THE CHALLENGE OF RDE

THE ROLE OF THE ELECTRICALLY HEATED CATALYST

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Rolf Brück, Paresh Laddha

CONTINENTAL POWERTRAIN WILL BECOME VITESCO TECHNOLOGIES

Approx. 50 locations
For worldwide development and manufacturing

More than 40.000 employees
Globaly working for VT

€ 7.7 bn. Sales
In 2018

AGENDA

WHAT DOES RDE MEANS

....INDEPENDENT FROM DRIVER






WHAT DOES RDE MEANS

….. ON ALL STREETS AND CONDITIONS

REAL DRIVING EMISSIONS

..... CAN BE MEASURED

AGENDA

1 INTRODUCTION

2 RDE CHALLENGE

3 SYSTEM SOLUTION - GASOLINE

4 SYSTEM SOLUTION – DIESEL

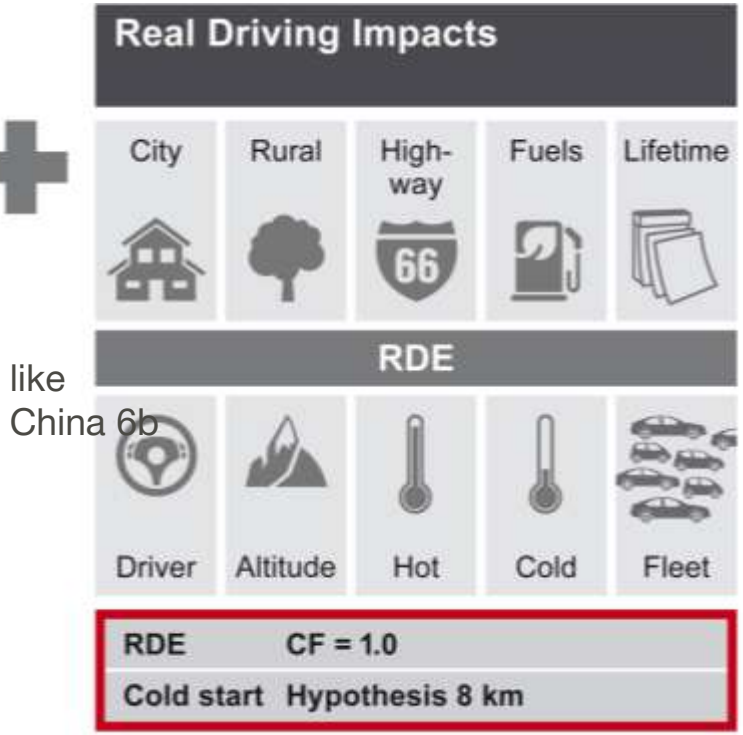
5 SUMMARY

EXHAUST GAS AFTERTREATMENT

MAIN CHALLENGES FOR EU7 (ASSUMPTION; MORE INFO MOST LIKELY NOT BEFORE AUTUM 2020)

	EU7 Assump. 2023 - 2025
Cycle	WLTP
PN	$6*10^{11}$ (reduce size 10nm)
PM	4.5 (mg/km)
THC	50 (mg/km)
NOx	35 (mg/km)
CO	500 (mg/km)
CO_2 (Fleet average)	15% reduction rel to 2020 30% (in 2030)
RDE	CF= 1,0 (+0,2) Temp.: 0~30°C; Altit.: 0~900m Ext:: -7~35°C; 0~1300m
New Pollut.	NH_3; N_2O; CH_4 ?
-7C Emiss.	Part of RDE extend (city)
OBD	Tighter limits & tougher procedures expected

like China 6b



INDIA REAL DRIVING EMISSION (RDE)

DISCUSSIONS IN INDIA AND EUROPE

EU Conformity Factor:
Today = 1.5; Future = 1

RDE test emission ≤ $NTE_{pollutant}$ = ($CF_{pollutant}$ x $BSVI\ limit_{pollutant}$)

NTE → Not To Exceed
pollutant → NOx, PN(GDI) & CO(monitoring only)

CF → Conformity factor
CF is yet to be notified. Monitoring in progress.

Porta... System... ...ent ...ests

Temperature Range
Ext.: -7 – 35°C

Altitude
Ext.: 0 – 1300 m

Ambient boundary conditions	Ambient Temperature	Altitude(above sea level)
Moderate	10°C < T_{amb} <=40°C	Alt <= 700m
Extended	8°C <= T_{amb} <10°C OR 40°C < T_{amb} <=45°C	700m < Altitude <= 1300m

The total trip duration should be between 90 min and 120 min

Speed Ranges

Urban

- Urban speed: < 45km/h
- 34% of distance, min. 16 km
- average speed between 15km/h and 30km/h
- stop periods 6% to 30%
- individual stops < 300s

Rural

- Rural speed: 45km/h <= Speed < 65km/h
- 33% of distance, min. 16km

Total RDE Driving Distance:
5 – 12 km (in dscussion)

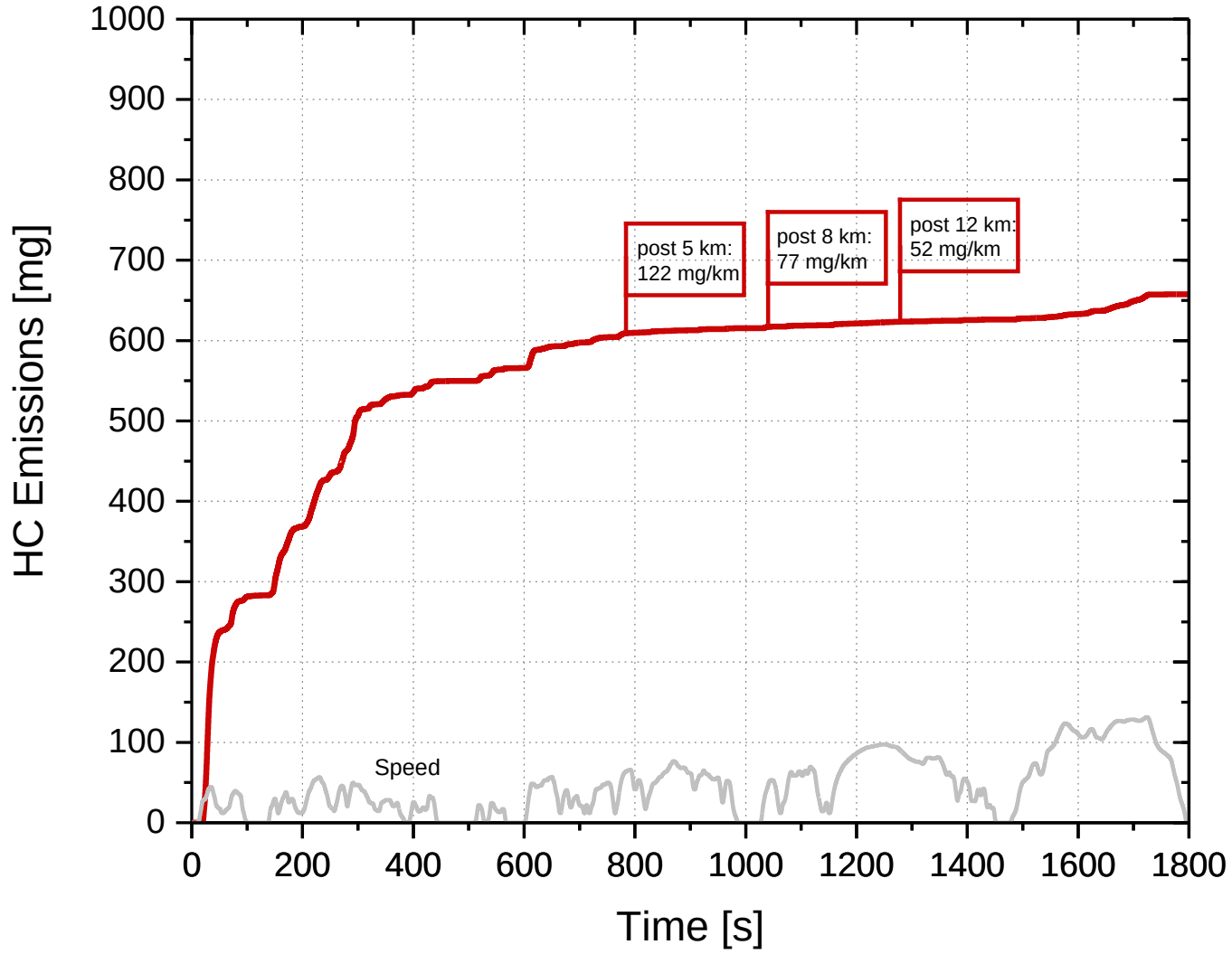
Motorway

- Motorway speed: > 65km/h
- 33 % of distance, min. 16km
- > 75km/h for at least 5m

...measurements monitoring by authority
>= 2023 → Rollout of CF and hence part of Type Approval

SUPER CLEAN ELECTRIFIED GASOLINE VEHICLE

WLTP: HC-TAILPIPE EMISSIONS DEPENDEND ON DRIVING DISTANCE



Cutting RDE driving distance by half for gasoline cars means about double the Emission in g/km

