Dual Fuel Combustion – an Applicable Technology for Mobile Application?

10th Conference „Eco Mobility 2025plus“

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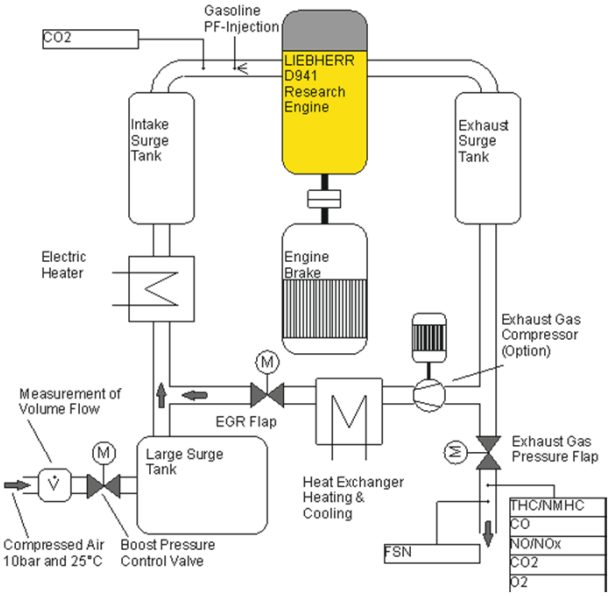
Dual Fuel – Definition and Possibilities



- Dual Fuel Compression Ignition Combustion Concept for Gasoline and Diesel

  Hepp et al.

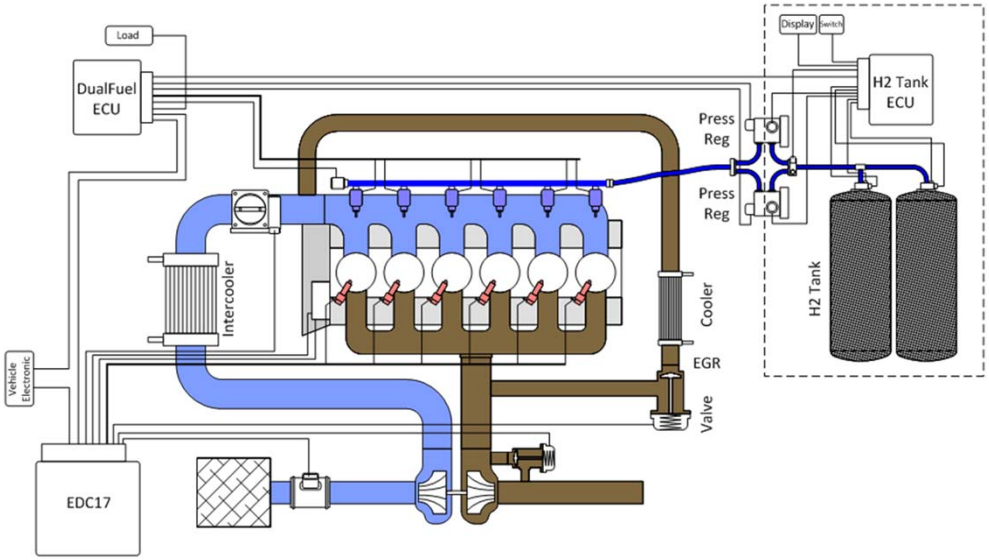
  SAE Paper 2014-01-1319

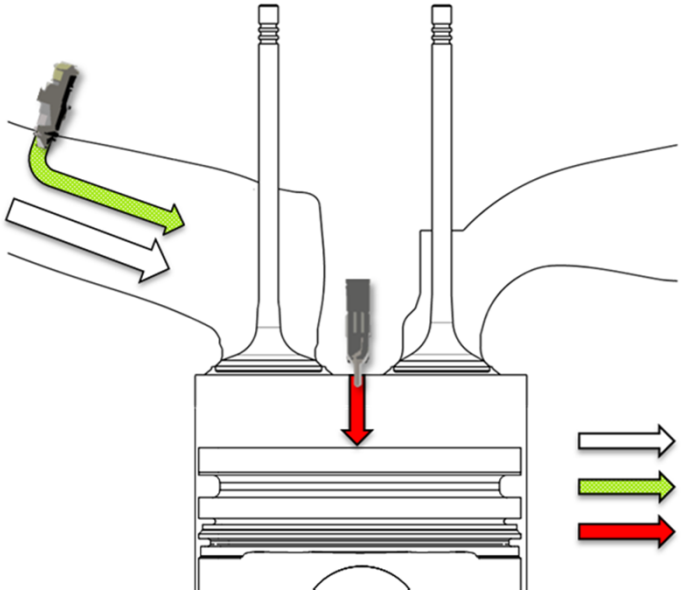
- Dual Fuel Hydrogen/Gasoline Concept for Aston Martin

