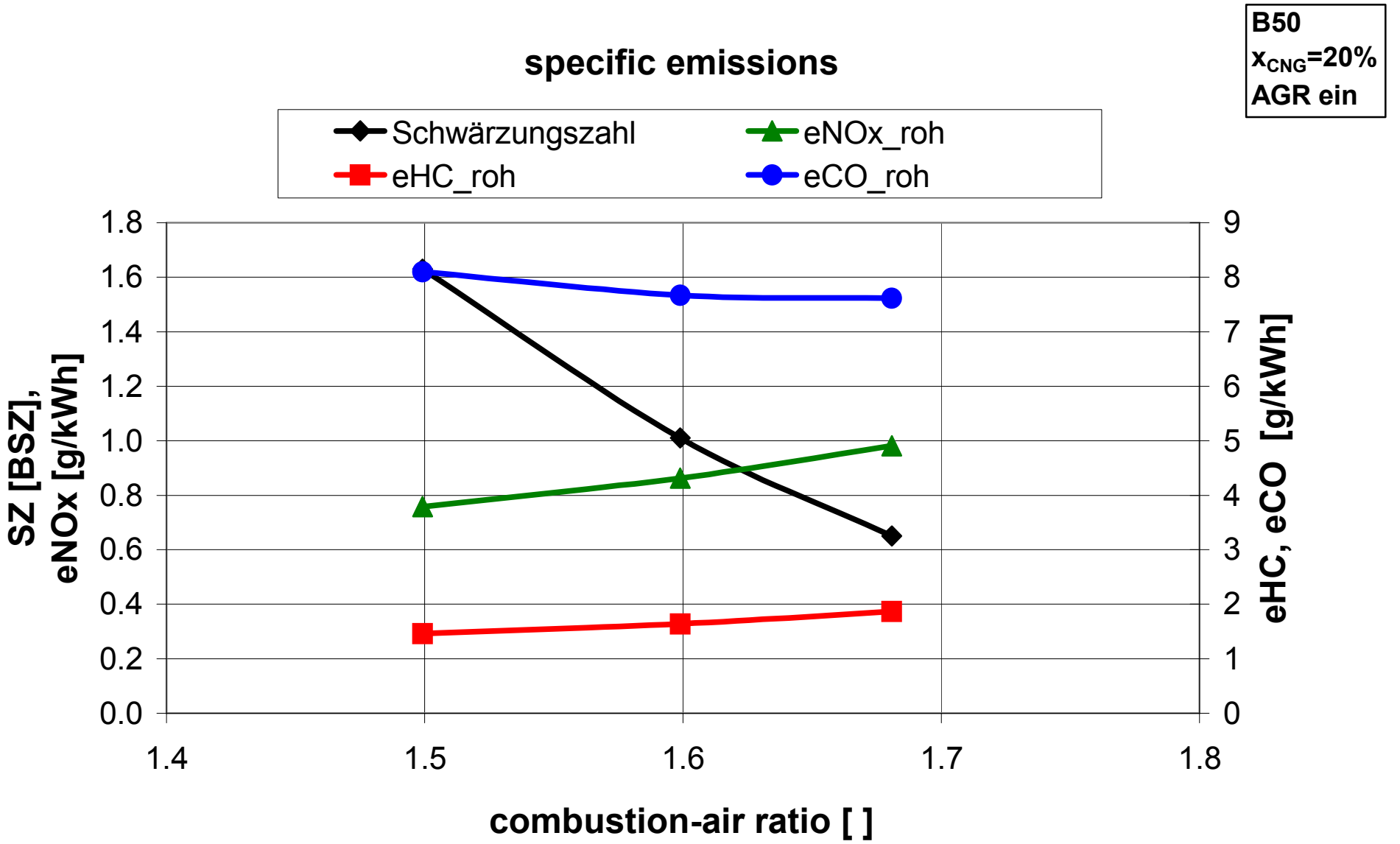
Results



CNG-Diesel-Mixed Combustion

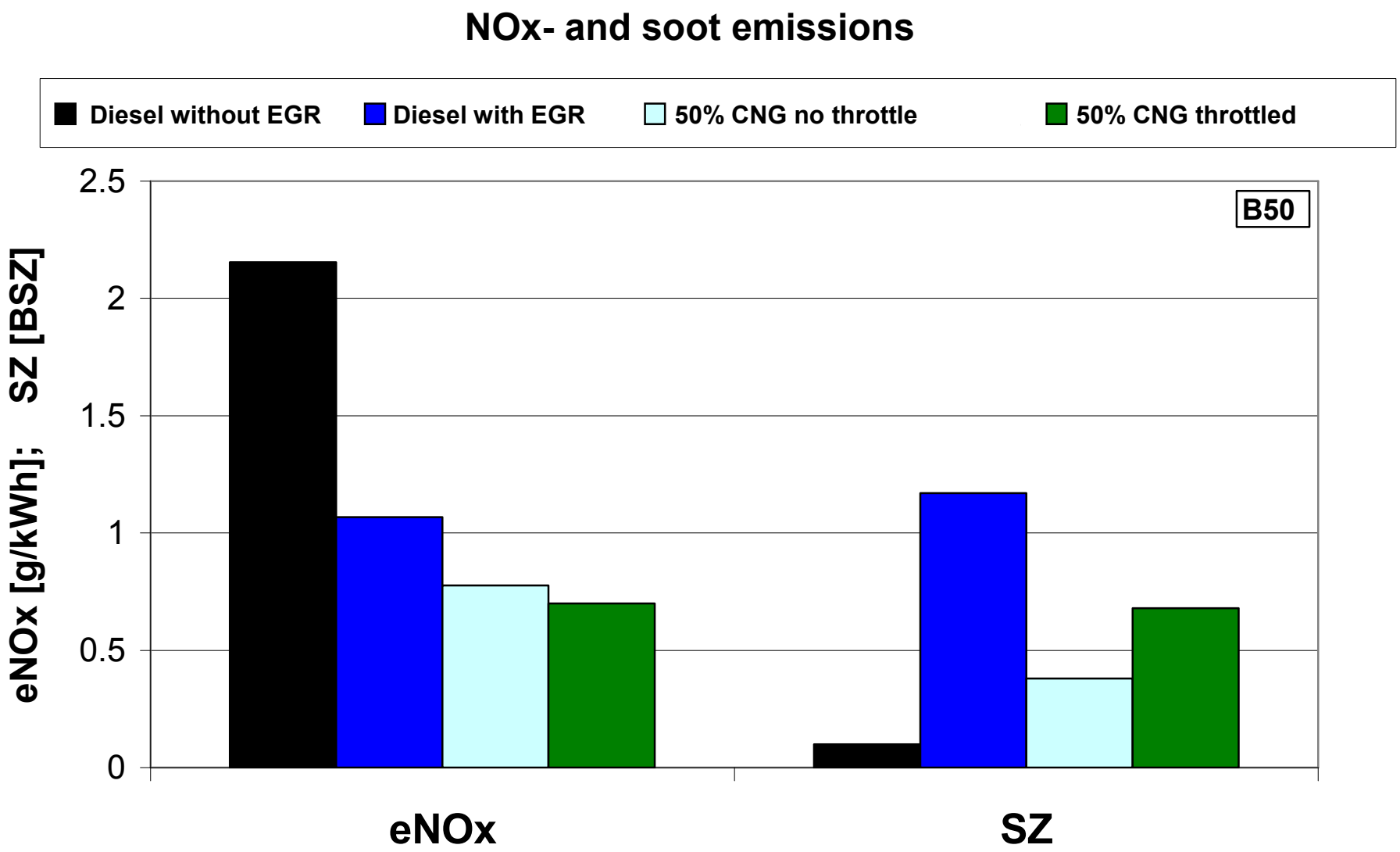
Variation: combustion-air ratio

B50
x_{CNG}=20%