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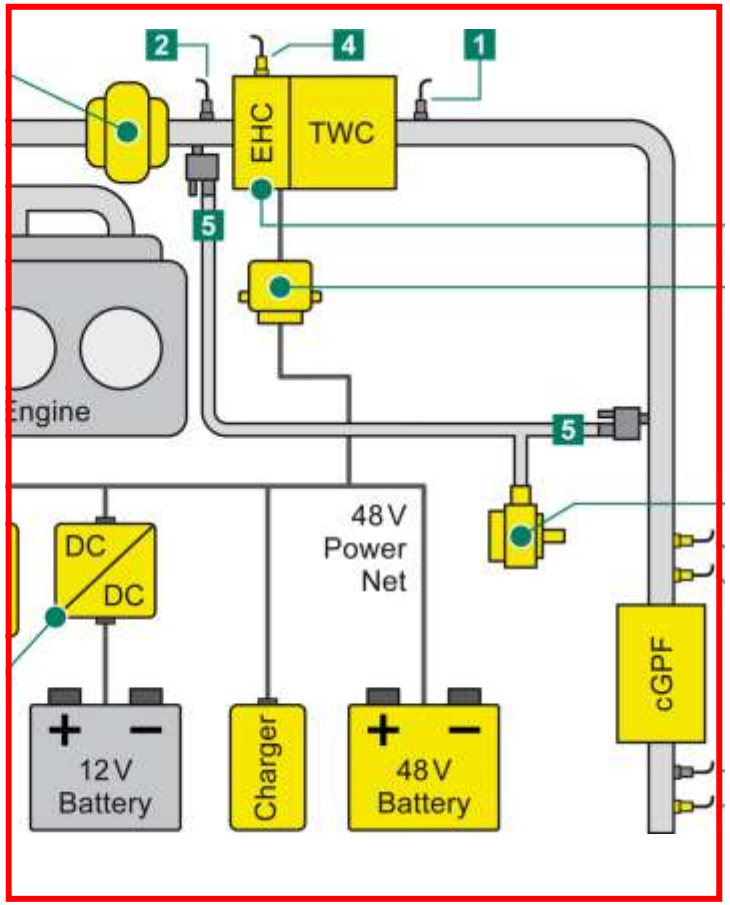
SOLUTIONS FOR CLEANER ELECTRIFIED ENGINES

EMISSION LEGISLATION AND SYSTEM CONFIGURATION



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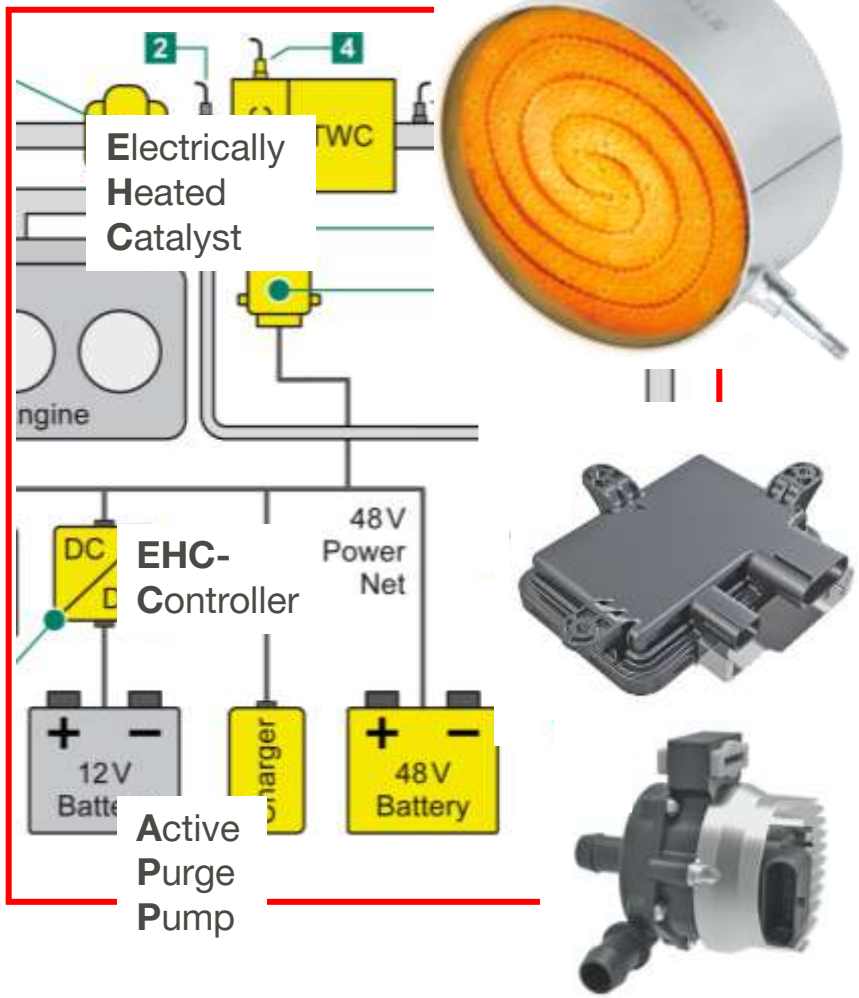
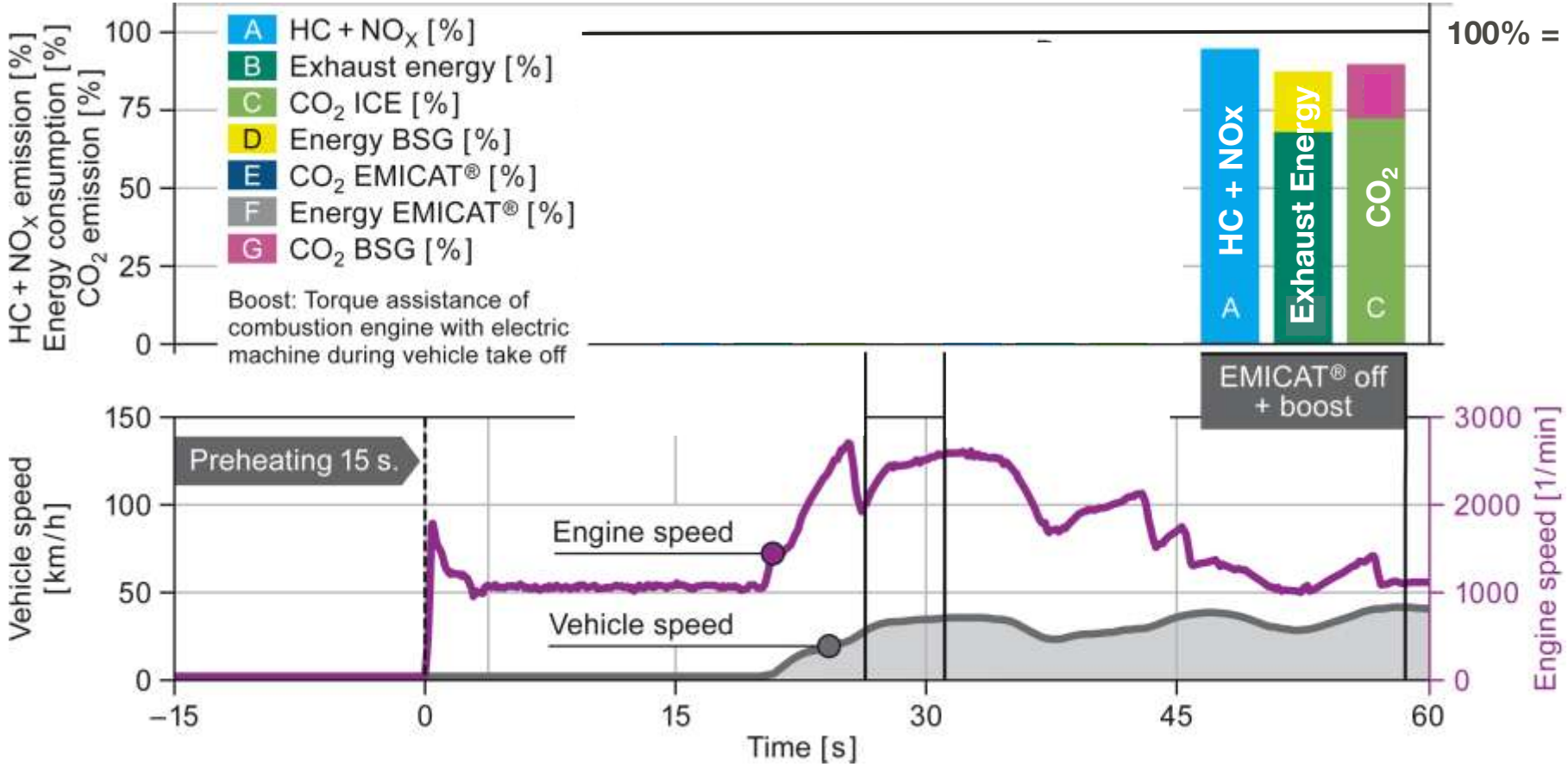


