

SCR Retrofit

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14th VERT Forum

22. March 2024



Bundesministerium
für Digitales
und Verkehr

Funded by



Content

SCR Retrofit for passenger cars

- Driving force of retrofit projects
- Technical Funding Guideline
- Description of the development procedure
- Extract of the development results
 - Stelantis Vehicles
 - BMW 4 & 6 Cyl.

Air quality situation in Germany

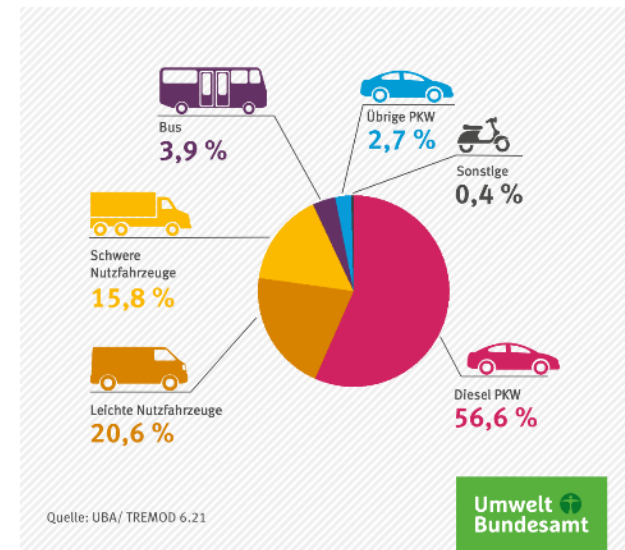
Dirk Messner (President UBA): "For truly healthy air, **pollution levels must be reduced permanently and throughout Germany.**

There is an urgent **need for action beyond the measures already defined in the Clean Air Programme:** the goal must be to get our air as clean as possible.

Anteil der Stationen mit Überschreitung	Interim Target 1	Interim Target 2	Interim Target 3	Interim Target 4	WHO-Richtwert
PM_{2.5}: Jahresmittelwert	0% > 35 µg/m ³	0% > 25 µg/m ³	0% > 15 µg/m ³	64% > 10 µg/m ³	1% > 5 µg/m ³
PM₁₀: Jahresmittelwert	0% > 70 µg/m ³	0% > 50 µg/m ³	0% > 30 µg/m ³	6% > 20 µg/m ³	40% > 15 µg/m ³
NO₂: Jahresmittelwert	0.5% > 40 µg/m ³	14% > 30 µg/m ³	39% > 20 µg/m ³	kein Interim Target	22% > 10 µg/m ³
Ozon: Max. tägl. 8-Stundenwert, 99. Perzentil	0% > 160 µg/m ³	29% > 120 µg/m ³	kein Interim Target	kein Interim Target	0.4% > 100 µg/m ³

Quelle, UBA, 10.02.2022 - Luftqualitätsgrenzwerte in Deutschland 2021

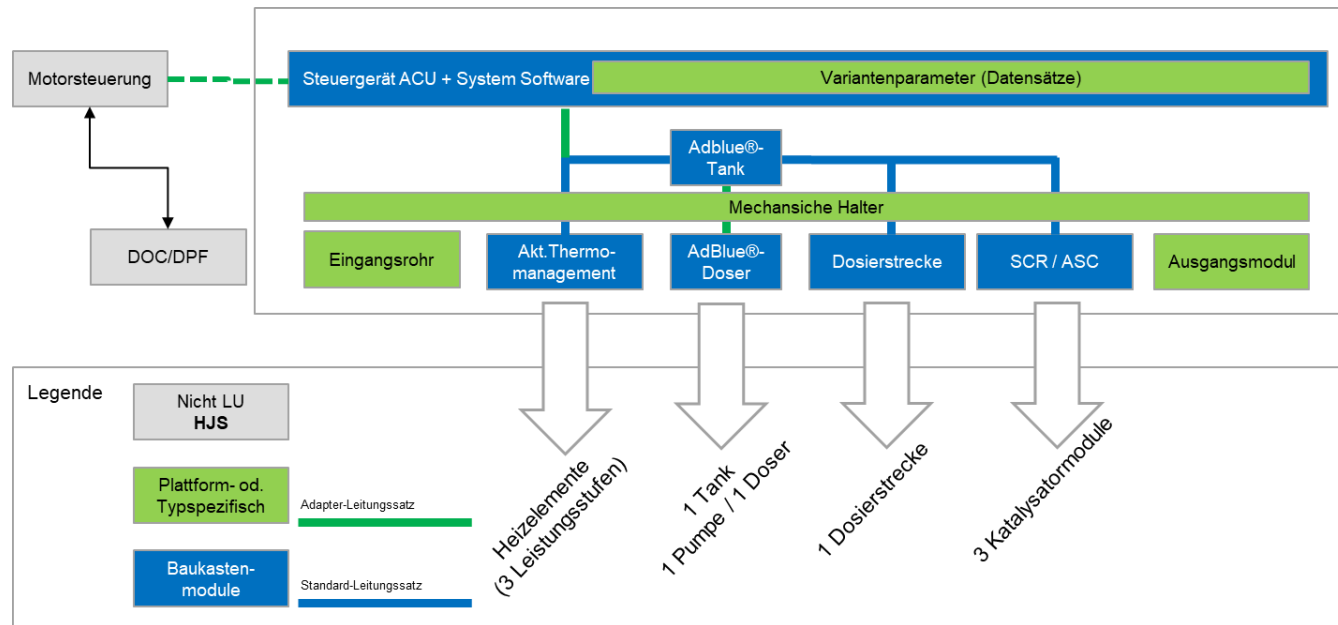
Stadtverkehr: Diesel-Autos stoßen das meiste NO₂ aus



