POWERTRAIN TECHNOLOGIES

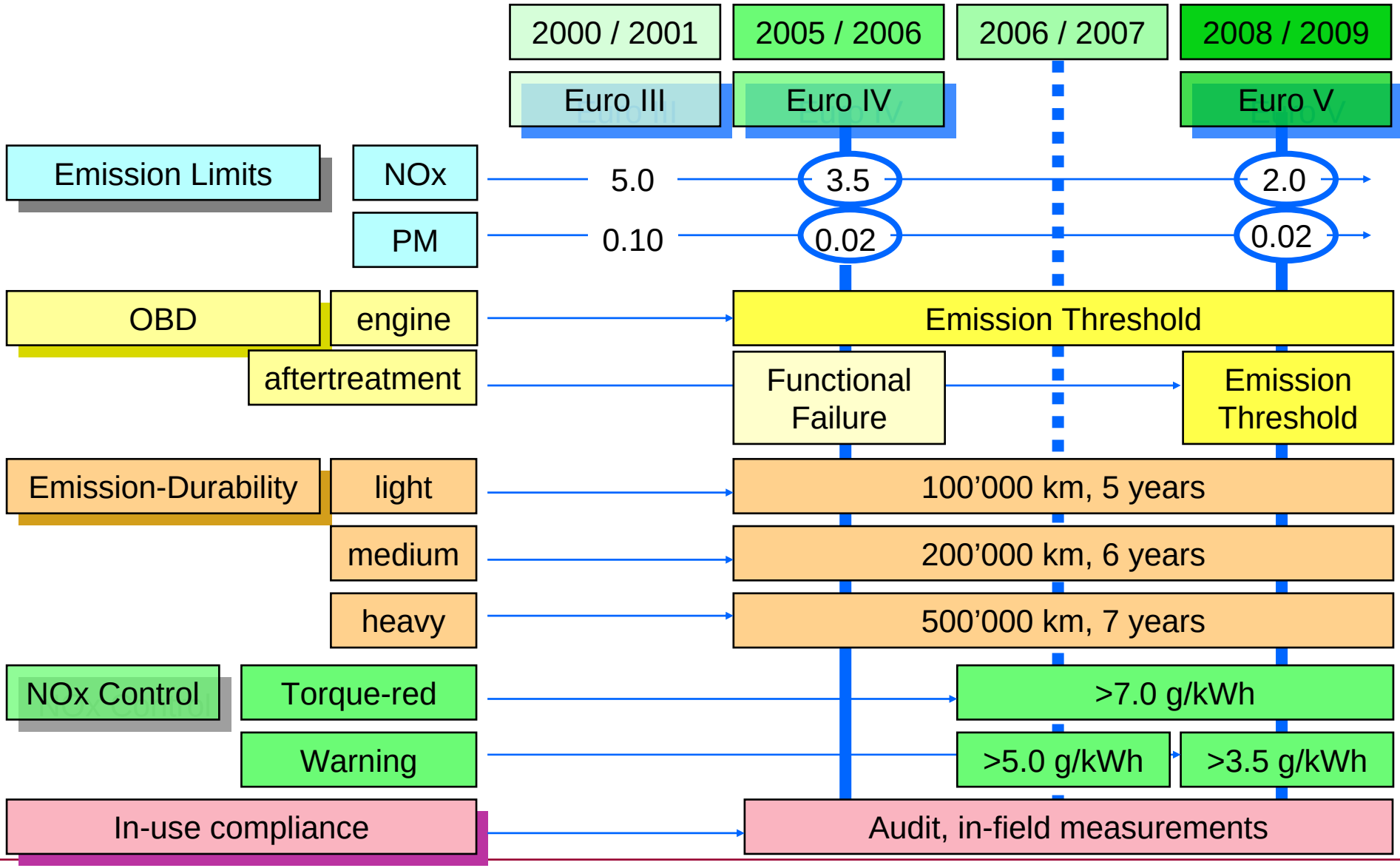
Industrial & Marine
Iveco Motorenforschung AG

OEM – Technology for Particle Elimination

10th ETH-Conference on Combustion Generated Nanoparticles 2006

Meinrad Signer
Dep. General Manager

Euro IV / V Directive



Euro IV and V

- With the introduction of euro IV and V the HD PM-emissions are reduced by 80% in comparison to Euro III
- Different technologies have been applied by the European OEM's:
  - Iveco, DaimlerChrysler, Daf and Volvo: SCR for Euro IV and V
  - MAN: EGR und PM-Kat for Euro IV, SCR for Euro V
  - Scania: EGR and Oxi-cat for Euro IV, SCR for Euro V
- All technologies result in similar emission values in the European Test Cycles

- Emission values are of importance, words can be misleading

Iveco Engine Technology

Iveco Engine Technology

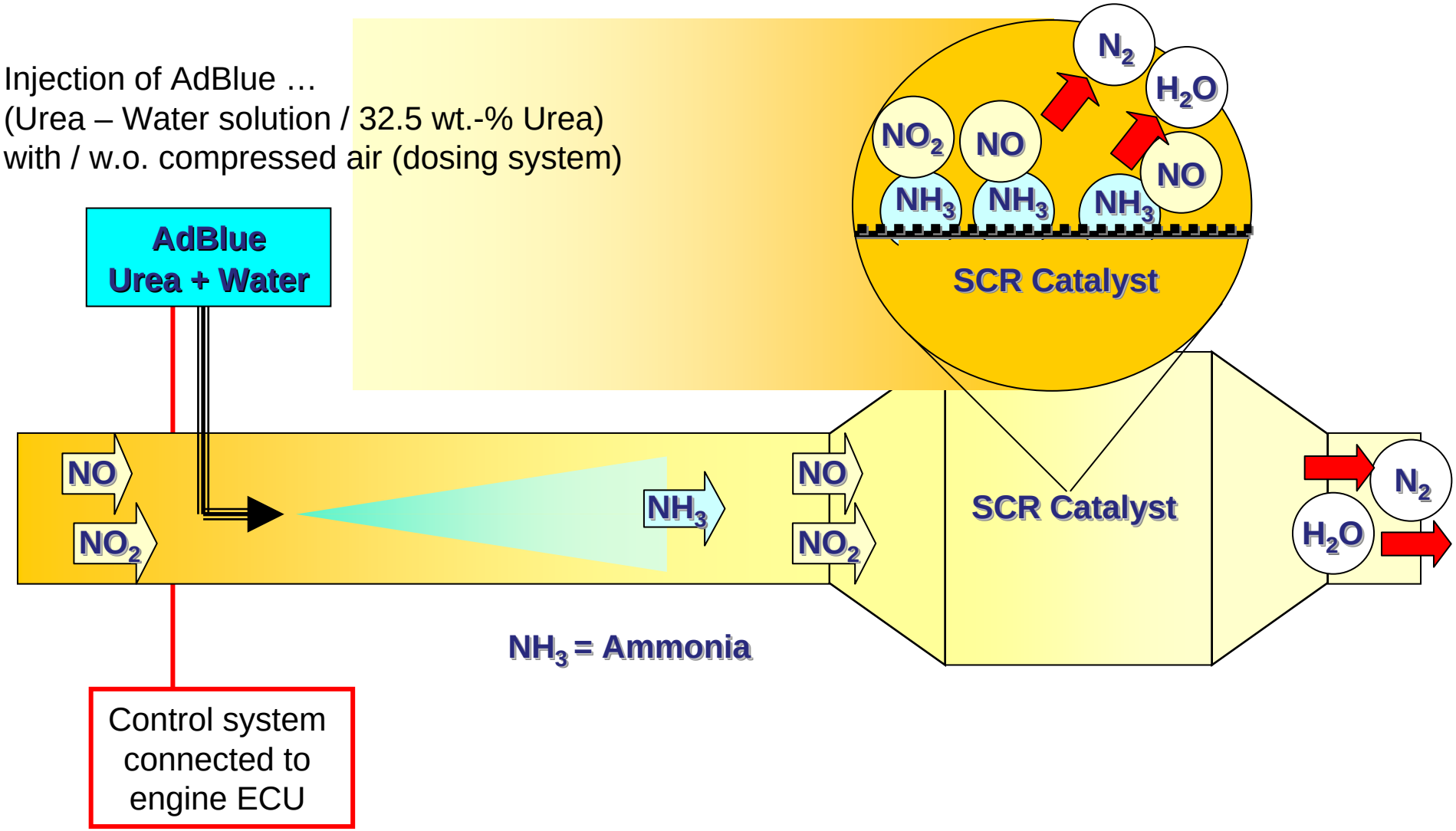
		Euro IV	Euro V	EEV-Diesel	EEV-CNG
Daily 3,5 t		EGR DPF Option			MPI-TWC
Daily >3.5 t	Light trucks	EGR + DPF			MPI-TWC
Eurocargo	medium	SCR	SCR		MPI-TWC
Trakker	Tipper	SCR	SCR		
Stralis	Heavy	SCR	SCR		
Irisbus	Citybus	SCR	SCR	SCRT (closed DPF)	MPI-TWC
	Coach	SCR	SCR	SCRT (closed DPF)	

