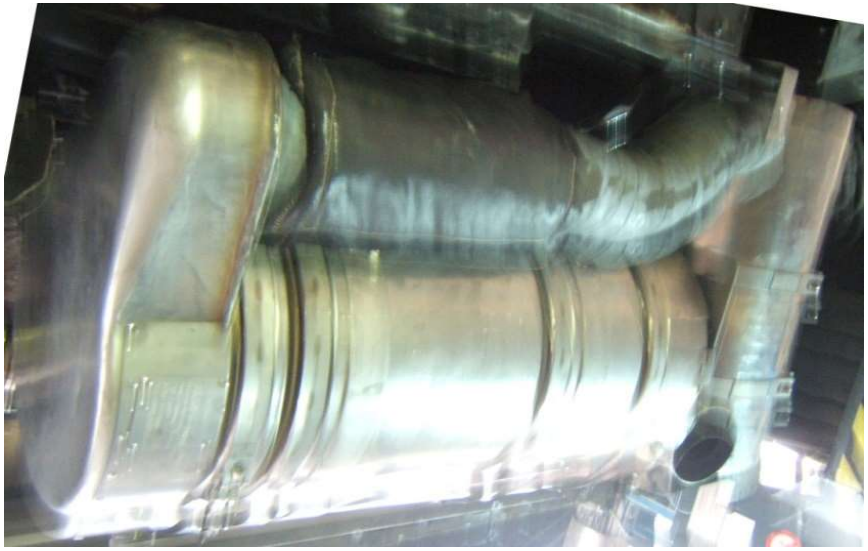
The pros and cons of SCR & DPF retrofit in German low emission zones

11th VERT Forum March 25th



Volker Schlickum

Senate Department for the Environment, Transport and Climate Protection

Berlin

1999

The beginning

1400 Busses for municipal public transport

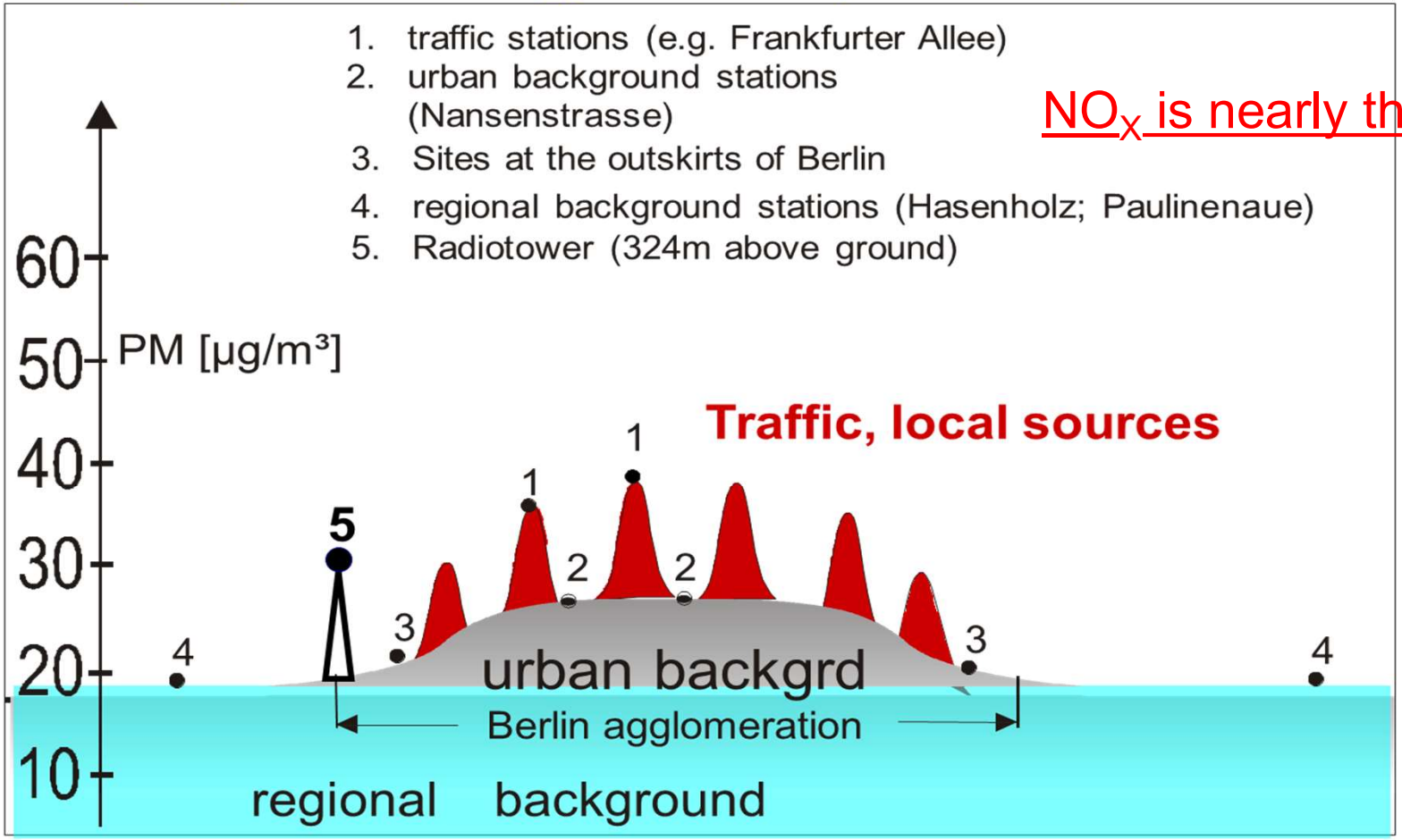
100% in only 8 years with particulate filter

	reference 2004	2005	2006	2007	2008	2009
EURO 0	28%	22%	10%			
EURO 0 with CRT- **Particulate filter**	11%	7%	7%	4%		
EURO 1 with CRT- Particulate filter	12%	12%	12%	12%	3%	
EURO 2 with CRT- Particulate filter	35%	35%	35%	35%	35%	26%
EURO 3 with CRT- Particulate filter	12%	21,9%	22%	22%	22%	22%
EURO 4 with CRT- Particulate filter	0,1%	0,1%	12%	12%	12%	12%
EURO 5 with Particulate filter / EEV	2%	2%	2%	15%	28%	40%

source analysis

☞ where does it come from & how much ?

