Intelligent Exhaust System Thermal Management by using CatVap® from Albonair and HVO to enable Zero-Impact city vehicles

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Who is Albonair?

- Part of the Hinduja Group and Ashok Leyland
- Foundation: 2007
- UDS Produced: > 2,000,000 parts
- Muffler Systems Produced: > 150,000 parts
- Applications: Bus, MD-Trucks, HD-Trucks, Construction, Agriculture, Stationary, Maritime, Rail etc.
- Global Presence: Germany, India, China
- Offers innovative solutions for cleaner mobility and power systems

Global Presence



Dortmund, Germany

» Headquarter
» R&D
» Sales/ Customers Service
» Urea Dosing System Assembly Line



Ennore, India

» Sales
» Customer Service
» Tank Assembly Line
» Urea Dosing System Assembly Line
» Nozzle Assembly
» Filter Assembly
» Muffler (Pass through)

Key Facts:

»250 000 dosing systems/year
»>2 000 000 Systems overall
»300+ employees
»160 Mio. € revenue


Taicang, China

» Sales
» Customer Service
» Urea Dosing System Assembly Line

1 **Challenges of the "Zero Impact Emission" strategy**

2 Albonair CatVap®

3 PEMS RDE Test with a Garbage Truck

4 Conclusions

Study on Zero-impact Vehicle Emissions (ZIE/ZIV)

FVV is an association of the Automotive Industry for basic research.
Members are (European) car and truck manufacturers (VW, Daimler, IVECO, Toyota, Honda ..) and suppliers (BOSCH, Schaeffler, AVL, FEV and also Albonair).
In total FVV has 220 members.

To prepare EURO 7 emission regulation FVV started two research projects between 2020 and 2023 to analyze the impact of vehicle emissions on the air quality.

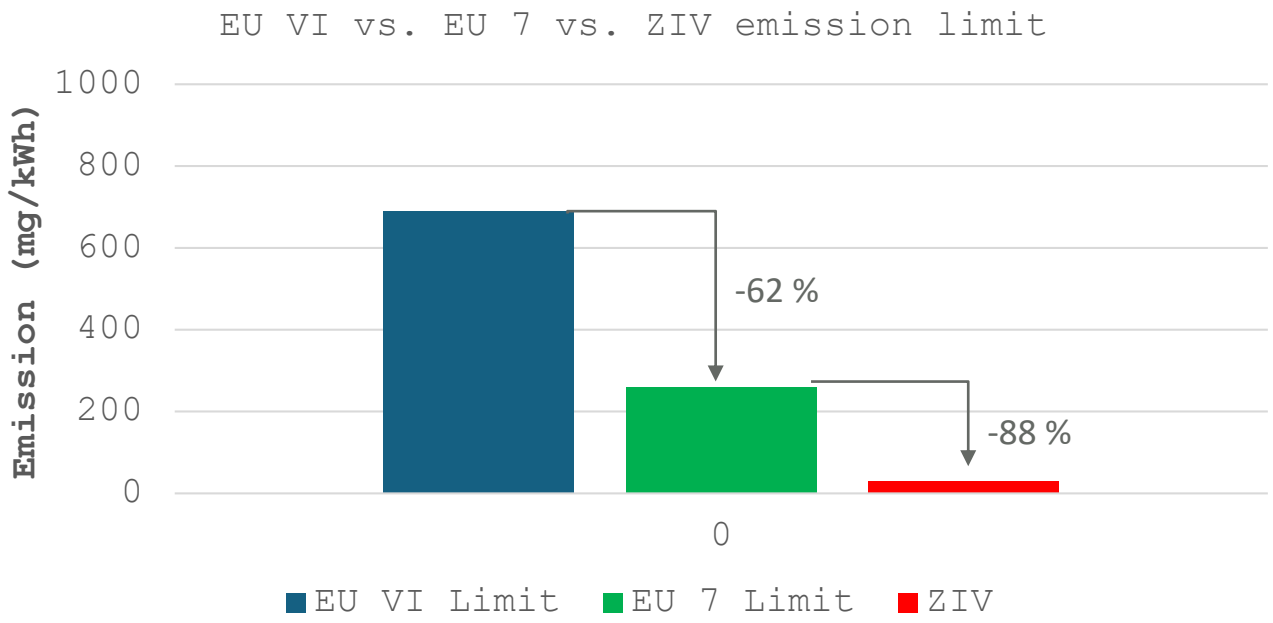
Study was headed by Bosch and VW.

Key Take away:
"Even a complete ZIV emission level fleet, passing a critical inner-city point, would not have a negative impact on air quality."

ZIV level for HDV was evaluated to be 28,1 mg/kWh for inner city operation, without cold start.