Extract from technical requirements for NO_x reduction systems for retrofit systems (NO_x-MS-PKW)

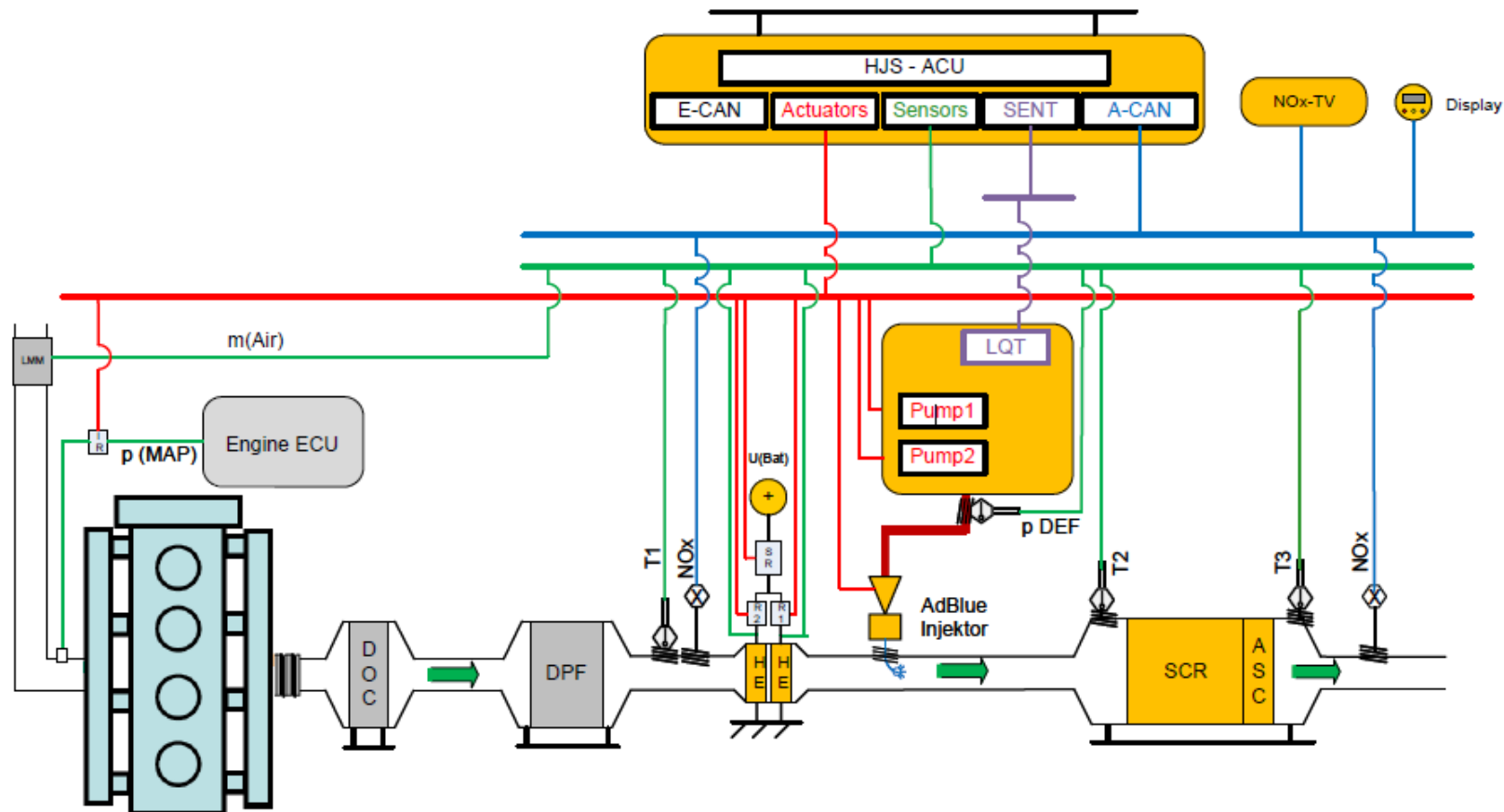
- **NO_x emissions: < 270 mg/km in the RDE cycle**
- Additional fuel consumption < 6%
- Functionality from - 7 °C ambient temperature (vehicle at operating temperature)
- Service life 100,000 km or 5 years
- The functionality of the originally installed DOC/DPF must not be affected
- Existing OBD functionality must be kept
- AdBlue tank level and quality control are mandatory
- The hardware retrofit system must have an NH₃ slip catalyst
- Durability must be proven by recurring measurements on vehicles in the field

Implementation Concept for Euro 5 vehicles



- The Concept is based on vehicle-specific and modular components
- Grey components are vehicle tied
 - Engine ECU
 - DOC/DPF
- Blue components are kit based
 - ACU and System Software
 - Thermo-Management
 - AdBlue Doser
 - Mixing device
 - SCR/ASC
- Green components are vehicle specific
 - Variants parameter data sets
 - In- and outlets
 - Brackets (SCR-System, ACU, Adblue-Tank,...)

Signal run



HJS-Scope in yellow:

- SCR- incl. Slip Catalyst
- Heater (multi stage)
- AdBlue hydraulics incl. dosing unit, pump and tank
- Sensors (3xT und 2xNO_x)
- Control unit and heating relay
- Wiring harness and display

Family Grouping (boundary conditions)

To perform the NO_xMS passenger car test, vehicle emission types can be grouped into PEMS test families. Within the respective PEMS test families, a representative vehicle must be determined on which the test must be carried out (test vehicle).