All systems in production and available

SCR: Selective Catalytic Reduction
EGR: exhasut gas recirculation
DPF: Diesel Particle Filter, closed (>90%)
MPI-TWC: Multi-point injection, 3-way catalyst
SCRT. CRT (DPF) + SCR

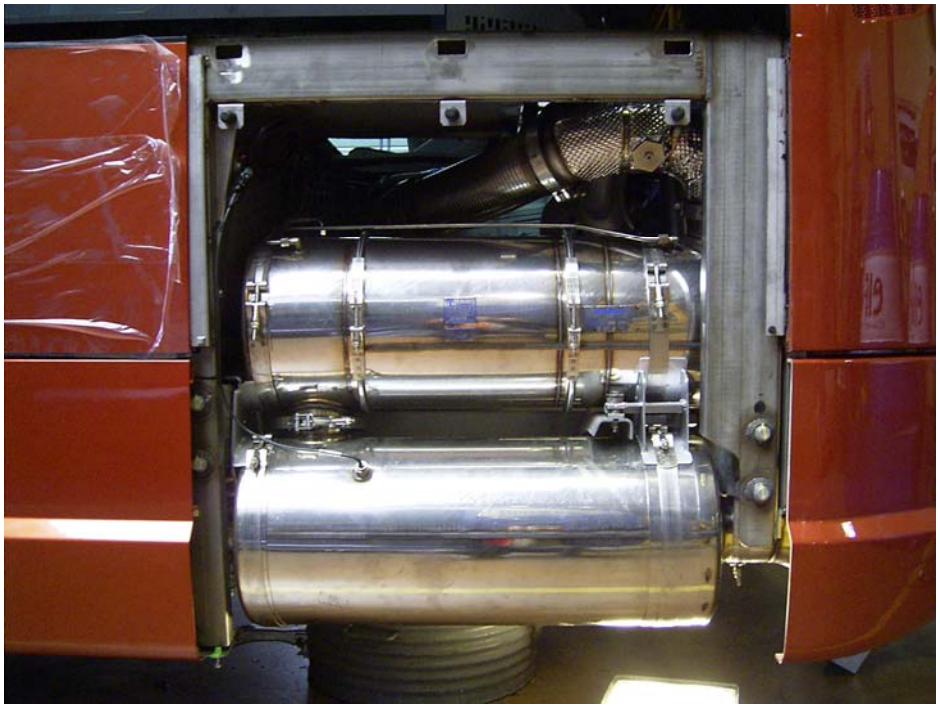
SCR Catalyst

Injection of AdBlue …
(Urea – Water solution / 32.5 wt.-% Urea)
with / w.o. compressed air (dosing system)



SCRT in city buses

Tector 6 GX127 City Bus application („Close Coupled“ SCRT)



Cursor 8 „Cigar“ application for city buses (Chorus Line, Citelis)

Experiences with chosen technologies

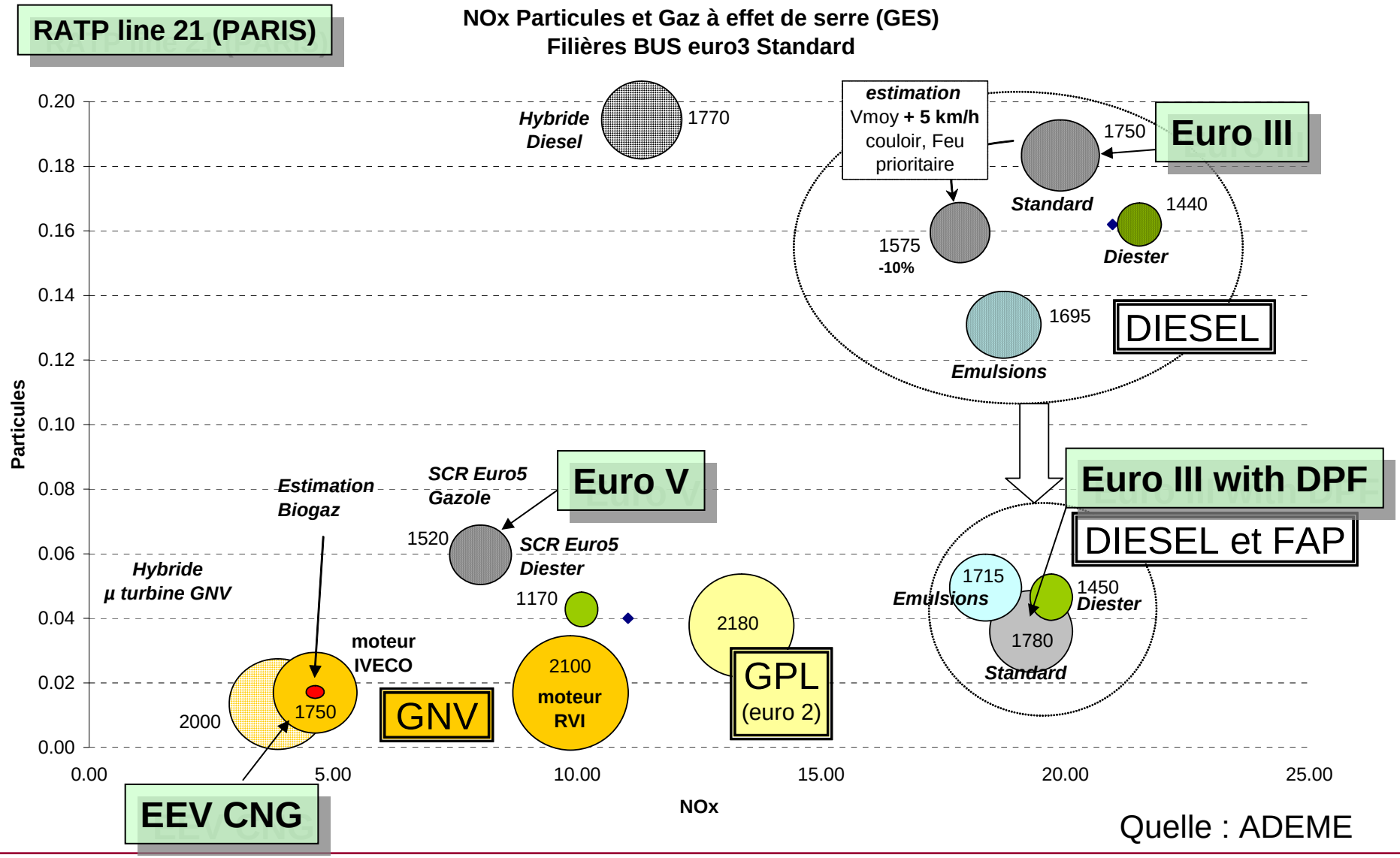
- SCR
  - Significant reduction of fuel consumption
  - Same / extended drain intervals …150’000km
  - Emission reductions effective under all ambient conditions
  - Reduced NO2-emission
- SCRT
  - as SCR (Consumtion, maintenance, emission reduction)
  - PM reduction as expected (gravimetric >90%, number >98%)
  - No increase in NO2-emission in comparison to engines w/o aftertreatment
  - DPF maintenance >300’000km with lowSAP lubricants