Challenges of the "Zero Impact Emission" strategy

Reduction of RDE NOx emission



ZIE = **Z**ero **I**mpact **E**mission
ZIV = **Z**ero **I**mpact **V**ehicle

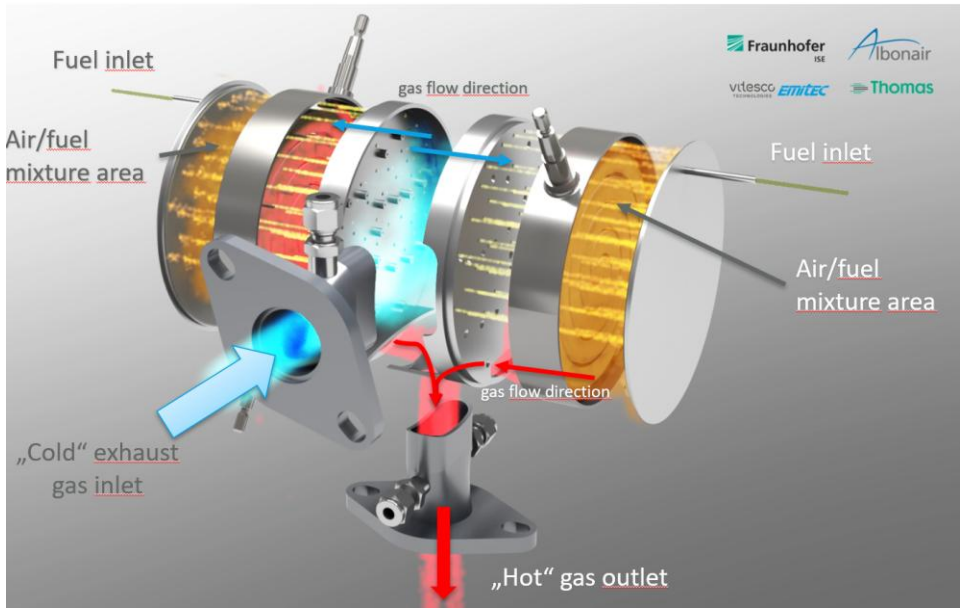
Target:
Achieving the lowest NOx emissions according to **ZIV specification (30 mg/kWh)** to avoid measurable effects on NOx emissions.

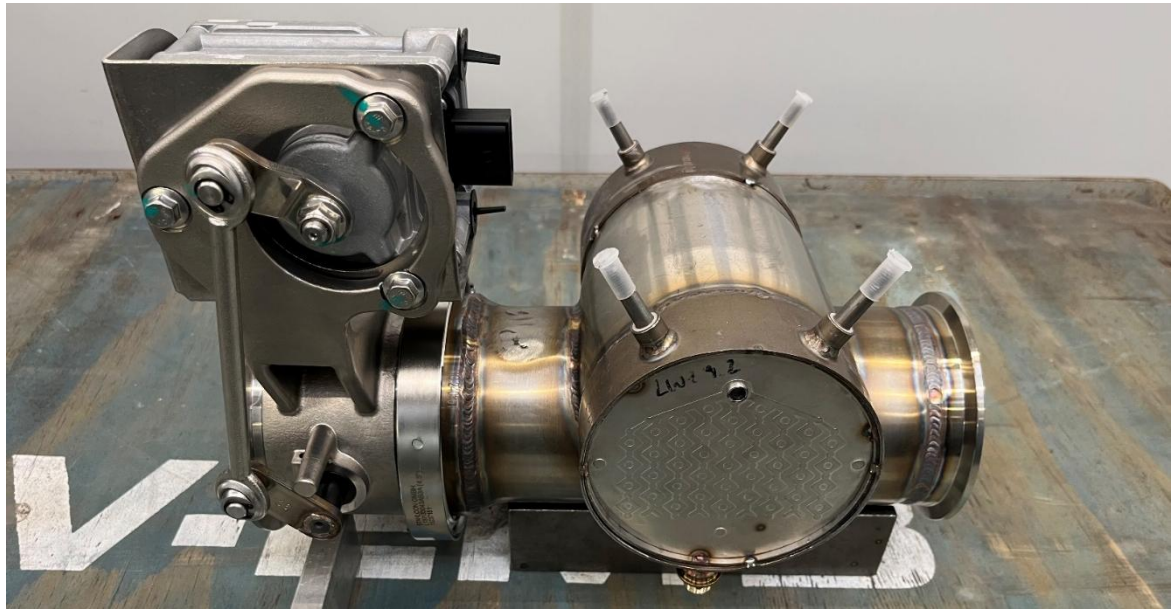
- EU VI and EU 7 RDE include urban, rural and motorway cycles.
- ZIV, on the other hand, only considers the urban cycle, in which the garbage truck cycle poses the greatest challenge.

1. Challenges of the "Zero Impact Emission" strategy
2. **Albonair CatVap®**
3. PEMS RDE Test with a Garbage Truck
4. Conclusions

CatVap®

Flexible system for heating up and keeping the exhaust gas warm





System Characteristics

- CatVap® is a catalytic heating system using already existing components
- Efficient and flexible aftertreatment thermal-management
- Powered with fuel only, after short electrical system start
- No electric power consumption during further operation
- Keeps the exhaust temperature at target level independent of engine operation
- Continuous DOC / SCR temperature stabilization in “Heat retention mode”
- Enables active DPF regeneration (replacing HC Doser) with high efficiency
- No engine thermal-management required

CatVap® system technology – Description & main functions

System description

The fuel processing technology CatVap® is a heating measure for Exhaust Aftertreatment systems.
The heat will be provided thermally by adding extra fuel with regulated dosing pumps depending on the actual power requirement into the CatVap® system.

- **Heating Mode**
  The CatVap® system provides the required thermal energy to heat up the DOC in the EATS from cold conditions within the given timeframe.

- **DOC Mode (Diesel dosing function)**
  The CatVap® system has the capability to provide mainly reactive reductants such as H_2, CO and short chained alkenes to the exhaust flow in order to react on the DOC (diesel oxidation catalyst) of the vehicle EATS, whereby reduction of light-off temperature will be achieved.

- **Heat Retention Mode**
  The CatVap® system is capable to keep the EATS warm and to protect the system from cooling down in (temporary) low load operation areas in order to keep AdBlue-dosing release under all circumstances.

- **DPF Regeneration Mode**
  The CatVap® system provides the required heat flow to regenerate the DPF (Diesel Particulate Filter) within a given time.