  Hepp et al.

  A3PS Conference 2013

Dual Fuel – Definition and Possibilities

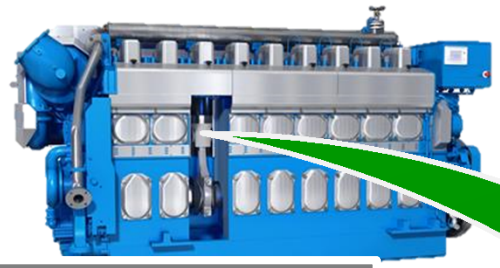




- H_2/Diesel Dual-Fuel Engine for Use in Public Transport
  Barnstedt et al.
  Gasfahrzeugtagung 2015

- Natural Gas/Diesel Dual Fuel System Principle

CNG-Diesel – A new combustion concept?



Large engines

Ship engines

?

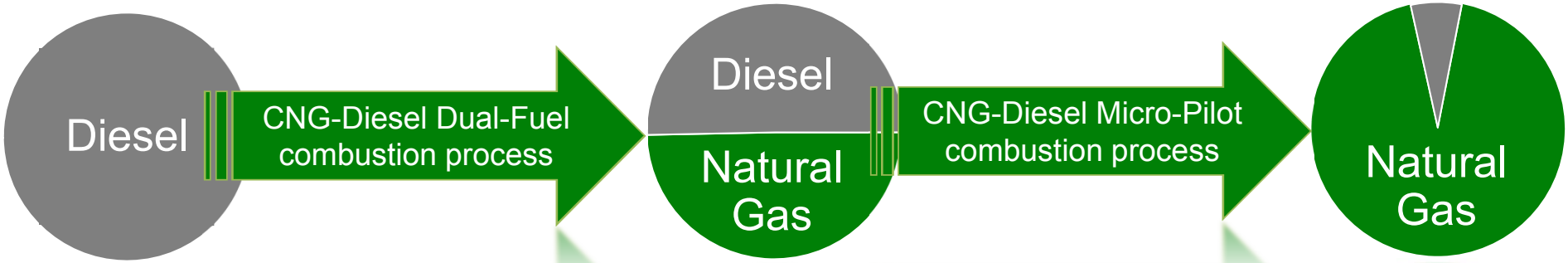
Truck engines ?

Passenger cars?

