

# **I/M experience in Germany / EU**

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# Emission Reduction Strategies in Europe

	Vehicles in production			Vehicles in the field		
	Type approval	Durability	Conformity of production	Road-worthiness	In-use compliance	On Board Diagnosis (OBD)
<b>Vehicle selection</b>	Prototypes of vehicles and engine families	Serial production or type approval vehicle	Random sample from the series production	All vehicles in the field	Random sample from vehicle fleet in the field	All vehicles in the field
<b>Application</b>	Type approval	Type approval	Sporadically	New vehicles after 3 years, then every 2 years	Regularly, if manufacturer audit not satisfactory	Quasi continuously in use
<b>Measurement procedure</b>	Type approval testing	Durability test (AMA) or deterioration factor	Type approval testing	Short test	Type approval testing	Real world conditions
<b>Legal basis</b>	European exhaust emissions directives 91/44/EEC 92/55/EEC 94/12/EEC 98/69/EC			96/96/EC 1999/52/EC	98/69/EC	98/69/EC 1999/102/EC
<b>Aimed at</b>	Production type approval of specific design / technology	Production type approval of specific design / technology	Statistical verification of series production	Significant deterioration; maintenance; tampering; misfuelling	Type specific misconstruction or insufficient maintenance instruction	Malfunction diagnosis and indication for immediate repair
<b>Influence on emission control</b>	Technology used	Durability under testing conditions	Technology used and its realisation in production	Maintenance condition	Technology and its realisation	Real world durability/maintenance condition
<b>On Board Diagnosis (OBD)</b>	Philosophy explained, functions tested	/	Quality control	Readiness/Diagnostic codes	Additional data	/
<b>Importance</b>	Small, only prototype	Small, artificial test	Increasing, because of quality control	Medium; test method find only major malfunctions	Large, real cars under test conditions	Large, real world emissions
<b>Future</b>	Self certification of manufacturer	Self certification of manufacturer	Audit	Better test; OBD check; safety check	Check of manufacturers audits	OBD; safety systems; OBD directive

# Goal of an I/M Program

The goal of an I/M program is to detect malfunctioning parts.

If an I/M program is working perfectly it keeps the emission level of the vehicles at the design values

But due to the fact is a short and warm test only high emitter can be detected

In spite of the fact that many research is done in the past the correlation with certification emissions can only be poor

Inspection and repair should separated.

# Legal Background in the EU

**European directive 96/96/EC**

**Actual version: 2010/48/EC**

Requirements and definitions for periodical technical inspection (PTI) for all member states

For safety relevant components/systems as well as for emission-check

Requirements and definitions are minimum-requirements for the member states

Member states can realize higher requirements

Actual: motorcycles are not included

# EU Legal Background

- 1996 the first consolidated road worthiness Directive (96/96/EC)

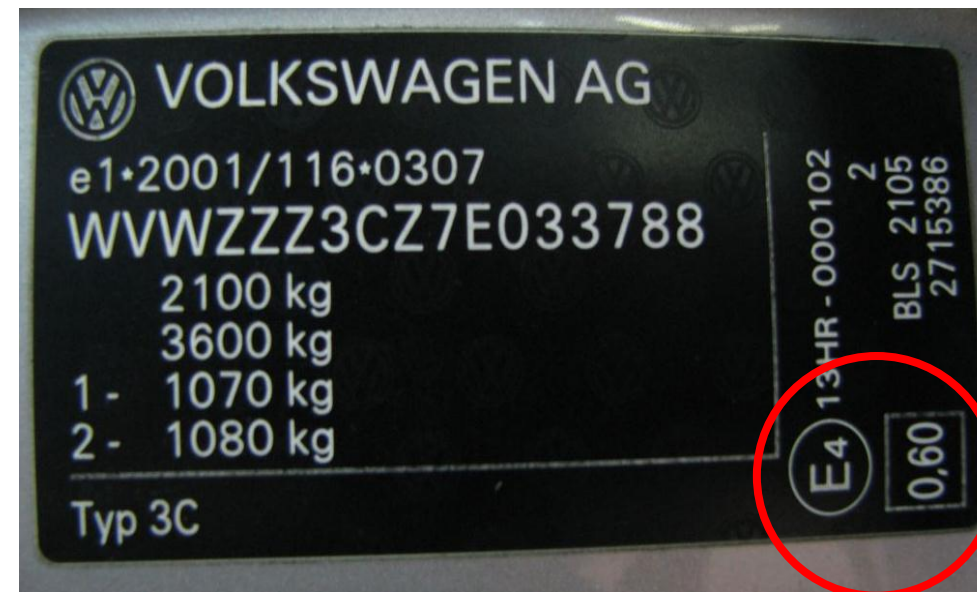
## For diesel vehicles:

Free acceleration test with the following limit values:

- 2,5 m<sup>-1</sup> for Naturally aspirated diesel engines
- 3,5 m<sup>-1</sup> for Turbocharged diesel engines
- 1,5 m<sup>-1</sup> for EURO 4 and higher standards
- or level recorded on the manufacturer's plate

Directive 2010/48/EC changed the limits to:

The level recorded on the manufacturer's plate on the vehicle for Diesel vehicles has to be met from 01.01.2012



# Legal Background in Germany

## ***§29 StVZO (Straßenverkehrszulassung) in combination with “AU-Richtlinie (AU guideline)”***

National implementation of the European regulation

Detailed requirements and definitions for periodical technical inspection (PTI) for all registered vehicles (own license-plate)

For safety relevant components/systems as well as for emission-check

motorcycles are included ( since 2006)

# **HISTORY of I/M in Germany**

- **1985 started an emission test for road vehicles as part of PTI only for vehicles with spark-ignition (petrol). Measuring CO at idle speed. Called “ASU (Special exhaust examination)”**
- **Dec 1993 started in Germany the Emission test “ AU “ for all vehicles with 4 or more wheels (passenger cars, heavy duty)**
- **For diesel vehicle**
- **For petrol vehicle:**
  - A) with or without catalyst**
  - B) with three - way catalyst**

# I/M in Germany

- Visual check

## For petrol engine vehicles:

- CO at idle speed
- CO and Lambda at high idle speed
- Without OBD: closed-loop-check of Lambda-regulation
- With OBD: OBD-Check (MIL, trouble codes,...)