CatVap® - Technical Details (single and double reactor)

	Single Reactor	Double Reactor
Power, max. heat up mode	10 kW	20 kW
Power, max. DOC mode	50 kW	100 kW
Power, min. (heat retention) (deactivated when engine exhaust temperature is high enough	1 kW	2 kW
Max. electrical power of electrical preheating	2 kW	4 kW
Maximum amperage of CatVap® during start period @ 24 V	90 A	180 A
Maximum operating duration of electrical preheating	150 s	150 s
Pressure drop over complete System	40 mbar	40 mbar

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Project Partners

Albonair

Albonair

HJS Emission Technology

REMONDIS®

➔ Remondis operates 11.000 trucks

MEG mbH Mülheimer Entsorgungsgesellschaft

transdev MOBILITY INSPIRED BY YOU

➔Transdev operates 47.000 buses

Fraunhofer ISE

Remondis service group: specialized services and products in four divisions

REMONDIS®
IM AUFTRAG DER ZUKUNFT

Environmental and industrial services

- Recycling
- Service
- Water

Revenues 2023 (Mn. €)	**12.000**
Employees	**43.000**

RHENUS LOGISTICS

Logistics

- Air & Ocean
- Automotive
- Contract Logistics
- Overland Transport
- Port Logistics

Revenues 2023 (Mn. €)	**7.500**
Employees	**40.000**

SARIA®

Bio-Industries

- Food & Pharma
- Organics 2 Power (O2P)
- Sinova

Revenues 2023 (Mn. €)	**3.300**
Employees	**13.000**

transdev

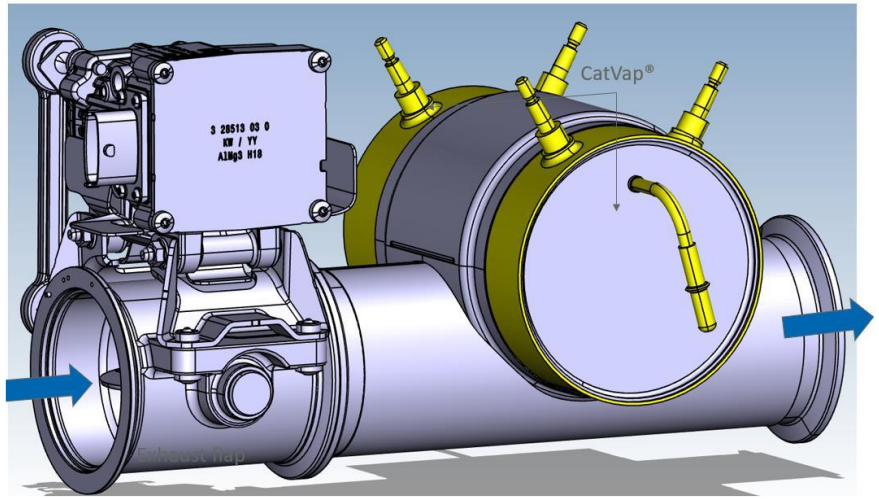
Transport

- Public transport/urban transport
- Mass rail transport
- On-Demand-Transport

Revenues 2023 (Mn. €)	**9.300**
Employees	**102.000**

Share of 66 %

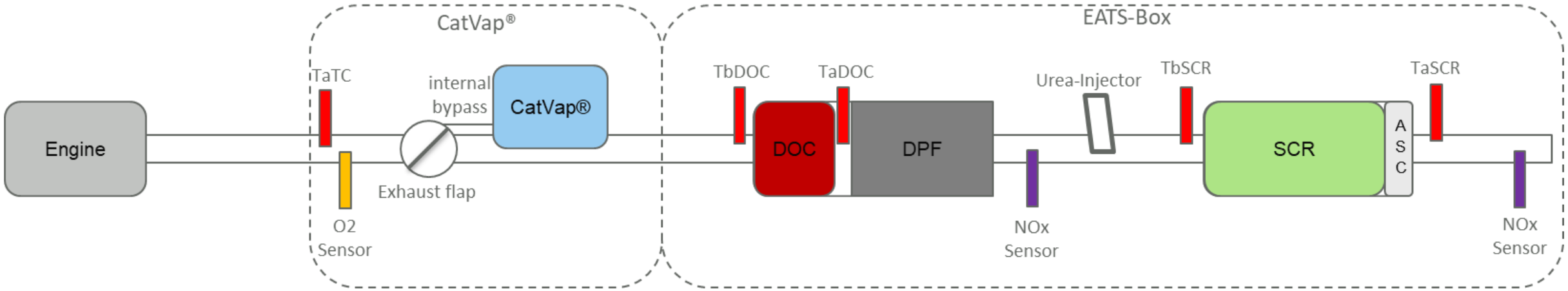
Project kick-off: MEG garbage truck with CatVap® to demonstrate ZIV Capability