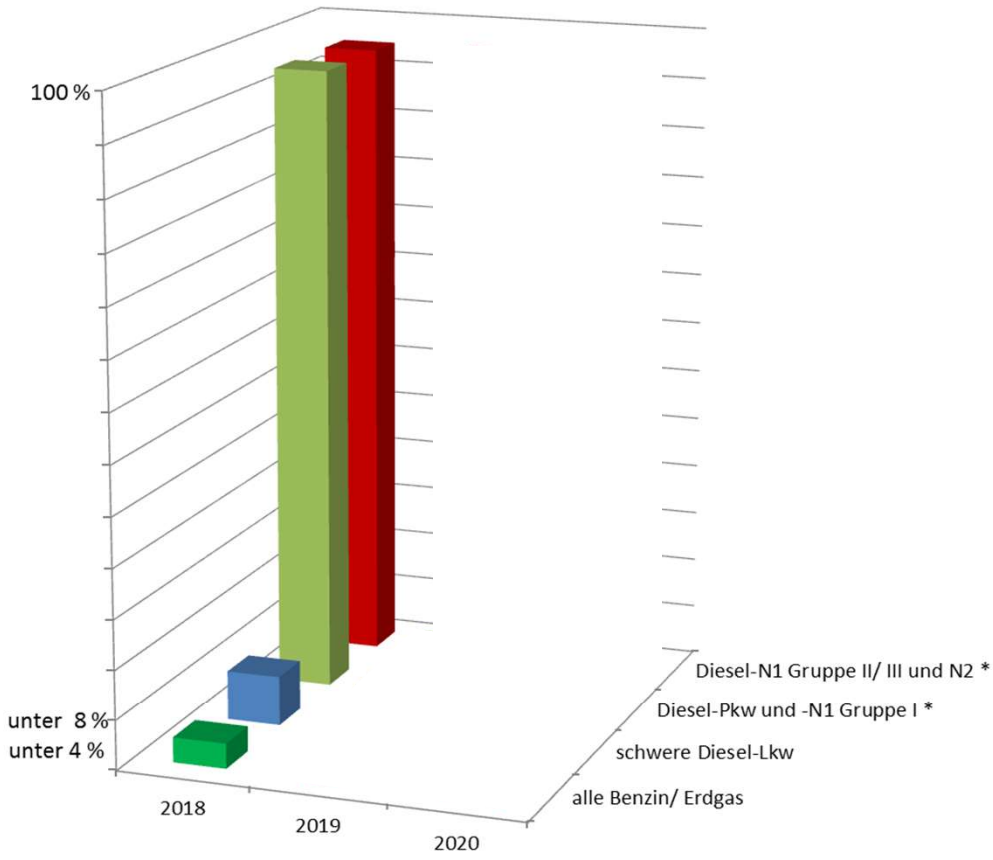
Example: phenomenology of the PM-pollution around Berlin



NO_X is nearly the same

Aktuelle Rahmenbedingungen

Max. NO_X-Realemissionen neu zugelassener Fahrzeuge



alle Benzin/ Erdgas
schwere Diesel-Lkw
Diesel-Pkw und -N1 Gruppe I *
Diesel-N1 Gruppe II/ III und N2 *

Nutzfahrzeuge 1,3 – 3,5 to

* dies sind spezielle Zulassungsgrößen

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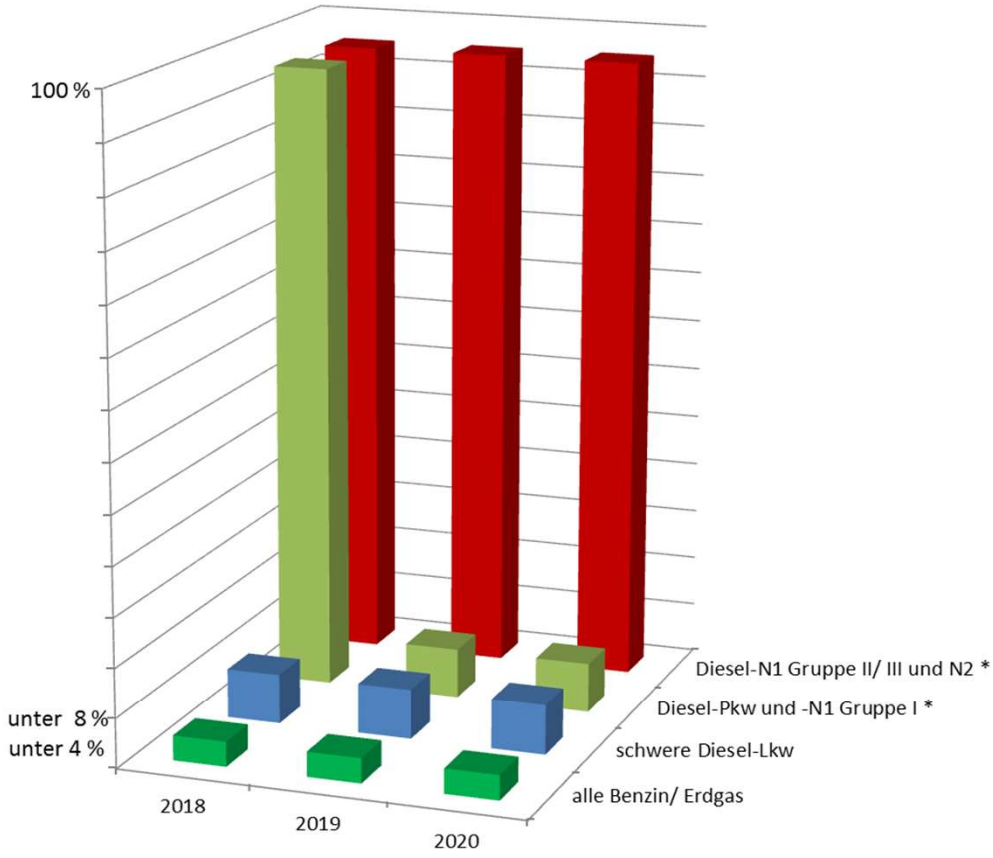

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Clean Air Plan Berlin ☞ transport measures

Cleaner vehicles and fuels…..