## For DIESEL engine vehicles:

- K-value at free acceleration

**Pass / fail criteria: generally manufacturer's data**

# Visual Check

- **Visual check of emission relevant components**  
like catalyst, oxygen sensors, exhaust gas recirculation, secondary air system and non removable fuel filler cap according existence, completeness, tightness and damage
- **Visual check of MIL status at ignition on and engine off:**  
if the MIL is off, the AU is failed
- **Visual check of MIL status at running engine:**  
if the MIL is on, the AU is failed

# Exhaust gas measurement for petrol cars

- **Engine temperature** (OBD information)
- **Precondition procedure**  
(for example running engine at increased idle speed for 30 seconds)
- **Emission measurement at increased idle speed**
  - Engine speed (OBD information)
  - CO, HC, CO<sub>2</sub> and O<sub>2</sub> □ Calculation of Lambda  
**Limits: CO > 0.2%; 0.97 > Lambda < 1.03**  
(or according to the manufacturers specifications)
- **Emission measurement at idle speed can be replaced by the reading of OBD- data**

# Reading of OBD Information

- MIL status
- Readiness Codes
  - Readiness code available?
  - Readiness code complete?
- Diagnostic trouble codes (P- fault codes)
  - number of fault codes in MODE 3
  - description of fault codes
- Actual data
  - Engine temperature
  - Engine speed

# **On Board Diagnosis according to 98/69/EG**

## **On-board diagnostic system (OBD) for emission control**



**detect failures of anti pollution devices  
immediately**

**monitor critical functions of the engine and  
emission control systems**

**store additional information about deviations**

**assist during maintenance with fault diagnosis  
and fault rectification**

**low exhaust emission level  
over the whole lifetime of the vehicle**

# **Integration of OBD data into periodic exhaust emission test for vehicles in Germany**

**Reading OBD data during periodic exhaust emission testing was admitted in Directive 96/96/EC.**

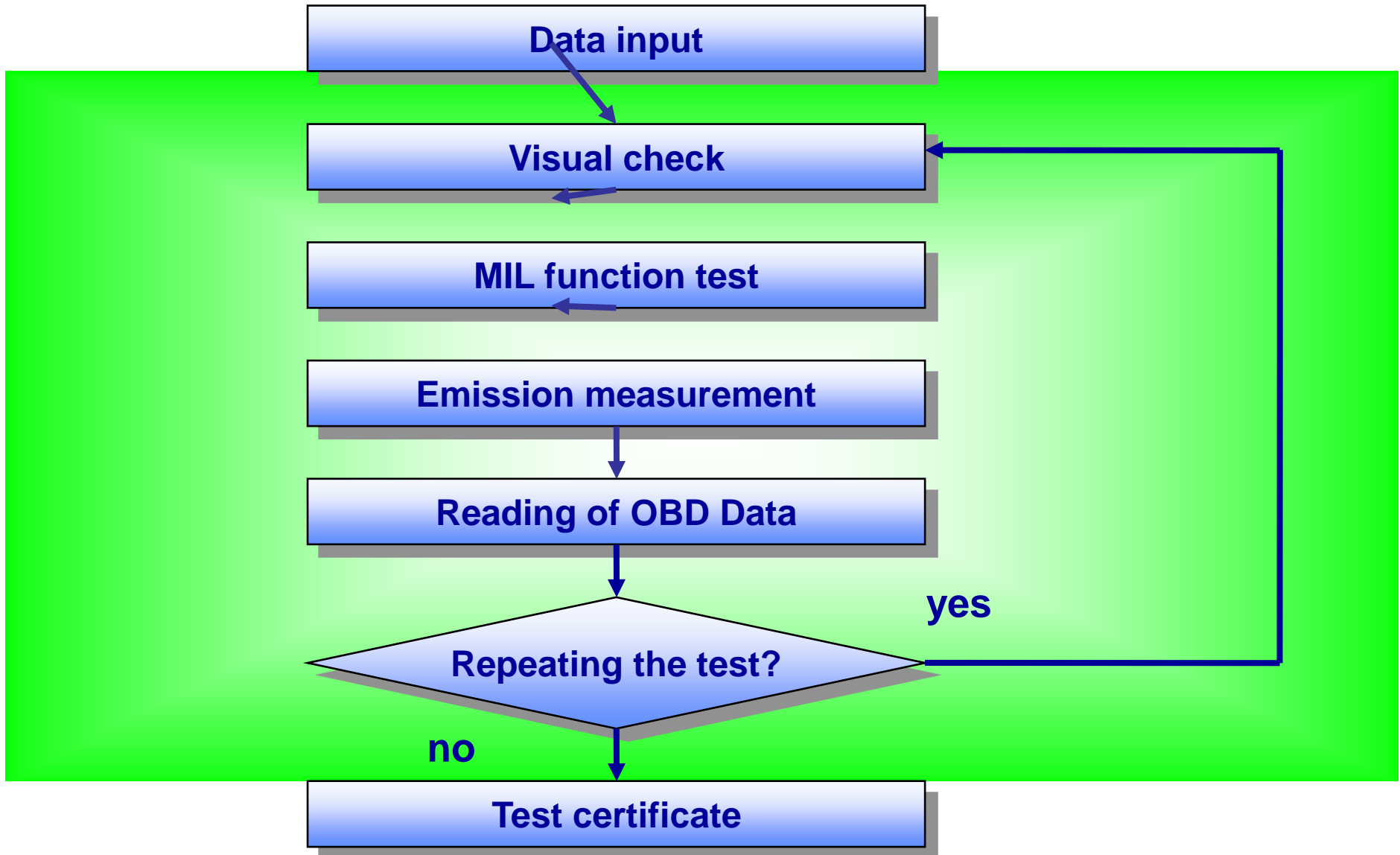
**From 01.04.2002 the I/M test for petrol vehicles uses informations of the OBD system:**

- Engine temperature , - Engine speed**
- MIL status**
- Readiness Codes**
- Diagnostic trouble codes**

**Aim: Increase of the reliability of the periodic exhaust emission test by using OBD data.**

**For cars with a first registration after 01.01.2006 no tailpipe measurement is necessary, if the OBD- system is completely ready to check, which means all readiness codes are set (also for diesel vehicles)**

# AU for vehicles with G-Kat and OBD (since 01.04.2002)



# Emission Test for Motorcycles in Germany (AUK)

All motorcycles with more 50 cm<sup>3</sup> engine volume and a maximum speed higher than 45 km/h have to perform the emission test every 24 month.

Besides the visual check CO is measured in idle.

As for petrol cars the limits are defined by the manufactures.