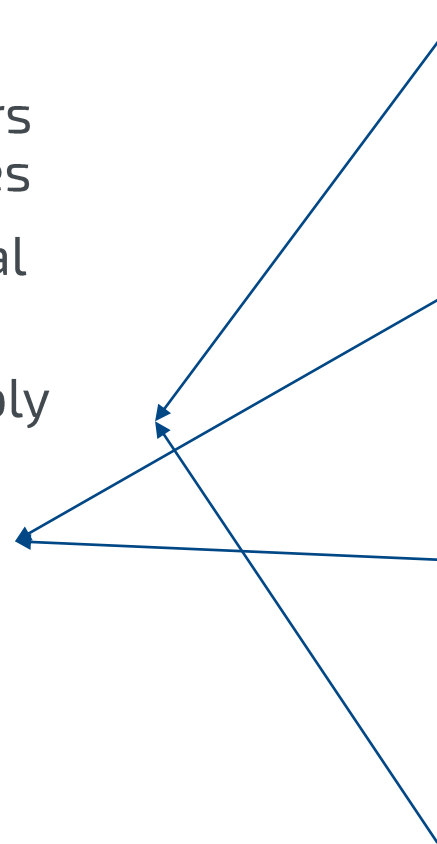
Boundary Conditions:

- Number and arrangement of cylinders
- Intake system
(naturally aspirated, mechanically super- or turbocharged)
- Injection System
- Total cylinder displacement
($\Delta \leq 1,000 \text{ cm}^3$)
- Operating principle of the emission-reducing measures, output system, e.g.
 - Exhaust gas recirculation
high/low pressure, cooled/uncooled
 - Particulate filter
yes/no
 - NO_x storage catalytic or SCR catalytic converter
 - Emission class

Stelantis vehicle population Euro 5 in 01/23

- 579,416 vehicles, 4 manufacturers of different cubic capacity classes
- Some engines are used by several manufacturers.
- Citroen and Peugeot demonstrably use the same engines (PSA)
- Further similarities by Opel and Fiat

Hersteller	cm ³	Summe von Anzahl der FZG
CITROEN (F)	1248	1.665
	1398	1.410
	1560	57.123
	1997	21.615
	2179	2.341
	2198	21.012
	2992	1.573
	2999	2.102
CITROEN (F)	Ergebnis	108.841
FIAT (I)	1248	14.438
	1598	12.101
	1956	13.299
	1997	4.741
	2287	54.473
	2999	7.512
FIAT (I)	Ergebnis	106.564
OPEL	1248	20.010
	1598	16.403
	1686	82.079
	1956	112.832
	1995	17.367
	2231	5.525
	2299	13.711
OPEL	Ergebnis	267.927
PEUGEOT (F)	1248	1.882
	1398	2.838
	1560	41.320
	1997	32.078
	2179	2.782
	2198	13.814
	2999	1.370
PEUGEOT (F)	Ergebnis	96.084
Gesamtergebnis		579.416



Vehicle Investigation Opel Insignia (underfloor and trunk)



Photo shows available space for SCR installation

Scan gives the digital basic for design

Photo below shows available space for AdBlue tank and ACU

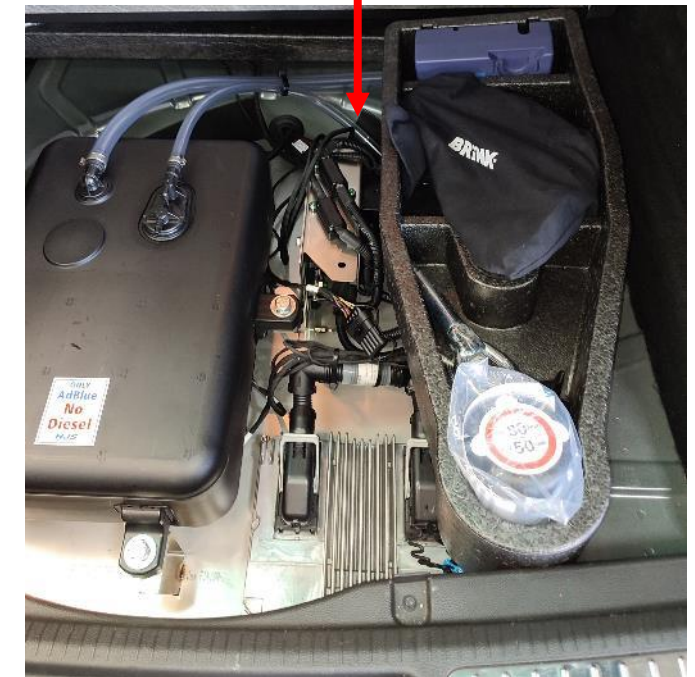
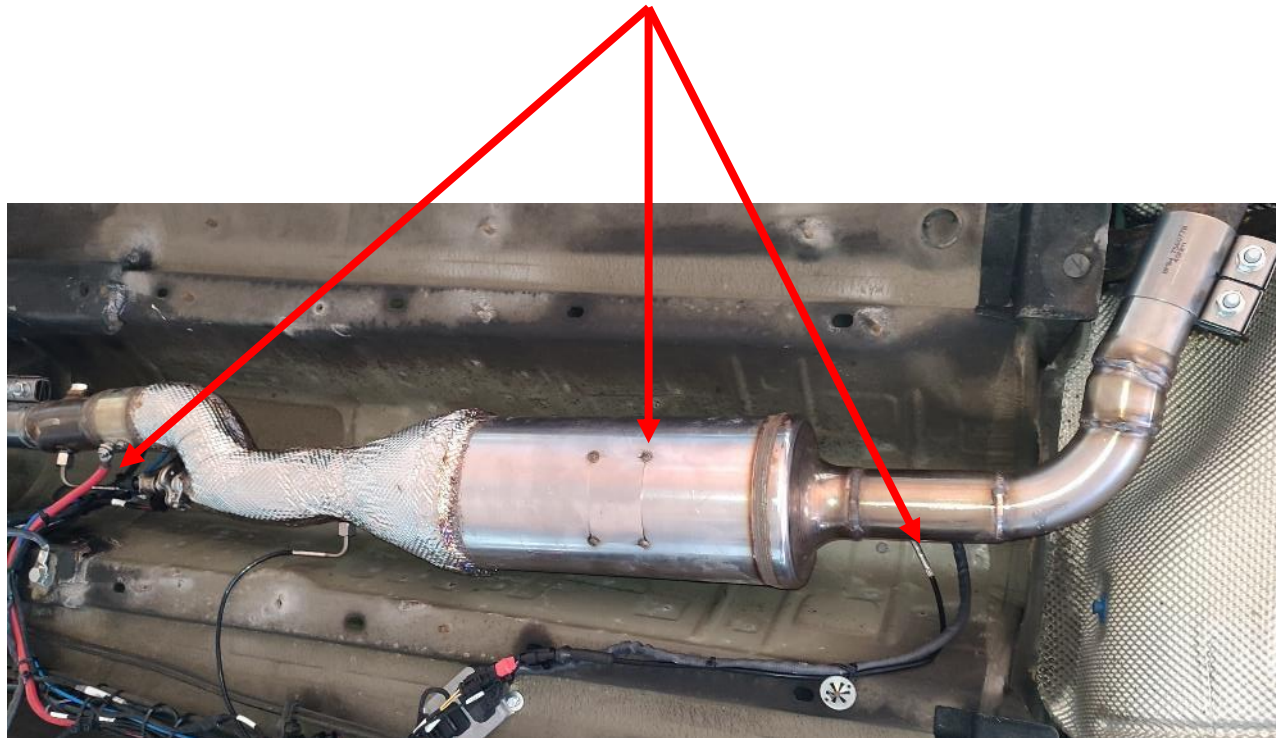