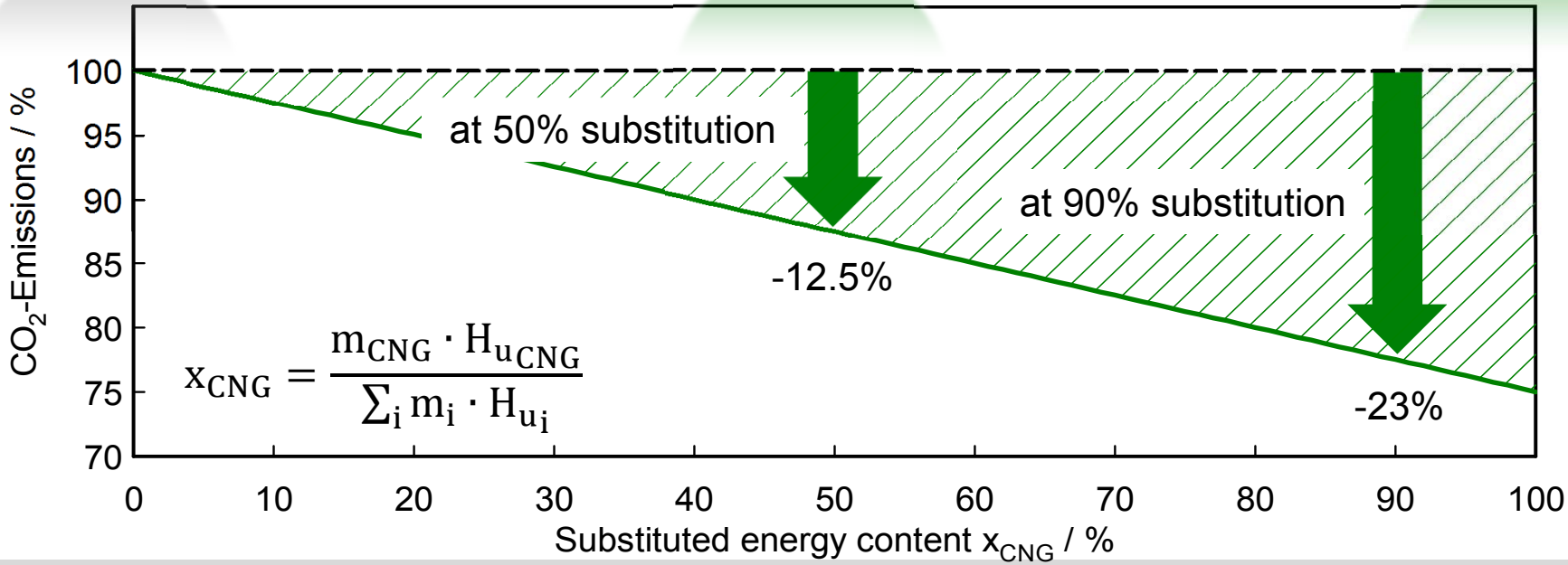
CNG-Diesel – Motivation

- Reduction of CO_2-Emissions
- Economy - Reduced Fuel Costs
- Improvement of Soot/NO_x-trade off
- Improved knocking behaviour
- Proven technology