If no manufacture data is available the max. CO value is 4,5 Vol% for motorcycles without catalyst.

For motorcycles with catalyst the max. value 0,3 Vol% at high speed idle.

# Requirements and Accreditation

- Accredited inspection companies (DEKRA, TÜVs, ....)
- Accredited workshops

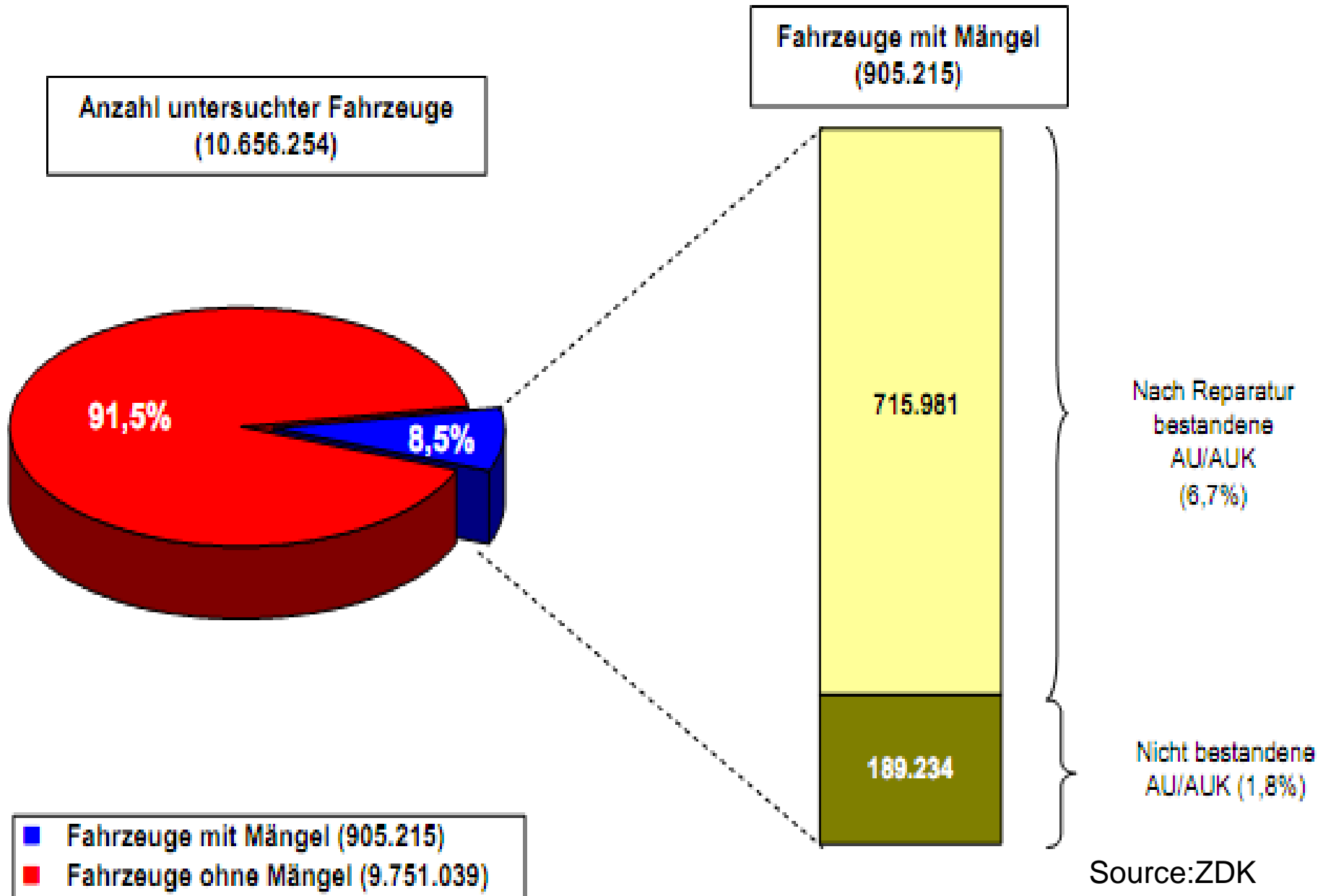
Precondition: every three year training course with examination.

Since 1. January 2010 emission test only in conjunction with the vehicle safety test

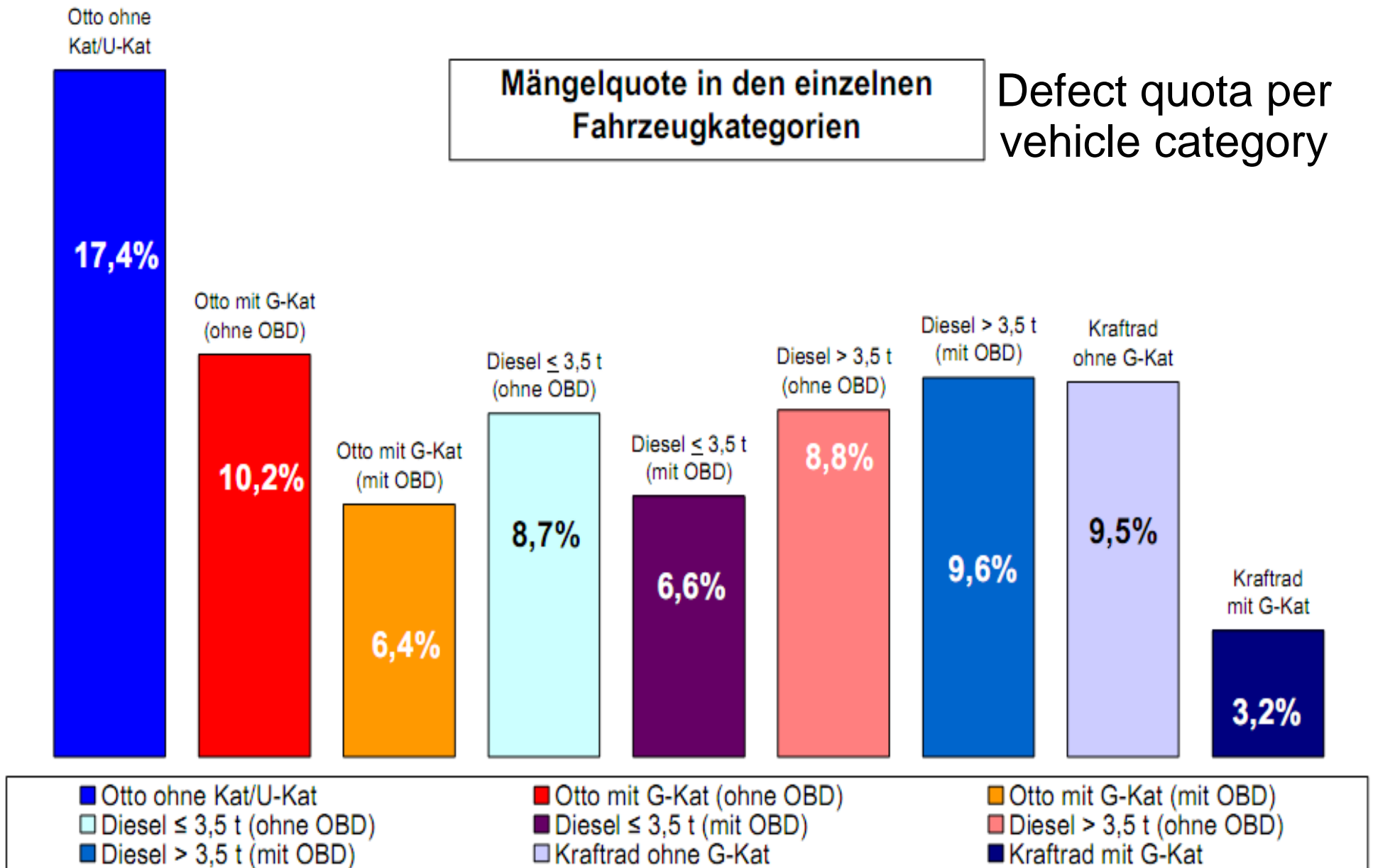
# Cost of the AU (Emission test )