SOLUTIONS FOR CLEANER ELECTRIFIED ENGINES

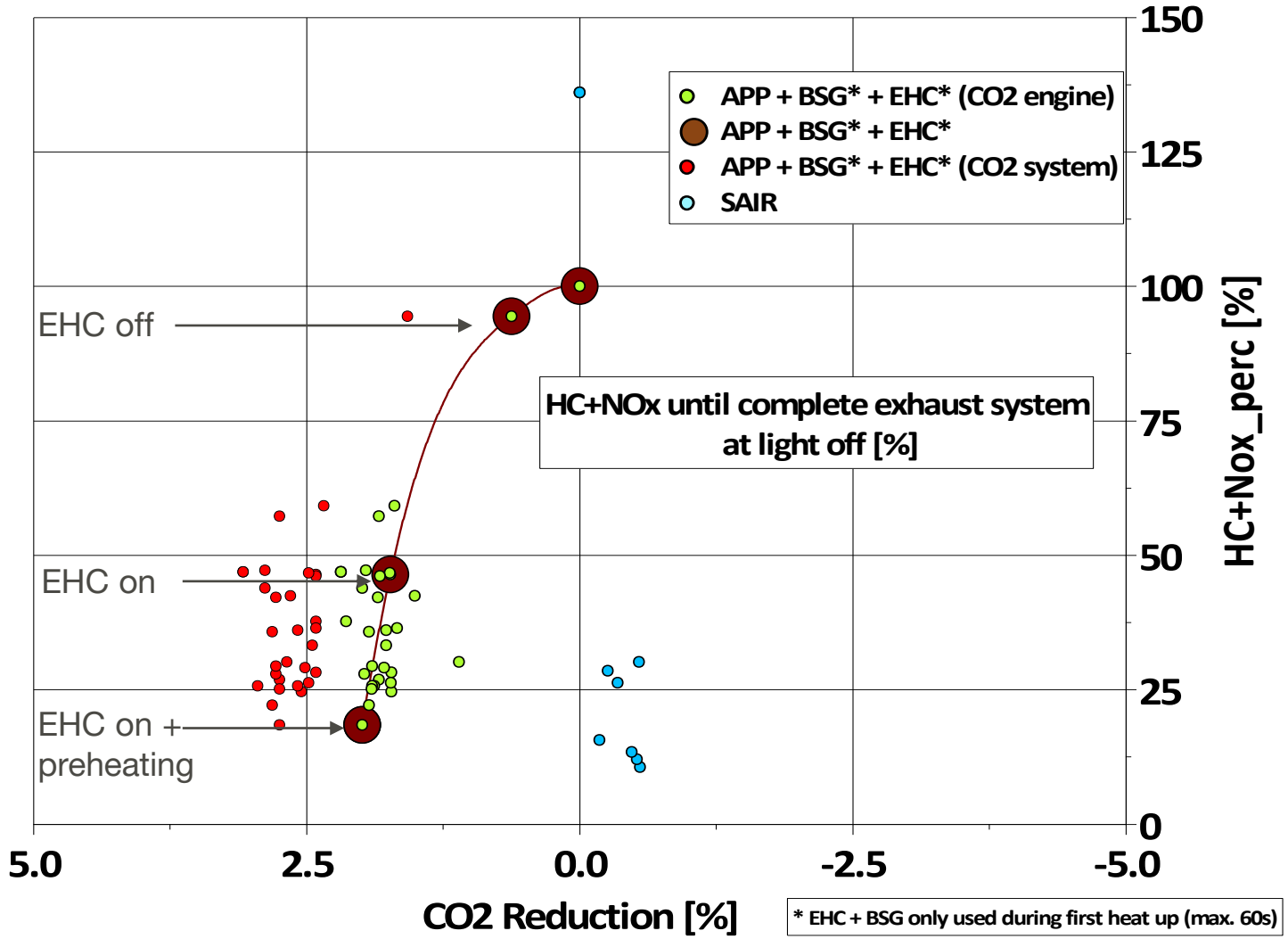
ELECTRICALLY HEATED CATALYST AND ACTIVE PURGE SYSTEM



100% = not electrified vehicle

SOLUTIONS FOR CLEANER ELECTRIFIED ENGINES

CO_2 AND GASEOUS EMISSION REDUCTION

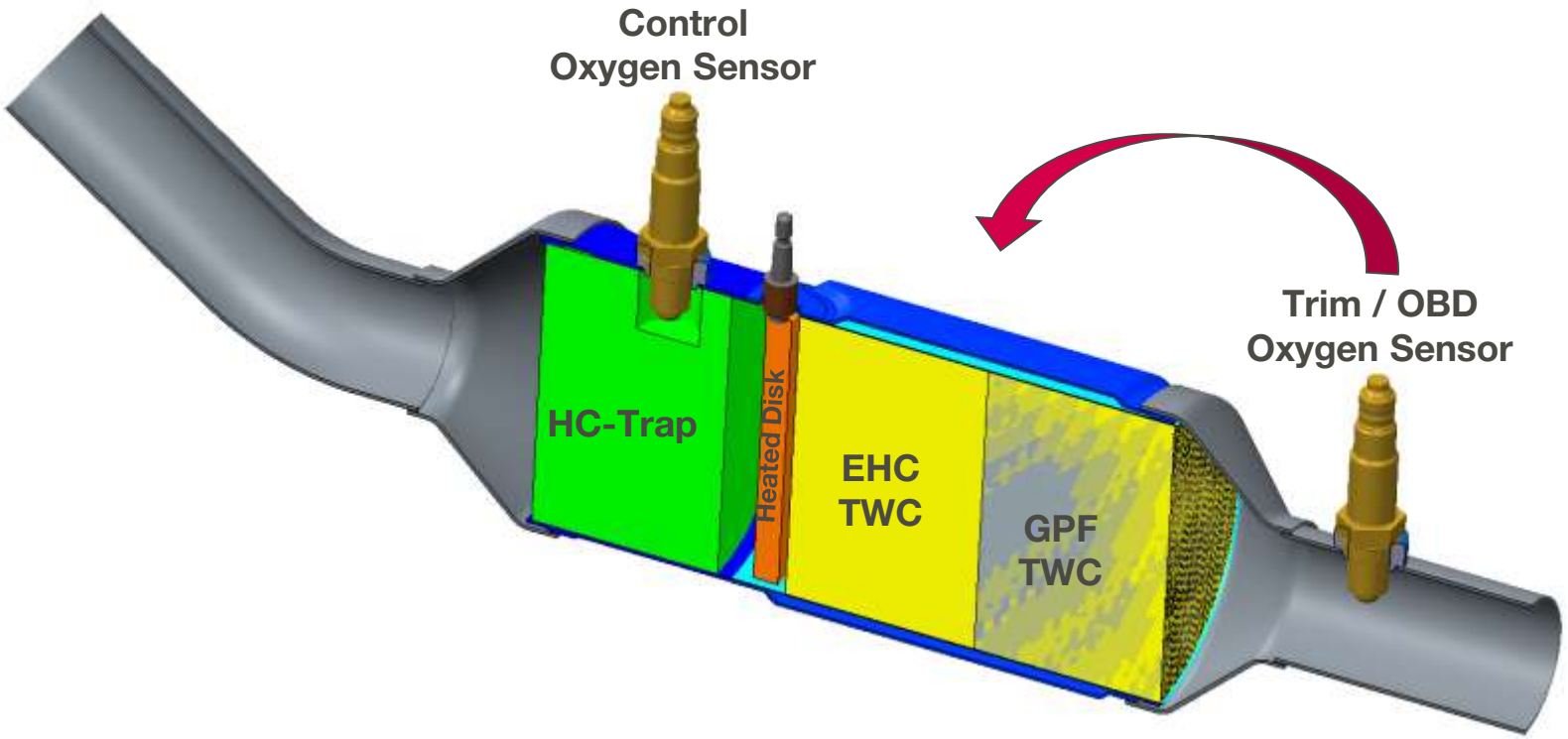


CO_2 benefit of Emicat due to faster light off and shortened catalyst heating phase