AGR ein



CNG-Diesel-Mixed Combustion

NOx- and soot emissions

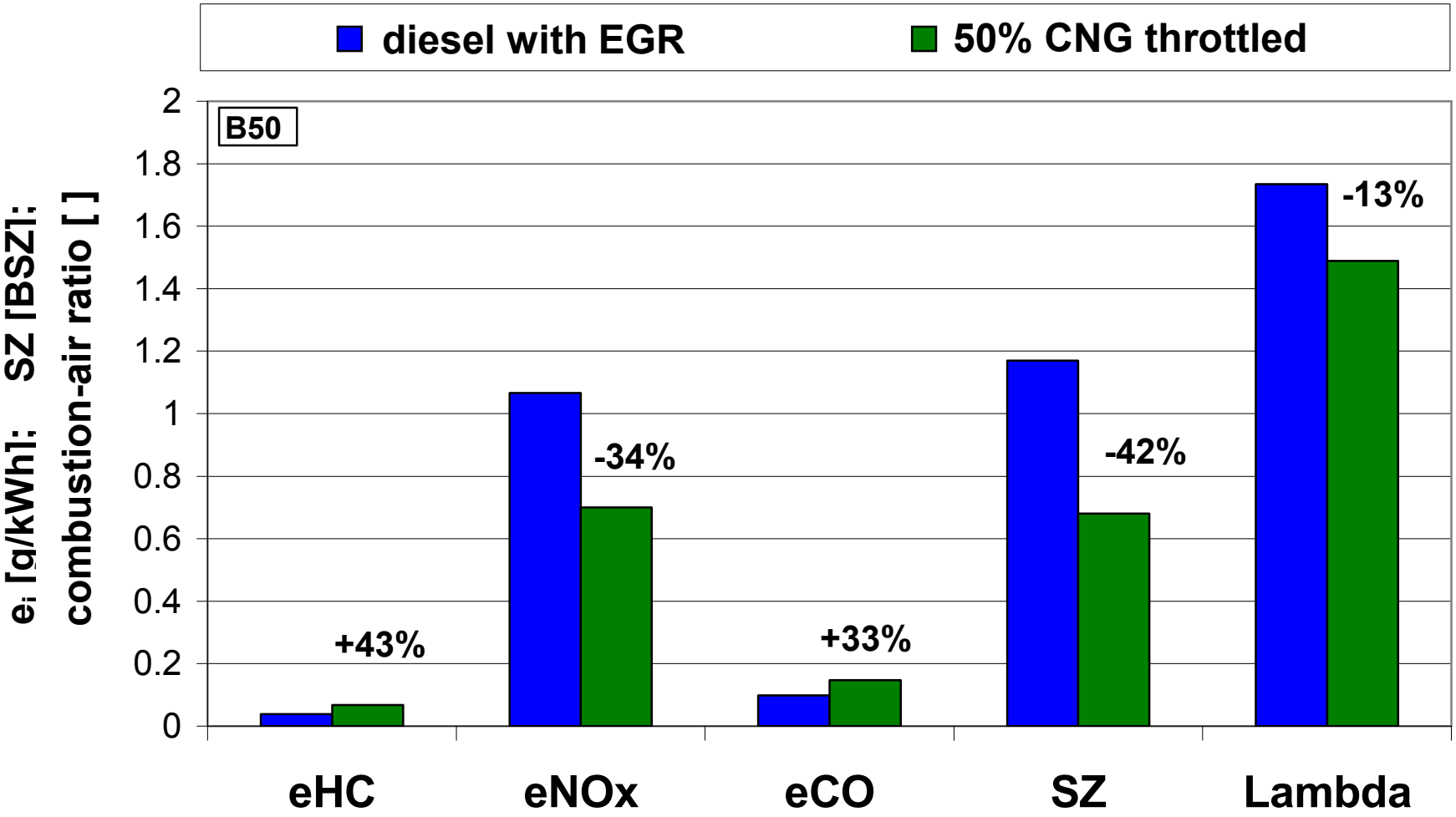


Anmerkung: 50% CNG ohne Anpassung des Zündzeitpunktes, mit Oxidationskatalysator