Vehicle category	Euro/ test
Petrol Car w/t catalyst	22,90
Petrol Car with catalyst	27,25
Petrol car OBD	15,29
Diesel car	35,00
Diesel car OBD	29,10
Motorcycle	20,30

# AU Statistics 2009 Germany (1)



# AU Statistics in Germany (2)



# AU (Emission Test) Success Control

## 1. AU (Emission Test) Success Control- petrol catalyst cars

Last evaluation was done 2001. 122 AU-failing cars with catalyst were measured in the New European driving cycle before and after repair in a certified workshop. A clear reduction for CO, HC and NOx was found. No cost benefit calculation was performed.

## 2. AU (Emission Test) Success Control- diesel cars

It was impossible to estimate a particle reduction for the Diesel- AU. In a parallel study. As reasons were the free acceleration test, no clear definition of free acceleration time, the lack of a clear definition of the conditioning of the vehicle and the deficits of the opacity meter found.

From this problems only the definition of free acceleration time and the vehicle conditioning were improved.

# Diesel- AU (Emission Test) with **OB**D Praxisbeispiel

## OBD AU

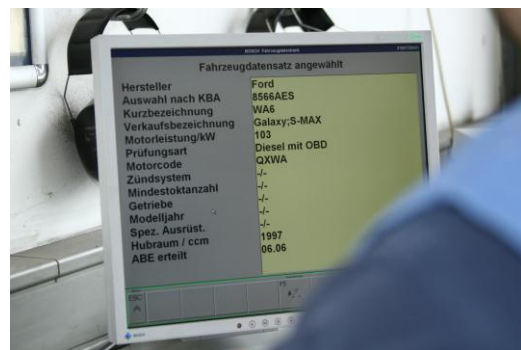
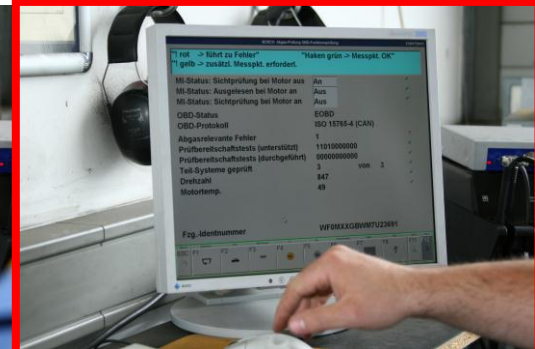
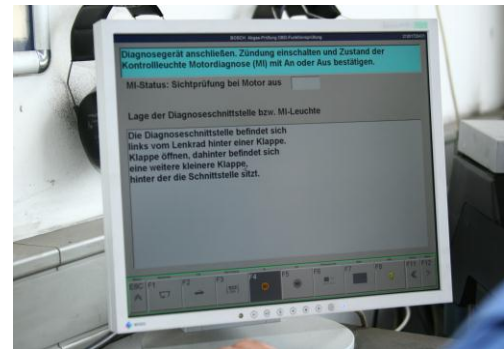
Ford Galaxy, 2.0, 103 kW, 09/2007, 85.000 km

Vehicle data

Visual check

OBD  
Mil/connection

OBD  
Connection/MIL



Error code  
**P2463**

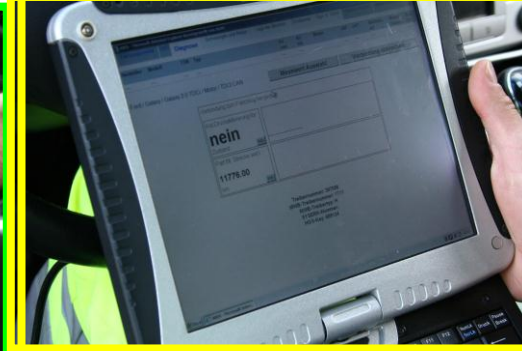
ADAC Diagnose  
„DPF Sättigung“  
last Reg. 11.760 km



Exhaust tube  
metallic blanc

OBD-control light i.O.

Source:



# Conclusions from Germany's „Emission Check 2010“

OBD: All deteriorations have neither triggered the MIL on, nor stored a DTC on the system !

Tail pipe measurement / thresholds:  
All deteriorations are not exceeding the mentioned and today binding threshold values!



New measuring devices:  
scattered light principle has shown its capability to detect all failures!