Red dots: Electrical energy not used for driving

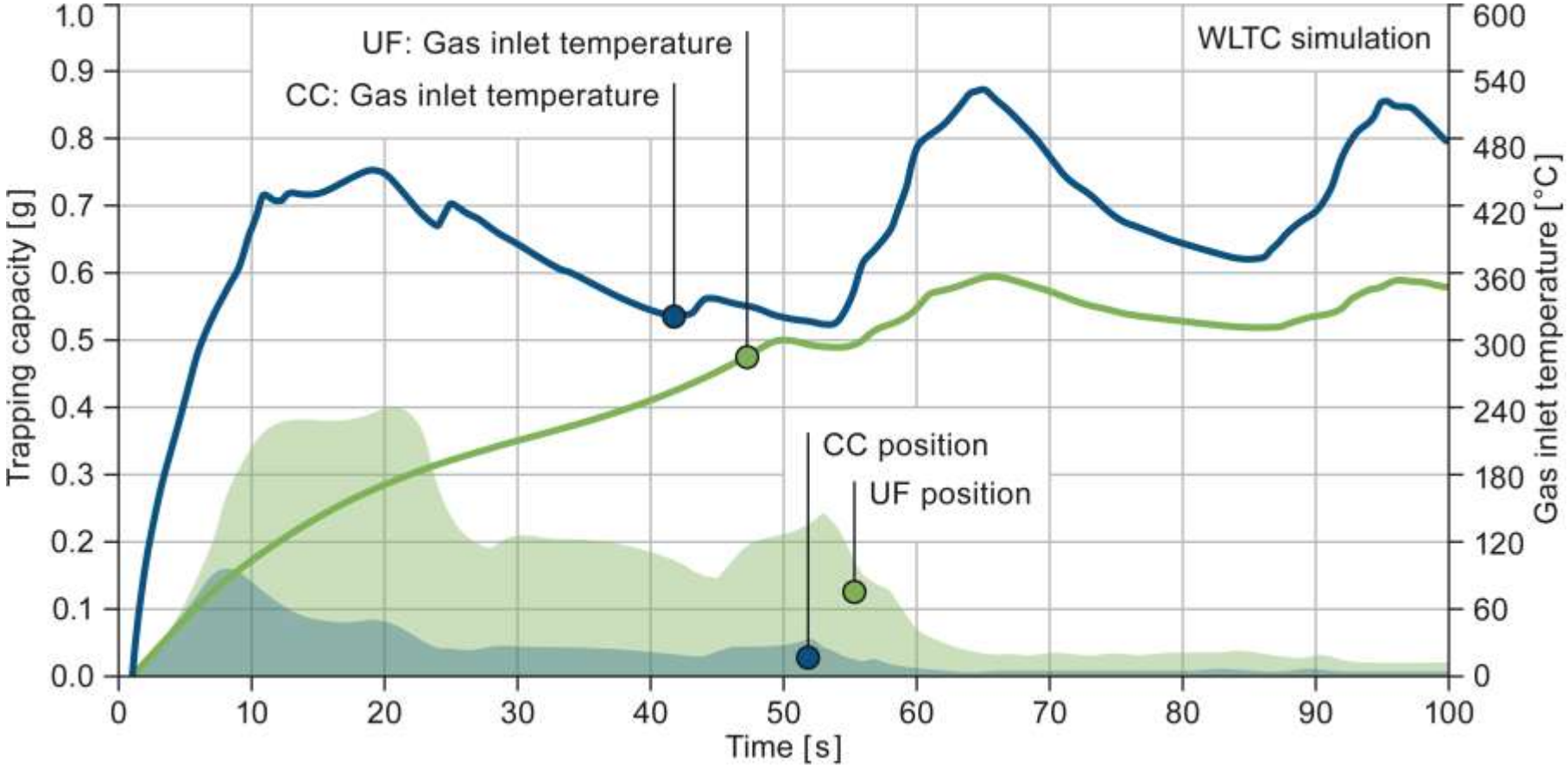
UNDERFLOOR CATALYST SYSTEM FOR EU7 RDE

HC-TRAP IN COMBINATION WITH ELECTRICALLY HEATED CATALYST

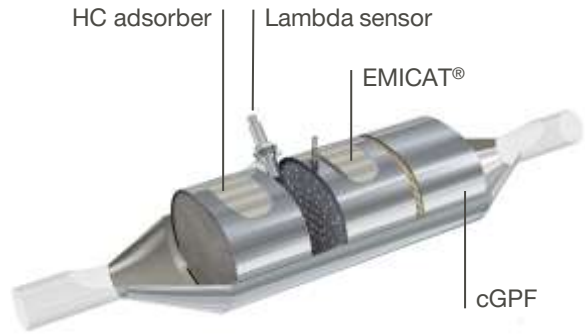


SOLUTIONS FOR CLEANER ELECTRIFIED ENGINES

HC ADSORBER



HC trap in under-floor position for delayed desorption and increased HC capacity



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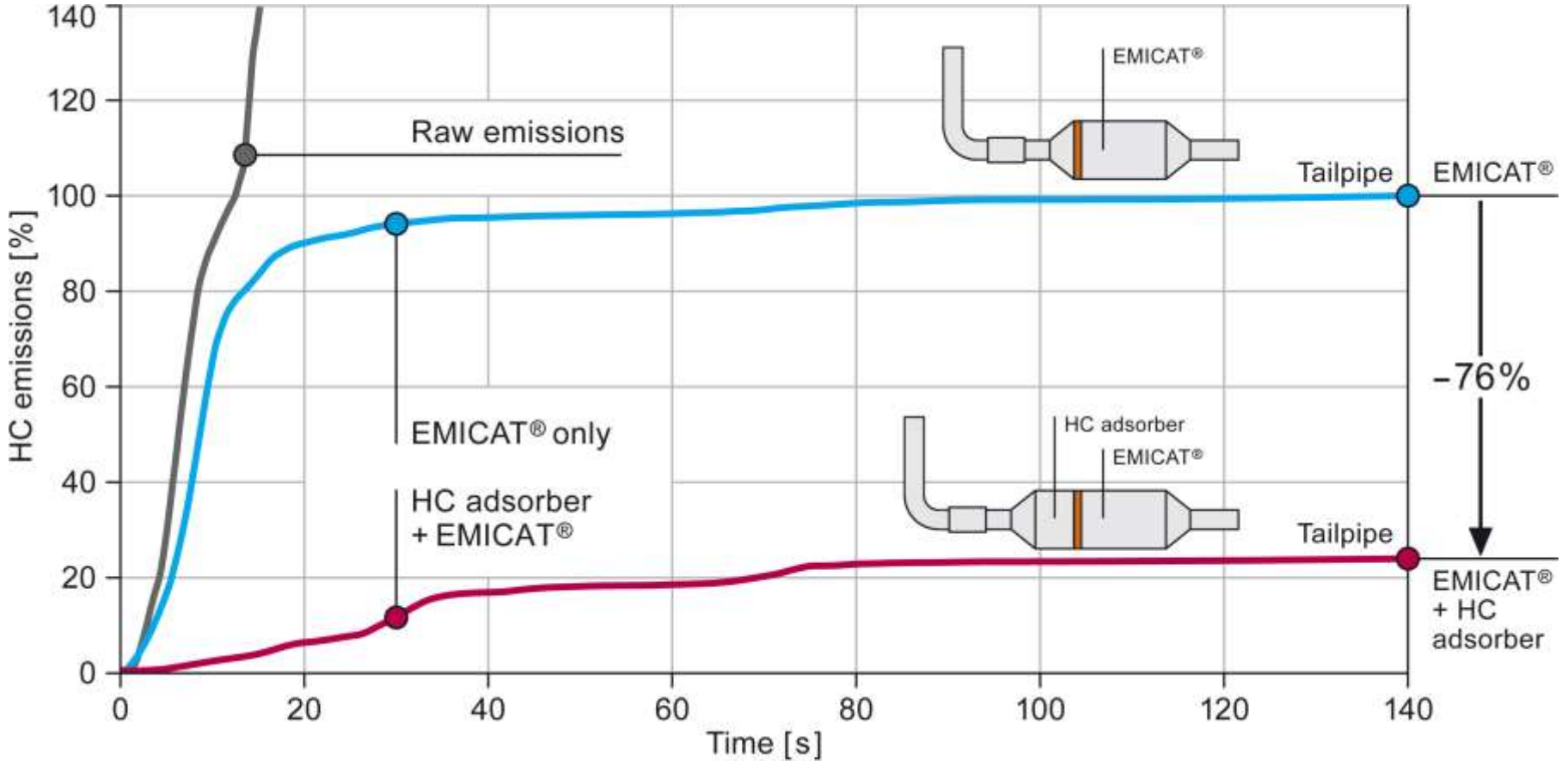
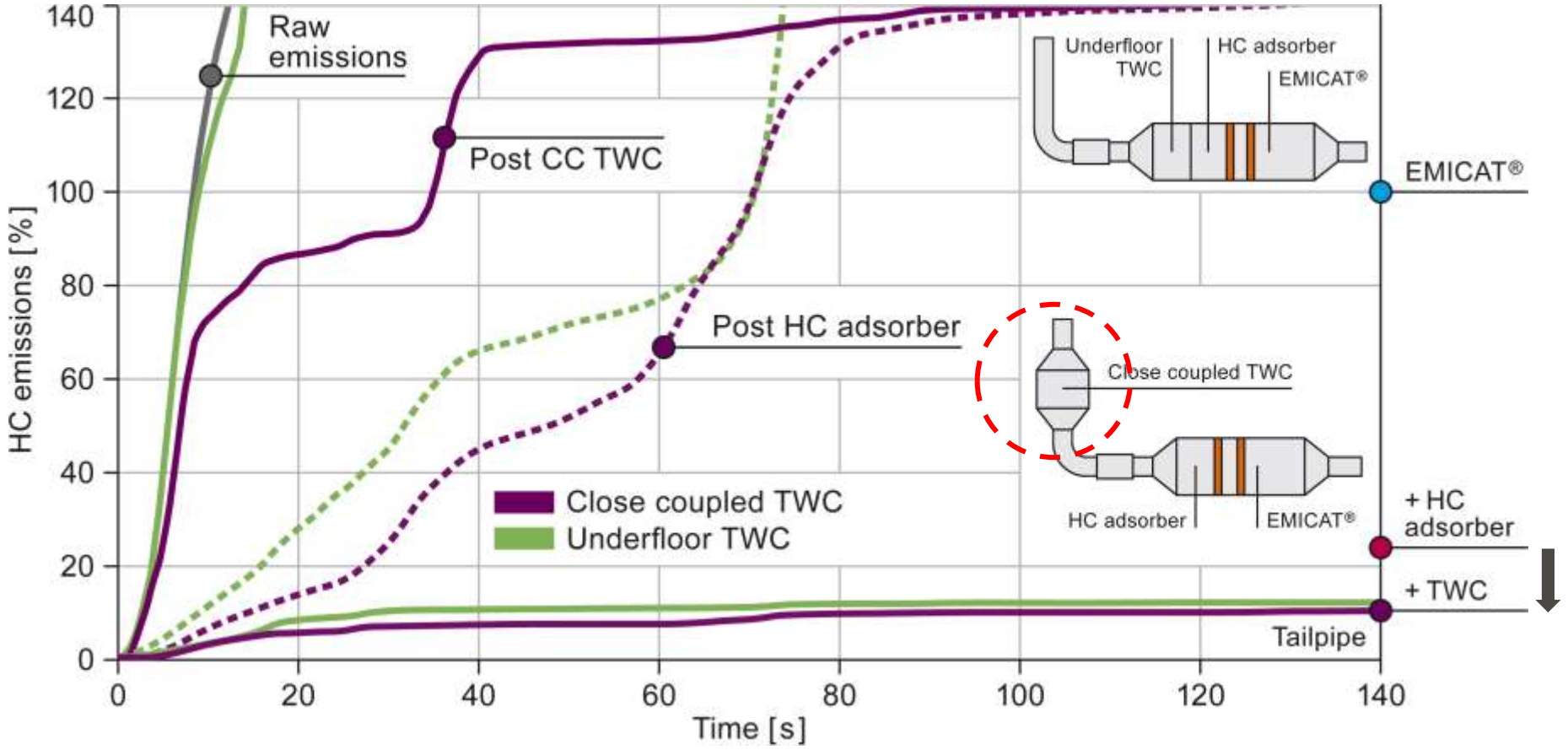


Fast EMICAT® light-off before HC trap desorption.