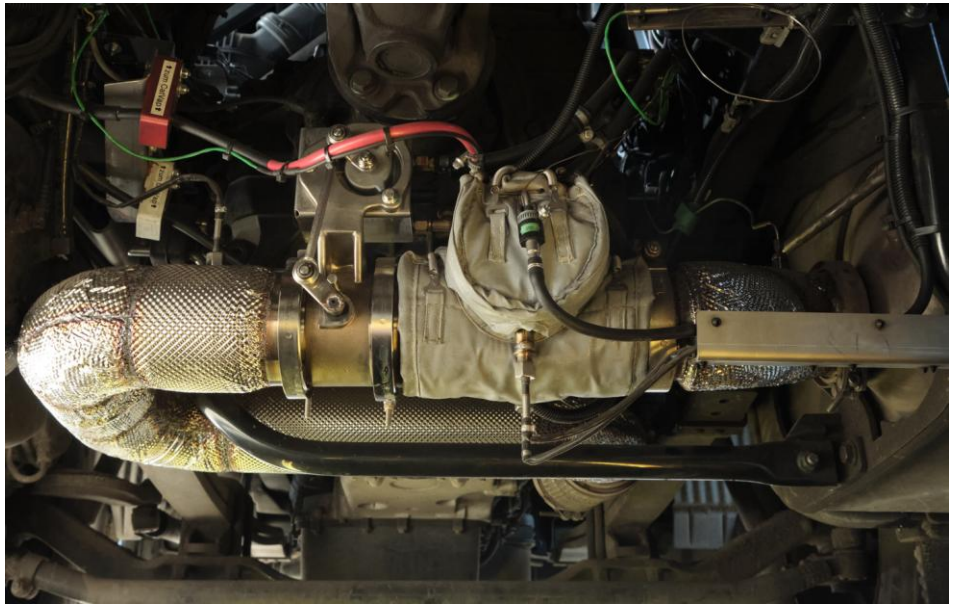


CatVap®
System

Garbage Truck
Owner: MEG
$V_H = 10{,}5\ l\ ;\ \ \mathrm{P} = 235\ \mathrm{kW}$
EURO VI c, MJ 2018, 70.000 km
Vanadium SCR catalyst

CatVap® Tests with Remondis/MEG garbage truck





Test Truck Modifications:

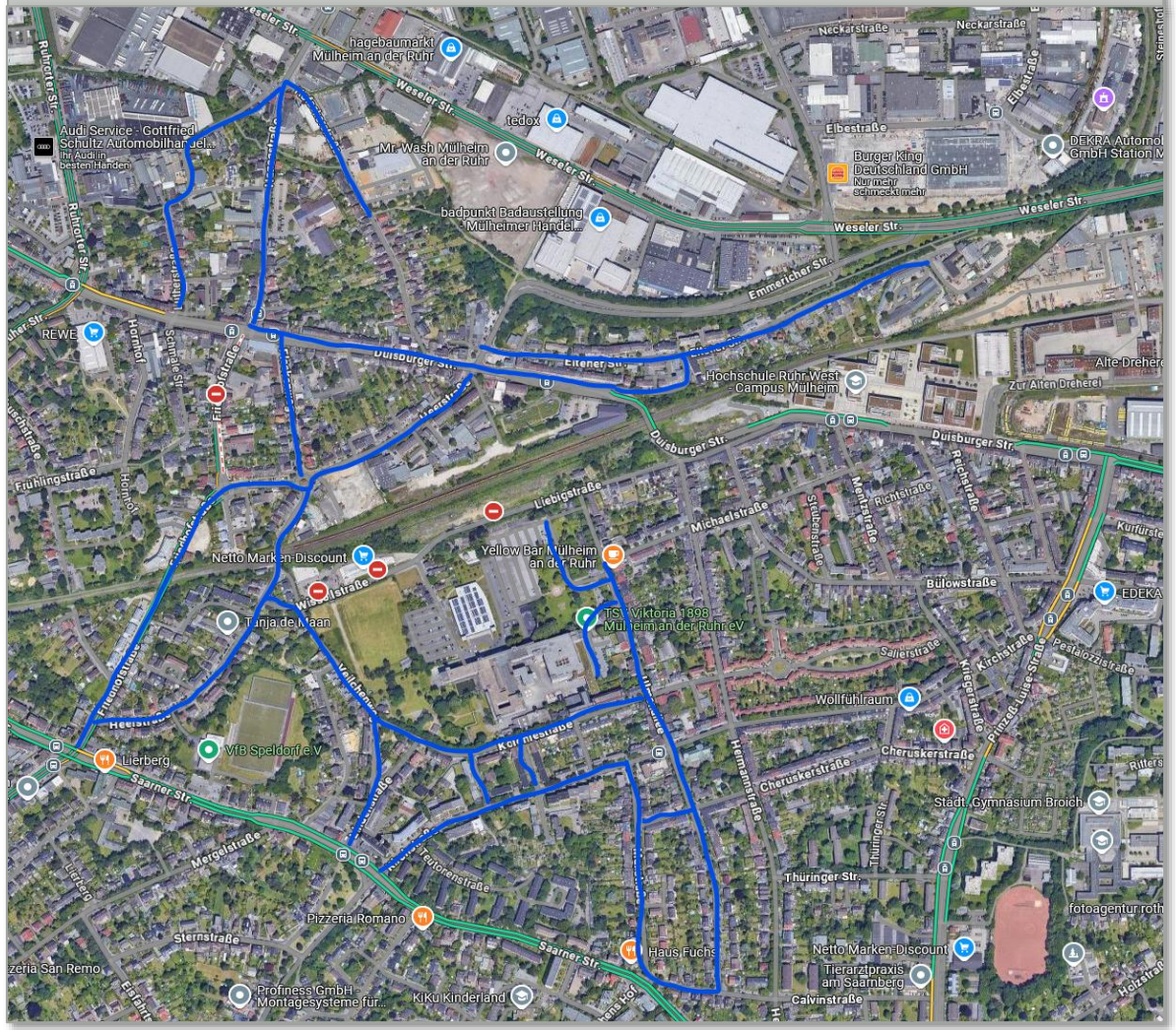
- Installation of the CatVap® downstream Turbo, upstream production Exhaust System
- No changes on EATS Box
- No changes on Engine, Aftertreatment ECU or Software

CatVap® PEMS Configuration - Semtech-DS+ [Source: Sensors Inc.]