**Tail pipe emissions can increase 50 times without detection!**

# Comparison of Sensitivity: Opacimeter vs. Scattered Light Particle Instrument (indicative)

NEW: Scattered Light Particle Instrument  
(Opacimeter II)

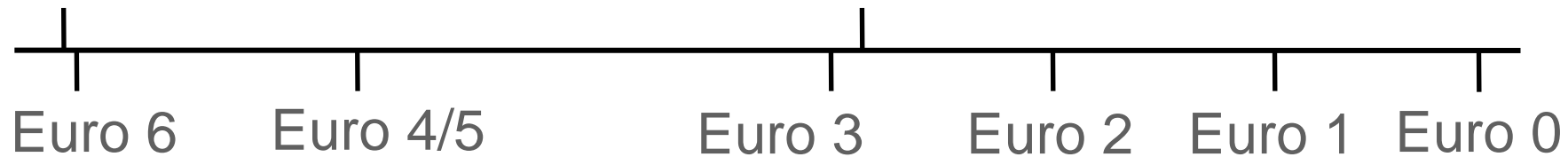


Standard Opacimeter/Smokemeter



Tier 2 Bin 5

Tier 1



Source:MAHA

# Homologation Project of New Opacimeter Second Generation

- ASA has initiated together with PTB a project named “Particle-Diagnostic”
- Built up know how on particle diagnostics with new measuring principles (e.g. scattered light)
- Correlation between transmission and scattered light
- Discussion about the proposals to calibration procedures
- Measurement have started in June 2011



# **Environmental Zones**

## EU limit values for PM<sub>10</sub> and NO<sub>2</sub>

averaging period	limit value	attainment period
<b>24 h</b>	<b>50 µg/m<sup>3</sup> PM<sub>10</sub></b> <b>35 exceedances/year</b>	<b>1 Jan. 2005</b>
<b>1 year</b>	<b>40 µg/m<sup>3</sup> PM<sub>10</sub></b>	<b>1 Jan. 2005</b>
<b>1 h</b>	<b>200 µg/m<sup>3</sup> NO<sub>2</sub></b> <b>18 exceedances/year</b>	<b>1 Jan. 2010</b>
<b>1 year</b>	<b>40 µg/m<sup>3</sup> NO<sub>2</sub></b>	<b>1 Jan. 2010</b>

# PM 2.5 Limits of the EU- DIRECTIVE on ambient Air Quality and cleaner Air for Europe




## LIMIT VALUE

Averaging period	Limit Value	Margin of tolerance	Date by which limit value is to be met
STAGE 1			
Calendar year	25 µg/m <sup>3</sup>	20 % on ...*, decreasing on the next 1 January and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2015	1 January 2015
STAGE 2 <sup>(1)</sup>			
Calendar year	20 µg/m <sup>3</sup>		1 January 2020
<sup>(1)</sup> Stage 2 - indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States.			

\* OJ: Date of entry into force of this Directive.

# EU- DIRECTIVE on ambient Air Quality and cleaner Air for Europe

Fine particulate matter (PM<sub>2,5</sub>) is responsible for significant negative impacts on human health. Further, there is as yet no identifiable threshold below which PM<sub>2,5</sub> would not pose a risk. As such, this pollutant should not be regulated in the same way as other air pollutants. The approach should aim at a general reduction of concentrations in the urban background to ensure that large sections of the population benefit from improved air quality. However, to ensure a minimum degree of health protection everywhere, that approach should be combined with a limit value, which is to be preceded in a first stage by a target value.

Emissions class	1	2	3	4
Sticker	No Sticker			
Requirement for diesel vehicles	Euro 1 or worse	Euro2 or Euro1 + particulate filter	Euro3 or Euro2 + particulate filter	Euro4 or Euro3 + particulate filter
Requirement for petrol vehicles	Without a catalytic converter			Euro1 with catalytic converter or better