cleaning up the municipal vehicle fleet

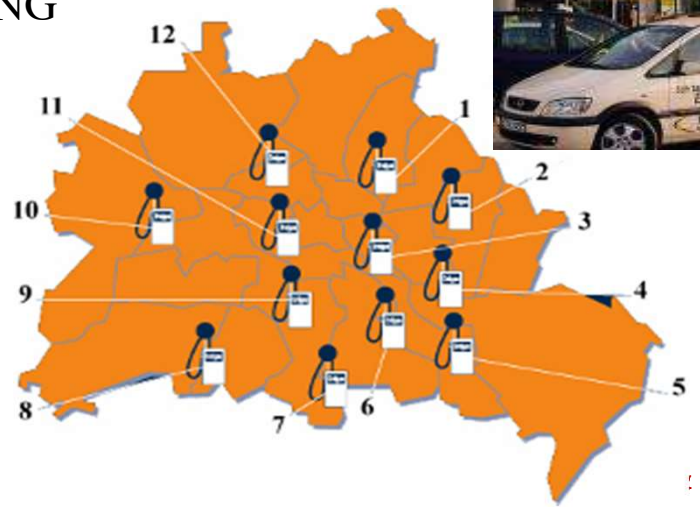
- **particle filter**: police, busses
  - 1000 old buses retrofitted with CRT since 1999
  - full CRT coverage by 2008
- **compressed natural gas & biogas**:
  - 25% of garbage collection vehicles, 50% by 2008
  - 15 buses running on CNG and 5 on hydrogen
- SCRT retrofit for public buses
  - retrofit programme of about 300 busses

CNG (compressed natural gas) for private & commercial Diesel vehicles

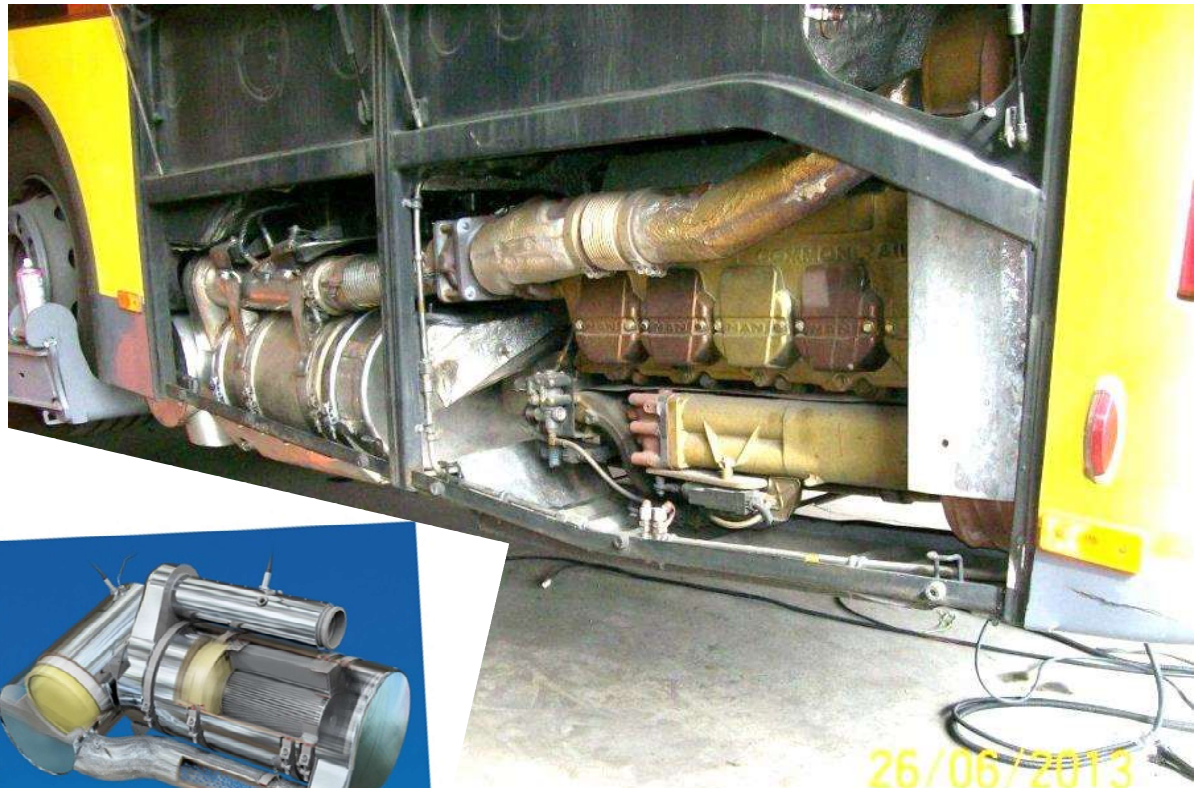
- 1000 private cars: gas-vouchers & tax refunds
- 1000 taxis and driving schools: funding of new CNG-vehicles
- 100 HGVs&LGVs: funding of new vehicles running on CNG

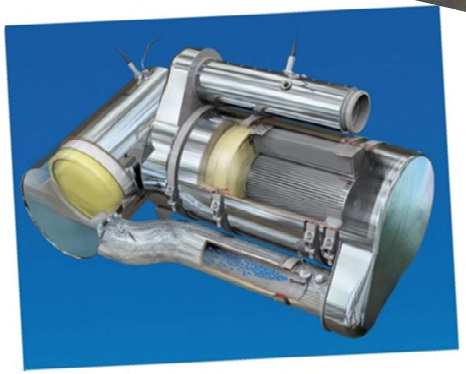
network of natural gas refilling stations (14 stations by now)