NO_2

- Typically in diesel exhaust (w/o any aftertreatment): 90% NO and about 10% NO_2
- In presence of oxidation catalyst NO_2 portion is significantly increased, oxidation catalysts are needed for PM-Kat and CRT-DPF systems
- Downstream SCR system reduces NO_2 to values similar or lower as w/o any aftertreatment system

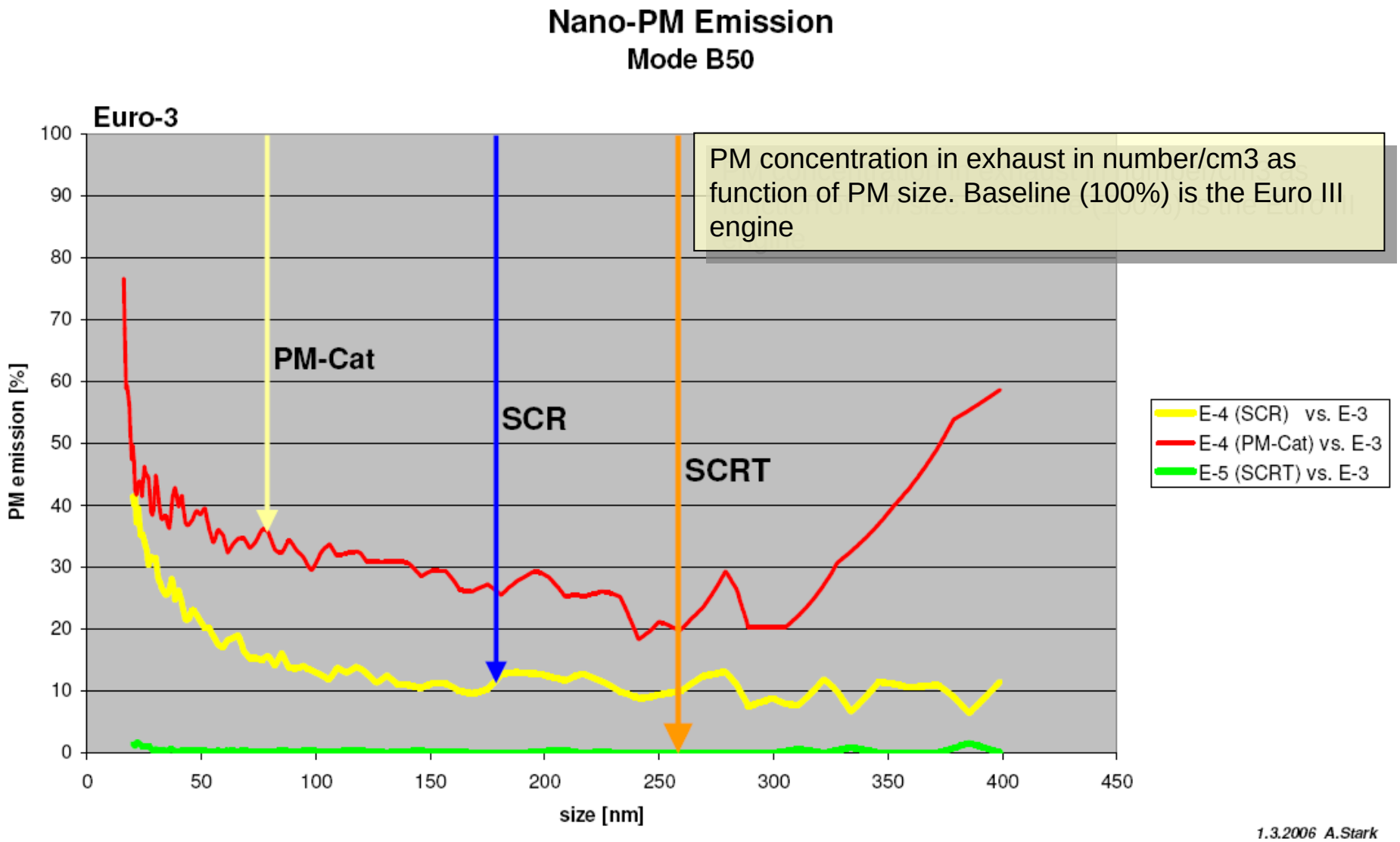
- CRT-SCR is the optimal technology combination for
  - Low PM
  - Low NOx and low NO_2
  - Low fuel consumption