CNG-Diesel-Mixed Combustion

diesel vs diesel-CNG mixed cumbustion

Emissionen im Vergleich: Diesel vs. CNG-Mischbetrieb

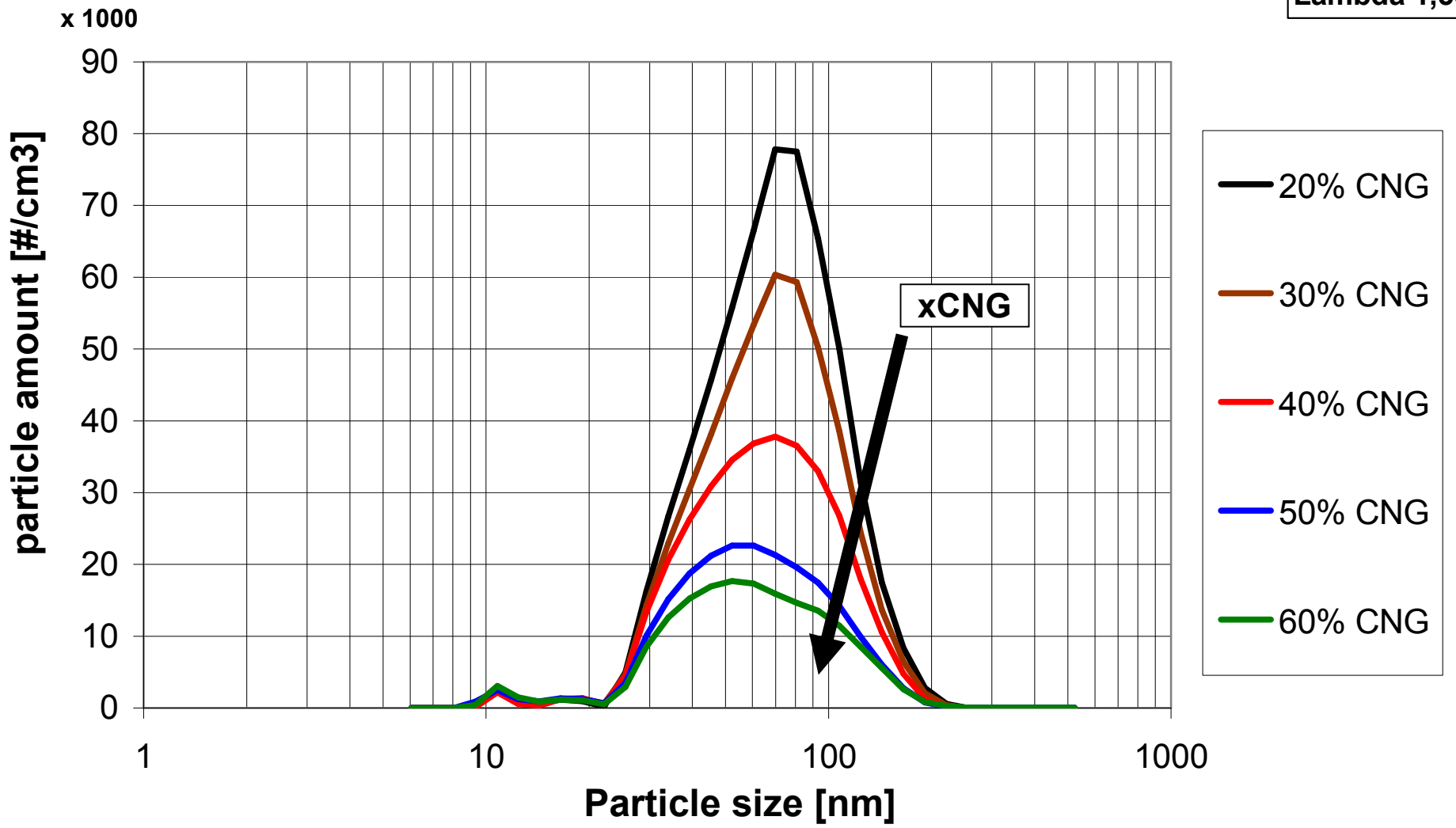