- increasing share of biogas



Public transport busses I



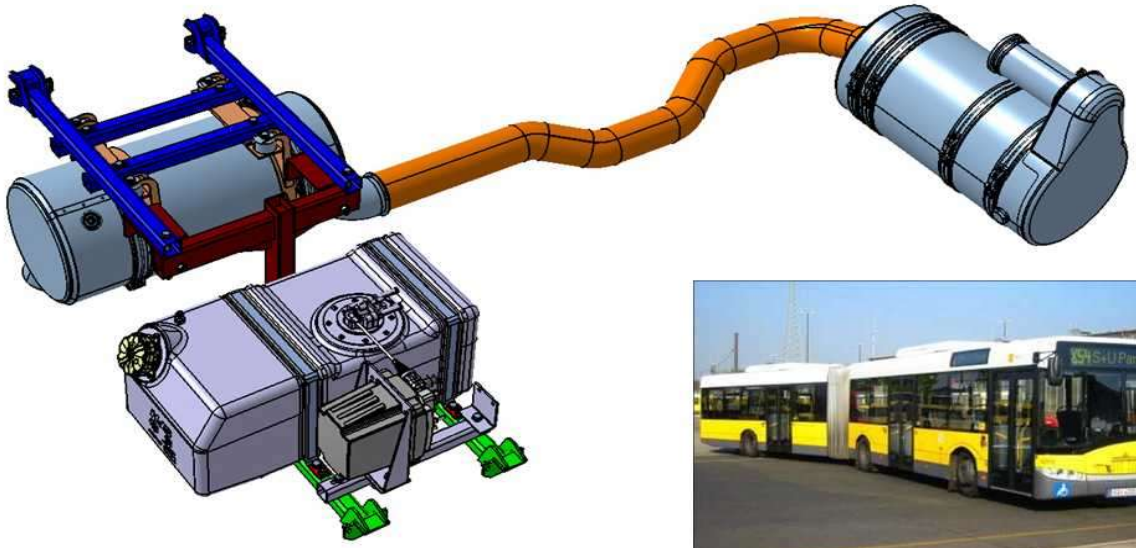


200 double-deckers of the Berlin-BVG retrofitted with SCR, thereby approaching EURO VI values

-75 % NO_X per vehicle

Public transport busses II

SCRT®-System Solaris Urbino 18 - Einbaulage



70 articulated-long-busses of the Berlin-BVG retrofitted with SCR, thereby approaching EURO VI values

-75 % NO_X per vehicle

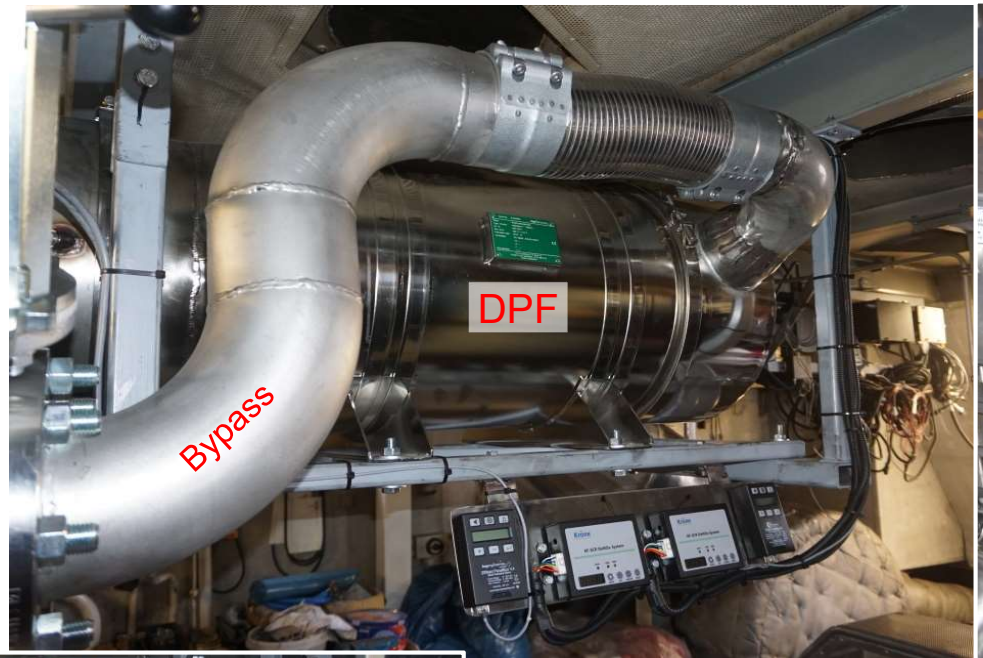
Public transport, measures by lower exhaust temperatures

SCR + particle filter in passenger cruise ships

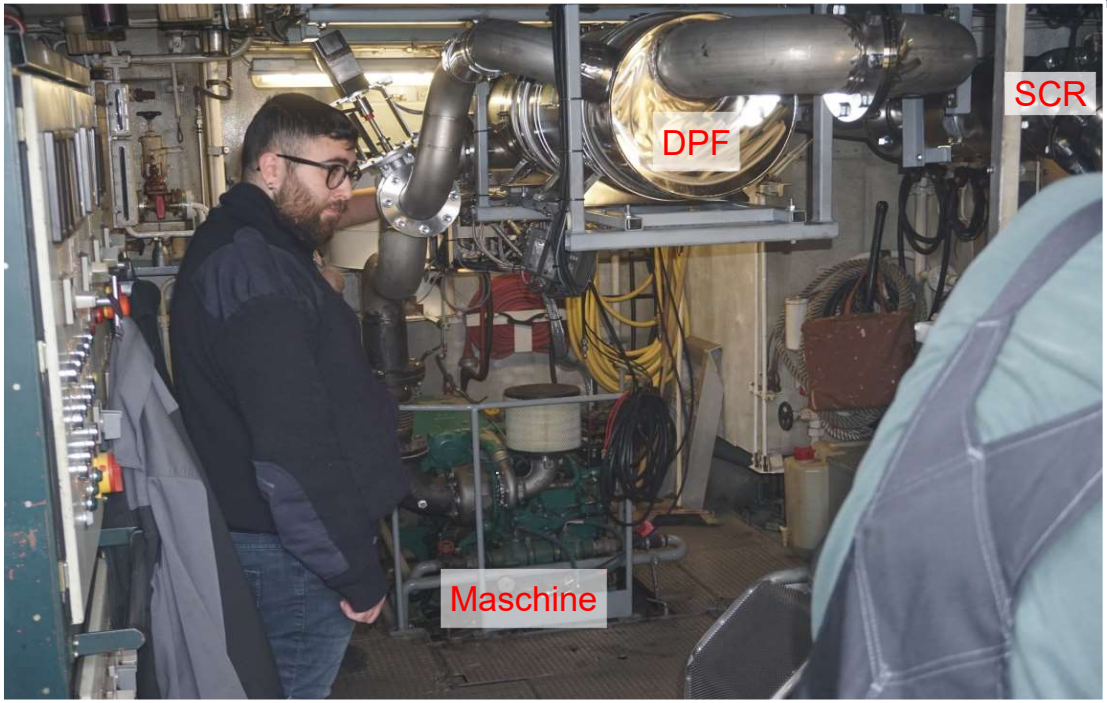
pilot project 2008-2010 with particle filter