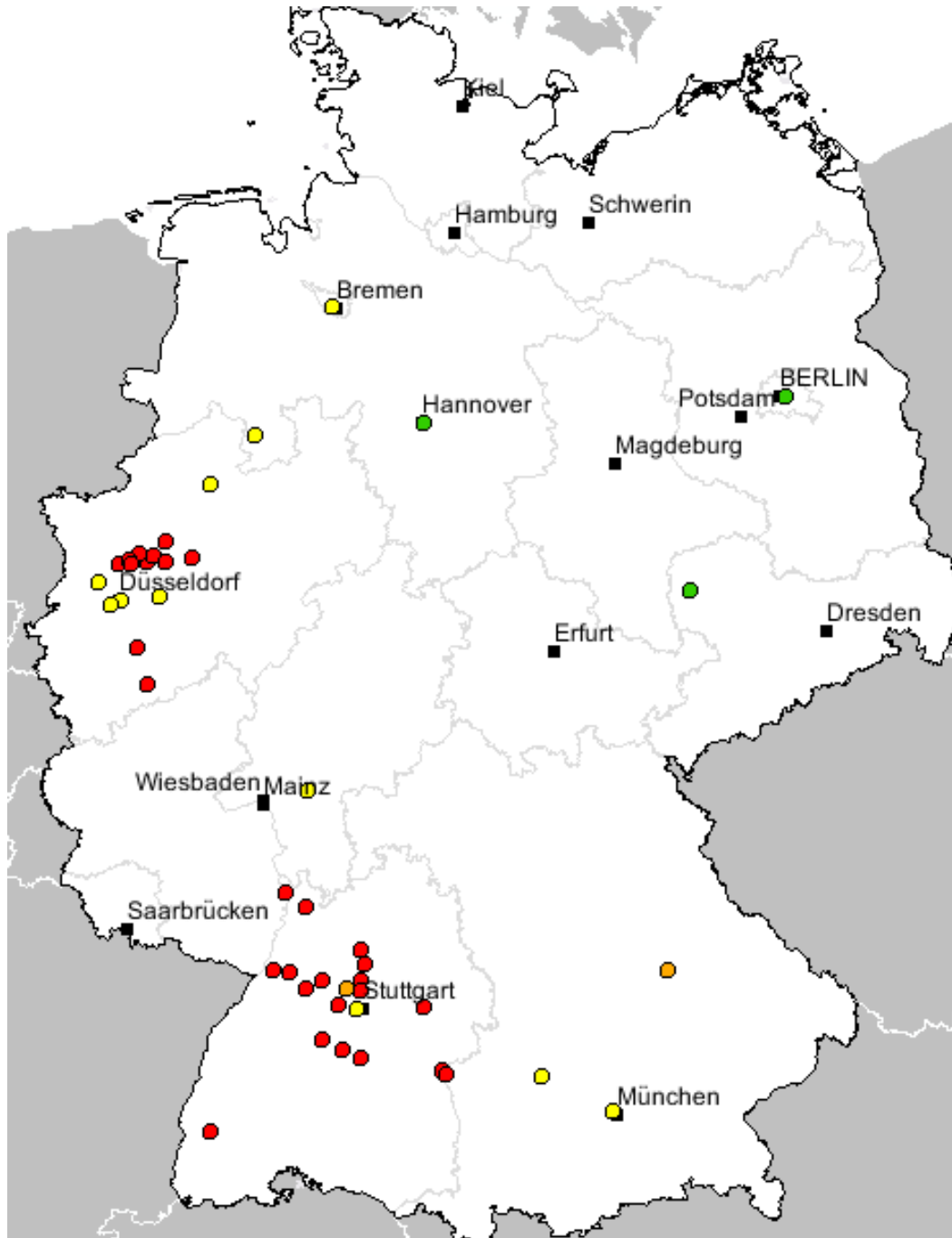


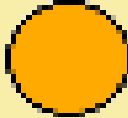
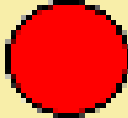
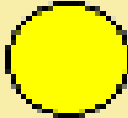
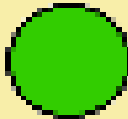
The bottom of the sign indicates which vehicle sticker(s) are allowed to enter.  
A sticker must be bought and displayed in the windscreen.

**Penalty;**

40 € fine and one point in the national traffic penalty register

# Environmental Zones in Germany



-  EZ planned
-  EZ only vehicles with a red, yellow or green sticker
-  EZ only vehicles with yellow or green sticker
-  EZ only vehicles with green sticker

# Berlin Environmental Zone Emission Criteria



## Area:

about 88 km<sup>2</sup>  
(Berlin total area: 892 km<sup>2</sup>)

## Inhabitants:

about **1 Million**  
(Berlin total: 3,4 Mio)

## Stage 1: since 1.1.2008



- ☞ Diesel vehicles: at least **Euro 2** or Euro 1 & retrofit
- ☞ Gasoline vehicles: at least **Euro 1**
- ☞ **7%** of vehicle fleet **affected**

## Stage 2: since 1.1.2010



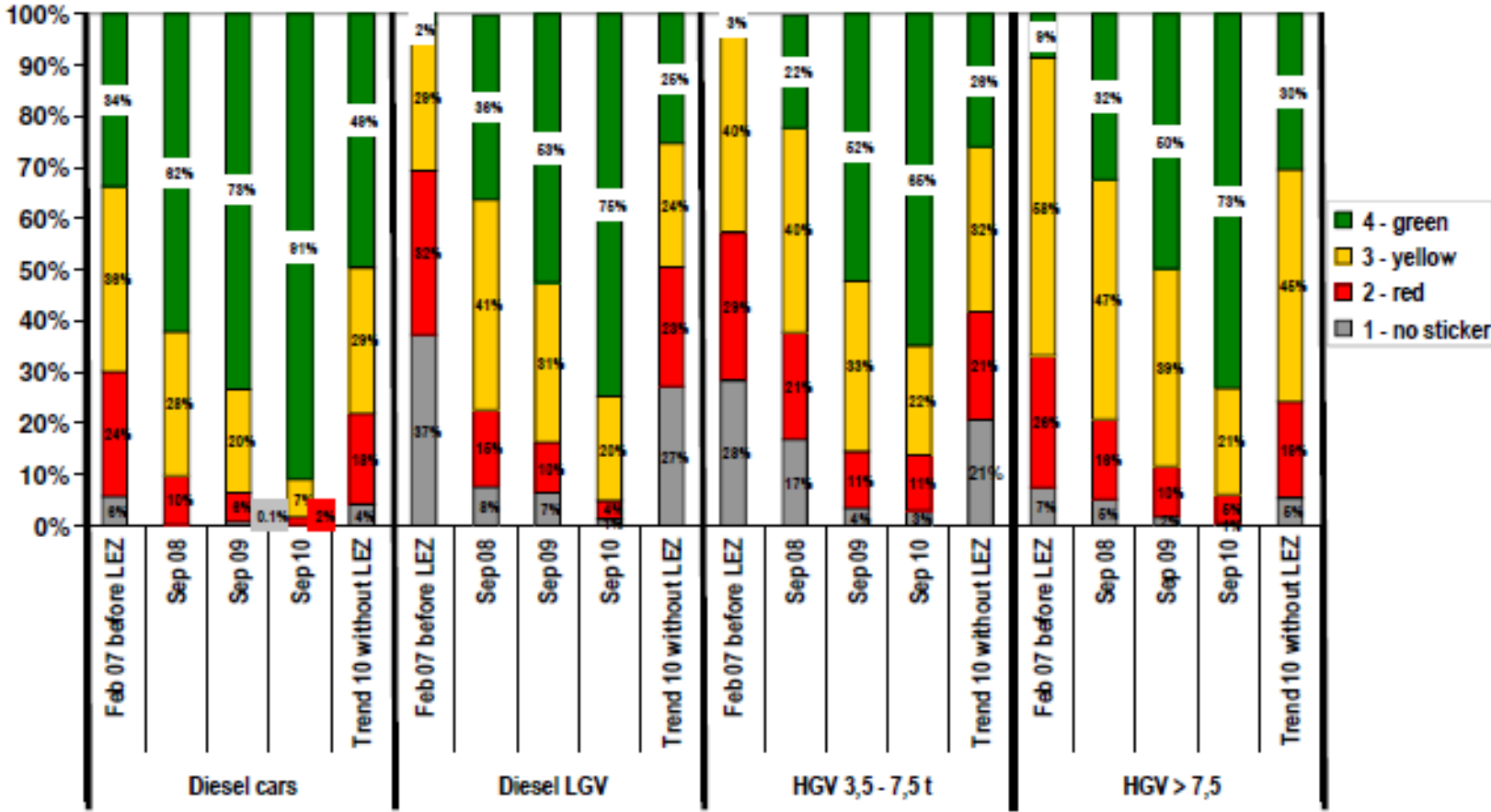
- ☞ Diesel: Particle emission **Euro 4**:
- ☞ cars: **Euro 3 + particle filter** or better
- ☞ goods vehicles: also **retrofit** of Euro 1-3 towards Euro 4<sub>Particle</sub>
- ☞ **10%** of the vehicle fleet **affected**

more than 40 LEZ planned/in force in Germany, 30 LEZ in the EU, but with different emission criteria



# Berlin Environmental Zone Impact Analysis

change of the vehicle fleet composition on the road  
(from number plate recognition)