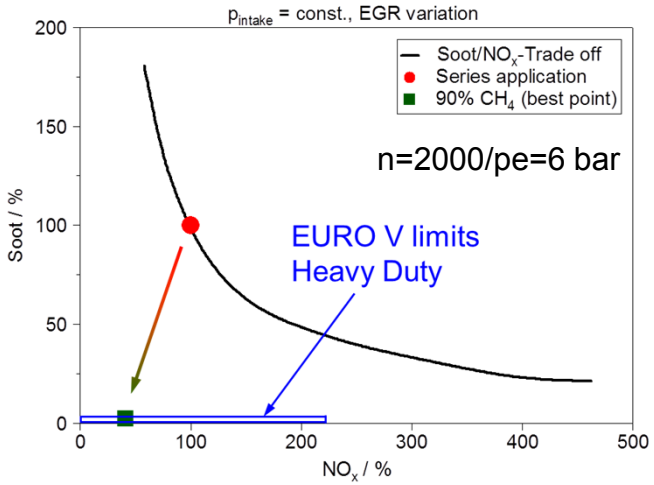
CNG-Diesel – Motivation



CO_2 reduction potential compared to diesel operation



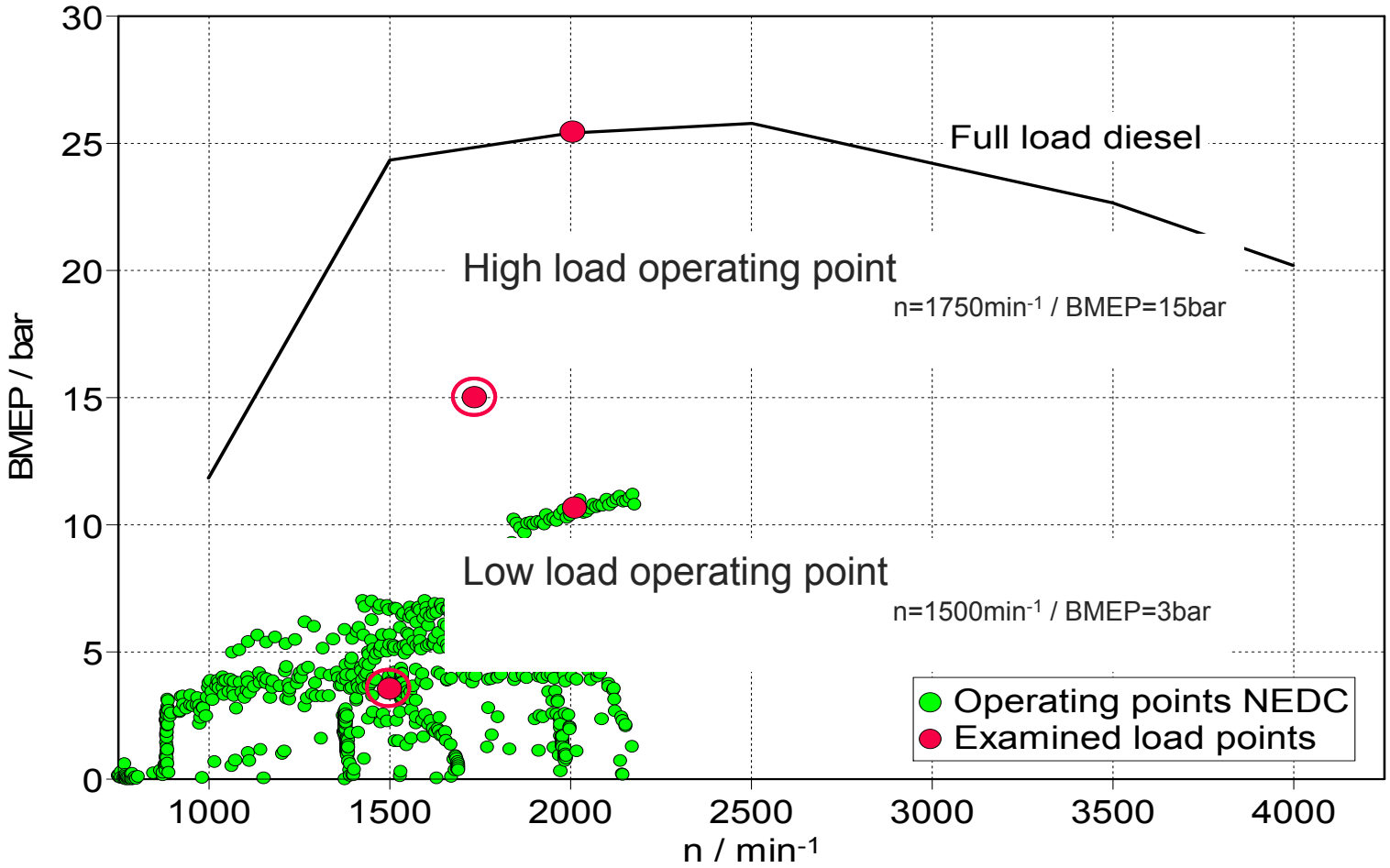
Results presented at A3PS 2012



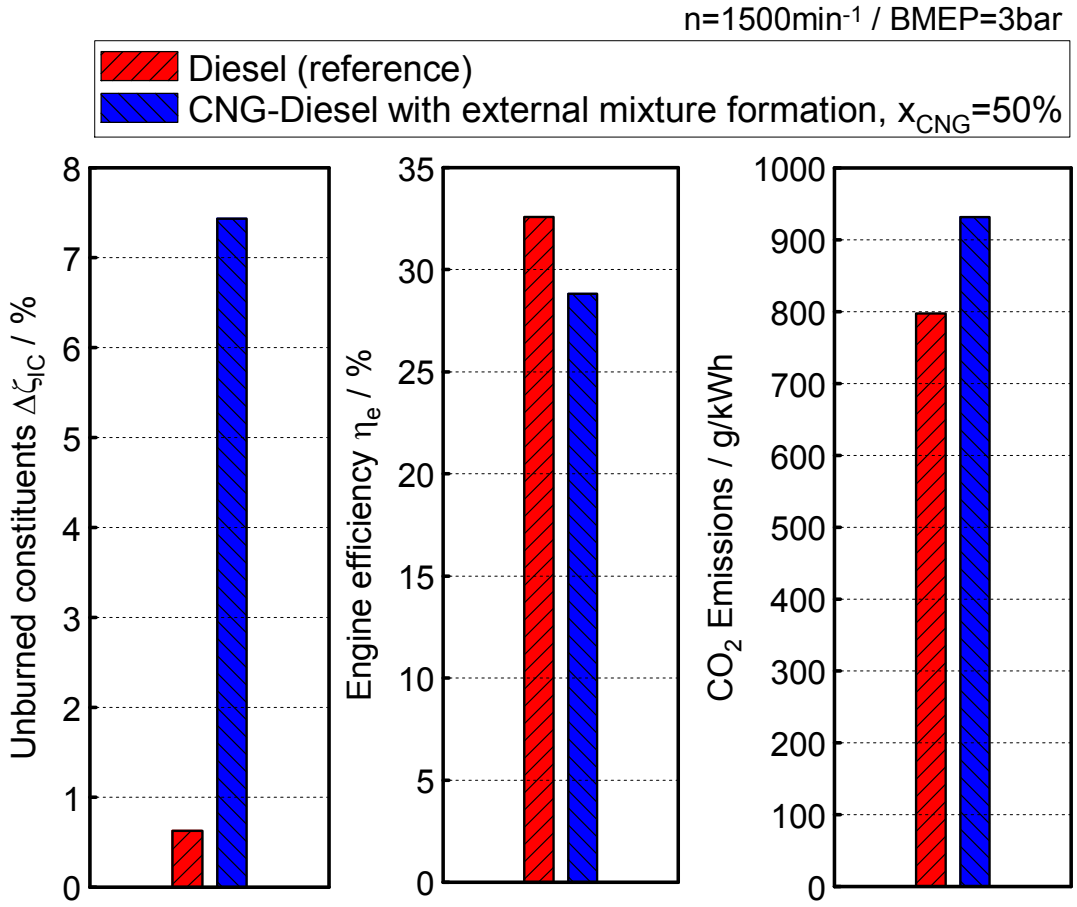
- High potential from medium-load upward; CH_4 emission !
- Operation above $\lambda_{CH_4} = 2$ not meaningful
  - ⇨ Content of CH_4 at low-load range limited (η_e)