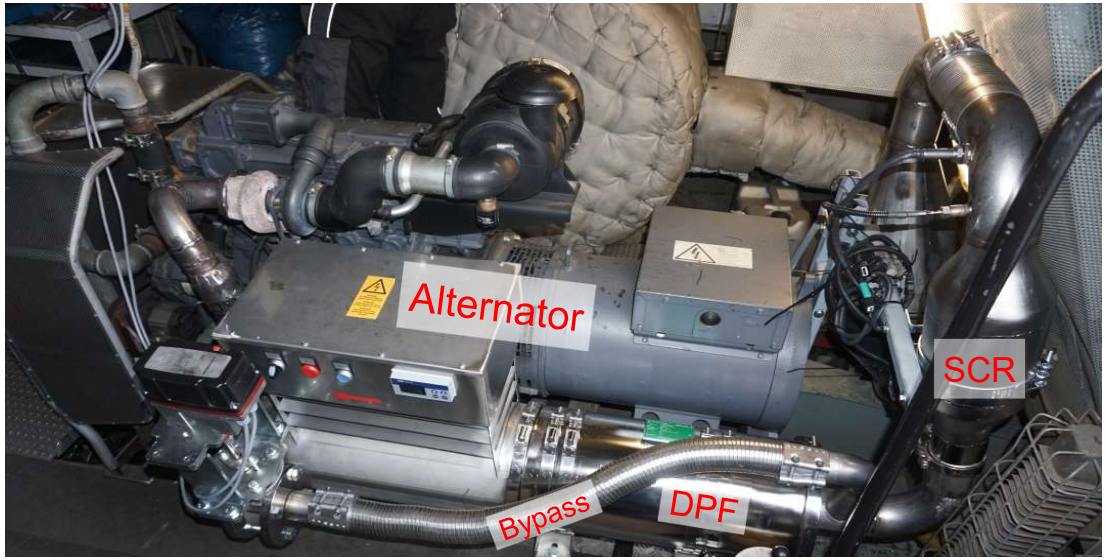
- **Now retrofit of 3 vessels with different SCR-systems**
- **monitoring of efficiency, performance and handling during routine operation**


Steering unit


DPF
Bypass


Steering unit
alternator


DPF
SCR
Maschine


Alternator
SCR
Bypass
DPF

Vehicles with lower exhaust temperatures II

☞ SCR + particle filter in garbage trucks

Up to 75 waste collection vehicles of the BSR equipped with highly efficient NO_X reduction (SCR) + exhaust particle filters thereby approaching EURO VI emission values.

Vehicles with lower exhaust temperatures III

☞ light delivery- and craftsman's van

subsidy directives

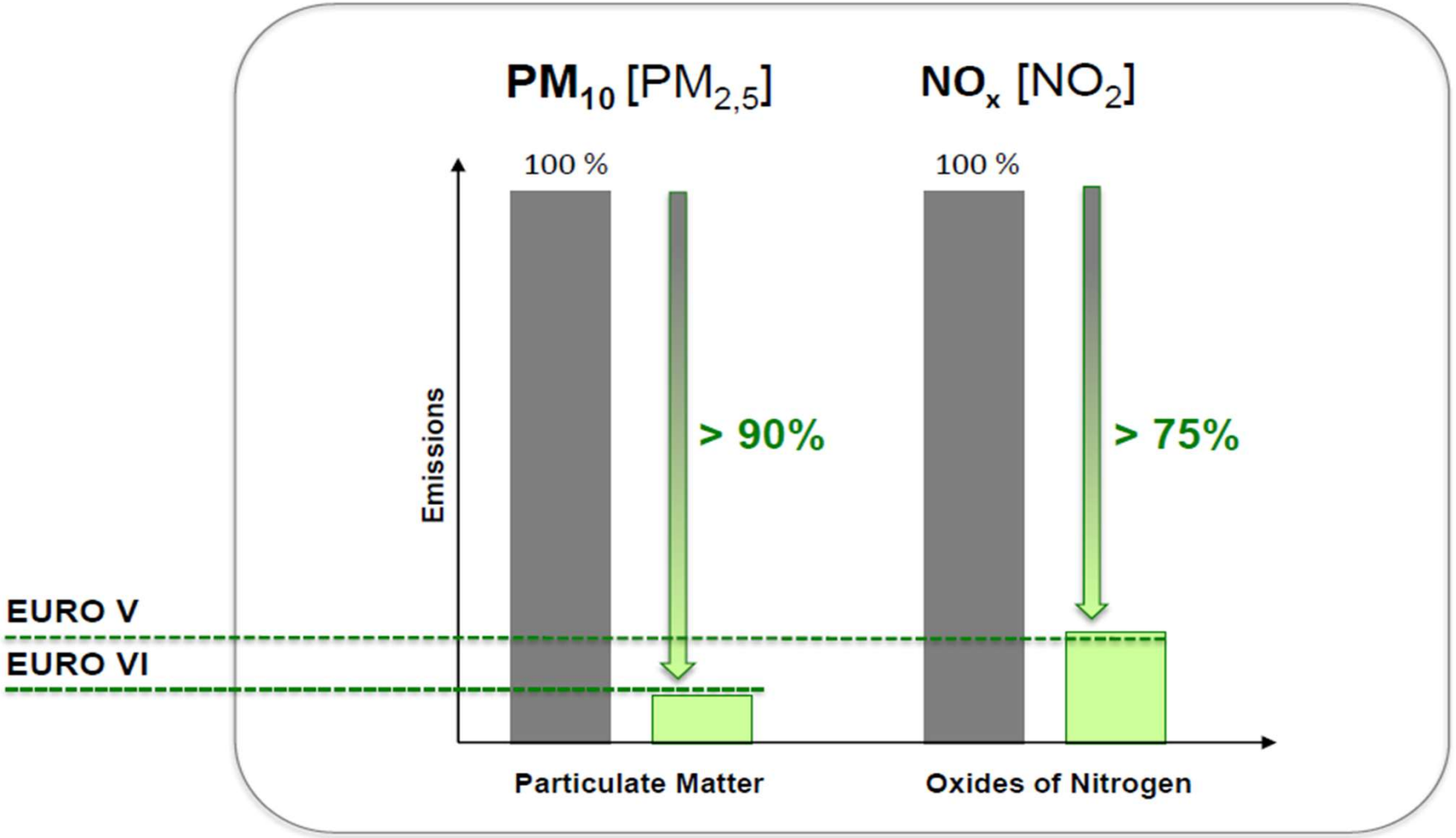
The funding guideline for public-busses (heavy-duty):
40-60% (80%) published in the Federal Gazette.

funding guideline for heavy-duty municipal vehicles .
40-60% (80%) published in the Federal Gazette.

funding guideline for heavy-duty delivery- and craftsman's vehicles (3,5-7,5 t):
40-60% published in the Federal Gazette.

funding guideline for light delivery- and craftsman's vans (2,8-3,5 t):
40-60% published in the Federal Gazette.