SOLUTIONS FOR CLEANER ELECTRIFIED ENGINES

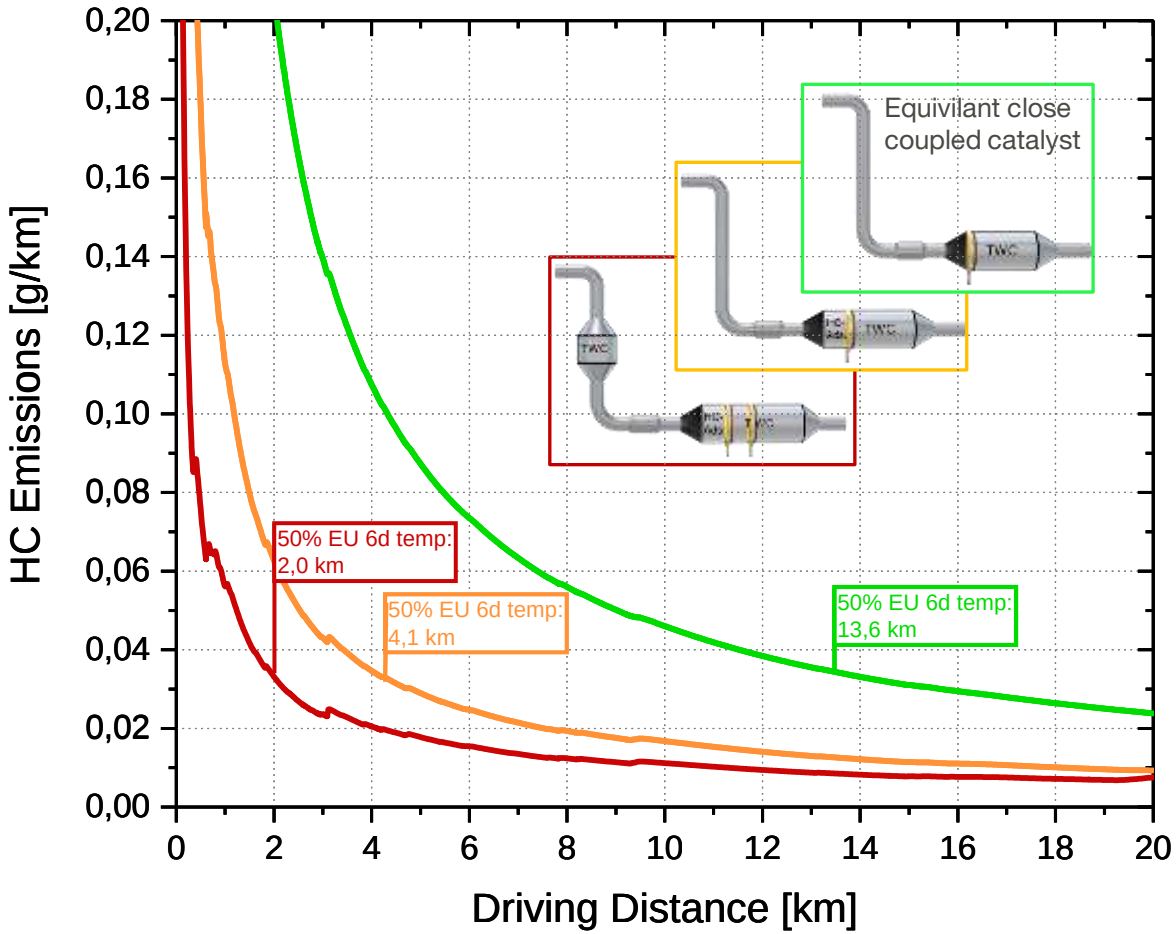
HC ADSORBER



90% HC improvement with close coupled catalyst + HC trap + EMICAT®.

RESULTS OF TESTED HC-ADSORBER SYSTEMS

HC-EMISSIONS DEPENDING ON WLTC DRIVING DISTANCE



- With close coupled catalyst 50% of WLTC HC-Limit is achieved after 13,6 km
- Pure underfloor adsorber system achieves 50% of WLTC HC-Limit after 4,1 km
- Combination of close-coupled small „start catalyst“ and underfloor adsorber System achieves 50% of WLTC HC-Limit after 2,0 km
- Increased adsorber volume shortens the distance to 1,3 km

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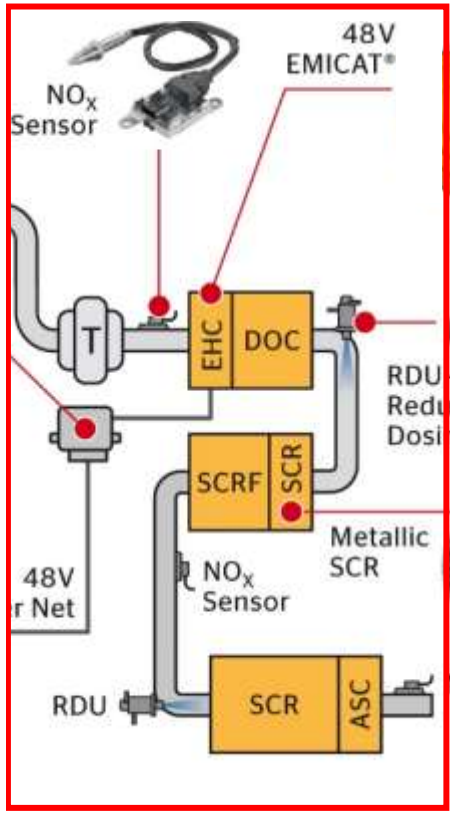
Super Clean Electrified Diesel

Technology Setup



Super Clean Electrified Diesel

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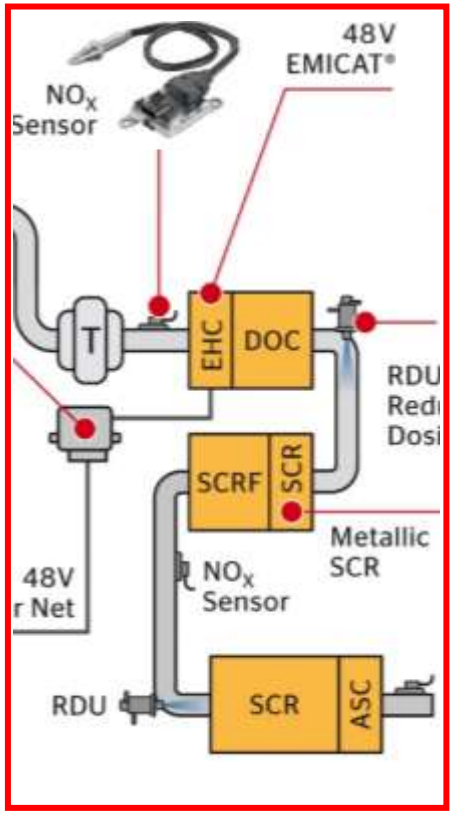
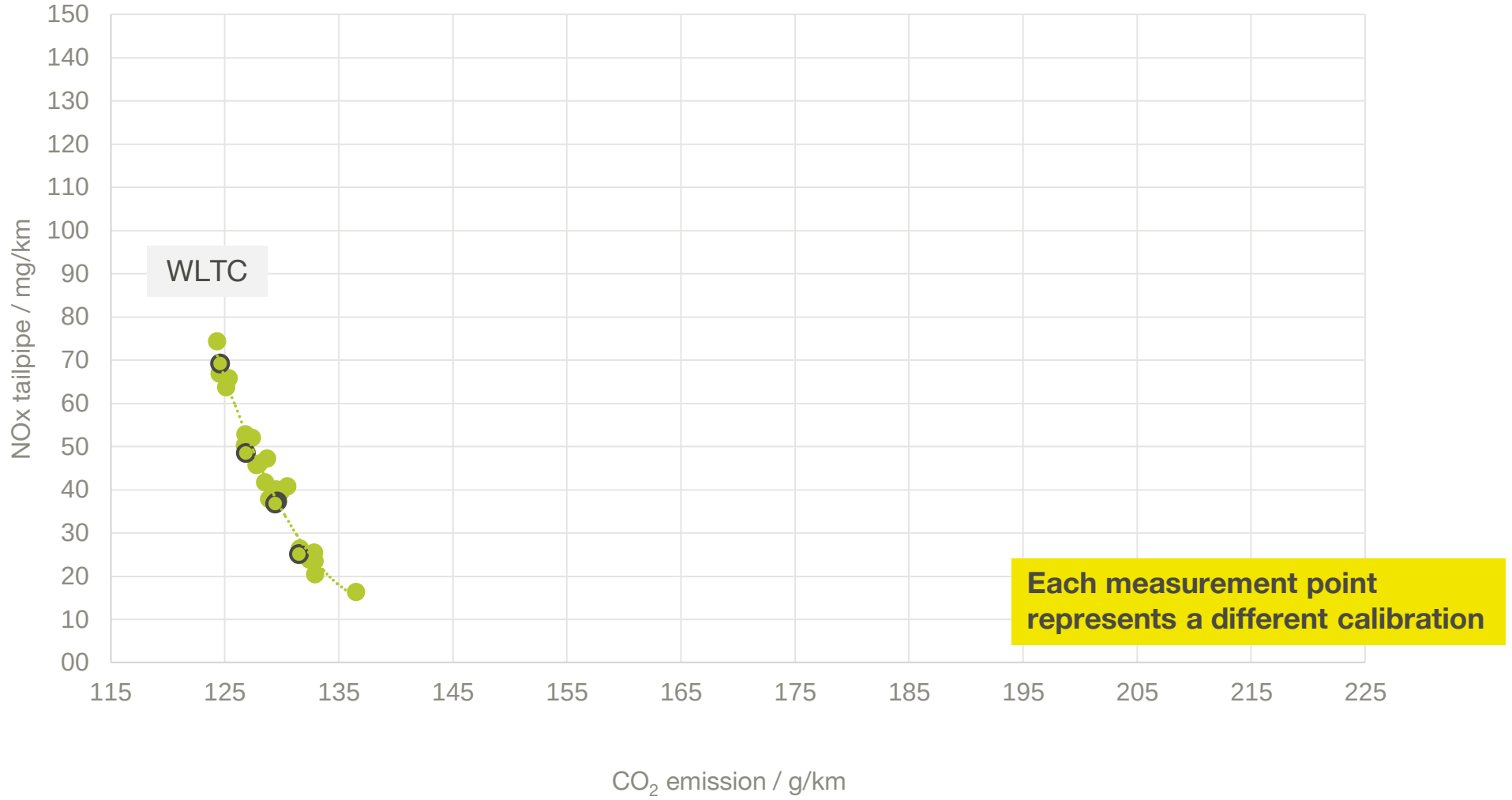