- Possible fields of application of this combustion process
  - Light-/Heavy Duty: long-distance traffic with LNG
  - Off-road sector: construction machines, tractors

} e.g. Biogas

Passenger Car - Operation conditions



Experimental results at low load operation with external mixture formation



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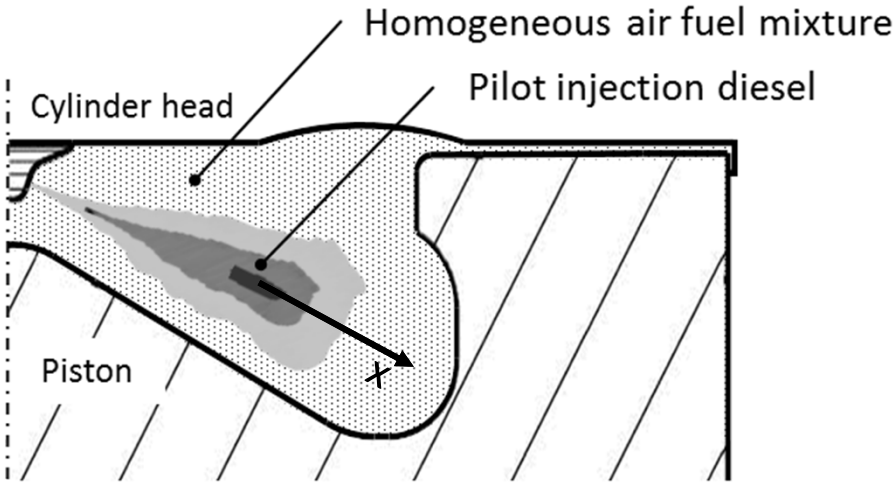
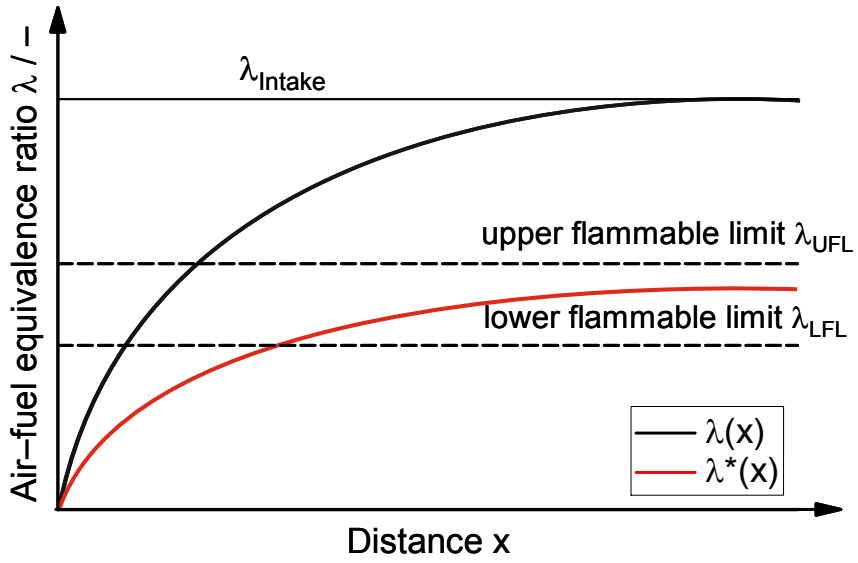