SCR-Installation, AdBlue Tank and ACU

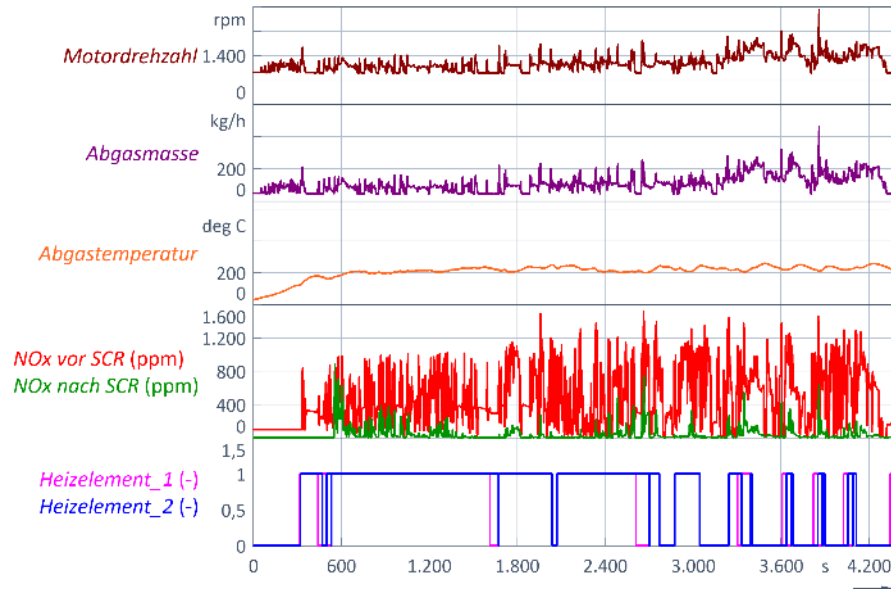


SCR-System, sensors and wiring harness fits well in the underbody of the vehicle

AdBlue tank, ACU and heater relays fits into the trunk



Results of test drives and RDE measurement Opel Insignia



- City 1/3
- Cross-Country 1/3
- Highway 1/3
- NO_x Reduktion von 89%

		WLTC
CO ₂ w/o SCR	[g/km]	141,01
CO ₂ with SCR	[g/km]	145,64
Deterioration	[%]	3,28

⇒ Fuel consumption < 6%

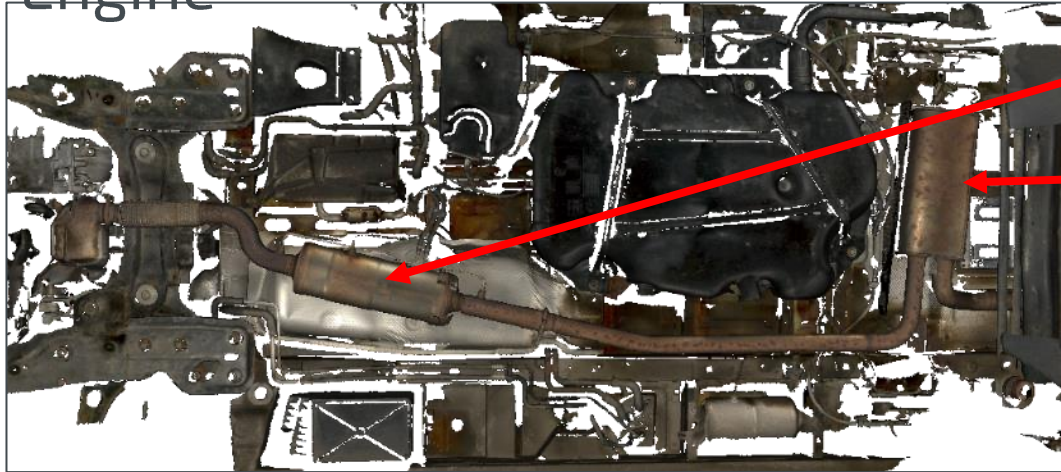
		RDE
NO _x _total.	[mg/km]	176,40
NO _x _city/cross country	[mg/km]	228,00
Legislation Limit	[mg/km]	270,00