Anmerkung: 50% CNG ohne Anpassung des Zündzeitpunktes, mit Oxidationskatalysator

CNG-Diesel-Mixed Combustion

particle size distribution: energetic CNG-ratio variation

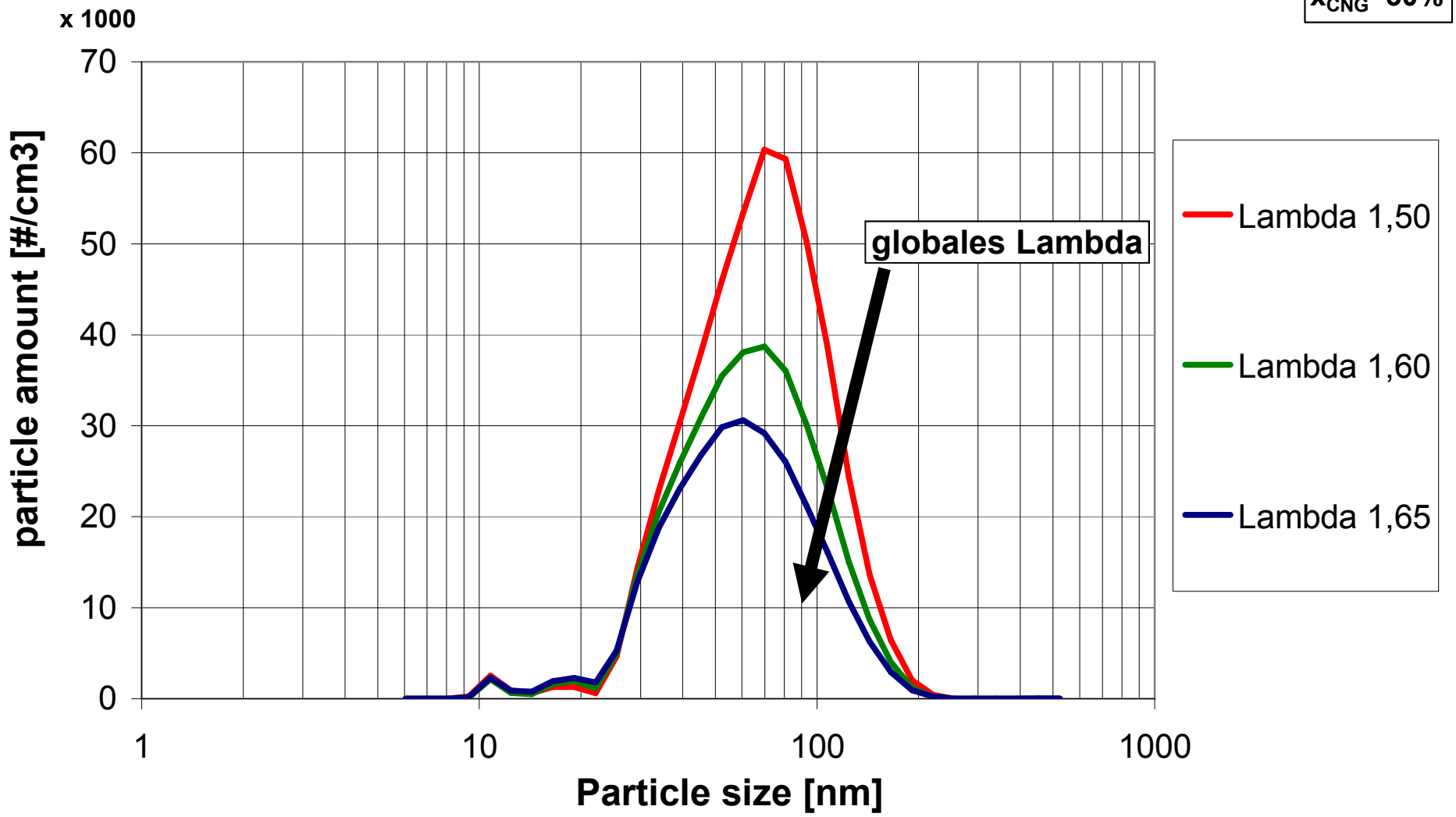
B50
AGRein
Lambda 1,50



CNG-Diesel-Mixed Combustion

particle size distribution: combustion-air ratio variation

B50
AGRein
x_{CNG}=30%