GAS MEASUREMENT PERFORMANCES				
Parameter	**CO**	**CO_2**	**NO**	**NO_2**
Maximum Range	8% vol	18% vol	0 to 3000 ppm	0 to 1000 ppm
Resolution	10 ppm	<0.01% vol.	0.1 ppm	0.1 ppm
Zero Drift (over 4 hrs)	≤ ±50 ppm	< ±0.1% vol.	≤ 5 ppm with $\Delta t \leq 10°C$ and using purified N_2 as zero gas	
Span Drift (over 4 hrs)	≤ 2% of span value or ≤ ±50 ppm, whichever is greater	≤ 2% of span value or ≤ ±0.1% vol., whichever is greater	≤ 2% of reading or ≤ 5 ppm, whichever is greater	
Linearity	$\lvert x_{min} \times (a_1 - 1) + a_0 \rvert \leq 0.5\%$ of span Standard Error of Estimates (SEE) ≤ 1% of span		Slope a_1 between 0.99 and 1.01 Coefficient of Determination $r^2 \geq 0.998$	
Accuracy	< ± 2% of reading or ≤ ± 0.3% of full scale, whichever is larger			
Precision	≤ 1% of full scale of span			
Repeatability	≤ ± 2% of point or ≤ ± 1% of span, whichever is larger			
Noise	≤ 1% of span			
Sample Flow Rate	3 l/min (LPM) nominal			
Rise Time	$T_{10\text{-}90} \leq 2.5$ seconds			
System Response Time	$T_{0\text{-}90} \leq 10$ seconds			
Data Rate	5 Hz			

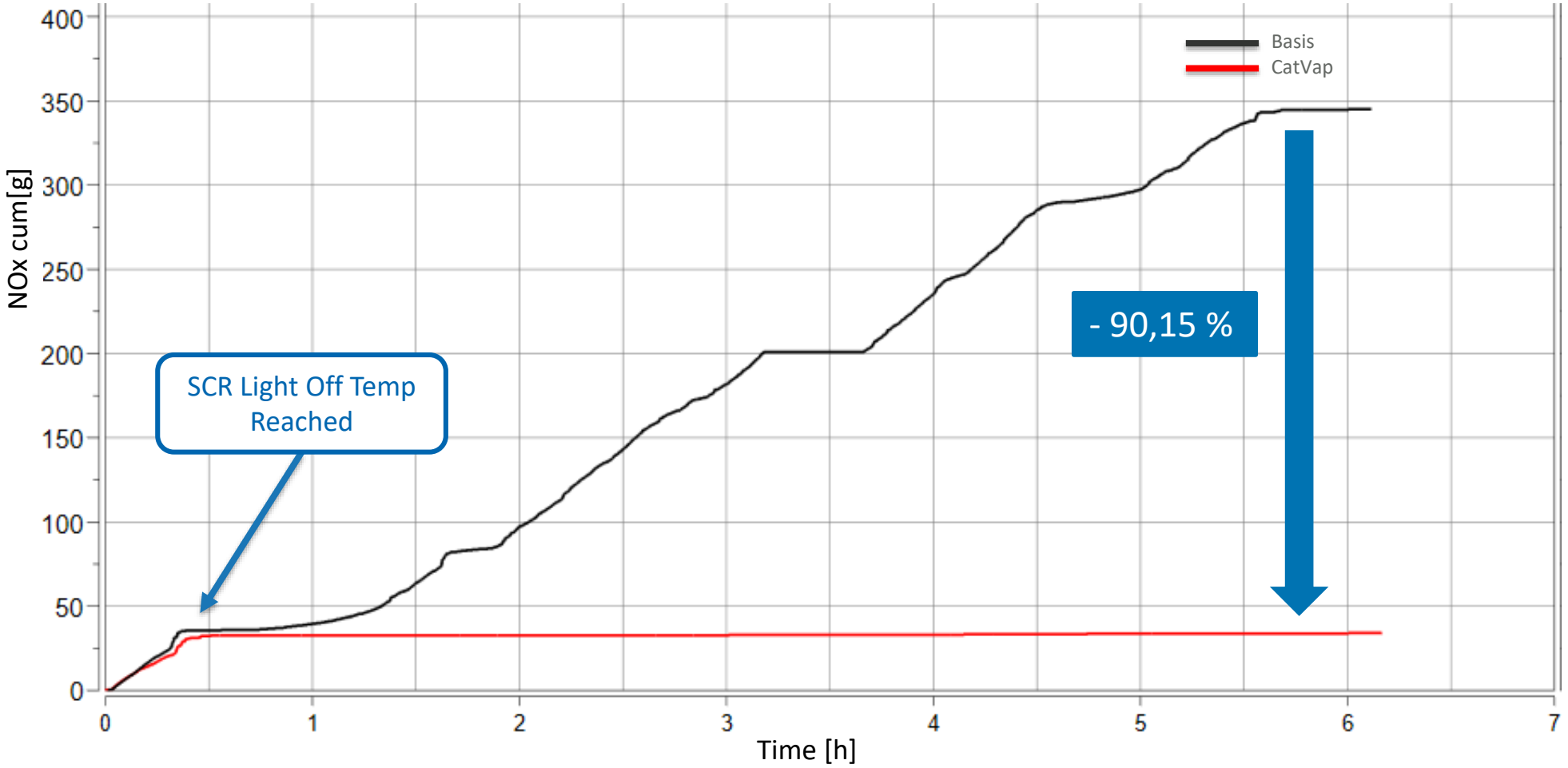
PEMS RDE Route Mühlheim an der Ruhr (Garbage Truck Route)