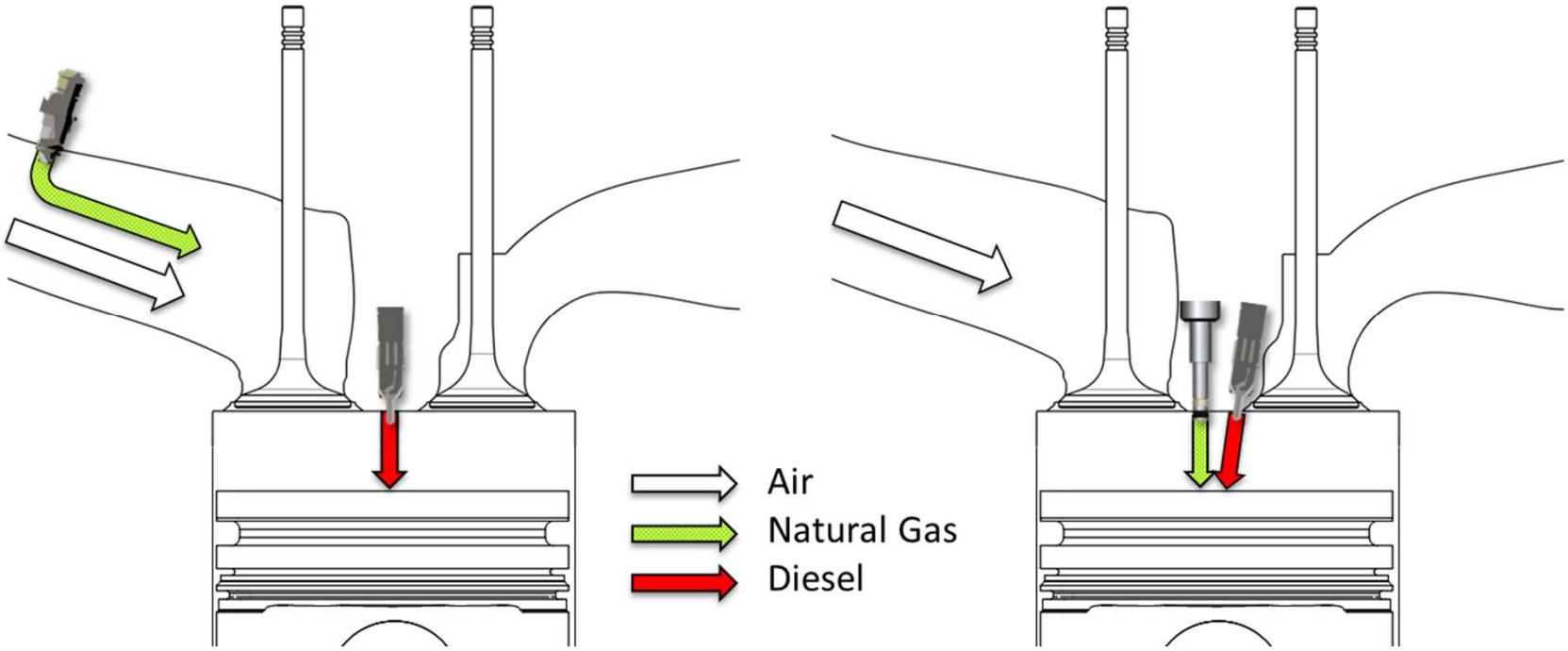
Aim: Combustion process within the ignition limits