CNG-Diesel-Mixed Combustion

ESC-test for EU-standard

VKM

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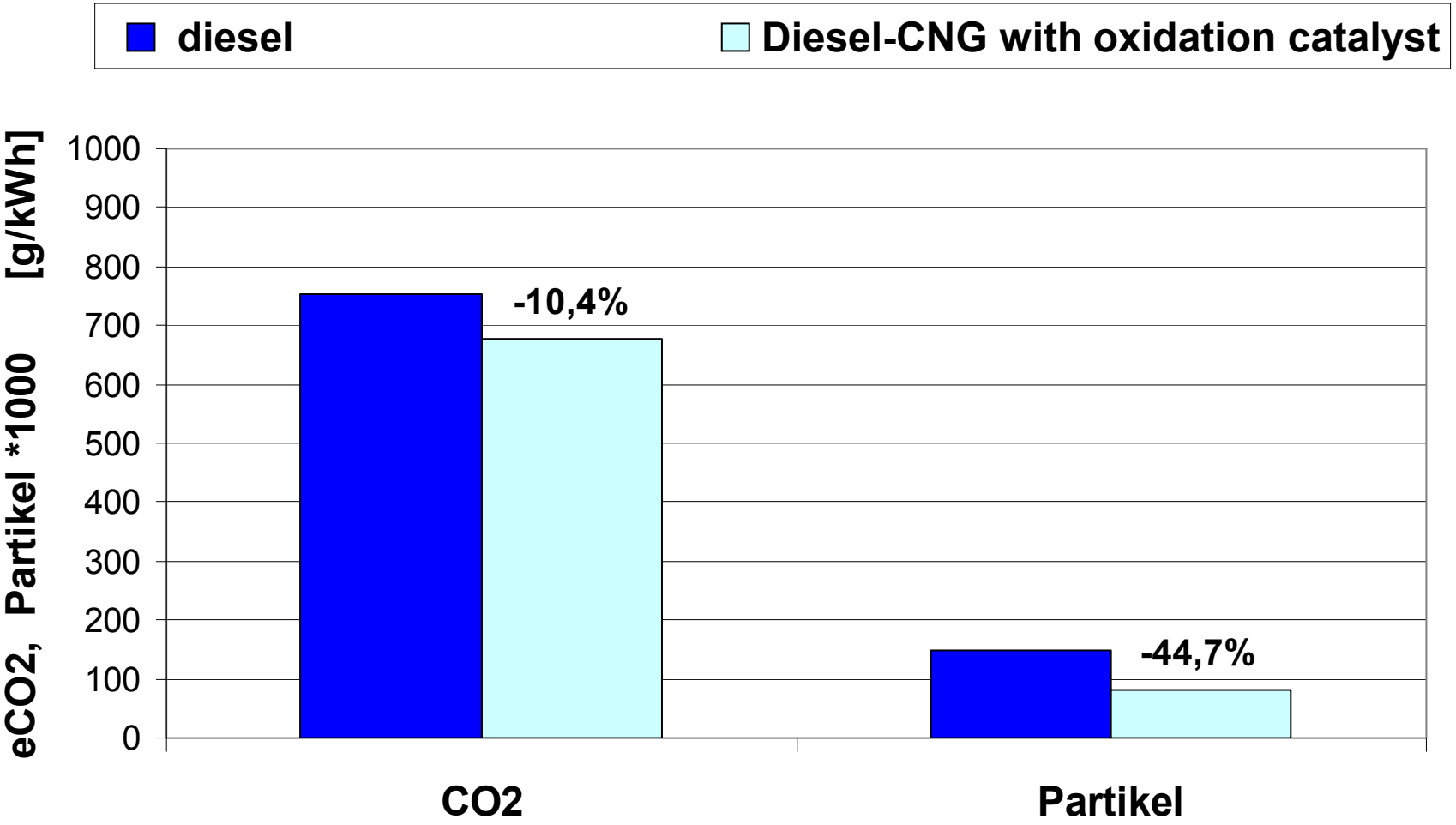
ESC-Prüfzyklus