Route with CatVap



Route without CatVap

RDE-Performance – cumulated NOx emission reduced by 90 %

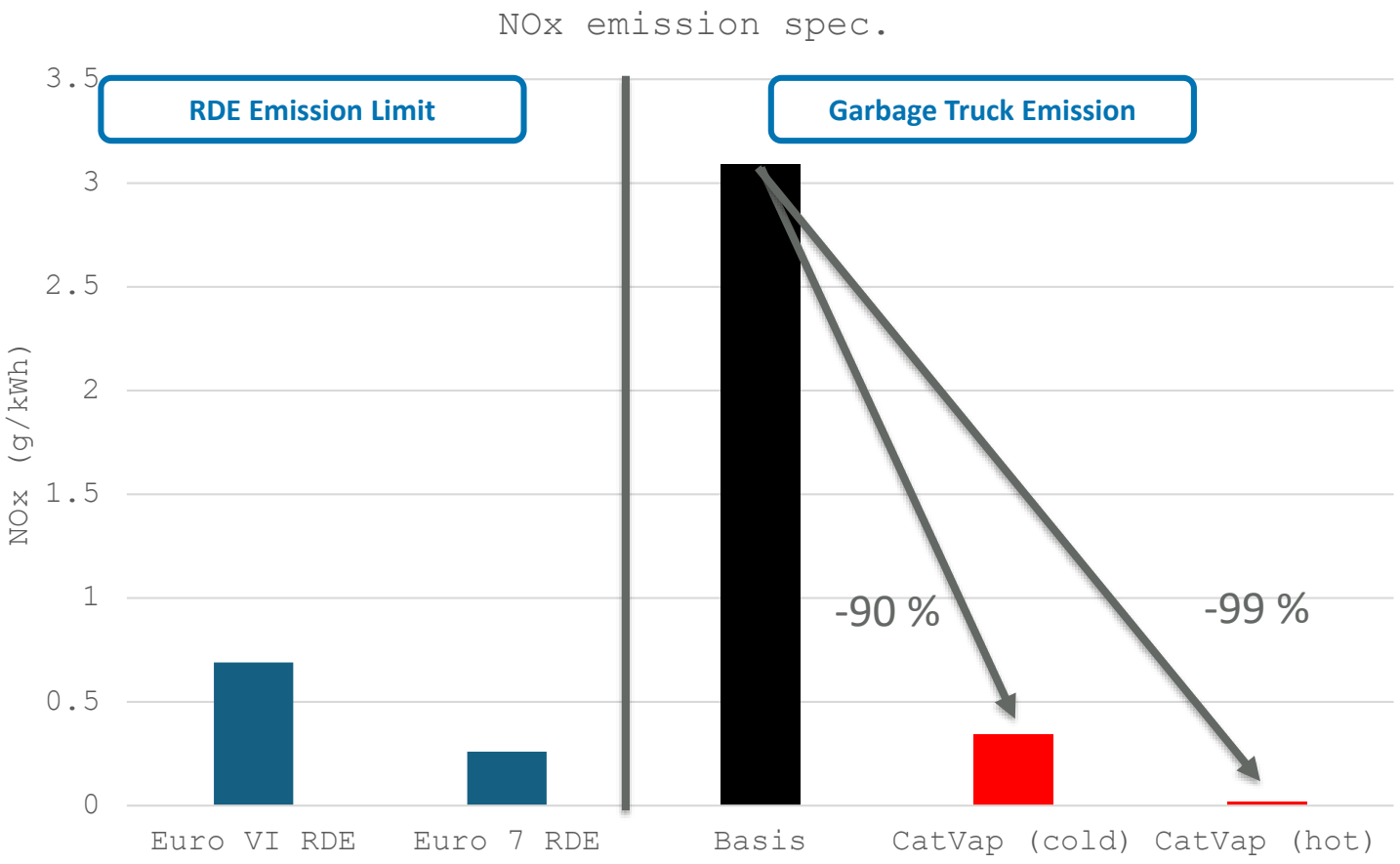


After Light Off the Exhaust Temp is always above 220 °C

90 % NOx Reduction in total

99% NOx Reduction after SCR light off

RDE-Performance – specific NOx emission reduced by 99 %