⇒ NO_x limit was achieved

Vehicle Investigation (underfloor)

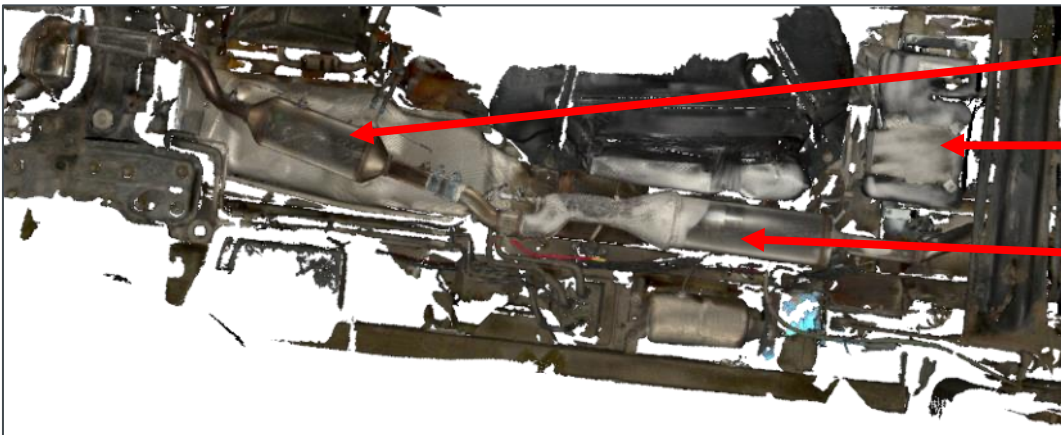


Engine



DOC/DPF

Silencer



DOC/DPF

Urea Tank (Silencer was removed)

SCR-System

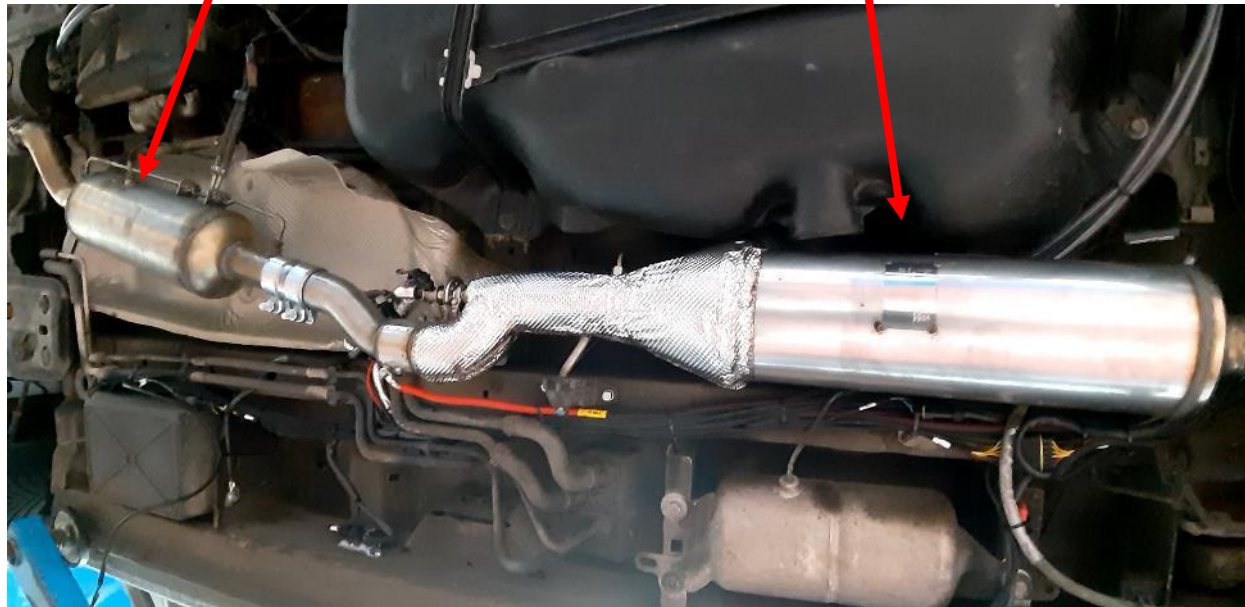
SCR-Installation, ACU and AdBlue Tank



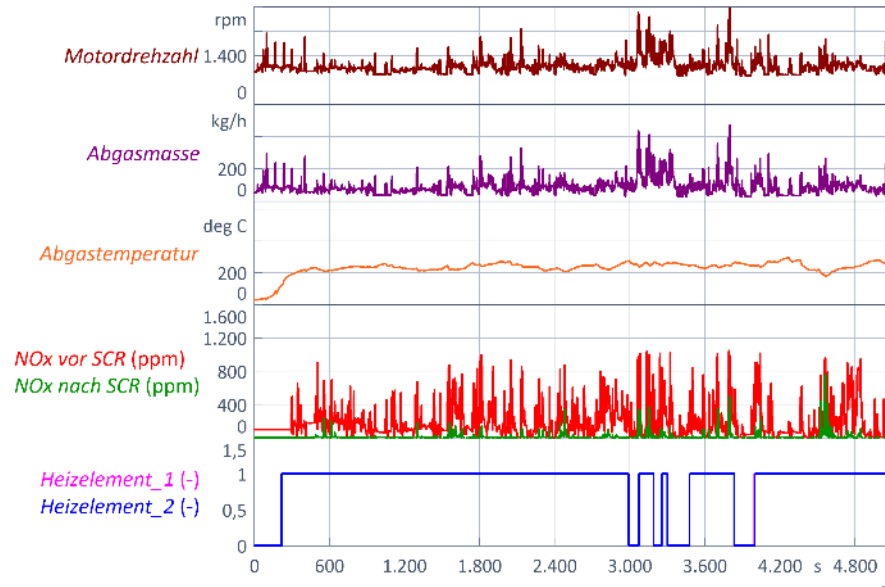
Urea Tank (Silencer was removed)