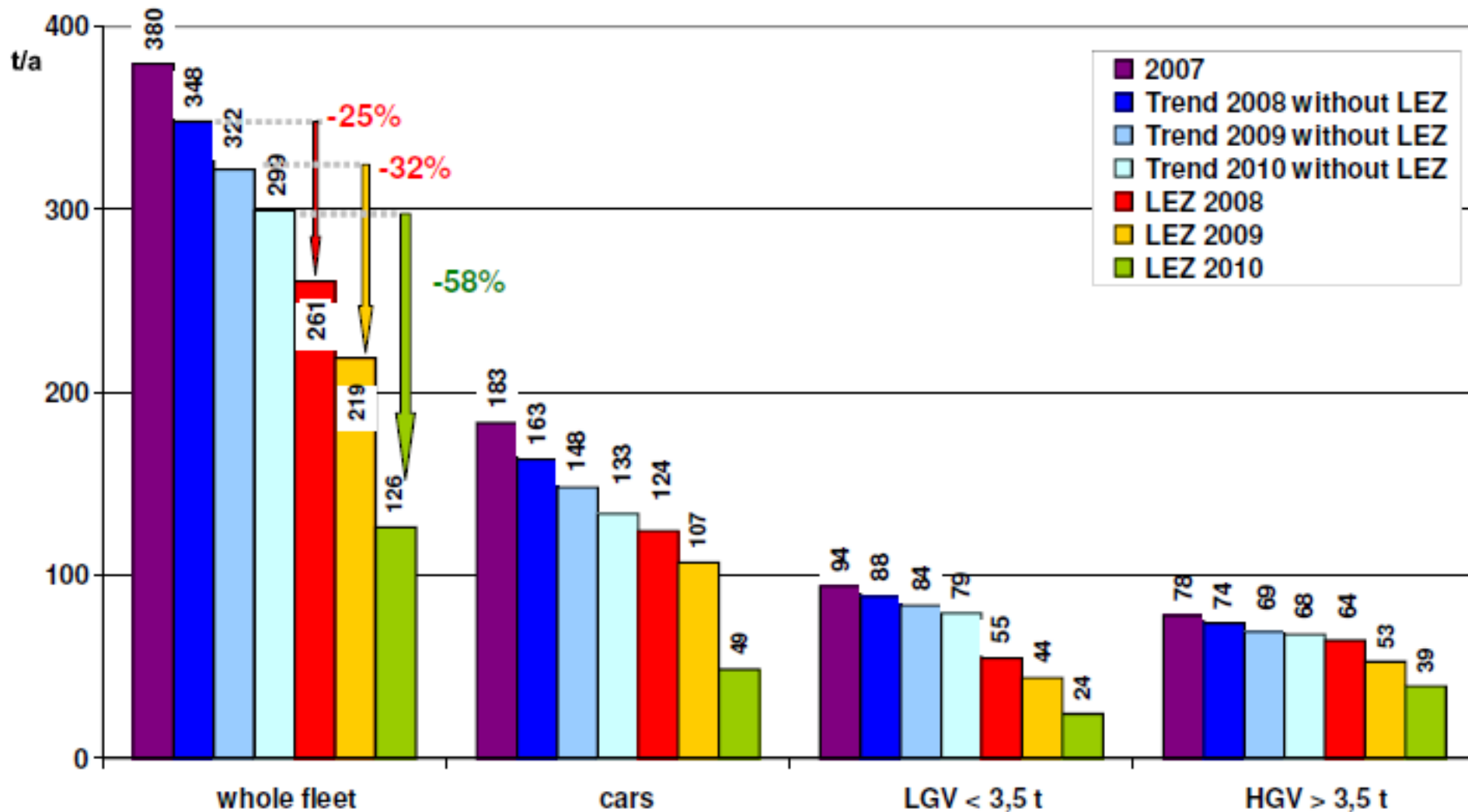


decrease: cat.1 (no sticker) by 70-90 %; **Cat 2 (red) by 50-80 %**  
increase: **category 4 (green) by factor 1,5 to 3**

# Berlin Environmental Zone – Impact Analysis

## Particle emissions-Black Carbon

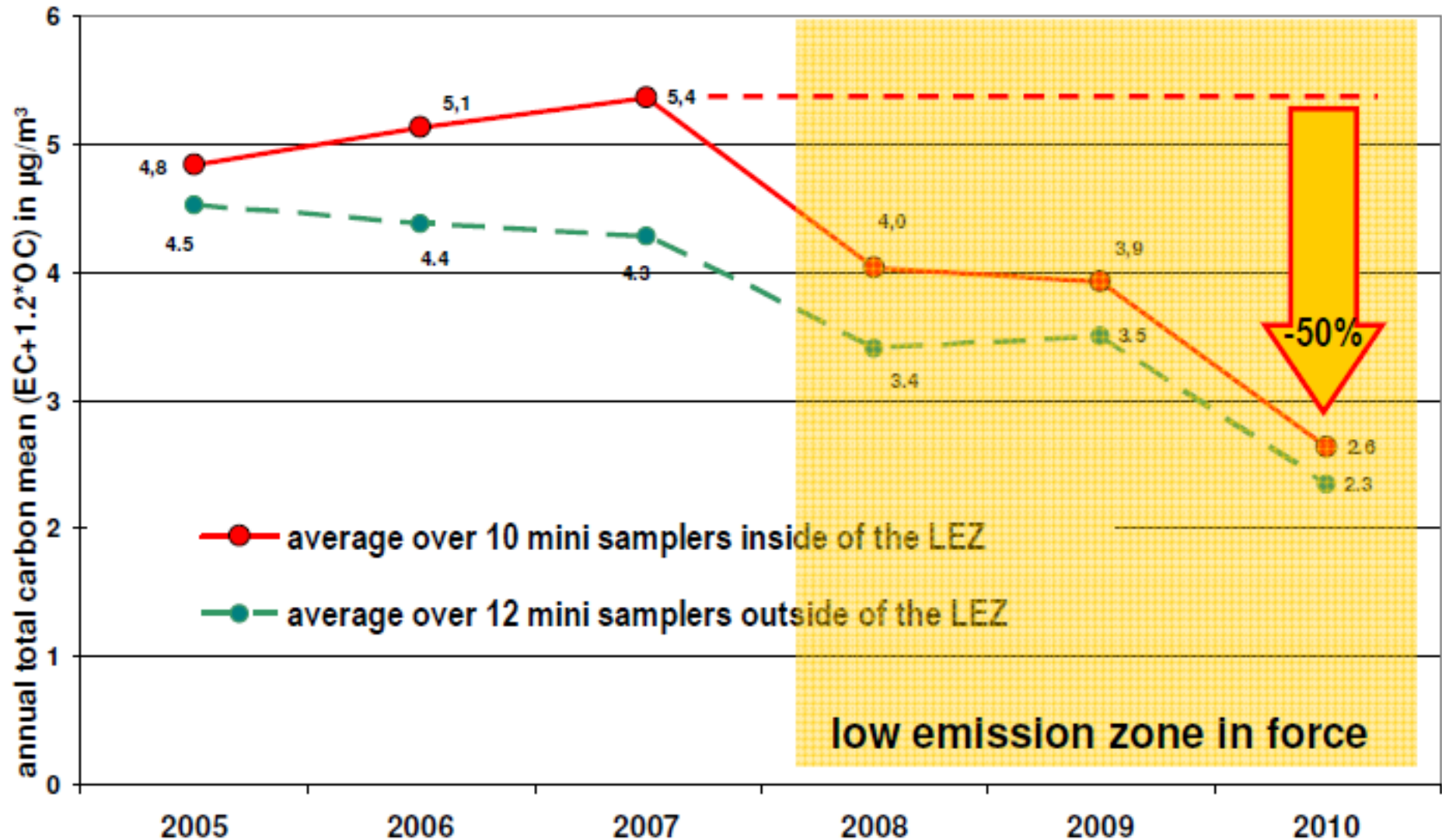
based on fleet composition at Frankfurter Allee (new emission factor data base HBEFa 3.1)