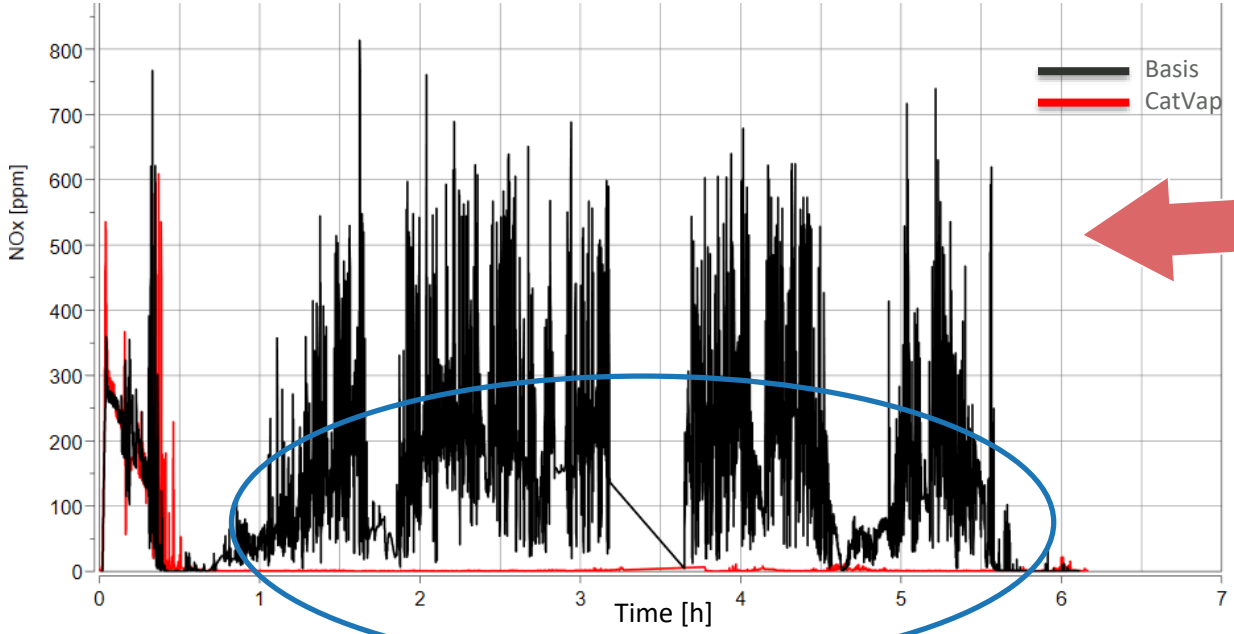


Without CatVap® the truck is often operated at too low exhaust temperatures.

CatVap® increases the Temperature:

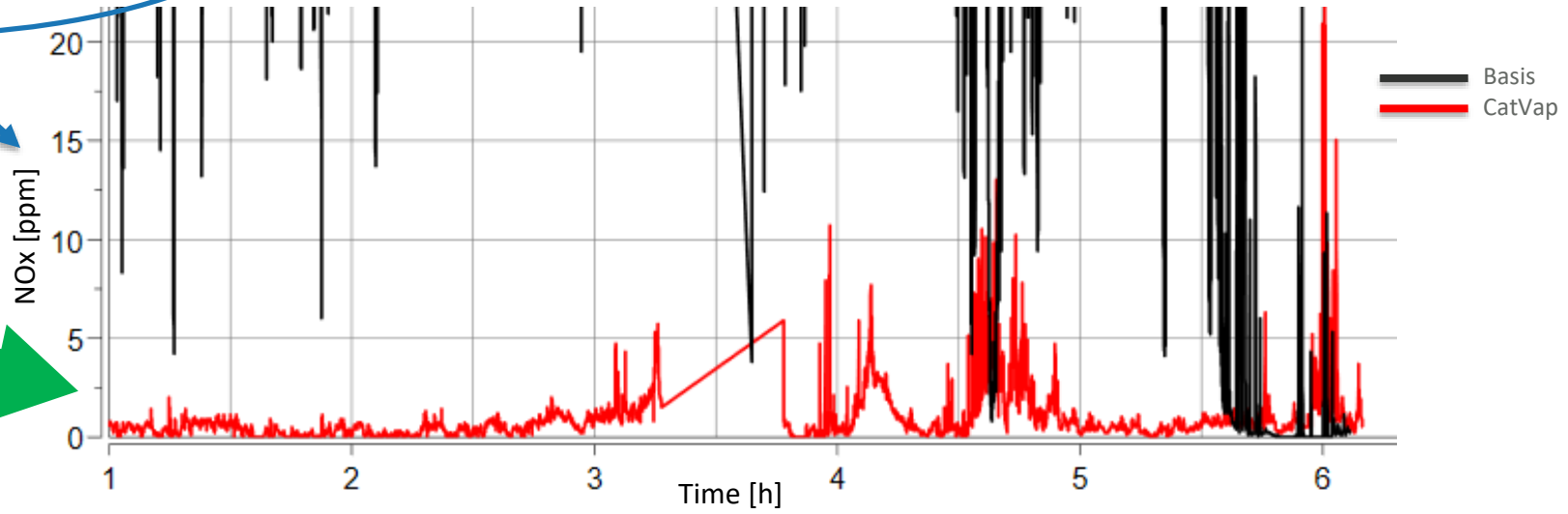
- ✓ **No more forced DPF Regen**
- ✓ **SCR always at nearly 100 % efficiency**