DOC/DPF

SCR-System



Results of test drives and RDE measurement Peugeot Expert



Share of approx. 80 km test track

- City 1/3
- Cross-Country 1/3
- Highway 1/3
- NO_x Reduktion von 90%

		WLTC
CO ₂ w/o SCR	[g/km]	181,02
CO ₂ with SCR	[g/km]	178,86
Deterioration	[%]	-

⇒ Fuel consumption < 6%

		RDE
NO _x _total.	[mg/km]	65,3
NO _x _city/cross country	[mg/km]	73,2
Legislation Limit	[mg/km]	270,00

⇒ NO_x limit was achieved

BMW vehicle population Euro 5 in 01/23



Motorkennbuchstabe	Hubraum [cm ³]	Zylinder	Leistung [kW]	Typ	Bestand
N47C16A	1598	R4	66 - 107	One, Cooper, Mini	10.432
N47D16A	1598	R4	70 - 99	1er, 114D, 116D	6.408
N47C20A	1995	R4	82 - 135	Cooper	8.791
N47D20C	1995	R4	85 - 169	1er, 2er, 3er, 4er, 5er, X1, X3	387.069
N47D20D	1995	R4	150 - 190	1er, 2er, 5er, X1, X5	20.233
306D5	2993	R6	210 - 254	335D	810
N57D30A	2993	R6	150 - 280	3er, 5er, 7er, X3, X4, X5, X6	74.642
N57D30B	2993	R6	210 - 285	5er, 6er, 7er, X3, X5, X6	19.102
N57D30C	2993	R6	280	X5, X6	863
					528.350

- X 3, 4 cyl. Engine 125 kW
- X 3, 6 cyl. Engine 190 kW
- With the selection of these two test vehicles and considering the family formation criteria, we cover an area of use of more than 450,000 vehicles

Vehicle Investigation BMW X3 2.0 l 4 Cyl. (underfloor)



Scan of BMW X3
underfloor



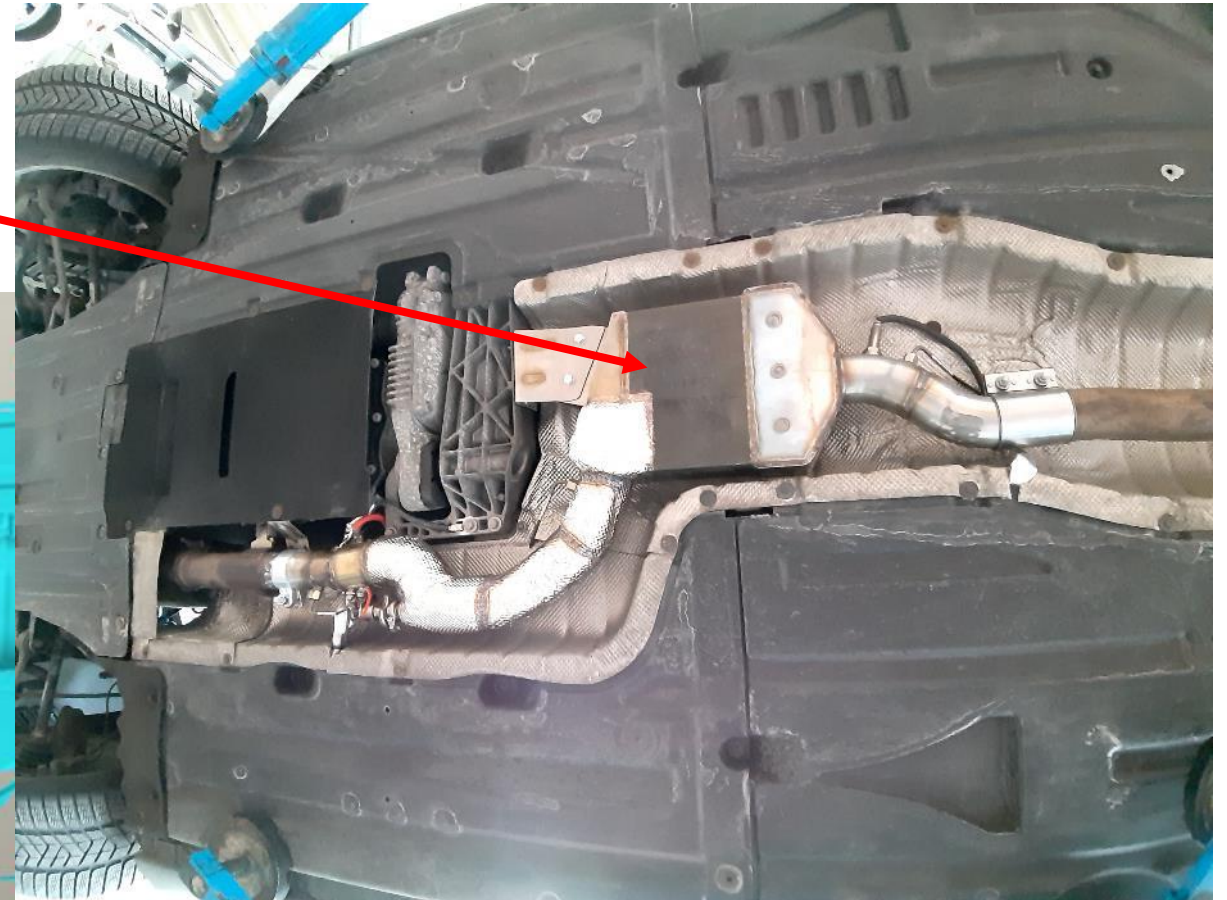
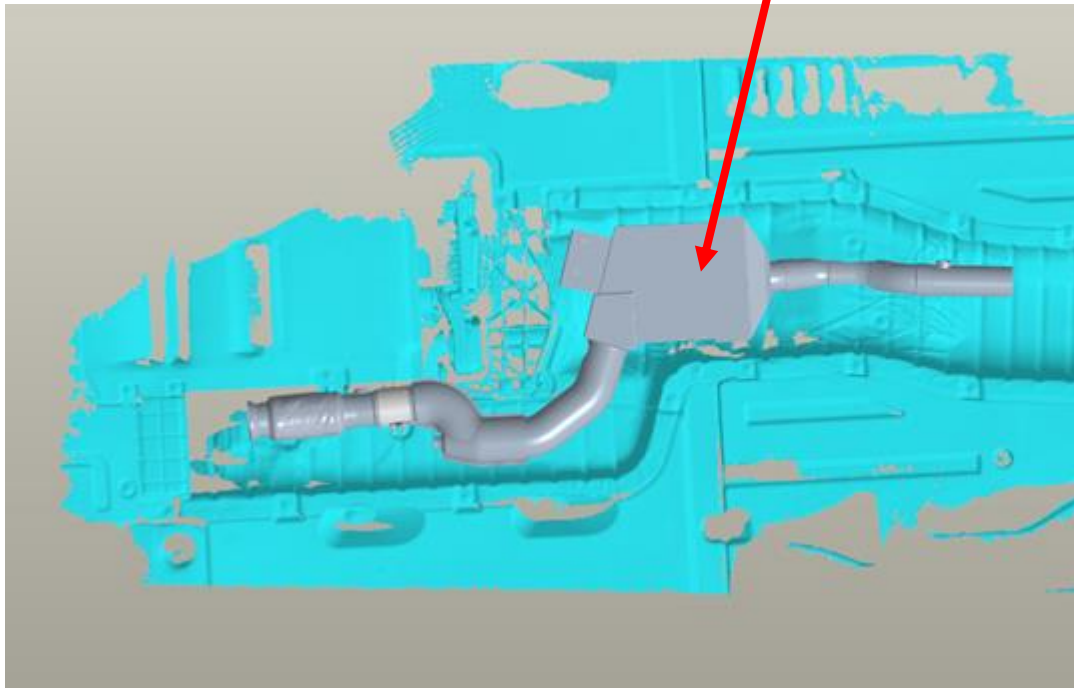
Photo of BMW
X3 underfloor