Retrofit – Efficiency SCR + DPF® Systems



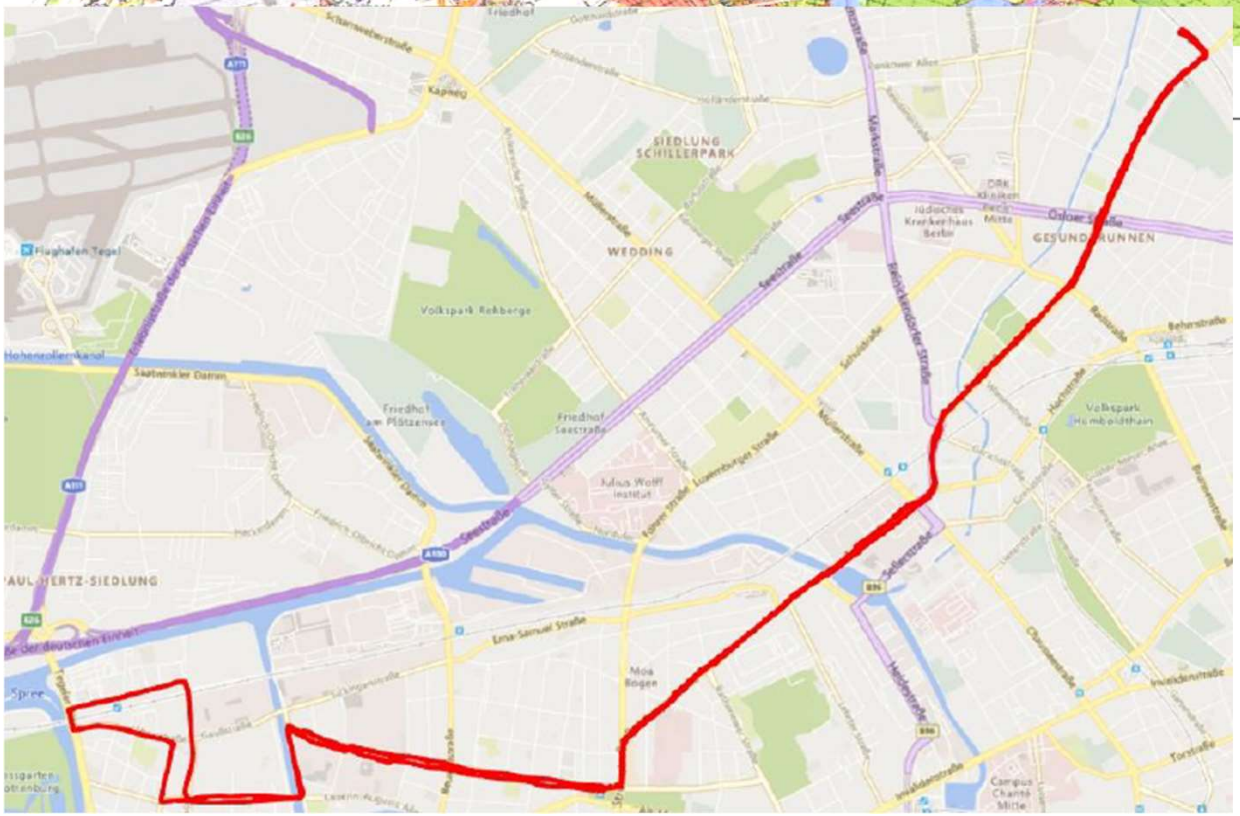
ERECA
Exhaust Retrofit Emission Control Alliance

That were the pros of SCR + DPF® Systems

To check on potential disadvantages (cons) we run test programs with retrofitted:

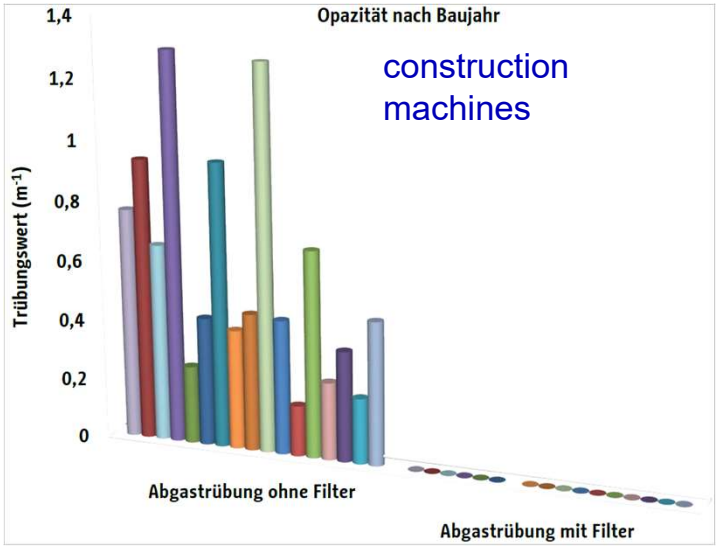
- public transport busses
- construction machines (DPF only)
- 2 aktuell Plug-In-Hybrid cars (GPF)
- passenger cruise ships
- and an own light delivery- and craftsman's van