Emission Citybus Euro III…V

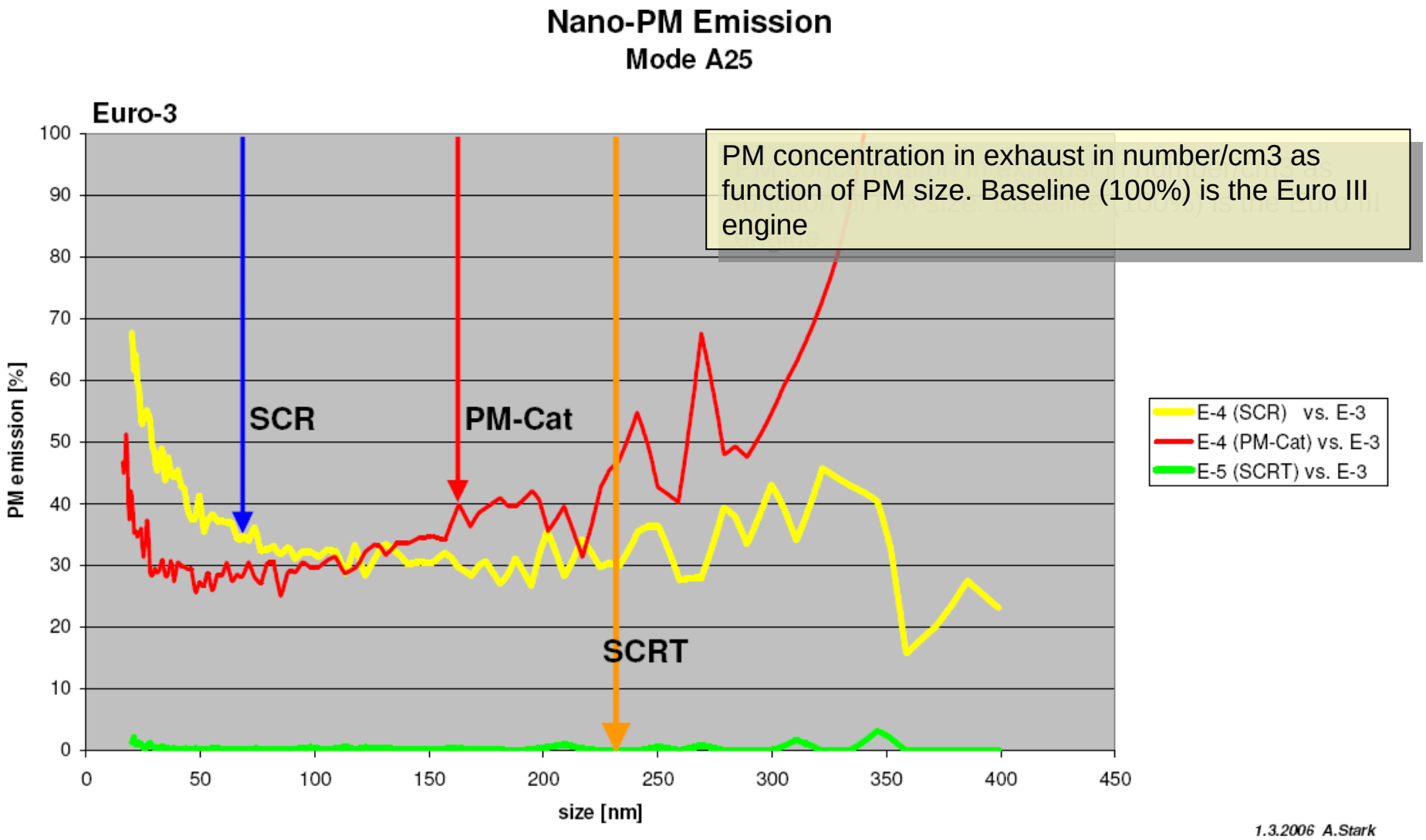


Quelle : ADEME

Nano-PM comparison (1)



Nano-PM Vergleich (2)



Euro VI

- Definition expected in 2007/2008
- Implementation ~2011, early introduction expected as result of fiscal incentives (probably 2009 onwards)
- **Closed DPF will represent the standard solution**
- NOx- limit values still unclear, different scenarios under evaluation (costs, effectiveness, technical solution)

- Integral approach should be chosen, taking into account air quality, fuel (energy) consumption and CO_2 as well as costs to the society

EU limit scenarios

Emission limit scenarios under investigation

	NOx	PM
scenario	g/kWh	g/kWh
1	2.0	0.03
2	1.0	0.015
3	0.5	0.015
4	0.4	0.025
5	0.3	0.02
6	0.2	0.02

Discussion

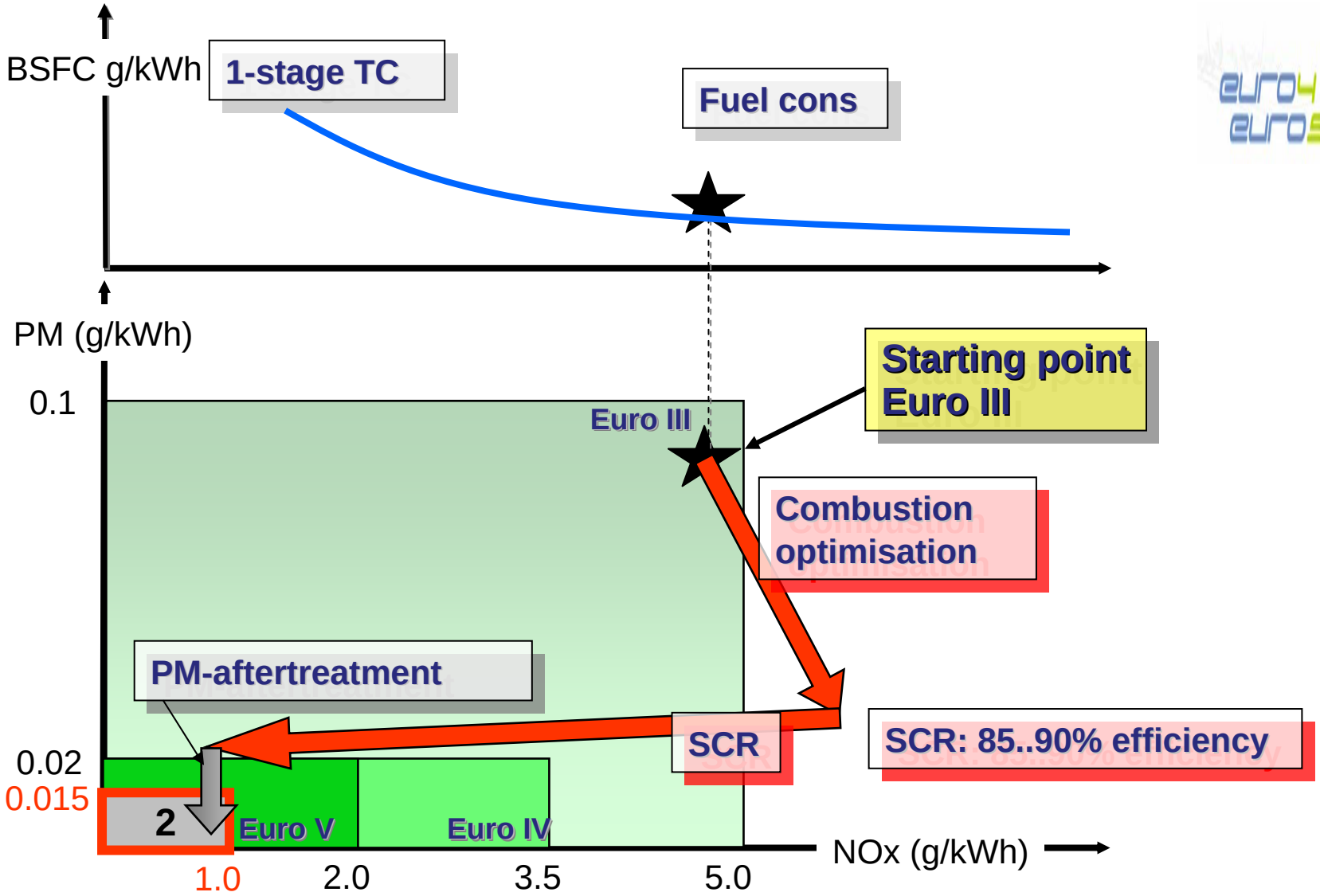
Szenario 2
NOx = 1.0 g/kWh
PM = 0.015 g/ kWh