SCR-Installation, ACU and AdBlue Tank (BMW X3 2.0 l 4 Cyl.)

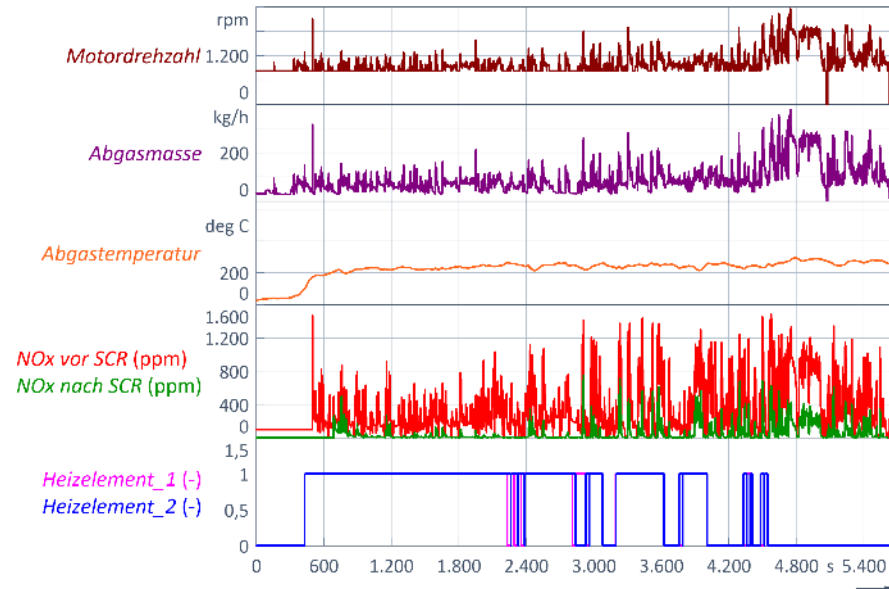


SCR-System



Results of test drives and RDE measurement

BMW X3 2.0 l 4 Cyl.



Share of approx. 80 km test track

- City 1/3
- Cross-Country 1/3
- Highway 1/3
- NO_x Reduktion von 79%

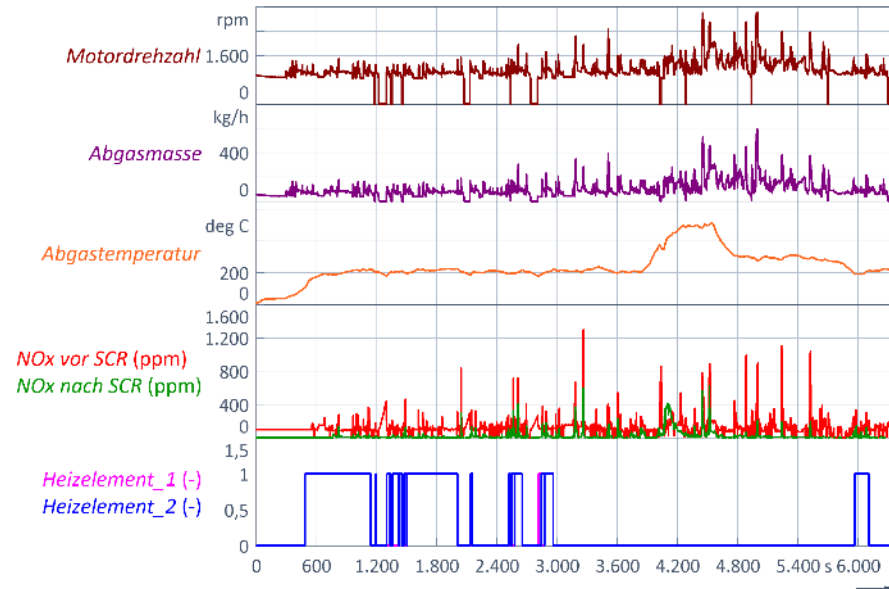
		WLTC
CO ₂ w/o SCR	[g/km]	178,9
CO ₂ with SCR	[g/km]	187,4
Deterioration	[%]	4,8