CHALLENGE OF DRIVING CYCLE AND DISTANCE ON NO_x AND CO_2 EMISSIONS; DIESEL; EHC OFF



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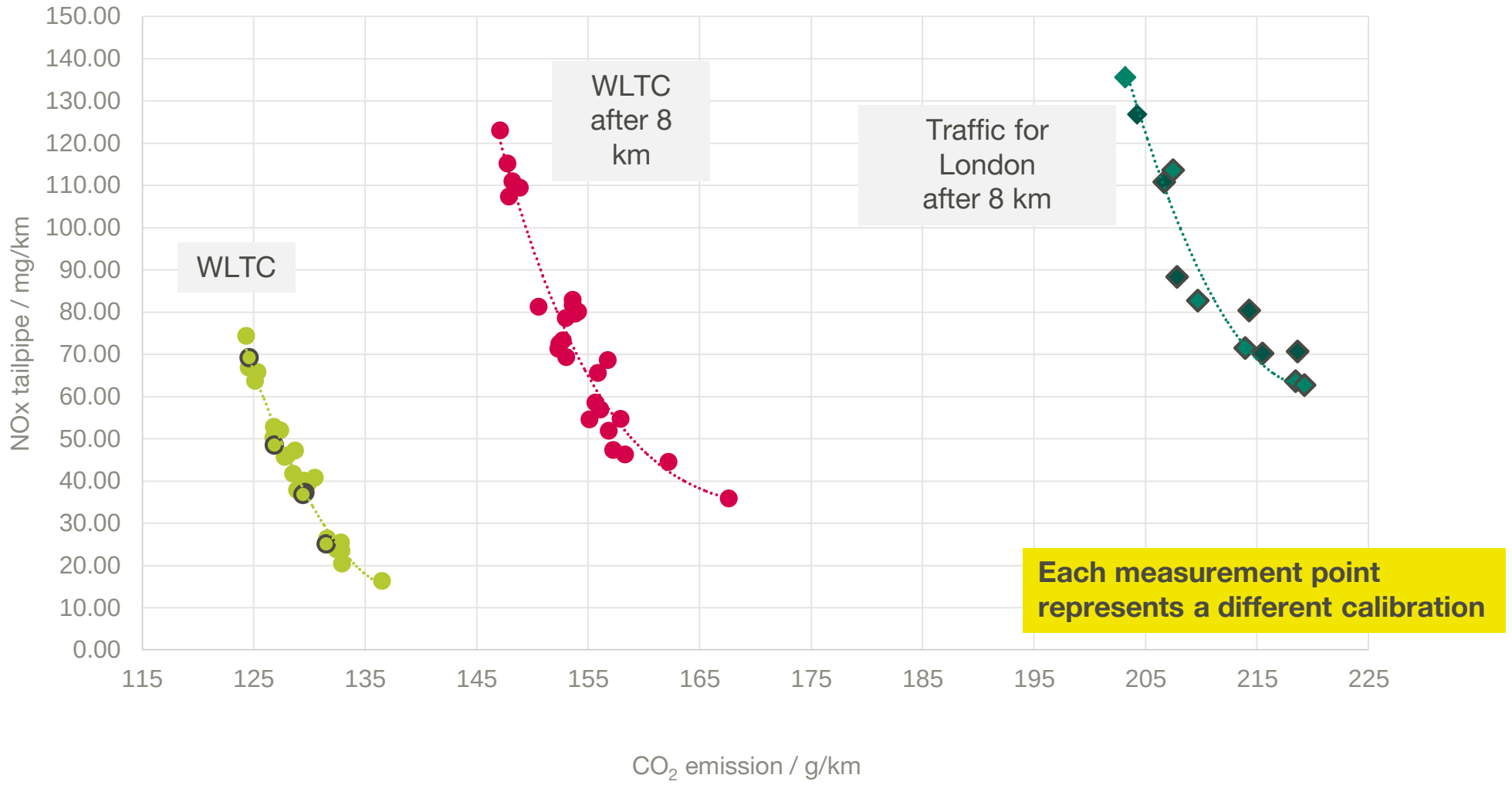
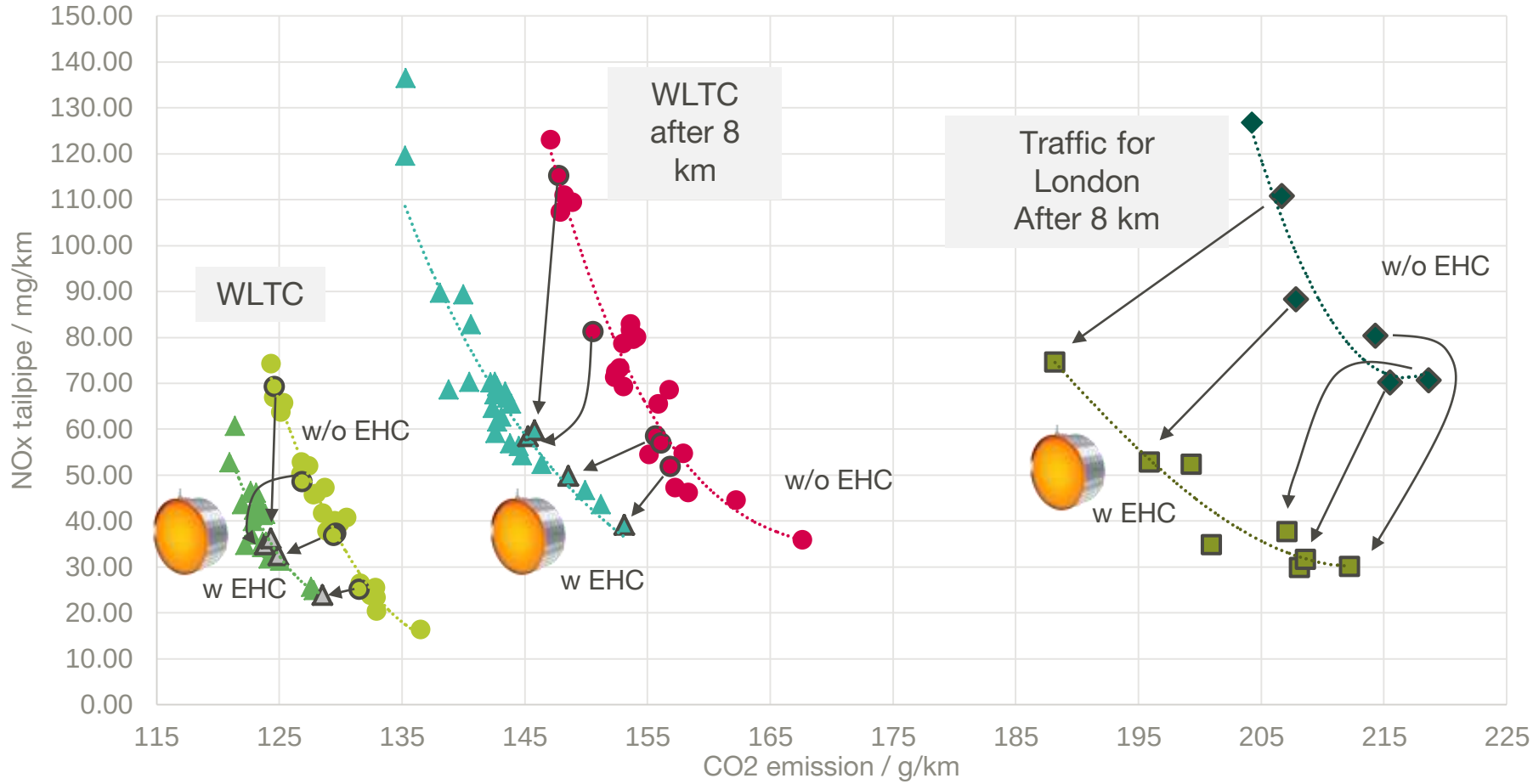