- Reduction of the intake manifold pressure (throttling)
- Exhaust gas recirculation (EGR)

CNG-Diesel – Concept

CNG-Diesel
External mixture formation

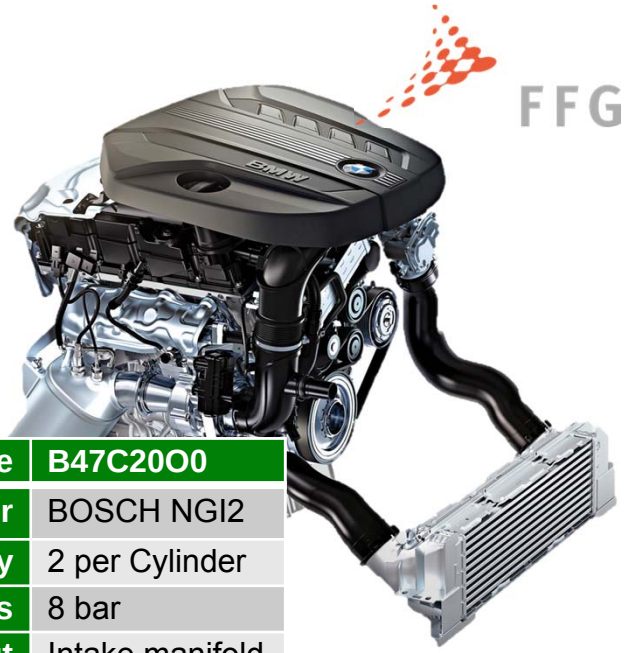
CNG-Diesel
Internal mixture formation



Experimental setups and operating conditions

DIESEL
(Reference)

Engine type	B47C20O0
Displacement	1995 cm³
Bore	84 mm
Stroke	90 mm
Compression ratio	16.5



CNG-Diesel
External Mixture Formation

Engine type	B47C20O0
Injector	BOSCH NGI2
Quantity	2 per Cylinder
Rail pressure gas	8 bar
Layout	Intake manifold

CNG-Diesel
Internal Mixture Formation

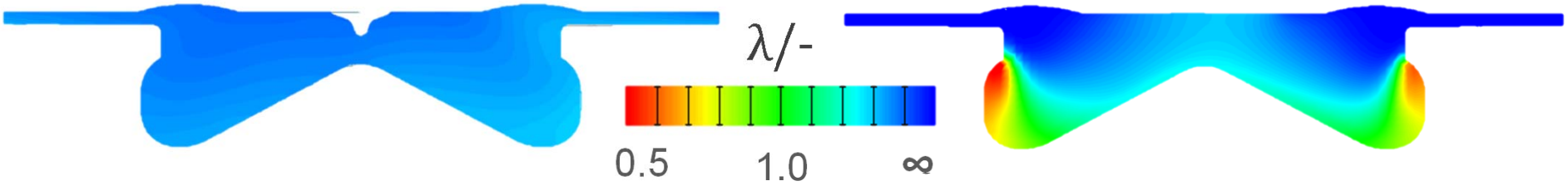
Engine type	B47C20O0
Injector	DELPHI CNG
Quantity	1 per Cylinder
Rail pressure gas	16 bar
Layout	Cylinder head Diesel injector

Numerical flow simulation at low load operation

External Mixture Formation

Parameter	Value
BMEP / bar	3
n / min^{-1}	1500
EGR / %	0
Piston shape	Omega
Displayed / °CA BTDC	10