50% of Euro V

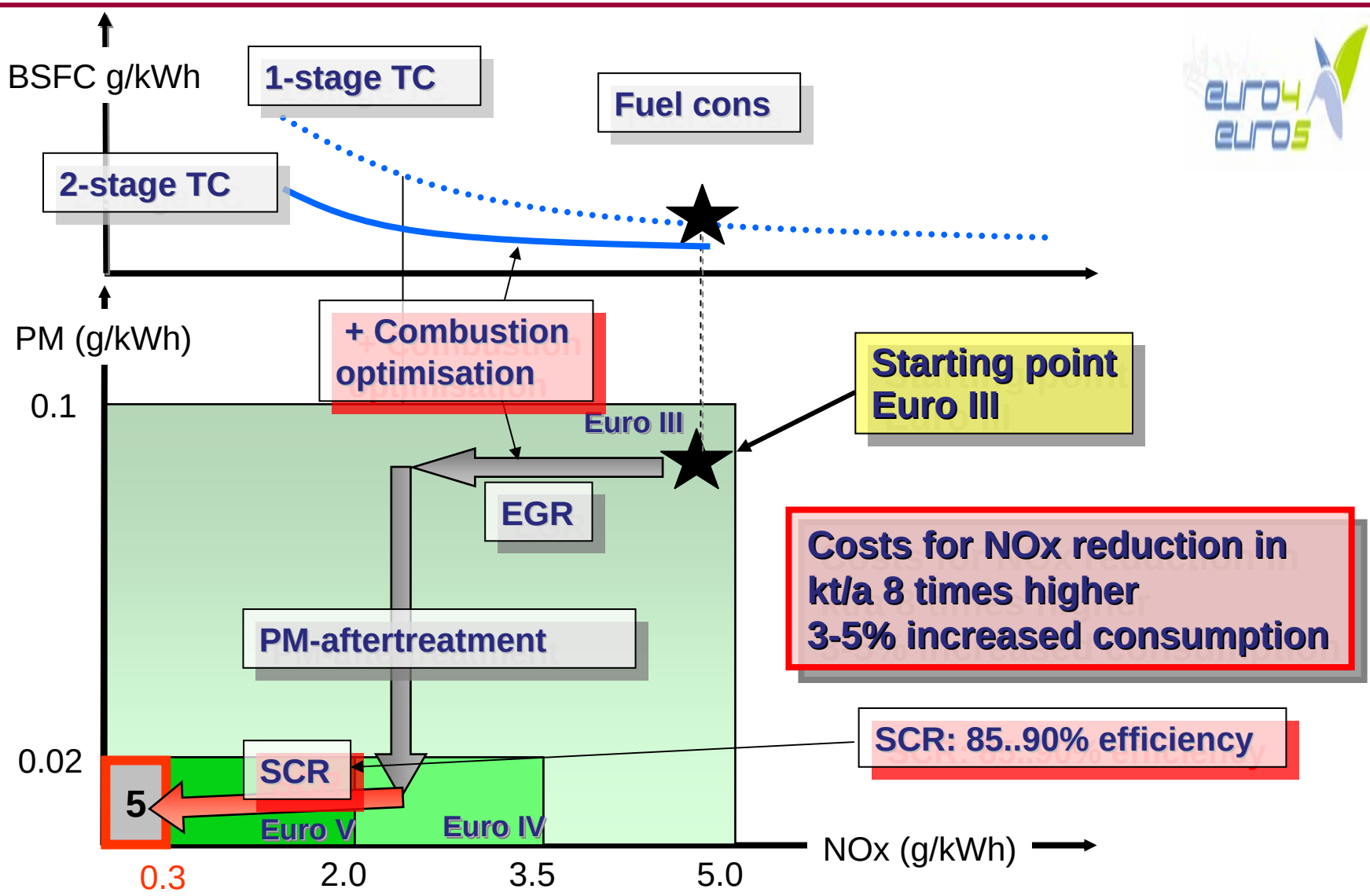
Szenario 5
NOx = 0.3 g/kWh
PM = 0.02 g/ kWh

similar as US 2010

Euro VI – scenario 2 Strategies



Euro VI – scenario 5 Strategies



DPF retrofitting

- Germany is most advanced in specifying labels for different emission levels and type approval and classification of retrofit systems
- The labelling will be according to the Euro – classes
- DPF retrofitting will be done by system suppliers in agreement with OEM's
- Technical Solution:
  - Euro III → Euro IV/V with closed DPF's, risk: no active regeneration
  - Euro II → Euro III with closed DPF's or PM-Kat, risk: no active regeneration, plugging (high oil consumption)
  - Euro I and older engines should not be retrofitted with DPF's.

DPF retrofitting, open points

- Noise emissions with retrofit systems
- Available space for installation
- No active regeneration, operating conditions must be considered first (min temperatures)
- Oil consumption and type of lubricant
  - Lubricant with low ash content is preferred (E7)
  - High oil consumption will plug the DPF in short time
- Fuel quality
  - To use only sulphur-free diesel fuel, as sulphur does reduce the effectiveness of oxidation catalysts and therefore influences the continuous regeneration

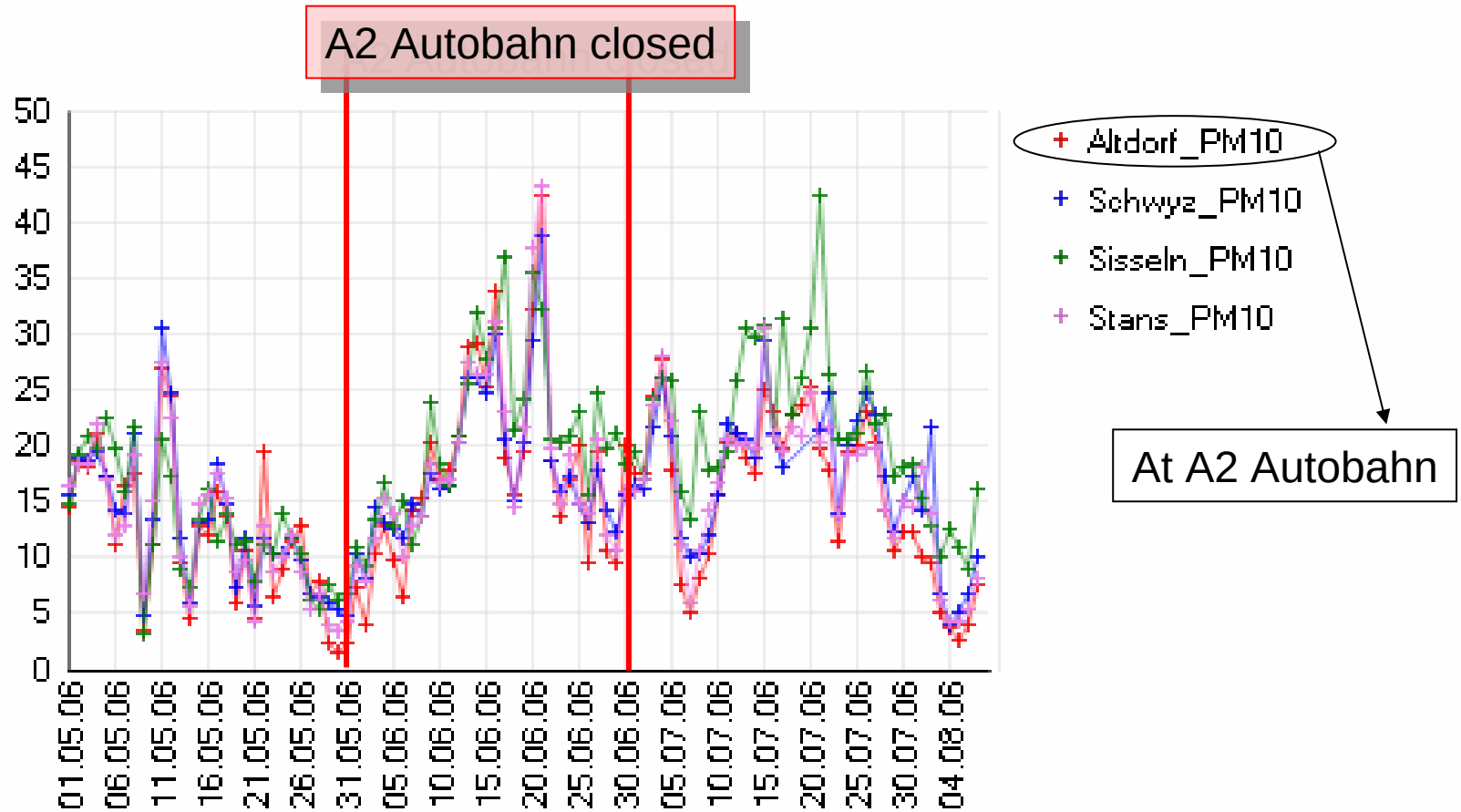
Summary

- Euro IV and V HD engines emit 80% less PM than Euro III engines (gravimetric) and significantly less nano-PM
- It is expected, that all Euro VI engines will be equipped with closed DPF's
- An integrated approach should be envisaged, taking into account CO_2, energy, PM, NOx and NO_2