The test programs



All measurements were carried out on tested routes

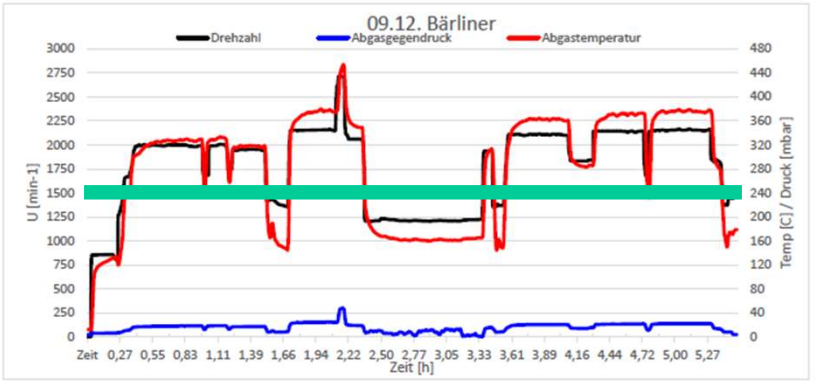
Retrofit – Real Conditions

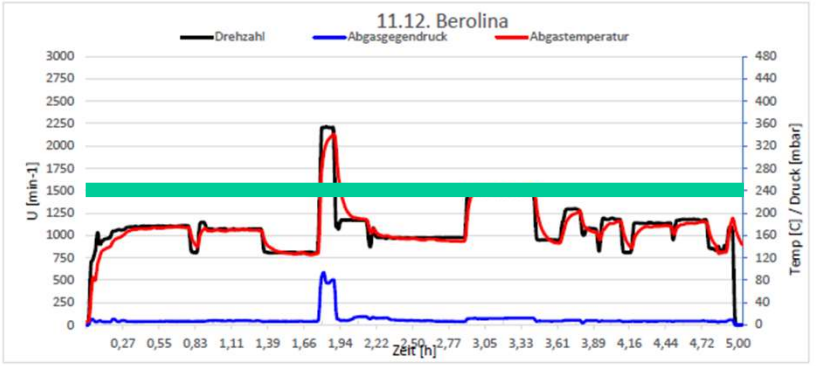


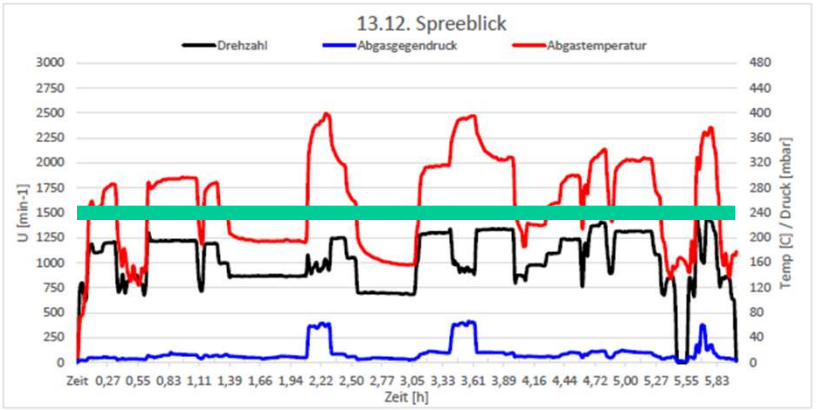
construction machines

In general, all manufacturers can be certified as having a system design with low exhaust backpressure and low particulate emissions.