Internal Mixture Formation

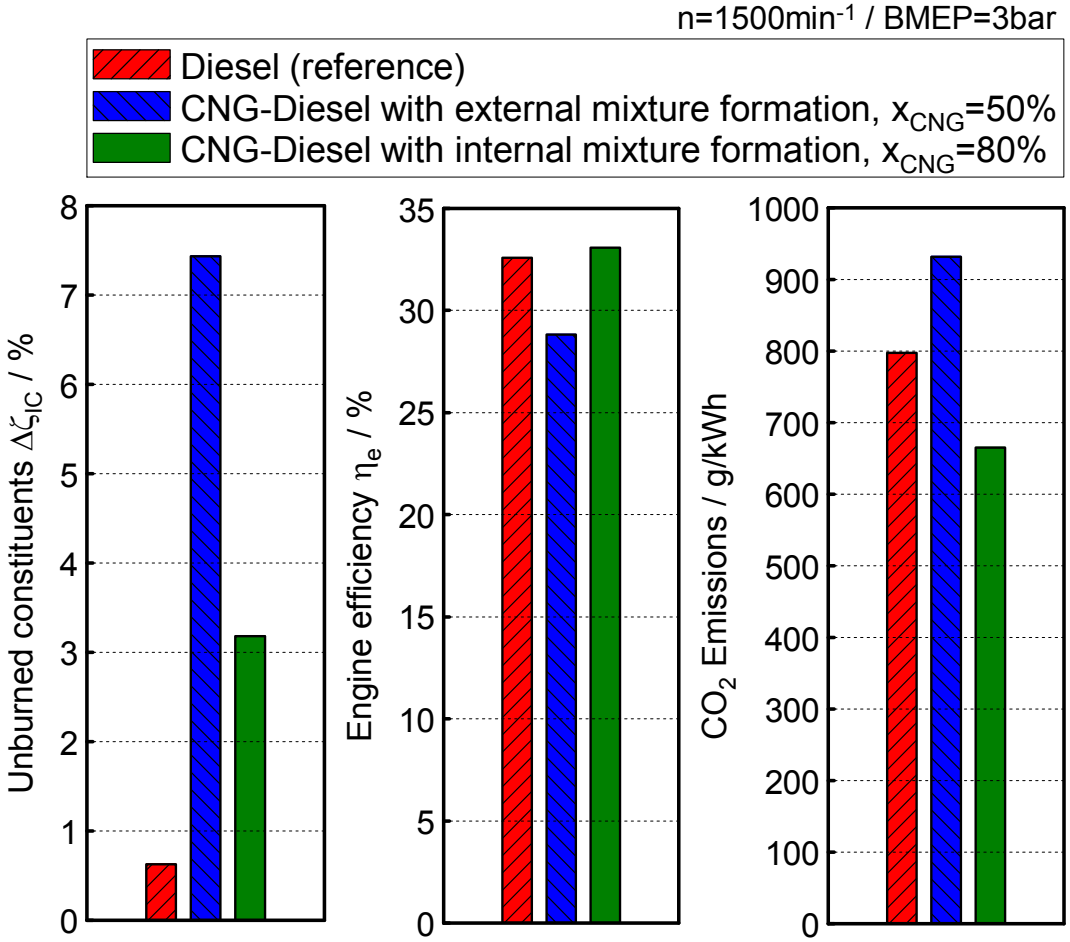


Injector	BOSCH NGI2
Position	Tangential port
Rail pressure gas	8 bar
Start of injection	340°CA BTDC

Injector	DELPHI CNG
Position	Central
Rail pressure gas	16 bar
Start of injection	80°CA BTDC

Homogeneous mixture ⟷ Stratified mixture

Comparison between external and internal mixture formation at low load operation



Summary

- With external mixture preparation PC required functionality (CH_4 emission !) not achievable
- Transition from homogeneous to stratified charge at low load operation required)
  - Reduction of the HC-emissions by more than 60% feasible
  - Increased efficiency
- CO_2 reduction potential from combustion also at low load operation, but: With todays exhaust aftertreatment future emission limits not achievable (Light off temperature for CH_4 conversion)

Outlook

- Further development of CNG-Diesel Micro-Pilot combustion process with internal mixture formation
  - Optimisation of application and hardware parameters
  - Operating strategy
  - Full load operation (knocking behaviour)
  - Exhaust gas aftertreatment progress ?

- Comparison to conventional spark ignition