emissions extrapolated to the entire main road network based on the fleet composition at Frankfurter Allee (with DPF-retrofit, only warm emissions, no cold start impact)  
 (preliminary results, vers. 22/3/2011)

# Berlin Environmental Zone Impact

traffic related\* black‡ carbon particle concentration in Berlin



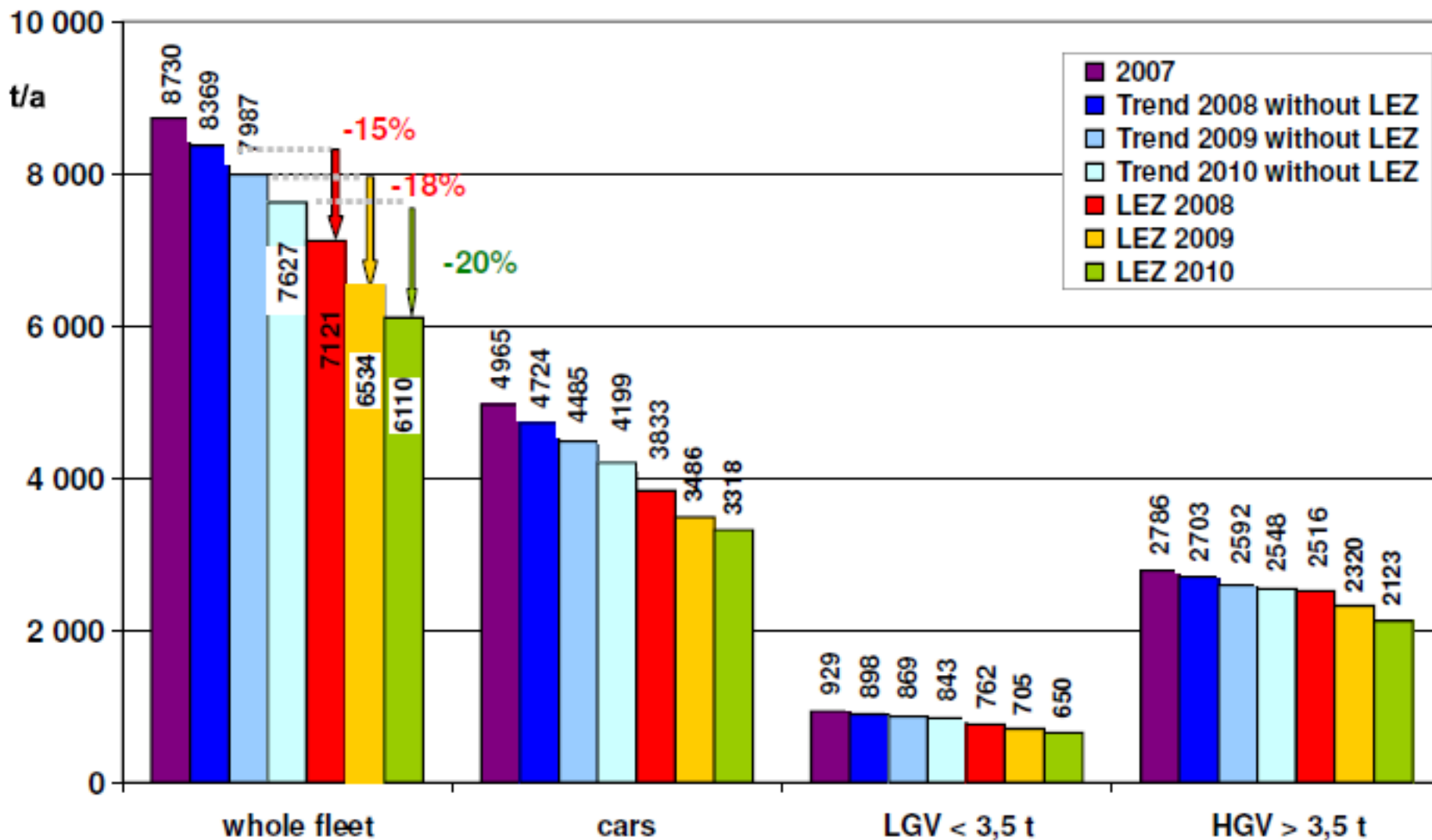
\* local BC increment at traffic sites, adjusted to traffic volumes trend relative to 2007 before LEZ came into force

‡ elemental carbon (EC) particles plus other deposited organic compounds (OC)

# Berlin Environmental Zone – Impact Analysis

## NO<sub>x</sub> Emissions

based on fleet composition at Frankfurter Allee (new emission factor data base HBEFa 3.1)



emissions extrapolated to the entire main road network based on the fleet composition at Frankfurter Allee (with DPF-retrofit, only warm emissions, no cold start impact)

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