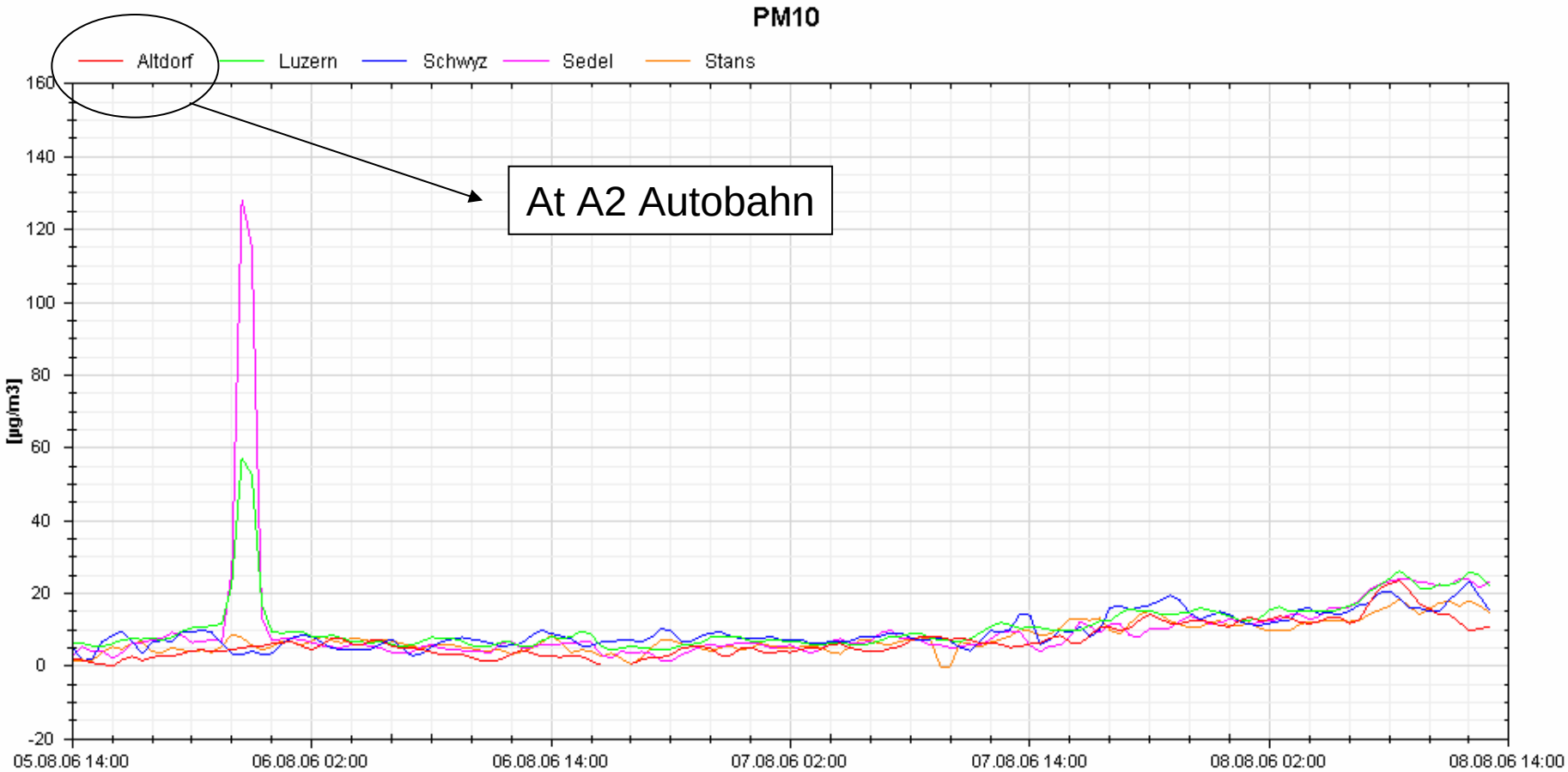
- As all Euro 5 diesel passenger cars and Euro VI trucks will have DPF's, the scientific or non-scientific or political or what-so-ever discussion must or will come to an end !!!
- When it comes to DPF applications, only measured values are of importance, words and names can be misleading !!!