RDE-Performance – No NOx Peaks with CatVap

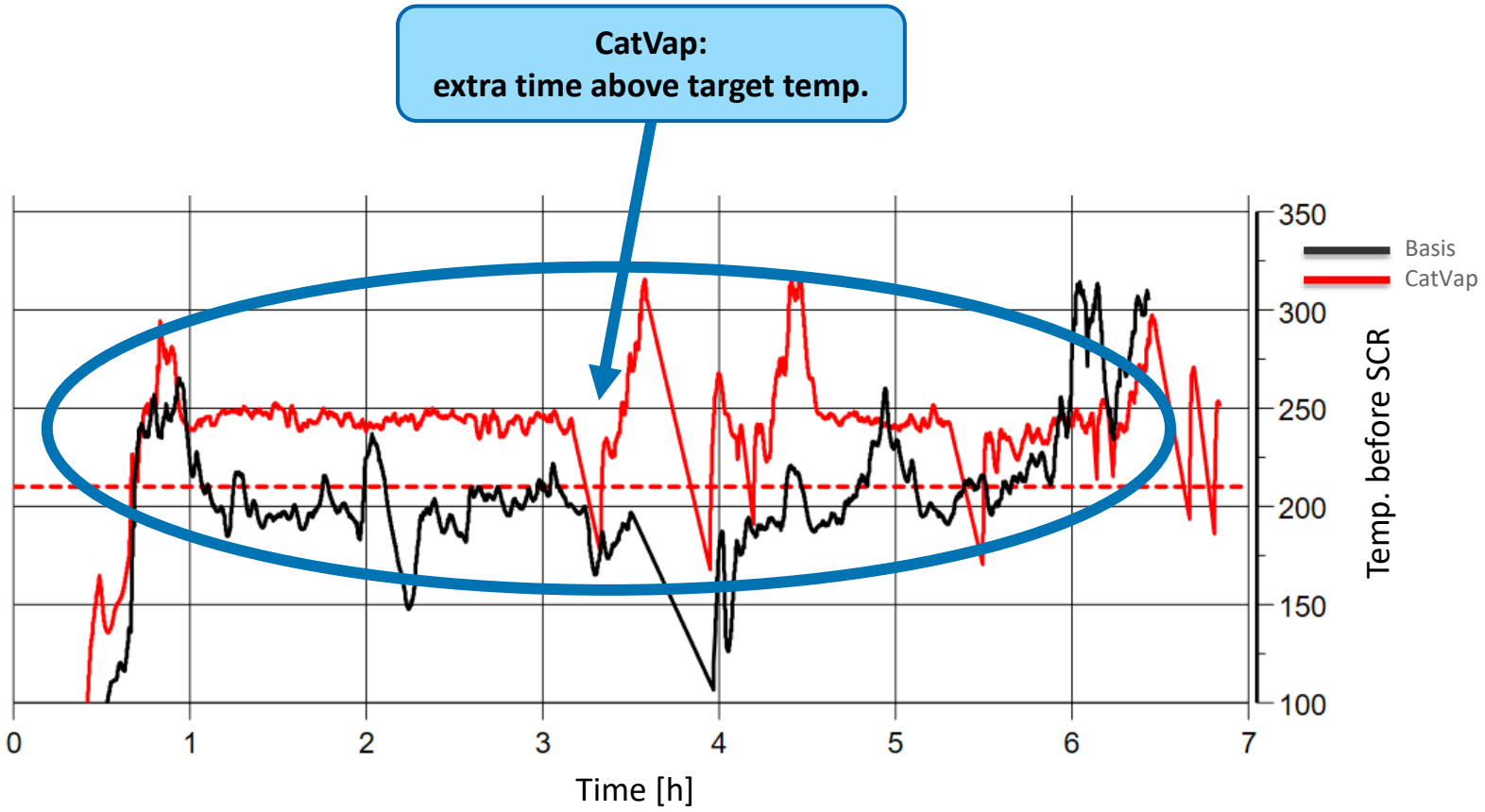


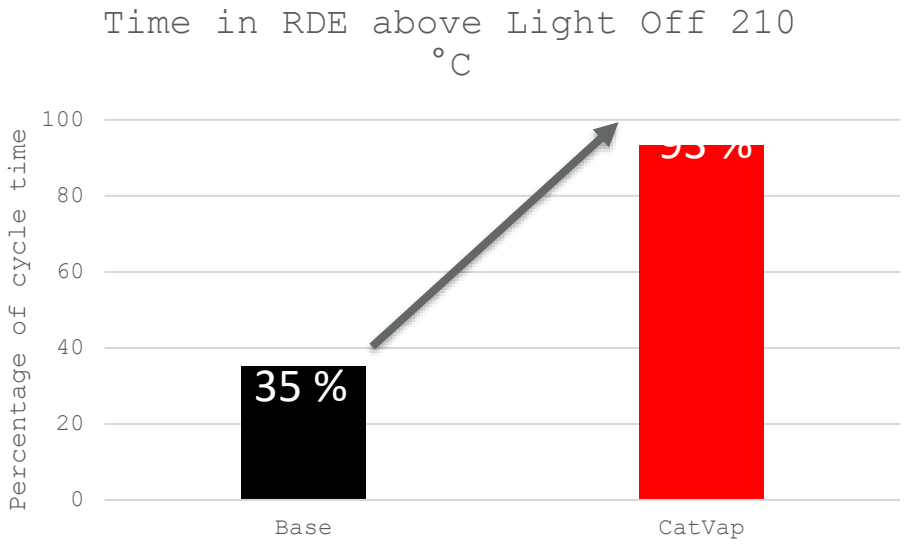
High NOx Peaks in Series .

NOx emission with CatVap mainly below 5 ppm.



RDE-Performance – Exhaust Temperature is kept always higher than 210 °C





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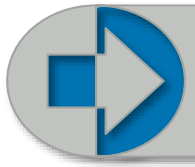
Conclusion

- ✓ It is possible to achieve the ZIV emission level of 30 mg/kWh NOx with EURO VI trucks by just heating up the exhaust temperature
- ✓ NOx emissions of a EURO VI Truck can be reduced by up to 99 % in warm conditions, even in very low load driving profiles
- ✓ EURO 7 / BS 7 NOx Emissions can be fulfilled with the existing EURO VI / BS 6 systems by adding a heating device

Next steps:

- ➢ Further operation of the system to prove system reliability
- ➢ Extension of the field trials to a City Bus



CatVap® is a proven and suitable solution for solving NOx restrictions.

Tank you for your attention!




German Engineering for clean air

Definition “Zero Impact Vehicle”

- In a study by Hausberger et al., the "zero-impact air quality contribution" was defined in such a way that the contribution of road traffic is lower than a defined "irrelevance threshold", which is 3% of the limit value for the average annual pollutant concentration in the European Union (EU). This limit value is derived from the air quality standards set by the World Health Organization (WHO) in 2006.

- The current EURO VI vehicles already fulfil the ZIV targets for particulate emissions

- For NOx emissions, 30 mg/kWh should not be exceeded for heavy commercial vehicles in dense urban driving situations.

Source: **Zero-Impact Fahrzeug-Emissionen (Konzeptionelle Studie)**
FVV Nr. 1407 | Abschlussbericht (AB)