BENEFIT OF HEATED CATALYST IN DIESEL APPLICATION

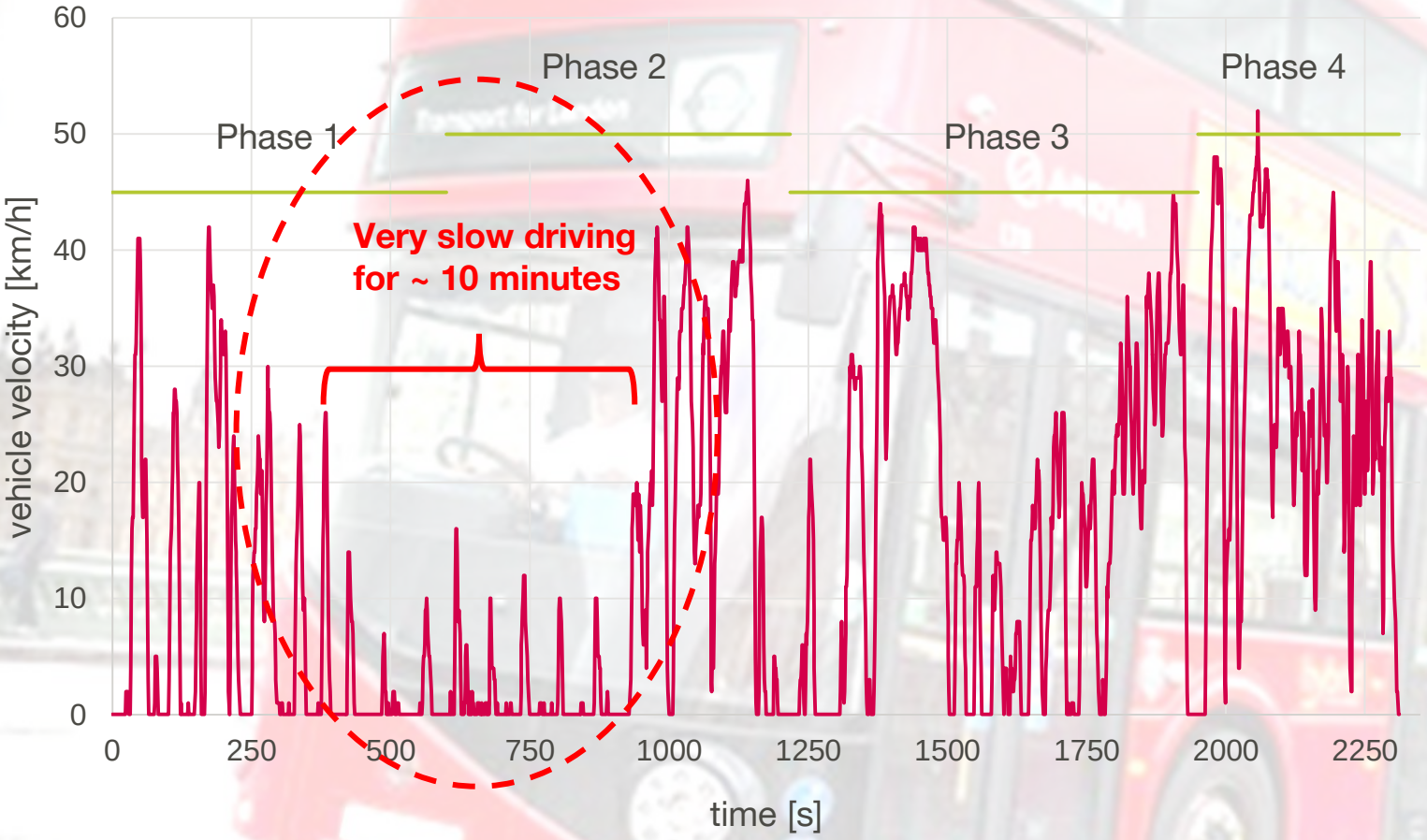
IMPACT OF HEATED CATALYST ON NO_x/CO_2 EMISSIONS



In low load cycles (TfL) emission target can be reached only with EHC

TFL TRAFIC FOR LONDON CYCLE

VEHICLE VELOCITY TRACE

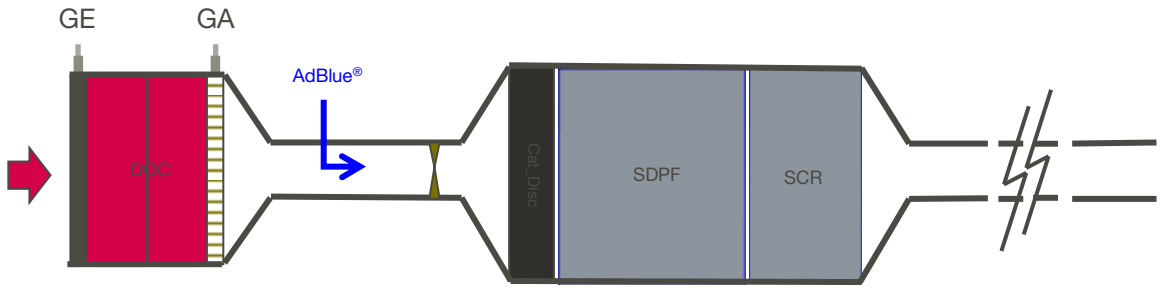


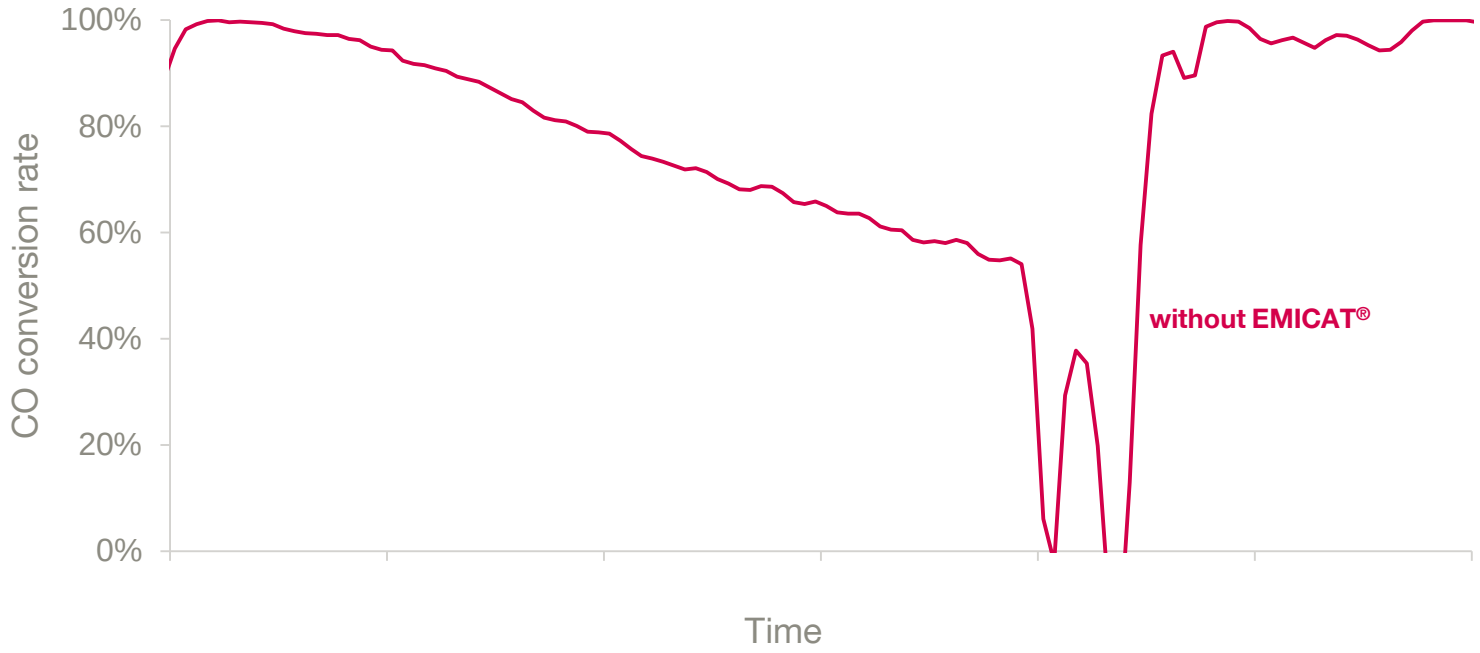
Cycle Characteristics

	Duration [s]	Distance [m]	Average Vehicle Velocity [km/h]
Complete Cycle	2311	8951	13,9
Phase 1	600	1199	7,2
Phase 2	618	1780	10,4
Phase 3	732	3319	16,3
Phase 4	361	2652	26,4