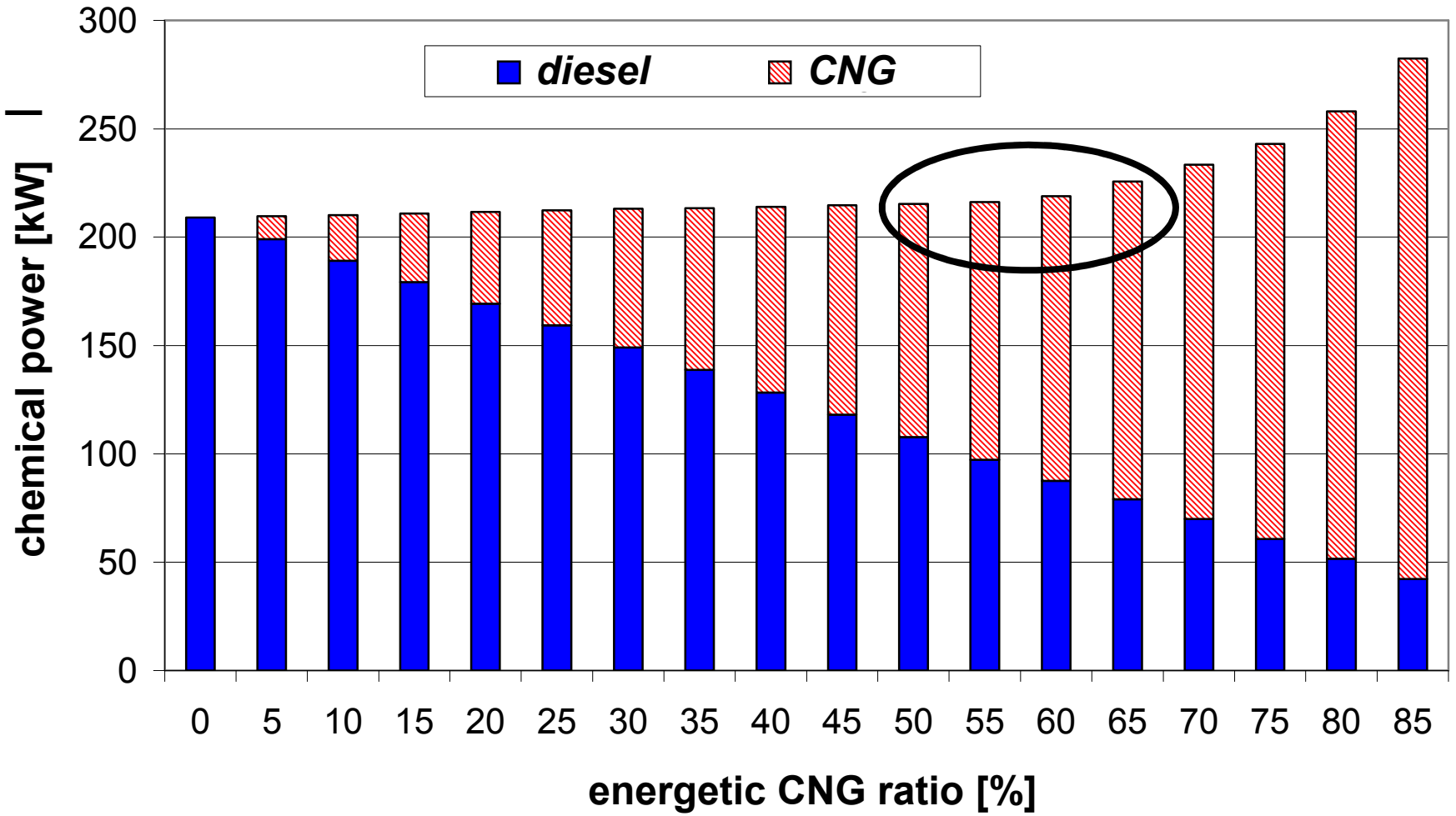
CO_2 and particle emissions



CNG-Diesel-Mixed Combustion

simulation: use of fuel energy

Simulation
const. BP, mittlere Last
Lambda = const.



CNG-Diesel-Mixed Combustion

simulation: efficency and cost

Simulation
const. BP, mittlere Last
Lambda = const.