⇒ Fuel consumption < 6%

		RDE
NO _x _total.	[mg/km]	
NO _x _city/cross country	[mg/km]	
Legislation Limit	[mg/km]	

⇒ NO_x limit was achieved

Results of test drives and RDE measurement BMW X3 3.0 l 6 Cyl.



Share of approx. 80 km test track

- City 1/3
- Cross-Country 1/3
- Highway 1/3
- NO_x Reduktion von 76%

		WLTC
CO ₂ w/o SCR	[g/km]	191,2
CO ₂ with SCR	[g/km]	200,2
Deterioration	[%]	4,7

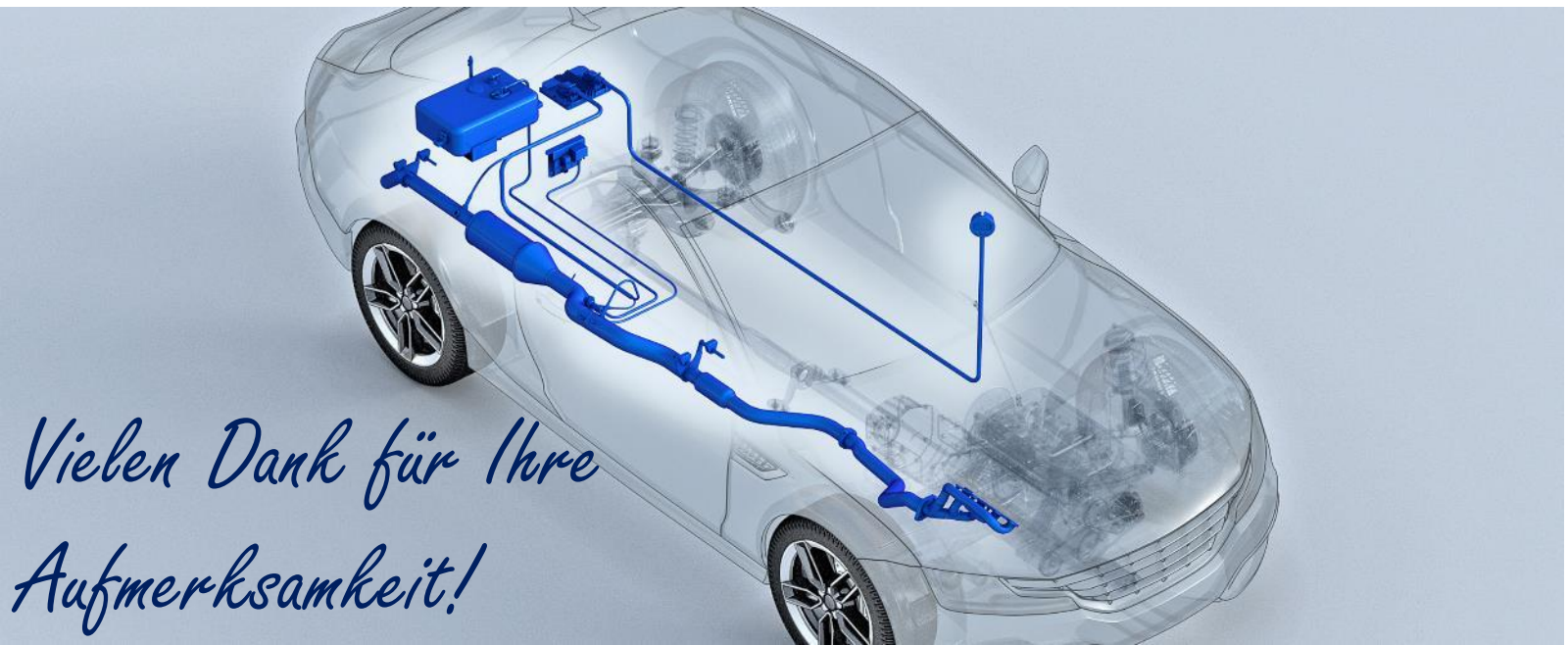
⇒ Fuel consumption < 6%

		RDE
NO _x _total.	[mg/km]	83,75
NO _x _city/cross country	[mg/km]	110,36
Legislation Limit	[mg/km]	270,00

⇒ NO_x limit was achieved

Summary SCR-Retrofit

- ✓ HJS concept is functioning and based on a "modular system"
 - ✓ HJS thermal management system is one of the success factors
 - ✓ SCR design and operation remain engine-specific (vehicle)
 - ✓ Vehicle selection important in terms of availability of installation space
 - ✓ Use family grouping criteria to utilize the area of application
 - ✓ Feasibility to vehicles of the same platforms is given
 - ✓ Other platforms possible with some adaptations
- ✓ 2 ABEs have already been issued, the remaining once were applied for.
- ⇒ Details will soon be available on our homepage (whitepaper)



*Vielen Dank für Ihre
Aufmerksamkeit!*

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