however

PM10 A2 with and w/o traffic



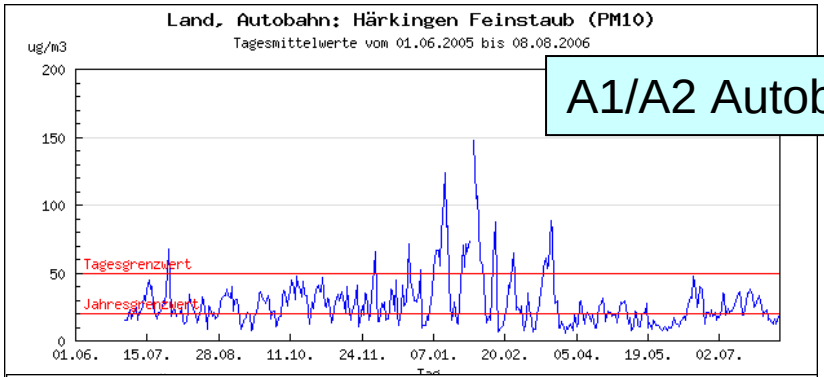
Mean hourly PM central Switzerland

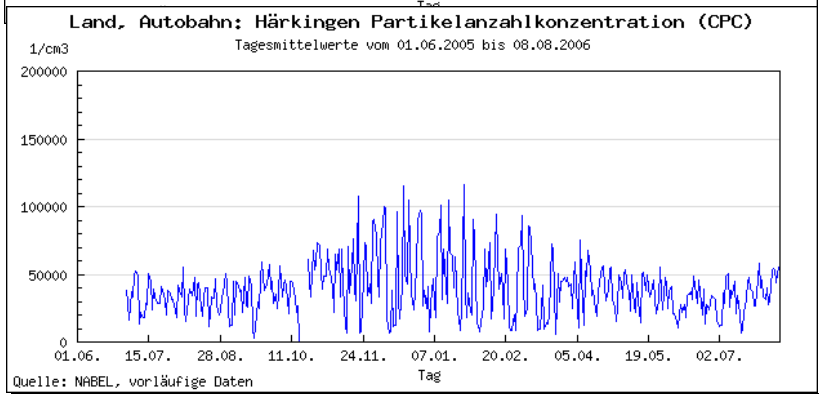


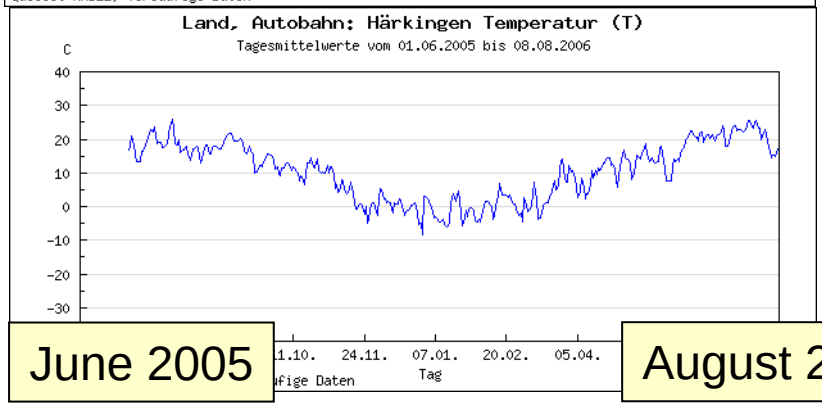
Daily mean PM Härkingen and Bern

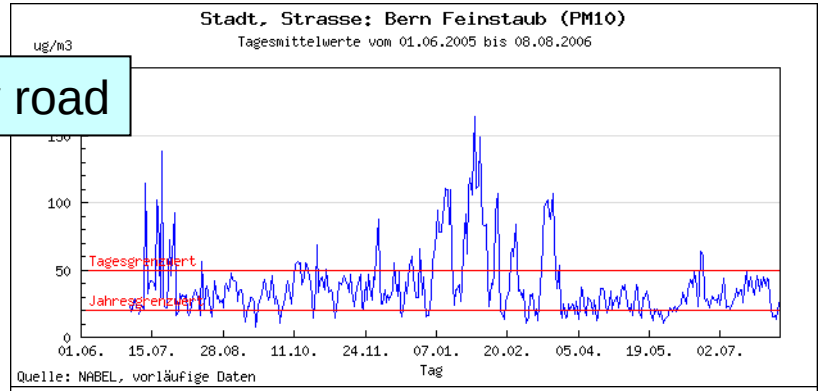
A1/A2 Autobahn

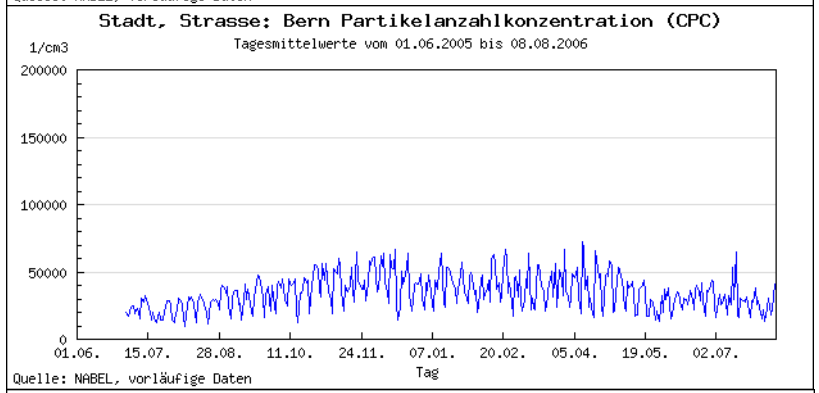
City road

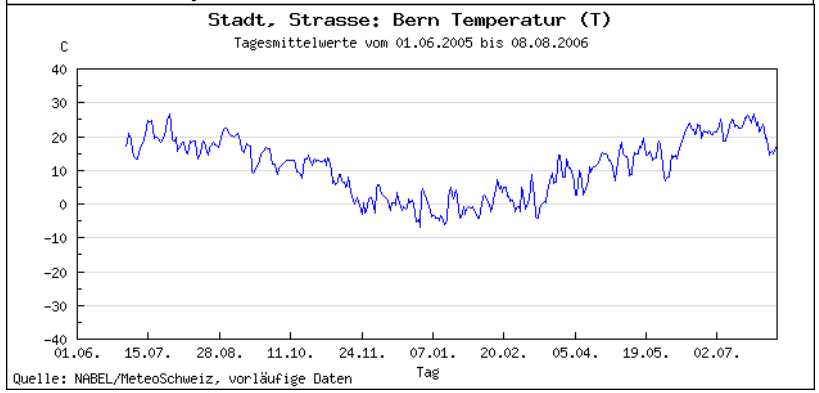








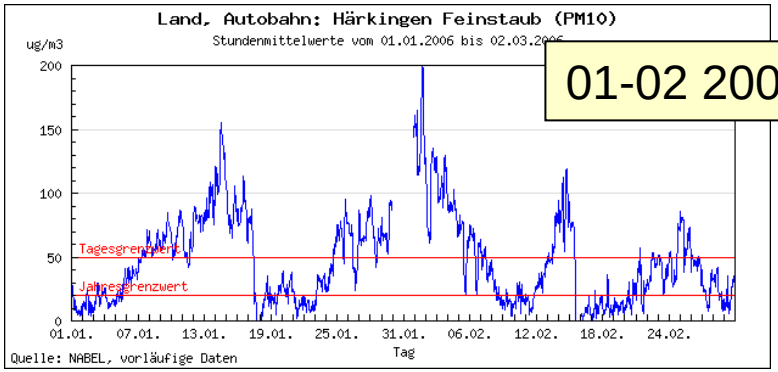




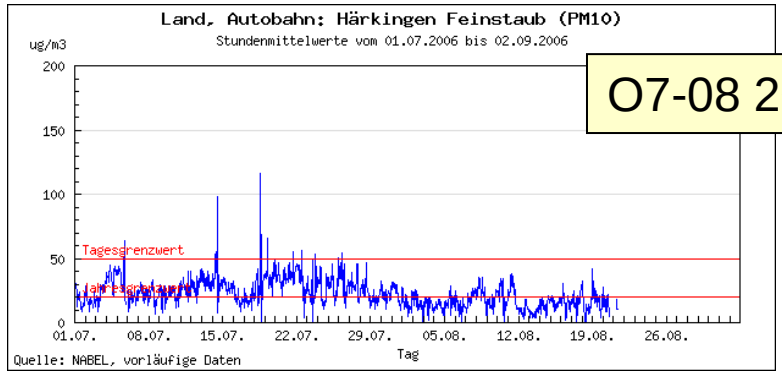
June 2005

August 2006

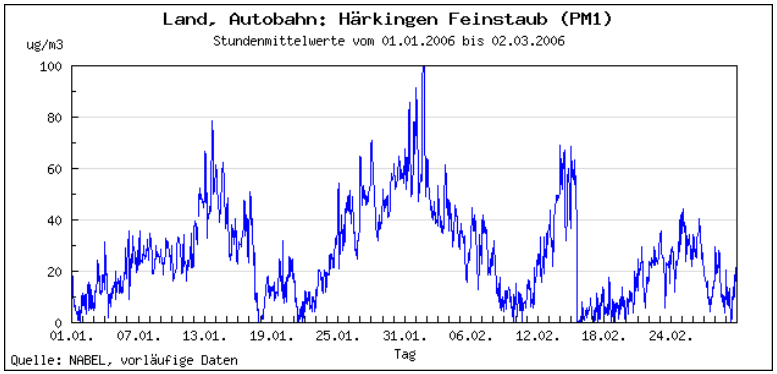
Hourly mean PM A1/A2 Autobahn Härk.