passenger cruise ships

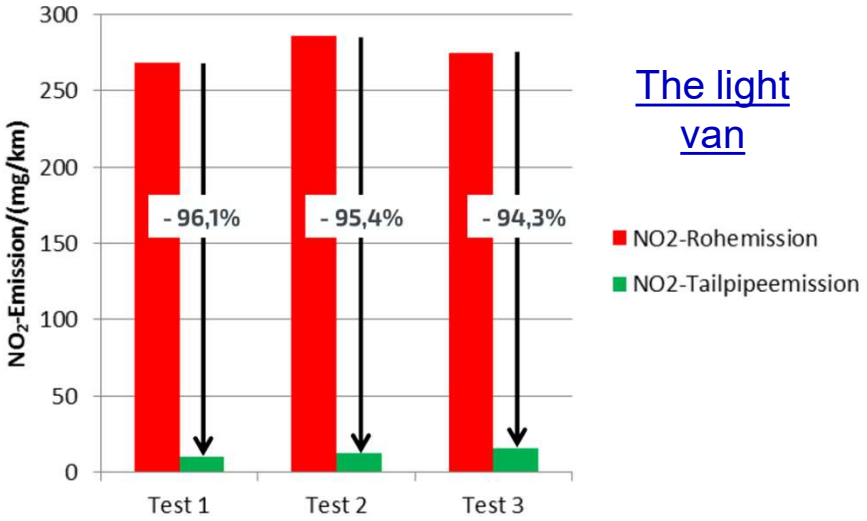






a bus

Retrofit – Real Efficiency SCR + DPF® Systems

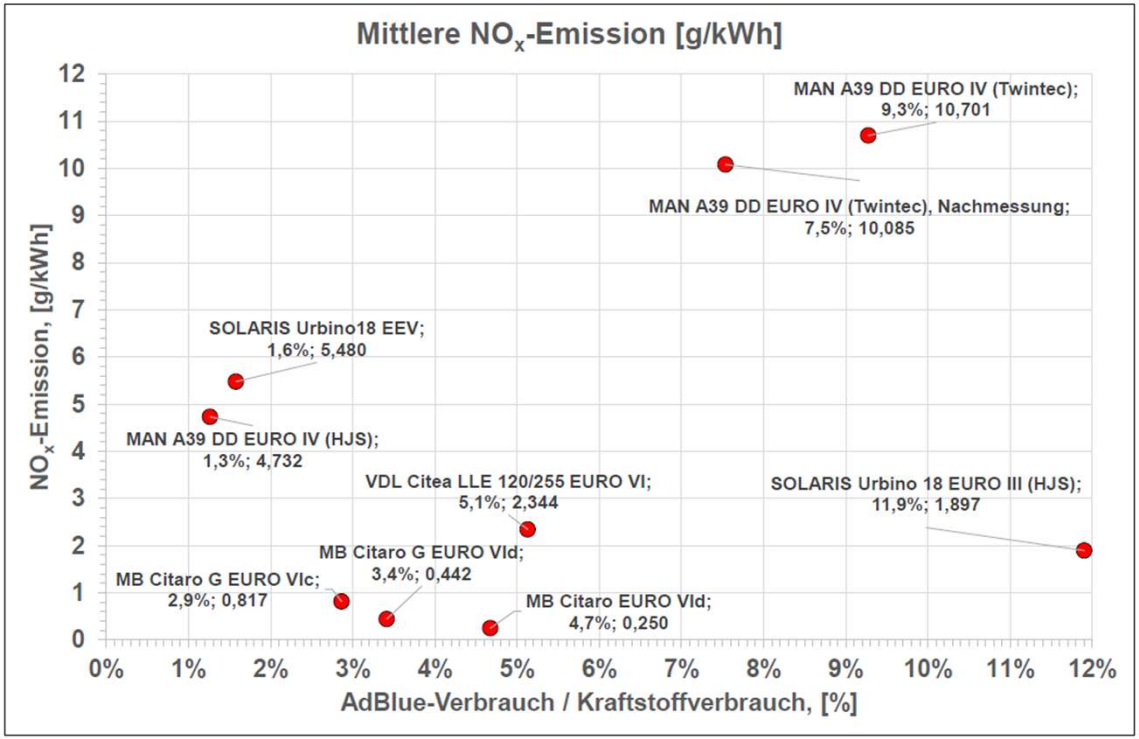


The light van

Passenger cruise ships

The SCR catalytic converter significantly reduces the nitrogen oxides after reaching the necessary temperature, in some cases to the detection limit).
However:
The requirements for the systems to reduce nitrogen oxides as well are very demanding, since the propulsion engines of the ships do not yet have an electronic control system by which the operating conditions of the engine can be determined or influenced. In addition, the exhaust gas temperature is too low to operate the SCR systems (without auxiliary heating) when sailing at low speed - due to the low load. All three manufacturers of the exhaust gas cleaning systems had difficulties with the urea dosing, resulting in an ammonia slip.

The retrofitted buses showed a split picture. While the exhaust gas after-treatment of the MAN A39 DD EURO IV with the Twintec BNOx system did not work due to an obvious defect and the vehicle emitted almost raw exhaust gas, the MAN A39 DD EURO IV with HJS SCRT system, which also had an obvious defect, showed reduced NOx reduction behaviour. The SOLARIS Urbino18 EURO III with HJS SCRT system, on the other hand, the vehicle with the greatest mileage, showed a comparatively very good NOx emission behaviour. At higher speeds, the NOx emission level of this bus is in the range of EURO VI vehicles. The NOx emission behaviour of the SOLARIS Urbino18 EEV, which is equipped with a standard SCR system, is at a high level, due to an obviously insufficient reagent injection.



Retrofit is more cost-effective

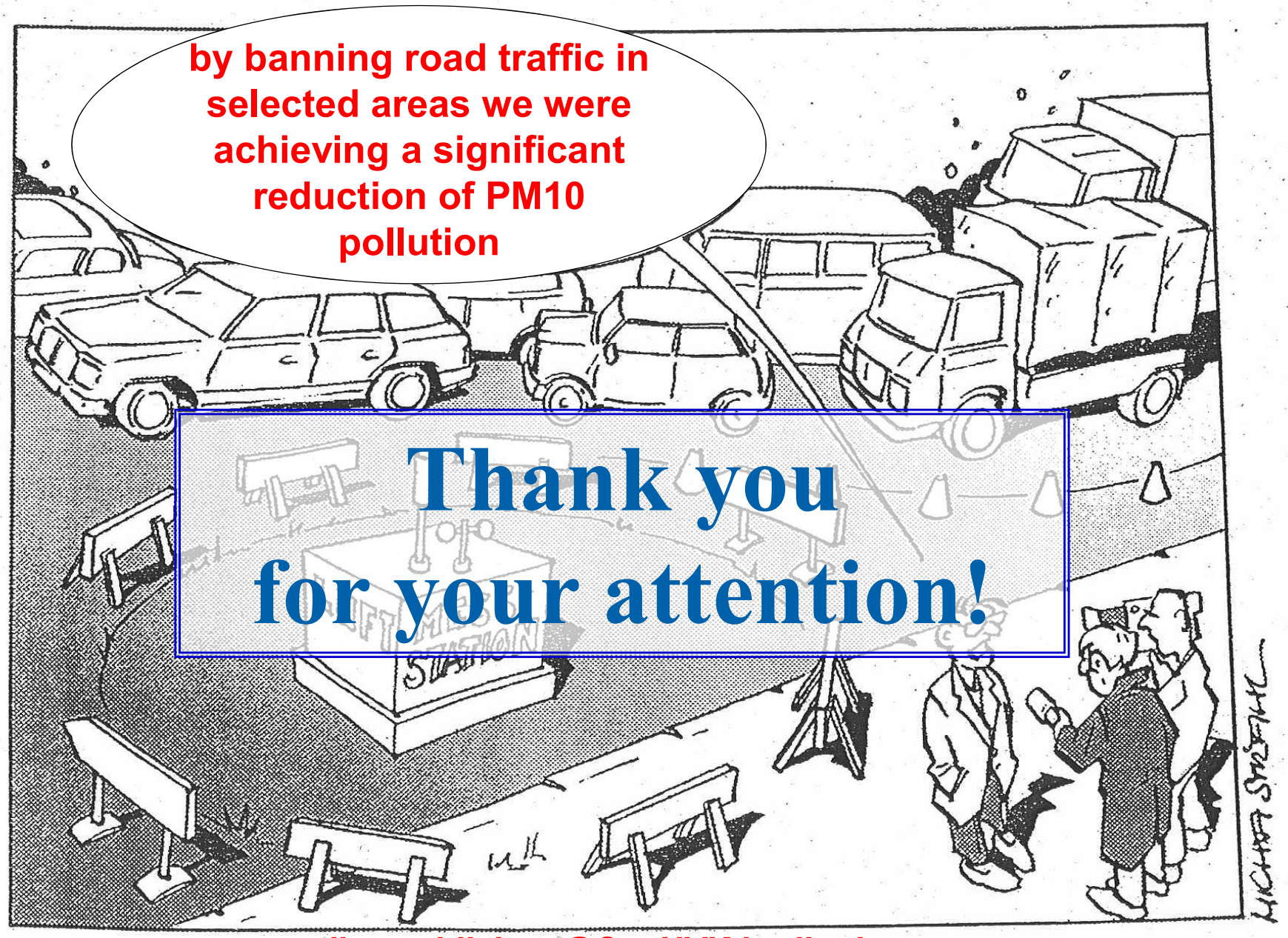
1 x EURO VI Bus

The same Budget for:

20 x Retrofit Bus

But don‘t forget the quality of the system AND the maintenance

ERECA
Exhaust Retrofit Emission Control Alliance



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