STOPP AND GO TRAFFIC / RED TRAFFIC LIGHT CO-PEAK

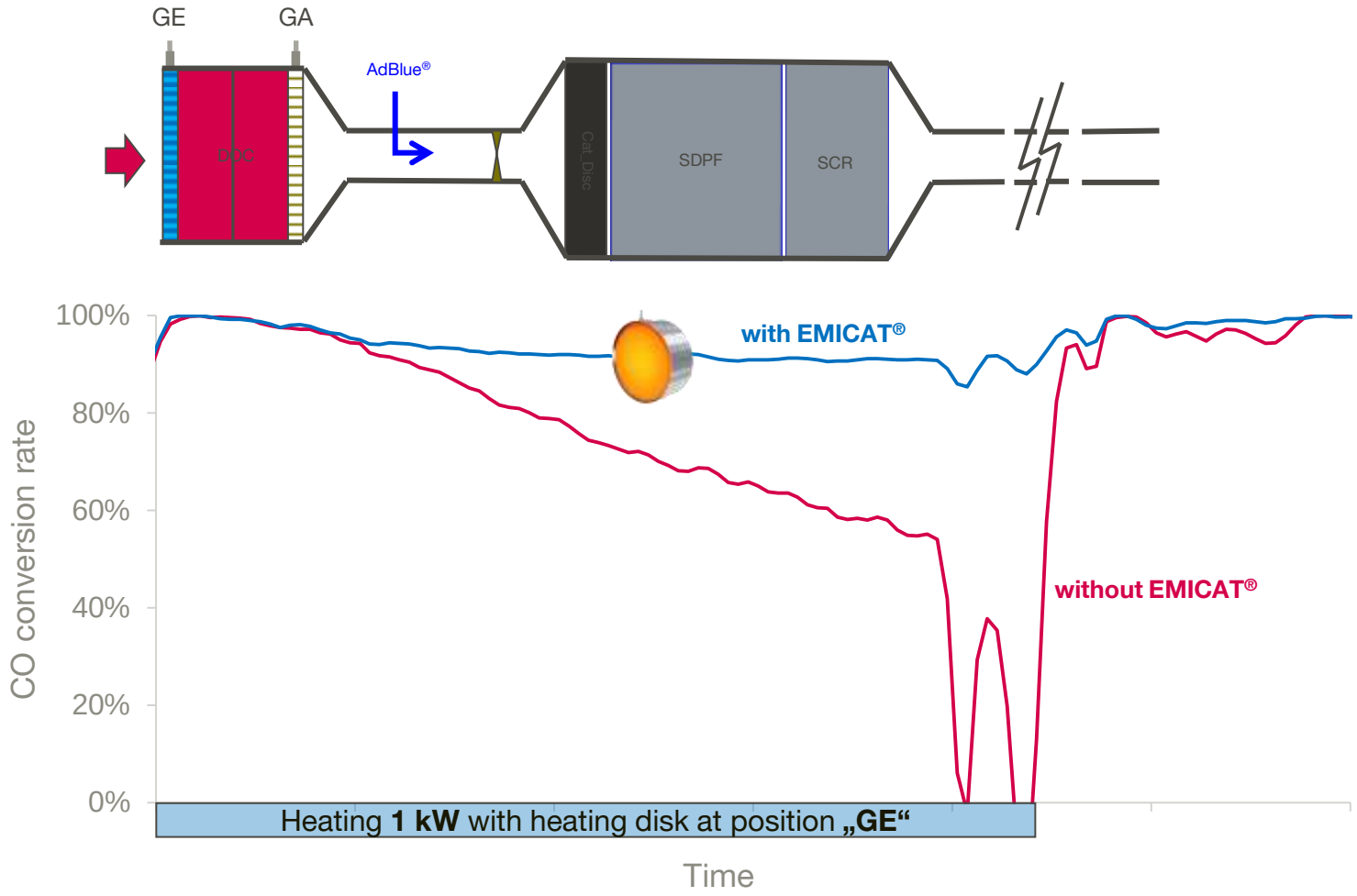
REAL WORLD CITY DRIVING





STOPP AND GO TRAFFIC / RED TRAFFIC LIGHT CO-PEAK

REAL WORLD CITY DRIVING; ADVANTAGE OF THE ELECTRICALLY HEATED CATALYST

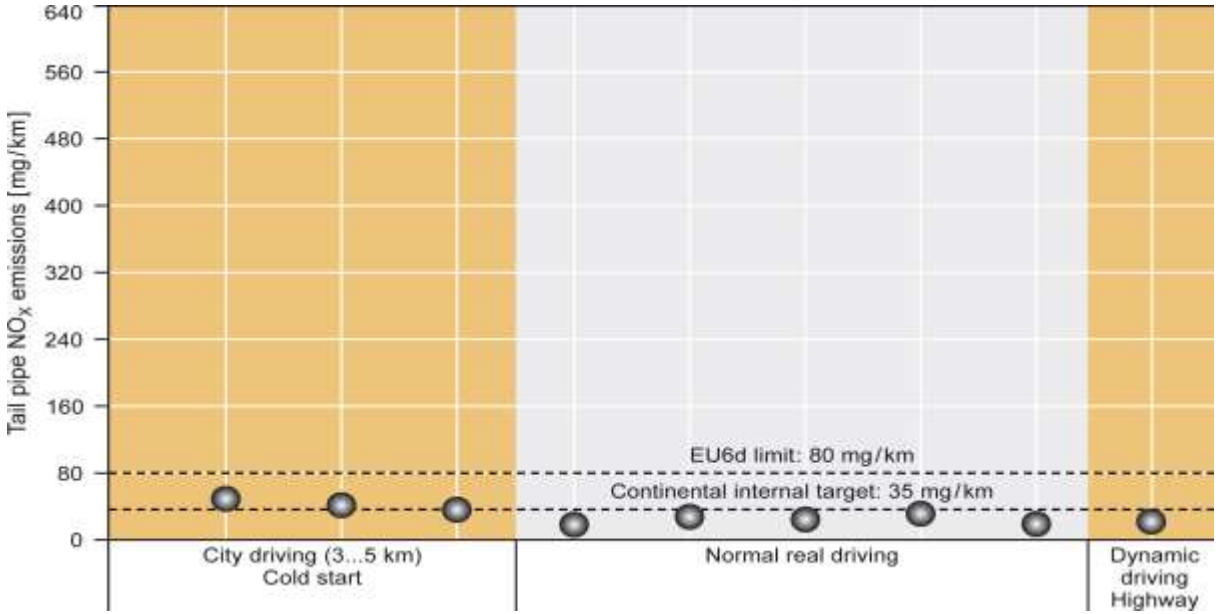


EMICAT® prevents blow out of catalytic converter

SUPER CLEAN ELECTRIFIED DIESEL

SUMMARY

Driving Cycle	Driven Distance [km]	Tail Pipe NO_x Emissions [mg/km]
WLTP City at 23°C T_{Amb}	3.1 / **8**	41 / **20**
WLTP City at 0°C T_{amb}	3.1 / **8**	103 / **41**
WLTP at 23°C T_{amb}	23	13
Transport for London	**8.3**	**27**
Regensburg City	**5**	**48**
RST95	13	20
Journalist Cycle City	**8**	**38**
Journalist Cycle Total	105	41
FTP75	17.7	13
US06	12.1	1.2



Solutions

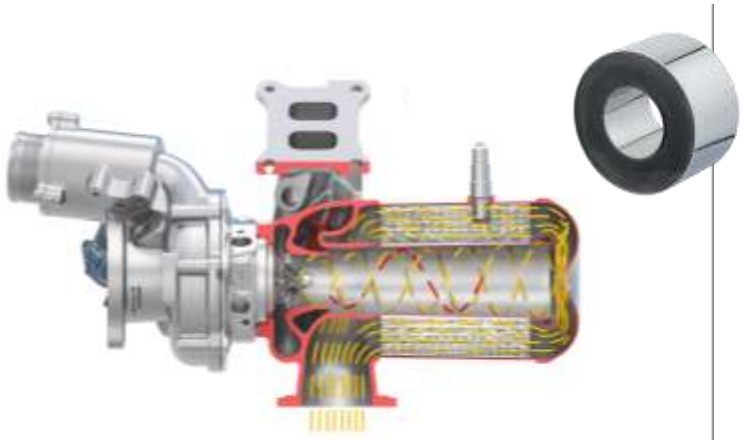
- **EMICAT® + 48 V System**
  - Accelerate catalyst warm-up
  - Keep **efficiently** EAT warm
  - **Reduce CO_2 emissions (7 g/km)**
- **Dual SCR System**
  - Keep high NO_X conversion efficiency by higher engine load
  - Limit NH_3 slip
  - **Reduce CO_2 emissions (3 g/km)**

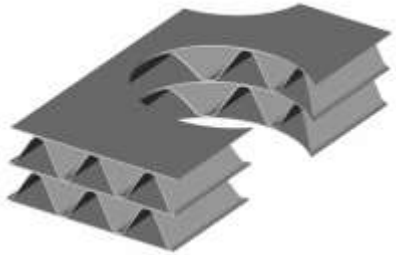
EAT: Exhaust After-treatment System

› Low NO_X: < 40 mg/km in cold short city driving; Low CO_2: - 10 g/km at low NO_X emissions.

EMITEC PROVIDES TECHNOLOGIES FOR ROBUST EMISSION SOLUTIONS

SUMMARY





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THANK YOU

EMITEC