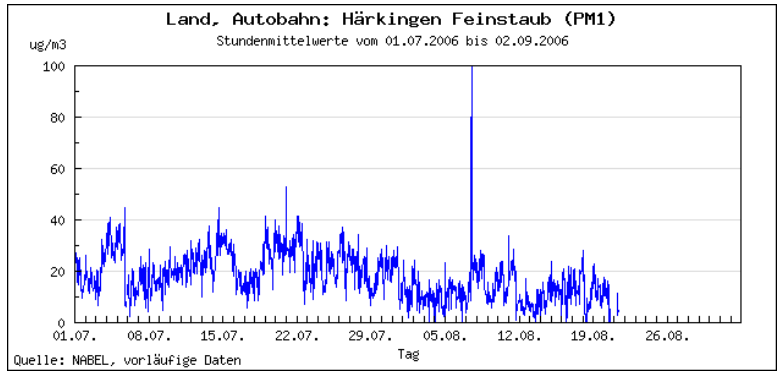


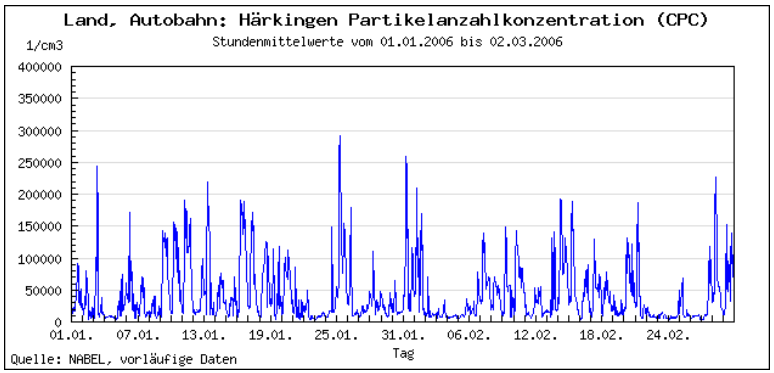
01-02 2006

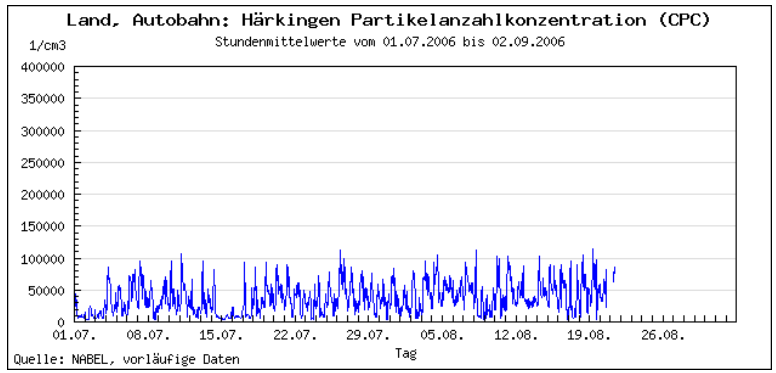


O7-08 2006

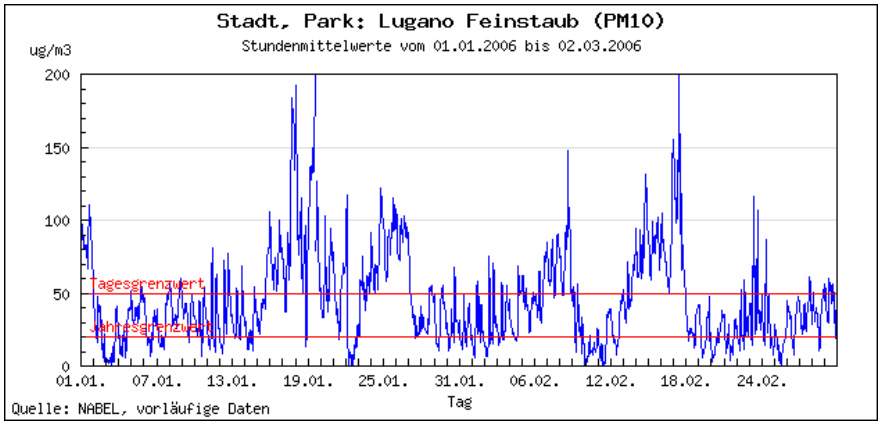


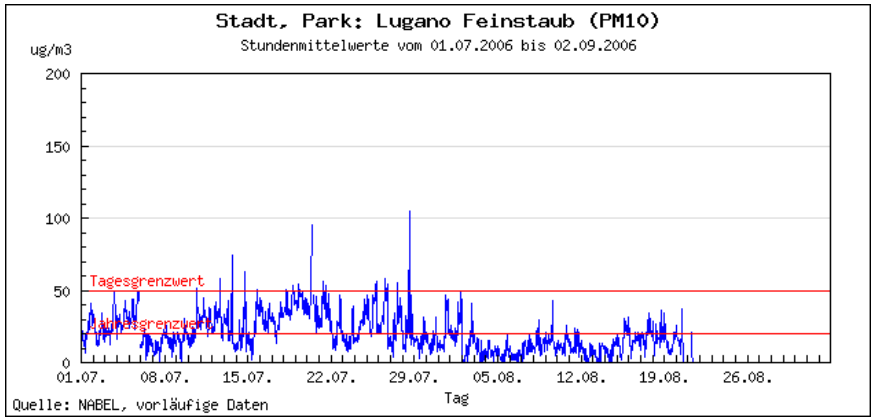


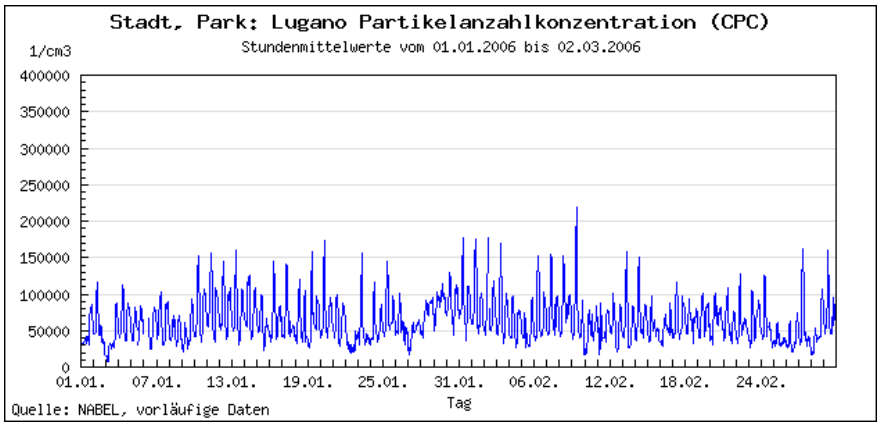


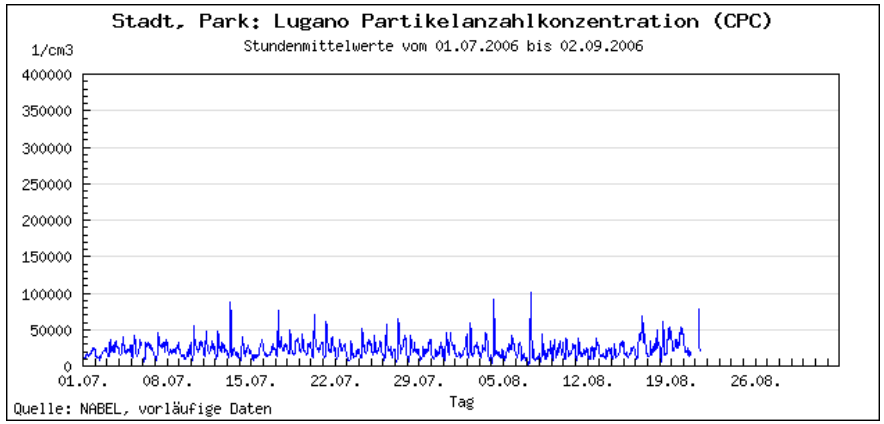


Hourly mean PM Lugano city-park









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